CHAPTER 1

Conceptual Problems

C1. A room in a house has a floor area of 120 ft^2. Which of the following is most likely the approximate volume of the room?

a. 3 m^3
b. 30 m^3
c. 300 m^3
d. 3 000 m^3

C2. When SI units are plugged into an equation, it is found that the units balance. Which of the following can we expect to be true for this equation?

a. The equation will be dimensionally correct.
b. The equation will be dimensionally correct except sometimes in cases when the right hand side of the equation has more than one term.
c. The equation will not be dimensionally correct.
d. All constants of proportionality will be correct.

C3. How long has it been that scientists have accepted that the nucleus of the atom consists of neutrons and protons? Think of your answers in terms of order of magnitude.

a. about a decade
b. about a century
c. about a thousand years
d. since Aristotle

C4. Consider the sine of any angle between 30° and 40°. If the angle were doubled, what would happen to the sine of the angle?

a. It would double.
b. It would more than double.
c. It would increase but be less than double.
d. In different cases, it could do any of the above.

C5. There are other ways of expressing uncertainty besides significant figures. For example, suppose a quantity is known to have a value between 20.4 and 20.0 and our best estimate of the value is midrange at 20.2. We could write the number as 20.2 +/- 0.2 and say that the number has a 1% uncertainty. We would also say it has 3 significant figures. If we square a number with 1% uncertainty (i.e., 2 parts in about 200) and 3 significant figures, what results?

a. A number with 1% uncertainty and 3 significant figures.
b. A number with 2% uncertainty and 3 significant figures.
c. A number with 2% uncertainty and 2 significant figures.
d. A number with 1% uncertainty and 2 significant figures.

1.1 Standards of Length, Mass, and Time

1. Since 1983 the standard meter has been defined in terms of which of the following?

   a. specific alloy bar housed at Sevres, France
   b. wavelength of light emitted by krypton-86
   c. distance from the Earth's equator to the North Pole
   d. the distance light travels in a certain fraction of a second

2. Since 1967 the standard definition for the second has been based on which of the following?

   a. characteristic frequency of the cesium-133 atom
   b. average solar day
   c. sidereal day
   d. Greenwich Civil Time

3. In mechanics, physicists use three basic quantities to derive additional quantities. Mass is one of the three quantities. What are the other two?

   a. length and force
   b. power and force
   c. length and time
   d. force and time

4. The prefixes which are abbreviated p, n, and G represent which of the following?

   a. 10^{-2}, 10^{-6}, and 10^{15}
   b. 10^{-9}, 10^{6}, and 10^{10}
   c. 10^{-12}, 10^{-9}, and 10^{9}
   d. 10^{-15}, 10^{-6}, and 10^{12}

5. The ratio M/m of the prefixes M and m has what value?

   a. 10^3
   b. 10^6
   c. 10^9
   d. 10^{18}

6. One year is about ________ seconds while one day is exactly ________ seconds.

   a. 3.16×10^7, 86 400
   b. 5.26×10^5, 86 400
   c. 3.16×10^7, 8 640
   d. 1.04×10^6, 36 000

1.2 The Building Blocks of Matter

7. The nuclei of atoms contain:

   a. electrons only.
   b. neutrons only.
   c. protons and electrons.
   d. protons and neutrons.

8. When was the existence of the neutron confirmed?

   a. in ancient times
   b. in 1895
   c. in 1932
   d. in 1969

9. The proton contains which of the following combination of quarks?

   a. two up quarks and one down quark
   b. one up quark and two down quarks
   c. one top quark and two bottom quarks
   d. two top quarks and one bottom quark

1.3 Dimensional Analysis

10. Which formula is dimensionally consistent with an expression yielding a value for velocity? (a is acceleration, x is distance, and t is time)

    a. v/t^2
    b. vx^2
    c. v^2/t
    d. at

11. Which expression is dimensionally consistent with an expression that would yield a value for time^{-1}?(v is velocity, x is distance, and t is time)

    a. v/x
    b. v^2/x
    c. x/t
    d. v^2t

12. If the displacement of an object, x, is related to velocity, v, according to the relation $x = Av$, the constant, A, has the dimension of which of the following?

    a. acceleration
    b. length
    c. time
    d. area

13. The speed of a boat is often given in knots. If a speed of 5 knots were expressed in the SI system of units, the units would be:

    a. m.
    b. s.
    c. m/s.
    d. kg/s.

14. If a is acceleration, v is velocity, x is position, and t is time, then which equation is not dimensionally correct?

    a. $t = x/v$
    b. $a = v^2/x$
    c. $v = a/t$
    d. $t^2 = 2x/a$

15. Suppose an equation relating position, x, to time, t, is given by $x = b\,t^3 + c\,t^4$, where b and c are constants. The dimensions of b and c are respectively:

    a. T^3, T^4.
    b. $1/T^3$, $1/T^4$.
    c. L/T^3, L/T^4.
    d. $L^2 \cdot T^3$, $L^2 \cdot T^4$.

16. Areas always have dimensions ____ while volumes always have dimensions ____.

    a. m^2, m^3
    b. L^2, L^3
    c. Both a and b are correct.
    d. No answer is correct because of the "always".

1.4 Uncertainty in Measurement and Significant Figures

17. Which one of the choices below represents the preferred practice regarding significant figures when adding the following: 12.4 + 11 + 67.37 + 4.201?

    a. 94.971
    b. 94.97
    c. 95.0
    d. 95

18. Which one of the choices below represents the preferred practice regarding significant figures when multiplying the following: $10.5 \times 8.8 \times 3.14$?

    a. 290
    b. 290.136
    c. 290.1
    d. 300

19. Calculate $(0.82 + 0.042) \times (4.4 \times 10^3)$, keeping only significant figures.

    a. 3 800
    b. 3 784
    c. 3 793
    d. 3 520

20. The length and width of a standard sheet of paper is measured, and then the area is found by calculation to be 93.50 in^2. The number of significant figures in the width measurement must be at least:

    a. 1.
    b. 2.
    c. 3.
    d. 4.

21. The number 0.000 17 has how many significant figures?

    a. 2
    b. 3
    c. 5
    d. 6

22. Multiplying a 2 significant figure number by a 3 significant figure number and then dividing the product by a six significant figure number yields a number with how many significant figures?

    a. 5/6
    b. 1
    c. 2
    d. 11

1.5 Conversion of Units

23. On planet Q the standard unit of volume is called the guppy. Space travelers from Earth have determined that one liter = 38.2 guppies. How many guppies are in 150 liters?

    a. 5 730 guppies
    b. 0.255 guppies
    c. 3.93 guppies
    d. 188 guppies

24. On planet Z, the standard unit of length is the foose. Ann the Astronaut is 5.90 feet tall on earth. She lands on planet Z and is measured to be 94 foosi tall. Her partner Rachael is 88 foosi tall. How tall is Rachael on Earth?

    a. 5.2 feet
    b. 5.5 feet
    c. 5.8 feet
    d. 6.3 feet

25. A furlong is a distance of 220 yards. A fortnight is a time period of two weeks. A race horse is running at a speed of 5.00 yards per second. What is his speed in furlongs per fortnight?

    a. 27 500 furlongs/fortnight
    b. 13 700 furlongs/fortnight
    c. 6 220 furlongs/fortnight
    d. 2 750 furlongs/fortnight

26. A cereal box has the dimensions of 0.19 m × 0.28 m × 0.070 m. If there are 3.28 feet per meter, then what is the volume of the box in cubic feet?

    a. 0.13 cubic feet
    b. 0.040 cubic feet
    c. 0.012 cubic feet
    d. 0.003 7 cubic feet

27. The distance to the Andromeda Galaxy is estimated at about 2×10^6 light years. A light year is the distance traveled by light in one year; if the speed of light is 3×10^8 m/s, about how far is it from our galaxy to Andromeda? (1 year = 3.15×10^7 s)

    a. 10×10^{15} m
    b. 1×10^{18} m
    c. 2×10^{22} m
    d. 6×10^{12} m

28. A cement truck can pour 20 cubic yards of cement per hour. Express this in ft^3/min.

    a. 1/3 ft^3/min
    b. 1.0 ft^3/min
    c. 3 ft^3/min
    d. 9 ft^3/min

29. Water flows into a swimming pool at the rate of 8.0 gal/min. The pool is 16 ft wide, 32 ft long and 8.0 ft deep. How long does it take to fill? (1 U.S. gallon = 231 cubic inches)

    a. 32 hours
    b. 64 hours
    c. 48 hours
    d. 24 hours

30. When NASA was communicating with astronauts on the moon, the time from sending on the Earth to receiving on the moon was 1.28 s. Find the distance from Earth to the moon. (The speed of radio waves is 3.00×10^8 m/s.)

    a. 240 000 km
    b. 384 000 km
    c. 480 000 km
    d. 768 000 km

31. The mass of the sun is 2.0×10^{30} kg, and the mass of a hydrogen atom is 1.67×10^{-27} kg. If we assume that the sun is mostly composed of hydrogen, how many atoms are there in the sun?

    a. 1.2×10^{56} atoms
    b. 3.4×10^{56} atoms
    c. 1.2×10^{57} atoms
    d. 2.4×10^{57} atoms

32. The information on a one-gallon paint can is that the coverage, when properly applied, is 450 ft^2. One gallon is 231 in^3. What is the average thickness of the paint in such an application?

    a. 0.003 6 in
    b. 0.009 0 in
    c. 0.043 in
    d. 0.051 in

1.6 Estimates and Order-of-Magnitude Calculations

33. Assume everyone in the United States consumes one soft drink in an aluminum can every two days. If there are 270 million Americans, how many tons of aluminum need to be recycled each year if each can weighs 1/16 pound and one ton = 2000 pounds?

    a. 750 000 tons
    b. 1.5 million tons
    c. 1.75 million tons
    d. 3 million tons

34. A physics class in a large lecture hall has 150 students. The total mass of the students is about _______ kg.

    a. 10^2
    b. 10^3
    c. 10^4
    d. 10^5

35. An apartment has 1100 ft^2 of floor space. What is the approximate volume of the apartment?

    a. 10^3 ft^3
    b. 10^4 ft^3
    c. 10^5 ft^3
    d. 10^6 ft^3

1.7 Coordinate Systems

36. Which point is nearest the *x*-axis?

    a. (–3, 4)
    b. (4, 5)
    c. (–5, 3)
    d. (5, –2)

37. Each edge of a cube has a length of 25.4 cm. What is the length of a diagonal of the cube going through the center of the cube?

    a. 25.4 in
    b. 17.3 in
    c. 14.4 in
    d. 10.0 in

38. If point A is located at coordinates (5, 3) and point B is located at coordinates (-3, 9), what is the distance from A to B if the units of the coordinated system are meters?

    a. 14 m
    b. 10 m
    c. 8 m
    d. 17 m

1.8 Trigonometry

39. A high fountain of water is in the center of a circular pool of water. You walk the circumference of the pool and measure it to be 150 meters. You then stand at the edge of the pool and use a protractor to gauge the angle of elevation of the top of the fountain. It is 55°. How high is the fountain?

    a. 17 m
    b. 23 m
    c. 29 m
    d. 34 m

40. A right triangle has sides 5.0 m, 12 m, and 13 m. The smallest angle of this triangle is nearest:

    a. 21°.
    b. 23°.
    c. 43°.
    d. Not attainable since this is not a right triangle.

41. If $\varphi = 90^\circ - \theta$, what is the value of $\sin^2 \varphi + \sin^2 \theta$?

    a. 0
    b. 1
    c. –1
    d. The answer depends on θ.

42. A triangle has sides of length 7.0 cm and 25 cm. If the triangle is a right triangle, which of the following could be the length of the third side?

a. 18 cm
b. 24 cm
c. 27 cm
d. 32 cm

43. A train slowly climbs a 500-m mountain track which is at an angle of 10.0° with respect to the horizontal. How much altitude does it gain?

a. 86.8 m
b. 88.2 m
c. 341 m
d. 492 m

Additional Problems

44. Note the expression: $y = x^2$. Which statement is most consistent with this expression?

a. if y doubles, then x quadruples
b. y is greater than x
c. if x doubles, then y doubles
d. if x doubles, then y quadruples

45. Note the expression: $y = A/x^3$. Which statement is most consistent with this expression?

a. y is less than A
b. if x is halved, y is multiplied by eight
c. if x is doubled, y is multiplied by a factor of 8
d. y is greater than x

46. For which of the values below is $x > x^3$?

a. $x = -1.5$
b. $x = 0$
c. $x = 1.0$
d. $x = 1.5$

47. Modern electroplaters can cover a surface area of 60.0 m^2 with one troy ounce of gold (volume = 1.611 cm^3). What is the thickness of the electroplated gold?

a. 2.68×10^{-8} m
b. 1.34×10^{-9} m
c. 1.67×10^{-6} m
d. 3.33×10^{-7} m

48. The basic function of an automobile's carburetor is to atomize the gasoline and mix it with air to promote rapid combustion. Assume that 30 cm^3 of gasoline is atomized into *N* spherical droplets. Each droplet has a radius of 2.0×10^{-5} m. Find the total surface area of these *N* spherical droplets.

a. 2 100 cm^2
b. 15 000 cm^2
c. 18 000 cm^2
d. 45 000 cm^2

49. A circle has an area of 2.0 m^2. A second circle has double the radius of the first. The area of the second circle is _____ times that of the first.

a. 0.50
b. 2.0
c. 4.0
d. 8.0

50. Doubling the radius of a sphere results in increasing its volume by a factor of

a. 2
b. 4
c. 8
d. 8 π

CHAPTER 1 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	B	2	24.	B	2
C2.	A	1	25.	A	2
C3.	B	1	26.	A	1
C4.	C	2	27.	C	2
C5.	B	2	28.	D	1
1.	D	1	29.	B	2
2.	A	1	30.	B	2
3.	C	1	31.	C	2
4.	C	1	32.	A	3
5.	C	2	33.	B	2
6.	A	2	34.	C	2
7.	D	1	35.	B	2
8.	C	1	36.	D	2
9.	A	2	37.	B	3
10.	D	1	38.	B	2
11.	A	1	39.	D	3
12.	C	1	40.	B	2
13.	C	1	41.	B	2
14.	C	1	42.	B	2
15.	C	2	43.	A	2
16.	B	1	44.	D	1
17.	D	1	45.	B	1
18.	A	1	46.	A	1
19.	A	1	47.	A	2
20.	D	1	48.	D	3
21.	A	2	49.	C	2
22.	C	3	50.	C	2
23.	A	1			

CHAPTER 2

Conceptual Problems

C1. A ball of relatively low density is thrown upwards. Because of air resistance the acceleration while traveling upwards is –10.8 m/s^2. On its trip downward the resistance is in the opposite direction and the resulting acceleration is –8.8 m/s^2. When the ball reaches the level from which it was thrown, how does its speed compare to that with which it was thrown?

a. It is greater than the original speed upward.
b. It is the same as the original speed upward.
c. It is less than the original speed upward.
d. Without knowing the original speed, this problem cannot be solved.

C2. Starting from rest, a car accelerates down a straight road with constant acceleration a_1 for a time t_1, then the acceleration is changed to a different constant value a_2 for an additional time t_2. The total elapsed time is $t_1 + t_2$. Can the equations of kinematics be used to find the total distance traveled?

a. No, because this is not a case of constant acceleration.
b. Yes, use $(a_1 + a_2)/2$ as the average acceleration and the total time in the calculation.
c. Yes, use $a_1 + a_2$ as the acceleration and the average time $(t_1 + t_2)/2$ in the calculation.
d. Yes, break the problem up into 2 problems, one with the conditions for the first time interval and the other with the conditions for the second time interval, noting that for the second time interval the initial velocity is that from the end of the first time interval. When done, add the distances from each of the time intervals.

C3. Starting from rest, a car accelerates down a straight road with constant acceleration a for a time t, then the direction of the acceleration is reversed, i.e., it is $-a$, and the car comes to a stop in an additional time t, the time for the whole trip being $2t$. At what time, or times, is the average velocity of the car for the trip equal to its instantaneous velocity during the trip?

a. There is no such time.
b. It is at the halfway point at t.
c. This occurs at 2 times, 0.5 t and 1.5 t.
d. This occurs at 2 times, 0.707 t and 1.293 t.

C4. A ball rolls down an incline, starting from rest. If the total time it takes to reach the end of the incline is T, how much time has elapsed when it is halfway down the incline?

a. 0.5 T
b. < 0.5 T
c. > 0.5 T
d. More information is needed.

C5. In which of the following cases is the displacement's magnitude half the distance traveled?

a. 10 steps east followed by 3 steps west
b. 22 steps east followed by 11 steps west
c. 5 steps east followed by 10 steps west
d. 15 steps east followed by 5 steps west

2.1 Displacement

1. A change in a physical quantity w having initial value w_i and final value w_f is given by which of the following?

a. $w_i - w_f$
b. $w_f - w_i$
c. $(w_f + w_i)/2$
d. none of the above

2. Displacement is which of the following types of quantities?

a. vector
b. scalar
c. magnitude
d. dimensional

3. A truck moves 70 m east, then moves 120 m west, and finally moves east again a distance of 90 m. If east is chosen as the positive direction, what is the truck's resultant displacement?

a. 40 m
b. – 40 m
c. 280 m
d. –280 m

4. Which of the following is not a vector quantity?

a. temperature
b. velocity
c. acceleration
d. displacement

2.2 Velocity

5. In one-dimensional motion, the average speed of an object that moves from one place to another and then back to its original place has which of the following properties?

a. It is positive.
b. It is negative.
c. It is zero.
d. It can be positive, negative, or zero.

6. In one-dimensional motion where the direction is indicated by a plus or minus sign, the average velocity of an object has which of the following properties?

   a. It is positive.
   b. It is negative.
   c. It is zero.
   d. It can be positive, negative, or zero.

7. An object moves 20 m east in 30 s and then returns to its starting point taking an additional 50 s. If west is chosen as the positive direction, what is the sign associated with the average velocity of the object?

   a. +
   b. –
   c. 0 (no sign)
   d. any of the above

8. An object moves 20 m east in 30 s and then returns to its starting point taking an additional 50 s. If west is chosen as the positive direction, what is the average speed of the object?

   a. 0.50 m/s
   b. –0.50 m/s
   c. 0.73 m/s
   d. 0 m/s

9. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the average velocity?

   a. 1.7 m/s
   b. 2.5 m/s
   c. 3.4 m/s
   d. zero

10. A cheetah can run at approximately 100 km/hr and a gazelle at 80.0 km/hr. If both animals are running at full speed, with the gazelle 70.0 m ahead, how long before the cheetah catches its prey?

    a. 12.6 s
    b. 25.2 s
    c. 6.30 s
    d. 10.7 s

11. A cheetah can maintain its maximum speed of 100 km/hr for 30.0 seconds. What minimum distance must a gazelle running 80.0 km/hr be ahead of the cheetah to escape?

    a. 100 m
    b. 167 m
    c. 70.0 m
    d. 83.0 m

12. Jeff throws a ball straight up. For which situation is the vertical velocity zero?

    a. on the way up
    b. at the top
    c. on the way back down
    d. none of the above

13. A railroad train travels forward along a straight track at 80.0 m/s for 1 000 m and then travels at 50.0 m/s for the next 1 000 m. What is the average velocity?

    a. 65.0 m/s
    b. 61.5 m/s
    c. 63.7 m/s
    d. 70.0 m/s

14. The distance of the Earth from the sun is 93 000 000 miles. If there are 3.15×10^7 s in one year, find the speed of the Earth in its orbit about the sun.

    a. 9.28 miles/s
    b. 18.6 miles/s
    c. 27.9 miles/s
    d. 37.2 miles/s

15. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average velocity is:

    a. 19.6 m/s.
    b. 9.80 m/s.
    c. 4.90 m/s.
    d. not given.

16. Changing the positive direction in a reference frame to the opposite direction does not change the sign of which of the following quantities?

    a. velocity
    b. average velocity
    c. speed
    d. displacement

17. On a position versus time graph, the slope of the straight line joining two points on the plotted curve that are separated in time by the interval Δt, is which of the following quantities?

    a. average steepness
    b. average velocity
    c. instantaneous velocity
    d. average acceleration

2.3 Acceleration

18. A European sports car dealer claims that his car will accelerate at a constant rate from rest to 100 km/hr in 8.00 s. If so, what is the acceleration? *(Hint:* First convert speed to m/s.)

    a. 3.47 m/s^2
    b. 6.82 m/s^2
    c. 11.4 m/s^2
    d. 17.4 m/s^2

19. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What is the speed after the first 5.00 s of acceleration? (*Hint:* First convert the speed to m/s.)

    a. 34.7 m/s
    b. 44.4 m/s
    c. 28.7 m/s
    d. 17.4 m/s

20. An x vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at $t = 5$ s the velocity of the ball is zero. We can be positive that at $t = 5$ s,

    a. the slope of the curve is non-zero.
    b. the ball has stopped.
    c. the acceleration is constant.
    d. the curve is at $x = 0$, $t = 0$.

21. A v vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at $t = 5$ s the acceleration of the ball is zero. We know that at $t = 5$ s,

    a. the slope of the curve is non-zero.
    b. the velocity of the ball is not changing.
    c. the curve is not crossing the time axis.
    d. the curve is at $v = 0$, $t = 0$.

22. The value of an object's acceleration may be characterized in equivalent words by which of the following?

    a. displacement
    b. rate of change of displacement
    c. velocity
    d. rate of change of velocity

23. A 50-g ball traveling at 25.0 m/s is bounced off a brick wall and rebounds at 22.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 3.50 ms, what is the average acceleration of the ball during this time interval?

    a. 13 400 m/s^2
    b. 6 720 m/s^2
    c. 857 m/s^2
    d. 20 m/s^2

24. An object is dropped from a height. Once it is moving, which of the following statements is true, at least at one point?

    a. Its velocity is more than its acceleration.
    b. Its velocity is less than its acceleration.
    c. Its velocity is the same as its acceleration.
    d. Its velocity is never equal to its acceleration.

25. The slope of the acceleration vs. time curve represents:

    a. the velocity.
    b. the rate of change of acceleration.
    c. the rate of change of displacement.
    d. the area under the position vs. time curve.

2.4 Motion Diagrams

26. A strobe photograph shows equally spaced images of a car moving along a straight road. If the time intervals between images is constant, which of the following cannot be positive?

    a. the speed of the car
    b. the average velocity of the car
    c. the acceleration of the car
    d. the direction of motion of the car

27. A strobe photograph of a car moving along a straight road shows the interval between each successive image to be diminishing. If the direction of motion of the car is taken as positive, which of the following are negative?

    a. the speed of the car
    b. the average velocity of the car
    c. the average acceleration of the car
    d. all of the above

2.5 One-Dimensional Motion with Constant Acceleration

28. A ball is pushed with an initial velocity of 4.0 m/s. The ball rolls down a hill with a constant acceleration of 1.6 m/s^2. The ball reaches the bottom of the hill in 8.0 s. What is the ball's velocity at the bottom of the hill?

    a. 10 m/s
    b. 12 m/s
    c. 16 m/s
    d. 17 m/s

29. A cart is given an initial velocity of 5.0 m/s and experiences a constant acceleration of 2.0 m/s^2. What is the magnitude of the cart's displacement during the first 6.0 s of its motion?

    a. 10 m
    b. 55 m
    c. 66 m
    d. 80 m

30. A vehicle designed to operate on a drag strip accelerates from zero to 30 m/s while undergoing a straight line path displacement of 45 m. What is the vehicle's acceleration if its value may be assumed to be constant?

    a. 2.0 m/s^2
    b. 5.0 m/s^2
    c. 10 m/s^2
    d. 15 m/s^2

31. When a drag strip vehicle reaches a velocity of 60 m/s, it begins a negative acceleration by releasing a drag chute and applying its brakes. While reducing its velocity back to zero, its acceleration along a straight line path is a constant –7.5 m/s^2. What displacement does it undergo during this deceleration period?

    a. 40 m
    b. 80 m
    c. 160 m
    d. 240 m

32. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity after 11 s?

    a. 1.8 m/s
    b. 3.2 m/s
    c. 5.1 m/s
    d. zero

33. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is its acceleration?

    a. 0.21 m/s^2
    b. 0.46 m/s^2
    c. 0.64 m/s^2
    d. 0.78 m/s^2

34. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What distance will the sports car travel during the 8 s acceleration period? (*Hint:* First convert speed to m/s.)

    a. 55.5 m
    b. 77.7 m
    c. 111 m
    d. 222 m

35. Norma releases a bowling ball from rest; it rolls down a ramp with constant acceleration. After half a second it has traveled 0.75 m. How far has it traveled after two seconds?

    a. 1.2 m
    b. 4.7 m
    c. 9.0 m
    d. 12 m

36. An automobile driver puts on the brakes and decelerates from 30.0 m/s to zero in 10.0 s. What distance does the car travel?

    a. 150 m
    b. 196 m
    c. 336 m
    d. 392 m

37. A drag racer starts from rest and accelerates at 10 m/s^2 for the entire distance of 400 m (1/4 mile). What is the velocity of the race car at the end of the run?

    a. 45 m/s
    b. 89 m/s
    c. 130 m/s
    d. 180 m/s

38. A Cessna aircraft has a lift-off speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a take-off run of 240 m?

    a. 2.31 m/s^2
    b. 3.63 m/s^2
    c. 4.63 m/s^2
    d. 5.55 m/s^2

39. If the displacement of an object is given in SI units by $\Delta x = -3\, t + 4\, t^2$, at $t = 2$ s its velocity and acceleration are, respectively:

    a. positive, positive.
    b. positive, negative.
    c. negative, negative.
    d. negative, positive.

40. In the case of constant acceleration, the average velocity equals the instantaneous velocity:

    a. at the beginning of the time interval.
    b. at the end of the time interval.
    c. half-way through the time interval.
    d. three-fourths of the way through the time interval.

2.6 Freely-Falling Objects

41. A rock is thrown straight down with an initial velocity of 14.5 m/s from a cliff. What is the rock's displacement after 2.0 s? (Acceleration due to gravity is 9.80 m/s^2.)

    a. 28 m
    b. 49 m
    c. 55 m
    d. 64 m

42. A rock is thrown straight up with an initial velocity of 24.5 m/s.What maximum height will the rock reach before starting to fall downward? (Take acceleration due to gravity as 9.80 m/s^2.)

    a. 9.80 m
    b. 19.6 m
    c. 24.5 m
    d. 30.6 m

43. A rock is thrown straight up with an initial velocity of 19.6 m/s. What time interval elapses between the rock's being thrown and its return to the original launch point? (Acceleration due to gravity is 9.80 m/s^2.)

    a. 4.00 s
    b. 5.00 s
    c. 8.00 s
    d. 10.0 s

44. Two objects of different mass are released simultaneously from the top of a 20-m tower and fall to the ground. If air resistance is negligible, which statement best applies?

    a. The greater mass hits the ground first.
    b. Both objects hit the ground together.
    c. The smaller mass hits the ground first.
    d. No conclusion can be made with the information given.

45. A baseball catcher throws a ball vertically upward and catches it in the same spot when it returns to his mitt. At what point in the ball's path does it experience zero velocity and non-zero acceleration at the same time?

    a. midway on the way up
    b. at the top of its trajectory
    c. the instant it leaves the catcher's hand
    d. the instant before it arrives in the catcher's mitt

46. A baseball is released at rest from the top of the Washington Monument. It hits the ground after falling for 6.0 s. What was the height from which the ball was dropped? (g = 9.8 m/s^2 and assume air resistance is negligible)

    a. 1.5 x 10^2 m
    b. 1.8 x 10^2 m
    c. 1.1 x 10^2 m
    d. 2.1 x 10^2 m

47. A rock, released at rest from the top of a tower, hits the ground after 1.5 s. What is the speed of the rock as it hits the ground? (g = 9.8 m/s^2 and air resistance is negligible)

    a. 15 m/s
    b. 20 m/s
    c. 31 m/s
    d. 39 m/s

48. Omar throws a rock down with speed 12 m/s from the top of a tower. The rock hits the ground after 2.0 s. What is the height of the tower? (air resistance is negligible)

    a. 20 m
    b. 24 m
    c. 44 m
    d. 63 m

49. Gwen releases a rock at rest from the top of a 40-m tower. If g = 9.8 m/s^2 and air resistance is negligible, what is the speed of the rock as it hits the ground?

    a. 28 m/s
    b. 30 m/s
    c. 56 m/s
    d. 784 m/s

50. John throws a rock down with speed 14 m/s from the top of a 30-m tower. If $g = 9.8\ m/s^2$ and air resistance is negligible, what is the rock's speed just as it hits the ground?

    a. 12 m/s
    b. 28 m/s
    c. 350 m/s
    d. 784 m/s

51. Human reaction time is usually about 0.20 s. If your lab partner holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch it? The nearest value is:

    a. 4.0 cm.
    b. 9.8 cm.
    c. 16 cm.
    d. 20 cm.

52. At the top of a cliff 100 m high, Raoul throws a rock upward with velocity 15.0 m/s. How much later should he drop a second rock from rest so both rocks arrive simultaneously at the bottom of the cliff?

    a. 5.05 s
    b. 3.76 s
    c. 2.67 s
    d. 1.78 s

53. Maria throws two stones from the top edge of a building with a speed of 20 m/s. She throws one straight down and the other straight up. The first one hits the street in a time t_1. How much later is it before the second stone hits?

    a. 5 s
    b. 4 s
    c. 3 s
    d. Not enough information is given to work this problem.

54. Mt. Everest is more than 8 000 m high. How fast would an object be moving if it could free fall to sea level after being released from an 8000-m elevation? (Ignore air resistance.)

    a. 396 m/s
    b. 120 m/s
    c. 1 200 m/s
    d. 12 000 m/s

55. A basketball player can jump 1.6 m off the hardwood floor. With what upward velocity did he leave the floor?

    a. 1.4 m/s
    b. 2.8 m/s
    c. 4.2 m/s
    d. 5.6 m/s

56. A water rocket, launched from the ground, rises vertically with acceleration of 30 m/s^2 for 1.0 s when it runs out of "fuel." Disregarding air resistance, how high will the rocket rise?

    a. 15 m
    b. 31 m
    c. 61 m
    d. 120 m

57. A parachutist jumps out of an airplane and accelerates with gravity to a maximum velocity of 58.8 m/s in 6.00 seconds. She then pulls the parachute cord and after a 4.00-second constant deceleration, descends at 10.0 m/s for 60.0 seconds, reaching the ground. From what height did the parachutist jump?

    a. 914 m
    b. 1 130 m
    c. 1 520 m
    d. 1 750 m

58. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average speed is:

    a. 19.6 m/s.
    b. 9.80 m/s.
    c. 4.90 m/s.
    d. not given.

Chapter 2 - Answers

#	Ans	Difficulty	#	Ans	Difficulty
C1.	C	2	28.	D	2
C2.	D	2	29.	C	2
C3.	C	2	30.	C	2
C4.	C	2	31.	D	2
C5.	D	2	32.	C	2
1.	B	1	33.	B	2
2.	A	1	34.	C	2
3.	A	2	35.	D	2
4.	A	1	36.	A	2
5.	A	2	37.	B	2
6.	D	1	38.	A	2
7.	C	1	39.	A	3
8.	A	2	40.	C	2
9.	B	1	41.	B	2
10.	A	2	42.	D	2
11.	B	3	43.	A	2
12.	B	1	44.	B	2
13.	B	2	45.	B	1
14.	B	2	46.	B	2
15.	D	2	47.	A	2
16.	C	1	48.	C	2
17.	B	1	49.	A	2
18.	A	2	50.	B	2
19.	D	2	51.	D	2
20.	B	1	52.	D	3
21.	B	1	53.	B	3
22.	D	1	54.	A	2
23.	A	2	55.	D	2
24.	D	2	56.	C	3
25.	B	2	57.	A	3
26.	C	2	58.	B	2
27.	C	2			

CHAPTER 3

Conceptual Problems

1. Vectors $\vec{\mathbf{A}}$, $\vec{\mathbf{B}}$, and $\vec{\mathbf{C}}$ have magnitudes 6, 11, and 20. When these vectors are added, what is the least possible magnitude of their resultant?

    a. 25
    b. 15
    c. 2
    d. 3

2. Four vectors all have the same magnitude. Vector 1 is at 30°, Vector 2 is at 135°, vector 3 is at 240°, and Vector 4 is at 315°. Which vector has the greatest magnitude x-component and which vector has the greatest magnitude y-component?

    a. Vector 1, Vector 2
    b. Vector 3, Vector 4
    c. Vector 1, Vector 3
    d. Vector 3, Vector 2

3. Vector 1 is 7 units long and is at 70°. Vector 2 is 5 units long and is at 225°. Vector 3 is 3 units long and is at 150°. Which vector has equal magnitude components?

    a. Vector 1
    b. Vector 2
    c. Vector 3
    d. None of the vectors has equal magnitude components.

4. A particle moves east at constant velocity $\vec{\mathbf{v}}$ for a time interval ΔT. It then moves north at a constant velocity, with the same speed as before, for another time interval ΔT. Finally it moves east again with the original velocity. At the instant an additional time interval ΔT has elapsed, which of the following are true about the average velocity and the average acceleration for the motion described?

    a. The average velocity is $\vec{\mathbf{v}}$ and the average acceleration is zero.
    b. The average velocity is $\vec{\mathbf{v}}$ and the average acceleration is not zero.
    c. The average velocity is not $\vec{\mathbf{v}}$ and the average acceleration is zero.
    d. The average velocity is not $\vec{\mathbf{v}}$ and the average acceleration is not zero.

5. A projectile is fired at an angle of elevation of 60°. Neglecting air resistance, what are possible angles in flight between the acceleration vector and the velocity vector?

    a. 160° and 40°
    b. 20° and 70°
    c. 90° and 60°
    d. none of the above

3.1 Vectors and Their Properties

1. Which type of quantity is characterized by both magnitude and direction?

   a. scalar
   b. vector
   c. trigonometric
   d. algebraic variable

2. Which of the following is an example of a vector quantity?

   a. velocity
   b. temperature
   c. volume
   d. mass

3. When we subtract a velocity vector from another velocity vector, the result is:

   a. another velocity.
   b. an acceleration.
   c. a displacement.
   d. a scalar.

4. When we add a displacement vector to another displacement vector, the result is:

   a. a velocity.
   b. an acceleration.
   c. another displacement.
   d. a scalar.

5. A student adds two vectors with magnitudes of 200 and 40. Which one of the following is the only possible choice for the magnitude of the resultant?

   a. 100
   b. 200
   c. 260
   d. 40

6. Vector $\vec{\mathbf{A}}$ points north and vector $\vec{\mathbf{B}}$ points east. If $\vec{\mathbf{C}} = \vec{\mathbf{B}} - \vec{\mathbf{A}}$, then vector $\vec{\mathbf{C}}$ points:

   a. north of east.
   b. south of east.
   c. north of west.
   d. south of west.

7. The first displacement is 6 m and the second displacement is 3 m. They <u>cannot</u> add together to give a total displacement of:

   a. 2 m.
   b. 3 m.
   c. 6 m.
   d. 9 m.

8. Vector $\vec{\mathbf{A}}$ is 3 m long and vector $\vec{\mathbf{B}}$ is 4 m long. The length of the sum of the vectors must be:

   a. 5 m.
   b. 7 m.
   c. 12 m.
   d. some value from 1 m to 7 m.

9. When three vectors are added graphically and form a closed triangle, the largest enclosed angle between any two of the vectors cannot be greater than:

   a. 60°.
   b. 90°.
   c. 180°°.
   d. No maximum exists.

10. A runner circles a track of radius 100 m one time in 100 s at a constant rate. The greatest change in his velocity from his starting velocity:

    a. occurs one-fourth of the way around the track.
    b. occurs one-half of the way around the track.
    c. occurs three-fourths of the way around the track.
    d. Both a and c are correct.

3.2 Components of a Vector

11. An object, initially moving in the negative x-direction, is subjected to a change in velocity in the positive y-direction. If the resulting velocity vector is drawn from the origin, into which quadrant does this vector point?

    a. 1^{st}
    b. 2^{nd}
    c. 3^{rd}
    d. None, since the object is now moving in the y-direction.

12. A car is initially moving at 20 m/s east and a little while later it is moving at 10 m/s north. Which of the following best describes the orientation of the average acceleration during this time interval?

    a. northeast
    b. northwest
    c. west
    d. north of west

13. A hiker walks 200 m west and then walks 100 m north. In what direction is her resulting displacement?

    a. north
    b. west
    c. northwest
    d. None of the answers is correct.

14. An object moves at a constant velocity of 11 m/s to the southwest for an interval of 20 s. Halfway through this interval, what is the magnitude of its instantaneous velocity?

    a. It can be any value from 0 to 22 m/s.
    b. 11 m/s
    c. 5.5 m/s
    d. More information is needed.

15. In a 2-dimensional Cartesian coordinate system the *x-component* of a given vector is equal to that vector's magnitude multiplied by which trigonometric function, with respect to the angle between vector and *x*-axis?

    a. sine
    b. cosine
    c. tangent
    d. cotangent

16. In a 2-dimensional Cartesian coordinate system the *y-component* of a given vector is equal to that vector's magnitude multiplied by which trigonometric function, with respect to the angle between vector and *y-axis*?

    a. sine
    b. cosine
    c. tangent
    d. cotangent

17. In a 2-dimensional Cartesian system, the *x-component* of a vector is known, and the angle between vector and *x*-axis is known. Which operation is used to calculate the magnitude of the vector? (taken with respect to the *x-component*)

    a. dividing by cosine
    b. dividing by sine
    c. multiplying by cosine
    d. multiplying by sine

18. A taxicab moves five blocks due north, five blocks due east, and another two blocks due north. Assume all blocks are of equal size. What is the magnitude of the taxi's displacement, start to finish?

    a. 12 blocks
    b. 9.8 blocks
    c. 9.2 blocks
    d. 8.6 blocks

19. The following force vectors act on an object: *i*) 50.0 newtons at 45.0° north of east and *ii*) 25.0 newtons at 30.0° south of east. Which of the following represents the magnitude of the resultant and its angle relative to the easterly direction?

    a. 75.0 newtons 7.50°
    b. 61.4 newtons 21.8°
    c. 23.4 newtons 18.3°
    d. 12.8 newtons 37.5°

20. Find the resultant of the following two vectors: *i*) 50 units due east and *ii*) 100 units 30° north of west.

    a. 100 units 30° north of west
    b. 62 units 15° north of west
    c. 87 units 60° north of west
    d. 62 units 54° north of west

21. Arvin the Ant is on a picnic table. He travels 30 cm eastward, then 25 cm northward, and finally 15 cm westward. What is the magnitude of Arvin's net displacement?

    a. 70 cm
    b. 57 cm
    c. 52 cm
    d. 29 cm

22. Arvin the Ant travels 30 cm eastward, then 25 cm northward, and finally 15 cm westward. What is Arvin's direction of displacement with respect to his original position?

    a. 59° N of E
    b. 29° N of E
    c. 29° N of W
    d. 77° N of E

23. A string attached to an airborne kite is maintained at an angle of 40° with the horizontal. If a total of 120 m of string is reeled in while bringing the kite back to the ground, what is the horizontal displacement of the kite in the process? (Assume the kite string doesn't sag.)

    a. 100 m
    b. 84 m
    c. 77 m
    d. 92 m

24. Jack pulls a sled across a level field by exerting a force of 110 N at an angle of 30° with the ground. What are the parallel and perpendicular components, respectively, of this force with respect to the ground?

    a. 64 N, 190 N
    b. 190 N, 64 N
    c. 95 N, 55 N
    d. 55 N, 95 N

25. Vector $\vec{\mathbf{A}}$ is 3.0 units in length and points along the positive *x*-axis; vector $\vec{\mathbf{B}}$ is 4.0 units in length and points along a direction 150° from the positive *x*-axis. What is the magnitude of the resultant when vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ are added?

    a. 7.0
    b. 6.7
    c. 4.7
    d. 2.1

26. Vector $\vec{\mathbf{A}}$ is 3.0 units in length and points along the positive *x*-axis; vector $\vec{\mathbf{B}}$ is 4.0 units in length and points along a direction 150° from the positive *x*-axis. What is the direction of the resultant with respect to the positive *x*-axis?

    a. 77°
    b. 13°
    c. 86°
    d. 103°

27. I walk six miles in a straight line in a direction north of east, and I end up two miles east and several miles north. How many degrees north of east have I walked?

    a. 19°
    b. 45°
    c. 60°
    d. 71°

28. Five boys are pushing on a snowball, and each is pushing with a force of 10.0 N. However, each boy is pushing in a different direction. They are pushing north, northeast, east, southeast, and south. (Each boy is pushing at an angle of 45.0° relative to his neighbor.) What is the magnitude of the total force on the ball?

    a. 0
    b. 17.1 N
    c. 24.1 N
    d. 27.1 N

3.3 Displacement, Velocity and Acceleration in Two Dimensions

29. A jogger runs halfway around a circular path with a radius of 60 m. What, respectively, are the magnitude of the displacement and the distance jogged?

    a. 60 m, 188 m
    b. 120 m, 188 m
    c. 0 m, 377 m
    d. 120 m, 377 m

30. A runner circles a track of radius 100 m in 100 s moving at a constant rate. If the runner was initially moving north, what has been the runner's average acceleration when halfway around the track?

    a. At a constant rate, the average acceleration would be zero.
    b. 2 m/s^2, west
    c. 0.25 m/s^2, south
    d. No answer is correct.

3.4 Motion in Two Dimensions

31. John throws a baseball from the outfield from shoulder height, at an initial velocity of 29.4 m/s at an initial angle of 30.0° with respect to the horizontal. The ball is in its trajectory for a total interval of 3.00 s before the third baseman catches it at an equal shoulder-height level. (Assume air resistance negligible.) What is the ball's horizontal displacement?

    a. 76.4 m
    b. 38.2 m
    c. 57.3 m
    d. zero

32. A baseball thrown from the outfield is released from shoulder height at an initial velocity of 29.4 m/s at an initial angle of 30.0° with respect to the horizontal. If it is in its trajectory for a total of 3.00 s before being caught by the third baseman at an equal shoulder-height level, what is the ball's net vertical displacement during its 3-s trajectory?

    a. 11.0 m
    b. 9.80 m
    c. 22.1 m
    d. zero

33. A baseball thrown from the outfield is released from shoulder height at an initial velocity of 29.4 m/s at an initial angle of 30.0° with respect to the horizontal. What is the maximum vertical displacement that the ball reaches during its trajectory?

    a. 11.0 m
    b. 9.80 m
    c. 22.1 m
    d. 44.1 m

34. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at an equal shoulder level) by the catcher. At what point is the ball's speed at a minimum? (air resistance is negligible)

    a. just after leaving the center fielder's hand
    b. just before arriving at the catcher's mitt
    c. at the top of the trajectory
    d. speed is constant during entire trajectory

35. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at shoulder level) by the catcher. At what point is the magnitude of the acceleration at a minimum? (air resistance is negligible)

    a. just after leaving the center fielder's hand
    b. just before arriving at the catcher's mitt
    c. at the top of the trajectory
    d. acceleration is constant during entire trajectory

36. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at shoulder level) by the catcher. At what point does the magnitude of the vertical component of velocity have its minimum value? (air resistance is negligible)

    a. just after leaving the center fielder's hand
    b. just before arriving at the catcher's mitt
    c. at the top of the trajectory
    d. magnitude of vertical component of velocity is constant

37. A helicopter is traveling at 40 m/s at a constant altitude of 100 m over a level field. If a wheel falls off the helicopter, with what speed will it hit the ground? (g = 9.8 m/s^2 and air resistance negligible)

    a. 40 m/s
    b. 50 m/s
    c. 60 m/s
    d. 70 m/s

38. A ball is rolled horizontally off a table with an initial speed of 0.24 m/s. A stopwatch measures the ball's trajectory time from table to the floor to be 0.30 s. What is the height of the table? (g = 9.8 m/s^2 and air resistance is negligible)

    a. 0.11 m
    b. 0.22 m
    c. 0.33 m
    d. 0.44 m

39. A ball is rolled horizontally off a table with an initial speed of 0.24 m/s. A stop watch measures the ball's trajectory time from table to the floor to be 0.30 s. How far away from the table does the ball land? (g = 9.8 m/s^2 and air resistance is negligible)

    a. 0.055 m
    b. 0.072 m
    c. 1.2 m
    d. 1.9 m

40. A stone is thrown at an angle of 30° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stop watch measures the stone's trajectory time from top of cliff to bottom to be 5.6 s. What is the height of the cliff? (g = 9.8 m/s^2 and air resistance is negligible)

    a. 58 m
    b. 154 m
    c. 120 m
    d. 197 m

41. A stone is thrown at an angle of 30° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stop watch measures the stone's trajectory time from top of cliff to bottom to be 5.6 s. How far out from the cliff's edge does the stone travel horizontally? (g = 9.8 m/s^2 and air resistance is negligible)

    a. 58 m
    b. 154 m
    c. 120 m
    d. 197 m

42. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If $g = 9.8$ m/s^2 and air resistance is negligible, then what is the magnitude of the vertical velocity component of the rock as it hits the ground?

    a. 9.0 m/s
    b. 18 m/s
    c. 26 m/s
    d. 29 m/s

43. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If $g = 9.8$ m/s^2 and air resistance is negligible, then what is the magnitude of the horizontal component of velocity as the rock strikes the ground?

    a. 7.5 m/s
    b. 9.0 m/s
    c. 12 m/s
    d. 29 m/s

44. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If $g = 9.8$ m/s^2 and air resistance is negligible, then what is the speed of the rock as it hits the ground?

    a. 15 m/s
    b. 21 m/s
    c. 30 m/s
    d. 36 m/s

45. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If $g = 9.8$ m/s^2 and air resistance is negligible, what is the magnitude of the horizontal displacement of the rock?

    a. 38 m
    b. 46 m
    c. 66 m
    d. 90 m

46. A bridge that was 5.0 m long has been washed out by the rain several days ago. How fast must a car be going to successfully jump the stream? Although the road is level on both sides of the bridge, the road on the far side is 2.0 m lower than the road on this side.

    a. 5.0 m/s
    b. 7.8 m/s
    c. 13 m/s
    d. 25 m/s

47. A rifle is aimed horizontally toward the center of a target 100 m away. If the bullet strikes 10 cm below the center, what was the velocity of the bullet? (Ignore air friction.)

    a. 300 m/s
    b. 333 m/s
    c. 500 m/s
    d. 700 m/s

48. A quarterback takes the ball from the line of scrimmage, runs backward for 10 yards, then sideways parallel to the line of scrimmage for 15 yards. He then throws a 50-yard forward pass straight downfield perpendicular to the line of scrimmage. The receiver is tackled immediately. How far is the football displaced from its original position?

    a. 43 yards
    b. 55 yards
    c. 63 yards
    d. 75 yards

49. A track star in the broad jump goes into the jump at 12 m/s and launches himself at 20° above the horizontal. How long is he in the air before returning to Earth? (g = 9.8 m/s^2)

    a. 0.42 s
    b. 0.84 s
    c. 1.25 s
    d. 1.68 s

50. Superguy is flying at treetop level near Paris when he sees the Eiffel Tower elevator start to fall (the cable snapped). His x-ray vision tells him Lois LaTour is inside. If Superguy is 1.00 km away from the tower, and the elevator falls from a height of 240 m, how long does Superguy have to save Lois, and what must be his average speed?

    a. 3.00 s, 333 m/s
    b. 5.00 s, 200 m/s
    c. 7.00 s, 143 m/s
    d. 9.00 s, 111 m/s

51. A ball is launched from ground level at 30 m/s at an angle of 35° above the horizontal. How far does it go before it is at ground level again?

    a. 14 m
    b. 21 m
    c. 43 m
    d. 86 m

52. A baseball leaves the bat with a speed of 44.0 m/s and an angle of 30.0° above the horizontal. A 5.0-m-high fence is located at a horizontal distance of 132 m from the point where the ball is struck. Assuming the ball leaves the bat 1.0 m above ground level, by how much does the ball clear the fence?

    a. 4.4 m
    b. 8.8 m
    c. 13.4 m
    d. 17.9 m

53. Wiley Coyote has missed the elusive road runner once again. This time, he leaves the edge of the cliff at 50.0 m/s horizontal velocity. If the canyon is 100 m deep, how far from his starting point at the edge of the cliff does the coyote land?

    a. 226 m
    b. 247 m
    c. 339 m
    d. 400 m

54. A fireman, 50.0 m away from a burning building, directs a stream of water from a fire hose at an angle of 30.0° above the horizontal. If the initial speed of the stream is 40.0 m/s, at what height will the stream of water strike the building?

    a. 9.60 m
    b. 13.4 m
    c. 18.7 m
    d. 22.4 m

55. The highest mountain on Mars is Olympus Mons, rising 22 000 meters above the Martian surface. If we were to throw an object horizontally off the mountain top, how long would it take to reach the surface? (Ignore atmospheric drag forces and use $g_{\text{Mars}} = 3.72 \text{ m/s}^2$.)

    a. 1.8 minutes
    b. 2.4 minutes
    c. 3.0 minutes
    d. 0.79 minute

56. Two projectiles are launched at 100 m/s, the angle of elevation for the first being 30° and for the second 60°. Which of the following statements is false?

    a. Both projectiles have the same acceleration while in flight.
    b. The second projectile has the lower speed at maximum altitude.
    c. Both projectiles have the same range.
    d. All of the above statements are false.

3.5 Relative Velocity

57. A jet airliner moving at 500 mph due east moves into a region where the wind is blowing at 120 mph in a direction 30.0° north of east. What is the new velocity and direction of the aircraft?

    a. 607 mph, 5.67° N of E
    b. 620 mph, 5.67° N of E
    c. 607 mph, 6.22° N of E
    d. 588 mph, 4.87° N of E

58. A boat moves at 10.0 m/s relative to the water. If the boat is in a river where the current is 2.00 m/s, how long does it take the boat to make a complete round trip of 1 000 m upstream followed by a 1 000-m trip downstream?

    a. 200 s
    b. 203 s
    c. 208 s
    d. 250 s

59. A river flows due east at 3.0 m/s. A boat crosses the 300-m-wide river by maintaining a constant velocity of 10 m/s due north relative to the water. If no correction is made for the current, how far downstream does the boat move by the time it reaches the far shore?

    a. 6 m
    b. 30 m
    c. 60 m
    d. 90 m

60. A boat moves through the water in a river at a speed of 8 m/s relative to the water. The boat makes a trip downstream and then makes a return trip upstream to the original starting place. Which trip takes longer?

    a. the downstream trip
    b. the upstream trip
    c. Both trips take the same amount of time.
    d. The answer cannot be figured without knowing the speed of the river flow.

61. A boat travels upstream and after one hour has gone 10 km. The boat next travels downstream and after one hour has gone 14 km. If the boat's speed relative to the water is constant, what is the speed of the current in the river?

    a. 1 km/h
    b. 2 km/h
    c. 3 km/h
    d. 4 km/h

62. Plane A is flying at 400 mph in the northeast direction relative to the earth. Plane B is flying at 500 mph in the north direction relative to the earth. What is the speed of Plane B as observed from Plane A?

    a. 900 mph
    b. 640 mph
    c. 357 mph
    d. 100 mph

63. Plane A is flying at 400 mph in the northeast direction relative to the earth. Plane B is flying at 500 mph in the north direction relative to the earth. What is the direction of motion of Plane B as observed from Plane A?

    a. 52.5° N of E
    b. 52.5° N or W
    c. 37.5° N of W
    d. 36.9° N of W

64. A plane is moving due north, directly towards its destination. Its airspeed is 200 mph. A constant breeze is blowing from west to east at 40 mph. How long will it take for the plane to travel 200 miles north?

    a. one hour
    b. more than one hour
    c. less than one hour
    d. more information is needed

65. A plane is moving due north, directly towards its destination. Its airspeed is 200 mph. A constant breeze is blowing from west to east at 20 mph. In which direction is the plane pointed?

    a. 5.7° W of N
    b. 10° W of N
    c. 22° W of N
    d. 11° E of N

66. A plane is moving due north, directly towards its destination. Its airspeed is 200 mph. A constant breeze is blowing from west to east at 30 mph. At what rate is the plane moving north?

    a. 198 mph
    b. 193 mph
    c. 188 mph
    d. 180 mph

CHAPTER 3 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	D	2	32.	D	2
C2.	C	2	33.	A	2
C3.	B	2	34.	C	2
C4.	C	3	35.	D	1
C5.	C	2	36.	C	1
1.	B	1	37.	C	3
2.	A	1	38.	D	2
3.	A	1	39.	B	2
4.	C	1	40.	C	3
5.	B	1	41.	A	3
6.	B	2	42.	D	2
7.	A	1	43.	B	2
8.	D	2	44.	C	3
9.	C	2	45.	A	3
10.	B	2	46.	B	3
11.	B	1	47.	D	3
12.	D	2	48.	A	2
13.	D	2	49.	B	3
14.	B	1	50.	C	2
15.	B	1	51.	D	3
16.	B	2	52.	C	3
17.	A	2	53.	A	3
18.	D	2	54	C	2
19.	B	2	55.	A	3
20.	D	2	56.	D	3
21.	D	2	57.	A	3
22.	A	2	58.	C	3
23.	D	2	59.	D	2
24.	C	2	60.	B	2
25.	D	2	61.	B	2
26.	D	2	62.	C	3
27.	D	2	63.	C	3
28.	C	2	64.	B	2
29.	B	1	65.	A	2
30.	C	2	66.	A	2
31.	A	2			

CHAPTER 4

Conceptual Problems

1. A crate of weight W is being pushed across a horizontal surface by a force directed at an angle of 20° below the horizontal. What is the magnitude of the normal force on the crate?

   a. It is less than W.
   b. It equals W.
   c. It is more than W.
   d. None of the above since the coefficient of kinetic friction is not given.

2. The net force on an object is in the positive x-direction. Consider the following statements.
   (i) The object can be moving in the negative x-direction.
   (ii) The object can be speeding up.
   (iii) The object can be slowing down.
   (iv) The object can be moving in the positive y-direction.
   Which of the statements are true?

   a. (i) and (ii)
   b. (ii) and (iii)
   c. (iii) and (iv)
   d. Choose this answer if all the statements are true.

3. An object weighs 100 N. If the gravitational constant G were half of what it is currently, what would the weight of the object be?

   a. 100 N
   b. 50 N
   c. 25 N
   d. 200 N

4. Five boxes, each having weight 100 N, are stacked up. The bottom box is the fifth from the top. What is the magnitude of the normal force upward exerted by the fourth box from the top on the third box from the top?

   a. 100 N
   b. 200 N
   c. 300 N
   d. 400 N

5. A box of mass m is placed on an incline with angle of inclination θ. The box does not slide. The magnitude of the frictional force in this case is:

   a. μ_s mg sin θ.
   b. mg cos θ.
   c. mg sin θ.
   d. not given.

4.1 Forces

4.2 Newton's First Law

4.3 Newton's Second Law

4.4 Newton's Third Law

1. Which of the following is an example of the type of force that acts at a distance?

   a. gravitational
   b. magnetic
   c. electrical
   d. all of the above

2. If we know an object is moving at constant velocity, we may assume:

   a. the net force acting on the object is zero.
   b. there are no forces acting on the object.
   c. the object is accelerating.
   d. the object is losing mass.

3. Which of the following expresses a principle, which was initially stated by Galileo and was later incorporated into Newton's laws of motion?

   a. An object's acceleration is inversely proportional to its mass.
   b. For every action there is an equal but opposite reaction.
   c. The natural condition for a moving object is to remain in motion.
   d. The natural condition for a moving object is to come to rest.

4. What condition must apply to a system's state of motion for it to be regarded as an inertial frame of reference?

   a. in decreasing velocity
   b. in constant velocity
   c. in constant acceleration
   d. in increasing acceleration

5. A 7.0-kg bowling ball experiences a net force of 5.0 N. What will be its acceleration?

   a. 35 m/s^2
   b. 7.0 m/s^2
   c. 5.0 m/s^2
   d. 0.71 m/s^2

6. An astronaut applies a force of 500 N to an asteroid, and it accelerates at 7.00 m/s^2. What is the asteroid's mass?

   a. 71 kg
   b. 135 kg
   c. 441 kg
   d. 3 500 kg

7. Two ropes are attached to a 40-kg object. The first rope applies a force of 25 N and the second, 40 N. If the two ropes are perpendicular to each other, what is the resultant acceleration of the object?

   a. 1.2 m/s^2
   b. 3.0 m/s^2
   c. 25 m/s^2
   d. 47 m/s^2

8. Two forces act on a 6.00-kg object. One of the forces is 10.0 N. If the object accelerates at 2.00 m/s^2, what is the greatest possible magnitude of the other force?

   a. 1.0 N
   b. 2.0 N
   c. 22.0 N
   d. 34.0 N

9. The acceleration due to gravity on the Moon's surface is one-sixth that on Earth. An astronaut's life support backpack weighs 300 lb on Earth. What does it weigh on the Moon?

   a. 1 800 lb
   b. 300 lb
   c. 135 lb
   d. 50 lb

10. The acceleration due to gravity on the Moon's surface is one-sixth that on Earth. What net force would be required to accelerate a 20-kg object at 6.0 m/s^2 on the moon?

    a. 1.3 N
    b. 20 N
    c. 33 N
    d. 120 N

11. If we know that a nonzero net force is acting on an object, which of the following must we assume regarding the object's condition? The object is:

    a. at rest.
    b. moving with a constant velocity.
    c. being accelerated.
    d. losing mass.

12. A 2 000-kg sailboat experiences an eastward force of 3 000 N by the ocean tide and a wind force against its sails with magnitude of 6 000 N directed toward the northwest (45° N of W). What is the magnitude of the resultant acceleration?

    a. 2.2 m/s^2
    b. 2.1 m/s^2
    c. 1.5 m/s^2
    d. 3.0 m/s^2

13. A 2 000-kg sailboat experiences an eastward force of 3 000 N by the ocean tide and a wind force against its sails with magnitude of 6 000 N directed toward the northwest (45° N of W). What is the direction of the resultant acceleration?

    a. 60° N of E
    b. 30° N of W
    c. 30° N of E
    d. 74° N of W

14. A cart of weight 20 N is accelerated across a level surface at 0.15 m/s^2. What net force acts on the wagon? (g = 9.8 m/s^2)

    a. 0.92 N
    b. 0.31 N
    c. 3.0 N
    d. 4.5 N

15. A rock is rolled in the sand. It starts at 5.0 m/s, moves in a straight line for a distance of 3.0 m, and then stops. What is the magnitude of the average acceleration?

    a. 1.8 m/s^2
    b. 4.2 m/s^2
    c. 5.4 m/s^2
    d. 6.2 m/s^2

16. Rita accelerates a 0.40-kg ball from rest to 9.0 m/s during the 0.15 s in which her foot is in contact with the ball. What average force does she apply to the ball during the kick?

    a. 48 N
    b. 72 N
    c. 24 N
    d. 60 N

17. A 70.0-kg man jumps 1.00 m down onto a concrete walkway. His downward motion stops in 0.0200 seconds. If he forgets to bend his knees, what force is transmitted to his leg bones?

    a. 15 500 N
    b. 7 010 N
    c. 4 900 N
    d. 3 500 N

18. The accelerating force of the wind on a small 200-kg sailboat is 707 N northeast. If the drag of the keel is 500 N acting west, what is the acceleration of the boat?

    a. 1.5 m/s^2 due east
    b. 2.5 m/s^2 due north
    c. 3.0 m/s^2 northeast
    d. 2.0 m/s^2 north by northwest

19. A barefoot field-goal kicker imparts a speed of 30 m/s to a football at rest. If the football has a mass of 0.50 kg and time of contact with the football is 0.025 s, what is the force exerted on the foot?

    a. 190 N
    b. 380 N
    c. 600 N
    d. 900 N

20. An automobile of mass 2 000 kg moving at 30 m/s is braked suddenly with a constant braking force of 10 000 N. How far does the car travel before stopping?

    a. 45 m
    b. 90 m
    c. 135 m
    d. 180 m

21. A shot-putter moves his arm and the 7.0-kg shot through a distance of 1.0 m, giving the shot a velocity of 10 m/s from rest. Find the average force exerted on the shot during this time.

    a. 175 N
    b. 350 N
    c. 525 N
    d. 700 N

22. A baseball batter hits an incoming 40-m/s fastball. The ball leaves the bat at 50 m/s after a ball-on-bat contact time of 0.030 s. What is the force exerted on the 0.15-kg baseball?

    a. 450 N
    b. 250 N
    c. 90 N
    d. 50 N

23. In the terminology *a 500-N block*, the *500-N* refers to the block's:

    a. mass.
    b. force.
    c. weight.
    d. None of the above.

24. The statement by Newton that "for every action there is an opposite but equal reaction" is regarded as which of his laws of motion?

    a. first
    b. second
    c. third
    d. fourth

25. A thrown stone hits a window, but doesn't break it. Instead it reverses direction and ends up on the ground below the window. In this case, we know:

    a. the force of the stone on the glass > the force of the glass on the stone.
    b. the force of the stone on the glass = the force of the glass on the stone.
    c. the force of the stone on the glass < the force of the glass on the stone.
    d. the stone didn't slow down as it broke the glass.

4.5 Applications of Newton's Laws

26. Two blocks, joined by a string, have masses of 6.0 and 9.0 kg. They rest on a frictionless horizontal surface. A 2nd string, attached only to the 9-kg block, has horizontal force = 30 N applied to it. Both blocks accelerate. Find the tension in the string between the blocks.

    a. 18 N
    b. 28 N
    c. 12 N
    d. 15 N

27. Three forces, 5.0 N, 15.0 N, and 20.0 N, are acting on a 9.81-kg object. Which of the following forces could also be acting on the object if it is moving with constant velocity?

    a. 1.0 N
    b. 19.0 N
    c. 39.0 N
    d. any of the above

28. An airplane of mass 1.2×10^4 kg tows a glider of mass 0.6×10^4 kg. The airplane propellers provide a net forward thrust of 3.6×10^4 N. What is the glider's acceleration?
    a. 2.0 m/s^2
    b. 3.0 m/s^2
    c. 6.0 m/s^2
    d. 9.8 m/s^2

29. Two blocks of masses 20 kg and 8 kg are connected together by a light string and rest on a frictionless level surface. Attached to the 8-kg mass is another light string, which a person

uses to pull both blocks horizontally. If the two-block system accelerates at 0.5 m/s^2 what is the tension in the connecting string between the blocks?

a. 14 N
b. 6 N
c. 10 N
d. 4.0 N

30. Two blocks of masses 20 kg and 8.0 kg are connected together by a light string and rest on a frictionless level surface. Attached to the 8-kg mass is a second light string, which a person uses to pull both blocks horizontally. If the two-block system accelerates at 0.5 m/s^2, what is the tension in the second string attached to the 8-kg mass?

a. 14 N
b. 6.0 N
c. 10 N
d. 4.0 N

31. A 10-kg mass and a 2.0-kg mass are connected by a light string over a massless, frictionless pulley. If g = 9.8 m/s^2, what is the acceleration of the system when released?

a. 2.5 m/s^2
b. 6.5 m/s^2
c. 7.8 m/s^2
d. 9.8 m/s^2

32. A 15-kg block rests on a level frictionless surface and is attached by a light string to a 5.0-kg hanging mass where the string passes over a massless frictionless pulley. If g = 9.8 m/s^2, what is the tension in the connecting string?

a. 65 N
b. 17 N
c. 49 N
d. 37 N

33. An elevator weighing 20 000 N is supported by a steel cable. What is the tension in the cable when the elevator is being accelerated upward at a rate of 3.00 m/s^2? (g = 9.80 m/s^2)

a. 13 900 N
b. 23 100 N
c. 20 000 N
d. 26 100 N

34. As a basketball player starts to jump for a rebound, he begins to move upward faster and faster until he leaves the floor. During this time that he is in contact with the floor, the force of the floor on his shoes is:

    a. bigger than his weight.
    b. equal in magnitude and opposite in direction to his weight.
    c. less than his weight.
    d. zero.

35. As I slide a box at constant speed up a frictionless slope, pulling parallel to the slope, the tension in the rope will be:

    a. greater than the tension would be if the box were stationary.
    b. greater than the weight of the box.
    c. equal to the weight of the box.
    d. less than the weight of the box.

36. A boxcar of mass 200 tons at rest becomes uncoupled on a 2.5° grade. If the track is considered to be frictionless, what speed does the boxcar have after 10 seconds?

    a. 0.37 m/s
    b. 0.59 m/s
    c. 1.3 m/s
    d. 4.3 m/s

37. As a 3.0-kg bucket is being lowered into a 10-m-deep well, starting from the top, the tension in the rope is 9.8 N. The acceleration of the bucket will be:

    a. 6.5 m/s^2 downward.
    b. 9.8 m/s^2 downward.
    c. zero.
    d. 3.3 m/s^2 upward.

38. A 5 000-N weight is held suspended in equilibrium by two cables. Cable 1 applies a horizontal force to the right of the object and has a tension, T_1. Cable 2 applies a force upward and to the left at an angle of 37.0° to the negative x axis and has a tension, T_2. What is the tension, T_1?

    a. 4 000 N
    b. 6 640 N
    c. 8 310 N
    d. 3 340 N

39. A 5 000-N weight is suspended in equilibrium by two cables. Cable 1 applies a horizontal force to the right of the object and has a tension, T_1. Cable 2 applies a force upward and to the left at an angle of 37.0° to the negative x-axis and has a tension, T_2. Find T_2.

    a. 4 000 N
    b. 6 640 N
    c. 8 310 N
    d. 3 340 N

40. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a force is applied to the left side of the left cube causing all three cubes to accelerate to the right at 2.0 m/s^2. What is the magnitude of the force exerted on the middle cube by the left cube in this case?

    a. 12 N
    b. 24 N
    c. 36 N
    d. none of the above

41. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a force is applied to the left side of the left cube causing all three cubes to accelerate to the right at 2.0 m/s^2. What is the magnitude of the force exerted on the right cube by the middle cube in this case?

    a. 12 N
    b. 24 N
    c. 36 N
    d. none of the above

42. A sled weighs 100 N. It is held in place on a frictionless 20° slope by a rope attached to a stake at the top; the rope is parallel to the slope. Find the tension in the rope.

    a. 94 N
    b. 47 N
    c. 37 N
    d. 34 N

43. A sled weighs 100 N. It is held in place on a frictionless 20° slope by a rope attached to a stake at the top; the rope is parallel to the slope. What is the normal force of the slope acting on the sled?

    a. 94 N
    b. 47 N
    c. 37 N
    d. 34 N

44. A 500-N tightrope walker stands at the center of the rope such that each half of the rope makes an angle of 10.0° with the horizontal. What is the tension in the rope?

    a. 1 440 N
    b. 1 000 N
    c. 500 N
    d. 2 900 N

45. A 500-N tightrope walker stands at the center of the rope. If the rope can withstand a tension of 1 800 N without breaking, what is the minimum angle the rope can make with the horizontal?

    a. 4°
    b. 8°
    c. 10°
    d. 15°

46. A 20-kg traffic light hangs midway on a cable between two poles 40 meters apart. If the sag in the cable is 0.40 meters, what is the tension in each side of the cable?

    a. 12 000 N
    b. 9 800 N
    c. 4 900 N
    d. 980 N

47. A girl is using a rope to pull a box that weighs 300 N across a level surface with constant velocity. The rope makes an angle of 30° above the horizontal, and the tension in the rope is 100 N. What is the normal force of the floor on the box?

    a. 300 N
    b. 86 N
    c. 50 N
    d. 250 N

48. A karate master strikes a board with an initial velocity of 10.0 m/s, decreasing to 1.0 m/s as his hand passes through the board. If the time of contact with the board is 0.002 0 s, and the mass of the coordinated hand and arm is 1.0 kg, what is the force exerted on the board?

    a. 1 000 N
    b. 1 800 N
    c. 2 700 N
    d. 4 500 N

49. Find the tension in an elevator cable if the 1 000-kg elevator is descending with an acceleration of 1.8 m/s^2, downward.

    a. 5 700 N
    b. 8 000 N
    c. 9 800 N
    d. 11 600 N

4.6 Forces of Friction

50. A block of mass 5.00 kg rests on a horizontal surface where the coefficient of kinetic friction between the two is 0.200. A string attached to the block is pulled horizontally, resulting in a 2.00-m/s^2 acceleration by the block. Find the tension in the string. (g = 9.80 m/s^2)

    a. 0.200 N
    b. 9.80 N
    c. 19.8 N
    d. 10.0 N

51. A horizontal force of 750 N is needed to overcome the force of static friction between a level floor and a 250-kg crate. If g = 9.8 m/s^2, what is the coefficient of static friction?

    a. 3.0
    b. 0.15
    c. 0.28
    d. 0.31

52. A horizontal force of 750 N is needed to overcome the force of static friction between a level floor and a 250-kg crate. What is the acceleration of the crate if the 750-N force is maintained after the crate begins to move and the coefficient of kinetic friction is 0.12?

    a. 1.8 m/s^2
    b. 2.5 m/s^2
    c. 3.0 m/s^2
    d. 3.8 m/s^2

53. A 100-kg box is placed on a ramp. As one end of the ramp is raised, the box begins to move downward just as the angle of inclination reaches 15°. What is the coefficient of static friction between box and ramp?

    a. 0.15
    b. 0.27
    c. 0.77
    d. 0.95

54. A 300-kg crate is placed on an adjustable inclined plane. As one end of the incline is raised, the crate begins to move downward. If the crate slides down the plane with an acceleration of 0.70 m/s^2 when the incline angle is 25°, what is the coefficient of kinetic friction between ramp and crate? (g = 9.8 m/s^2)

    a. 0.47
    b. 0.42
    c. 0.39
    d. 0.12

55. A 250-kg crate is placed on an adjustable inclined plane. If the crate slides down the incline with an acceleration of 0.70 m/s^2 when the incline angle is 25°, then what should the incline angle be for the crate to slide down the plane at constant speed? (g = 9.8 m/s^2)

    a. 12°
    b. 21°
    c. 25°
    d. 29°

56. Doug hits a hockey puck, giving it an initial velocity of 6.0 m/s. If the coefficient of kinetic friction between ice and puck is 0.050, how far will the puck slide before stopping?

    a. 19 m
    b. 25 m
    c. 37 m
    d. 57 m

57. It is late and Carlos is sliding down a rope from his third floor window to meet his friend Juan. As he slides down the rope faster and faster, he becomes frightened and grabs harder on the rope, increasing the tension in the rope. As soon as the upward tension in the rope becomes equal to his weight:

    a. Carlos will stop.
    b. Carlos will slow down.
    c. Carlos will continue down at a constant velocity.
    d. the rope must break.

58. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a 36-N force is applied to the left side of the left cube causing all three cubes to accelerate to the right. If the cubes are each subject to a frictional force of 6.0 N, what is the magnitude of the force exerted on the middle cube by the left cube in this case?

    a. 12 N
    b. 24 N
    c. 36 N
    d. none of the above

59. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a 36-N force is applied to the left side of the left cube causing all three cubes to accelerate to the right. If the cubes are each subject to a frictional force of 6.0 N, what is the magnitude of the force exerted on the right cube by the middle cube in this case?

    a. 12 N
    b. 24 N
    c. 36 N
    d. none of the above

60. As a car goes up a hill, there is a force of friction between the road and the tires rolling on the road. The maximum force of friction is equal to:

    a. the weight of the car times the coefficient of kinetic friction.
    b. the normal force of the road times the coefficient of kinetic friction.
    c. the normal force of the road times the coefficient of static friction.
    d. zero.

61. As a car moves forward on a level road at constant velocity, the net force acting on the tires is:

    a. greater than the normal force times the coefficient of static friction.
    b. equal to the normal force times the coefficient of static friction.
    c. the normal force times the coefficient of kinetic friction.
    d. zero.

62. As a car skids with its wheels locked trying to stop on a road covered with ice and snow, the force of friction between the icy road and the tires will usually be:

    a. greater than the normal force of the road times the coefficient of static friction.
    b. equal to the normal force of the road times the coefficient of static friction.
    c. less than the normal force of the road times the coefficient of static friction.
    d. greater than the normal force of the road times the coefficient of kinetic friction.

63. There are six books in a stack, each with a weight of 5.0 N. The coefficient of friction between all the books is 0.20 as is the coefficient between the table and the bottom book. What horizontal push must I just exceed on the next to bottom book to start sliding the top five books off the bottom one?

    a. 1.0 N
    b. 5.0 N
    c. 3.0 N
    d. 7.0 N

64. Two objects, A and B, are placed on an inclined plane that can be rotated to different angles of elevation. A starts to slide at twice the angle of elevation that B starts sliding. The respective coefficients for static friction for A and B are μ_A and μ_B. Choose the last answer that is correct.

    a. $\mu_B > \mu_A$
    b. $\mu_A > \mu_B$
    c. $\mu_B = 2\ \mu_A$
    d. $\mu_A = 2\ \mu_B$

65. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580, and the coefficient of sliding friction is 0.520. What is the frictional force in this situation?

    a. 41.4 N
    b. 88.8 N
    c. 46.2 N
    d. 51.5 N

66. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580, and the coefficient of sliding friction is 0.520. The mass is given a shove causing it to slide down the incline. What is the frictional force while the mass is sliding?

    a. 41.4 N
    b. 88.8 N
    c. 46.2 N
    d. 51.5 N

67. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580 and the coefficient of sliding friction is 0.520. The mass is given a shove causing it to slide down the incline. Taking down the incline as positive, what is the acceleration of the mass while it is sliding?

    a. 0.477 m/s^2
    b. -0.477 m/s^2
    c. 1.99 m/s^2
    d. -1.99 m/s^2

68. A man pulls a sled at a constant velocity across a horizontal snow surface. If a force of 80 N is being applied to the sled rope at an angle of 53° to the ground, what is the force of friction between sled and snow?

    a. 80 N
    b. 64 N
    c. 48 N
    d. 40 N

69. A trapeze artist, with swing, weighs 800 N; he is momentarily held to one side by his partner so that the swing ropes make an angle of 30.0° with the vertical. In such a condition of static equilibrium, what is the horizontal force being applied by the partner?

    a. 924 N
    b. 400 N
    c. 196 N
    d. 462 N

70. A trapeze artist, with swing, weighs 800 N; he is being held to one side by his partner so that the swing ropes make an angle of 30.0° with the vertical. In such a condition of static equilibrium what is the tension in the rope?

    a. 924 N
    b. 400 N
    c. 196 N
    d. 461 N

71. A 200-N crate rests on an ramp; the maximum angle just before it slips is 25° with the horizontal. What is the coefficient of static friction between crate and ramp surfaces?

    a. 0.11
    b. 0.21
    c. 0.38
    d. 0.47

72. A 150-N sled is pulled up a 28° slope at a constant speed by a force of 100 N. What is the coefficient of kinetic friction between sled and slope?

    a. 0.53
    b. 0.22
    c. 0.13
    d. 0.33

73. Jamal pulls a 150-N sled up a 28.0° slope at constant speed by a force of 100 N. Near the top of the hill he releases the sled. With what acceleration does the sled go down the hill?

    a. 1.20 m/s^2
    b. 1.67 m/s^2
    c. 2.22 m/s^2
    d. 2.67 m/s^2

74. Dana uses a rope to pull a box that weighs 300 N across a level surface with constant velocity. The rope makes an angle of 30° above the horizontal and the tension in the rope is 100 N. What is the coefficient of friction?

    a. 0.35
    b. 0.29
    c. 0.17
    d. 0.20

75. Hector drives a pickup truck horizontally at 15.0 m/s. He is transporting a crate of delicate lead crystal. If the coefficient of static friction between the crate and the truck bed is 0.400, what is the minimum stopping distance for the truck so the crate will not slide?

    a. 28.7 m
    b. 51.0 m
    c. 33.6 m
    d. 44.4 m

76. The coefficient of friction between a racecar's wheels and the track is 1.0. The car starts from rest and accelerates at a constant rate for 400 m. Find the maximum speed at the end of the race.

    a. 44 m/s
    b. 66 m/s
    c. 89 m/s
    d. 99 m/s

77. A worker pulls a 200-N packing crate at constant velocity across a rough floor by exerting a force F = 55.0 N at an angle of 35.0° above the horizontal. What is the coefficient of kinetic friction of the floor?

    a. 0.133
    b. 0.267
    c. 0.400
    d. 0.200

78. A hockey puck moving at 7.0 m/s coasts to a halt in 75 m on a smooth ice surface. What is the coefficient of friction between the ice and the puck?

    a. μ = 0.025
    b. μ = 0.033
    c. μ = 0.12
    d. μ = 0.25

79. An Olympic skier moving at 20.0 m/s down a 30.0° slope encounters a region of wet snow, of coefficient of friction $\mu_k = 0.740$. How far down the slope does she go before stopping?

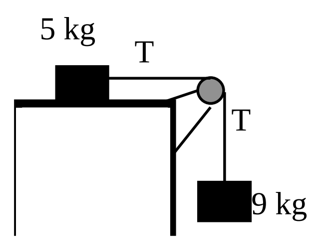
    a. 119 m
    b. 145 m
    c. 170 m
    d. 199 m

80. The coefficient of static friction between the tires of a car and the street is $\mu_s = 0.77$. Of the following, what is the steepest inclination angle of a street on which a car can be parked (with wheels locked) without slipping?

    a. 22.5°
    b. 30°
    c. 37°
    d. 45°

81. A 9.0-kg hanging weight is connected by a string over a pulley to a 5.0-kg block sliding on a flat table. If the coefficient of sliding friction is 0.20, find the tension in the string.

    a. 19 N
    b. 24 N
    c. 32 N
    d. 38 N



82. A 100-N block, on a 30° incline, is being held motionless by friction. The coefficient of static friction between the block and the plane is 0.60. The force due to friction is:

    a. 0 N.
    b. 30 N.
    c. 50 N.
    d. 52 N.

83. A block is launched up an incline plane. After going up the plane, it slides back down to its starting position. The coefficient of friction between the block and the plane is 0.3. The time for the trip up the plane:

    a. is the same as the time for the trip down.
    b. is more than the time for the trip down.
    c. is less than the time for the trip down.
    d. cannot be found without knowing the angle of inclination.

84. A block is launched up an incline plane. After going up the plane, it slides back down to its starting position. The coefficient of friction between the block and the plane is 0.3. The speed of the block when it reaches the starting position on the trip down:

    a. is the same as the launching speed.
    b. is less than the launching speed.
    c. is more than the launching speed.
    d. cannot be compared to the launch speed with the information given.

85. The maximum possible value for the coefficient of static friction is:

    a. 0.50.
    b. 1.00.
    c. a value up to but not quite 1.00.
    d. greater than 1.00.

86. A box is to be moved across a level surface. A force of magnitude 200 N may be applied at an angle of 30° below the horizontal to push the box or at an angle of 30° above the horizontal to pull the box, either application sufficient to overcome friction and move the box. Which application will cause the box to have the greater acceleration?

    a. the one below the horizontal
    b. the one above the horizontal
    c. both give equal acceleration
    d. more information is needed

CHAPTER 4 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	C	2	42.	D	2
C2.	D	2	43.	A	2
C3.	B	1	44.	A	2
C4.	C	2	45.	B	2
C5.	C	3	46.	C	2
1.	D	1	47.	D	2
2.	A	1	48.	D	2
3.	C	1	49.	B	2
4.	B	1	50.	C	2
5.	D	1	51.	D	2
6.	A	1	52.	A	3
7.	A	2	53.	B	2
8.	C	2	54.	C	3
9.	D	1	55.	B	3
10.	D	2	56.	C	2
11.	C	1	57.	C	1
12.	A	2	58.	B	3
13.	D	2	59.	A	3
14.	B	2	60.	C	2
15.	B	2	61.	D	2
16.	C	2	62.	C	2
17.	A	3	63.	B	2
18.	B	2	64.	B	2
19.	C	2	65.	A	2
20.	B	2	66.	C	3
21.	B	2	67.	B	3
22.	A	2	68.	C	2
23.	C	1	69.	D	2
24.	C	1	70.	A	2
25.	B	2	71.	D	2
26.	C	2	72.	B	3
27.	D	2	73.	D	3
28.	A	2	74.	A	2
29.	C	2	75.	A	3
30.	A	2	76.	C	2
31.	B	3	77.	B	3
32.	D	3	78.	B	2
33.	D	2	79.	B	3
34.	A	2	80.	C	2
35.	D	2	81.	D	3
36.	D	2	82.	C	2
37.	A	3	83.	C	3
38.	B	3	84.	B	3
39.	C	3	85.	D	2
40.	B	2	86.	B	3
41.	A	2			

CHAPTER 5

Conceptual Problems

C1. Is it possible for the total mechanical energy of a moving particle to be negative?

a. No, because a moving particle has positive kinetic energy.
b. No, because potential energy cannot have a value more negative than the value of the positive kinetic energy of the particle.
c. Only if friction is involved.
d. yes

C2. Three different mass projectiles are launched from the top of a building each at different angles of elevation. Each particle has the same initial kinetic energy. Which particle has the greatest kinetic energy just as it impacts with the ground?

a. The one launched at the highest angle of elevation.
b. The one with the highest mass.
c. The one with the lowest mass.
d. They all will have the same kinetic energy on impact.

C3. Three different mass projectiles are launched from the top of a building each at different angles of elevation. Each particle has the same initial kinetic energy. Which particle has the greatest speed just as it impacts with the ground?

a. The one launched at the highest angle of elevation.
b. The one with the highest mass.
c. The one with the lowest mass.
d. They all will have the same speed on impact.

C4. A block is projected with speed v across a horizontal surface and slides to a stop due to friction. The same block is then projected with the same speed v up an incline where is slides to a stop due to friction. In which case did the total mechanical energy of the block decrease the least?

a. This problem cannot be solved since it was not indicated whether the horizontal surface and the incline both had the same coefficient of kinetic friction.
b. The case on the horizontal surface had the least decrease in total mechanical energy.
c. The case on the inclined surface had the least decrease in total mechanical energy.
d. In both cases the decrease in mechanical energy was the same.

C5. In a problem using energy considerations to solve for the speed of a ball thrown from the top of a building when it strikes the ground below, where should the potential energy have its zero value?

a. It should be at the level from where the ball is thrown.
b. It should be at the ground level where the ball hits.
c. It should be slightly below ground level so the potential energy is always positive.
d. It doesn't matter since only differences in potential energy matter in solutions.

5.1 Work

1. The unit of work, joule, is dimensionally the same as:

    a. newton/second.
    b. newton/kilogram.
    c. newton-second.
    d. newton-meter.

2. Rupel pushes a box 5.00 m by applying a 25.0-N horizontal force. What work does she do?

    a. 10.0 J
    b. 25.0 J
    c. 125 J
    d. 550 J

3. A worker pushes a sled with a force of 40 N over a level distance of 6.0 m. If a frictional force of 24 N acts on the wheelbarrow in a direction opposite to that of the worker, what net work is done on the wheelbarrow?

    a. 240 J
    b. 216 J
    c. 144 J
    d. 96 J

4. A horizontal force of 100 N is applied to move a 45-kg cart across a 9.0-m level surface. What work is done by the 100-N force?

    a. 405 J
    b. 500 J
    c. 900 J
    d. 4 500 J

5. I use a rope 2.00 m long to swing a 10.0-kg weight around my head. The tension in the rope is 20.0 N. In half a revolution how much work is done by the rope on the weight?

    a. 40.0 J
    b. 126 J
    c. 251 J
    d. 0

6. The work done by static friction can be:

a. positive.
b. negative.
c. zero.
d. Any of the above.

7. A satellite is held in orbit by a 2 000-N gravitational force. Each time the satellite completes an orbit of circumference 80 000 km, the work done on it by gravity is:

a. 1.6×10^{8} J.
b. 1.6×10^{11} J.
c. 6.4×10^{11} J.
d. 0.

5.2 Kinetic Energy and the Work-Energy Theorem

8. Which of the following is an example of a nonconservative force?

a. gravity
b. magnetism
c. friction
d. Both choices A and B are valid.

9. Which of the following is that form of energy associated with an object's motion?

a. potential
b. thermal
c. bio-chemical
d. kinetic

10. Which of the following is that form of energy associated with an object's location in a conservative force field?

a. potential
b. thermal
c. bio-chemical
d. kinetic

11. What is the kinetic energy of a 0.135-kg baseball thrown at 40.0 m/s (90.0 mph)?

a. 54.0 J
b. 87.0 J
c. 108 J
d. 216 J

12. A horizontal force of 200 N is applied to a 55-kg cart across a 10-m level surface. If the cart accelerates at 2.0 m/s^2, then what is the work done by the force of friction as it acts to retard the motion of the cart?

    a. -1 100 J
    b. -900 J
    c. -800 J
    d. -700 J

13. A golf ball hits a wall and bounces back at 3/4 the original speed. What part of the original kinetic energy of the ball did it lose in the collision?

    a. 1/4
    b. 3/8
    c. 7/16
    d. 9/16

14. If both mass and velocity of a ball are tripled, the kinetic energy is increased by a factor of:

    a. 3.
    b. 6.
    c. 9.
    d. 27.

15. A 1 200-kg automobile moving at 25 m/s has the brakes applied with a deceleration of 8.0 m/s^2. How far does the car travel before it stops?

    a. 39 m
    b. 47 m
    c. 55 m
    d. 63 m

16. If during a given physical process the only force acting on an object is friction, which of the following must be assumed in regard to the object’s kinetic energy?

    a. decreases
    b. increases
    c. remains constant
    d. cannot tell from the information given

5.3 Gravitational Potential Energy

17. A very light cart holding a 300-N box is moved at constant velocity across a 15-m level surface. What is the net work done in the process?

    a. zero
    b. 1/20 J
    c. 20 J
    d. 2 000 J

18. A 7.00-kg bowling ball falls from a 2.00-m shelf. Just before hitting the floor, what will be its kinetic energy? (g = 9.80 m/s^2 and assume air resistance is negligible)

    a. 14.0 J
    b. 19.6 J
    c. 29.4 J
    d. 137 J

19. A rock is thrown straight up with an initial velocity of 15.0 m/s. Ignore energy lost to air friction. How high will the rock rise?

    a. 1.53 m
    b. 22.9 m
    c. 6.50 m
    d. 11.5 m

20. What is the minimum amount of energy required for an 80-kg climber carrying a 20-kg pack to climb Mt. Everest, 8 850 m high?

    a. 8.67 MJ
    b. 4.16 MJ
    c. 2.47 MJ
    d. 1.00 MJ

21. A professional skier reaches a speed of 56 m/s on a 30° ski slope. Ignoring friction, what was the minimum distance along the slope the skier would have had to travel, starting from rest?

    a. 110 m
    b. 160 m
    c. 320 m
    d. 640 m

22. As an object is lowered into a deep hole in the surface of the earth, which of the following must be assumed in regard to its potential energy?

    a. increase
    b. decrease
    c. remain constant
    d. cannot tell from the information given

23. When an object is dropped from a tower, what is the effect of the air resistance as it falls?

    a. does positive work
    b. increases the object’s kinetic energy
    c. increases the object’s potential energy
    d. None of the above choices are valid.

24. Samantha pushes a 50-N crate up a ramp 25.0 m in length and inclined at 10° with the horizontal. What potential energy change does the crate experience?

    a. 13 J
    b. 55 J
    c. 120 J
    d. 220 J

25. A 15.0-kg crate, initially at rest, slides down a ramp 2.0 m long and inclined at an angle of 20° with the horizontal. If there is no friction between ramp surface and crate, what is the kinetic energy of the crate at the bottom of the ramp? (g = 9.8 m/s^2)

    a. 220 J
    b. 690 J
    c. 10 J
    d. 100 J

26. A 10.0-kg box starts at rest and slides 3.5 m down a ramp inclined at an angle of 10° with the horizontal. If there is no friction between the ramp surface and crate, what is the velocity of the crate at the bottom of the ramp? (g = 9.8 m/s^2)

    a. 6.1 m/s
    b. 3.5 m/s
    c. 10.7 m/s
    d. 8.3 m/s

27. A baseball catcher puts on an exhibition by catching a 0.15-kg ball dropped from a helicopter at a height of 101 m. What is the speed of the ball just before it hits the catcher's glove 1.0 m above the ground? (g = 9.8 m/s^2 and ignore air resistance)

    a. 44 m/s
    b. 38 m/s
    c. 31 m/s
    d. 22 m/s

28. A simple pendulum, 1.00 m in length, is released from rest when the support string is at an angle of 35.0° from the vertical. What is the speed of the suspended mass at the bottom of the swing? (g = 9.80 m/s^2 and ignore air resistance)

    a. 0.67 m/s
    b. 0.94 m/s
    c. 1.33 m/s
    d. 1.88 m/s

29. A simple pendulum, 2.0 m in length, is released with a push when the support string is at an angle of 25° from the vertical. If the initial speed of the suspended mass is 1.2 m/s when at the release point, what is its speed at the bottom of the swing? (g = 9.8 m/s^2)

    a. 2.3 m/s
    b. 2.6 m/s
    c. 2.0 m/s
    d. 0.5 m/s

30. A simple pendulum, 2.0 m in length, is released by a push when the support string is at an angle of 25° from the vertical. If the initial speed of the suspended mass is 1.2 m/s when at the release point, to what maximum angle will it move in the second half of its swing?

    a. 37°
    b. 30°
    c. 27°
    d. 21°

31. A hill is 100 m long and makes an angle of 12° with the horizontal. As a 50-kg jogger runs up the hill, how much work does gravity do on the jogger?

    a. 49 000 J
    b. 10 000 J
    c. –10 000 J
    d. zero

32. A 2.00-kg ball has zero kinetic and potential energy. Ernie drops the ball into a 10.0-m-deep well. Just before the ball hits the bottom, the sum of its kinetic and potential energy is:

    a. zero.
    b. 196 J.
    c. –196 J.
    d. 392 J.

33. A 2.00-kg ball has zero potential and kinetic energy. Maria drops the ball into a 10.0-m-deep well. After the ball comes to a stop in the mud, the sum of its potential and kinetic energy is:

    a. zero.
    b. 196 J.
    c. –196 J.
    d. 392 J.

34. Two blocks are released from the top of a building. One falls straight down while the other slides down a smooth ramp. If all friction is ignored, which one is moving faster when it reaches the bottom?

    a. The block that went straight down.
    b. The block that went down the ramp.
    c. They both will have the same speed.
    d. Insufficient information to work the problem.

35. Old Faithful geyser in Yellowstone Park shoots water hourly to a height of 40 m. With what velocity does the water leave the ground?

    a. 7.0 m/s
    b. 14 m/s
    c. 20 m/s
    d. 28 m/s

36. An 80 000-kg airliner is flying at 900 km/h at a height of 10.0 km. What is its total energy (kinetic + potential) if the total was 0 when the airliner was at rest on the ground?

    a. 250 MJ
    b. 478 MJ
    c. 773 MJ
    d. 10 300 MJ

37. A pole vaulter clears 6.00 m. With what speed does he strike the mat in the landing area?

    a. 2.70 m/s
    b. 5.40 m/s
    c. 10.8 m/s
    d. 21.6 m/s

38. A baseball outfielder throws a baseball of mass 0.15 kg at a speed of 40 m/s and initial angle of 30°. What is the kinetic energy of the baseball at the highest point of the trajectory? Ignore air friction.

    a. zero
    b. 30 J
    c. 90 J
    d. 120 J

39. A bobsled makes a run down an ice track starting at 150 m vertical distance up the hill. If there is no friction, what is the velocity at the bottom of the hill?

    a. 27 m/s
    b. 36 m/s
    c. 45 m/s
    d. 54 m/s

5.4 Spring Potential Energy

40. A 2 000-kg ore car rolls 50.0 m down a frictionless 10.0° incline. If there is a horizontal spring at the end of the incline, what spring constant is required to stop the ore car in a distance of 1.00 m?

    a. 340 kN/m
    b. 681 kN/m
    c. 980 kN/m
    d. 1 960 kN/m

41. An amount of work equal to 1.5 J is required to compress the spring in a spring-gun. What is the “launch speed” of a 15-g marble?

    a. 14 m/s
    b. 15 m/s
    c. 18 m/s
    d. 21 m/s

42. The SI units for *k*, the spring constant, are equivalent to:

    a. J.
    b. J / N.
    c. kg / s^2.
    d. None of the above.

43. By how much is the energy stored in a Hooke’s law spring increased when its stretch is increased from 8.00 cm to 16.0 cm?

    a. 100%
    b. 200%
    c. 300 %
    d. The correct answer is not given.

44. A Hooke’s law spring is compressed 12.0 cm from equilibrium and the potential energy stored is 72.0 J. What is the spring constant in this case?

    a. 10 000 N/m
    b. 5 000 N/m
    c. 1 200 N/m
    d. No answer is correct.

45. A Hooke's law spring is compressed 12.0 cm from equilibrium, and the potential energy stored is 72.0 J. What compression (as measured from equilibrium) would result in 100 J being stored in this case?

    a. 16.7 cm
    b. 14.1 cm
    c. 13.6 cm
    d. No answer is correct.

46. A Hooke's law spring is mounted horizontally over a frictionless surface. The spring is then compressed a distance *d* and is used to launch a mass *m* along the frictionless surface. What compression of the spring would result in the mass attaining double the kinetic energy received in the above situation?

    a. 1.41 *d*
    b. 1.73 *d*
    c. 2.00 *d*
    d. 4.00 *d*

47. A Hooke's law spring is mounted horizontally over a frictionless surface. The spring is then compressed a distance *d* and is used to launch a mass *m* along the frictionless surface. What compression of the spring would result in the mass attaining double the speed received in the above situation?

    a. 1.41 *d*
    b. 1.73 *d*
    c. 2.00 *d*
    d. 4.00 *d*

5.5 Systems and Energy Conservation

48. A 50-N crate is pulled up a 5-m inclined plane by a worker at constant velocity. If the plane is inclined at an angle of 37° to the horizontal and there exists a constant frictional force of 10 N between the crate and the surface, what is the force applied by the worker?

    a. zero
    b. 20 N
    c. 30 N
    d. 40 N

49. Adisa pulls a 40-N crate up a 5.0-m long inclined plane at a constant velocity. If the plane is inclined at an angle of 37° to the horizontal and there is a constant force of friction of 10 N between the crate and the surface, what is the net change in potential energy of the crate?

    a. 120 J
    b. –120 J
    c. 200 J
    d. –200 J

50. A 20-N crate starting at rest slides down a rough 5.0-m long ramp, inclined at 25° with the horizontal. 20 J of energy is lost to friction. What will be the speed of the crate at the bottom of the incline?

    a. 0.98 m/s
    b. 1.9 m/s
    c. 3.2 m/s
    d. 4.7 m/s

51. Preston pushes a wheelbarrow weighing 500 N to the top of a 50.0-m ramp, inclined at 20.0° with the horizontal, and leaves it. Tamara accidentally bumps the wheelbarrow. It slides back down the ramp, during which an 80.0-N frictional force acts on it over the 50.0 m. What is the wheelbarrow's kinetic energy at the bottom at of the ramp? (g = 9.8 m/s^2)

    a. 4 550 J
    b. 6 550 J
    c. 8 150 J
    d. 13 100 J

52. A pile driver drives a post into the ground. The mass of the pile driver is 2 500 kg and it is dropped through a height of 8.0 m on each stroke. If the resisting force of the ground is 4.0×10^6 N, how far is the post driven in on each stroke?

    a. 4.9 cm
    b. 9.8 cm
    c. 16 cm
    d. 49 cm

53. A baseball catcher puts on an exhibition by catching a 0.150-kg ball dropped from a helicopter at a height of 100 m above the catcher. If the catcher "gives" with the ball for a distance of 0.750 m while catching it, what average force is exerted on the mitt by the ball? (g = 9.80 m/s^2)

    a. 78 N
    b. 119 N
    c. 197 N
    d. 392 N

54. A girl and her bicycle have a total mass of 40.0 kg. At the top of the hill her speed is 5.0 m/s, and her speed doubles as she rides down the hill. The hill is 10.0 m high and 100 m long. How much kinetic energy and potential energy is lost to friction?

    a. 2 420 J
    b. 1 500 J
    c. 2 000 J
    d. 3 920 J

55. A girl and her bicycle have a total mass of 40 kg. At the top of the hill her speed is 5.0 m/s. The hill is 10 m high and 100 m long. If the force of friction as she rides down the hill is 20 N, what is her speed at the bottom?

    a. 5.0 m/s
    b. 10 m/s
    c. 11 m/s
    d. She stops before she reaches the bottom.

56. I drop a 60-g golf ball from 2.0 m high. It rebounds to 1.5 m. How much energy is lost?

    a. 0.29 J
    b. 0.50 J
    c. 0.88 J
    d. 1.0 J

57. A parachutist of mass 50.0 kg jumps out of an airplane at a height of 1 000 m. The parachute deploys, and she lands on the ground with a speed of 5.0 m/s. How much energy was lost to air friction during this jump?

    a. 49 400 J
    b. 98 700 J
    c. 198 000 J
    d. 489 000 J

58. A Hooke's law spring is compressed a distance d and is used to launch a mass m vertically to a height h above its starting position. Under the same compression d, the spring is now used to launch a mass of $2m$. How high does this second mass rise?

    a. h
    b. $h/2$
    c. $h/1.41$
    d. $h/4$

59. A Hooke's law spring is compressed a distance d and is used to launch a mass m vertically to a height h above its starting position. Under double the compression, the spring is now used to launch the mass. How high does the mass now rise above its starting position?

    a. $2\,h$
    b. $1.41\,h$
    c. $3\,h$
    d. $4\,h$

60. A Hooke's law spring is compressed a distance d and is used to launch a particle of mass m vertically to a height h above its starting position. Under double the compression, the spring is now used to launch a particle of mass 2 m. How high does the second mass rise above its starting position?

    a. h
    b. 2 h
    c. 3 h
    d. 4 h

5.6 Power

61. The quantity of work equal to one joule is also equivalent to which of the following?

    a. watt
    b. watt /s
    c. watt · s
    d. watt /s^2

62. The rate at which work is done is equivalent to which of the following?

    a. increase in potential energy
    b. thermal energy
    c. potential energy
    d. power

63. The unit of power, watt, is dimensionally the same as:

    a. joule-second.
    b. joule/second.
    c. joule-meter.
    d. joule/meter.

64. A 60-kg woman runs up a flight of stairs having a rise of 4.0 m in a time of 4.2 s. What average power did she supply?

    a. 380 W
    b. 560 W
    c. 620 W
    d. 670 W

65. An automobile delivers 30.0 hp to its wheels when moving at a constant speed of 22.0 m/s. What is the resistance force on the automobile at this speed? (1 hp = 746 watts)

    a. 18 600 N
    b. 410 000 N
    c. 1 020 N
    d. 848 N

66. Yuri, a Russian weightlifter, is able to lift 250 kg 2.00 m in 2.00 s. What is his power output?

    a. 500 W
    b. 2.45 kW
    c. 4.90 kW
    d. 9.80 kW

67. A jet engine develops 1.0×10^5 N of thrust in moving an airplane forward at a speed of 900 km/h. What is the power developed by the engine?

    a. 500 kW
    b. 10 MW
    c. 25 MW
    d. 50 MW

68. A speed boat requires 80 kW to move at a constant speed of 15 m/s. What is the resistive force of the water at this speed?

    a. 2 700 N
    b. 5 300 N
    c. 6 500 N
    d. 7 700 N

69. Water flows over a section of Niagara Falls at a rate of 1.20×10^6 kg/s and falls 50.0 m. What is the power dissipated by the waterfall?

    a. 588 MW
    b. 294 MW
    c. 147 MW
    d. 60.0 MW

70. A 1 000-kg sports car accelerates from zero to 25 m/s in 7.5 s. What is the average power delivered by the automobile engine?

    a. 20.8 kW
    b. 30.3 kW
    c. 41.7 kW
    d. 52.4 kW

71. A force of 5.0 N is applied to a 20-kg mass on a horizontal frictionless surface. As the speed of the mass increases at a constant acceleration, the power delivered to it by the force:

    a. remains the same.
    b. increases.
    c. decreases.
    d. doubles every 4.0 seconds.

72. A 100-W light bulb is left on for 10.0 hours. Over this period of time, how much energy was used by the bulb?

    a. 1 000 J
    b. 3 600 J
    c. 3 600 000 J
    d. 1.34 hp

73. A 200-hp engine can deliver, in SI units, an average power of ________. (1 hp = 746 W)

    a. 200 W
    b. 74 600 W
    c. 149 000 W
    d. 298 000 W

5.7 Work Done by a Varying Force

74. The area under the force vs. displacement curve represents:

    a. area.
    b. force.
    c. work.
    d. coefficient of static friction.

75. A force of 100 N is applied to a 50-kg mass in the direction of motion for a distance of 6.0 m and then the force is increased to 150 N for the next 4.0 m. For the 10 m of travel, how much work is done by the varying force?

    a. 1 200 J
    b. 1 500 J
    c. 2 400 J
    d. –1 500 J

76. The net force acting on a 6.0-kg object is given by $F_x = (10 - x)$ N, where F_x is in newtons and x is in meters. How much work is done on the object as it moves from $x = 0$ to $x = 10$ m?

    a. 100 J
    b. 75 J
    c. 50 J
    d. 25 J

77. The net force acting on a 12.6-kg object is given by $F_x = (20 - x)$ N, where F_x is in newtons and x is in meters. How much work is done on the object as it moves from $x = 0$ to $x = 10$ m?

    a. 300 J
    b. 200 J
    c. 150 J
    d. 100 J

CHAPTER 5 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	D	2	37.	C	2
C2.	B	2	38.	C	2
C3.	C	3	39.	D	2
C4.	C	3	40.	A	2
C5.	D	2	41.	A	2
1.	D	1	42.	C	2
2.	C	1	43.	C	2
3.	D	2	44.	A	2
4.	C	1	45.	B	3
5.	D	2	46.	A	2
6.	D	2	47.	C	3
7.	D	2	48.	D	2
8.	C	1	49.	A	2
9.	D	1	50.	D	2
10.	A	1	51.	A	2
11.	C	1	52.	A	2
12.	B	2	53.	C	2
13.	C	2	54.	A	2
14.	D	1	55.	C	2
15.	A	2	56.	A	2
16.	D	1	57.	D	2
17.	A	1	58.	B	2
18.	D	1	59.	D	2
19.	D	2	60.	B	2
20.	A	2	61.	C	1
21.	C	2	62.	D	1
22.	B	1	63.	B	1
23.	D	1	64.	B	2
24.	D	1	65.	C	2
25.	D	2	66.	B	2
26.	B	2	67.	C	2
27.	A	2	68.	B	2
28.	D	2	69.	A	3
29.	A	3	70.	C	2
30.	B	3	71.	B	2
31.	C	1	72.	C	2
32.	A	1	73.	C	1
33.	C	2	74.	C	1
34.	C	1	75.	A	2
35.	D	2	76	C	3
36.	D	2	77.	C	3

CHAPTER 6

Conceptual Problems

C1. Two masses collide and stick together. Before the collision one of the masses was at rest. Is there a situation in which the kinetic energy is conserved in such a collision?

a. Yes, if the less massive particle is the one initially at rest.
b. Yes, if the more massive particle is the one initially at rest.
c. Yes, if the two particles have the same mass.
d. No, kinetic energy is always lost is such a collision.

C2. In an automobile collision, how does an airbag lessen the blow to the passenger? Assume as a result of the collision, the passenger stops.

a. The air bag decreases the momentum change of the passenger in the collision.
b. During the collision, the force from the air bag is greater than would be the force from the windshield or dashboard so the passenger cannot hit the hard objects.
c. The stopping impulse is the same for either the hard objects or the airbag. Unlike the windshield or dashboard, the air bag gives some increasing the time for the slowing process and thus decreasing the average force on the passenger.
d. The airbag is there to insure the seatbelt holds.

C3. Two masses m_1 and m_2, with $m_1 = 3\ m_2$, undergo a head-on elastic collision. If the particles were approaching with speed v before the collision, with what speed are they moving apart after collision?

a. $3\ v$
b. $v/3$
c. $3v/4$
d. v

C4. Two masses m_1 and m_2, with $m_1 < m_2$, have momenta with equal magnitudes. How do their kinetic energies compare?

a. $KE_1 < KE_2$
b. $KE_1 = KE_2$
c. $KE_1 > KE_2$
d. More information is needed.

C5. Two particles collide, one of them initially being at rest. Is it possible for both particles to be at rest after the collision?

a. If the collision is perfectly inelastic, then this happens.
b. If the collision is elastic, then this happens.
c. This can happen sometimes if the more massive particle was at rest.
d. No.

6.1 Momentum and Impulse

1. A valid unit for momentum is which of the following?

   a. kg·m/s^2
   b. kg/m^2
   c. kg·m/s
   d. N·m

2. The dimensional equivalent of the quantity impulse in terms of the fundamental quantities (mass, length, time) is which of the following?

   a. MLT^{-1}
   b. ML^2T^{-2}
   c. MLT
   d. MLT^{-2}

3. A 75-kg swimmer dives horizontally off a 500-kg raft. The diver's speed immediately after leaving the raft is 4.0 m/s. A micro-sensor system attached to the edge of the raft measures the time interval during which the diver applies an impulse to the raft just prior to leaving the raft surface. If the time interval is read as 0.20 s, what is the magnitude of the average horizontal force by diver on the raft?

   a. 900 N
   b. 450 N
   c. 525 N
   d. 1 500 N

4. A 0.12-kg ball is moving at 6 m/s when it is hit by a bat, causing it to reverse direction and have a speed of 14 m/s. What is the change in the magnitude of the momentum of the ball?

   a. 0.39 kg·m/s
   b. 0.42 kg·m/s
   c. 1.3 kg·m/s
   d. 2.4 kg·m/s

5. The impulse experienced by a body is equivalent to its change in:

   a. velocity.
   b. kinetic energy.
   c. momentum.
   d. None of the above choices are valid.

6. The dimensional equivalence of the quantity “momentum” in terms of the fundamental quantities (mass, length, time) is:

   a. MLT^{-1}.
   b. $ML^{2}T^{-2}$.
   c. MLT.
   d. MLT^{-2}.

7. Alex throws a 0.15-kg rubber ball down onto the floor. The ball’s speed just before impact is 6.5 m/s, and just after is 3.5 m/s. What is the change in the magnitude of the ball’s momentum?

   a. 0.09 kg·m/s
   b. 1.5 kg·m/s
   c. 4.3 kg·m/s
   d. 126 kg·m/s

8. Alex throws a 0.15-kg rubber ball down onto the floor. The ball’s speed just before impact is 6.5 m/s, and just after is 3.5 m/s. If the ball is in contact with the floor for 0.025 s, what is the magnitude of the average force applied by the floor on the ball?

   a. 60 N
   b. 133 N
   c. 3.0 N
   d. 3.5 N

9. A crane drops a 0.30 kg steel ball onto a steel plate. The ball’s speeds just before impact and after are 4.5 m/s and 4.2 m/s, respectively. If the ball is in contact with the plate for 0.030 s, what is the magnitude of the average force that the ball exerts on the plate during impact?

   a. 87 N
   b. 133 N
   c. 3.0 N
   d. 3.5 N

10. Jerome pitches a baseball of mass 0.20 kg. The ball arrives at home plate with a speed of 40 m/s and is batted straight back to Jerome with a return speed of 60 m/s. What is the magnitude of change in the ball’s momentum?

   a. 4.0 kg·m/s
   b. 8.0 kg·m/s
   c. 18 kg·m/s
   d. 20 kg·m/s

11. Lonnie pitches a baseball of mass 0.20 kg. The ball arrives at home plate with a speed of 40 m/s and is batted straight back to Lonnie with a return speed of 60 m/s. If the bat is in contact with the ball for 0.050 s, what is the impulse experienced by the ball?

    a. 360 N·s
    b. 20 N·s
    c. 400 N·s
    d. 9.0 N·s

12. A ball with original momentum +4.0 kg·m/s hits a wall and bounces straight back without losing any kinetic energy. The change in momentum of the ball is:

    a. 0.
    b. –4.0 kg·m/s.
    c. 8.0 kg·m/s.
    d. –8.0 kg·m/s.

13. If a glass of water is on a table with a piece of paper under it, it is relatively easy to pull the paper out without disturbing the glass very much if the pull is done very quickly. This is because, with a quick pull:

    a. the force on the glass will be less.
    b. the momentum of the paper will be greater.
    c. the time for the pull will be less.
    d. the coefficient of kinetic friction will be less.

14. A car wash nozzle directs a steady stream of water at 1.5 kg/s, with a speed of 30 m/s, against a car window. What force does the water exert on the glass? Assume the water does not splash back.

    a. 11 N
    b. 45 N
    c. 110 N
    d. 440 N

15. The units of impulse are equivalent to:

    a. those of energy.
    b. N·m.
    c. kg·m/s.
    d. those of force.

6.2 Conservation of Momentum

16. A 75-kg swimmer dives horizontally off a 500-kg raft. If the diver's speed immediately after leaving the raft is 4 m/s, what is the corresponding raft speed?

    a. 0.2 m/s
    b. 0.5 m/s
    c. 0.6 m/s
    d. 4.0 m/s

17. A cannon of mass 1 500 kg fires a 10-kg shell with a velocity of 200 m/s at an angle of 45° above the horizontal. Find the recoil velocity of the cannon across the level ground.

    a. 1.33 m/s
    b. 0.94 m/s
    c. 2.41 m/s
    d. 1.94 m/s

18. The law of conservation of momentum is applicable to systems made up of objects described by which of the following?

    a. macroscopic
    b. microscopic
    c. interacting through friction
    d. All the above choices are valid.

19. A machine gun is attached to a railroad flatcar that rolls with negligible friction. If the railroad car has a mass of 6.25×10^4 kg, how many bullets of mass 25 g would have to be fired at 250 m/s off the back to give the railroad car a forward velocity of 0.5 m/s?

    a. 400
    b. 2 000
    c. 3 000
    d. 5 000

20. Ann the Astronaut weighs 60 kg. She is space walking outside the space shuttle and pushes a 350-kg satellite away from the shuttle at 0.90 m/s. What speed does this give Ann as she moves toward the shuttle?

    a. 4.0 m/s
    b. 5.3 m/s
    c. 8.5 m/s
    d. 9.0 m/s

21. A miniature spring-loaded, radio-controlled gun is mounted on an air puck. The gun's bullet has a mass of 5.00 g, and the gun and puck have a combined mass of 120 g. With the system initially at rest, the radio controlled trigger releases the bullet causing the puck and empty gun to move with a speed of 0.500 m/s. What is the bullet's speed?

    a. 4.80 m/s
    b. 11.5 m/s
    c. 48.0 m/s
    d. 12.0 m/s

22. A uranium nucleus (mass 238 units) at rest decays into a helium nucleus (mass 4.0 units) and a thorium nucleus (mass 234 units). If the speed of the helium nucleus is 6.0×10^5 m/s, what is the speed of the thorium nucleus?

    a. $1.0 \text{ x } 10^4$ m/s
    b. 3.0×10^4 m/s
    c. 3.6×10^4 m/s
    d. 4.1×10^4 m/s

23. If the momentum of an object is tripled, its kinetic energy will change by what factor?

    a. zero
    b. one-third
    c. three
    d. nine

24. The kinetic energy of an object is quadrupled. Its momentum will change by what factor?

    a. zero
    b. two
    c. eight
    d. four

25. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually doesn't break. This is because for the egg dropped on the grass:

    a. the change in momentum is greater.
    b. the change in momentum is less.
    c. the time interval for stopping is greater.
    d. the time interval for stopping is less.

26. A 70-kg man is standing in a 20-kg boat. The man steps to the right thinking he is stepping out onto the dock. However, the following will actually happen (ignore the friction of the water or air on the boat or the man):

    a. The man only moves a short distance to the right while the boat moves a larger distance to the left.
    b. The man actually stays still while the boat moves toward the left.
    c. The boat doesn't move and the man moves to the right.
    d. None of the above.

27. A lump of clay is thrown at a wall. A rubber ball of identical mass is thrown with the same speed toward the same wall. Which statement is true?

    a. The clay experiences a greater change in momentum than the ball.
    b. The ball experiences a greater change in momentum than the clay.
    c. The clay and the ball experience the same change in momentum.
    d. It is not possible to know which object has the greater change in momentum.

28. A high-diver of mass 70 kg jumps off a board 10 m above the water. If, 1.0 s after entering the water his downward motion is stopped, what average upward force did the water exert?

    a. 100 N
    b. 686 N
    c. 980 N
    d. No answer is correct.

29. Object 1 has twice the mass of Object 2. Both objects have the same kinetic energy. Which of the following statements is true?

    a. Both objects can have the same magnitude of momentum.
    b. Object 1 has a momentum of greater magnitude than Object 2.
    c. The magnitude of the momentum of Object 2 is four times that of Object 1.
    d. All the statements are false.

30. Object 1 has twice the mass of Object 2. Each of the objects has the same magnitude of momentum. Which of the following statements is true?

    a. Both objects can have the same kinetic energy.
    b. One object has 0.707 times the kinetic energy of the other.
    c. One object has twice the kinetic energy of the other.
    d. One object has 4 times the kinetic energy of the other.

31. Three satellites are launched into space connected together. Once in deep space, an explosive charge separates the three satellites and they move apart. The satellites each have different masses with $m_1 < m_2 < m_3$. Which of the following statements is always true?

    a. The one with mass m_1 receives the greatest impulse.
    b. The one with mass m_3 receives the greatest impulse.
    c. The all must receive equal impulses.
    d. Although one or more of the above statements could be true in special cases, they are not always true.

6.3 Collisions

6.4 Glancing Collisions

32. A 20-g bullet moving at 1 000 m/s is fired through a one-kg block of wood emerging at a speed of 100 m/s. If the block had been originally at rest and is free to move, what is its resulting speed?

    a. 9 m/s
    b. 18 m/s
    c. 90 m/s
    d. 900 m/s

33. A 20-g bullet moving at 1 000 m/s is fired through a one-kg block of wood emerging at a speed of 100 m/s. What is the kinetic energy of the block that results from the collision if the block had not been moving prior to the collision and was free to move?

    a. 10 kJ
    b. 9.8 kJ
    c. 0.16 kJ
    d. 0.018 kJ

34. A 20-g bullet moving at 1 000 m/s is fired through a one-kg block of wood emerging at a speed of 100 m/s. What is the change in the kinetic energy of the bullet-block system as a result of the collision assuming the block is free to move?

    a. 0 J
    b. 9.7 kJ
    c. – 9.7 kJ
    d. – 18 J

35. An object of mass m moving at speed v_0 strikes an object of mass $2m$ which had been at rest. The first object bounces backward along its initial path at speed v_0. Is this collision elastic, and if not, what is the change in kinetic energy of the system?

    a. The collision is elastic.
    b. The kinetic energy decreases by mv^2.
    c. The kinetic energy decreases by $½mv^2$.
    d. The kinetic energy increases by mv^2.

36. A billiard ball is moving in the *x*-direction at 30.0 cm/s and strikes another billiard ball moving in the *y*-direction at 40.0 cm/s. As a result of the collision, the first ball moves at 50.0 cm/s, and the second ball stops. In what final direction does the first ball move?

    a. in the *x*-direction
    b. at an angle of 53.1° ccw from the *x*-direction
    c. at an angle of 45.0° ccw from the *x*-direction
    d. Such a collision cannot happen.

37. A billiard ball is moving in the *x*-direction at 30.0 cm/s and strikes another billiard ball moving in the *y*-direction at 40.0 cm/s. As a result of the collision, the first ball moves at 50.0 cm/s, and the second ball stops. What is the change in kinetic energy of the system as a result of the collision?

    a. 0
    b. some positive value
    c. some negative value
    d. No answer above is correct.

38. During a snowball fight two balls with masses of 0.4 and 0.6 kg, respectively, are thrown in such a manner that they meet head-on and combine to form a single mass. The magnitude of initial velocity for each is 15 m/s. What is the speed of the 1.0-kg mass immediately after collision?

    a. zero
    b. 3 m/s
    c. 6 m/s
    d. 9 m/s

39. A 2 500-kg truck moving at 10.00 m/s strikes a car waiting at a traffic light, hooking bumpers. The two continue to move together at 7.00 m/s. What was the mass of the struck car?

    a. 1 730 kg
    b. 1 550 kg
    c. 1 200 kg
    d. 1 070 kg

40. A billiard ball collides in an elastic head-on collision with a second stationary identical ball. After the collision which of the following conditions applies to the first ball?

    a. maintains the same velocity as before
    b. has one half its initial velocity
    c. comes to rest
    d. moves in the opposite direction

41. A billiard ball collides in an elastic head-on collision with a second identical ball. What is the kinetic energy of the system after the collision compared to that before collision?

    a. the same as
    b. one fourth
    c. twice
    d. four times

42. In a two-body collision, if the momentum of the system is conserved, then which of the following best describes the kinetic energy after the collision?

    a. must be less
    b. must also be conserved
    c. may also be conserved
    d. is doubled in value

43. In a two-body collision, if the kinetic energy of the system is conserved, then which of the following best describes the momentum after the collision?

    a. must be less
    b. must also be conserved
    c. may also be conserved
    d. is doubled in value

44. A railroad freight car, mass 15 000 kg, is allowed to coast along a level track at a speed of 2.0 m/s. It collides and couples with a 50 000-kg loaded second car, initially at rest and with brakes released. What percentage of the initial kinetic energy of the 15 000-kg car is preserved in the two-coupled cars after collision?

    a. 14%
    b. 23%
    c. 86%
    d. 100%

45. A miniature, spring-loaded, radio-controlled gun is mounted on an air puck. The gun's bullet has a mass of 5.00 g, and the gun and puck have a combined mass of 120 g. With the system initially at rest, the radio-controlled trigger releases the bullet, causing the puck and empty gun to move with a speed of 0.500 m/s. Of the total kinetic energy of the gun-puck-bullet system, what percentage is in the bullet?

    a. 4.0%
    b. 50%
    c. 96%
    d. 100%

46. A 20-kg object sitting at rest is struck elastically in a head-on collision with a 10-kg object initially moving at +3.0 m/s. Find the final velocity of the 20-kg object after the collision.

    a. –1.0 m/s
    b. –2.0 m/s
    c. +1.5 m/s
    d. +2.0 m/s

47. A 0.10-kg object moving initially with a velocity of +0.20 m/s makes an elastic head-on collision with a 0.15-kg object initially at rest. What percentage of the original kinetic energy is retained by the 0.10-kg object?

    a. 4%
    b. –4%
    c. 50%
    d. 96%

48. Two billiard balls have velocities of 2.0 m/s and –1.0 m/s when they meet in an elastic head-on collision. What is the final velocity of the first ball after collision?

    a. –2.0 m/s
    b. –1.0 m/s
    c. –0.5 m/s
    d. +1.0 m/s

49. Two objects, one less massive than the other, collide elastically and bounce back after the collision. If the two originally had velocities that were equal in size but opposite in direction, then which one will be moving faster after the collision?

    a. The less massive one.
    b. The more massive one.
    c. The speeds will be the same after the collision.
    d. There is no way to be sure without the actual masses.

50. In a partially elastic collision between two objects with unequal mass:

    a. the velocity of one will increase by the amount that the velocity of the other decreases.
    b. the momentum of one will increase by the amount that the momentum of the other decreases.
    c. the energy of one increases by the amount that the energy of the other decreases.
    d. the total momentum of the system will decrease.

51. A 7.0-kg bowling ball strikes a 2.0-kg pin. The pin flies forward with a velocity of 6.0 m/s; the ball continues forward at 4.0 m/s. What was the original velocity of the ball?

    a. 4.0 m/s
    b. 5.7 m/s
    c. 6.6 m/s
    d. 3.3 m/s

52. A 1.00-kg duck is flying overhead at 1.50 m/s when a hunter fires straight up. The 0.010 0-kg bullet is moving 100 m/s when it hits the duck and stays lodged in the duck's body. What is the speed of the duck and bullet immediately after the hit?

    a. 1.49 m/s
    b. 2.48 m/s
    c. 1.80 m/s
    d. 1.78 m/s

53. Kaitlin uses a bat to hit a thrown baseball. She knocks the ball back in the direction from which it came in a partially inelastic collision. The bat, which is heavier than the baseball, continues to move in the same direction after the hit as Kaitlin "follows through." Is the ball moving faster before or after it was hit?

    a. The ball was moving faster before it was hit.
    b. The ball was moving faster after it was hit.
    c. The ball was moving at essentially the same speed before and after the hit.
    d. There is insufficient information to answer this problem.

54. A tennis ball is held above and in contact with a basketball, and then both are simultaneously dropped. The tennis ball bounces off the basketball at a fairly high speed. This is because:

    a. the basketball falls farther than the tennis ball.
    b. the tennis ball is slightly shielded from the Earth's gravitational pull.
    c. the massive basketball transfers momentum to the lighter tennis ball.
    d. the tennis ball has a smaller radius.

55. Two skaters, both of mass 75 kg, are on skates on a frictionless ice pond. One skater throws a 0.3-kg ball at 5 m/s to his friend, who catches it and throws it back at 5 m/s. When the first skater has caught the returned ball, what is the velocity of each of the two skaters?

    a. 0.02 m/s, moving apart
    b. 0.04 m/s, moving apart
    c. 0.02 m/s, moving towards each other
    d. 0.04 m/s, moving towards each other

56. A 90-kg halfback running north with a speed of 10 m/s is tackled by a 120-kg opponent running south at 4 m/s. The collision is perfectly inelastic. Compute the velocity of the two players just after the tackle.

    a. 3 m/s south
    b. 2 m/s south
    c. 2 m/s north
    d. 3 m/s north

57. A neutron in a nuclear reactor makes an elastic head-on collision with a carbon atom initially at rest. (The mass of the carbon atom is 12 times that of the neutron.) What fraction of the neutron's kinetic energy is transferred to the carbon atom?

    a. 14.4%
    b. 28.4%
    c. 41.4%
    d. 56.6%

58. Popeye, of mass 70 kg, has just downed a can of spinach. He accelerates quickly and stops Bluto, of mass 700 kg (Bluto is very dense), who is charging in at 10 m/s. What was Popeye's speed?

    a. 10 m/s
    b. 31 m/s
    c. 50 m/s
    d. 100 m/s

59. Mitch throws a 100-g lump of clay at a 500-g target, which is at rest on a horizontal surface. After impact, the target, including the attached clay, slides 2.1 m before stopping. If the coefficient of friction is $\mu = 0.50$, find the speed of the clay before impact.

    a. 4.5 m/s
    b. 12 m/s
    c. 27 m/s
    d. 36 m/s

60. Two identical 7-kg bowling balls roll toward each other. The one on the left is moving at +4 m/s while the one on the right is moving at –4 m/s. What is the velocity of each ball after they collide elastically?

    a. Neither is moving.
    b. –4 m/s, +4 m/s
    c. +4 m/s, –4 m/s
    d. –14 m/s, 14 m/s

61. A 5-kg object is moving to the right at 4 m/s and collides with another object moving to the left at 5 m/s. The objects collide and stick together. After the collision, the combined object:

    a. is moving to the right.
    b. is moving to the left.
    c. is at rest.
    d. has less kinetic energy than the system had before the collision.

62. A 5-kg object is moving to the right at 4 m/s and collides with a 4-kg object moving to the left at 5 m/s. The objects collide and stick together. After the collision, the combined object:

    a. has the same kinetic energy that the system had before the collision.
    b. has more kinetic energy than the system had before the collision.
    c. has no kinetic energy.
    d. has less momentum than the system had before the collision.

63. If a two-body collision is not head-on, then we may always assume that:

    a. momentum is conserved.
    b. kinetic energy is conserved.
    c. neither momentum nor kinetic energy are conserved.
    d. both momentum and kinetic energy are conserved.

64. In a system with two moving objects, when a collision occurs between the objects:

    a. the total kinetic energy is always conserved.
    b. the total momentum is always conserved.
    c. the total kinetic energy and total momentum are always conserved.
    d. neither the kinetic energy nor the momentum is conserved.

65. A billiard ball (Ball #1) moving at 5.00 m/s strikes a stationary ball (Ball #2) of the same mass. After the collision, Ball #1 moves at a speed of 4.35 m/s. Find the speed of Ball #2 after the collision.

    a. 1.25 m/s
    b. 1.44 m/s
    c. 2.16 m/s
    d. 2.47 m/s

66. A baseball infielder, mass 75.0 kg, jumps up with velocity 3.00 m/s and catches a 0.150-kg baseball moving horizontally at 50.0 m/s. Of the following, which is closest to the final momentum of the system, infielder and baseball?

    a. 225 kg·m/s
    b. 228 kg·m/s
    c. 230 kg·m/s
    d. 233 kg·m/s

67. When a collision is perfectly inelastic, then:

    a. all the kinetic energy is conserved.

b. all the kinetic energy is gone.
c. the participants stick together.
d. the total momentum is zero.

6.5 Rocket Propulsion

68. A model car is propelled by a cylinder of carbon dioxide gas. The cylinder emits gas at a rate of 4.5 g/s with an exit speed of 80.0 m/s. The car has a mass of 400 g, including the CO_2 cylinder. Starting from rest, what is the car's initial acceleration?

a. 0.90 m/s^2
b. 4.5 m/s^2
c. 9.0 m/s^2
d. 36 m/s^2

69. A 1 000-kg experimental rocket sled on level frictionless rails is loaded with 50 kg of propellant. It exhausts the propellant in a 20-s "burn." If the rocket, initially at rest, moves at 150 m/s after the burn, what impulse is experienced by the rocket sled?

a. 1.1×10^5 kg·m/s
b. 1.6×10^5 kg·m/s
c. 1.5×10^5 kg·m/s
d. 1.9×10^5 kg·m/s

70. A 1 000-kg experimental rocket sled at rest on level frictionless rails is loaded with 50 kg of propellant. It exhausts the propellant in a 20-s "burn." The rocket moves at 150 m/s after the burn. What average force is experienced by the rocket during the burn?

a. 0.95×10^4 N
b. 0.75×10^4 N
c. 0.60×10^4 N
d. 0.35×10^4 N

71. A helicopter stays aloft by pushing large quantities of air downward every second. What mass of air must be pushed downward at 40.0 m/s every second to keep a 1 000-kg helicopter aloft?

a. 120 kg
b. 245 kg
c. 360 kg
d. 490 kg

72. A model rocket sits on the launch pad until its fuel is ignited, blasting the rocket upward. During the short time of blast-off, as the ignited fuel goes down, the rocket goes up because:

    a. the fuel pushes on the ground.
    b. air friction pushes on the escaping fuel.
    c. the downward force of gravity is less than the downward momentum of the fuel.
    d. of none of the above reasons.

73. At liftoff, the engines of the Saturn V rocket consumed 13 000 kg/s of fuel and exhausted the combustion products at 2 900 m/s. What was the total upward force (thrust) provided by the engines?

    a. 3.77×10^7 N
    b. 7.54×10^7 N
    c. 1.47×10^8 N
    d. 2.95×10^8 N

74. Neglecting gravity, doubling the exhaust velocity from a single stage rocket initially at rest changes the final velocity attainable by what factor? Assume all other variables, such as the mass of the rocket and the mass of the fuel, do not change.

    a. The final velocity stays the same.
    b. The final velocity doubles.
    c. The final velocity increases by a factor of 0.693.
    d. The final velocity increases by a factor of 0.310.

75. Neglecting gravity, doubling the exhaust velocity from a single stage rocket initially at rest changes the final kinetic energy of the burnout stage by what factor? Assume all other variables, such as the mass of the rocket and the mass of the fuel, do not change.

    a. It is the same.
    b. It doubles.
    c. It quadruples.
    d. It increases by a factor of 1.693.

76. A rocket of total mass M and with burnout mass 0.20 M attains a speed of 3 200 m/s after starting from rest in deep space. What is the exhaust velocity of the rocket?

    a. 1 000 m/s
    b. 2 000 m/s
    c. 3 000 m/s
    d. 4 000 m/s

Chapter 6 - Answers

#	Ans	Difficulty	#	Ans	Difficulty
C1.	D	2	37.	A	2
C2.	C	2	38.	B	2
C3.	D	2	39.	D	2
C4.	C	2	40.	C	1
C5.	D	1	41.	A	1
1.	C	1	42.	C	1
2.	A	1	43.	B	1
3.	D	2	44.	B	3
4.	D	2	45.	C	3
5.	C	1	46.	D	3
6.	A	1	47.	A	2
7.	B	2	48.	B	2
8.	A	2	49.	A	2
9.	A	2	50.	B	2
10.	D	2	51.	B	2
11.	B	2	52.	D	3
12.	D	1	53.	D	2
13.	C	2	54.	C	2
14.	B	2	55.	B	2
15.	C	1	56.	C	2
16.	C	2	57.	B	3
17.	B	2	58.	D	2
18.	D	1	59.	C	3
19.	D	2	60.	B	2
20.	B	2	61.	D	2
21.	D	2	62.	C	2
22.	A	2	63.	A	1
23.	D	1	64.	B	1
24.	B	1	65.	D	3
25.	C	1	66.	A	3
26.	A	2	67.	C	1
27.	B	2	68.	A	2
28.	D	3	69.	C	2
29.	B	3	70.	B	2
30.	C	3	71.	B	2
31.	D	2	72.	D	2
32.	B	2	73.	A	2
33.	C	2	74.	B	1
34.	C	3	75	C	2
35.	D	2	76.	B	2
36.	B	2			

CHAPTER 7

Conceptual Problems

C1. The Earth's orbit is closest to the Sun in January and farthest from the Sun in July. When is the Earth moving the fastest in orbit?

a. Neither January nor July since the orbital speed of the Earth is a constant.
b. January
c. July
d. This occurs twice a year, in April and in October.

C2. Two objects are in circular orbits of different radii around the Sun. Which object has the highest orbital speed?

a. The one closest to the Sun.
b. The one farthest from the Sun.
c. Once in orbit around the Sun, all objects have the same orbital speed regardless of distance from the Sun. It is the greater radius and greater resulting circumference that causes the object farther from the Sun to take longer to complete an orbit.
d. This cannot be found without knowing the relative masses of the objects.

C3. For a point on a spinning disc in uniform circular motion, which of the following is not constant?

a. Its angular speed.
b. Its angular acceleration.
c. Its centripetal acceleration.
d. The magnitude of its total acceleration.

C4. Two points on a merry-go-round are located at distances from the center r_1 and r_2, where $r_1 < r_2$. While the merry-go-round is in the process of speeding up to operational speed, which of the following equations involving magnitudes of angular speed, angular acceleration, and tangential speed for these points is incorrect?

a. $\omega_1 = \omega_2$
b. $\alpha_1 = \alpha_2$
c. $v_{t1} = v_{t2}$
d. All of the equations are correct.

C5. A car is going around a racetrack at constant speed. The curves around the track have different radii. In which turn is the magnitude of the car's acceleration the greatest?

a. It is the greatest in the turn with the greatest radius.
b. It is the greatest in the turn with the smallest radius.
c. The acceleration is zero everywhere because of the constant speed.
d. More information is needed to determine the answer.

7.1 Angular Speed and Angular Acceleration

1. 2 600 rev/min is equivalent to which of the following?

   a. 2600 rad/s
   b. 43.3 rad/s
   c. 273 rad/s
   d. 60 rad/s

2. A grindstone spinning at the rate of 8.3 rev/s has what approximate angular speed?

   a. 3.2 rad/s
   b. 26 rad/s
   c. 52 rad/s
   d. 81 rad/s

3. A 0.12-m-radius grinding wheel takes 5.5 s to speed up from 2.0 rad/s to 11.0 rad/s. What is the wheel's average angular acceleration?

   a. 9.6 rad/s^2
   b. 4.8 rad/s^2
   c. 1.6 rad/s^2
   d. 0.33 rad/s^2

4. What is the angular speed about the rotational axis of the Earth for a person standing on the surface?

   a. 7.3×10^{-5} rad/s
   b. 3.6×10^{-5} rad/s
   c. 6.28×10^{-5} rad/s
   d. 3.14×10^{-5} rad/s

5. A spool of thread has an average radius of 1.00 cm. If the spool contains 62.8 m of thread, how many turns of thread are on the spool? "Average radius" allows us to not need to treat the layering of threads on lower layers.

   a. 100
   b. 1 000
   c. 3 140
   d. 62 800

6. A ceiling fan is turned on and reaches an angular speed of 120 rev/min in 20 s. It is then turned off and coasts to a stop in an additional 40 s. The ratio of the average angular acceleration for the first 20 s to that for the last 40 s is which of the following?

   a. 2
   b. 0.5
   c. –0.5
   d. –2

7.2 Rotational Motion Under Constant Angular Acceleration

7. A 0.30-m-radius automobile tire rotates how many rad after starting from rest and accelerating at a constant 2.0 rad/s^2 over a 5.0-s interval?

   a. 12.5 rad
   b. 25 rad
   c. 2.0 rad
   d. 0.50 rad

8. A fan blade, initially at rest, rotates with a constant acceleration of 0.025 rad/s^2. What is its angular speed at the instant it goes through an angular displacement of 4.2 rad?

   a. 0.025 rad/s
   b. 0.11 rad/s
   c. 0.46 rad/s
   d. 1.2 rad/s

9. A fan blade, initially at rest, rotates with a constant acceleration of 0.025 rad/s^2. What is the time interval required for it to reach a 4.2-rad displacement after starting from rest?

   a. 1.8 s
   b. 2.0 s
   c. 16 s
   d. 18 s

10. A ceiling fan is turned on and reaches an angular speed of 120 rev/min in 20 s. It is then turned off and coasts to a stop in 40 s. In the one minute of rotation, through how many revolutions did the fan turn?

   a. 20
   b. 60
   c. 0
   d. 600

11. Starting from rest, a wheel undergoes constant angular acceleration for a period of time T. At what time after the start of rotation does the wheel reach an angular speed equal to its average angular speed for this interval?

    a. 0.25 T
    b. 0.50 T
    c. 0.67 T
    d. 0.71 T

12. Starting from rest, a wheel undergoes constant angular acceleration for a period of time T. At which of the following times does the average angular acceleration equal the instantaneous angular acceleration?

    a. 0.50 T
    b. 0.67 T
    c. 0.71 T
    d. all of the above

13. A Ferris wheel starts at rest and builds up to a final angular speed of 0.70 rad/s while rotating through an angular displacement of 4.9 rad. What is its average angular acceleration?

    a. 0.10 rad/s^2
    b. 0.05 rad/s^2
    c. 1.8 rad/s^2
    d. 0.60 rad/s^2

14. A Ferris wheel, rotating initially at an angular speed of 0.50 rad/s, accelerates over a 7.0-s interval at a rate of 0.040 rad/s^2. What is its angular speed after this 7-s interval?

    a. 0.20 rad/s
    b. 0.30 rad/s
    c. 0.46 rad/s
    d. 0.78 rad/s

15. A Ferris wheel, rotating initially at an angular speed of 0.500 rad/s, accelerates over a 7.00-s interval at a rate of 0.040 0 rad/s^2. What angular displacement does the Ferris wheel undergo in this 7-s interval?

    a. 4.48 rad
    b. 2.50 rad
    c. 3.00 rad
    d. 0.500 rad

7.3 Relations Between Angular and Linear Quantities

16. A ventilation fan has blades 0.25 m in radius rotating at 20 rpm. What is the tangential speed of each blade tip?

    a. 0.02 m/s
    b. 0.52 m/s
    c. 5.0 m/s
    d. 20 m/s

17. A 0.30-m-radius automobile tire accelerates from rest at a constant 2.0 rad/s^2 over a 5.0-s interval. What is the tangential component of acceleration for a point on the outer edge of the tire during the 5-s interval?

    a. 33 m/s^2
    b. 6.7 m/s^2
    c. 0.60 m/s^2
    d. 0.30 m/s^2

18. A point on the rim of a 0.30-m-radius rotating wheel has a tangential speed of 4.0 m/s. What is the tangential speed of a point 0.20 m from the center of the same wheel?

    a. 1.0 m/s
    b. 1.3 m/s
    c. 2.7 m/s
    d. 8.0 m/s

19. A 0.15-m-radius grinding wheel starts at rest and develops an angular speed of 12.0 rad/s in 4.0 s. What is the average tangential acceleration of a point on the wheel's edge?

    a. 0.45 m/s^2
    b. 6.8 m/s^2
    c. 28 m/s^2
    d. 14 m/s^2

20. The end of the cutting cord on a gas-powered weed cutter is 0.15 m in length. If the motor rotates at the rate of 20 rev/s, what is the tangential speed of the end of the cord?

    a. 628 m/s
    b. 25 m/s
    c. 19 m/s
    d. 63 m/s

21. A bucket in an old well is hoisted upward by a rope which winds up on a cylinder having a radius of 0.050 m. How many rev/s must the cylinder turn if the bucket is raised at a speed of 0.15 m/s?

    a. 3.0 rev/s
    b. 1.5 rev/s
    c. 0.48 rev/s
    d. 0.24 rev/s

22. Consider a point on a bicycle wheel as the wheel makes exactly four complete revolutions about a fixed axis. Compare the linear and angular displacement of the point.

    a. Both are zero.
    b. Only the angular displacement is zero.
    c. Only the linear displacement is zero.
    d. Neither is zero.

23. Consider a point on a bicycle wheel as the wheel turns about a fixed axis, neither speeding up nor slowing down. Compare the linear and angular velocities of the point.

    a. Both are constant.
    b. Only the angular velocity is constant.
    c. Only the linear velocity is constant.
    d. Neither is constant.

24. Consider a point on a bicycle wheel as the wheel turns about a fixed axis, neither speeding up nor slowing down. Compare the linear and angular accelerations of the point.

    a. Both are zero.
    b. Only the angular acceleration is zero.
    c. Only the linear acceleration is zero.
    d. Neither is zero.

25. Calculate the linear speed due to the Earth's rotation for a person at the equator of the Earth. The radius of the Earth is 6.40×10^6 m.

    a. 74.0 m/s
    b. 233 m/s
    c. 465 m/s
    d. 73.0 m/s

26. Calculate the linear speed due to the Earth's rotation for a person at a point on its surface located at 40^o N latitude. The radius of the Earth is 6.40×10^6 m.

    a. 299 m/s
    b. 357 m/s
    c. 390 m/s
    d. 465 m/s

7.4 Centripetal Acceleration

27. A ventilation fan has blades 0.25 m long rotating at 20 rpm. What is the centripetal acceleration of a point on the outer tip of a blade?

    a. 1.1 m/s^2
    b. 0.87 m/s^2
    c. 0.55 m/s^2
    d. 0.23 m/s^2

28. A 0.30-m-radius automobile tire accelerates from rest at a constant 2.0 rad/s^2. What is the centripetal acceleration of a point on the outer edge of the tire after 5.0 s?

    a. 300 m/s^2
    b. 33 m/s^2
    c. 30 m/s^2
    d. 3.0 m/s^2

29. A 0.40-kg mass, attached to the end of a 0.75-m string, is whirled around in a circular horizontal path. If the maximum tension that the string can withstand is 450 N, then what maximum speed can the mass have if the string is not to break?

    a. 370 m/s
    b. 22 m/s
    c. 19 m/s
    d. 29 m/s

30. A point on the rim of a 0.25-m-radius fan blade has centripetal acceleration of 0.20 m/s^2. Find the centripetal acceleration of a point 0.05 m from the center of the same wheel.

    a. 0.01 m/s^2
    b. 0.02 m/s^2
    c. 0.04 m/s^2
    d. 0.08 m/s^2

31. A point on the rim of a 0.25-m-radius rotating wheel has a centripetal acceleration of 4.0 m/s^2. What is the angular speed of the wheel?

    a. 1.0 rad/s
    b. 2.0 rad/s
    c. 3.2 rad/s
    d. 4.0 rad/s

32. A point on the rim of a 0.15-m-radius rotating disk has a centripetal acceleration of 5.0 m/s^2. What is the angular speed of a point 0.075 m from the center of the disk?

    a. 0.89 rad/s
    b. 1.6 rad/s
    c. 3.2 rad/s
    d. 5.8 rad/s

33. When a point on the rim of a 0.30-m-radius wheel experiences a centripetal acceleration of 4.0 m/s^2, what tangential acceleration does that point experience?

    a. 1.2 m/s^2
    b. 2.0 m/s^2
    c. 4.0 m/s^2
    d. Cannot determine with the information given.

34. A 0.150-m-radius grinding wheel, starting at rest, develops an angular speed of 12.0 rad/s in a time interval of 4.00 s. What is the centripetal acceleration of a point 0.100 m from the center when the wheel is moving at an angular speed of 12.0 rad/s?

    a. 0.450 m/s^2
    b. 7.20 m/s^2
    c. 14.4 m/s^2
    d. 28.8 m/s^2

35. The distance from the center of a Ferris wheel to a passenger seat is 12 m. What centripetal acceleration does a passenger experience when the wheel's angular speed is 0.50 rad/s?

    a. 16.9 m/s^2
    b. 9.0 m/s^2
    c. 3.0 m/s^2
    d. 6.0 m/s^2

36. What centripetal force does an 80-kg passenger experience when seated 12 m from the center of a Ferris wheel whose angular speed is 0.50 rad/s?

    a. 484 N
    b. 720 N
    c. 914 N
    d. 240 N

37. A 0.400-kg object is swung in a circular path and in a vertical plane on a 0.500-m-length string. If the angular speed at the bottom is 8.00 rad/s, what is the tension in the string when the object is at the bottom of the circle?

    a. 5.60 N
    b. 10.5 N
    c. 16.7 N
    d. 19.6 N

38. A 0.30-kg rock is swung in a circular path and in a vertical plane on a 0.25-m-length string. At the top of the path, the angular speed is 12.0 rad/s. What is the tension in the string at that point?

    a. 7.9 N
    b. 16 N
    c. 18 N
    d. 83 N

39. A 1 500-kg car rounds an unbanked curve with a radius of 52 m at a speed of 12 m/s. What minimum coefficient of friction must exist between the road and tires to prevent the car from slipping? (g = 9.8 m/s^2)

    a. 0.18
    b. 0.30
    c. 0.28
    d. 0.37

40. At what angle (relative to the horizontal) should a curve 52 m in radius be banked if no friction is required to prevent the car from slipping when traveling at 12 m/s? (g = 9.8 m/s^2)

    a. 28°
    b. 32°
    c. 16°
    d. 10°

41. At what speed will a car round a 52-m-radius curve, banked at a 45° angle, if no friction is required between the road and tires to prevent the car from slipping? (g = 9.8 m/s^2)

    a. 27 m/s
    b. 17 m/s
    c. 23 m/s
    d. 35 m/s

42. A roller coaster, loaded with passengers, has a mass of 2 000 kg; the radius of curvature of the track at the bottom point of the dip is 24 m. If the vehicle has a speed of 18 m/s at this point, what force is exerted on the vehicle by the track? (g = 9.8 m/s^2)

    a. 2.3×10^4 N
    b. 4.7×10^4 N
    c. 3.0×10^4 N
    d. 1.0×10^4 N

43. Consider a point on a bicycle tire that is momentarily in contact with the ground as the bicycle rolls across the ground with constant speed. The direction for the acceleration for this point at that moment is:

    a. upward.
    b. down toward the ground.
    c. forward.
    d. at that moment the acceleration is zero.

44. Consider a child who is swinging. As she reaches the lowest point in her swing:

    a. the tension in the rope is equal to her weight.
    b. the tension in the rope is equal to her mass times her acceleration.
    c. her acceleration is downward at 9.8 m/s^2.
    d. none of the above.

45. What angular speed (in revolutions/second) is needed for a centrifuge to produce an acceleration of 1 000 *g* at a radius arm of 15.0 cm?

    a. 40.7 rev/s
    b. 75.4 rev/s
    c. 81.4 rev/s
    d. 151 rev/s

46. An airplane in a wide sweeping “outside” loop can create zero gees inside the aircraft cabin. What must be the radius of curvature of the flight path for an aircraft moving at 150 m/s to create a condition of “weightlessness” inside the aircraft?

    a. 1 150 m
    b. 1 800 m
    c. 2 300 m
    d. 3 600 m

47. A cylindrical space colony 8 km in diameter and 30 km long has been proposed as living quarters for future space explorers. Such a habitat would have cities, land and lakes on the inside surface and air and clouds in the center. All this would be held in place by the rotation of the cylinder about the long axis. How fast would such a cylinder have to rotate to produce a 1-*g* gravitational field at the walls of the cylinder?

    a. 0.05 rad/s
    b. 0.10 rad/s
    c. 0.15 rad/s
    d. 0.20 rad/s

48. The Earth is 93 million miles (mi) from the Sun and its period of revolution is 1 year = 3.15×10^7 s. What is the acceleration of the Earth in its orbit about the Sun?

    a. 18.6 mi/s^2
    b. 9.3×10^{-3} mi/s^2
    c. 13.6×10^{-6} mi/s^2
    d. 3.7×10^{-6} mi/s^2

49. A wheel is rotated about a horizontal axle at a constant angular speed. Next it is rotated in the opposite direction with the same angular speed. The acceleration at a point on the top of the wheel in the second case as compared to the acceleration in the first case:

    a. is in the same direction.
    b. is in the opposite direction.
    c. is upward.
    d. is tangential to the wheel.

7.5 Newtonian Gravitation

50. An object of mass 0.50 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is 4.0×10^6 m. What is the mass of Planet X? ($G = 6.67 \times 10^{-11}$ $N \cdot m^2/kg^2$)

    a. 13×10^{19} kg
    b. 17×10^{22} kg
    c. 9.6×10^{24} kg
    d. 21×10^{25} kg

51. An object of mass 0.50 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is 4.0×10^6 m. What free fall acceleration will the 0.50-kg object experience when at the surface of Planet X?

    a. 48 m/s^2
    b. 20 m/s^2
    c. 16 m/s^2
    d. 40 m/s^2

52. An object of mass 0.50 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is 4.0×10^6 m. What free fall acceleration will the 0.50-kg object experience when transported to a distance of 2.0×10^6 m from the surface of this planet?

    a. 90 m/s^2
    b. 20 m/s^2
    c. 13 m/s^2
    d. 18 m/s^2

53. An Earth satellite is orbiting at a distance from the Earth's surface equal to one Earth radius (4 000 miles). At this location, the acceleration due to gravity is what factor times the value of *g* at the Earth's surface?

    a. There is no acceleration since the satellite is in orbit.
    b. 2
    c. 1/2
    d. 1/4

54. If a planet has 3 times the radius of the Earth, but has the same density as the Earth, what is the gravitational acceleration at the surface of the planet? (g = 9.8 m/s^2)

    a. 29.4 m/s^2
    b. 88.2 m/s^2
    c. 265 m/s^2
    d. 3.27 m/s^2

55. If a planet has a radius 20% greater than that of the Earth but has the same mass as the Earth, what is the acceleration due to gravity at its surface?

    a. 14 m/s^2
    b. 12 m/s^2
    c. 8.2 m/s^2
    d. 6.8 m/s^2

56. The acceleration due to gravity at the surface of Planet X is 10 m/s^2. What is the acceleration due to gravity at an altitude of 3 000 km above the surface of this planet?

    a. 10 m/s^2
    b. 8.0 m/s^2
    c. 4.4 m/s^2
    d. More information is needed.

57. An object when orbiting the Earth at a height of three Earth radii from the center of the Earth has a weight of 1.00 N. What is the object's mass? (g at the surface of the Earth is 9.8 m/s^2)

    a. 0.102 kg
    b. 0.306 kg
    c. 0.92 kg
    d. 1.0 kg

58. Somewhere between the Earth and the Moon is a point where the gravitational attraction of the Earth is canceled by the gravitational pull of the Moon. The mass of the Moon is 1/81 that of the Earth. How far from the center of the Earth is this point?

    a. 8/9 the way to the Moon
    b. 9/10 the way to the Moon
    c. 3/4 the way to the Moon
    d. 80/81 the way to the Moon

59. A satellite is in a circular orbit about the Earth at a distance of one Earth radius above the surface. What is the speed of the satellite? (The radius of the Earth is 6.4×10^6 m, and $G = 6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$.)

    a. 2 800 m/s
    b. 4 200 m/s
    c. 5 600 m/s
    d. 16 800 m/s

60. A careful photographic survey of Jupiter's moon Io by the spacecraft *Voyager 1* showed active volcanoes spewing liquid sulfur to heights of 70 km above the surface of this moon. If the value of g on Io is 2.0 m/s^2, estimate the speed with which the liquid sulfur left the volcano.

    a. 260 m/s
    b. 530 m/s
    c. 790 m/s
    d. 970 m/s

61. If the mass of Mars is 0.107 times that of Earth, and its radius is 0.530 that of Earth, estimate the gravitational acceleration g at the surface of Mars. ($g_{\text{earth}} = 9.80$ m/s^2)

    a. 2.20 m/s^2
    b. 3.73 m/s^2
    c. 4.20 m/s^2
    d. 5.50 m/s^2

62. The escape speed from the surface of the Earth is 11.2 km/s. Estimate the escape speed for a spacecraft from the surface of the Moon. The Moon has a mass 1/81 that of Earth and a radius 0.25 that of Earth.

    a. 2.5 km/s
    b. 4.0 km/s
    c. 5.6 km/s
    d. 8.7 km/s

63. Geosynchronous satellites orbit the Earth at a distance of 42 000 km from the Earth's center. Their angular speed at this height is the same as the rotation rate of the Earth, so they appear stationary at certain locations in the sky. What is the force acting on a 1 500-kg satellite at this height?

    a. 85 N
    b. 333 N
    c. 404 N
    d. 457 N

64. At an altitude of 4 times the radius of the earth, the acceleration due to gravity is

    a. g/2.
    b. g/4.
    c. g/16.
    d. not given.

7.6 Kepler's Laws

65. An asteroid has a perihelion (the orbit's closest approach to the sun) of 1.5 AU and a period of revolution of 8.0 y. What is its greatest distance from the sun (its aphelion)?

    a. 8.0 AU
    b. 6.5 AU
    c. 4.0 AU
    d. 2.5 AU

66. Two satellites are monitored as they orbit the Earth; satellite X is eight times as far from the Earth's center as is satellite Y. From Kepler's third law one may conclude that the period or revolution of X is what factor times that of Y?

    a. 1/2
    b. 2.0
    c. 4.0
    d. 22.6

67. At what location does an artificial Earth satellite in elliptical orbit have its greatest speed?

    a. nearest the Earth
    b. farthest from the Earth
    c. between Earth and Moon
    d. between Earth and Sun

68. An asteroid in orbit about the sun has a linear speed of 4 km/s when at a distance of closest approach *d* from the sun. What is its linear speed when it is at its greatest distance from the sun, a distance 2 *d*?

    a. 1 km/s
    b. 2 km/s
    c. 8 km/s
    d. 16 km/s

69. An artificial Earth satellite in an elliptical orbit has its greatest centripetal acceleration when it is at what location?

    a. nearest the Earth
    b. farthest from the Earth
    c. between Earth and Moon
    d. between Earth and Sun

70. Which of the following best describes the property of the period of orbital revolution for an Earth satellite?

    a. greater when the orbital radius is smaller
    b. greater when the orbital radius is larger
    c. independent of the orbital radius
    d. determined mainly by the satellite's mass

71. Of the nine known planets in our solar system, the innermost is Mercury. When compared to the other planets in the system, Mercury has the:

    a. greatest centripetal acceleration.
    b. greatest period of revolution.
    c. smallest angular velocity.
    d. smallest tangential velocity.

72. According to Kepler's second law, Halley's Comet circles the Sun in an elliptical path with the Sun at one focus of the ellipse. What is at the other focus of the ellipse?

    a. nothing
    b. the Earth
    c. The comet itself passes through the other focus.
    d. The tail of the comet stays at the other ellipse.

73. For any object orbiting the Sun, Kepler's Law may be written $T^2 = kr^3$. If T is measured in years and r in units of the Earth's distance from the Sun, then $k = 1$. What, therefore, is the time (in years) for Mars to orbit the Sun if its mean radius from the Sun is 1.5 times the Earth's distance from the Sun?

    a. 1.8 years
    b. 2.8 years
    c. 3.4 years
    d. 4.2 years

74. In order for a satellite to be geosynchronous, its orbit must:

    a. go over the North and South Poles.
    b. be over the equator.
    c. be over a single longitude.
    d. emit television signals.

75. An asteroid is in orbit at 4 times the earth's distance from the Sun. What is its period of revolution?

    a. one fourth year
    b. 4 years
    c. 8 years
    d. 16 years

76. Doubling the mean distance from the Sun results in changing the orbital period of revolution by what factor?

    a. $2^{1/2}$
    b. 2
    c. $2^{3/2}$
    d. 2^2

CHAPTER 7 - ANSWERS

#	Ans	Difficulty
C1.	B	1
C2.	A	2
C3.	C	2
C4.	C	2
C5.	B	2
1.	C	1
2.	C	1
3.	C	1
4.	A	2
5.	B	2
6.	D	2
7.	B	1
8.	C	2
9.	D	2
10.	B	2
11.	B	1
12.	D	1
13.	B	2
14.	D	2
15.	A	2
16.	B	1
17.	C	1
18.	C	2
19.	A	2
20.	C	2
21.	C	2
22.	C	2
23.	B	2
24.	B	2
25.	C	2
26.	B	3
27.	A	2
28.	C	2
29.	D	2
30.	C	2
31.	D	2
32.	D	2
33.	D	2
34.	C	2
35.	C	2
36.	D	2
37.	C	3
38.	A	3
39.	C	2
40.	C	2
41.	C	2
42.	B	3
43.	A	1
44.	D	2
45.	A	2
46.	C	2
47.	A	2
48.	D	2
49.	A	1
50.	C	3
51.	D	2
52.	D	3
53.	D	2
54.	A	2
55.	D	2
56.	D	2
57.	C	2
58.	B	3
59.	C	2
60.	B	2
61.	B	3
62.	A	3
63.	B	3
64.	D	3
65.	B	3
66.	D	2
67.	A	1
68.	B	2
69.	A	2
70.	B	1
71.	A	1
72.	A	1
73.	A	2
74.	B	1
75.	C	2
76.	C	2

CHAPTER 8

Conceptual Problems

C1. Two spheres, one with the center core up to $r = R/2$ hollow and the other solid, have the same mass M and same outer radius R. If they are both rolling at the same linear speed, which one has the greater kinetic energy?

a. The both have the same kinetic energy.
b. The hollow one has the greater kinetic energy.
c. The solid one has the greater kinetic energy.
d. More information is needed to choose an answer.

C2. A box slides down a frictionless incline, and a hoop rolls down another incline. Both inclines have the same height, and both the box and the hoop have the same mass. If both objects start from rest, upon reaching the bottom of the incline which one will have the greater kinetic energy and which one will have the greater speed?

a. The box will have both the greater kinetic energy and the greater speed.
b. The hoop will have both the greater kinetic energy and the greater speed.
c. Both will have the same kinetic energy but the hoop will have the greater speed.
d. Both will have the same kinetic energy but the box will have the greater speed.

C3. The torque caused by a force F applied at a distance r from the axis of rotation, is given by $\tau = rF\sin\theta$, where θ is the angle between $\vec{\mathbf{r}}$ and $\vec{\mathbf{F}}$. If the magnitudes r and F remain the same, what other angle θ' will produce the same torque as was produced at angle θ if θ was less than 90°?

a. $\theta' = 90° - \theta$
b. $\theta' = 90^{\circ} + \theta$
c. $\theta' = 180^{\circ} - \theta$
d. None of the above.

C4. Two equal magnitude forces are in opposite directions and their lines of action are separated by distance d. These two forces are applied to a solid disk, which is mounted on a frictionless axle. If d is half the radius r of the disk, which of the following positions for the forces would give the most torque.

a. One force on a line touching the circumference of the disk, the other on a line halfway to the center.
b. One force on a line at a distance d from the center and the other on a line through the center of the disk.
c. One force on a line at a distance $d/2$ from the center of the disk, and the other on a line at a distance $d/2$ on the opposite side of the center of the disk.
d. Since all the above orientations give the same torque, choose this answer.

C5. A uniform meter stick balances on a fulcrum placed at the 40 cm mark when a weight W is placed at the 30 cm mark. What is the weight of the meter stick?

a. W
b. 2W
c. W/2
d. 0.4 W

8.1 Torque

1. A vault is opened by applying a force of 300 N perpendicular to the plane of the door, 0.80 m from the hinges. Find the torque due to this force about an axis through the hinges.

   a. 120 N·m
   b. 240 N·m
   c. 300 N·m
   d. 360 N·m

2. A 3.0-m rod is pivoted about its left end. A force of 6.0 N is applied perpendicular to the rod at a distance of 1.2 m from the pivot causing a ccw torque, and a force of 5.2 N is applied at the end of the rod 3.0 m from the pivot. The 5.2 N is at an angle of 30^o to the rod and causes a cw torque. What is the net torque about the pivot?

   a. 15 N·m
   b. 0 N·m
   c. –6.3 N·m
   d. –0.6 N·m

3. A rod of length L is pivoted about its left end and has a force F applied perpendicular to the other end. The force F is now removed and another force F' is applied at the midpoint of the rod. If F' is at an angle of 30° with respect to the rod, what is its magnitude if the resulting torque is the same as when F was applied?

   a. F
   b. 2F
   c. 3F
   d. 4F

4. Two children seat themselves on a seesaw. The one on the left has a weight of 400 N while the one on the right weighs 300 N. The fulcrum is at the midpoint of the seesaw. If the child on the left is not at the end but is 1.50 m from the fulcrum and the seesaw is balanced, what is the torque provided by the weight of the child on the right?

   a. 600 N·m
   b. 450 N·m
   c. –600 N·m
   d. –450 N·m

5. A bucket filled with water has a mass of 23 kg and is attached to a rope, which in turn, is wound around a 0.050-m radius cylinder at the top of a well. What torque does the weight of water and bucket produce on the cylinder if the cylinder is not permitted to rotate? (g = 9.8 m/s^2)

   a. 34 N·m
   b. 17 N·m
   c. 11 N·m
   d. 23 N·m

6. A bucket of water with total mass 23 kg is attached to a rope, which in turn, is wound around a 0.050-m radius cylinder at the top of a well. A crank with a turning radius of 0.25 m is attached to the end of the cylinder. What minimum force directed perpendicular to the crank handle is required to just raise the bucket? (Assume the rope's mass is negligible, that cylinder turns on frictionless bearings, and that g = 9.8 m/s^2.)

   a. 45 N
   b. 68 N
   c. 90 N
   d. 135 N

8.2 Torque and the Two Conditions for Equilibrium

8.3 The Center of Gravity

8.4 Examples of Objects in Equilibrium

7. A uniform bridge span weighs 50.0×10^3 N and is 40.0 m long. An automobile weighing 15.0×10^3 N is parked with its center of gravity located 12.0 m from the right pier. What upward support force does the left pier provide?

   a. 29.5×10^3 N
   b. 35.5×10^3 N
   c. 65.0×10^3 N
   d. 32.5×10^3 N

8. Masses are distributed in the *x,y*-plane as follows: 6.0 kg at (0.0, 0.0) m, 4.0 kg at (2.0, 0.0) m, and 5.0 kg at (2.0, 3.0) m. What is the *x*-coordinate of the center of gravity of this system of masses?

   a. 18 m
   b. 2.0 m
   c. 1.2 m
   d. 1.0 m

9. Masses are distributed in the *xy*-plane as follows: 10 kg at (2.0, 6.0) m, 4.0 kg at (2.0, 0.0) m, and 6.0 kg at (0.0, 3.0) m. Where would a 20-kg mass need to be positioned so that the center of gravity of the resulting four mass system would be at the origin?

   a. (1.4, 3.9) m
   b. (3.9, 1.4) m
   c. (-1.4, -3.9) m
   d. (-3.9, -1.4) m

10. A hoop of radius 1.0 m is placed in the first quadrant of an *xy*-coordinate system with its rim touching both the *x*-axis and the *y*-axis. What are the coordinates of its center of gravity?

   a. (1.0, 1.0) m
   b. (0.7, 0.7) m
   c. (0.5, 0.5) m
   d. Since there is nothing at the center of the hoop, it has no center of gravity.

11. Tasha has mass 20 kg and wants to use a 4.0-m board of mass 10 kg as a seesaw. Her friends are busy, so Tasha seesaws by herself by putting the support at the system's center of gravity when she sits on one end of the board. How far is she from the support point?

   a. 2.0 m
   b. 1.0 m
   c. 0.67 m
   d. 0.33 m

12. An 80-kg man is one fourth of the way up a 10-m ladder that is resting against a smooth, frictionless wall. If the ladder has a mass of 20 kg and it makes an angle of 60° with the ground, find the force of friction of the ground on the foot of the ladder.

   a. 7.8×10^2 N
   b. 2.0×10^2 N
   c. 50 N
   d. 1.7×10^2 N

13. A 100-N uniform ladder, 8.0 m long, rests against a smooth vertical wall. The coefficient of static friction between ladder and floor is 0.40. What minimum angle can the ladder make with the floor before it slips?

   a. 22°
   b. 51°
   c. 18°
   d. 42°

14. A meter stick is supported by a knife-edge at the 50-cm mark. Doug hangs masses of 0.40 and 0.60 kg from the 20-cm and 80-cm marks, respectively. Where should Doug hang a third mass of 0.30 kg to keep the stick balanced?

    a. 20 cm
    b. 70 cm
    c. 30 cm
    d. 25 cm

15. An 800-N billboard worker stands on a 4.0-m scaffold supported by vertical ropes at each end. If the scaffold weighs 500 N and the worker stands 1.0 m from one end, what is the tension in the rope nearest the worker?

    a. 450 N
    b. 500 N
    c. 800 N
    d. 850 N

16. An 800-N billboard worker stands on a 4.0-m scaffold weighing 500 N and supported by vertical ropes at each end. How far would the worker stand from one of the supporting ropes to produce a tension of 550 N in that rope?

    a. 1.4 m
    b. 2.0 m
    c. 2.5 m
    d. 2.7 m

17. A woman who weighs 500 N stands on an 8.0-m-long board that weighs 100 N. The board is supported at each end. The support force at the right end is 3 times the support force at the left end. How far from the right end is the woman standing?

    a. 4.0 m
    b. 2.0 m
    c. 2.7 m
    d. 1.6 m

18. A uniform, horizontal beam of length 6.0 m and weight 120 N is attached at one end to a wall by a pin connection (so that it may rotate). A cable attached to the wall above the pin supports the opposite end. The cable makes an angle of 60° with the horizontal. What is the tension in the cable needed to maintain the beam in equilibrium?

    a. 35 N
    b. 69 N
    c. 60 N
    d. 120 N

19. A uniform 1.0-N meter stick is suspended horizontally by vertical strings attached at each end. A 2.0-N weight is suspended from the 10-cm position on the stick, another 2.0-N weight is suspended from the 50 cm position, and a 3.0-N weight is suspended from the 60 cm position. What is the tension in the string attached at the 100-cm end of the stick?

    a. 1.9 N
    b. 3.0 N
    c. 3.5 N
    d. 4.0 N

8.5 Relationship Between Torque and Angular Acceleration

20. The quantity "moment of inertia" (in terms of the fundamental quantities of mass, length, and time) is equivalent to:

    a. ML^2T^{-2}.
    b. ML.
    c. ML^2.
    d. $ML^{-1}T^{-2}$.

21. A 4.2-kg mass is placed at (3.0, 4.0) m. Where can an 8.4-kg mass be placed so that the moment of inertia about the *z*-axis is zero?

    a. (-3.0, -4.0) m
    b. (-6.0, -8.0) m
    c. (-1.5, -2.0) m
    d. There is no position giving this result.

22. A 4.0-kg mass is placed at (3.0, 4.0) m, and a 6.0-kg mass is placed at (3.0, -4.0) m. What is the moment of inertia of this system of masses about the *x*-axis?

    a. 160 $kg{\cdot}m^2$
    b. 90 $kg{\cdot}m^2$
    c. 250 $kg{\cdot}m^2$
    d. 32 $kg{\cdot}m^2$

23 A 4.0-kg mass is placed at (3.0, 4.0) m, and a 6.0-kg mass is placed at (3.0, -4.0) m. What is the moment of inertia of this system of masses about the *y*-axis?

    a. 160 $kg{\cdot}m^2$
    b. 90 $kg{\cdot}m^2$
    c. 250 $kg{\cdot}m^2$
    d. 180 $kg{\cdot}m^2$

24. A 4.0-kg mass is placed at (3.0, 4.0) m, and a 6.0-kg mass is placed at (3.0, -4.0) m. What is the moment of inertia of this system of masses about the *z*-axis?

    a. 160 $kg \cdot m^2$
    b. 90 $kg \cdot m^2$
    c. 250$kg \cdot m^2$
    d. 180 $kg \cdot m^2$

25. If a net torque is applied to an object, that object will experience:

    a. a constant angular speed.
    b. an angular acceleration.
    c. a constant moment of inertia.
    d. an increasing moment of inertia.

26. According to Newton's second law, the angular acceleration experienced by an object is directly proportional to:

    a. its moment of inertia.
    b. the net applied torque.
    c. the object's size.
    d. choices a and b above are both valid.

27. A ventilation fan with a moment of inertia of 0.034 $kg \cdot m^2$ has a net torque of 0.11 N·m applied to it. What angular acceleration does it experience?

    a. 5.3 rad/s^2
    b. 4.0 rad/s^2
    c. 3.2 rad/s^2
    d. 0.31 rad/s^2

28. A disk has a moment of inertia of 3.0×10^{-4} $kg \cdot m^2$ and rotates with an angular speed of 3.5 rad/sec. What net torque must be applied to bring it to rest within 3 s?

    a. 4.5×10^{-3} N·m
    b. 7.5×10^{-4} N·m
    c. 3.5×10^{-4} N·m
    d. 5.0×10^{-4} N·m

29. The Earth moves about the Sun in an elliptical orbit. As the Earth moves closer to the Sun, which of the following best describes the Earth-Sun system's moment of inertia?

    a. decreases
    b. increases
    c. remains constant
    d. none of the above choices are valid

30. A bowling ball has a mass of 7.0 kg, a moment of inertia of 2.8×10^{-2} kg·m^2 and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m/s, what is its angular speed?

    a. 0.80 rad/s
    b. 10 rad/s
    c. 0.050 rad/s
    d. 40 rad/s

31. A baseball pitcher, loosening up his arm before a game, tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. If the ball starts at rest and is released with a speed of 12 m/s in a time of 0.40 s, what is the average angular acceleration of the arm and ball?

    a. 0.067 rad/s^2
    b. 94 rad/s^2
    c. 15 rad/s^2
    d. 37 rad/s^2

32. A baseball pitcher loosens up his pitching arm. He tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. What is the moment of inertia of the ball alone as it moves in a circular arc with a radius of 0.32 m?

    a. 1.5×10^{-2} kg·m^2
    b. 16×10^{-2} kg·m^2
    c. 4.0×10^{-2} kg·m^2
    d. 7.6×10^{-2} kg·m^2

33. A baseball pitcher loosens up his pitching arm. He tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. If the ball starts at rest and is released with a speed of 12 m/s in a time of 0.40 s, what torque is applied to the ball while being held by the pitcher's hand to produce the angular acceleration?

    a. 1.1 N·m
    b. 11 N·m
    c. 7.2 N·m
    d. 1.4 N·m

34. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. A crank with a turning radius of 0.25 m is attached to the end of the cylinder and the moment of inertia of cylinder and crank is 0.12 kg·m^2. If the bucket is raised to the top of the well and released, what is the acceleration of the bucket as it falls toward the bottom of the well? (Assume rope's mass is negligible, that cylinder turns on frictionless bearings and that $g = 9.8$ m/s^2.)

    a. 3.2 m/s^2
    b. 6.3 m/s^2
    c. 7.4 m/s^2
    d. 9.8 m/s^2

35. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. The bucket is raised to the top of the well and released. The bucket is moving with a speed of 8.0 m/s upon hitting the water surface in the well. What is the angular speed of the cylinder at this instant?

    a. 39 rad/s
    b. 79 rad/s
    c. 120 rad/s
    d. 160 rad/s

36. A majorette takes two batons and fastens them together in the middle at right angles to make an “x” shape. Each baton was 0.80 m long and each ball on the end is 0.20 kg. (Ignore the mass of the rods.) What is the moment of inertia if the arrangement is spun around an axis formed by one of the batons?

    a. 0.048 kg·m^2
    b. 0.064 kg·m^2
    c. 0.19 kg·m^2
    d. 0.32 kg·m^2

37. A majorette takes two batons and fastens them together in the middle at right angles to make an “x” shape. Each baton was 0.80 m long and each ball on the end is 0.20 kg. (Ignore the mass of the rods.) What is the moment of inertia if the arrangement is spun around an axis through the center perpendicular to both rods?

    a. 0.064 kg·m^2
    b. 0.096 kg·m^2
    c. 0.13 kg·m^2
    d. 0.32 kg·m^2

38. A solid cylinder ($I = MR^2/2$) has a string wrapped around it many times. When I release the cylinder, holding on to the string, the cylinder falls and spins as the string unwinds. What is the downward acceleration of the cylinder as it falls?

    a. 0
    b. 4.9 m/s^2
    c. 6.5 m/s^2
    d. 9.8 m/s^2

39. A 40-kg boy is standing on the edge of a stationary 30-kg platform that is free to rotate. The boy tries to walk around the platform in a counterclockwise direction. As he does:

    a. the platform doesn’t rotate.
    b. the platform rotates in a clockwise direction just fast enough so that the boy remains stationary relative to the ground.
    c. the platform rotates in a clockwise direction while the boy goes around in a counterclockwise direction relative to the ground.
    d. both go around with equal angular velocities but in opposite directions.

40. A rod of length L is hinged at one end. The moment of inertia as the rod rotates around that hinge is $ML^2/3$. Suppose a 2.00-m rod with a mass of 3.00 kg is hinged at one end and is held in a horizontal position. The rod is released as the free end is allowed to fall. What is the angular acceleration as it is released?

    a. 3.70 rad/s^2
    b. 7.35 rad/s^2
    c. 2.45 rad/s^2
    d. 4.90 rad/s^2

41. Two hoops or rings ($I = MR^2$) are centered, lying on a turntable. The smaller ring has radius = 0.050 m; the larger has radius = 0.10 m. Both have a mass of 3.0 kg. What is the total moment of inertia as the turntable spins? Ignore the mass of the turntable.

    a. 0.030 kg·m^2
    b. 0.007 5 kg·m^2
    c. 0.038 kg·m^2
    d. 0.075 kg·m^2

42. An automobile accelerates from zero to 30 m/s in 6.0 s. The wheels have a diameter of 0.40 m. What is the average angular acceleration of each wheel?

    a. 5.0 rad/s^2
    b. 15 rad/s^2
    c. 25 rad/s^2
    d. 35 rad/s^2

43. An object consists of a rod (of length 3.0 m and negligible moment of inertia) to which four small 2.0-kg masses are attached, one at each end and one at each point on the rod 1.0 m from each end. (The masses are one meter apart.) The moment of inertia of this object about an axis perpendicular to the rod and through one of the inner masses:

    a. is 72 kg·m^2.
    b. is 12 kg·m^2.
    c. is 4 kg·m^2.
    d. cannot be uniquely determined until it is stated which inner mass the axis goes through.

8.6 Rotational Kinetic Energy

44. A ventilation fan with a moment of inertia of 0.034 kg·m^2 has a net torque of 0.11 N·m applied to it. If it starts from rest, what kinetic energy will it have 8.0 s later?

    a. 31 J
    b. 17 J
    c. 11 J
    d. 6.6 J

45. The total kinetic energy of a baseball thrown with a spinning motion is a function of:

    a. its linear speed but not rotational speed.
    b. its rotational speed but not linear speed.
    c. both linear and rotational speeds.
    d. neither linear nor rotational speed.

46. A bowling ball has a mass of 7.0 kg, a moment of inertia of 2.8×10^{-2} kg·m^2 and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m/s, what is its total kinetic energy?

    a. 45 J
    b. 32 J
    c. 11 J
    d. 78 J

47. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder, with crank, at the top of a well. The moment of inertia of the cylinder and crank is 0.12 kg·m^2. The bucket is raised to the top of the well and released to fall back into the well. What is the kinetic energy of the cylinder and crank at the instant the bucket is moving with a speed of 8.0 m/s?

    a. 2.1×10^3 J
    b. 1.5×10^3 J
    c. 0.70×10^3 J
    d. 0.40×10^3 J

48. A solid sphere of mass 4.0 kg and radius 0.12 m is at rest at the top of a ramp inclined 15°. It rolls to the bottom without slipping. The upper end of the ramp is 1.2 m higher than the lower end. Find the sphere's total kinetic energy when it reaches the bottom.

    a. 70 J
    b. 47 J
    c. 18 J
    d. 8.8 J

49. A solid sphere of mass 4.0 kg and radius 0.12 m starts from rest at the top of a ramp inclined 15°, and rolls to the bottom. The upper end of the ramp is 1.2 m higher than the lower end. What is the linear speed of the sphere when it reaches the bottom of the ramp? (Note: $I = 0.4MR^2$ for a solid sphere and $g = 9.8$ m/s^2)

    a. 4.7 m/s
    b. 4.1 m/s
    c. 3.4 m/s
    d. 2.4 m/s

50. A solid cylinder of mass 3.0 kg and radius 0.2 m starts from rest at the top of a ramp, inclined 15°, and rolls to the bottom without slipping. (For a cylinder $I = 0.5MR^2$) The upper end of the ramp is 1.2 m higher than the lower end. Find the linear speed of the cylinder when it reaches the bottom of the ramp. ($g = 9.8$ m/s^2)

    a. 4.7 m/s
    b. 4.3 m/s
    c. 4.0 m/s
    d. 2.4 m/s

51. A gyroscope has a moment of inertia of 0.14 kg·m^2 and an initial angular speed of 15 rad/s. Friction in the bearings causes its speed to reduce to zero in 30 s. What is the value of the average frictional torque?

    a. 3.3×10^{-2} N·m
    b. 8.1×10^{-2} N·m
    c. 14×10^{-2} N·m
    d. 7.0×10^{-2} N·m

52. A gyroscope has a moment of inertia of 0.140 kg·m^2 and has an initial angular speed of 15.0 rad/s. If a lubricant is applied to the bearings of the gyroscope so that frictional torque is reduced to 2.00×10^{-2} N·m, then in what time interval will the gyroscope coast from 15.0 rad/s to zero?

    a. 150 s
    b. 105 s
    c. 90.0 s
    d. 180 s

53. A cylinder with its mass concentrated toward the center has a moment of inertia of 0.1 MR^2. If this cylinder is rolling without slipping along a level surface with a linear speed v, what is the ratio of its rotational kinetic energy to its linear kinetic energy?

    a. 1/l0
    b. 1/5
    c. 1/2
    d. 1/1

54. A solid sphere with mass, M, and radius, R, rolls along a level surface without slipping with a linear speed, v. What is the ratio of rotational to linear kinetic energy? (For a solid sphere, I = 0.4 MR^2).

    a. 1/4
    b. 1/2
    c. 1/1
    d. 2/5

55. A rotating flywheel can be used as a method to store energy. If it is required that such a device be able to store up to a maximum of 1.00×10^6 J when rotating at 400 rad/s, what moment of inertia is required?

    a. 50 kg·m^2
    b. 25 kg·m^2
    c. 12.5 kg·m^2
    d. 6.3 kg·m^2

56. A rotating flywheel can be used as a method to store energy. If it has 1.0×10^6 J of kinetic energy when rotating at 400 rad/s, and if a frictional torque of 4.0 N·m acts on the system, in what interval of time would the flywheel come to rest?

    a. 3.5 min
    b. 7.0 min
    c. 14 min
    d. 21 min

57. An initially installed flywheel can store 10^6 J of kinetic energy when rotating at 300 rad/s. It is replaced by another flywheel of the same size but made of a lighter and stronger material. If its mass is half that of the original and it is now capable of achieving a rotational speed of 600 rad/s, what maximum energy can be stored?

    a. 40×10^5 J
    b. 20×10^5 J
    c. 10×10^5 J
    d. 5.0×10^5 J

58. A cylinder ($I = MR^2/2$) is rolling along the ground at 7.0 m/s. It comes to a hill and starts going up. Assuming no losses to friction, how high does it get before it stops?

    a. 1.2 m
    b. 3.7 m
    c. 4.2 m
    d. 5.9 m

59. A meter stick is hinged at its lower end and allowed to fall from a vertical position. If its moment of inertia is $ML^2/3$, with what angular speed does it hit the table?

    a. 5.42 rad/s
    b. 2.71 rad/s
    c. 1.22 rad/s
    d. 7.67 rad/s

60. A bus is designed to draw its power from a rotating flywheel that is brought up to its maximum speed (3 000 rpm) by an electric motor. The flywheel is a solid cylinder of mass 500 kg and radius 0.500 m ($I_{cylinder} = MR^2/2$). If the bus requires an average power of 10.0 kW, how long will the flywheel rotate?

    a. 154 s
    b. 308 s
    c. 463 s
    d. 617 s

61. An object of radius R and moment of inertia I rolls down an incline of height H after starting from rest. Its total kinetic energy at the bottom of the incline:

    a. is gR/I.
    b. is I/gH.
    c. is 0.5 Ig/H.
    d. cannot be found from the given information alone.

62. A uniform solid sphere rolls down an incline of height 3 m after starting from rest. In order to calculate its speed at the bottom of the incline, one needs to know:

    a. the mass of the sphere.
    b. the radius of the sphere.
    c. the mass and the radius of the sphere.
    d. no more than is given in the problem.

63. Consider the use of the terms “rotation” and “revolution”. In physics:

    a. the words are used interchangeably.
    b. the words are used interchangeably but “rotation” is the preferred word.
    c. the words have different meaning.
    d. “rotation” is the correct word and “revolution” should not be used.

64. A solid disk of radius R rolls down an incline in time T. The center of the disk is removed up to a radius of R/2. The remaining portion of the disk with its center gone is again rolled down the same incline. The time it takes is:

    a. T.
    b. more than T.
    c. less than T.
    d. requires more information than given in the problem to figure out.

8.7 Angular Momentum

65. The quantity “angular momentum” (in terms of the fundamental quantities of mass, length, and time) is equivalent to:

    a. MLT^{-2}.
    b. ML^2T^{-1}.
    c. ML^2T^{-3}.
    d. ML^3T.

66. A ventilation fan with a moment of inertia of 0.034 kg·m^2 has a net torque of 0.11 N·m applied to it. If it starts from rest, what angular momentum will it have 8.0 s later?

    a. 0.88 kg·m^2/s
    b. 0.97 kg·m^2/s
    c. 2.0 kg·m^2/s
    d. 3.25 kg·m^2/s

67. A figure skater with arms initially extended starts spinning on the ice at 3 rad/s. She then pulls her arms in close to her body. Which of the following results?

    a. a smaller rotational rate
    b. a greater rotational rate
    c. a greater angular momentum
    d. a smaller angular momentum

68. An ice skater spins at 2.5 rev/s when his arms are extended. He draws his arms in and spins at 6.0 rev/s. By what factor does his moment of inertia change in the process?

    a. 2.4
    b. 1.0
    c. 0.42
    d. 0.12

69. A figure skater on ice with arms extended, spins at a rate of 2.5 rev/s. After he draws his arms in, he spins at 6.0 rev/s. By what factor does the skater’s kinetic energy change when he draws his arms in?

    a. 2.4
    b. 1.0
    c. 0.42
    d. 0.12

70. A turntable has a moment of inertia of 3.00×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25.0 rev/min. A 0.300-kg ball of putty is dropped vertically onto the turntable and sticks at a point 0.100 m from the center. What is the new rate of rotation of the system?

    a. 40.8 rev/min
    b. 22.7 rev/min
    c. 33.3 rev/min
    d. 27.2 rev/min

71. A turntable has a moment of inertia of 3.00×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25.0 rev/min. A 0.300-kg ball of putty is dropped vertically on the turntable and sticks at a point 0.100 m from the center. By what factor does the angular momentum of the system change after the putty is dropped onto the turntable?

    a. 1.22
    b. 1.00 (no change)
    c. 0.820
    d. 1.50

72. A turntable has a moment of inertia of 3.0×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25 rev/min. A 0.30-kg ball of putty is dropped vertically on the turntable and sticks at a point 0.10 m from the center. By what factor does the kinetic energy of the system change after the putty is dropped onto the turntable?

    a. 0.91
    b. 1.0
    c. 0.82
    d. 1.5

73. The Earth's gravity exerts no torque on a satellite orbiting the Earth in an elliptical orbit. Compare the motion of the satellite at the point nearest the Earth (perigee) to the motion at the point farthest from the Earth (apogee). At these two points:

    a. the tangential velocities are the same.
    b. the angular velocities are the same.
    c. the angular momenta are the same.
    d. the kinetic energies are the same.

74. The Earth's gravity exerts no torque on a satellite orbiting the Earth in an elliptical orbit. Compare the motion at the point nearest the Earth (perigee) to the motion at the point farthest from the Earth (apogee). At the point closest to the Earth:

    a. the angular speed will be greatest although the linear speed will be the same.
    b. the speed will be greatest although the angular speed will be the same.
    c. the kinetic energy and angular momentum will both be greater.
    d. None of the above.

75. A tetherball is attached to a pole with a 2.0-m rope. It is circling at 0.20 rev/s. As the rope wraps around the pole it shortens. How long is the rope when the ball is moving at 5.0 m/s?

a. 1.8 m
b. 1.5 m
c. 1.2 m
d. 1.0 m

76. An astronaut is on a 100-m lifeline outside a spaceship, circling the ship with an angular speed of 0.100 rad/s. How far inward can she be pulled before the centripetal acceleration reaches $5g = 49\ m/s^2$?

a. 10.1 m
b. 50.0 m
c. 72.7 m
d. 89.9 m

77. An object with mass m and moment of inertia I is spinning with an angular momentum L. Its kinetic energy is:

a. $0.5\ I^2/L$.
b. $0.5\ L^2/I$.
c. $0.5\ L^2/m$.
d. $0.5\ I^2/m$.

78. An object of mass m and moment of inertia I has rotational kinetic energy K_R. Its angular momentum is:

a. 0.5 I/m.
b. $(2\ IK_R)^{1/2}$.
c. $(2\ mK_R)^{1/2}$.
d. not given above.

CHAPTER 8 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	B	1	38.	C	3
C2	D	2	39.	C	2
C3.	C	2	40.	B	2
C4.	D	2	41.	C	2
C5.	A	2	42.	C	2
1.	B	1	43.	B	2
2.	D	2	44.	C	3
3.	D	2	45.	C	1
4.	C	2	46.	D	2
5.	C	2	47.	B	2
6.	A	3	48.	B	2
7.	A	2	49.	B	3
8.	C	2	50.	C	3
9.	C	2	51.	D	2
10.	A	1	52.	B	2
11.	C	2	53.	A	2
12.	D	3	54.	D	2
13.	B	3	55.	C	2
14.	C	2	56.	D	2
15.	D	2	57.	B	2
16.	C	2	58.	B	2
17.	D	2	59.	A	3
18.	B	3	60.	B	2
19.	C	2	61.	D	2
20.	C	1	62.	D	2
21.	D	2	63.	C	2
22.	A	2	64.	B	3
23.	B	2	65.	B	1
24.	C	2	66.	A	2
25.	B	1	67.	B	1
26.	B	1	68.	C	1
27.	C	1	69.	A	2
28.	C	2	70.	B	2
29.	A	1	71.	B	2
30.	D	1	72.	A	3
31.	B	2	73.	C	2
32.	A	2	74.	D	2
33.	D	2	75.	D	2
34.	A	3	76.	C	3
35.	D	1	77.	B	1
36.	B	2	78.	B	2
37.	C	2			

CHAPTER 9

Conceptual Problems

C1. A container is filled with water and the pressure at the container bottom is P. If the container is instead filled with oil having specific gravity 0.80, what new bottom pressure results?

a. a pressure < P
b. the same pressure P
c. a pressure > P
d. This is unable to be determined with the information given.

C2. A container is filled with water and the pressure at the bottom of the container is P. Then the container is emptied halfway and topped off with oil of density $0.80 \times 10^3 \text{ kg/m}^3$, which floats on top of the water. What is the pressure at the bottom of the container now?

a. a pressure < P
b. the same pressure P
c. a pressure > P
d. This is unable to be determined with the information given.

C3. At a pressure of 1 atmosphere a column of mercury in a barometer is supported to the height h = 0.76 m. The density of mercury is $13.6 \times 10^3 \text{ kg/m}^3$. A barometer of similar design filled with water would support a column of water how high at a pressure of 1 atmosphere?

a. more than ten times h
b. about 1.36 h
c. less than one tenth h
d. the same height h

C4. When an artery gets a constricted region due to plaque, how does the pressure in this region compare to the pressure in an unconstricted region adjacent?

a. Since this is a closed system, the pressure is the same in both regions.
b. In the constricted region the blood moves at a higher speed than in the unconstricted region resulting in an increased pressure.
c. In the constricted region the blood moves at a higher speed than in the unconstricted region resulting in a decreased pressure.
d. In the constricted region the blood moves at a lower speed than in the unconstricted region resulting in an increased pressure.

C5. An ice cube with a small solid steel sphere frozen inside floats in a glass of water filled to the brim. What happens to the level of water in the glass as a result of the ice melting?

a. It goes up, overflowing.
b. It stays the same.
c. It goes down.
d. It depends on air pressure, thus the answer is indeterminate.

9.1 States of Matter

9.2 The Deformation of Solids

1. Which state of matter is associated with the very highest of temperatures?

   a. liquid
   b. plasma
   c. gas
   d. solid

2. A copper wire of length 2.0 m, cross sectional area 7.1×10^{-6} m^2 and Young's modulus 11×10^{10} N/m^2 has a 200-kg load hung on it. What is its increase in length? (g = 9.8 m/s^2)

   a. 0.50 mm
   b. 1.0 mm
   c. 2.5 mm
   d. 5.0 mm

3. In an elastic solid there is a direct proportionality between strain and:

   a. elastic modulus.
   b. temperature.
   c. cross-sectional area.
   d. stress.

4. The quantity "stress" expressed in terms of the fundamental quantities (mass, length, time) is equivalent to:

   a. MLT^{-1}.
   b. $ML^{-1}T^{-2}$.
   c. $M^2L^{-1}T^{-3}$.
   d. a dimensionless quantity.

5. The quantity "strain" expressed in terms of the fundamental quantities (mass, length, time) is equivalent to:

   a. MLT^{-1}.
   b. $ML^{-1}T^{-2}$.
   c. $M^2L^{-1}T^{-3}$.
   d. a dimensionless quantity.

6. The bulk modulus of a material, as a meaningful physical property, is applicable to which of the following?

   a. only solids
   b. only liquids
   c. only gases
   d. solids, liquids and gases

7. A uniform pressure of 7.0×10^5 N/m^2 is applied to all six sides of a copper cube. What is the percentage change in volume of the cube? (for copper, $B = 14 \times 10^{10}$ N/m^2)

   a. 2.4×10^{-2} %
   b. 0.4×10^{-2} %
   c. 8.4×10^{-2} %
   d. 0.5×10^{-3} %

8. Bar One has a Young's modulus that is bigger than that of Bar Two. This indicates Bar One:

   a. is longer than Bar Two.
   b. has a greater cross-sectional area than Bar Two.
   c. has a greater elastic limit than Bar Two.
   d. is made of material that is different from Bar Two.

9. Consider two steel rods, A and B. B has three times the area and twice the length of A, so Young's modulus for B will be what factor times Young's modulus for A?

   a. 3.0
   b. 0.5
   c. 1.5
   d. 1.0

10. A tire stops a car by use of friction. What modulus should we use to calculate the stress and strain on the tire?

    a. Young's modulus
    b. compression modulus
    c. shear modulus
    d. bulk modulus

11. How large a force is necessary to stretch a 2.0-mm-diameter steel wire ($Y = 2.0 \times 10^{11}$ N/m^2) by 1.0%?

    a. 3.1×10^3 N
    b. 6.3×10^3 N
    c. 9.4×10^3 N
    d. 1.3×10^4 N

9.3 Density and Pressure

12. The standard kilogram is a platinum-iridium cylinder 39.0 mm in height and 39.0 mm in diameter. What is the density of the material?

    a. 21.5 g/cm^3
    b. 19.3 g/cm^3
    c. 13.6 g/cm^3
    d. 10.7 g/cm^3

13. The quantity "pressure" expressed in terms of the fundamental quantities (mass, length, time) is equivalent to:

    a. MLT^{-1}.
    b. $ML^{-1}T^{-2}$.
    c. $M^2L^{-1}T^{-3}$.
    d. a dimensionless quantity.

14. The pressure inside a commercial airliner is maintained at 1.00 atm (10^5 Pa). What is the net outward force exerted on a 1.0 m × 2.0 m cabin door if the outside pressure is 0.30 atm?

    a. 140 N
    b. 1 400 N
    c. 14 000 N
    d. 140 000 N

15. A stonecutter's chisel has an edge area of 0.50 cm^2. If the chisel is struck with a force of 45 N, what is the pressure exerted on the stone?

    a. 9 000 Pa
    b. 90 000 Pa
    c. 450 000 Pa
    d. 900 000 Pa

16. When water freezes, it expands about nine percent. What would be the pressure increase inside your automobile engine block if the water in there froze? (The bulk modulus of ice is 2.0×10^9 Pa, and 1 atm = 1.0×10^5 Pa.)

    a. 18 atm
    b. 270 atm
    c. 1 080 atm
    d. 1 800 atm

17. The Greenland ice sheet can be one km thick. Estimate the pressure underneath the ice. (The density of ice is 918 kg/m^3.)

    a. 9.0×10^5 Pa (9 atm)
    b. 2.5×10^6 Pa (25 atm)
    c. 4.5×10^6 Pa (45 atm)
    d. 9.0×10^6 Pa (90 atm)

18. What is the total mass of the Earth's atmosphere? (The radius of the Earth is 6.4×10^6 m, and atmospheric pressure at the surface is 10^5 N/m^2.)

    a. 5×10^{16} kg
    b. 1×10^{18} kg
    c. 5×10^{18} kg
    d. 1×10^{20} kg

19. A solid object is made of two materials, one material having density of 2 000 kg/m^3 and the other having density of 6 000 kg/m^3. If the object contains equal volumes of the materials, what is its average density?

    a. 3 000 kg/m^3
    b. 4 000 kg/m^3
    c. 5 300 kg/m^3
    d. more information is needed

20. A solid object is made of two materials, one material having density of 2 000 kg/m^3 and the other having density of 6 000 kg/m^3. If the object contains equal masses of the materials, what is its average density?

    a. 3 000 kg/m^3
    b. 4 000 kg/m^3
    c. 5 300 kg/m^3
    d. more information is needed

9.4 Variation of Pressure with Depth

9.5 Pressure Measurements

21. What is the total force on the bottom of a 2.0-m-diameter by 1.0-m-deep round wading pool due to the weight of the air and the weight of the water? (Note the pressure contribution from the atmosphere is 1.0×10^5 N/m^2, the density of water is 1 000 kg/m^3, and $g = 9.8$ m/s^2.)

    a. 3.4×10^5 N
    b. 2.4×10^6 N
    c. 3.2×10^6 N
    d. 6.0×10^6 N

22. In a large tank of liquid, the hydrostatic pressure at a given depth is a function of:

    a. depth.
    b. surface area.
    c. liquid density.
    d. Choices a and c are both valid.

23. A 15 000-N car on a hydraulic lift rests on a cylinder with a piston of radius 0.20 m. If a connecting cylinder with a piston of 0.040-m radius is driven by compressed air, what force must be applied to this smaller piston in order to lift the car?

    a. 600 N
    b. 1 500 N
    c. 3 000 N
    d. 15 000 N

24. By what factor is the total pressure greater at a depth of 850 m in water than at the surface where pressure is one atmosphere? (water density = 1.0×10^3 kg/m^3, 1 atmosphere pressure = 1.01×10^5 N/m^2, and g = 9.8 m/s^2)

    a. 100
    b. 83
    c. 74
    d. 19

25. If the column of mercury in a barometer stands at 72.6 cm, what is the atmospheric pressure? (The density of mercury is 13.6×10^3 kg/m^3 and g = 9.80 m/s^2)

    a. 0.968×10^5 N/m^2
    b. 1.03×10^5 N/m^2
    c. 0.925×10^5 N/m^2
    d. 1.07×10^5 N/m^2

26. Dams at two different locations are needed to form a lake. When the lake is filled, the water level will be at the top of both dams. The Dam #2 is twice as high and twice as wide as Dam #1. How much greater is the force of the water on Dam #2 than the force on Dam #1? (Ignore atmospheric pressure; it is pushing on both sides of the dams.)

    a. 2
    b. 4
    c. 8
    d. 16

27. Atmospheric pressure is 1.0×10^5 N/m^2, and the density of air is 1.29 kg/m^3. If the density of air is constant as you get higher and higher, calculate the height of the atmosphere needed to produce this pressure.

    a. 7 900 m
    b. 77 000 m
    c. 1 260 m
    d. 10 300 m

28. The water behind Grand Coulee Dam is 1 200 m wide and 150 m deep. Find the hydrostatic force on the back of the dam. (Hint: the total force = average pressure × area)

    a. 5.2×10^9 N
    b. 8.8×10^{10} N
    c. 13.2×10^{10} N
    d. 18.0×10^{10} N

29. How deep under the surface of a lake would the pressure be double that at the surface? (1 atm = 1.01×10^5 Pa)

    a. 1.00 m
    b. 9.80 m
    c. 10.3 m
    d. 32.2 m

9.6 Buoyant Forces and Archimedes's Principle

30. A piece of aluminum has density 2.70 g/cm^3 and mass 775 g. The aluminum is submerged in a container of oil (oil's density = 0.650 g/cm^3). How much oil does the metal displace?

    a. 287 cm^3
    b. 309 cm^3
    c. 232 cm^3
    d. 1 125 cm^3

31. A piece of aluminum has density 2.70 g/cm^3 and mass 775 g. The aluminum is submerged in a container of oil of density 0.650 g/cm^3. A spring balance is attached with string to the piece of aluminum. What reading will the balance register in grams (g) for the submerged metal?

    a. 960 g
    b. 775 g
    c. 588 g
    d. 190 g

32. A block of wood has density 0.50 g/cm^3 and mass 1 500 g. It floats in a container of oil (the oil's density is 0.75 g/cm^3). What volume of oil does the wood displace?

    a. 3 000 cm^3
    b. 2 000 cm^3
    c. 1 500 cm^3
    d. 1 000 cm^3

33. What volume of water is displaced by a submerged 2.0-kg cylinder made of solid aluminum? (aluminum density = 2.7×10^3 kg/m^3 and water density = 1.0×10^3 kg/m^3)

    a. 7.4×10^{-4} m^3
    b. 1.4×10^3 m^3
    c. 9.9×10^3 m^3
    d. 6.0×10^2 m^3

34. A ping-pong ball has an average density of 0.0840 g/cm^3 and a diameter of 3.80 cm. What force would be required to keep the ball completely submerged under water?

    a. 1.000 N
    b. 0.788 N
    c. 0.516 N
    d. 0.258 N

35. A cube of wood of density 0.78 g/cm^3 is 10 cm on a side. When placed in water, what height of the block will float above the surface? (water density = 1.00 g/cm^3)

    a. 7.8 cm
    b. 5.0 cm
    c. 2.2 cm
    d. 6.4 cm

36. The bottom of a flat-bottomed aluminum boat has an area of 4.0 m^2 and the boat's mass is 60 kg. When set afloat in water, how far below the water surface is the boat bottom? (water density = 1.0×10^3 kg/m^3)

    a. 0.060 m
    b. 0.015 m
    c. 0.030 m
    d. 0.075 m

37. The bottom of a flat-bottomed aluminum boat has area = 4.0 m^2 and mass = 60 kg. If two fishermen and their fishing gear with total mass of 300 kg are placed in the boat, how much lower will the boat ride in the water? (H_2O density = 1.0×10^3 kg/m^3)

    a. 0.15 m
    b. 0.090 m
    c. 0.075 m
    d. 0.060 m

38. Legend says that Archimedes, in determining whether or not the king's crown was made of pure gold, measured its volume by the water displacement method. If the density of gold is 19.3 g/cm^3, and the crown's mass is 600 g, what volume would be necessary to prove that it is pure gold?

    a. 31.1 cm^3
    b. 114×10^3 cm^3
    c. 22.8×10^3 cm^3
    d. 1.81×10^{-2} cm^3

39. A solid rock, suspended in air by a spring scale, has a measured mass of 9.00 kg. When the rock is submerged in water, the scale reads 3.30 kg. What is the density of the rock? (water density = 1 000 kg/m^3)

    a. 4.55×10^3 kg/m^3
    b. 3.50×10^3 kg/m^3
    c. 1.20×10^3 kg/m^3
    d. 1.58×10^3 kg/m^3

40. As ice floats in water, about 10% of the ice floats above the surface of the water. If we float some ice in a glass of water, what will happen to the water level as the ice melts?

    a. The water level will rise 10% of the volume of the ice that melts.
    b. The water level will rise, but not as much as the 10% indicated in answer a.
    c. The water level will remain unchanged.
    d. The water level will become lower.

41. A large stone is resting on the bottom of the swimming pool. The normal force of the bottom of the pool on the stone is equal to the:

    a. weight of the stone.
    b. weight of the water displaced.
    c. sum of the weight of the stone and the weight of the displaced water.
    d. difference between the weight of the stone and the weight of the displaced water.

42. A blimp is filled with 400 m^3 of helium. How big a payload can the balloon lift? (The density of air is 1.29 kg/m^3; the density of helium is 0.18 kg/m^3.)

    a. 111 kg
    b. 129 kg
    c. 215 kg
    d. 444 kg

43. A heavily loaded boat is floating in a pond. The boat sinks because of a leak. What happens to the surface level of the pond?

    a. It stays the same.
    b. It goes up.
    c. It goes down.
    d. More information is needed to reach a conclusion.

44. A heavily loaded boat is floating in a pond. The boat starts to sink because of a leak but quick action plugging the leak stops the boat from going under although it is now deeper in the water. What happens to the surface level of the pond?

    a. It stays the same.
    b. It goes up.
    c. It goes down.
    d. More information is needed to reach a conclusion.

45. A block of wood has specific gravity 0.80. When placed in water, what percent of the volume of the wood is above the surface?

    a. 0, the block sinks.
    b. 20%
    c. 25%
    d. 80%

9.7 Fluids in Motion

9.8 Other Applications of Fluid Dynamics

46. An ideal fluid flows through a pipe made of two sections with diameters of 1.0 and 3.0 inches, respectively. The speed of the fluid flow through the 3.0-inch section will be what factor times that through the 1.0-inch section?

    a. 6.0
    b. 9.0
    c. 1/3
    d. 1/9

47. The flow rate of a liquid through a 2.0-cm-radius pipe is 0.008 0 m^3/s. The average fluid speed in the pipe is:

    a. 0.64 m/s.
    b. 2.0 m/s.
    c. 0.040 m/s.
    d. 6.4 m/s.

48. Think of Bernoulli's equation as it pertains to an ideal fluid flowing through a horizontal pipe. Imagine that you take measurements along the pipe in the direction of fluid flow. What happens to the sum of the pressure and energy per unit volume?

    a. It increases as the pipe diameter increases.
    b. It decreases as the pipe diameter increases.
    c. It remains constant as the pipe diameter increases.
    d. No choices above are valid.

49. An ideal fluid, of density 0.85×10^3 kg/m^3, flows at 0.25 kg/s through a pipe of radius 0.010 m. What is the fluid speed?

    a. 0.85 m/s
    b. 1.3 m/s
    c. 3.0 m/s
    d. 0.94 m/s

50. An ideal fluid, of density 0.90×10^3 kg/m^3, flows at 6.0 m/s through a level pipe with radius of 0.50 cm. The pressure in the fluid is 1.3×10^5 N/m^2. This pipe connects to a second level pipe, with radius of 1.5 cm. Find the speed of flow in the second pipe.

    a. 54 m/s
    b. 18 m/s
    c. 0.67 m/s
    d. 0.33 m/s

51. The flow rate of blood through the average human aorta, of radius 1.0 cm, is about 90 cm^3/s. What is the speed of the blood flow through the aorta?

    a. 14 cm/s
    b. 32 cm/s
    c. 37 cm/s
    d. 29 cm/s

52. Water (density = 1×10^3 kg/m^3) flows at 15 m/s through a pipe with radius 0.040 m. The pipe goes up to the second floor of the building, 3.0 m higher, and the pressure remains unchanged. What is the speed of the water flow in the pipe on the second floor?

    a. 13 m/s
    b. 14 m/s
    c. 15 m/s
    d. 16 m/s

53. Water (density = 1×10^3 kg/m^3) flows at 10 m/s through a pipe with radius 0.030 m. The pipe goes up to the second floor of the building, 2.0 m higher, and the pressure remains unchanged. What is the radius of the pipe on the second floor?

    a. 0.046 m
    b. 0.034 m
    c. 0.015 m
    d. 0.012 m

54. Air pressure is 1.0×10^5 N/m^2, air density is 1.3 kg/m^3, and the density of soft drinks is 1.0×10^3 kg/m^3. If one blows carefully across the top of a straw sticking up 0.100 m from the liquid in a soft drink can, it is possible to make the soft drink rise half way up the straw and stay there. How fast must the air be blown across the top of the straw?

    a. 76 m/s
    b. 27 m/s
    c. 19 m/s
    d. 0.99 m/s

55. A hole is poked through the metal side of a drum holding water. The hole is 18 cm below the water surface. What is the initial speed of outflow?

    a. 1.9 m/s
    b. 2.96 m/s
    c. 3.2 m/s
    d. 3.5 m/s

56. Water comes down the spillway of a dam from an initial vertical height of 170 m. What is the highest possible speed of the water at the end of the spillway?

    a. 15 m/s
    b. 25 m/s
    c. 58 m/s
    d. 1 370 m/s

57. Water pressurized to 3×10^5 Pa is flowing at 5.0 m/s in a pipe which contracts to 1/3 of its former area. What are the pressure and speed of the water after the contraction? (Density of water = 1×10^3 kg/m^3.)

    a. 2×10^5 Pa, 15 m/s
    b. 3×10^5 Pa, 10 m/s
    c. 3×10^5 Pa, 15 m/s
    d. 4×10^5 Pa, 1.5 m/s

58. A fountain sends water to a height of 100 m. What must be the pressurization (above atmospheric) of the underground water system? (1 atm = 10^5 N/m^2)

    a. 1 atm
    b. 4.2 atm
    c. 7.2 atm
    d. 9.8 atm

59. The Garfield Thomas water tunnel at Pennsylvania State University has a circular cross-section that constricts from a diameter of 3.6 m to the test section, which is 1.2 m in diameter. If the speed of flow is 3.0 m/s in the large-diameter pipe, determine the speed of flow in the test section.

    a. 9.0 m/s
    b. 18 m/s
    c. 27 m/s
    d. 1.0 m/s

60. A Boeing-737 airliner has a mass of 20 000 kg. The total area of the wings is 100 m^2. What must be the pressure difference between the top and bottom of the wings to keep the airplane up?

    a. 1 960 Pa
    b. 3 920 Pa
    c. 7 840 Pa
    d. 15 700 Pa

61. How much air must be pushed downward at 40.0 m/s to keep an 800-kg helicopter aloft?

    a. 98.0 kg/s
    b. 196 kg/s
    c. 294 kg/s
    d. 392 kg/s

62. A jet of water flowing from a hose at 15 m/s is directed against a wall. If the mass flow in the fluid stream is 2.0 kg/s, what force is the water applying to the wall if backsplash is negligible?

    a. 30 N
    b. 40 N
    c. 65 N
    d. 127 N

63. A Venturi tube may be used as the inlet to an automobile carburetor. If the inlet pipe of 2.0 cm diameter narrows to 1.0 cm diameter, what is the pressure drop in the constricted section for airflow of 3.0 m/s in the 2-cm section? (Assume air density is 1.25 kg/m^3.)

    a. 70 Pa
    b. 84 Pa
    c. 100 Pa
    d. 115 Pa

64. Water is sent from a fire hose at 30 m/s at an angle of 30° above the horizontal. What is the maximum height reached by the water?

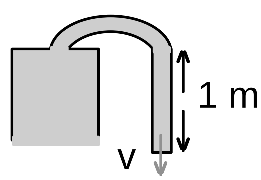
    a. 7.5 m
    b. 11 m
    c. 15 m
    d. 19 m

65. How much power is theoretically available from a mass flow of 1 000 kg/s of water that falls a vertical distance of 100 m?

    a. 980 kW
    b. 98 kW
    c. 4 900 W
    d. 980 W

66. A fluid is drawn up through a tube as shown below. The atmospheric pressure is the same at both ends. Use Bernoulli's equation to determine the speed of fluid flow out of the tank. If the height difference from the top of the tank to the bottom of the siphon is 1.0 m, then the speed of outflow is:

    a. 1.1 m/s.
    b. 2.2 m/s.
    c. 4.4 m/s.
    d. 8.8 m/s.



67. It takes 2.0 minutes to fill a gas tank with 40 liters of gasoline. If the pump nozzle is 1.0 cm in radius, what is the average speed of the gasoline as it leaves the nozzle? (1 000 liters = one cubic meter)

    a. 0.27 m/s
    b. 1.1 m/s
    c. 11 m/s
    d. 64 m/s

68. Water is being sprayed from a nozzle at the end of a garden hose of diameter 2.0 cm. If the nozzle has an opening of diameter 0.50 cm, and if the water leaves the nozzle at a speed of 10 m/s, what is the speed of the water inside the hose?

    a. 0.63 m/s
    b. 0.80 m/s
    c. 2.5 m/s
    d. also 10 m/s

9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

69. A unit for viscosity, the centipoise, is equal to which of the following?

    a. 10^{-3} N·s/m^2
    b. 10^{-2} N·s/m^2
    c. 10^{-1} N·s/m^2
    d. 10^{2} N·s/m^2

70. The condition for onset of turbulent flow is that the Reynolds Number reaches what value?

    a. 1 000
    b. 2 000
    c. 3 000
    d. 4 000

71. A fluid has a density of 1 040 kg/m^3. If it rises to a height of 1.8 cm in a 1.0-mm diameter capillary tube, what is the surface tension of the liquid? Assume a contact angle of zero.

    a. 0.046 N/m
    b. 0.056 N/m
    c. 0.092 N/m
    d. 0.11 N/m

72. A pipe carrying water has a radius of 1.0 cm. If the flow velocity is 9.0 cm/s, which of the following characterizes the flow? Take the viscosity of water to be 1.0×10^{-3} N·s/m.

    a. streamlined
    b. unstable
    c. turbulent
    d. stagnant

73. In order to overcome a surface tension of a fluid, a force of 1.32×10^{-2} N is required to lift a wire ring of circumference 12.0 cm. What is the surface tension of the fluid?

    a. 0.055 N/m
    b. 0.11 N/m
    c. 0.035 N/m
    d. 0.018 N/m

74. A pipe of diameter three cm is replaced by one of the same length but of diameter six cm. If the pressure difference between the ends of the pipe remains the same, by what factor is the rate of flow of a viscous liquid through it changed?

    a. 2
    b. 4
    c. 8
    d. 16

9.10 Transport Phenomena

75. Spherical particles of density 2.0 g/cm^3 are shaken in a container of water (viscosity = 1.0 × 10^{-3} N·s/m^3). The water is 8.0 cm deep and is allowed to stand for 30 minutes. What is the greatest terminal velocity of the particles still in suspension at that time?

    a. 0.55×10^{-5} m/s
    b 1.1×10^{-5} m/s
    c. 2.2×10^{-5} m/s
    d. 4.4×10^{-5} m/s

76. Spherical particles of density 2.0 g/cm^3 are shaken in a container of water (viscosity = 1.0 × 10^{-3} N·s/m^3). The water is 8.0 cm deep and is allowed to stand for 30 minutes. What is the radius of the largest particles still in suspension at that time?

    a. 4.5×10^{-6} m
    b. 9.0×10^{-6} m
    c. 2.3×10^{-6} m
    d. 5.6×10^{-6} m

77. A centrifuge rotates at 100 rev/s (i.e., 628 rad/s). If the test tube places the suspension at 8.0 cm from the axis of rotation, by what factor are the terminal speeds of the settling particles increased as compared to sedimentation cause by gravity?

    a. 3.2×10^2
    b. 64
    c. 800
    d. 3.9×10^5

78. Which of the following characterizes the net force on a particle falling through a fluid at its terminal speed?

    a. It is at a maximum.
    b. It is upwards.
    c. It is downwards.
    d. It is zero.

CHAPTER 9 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	A	1	38.	A	2
C2.	A	1	39.	D	2
C3.	A	2	40.	C	2
C4.	C	2	41.	D	2
C5.	C	2	42.	D	2
1.	B	1	43.	C	2
2.	D	2	44.	A	2
3.	D	1	45.	B	2
4.	B	1	46.	D	2
5.	D	1	47.	D	2
6.	D	1	48.	C	2
7.	D	2	49.	D	2
8.	D	1	50.	C	2
9.	D	2	51.	D	2
10.	C	2	52.	A	2
11.	B	2	53.	B	3
12.	A	2	54.	B	2
13.	B	1	55.	A	2
14.	D	2	56.	C	2
15.	D	2	57.	A	2
16.	D	3	58.	D	2
17.	D	2	59.	C	2
18.	C	2	60.	A	2
19.	B	1	61.	B	2
20.	A	2	62.	A	2
21.	A	2	63.	B	2
22.	D	1	64.	B	2
23.	A	2	65.	A	2
24.	B	2	66.	C	2
25.	A	2	67.	B	2
26.	C	2	68.	A	2
27.	A	2	69.	A	1
28.	C	2	70.	C	1
29.	C	2	71.	A	2
30.	A	1	72.	A	2
31.	C	3	73.	A	2
32.	B	2	74.	D	2
33.	A	1	75.	D	2
34.	D	2	76.	A	3
35.	C	2	77.	A	2
36.	B	2	78.	D	1
37.	C	2			

CHAPTER 10

Conceptual Problems

C1. Metal lids on glass jars can often be loosened by running them under hot water. Why is this?

a. The hot water is a lubricant.
b. The metal and glass expand due to the heating, and the glass being of smaller radius expands less than the metal.
c. The metal has a higher coefficient of thermal expansion than glass so the metal expands more than the glass thus loosening the connection.
d. This is just folklore.

C2. Why do vapor bubbles get larger in boiling water as they approach the surface?

a. They only appear to get larger, this being a magnification effect due to looking through the water.
b. The bubbles’ pressure increases as they rise.
c. The pressure in the water decreases as the bubble moves toward the surface.
d. Bubbles always get bigger after they form.

C3. Suppose the pressure of 20 g of an ideal monatomic gas is tripled while its volume is halved. What happens to the internal energy of the gas?

a. It stays the same, as the described changes do not involve internal energy.
b. It increases.
c. It decreases.
d. This depends on the molecular weight of the gas involved, thus this is indeterminate.

C4. The temperature of a quantity of ideal gas in a sealed container is increased from $0°C$ to $273^{\circ}C$. What happens to the rms speed of the molecules of the gas as a result of this temperature increase?

a. It does not change since rms speed is independent of temperature.
b. It increases but it less than doubles.
c. It doubles.
d. It quadruples.

C5. The noble gases, listed by increasing molecular weight, are He, Ne, Ar, Kr, Xe, and Rn. If samples of 1 mole each of these gases are placed in separate containers and heated to 300 K, which gas has the greatest internal energy and the molecules of which gas have the highest rms speed?

a. The He has the greatest internal energy, and the Rn has the greatest rms speed.
b. The Rn has the greatest internal energy, and the He has the greatest rms speed.
c. All the gases have the same internal energy, and the Rn has the greatest rms speed.
d. All the gases have the same internal energy, and the He has the greatest rms speed.

10.1 Temperature and the Zeroth Law of Thermodynamics

10.2 Thermometers and Temperature Scales

1. Which best describes the relationship between two systems in thermal equilibrium?

   a. no net energy is exchanged
   b. volumes are equal
   c. masses are equal
   d. zero velocity

2. The zeroth law of thermodynamics pertains to what relational condition that may exist between two systems?

   a. zero net forces
   b. zero velocities
   c. zero temperature
   d. thermal equilibrium

3. If it is given that 546 K equals 273°C, then it follows that 400 K equals:

   a. 127°C.
   b. 150°C.
   c. 473°C.
   d. 1 200°C.

4. What is the temperature of a system in thermal equilibrium with another system made up of water and steam at one atmosphere of pressure?

   a. 0°F
   b. 273 K
   c. 0 K
   d. 100°C

5. What is the temperature of a system in thermal equilibrium with another system made up of ice and water at one atmosphere of pressure?

   a. 0°F
   b. 273 K
   c. 0 K
   d. 100°C

6. Which best describes a system made up of ice, water and steam existing together?

   a. absolute zero
   b. triple point
   c. ice point
   d. steam point

7. A temperature change from 15°C to 35°C corresponds to what incremental change in °F?

   a. 20
   b. 40
   c. 36
   d. 313

8. A substance is heated from 15°C to 35°C. What would the same incremental change be when registered in kelvins?

   a. 20
   b. 40
   c. 36
   d. 313

9. 88°F is how many degrees Celsius?

   a. 31
   b. 49
   c. 56
   d. 158

10. At what temperature is the same numerical value obtained in Celsius and Fahrenheit?

    a. –40°
    b. 0°
    c. 40°
    d. –72°

11. Normal body temperature for humans is 37°C. What is this temperature in kelvins?

    a. 296
    b. 310
    c. 393
    d. 273

12. Carbon dioxide forms into a solid (dry ice) at approximately −157°F. What temperature in degrees Celsius does this correspond to?

    a. –157°C
    b. –93°C
    c. –121°C
    d. –105°C

13. An interval of one Celsius degree is equivalent to an interval of:

    a. one Fahrenheit degree.
    b. one kelvin.
    c. 5/9 Fahrenheit degree.
    d. 5/9 kelvin.

14. A temperature of 233 K equals which of the following?

    a. 506°C
    b. 40°C
    c. –40°F
    d. 40°F

15. Which of the following properties can be used to measure temperature?

    a. the color of a glowing object
    b. the length of a solid
    c. the volume of gas held at constant pressure
    d. all of the above

16. The pressure in a constant-volume gas thermometer extrapolates to zero at what temperature?

    a. 0°C
    b. 0 K
    c. 0°F
    d. 0 Pa

10.3 Thermal Expansion of Solids and Liquids

17. A steel wire, 150 m long at 10°C, has a coefficient of linear expansion of 11×10^{-6}/C°. Give its change in length as the temperature changes from 10°C to 45°C.

    a. 0.65 cm
    b. 1.8 cm
    c. 5.8 cm
    d. 12 cm

18. A rectangular steel plate with dimensions of 30 cm × 25 cm is heated from 20°C to 220°C. What is its change in area? (Coefficient of linear expansion for steel is 11×10^{-6}/C°.)

    a. 0.82 cm^2
    b. 1.65 cm^2
    c. 3.3 cm^2
    d. 6.6 cm^2

19. What happens to a given mass of water as it is cooled from 4°C to zero?

    a. expands
    b. contracts
    c. vaporizes
    d. Neither expands, contracts, nor vaporizes.

20. The observation that materials expand in size with an increase in temperature can be applied to what proportion of existing substances?

    a. 100%
    b. most
    c. few
    d. none

21. Which best expresses the value for the coefficient of volume expansion, β, for given material as a function of its corresponding coefficient of linear expansion, α?

    a. $\beta = \alpha^3$
    b. $\beta = 3\alpha$
    c. $\beta = \alpha^2$
    d. $\beta = 2\alpha$

22. A steel plate has a hole drilled through it. The plate is put into a furnace and heated. What happens to the size of the inside diameter of a hole as its temperature increases?

    a. increases
    b. decreases
    c. remains constant
    d. becomes elliptical

23. A brass cube, 10 cm on a side, is raised in temperature by 200°C. The coefficient of volume expansion of brass is 57×10^{-6}/C°. By what percentage does volume increase?

    a. 12%
    b. 2.8%
    c. 1.1%
    d. 0.86%

24. A brass cube, 10 cm on a side, is raised in temperature by 200°C. The coefficient of volume expansion of brass is 57×10^{-6}/C°. By what percentage is any one of the 10-cm edges increased in length?

    a. 4%
    b. 2.8%
    c. 0.38%
    d. 0.29%

25. An automobile gas tank is filled to its capacity of 15.00 gallons with the gasoline at an initial temperature of 10°C. The automobile is parked in the sun causing the gasoline's temperature to rise to 60°C. If the coefficient of volume expansion for gasoline is 9.6×10^{-4}/C°, what volume runs out the overflow tube? Assume the change in volume of the tank is negligible.

    a. 1.74 gallons
    b. 1.18 gallons
    c. 0.72 gallons
    d. 0.30 gallons

26. What happens to a given volume of water when heated from 0°C to 4°C?

    a. density increases
    b. density decreases
    c. density remains constant
    d. vaporizes

27. What happens to a volume of water when its temperature is reduced from 8°C to 4°C?

    a. density increases
    b. density decreases
    c. density remains constant
    d. vaporizes

28. The thermal expansion of a solid is caused by:

    a. the breaking of bonds between atoms.
    b. increasing the amplitude of the atoms vibration.
    c. increasing the distance between equilibrium positions for the vibrating atoms.
    d. all of the above.

29. A steel sphere sits on top of an aluminum ring. The steel sphere ($\alpha = 1.10 \times 10^{-5}$/C°) has a diameter of 4.000 0 cm at 0°C. The aluminum ring ($\alpha = 2.40 \times 10^{-5}$/C°) has an inside diameter of 3.994 0 cm at 0°C. Closest to which temperature given will the sphere just fall through the ring?

    a. 462°C
    b. 208°C
    c. 116°C
    d. 57.7°C

30. Between 0° and 4°C, the volume coefficient of expansion for water:

    a. is positive.
    b. is zero.
    c. is becoming less dense.
    d. is negative.

31. A long steel beam has a length of twenty-five meters on a cold day when the temperature is 0°C. What is the length of the beam on a hot day when T = 40°C? ($\alpha_{steel} = 1.1 \times 10^{-5}$/C°)

    a. 25.000 44 m
    b. 25.004 4 m
    c. 25.011 m
    d. 25.044 m

32. Suppose the ends of a 20-m-long steel beam are rigidly clamped at 0°C to prevent expansion. The rail has a cross-sectional area of 30 cm^2. What force does the beam exert when it is heated to 40°C? ($\alpha_{steel} = 1.1 \times 10^{-5}$/C°, $Y_{steel} = 2.0 \times 10^{11}$ N/m^2).

    a. 2.6×10^5 N
    b. 5.6×10^4 N
    c. 1.3×10^3 N
    d. 6.5×10^2 N

33. At 20°C an aluminum ring has an inner diameter of 5.000 cm, and a brass rod has a diameter of 5.050 cm. Keeping the brass rod at 20°C, which of the following temperatures of the ring will allow the ring to just slip over the brass rod?
    ($\alpha_{Al} = 2.4 \times 10^{-5}$ /C°, $\alpha_{brass} = 1.9 \times 10^{-5}$/C°)

    a. 111°C
    b. 236°C
    c. 384°C
    d. 437°C

34. As a copper wire is heated, its length increases by 0.100%. What is the change of the temperature of the wire? ($\alpha_{Cu} = 16.6 \times 10^{-6}$/C°)

    a. 120.4°C
    b. 60.2°C
    c. 30.1°C
    d. 6.0°C

35. The coefficient of area expansion is:

    a. half the coefficient of volume expansion.
    b. three halves the coefficient of volume expansion.
    c. double the coefficient of linear expansion.
    d. triple the coefficient of linear expansion.

36. At room temperature, the coefficient of linear expansion for Pyrex glass is _____________ that for ordinary glass.

    a. the same as
    b. more than
    c. less than
    d. stronger than

37. A pipe of length 10.0 m increases in length by 1.5 cm when its temperature is increased by 90°F. What is its coefficient of linear expansion?

    a. 30×10^{-6}/°C
    b. 17×10^{-6}/°C
    c. 13×10^{-6}/°C
    d. 23×10^{-6}/°C

38. A material has a coefficient of volume expansion of 60×10^{-6}/°C. What is its area coefficient of expansion?

    a. 120×10^{-6}/°C
    b. 40×10^{-6}/°C
    c. 20×10^{-6}/°C
    d. 180×10^{-6}/°C

39. What happens to its moment of inertia when a steel disk is heated?

    a. It increases.
    b. It decreases.
    c. It stays the same.
    d. It increases for half the temperature increase and then decreases for the rest of the temperature increase.

10.4 Macroscopic Description of an Ideal Gas

40. An ideal gas is confined to a container with adjustable volume. The pressure and mole number are constant. By what factor will volume change if absolute temperature triples?

    a. 1/9
    b. 1/3
    c. 3.0
    d. 9.0

41. An ideal gas is confined to a container with constant volume. The number of moles is constant. By what factor will the pressure change if the absolute temperature triples?

    a. 1/9
    b. 1/3
    c. 3.0
    d. 9.0

42. An ideal gas is confined to a container with adjustable volume. The number of moles and temperature are constant. By what factor will the volume change if pressure triples?

    a. 1/9
    b. 1/3
    c. 3.0
    d. 9.0

43. A 2.00-L container holds half a mole of an ideal gas at a pressure of 12.5 atm. What is the gas temperature? (R = 0.082 1 L·atm/mol·K)

    a. 1 980 K
    b. 1 190 K
    c. 965 K
    d. 609 K

44. With volume and molar quantity held constant, by what factor does the absolute temperature change for an ideal gas when the pressure is five times bigger?

    a. 0.2
    b. 1.0
    c. 5.0
    d. 25.0

45. With molar quantity and temperature held constant, by what factor does the pressure of an ideal gas change when the volume is five times bigger?

    a. 0.2
    b. 1.0
    c. 5.0
    d. 25.0

46. Two moles of nitrogen gas are contained in an enclosed cylinder with a movable piston. If the molecular mass of nitrogen is 28, how many grams of nitrogen are present?

    a. 0.14
    b. 56
    c. 42
    d. 112

47. Two moles of nitrogen gas are contained in an enclosed cylinder with a movable piston. If the gas temperature is 298 K, and the pressure is 1.01×10^6 N/m^2, what is the volume? (R = 8.31 J/mol·K)

    a. 9.80×10^{-3} m^3
    b. 4.90×10^{-3} m^3
    c. 17.3×10^{-3} m^3
    d. 8.31×10^{-3} m^3

48. Boltzmann's constant, k_B, may be derived as a function of R, the universal gas constant, and N_A, Avogadro's number. Which expresses the value of k_B?

    a. $N_A R^2$
    b. $N_A R$
    c. R/N_A
    d. N_A/R

49. How many atoms are present in a sample of pure iron with a mass of 300 g? (The atomic mass of iron = 56 and $N_A = 6.02 \times 10^{23}$)

    a. 1.8×10^{19}
    b. 6.7×10^{22}
    c. 1.6×10^{28}
    d. 3.2×10^{24}

50. Two moles of an ideal gas at 3.0 atm and 10°C are heated up to 150 °C. If the volume is held constant during this heating, what is the final pressure?

    a. 4.5 atm
    b. 1.8 atm
    c. 0.14 atm
    d. 1.0 atm

51. One way to heat a gas is to compress it. A gas at 1.00 atm at 25.0°C is compressed to one tenth of its original volume, and it reaches 40.0 atm pressure. What is its new temperature?

    a. 1 500 K
    b. 1 500°C
    c. 1 192°C
    d. 919°C

52. A pressure of 1.0×10^{-7} mm of Hg is achieved in a vacuum system. How many gas molecules are present per liter volume if the temperature is 293 K? (760 mm of Hg = 1 atm, R = 0.082 1 L·atm/mol·K, and $N_A = 6.02 \times 10^{23}$)

    a. 16×10^{18}
    b. 4.7×10^{16}
    c. 3.3×10^{12}
    d. 3.4×10^{9}

53. A helium-filled weather balloon has a 0.90 m radius at liftoff where air pressure is 1.0 atm and the temperature is 298 K. When airborne, the temperature is 210 K, and its radius expands to 3.0 m. What is the pressure at the airborne location?

    a. 0.50 atm
    b. 0.013 atm
    c. 0.019 atm
    d. 0.38 atm

54. One mole of an ideal gas at 1.00 atm and 0.00°C occupies 22.4 L. How many molecules of an ideal gas are in one cm^3 under these conditions?

    a. 28.9
    b. 22 400
    c. 2.69×10^{19}
    d. 6.02×10^{23}

55. How many moles of air must escape from a 10-m × 8.0-m × 5.0-m room when the temperature is raised from 0°C to 20°C? Assume the pressure remains unchanged at one atmosphere while the room is heated.

    a. 1.3×10^{3} moles
    b. 1.2×10^{3} moles
    c. 7.5×10^{2} moles
    d. 3.7×10^{2} moles

56. Estimate the volume of a helium-filled balloon at STP if it is to lift a payload of 500 kg. The density of air is 1.29 kg/m^3 and helium has a density of 0.178 kg/m^3.

    a. 4 410 m^3
    b. 932 m^3
    c. 450 m^3
    d. 225 m^3

57. Tricia puts 44 g of dry ice (solid CO_2) into a 2.0-L container and seals the top. The dry ice turns to gas at room temperature (20°C). Find the pressure increase in the 2.0-L container. (One mole of CO_2 has a mass of 44 g, R = 0.082 1 L·atm/mol·K. Ignore the initial volume of the dry ice.)

    a. 6.0 atm
    b. 12 atm
    c. 18 atm
    d. 2.0 atm

58. The mass of a hot-air balloon and its cargo (not including the air inside) is 200 kg. The air outside is at a temperature of 10°C and a pressure of 1 atm = 10^5 N/m^2. The volume of the balloon is 400 m^3. Which temperature below of the air in the balloon will allow the balloon to just lift off? (Air density at 10°C is 1.25 kg/m^3.)

    a. 37°C
    b. 69°C
    c. 99°C
    d. 200°C

59. 9.0 g of water in a 2.0-L pressure vessel is heated to 500°C. What is the pressure inside the container? (R = 0.082 L·atm/mol·K, one mole of water has a mass of 18 grams)

    a. 7.9 atm
    b. 16 atm
    c. 24 atm
    d. 32 atm

60. A spherical air bubble originating from a scuba diver at a depth of 18.0 m has a diameter of 1.0 cm. What will the bubble's diameter be when it reaches the surface? (Assume constant temperature.)

    a. 0.7 cm
    b. 1.0 cm
    c. 1.4 cm
    d. 1.7 cm

61. A tank with a volume of 0.150 m^3 contains 27.0°C helium gas at a pressure of 100 atm. How many balloons can be blown up if each filled balloon is a sphere 30.0 cm in diameter at 27.0°C and absolute pressure of 1.20 atm? Assume all the helium is transferred to the balloons.

    a. 963 balloons
    b. 884 balloons
    c. 776 balloons
    d. 598 balloons

62. The ideal gas law treats gas as consisting of:

    a. atoms.
    b. molecules.
    c. chemicals.
    d. bubbles.

63. The sulfur hexafluoride molecule consists of one sulfur atom and six fluorine atoms. The atomic masses of sulfur and fluorine are 32.0 u and 19.0 u respectively. One mole of this very heavy gas has what mass?

    a. 32 g
    b. 51 g
    c. 146 g
    d. 608 g

64. A room has a volume of 60 m^3 and is filled with air of an average molecular mass of 29 u. What is the mass of the air in the room at a pressure of 1.0 atm and temperature of 22°C? R = 0.082 L·atm/mol·K

    a. 2.4 kg
    b. 2 400 kg
    c. 72 kg
    d. 700 kg

65. Different units can be used for length: m and cm, and of these two, m is the larger by a factor of 100. Different units can also be used for R: (1) J/mol·K, (2) L·atm/mol·K, and (3) (N/m^2)·m^3/mol·K. Which of these units for R is the largest? Hint: When expressing R in each of these units, which expression has the lowest numerical factor? (1L = 10^{-3} m^3, 1 atm = 1.01 × 10^5 Pa)

    a. 1
    b. 2
    c. 3
    d. They are all equal.

66. Two one-liter containers each contain 10 moles of a gas. The temperature is the same in both containers. Container A holds helium (molecular mass = 4 u), and Container B holds oxygen (molecular mass = 16 u). Which container has the higher pressure and by what factor?

    a. Container A has 4 times the pressure of Container B.
    b. Container A has 2 times the pressure of Container B.
    c. Both containers have the same pressure.
    d. More information is needed to answer this question.

10.5 The Kinetic Theory of Gases

67. Two ideal gases, X and Y, are thoroughly mixed and at thermal equilibrium in a single container. The molecular mass of X is 9 times that of Y. What is the ratio of root-mean-square velocities of the two gases, $v_{X, rms}/v_{Y, rms}$?

    a. 9/1
    b. 3/1
    c. 1/3
    d. 1/9

68. The absolute temperature of an ideal gas is directly proportional to which of the following properties, when taken as an average, of the molecules of that gas?

    a. speed
    b. momentum
    c. mass
    d. kinetic energy

69. What is the root-mean-square speed of chlorine gas molecules at a temperature of 320 K? (R = 8.31 J/mol·K, $N_A = 6.02 \times 10^{23}$, and the molecular mass of Cl_2 = 71)

    a. 1.7×10^2 m/s
    b. 3.4×10^2 m/s
    c. 0.8×10^4 m/s
    d. 1.1×10^5 m/s

70. If the temperature of an ideal gas contained in a box is increased:

    a. the average velocity of the molecules in the box will be increased.
    b. the average speed of the molecules in the box will be increased.
    c. the distance between molecules in the box will be increased.
    d. all of the above.

71. For an ideal gas of a given mass, if the pressure remains the same and the volume increases:

    a. the average kinetic energy of the molecules decreases.
    b. the average kinetic energy of the molecules stays the same.
    c. the average kinetic energy of the molecules increases.
    d. Nothing can be determined about the molecular kinetic energy.

72. John rapidly pulls a plunger out of a cylinder. As the plunger moves away, the gas molecules bouncing elastically off the plunger are:

    a. rebounding at a higher speed than they would have if the plunger weren't removed.
    b. rebounding at a lower speed than they would have if the plunger weren't removed.
    c. rebounding at the same speed as they would have if the plunger weren't removed.
    d. Whether they speed up or slow down depends on how fast the plunger is removed.

73. Consider two containers with the same volume and temperature. Container One holds "dry" air—a mixture of nitrogen and oxygen. Container Two holds "moist" air. The "moist" air has the same ratio of nitrogen to oxygen molecules, but also contains water vapor. According to the ideal gas law, if the pressures are equal, the weight of the gas in Container One will be:

    a. lighter than the gas inside the second container.
    b. equal to the weight of the gas in the second container.
    c. heavier than the gas inside the second container.
    d. all the above are incorrect because the pressures cannot be equal.

74. Evaporation cools the liquid that is left behind because the molecules that leave the liquid during evaporation:

    a. have kinetic energy.
    b. have greater than average speed.
    c. have broken the bonds that held them in the liquid.
    d. create vapor pressure.

75. What is the internal energy of 50 moles of Neon gas (molecular mass = 20 u) at 27°C? (R = 8.31 J/mol·K)

    a. 1.9×10^5 J
    b. 1.6×10^5 J
    c. 3.8×10^3 J
    d. It depends on the container size, which is not given.

76. A quantity of a monatomic ideal gas expands to twice the volume while maintaining the same pressure. If the internal energy of the gas were U_0 before the expansion, what is it after the expansion?

a. U_0
b. 2 U_0
c. 4 U_0
d. The change in temperature must also be known to answer this question.

77. The internal energy of a monatomic ideal gas is equal to which of the following?

a. (3/2)PV
b. (3/2)nT/V
c. 3 T/P
d. none of the above

Chapter 10 - Answers

#	Ans	Difficulty	#	Ans	Difficulty
C1.	C	1	37.	A	2
C2.	C	2	38.	B	2
C3.	B	2	39.	A	2
C4.	B	2	40.	C	1
C5.	D	2	41.	C	1
1.	A	1	42.	B	1
2.	D	1	43.	D	2
3.	A	2	44.	C	1
4.	D	1	45.	A	1
5.	B	1	46.	B	1
6.	B	1	47.	B	2
7.	C	2	48.	C	2
8.	A	1	49.	D	2
9.	A	1	50.	A	2
10.	A	2	51.	D	3
11.	B	2	52.	C	3
12.	D	2	53.	C	2
13.	B	1	54.	C	2
14.	C	2	55.	B	3
15.	D	2	56.	C	3
16.	B	1	57.	B	2
17.	C	2	58.	D	3
18.	C	2	59.	B	2
19.	A	2	60.	C	3
20.	B	1	61.	B	3
21.	B	2	62.	B	1
22.	A	1	63.	C	2
23.	C	2	64.	C	2
24.	C	2	65.	B	2
25.	C	2	66.	C	2
26.	A	1	67.	C	2
27.	A	1	68.	D	1
28.	C	1	69.	B	2
29.	C	3	70.	B	2
30.	D	1	71.	C	2
31.	C	2	72.	B	2
32.	A	3	73.	C	3
33.	D	2	74.	B	1
34.	B	2	75.	A	2
35.	C	1	76.	B	2
36.	C	1	77.	A	2

CHAPTER 11

Conceptual Problems

C1. Pennies used to be made of copper, but now they are made of copper-coated zinc. If one were to do a precise calorimetry experiment to determine the specific heat of the new pennies, what would the result be?

a. It would be that of copper since copper is on the outside.
b. It would be that of zinc since zinc is in the center.
c. It would be the sum of the copper and zinc specific heats.
d. It would be between that of copper and that of zinc, depending on coating thickness.

C2. Inside a house, stepping on a tile floor barefooted may feel almost cold, but stepping on carpet in an adjacent room feels comfortably warm. Why is this?

a. It’s because the tile is below room temperature while the carpet is at room temperature.
b. It’s because the tile is at room temperature while carpet is normally warmer.
c. It’s because the thermal conductivity of tile is less than that of carpet.
d. It’s because the thermal conductivity of carpet is less than that of tile.

C3. Two stars, A and B, have the same emissivity, but the radii and surface temperatures are different with $R_A = 0.5\ R_B$, and $T_A = 2\ T_B$. Assuming the temperature of space to be negligible, which star radiates the most energy per unit time?

a. Star A
b. Star B
c. Both radiate the same amount of energy per unit time.
d. More information is needed in order to make a determination.

C4. The inside of a house is at 20 $^{\circ}$C on an early morning when the temperature outside is 15 $^{\circ}$C. The next morning the inside temperature is the same but the outside temperature is now 10 $^{\circ}$C. How much does the energy per unit time lost by conduction through the walls, windows, doors, etc., change for the house from the first morning to the second one?

a. Since the inside temperature stays the same, the loss is the same both days.
b. The loss doubles.
c. The loss halves.
d. The loss increases by 5/288 since we need to use the Kelvin scale for this calculation.

C5. A plot of the temperature versus the energy per kg added to a piece of ice as it goes from below freezing at – 10 $^{\circ}$C to becoming steam at 110 $^{\circ}$C consists of straight lines, some horizontal and some with an upward slope. What do the upward slopes represent?

a. specific heats
b. reciprocals of specific heats
c. latent heats
d. reciprocals of latent heats

11.1 Heat and Internal Energy

11.2 Specific Heat

1. Arrange from smallest to largest: the BTU, the joule, and the calorie.

    a. BTU, J, cal
    b. J, cal, BTU
    c. cal, BTU, J
    d. J, BTU, cal

2. Of the following systems, which contains the most heat?

    a. 100 kg of water at 80°C
    b. 250 kg of water at 40°C
    c. 600 kg of ice at 0°C
    d. Systems do not contain heat.

3. Heat flow occurs between two bodies in thermal contact when they differ in what property?

    a. mass
    b. specific heat
    c. density
    d. temperature

4. Calories of the food type are equal to which of the following?

    a. 4.186 J
    b. 4 186 J
    c. 1 BTU
    d. 1054 J

5. Who demonstrated that when heat is gained or lost by a system during some process, the gain or loss can be accounted for by an equivalent quantity of mechanical work done on the system?

    a. Joule
    b. Boltzmann
    c. Thompson, Count Rumford
    d. Kelvin

6. The first experiment, which systematically demonstrated the equivalence of mechanical energy and heat, was performed by:

   a. Joule.
   b. Boltzmann.
   c. Thompson, Count Rumford.
   d. Kelvin.

7. If heat is flowing from a table to a block of ice moving across the table, which of the following <u>must</u> be true?

   a. The table is rough and there is friction between the table and ice.
   b. The ice is cooler than the table.
   c. The ice is changing phase.
   d. All three are possible, but none is absolutely necessary.

8. How many calories are equal to one BTU? (One calorie = 4.186 J, one BTU = 1 054 J.)

   a. 0.252
   b. 3.97
   c. 252
   d. 397

9. Which of the following statements is true?

   a. A hot object contains a lot of heat.
   b. A cold object contains only a little heat.
   c. Objects do not contain heat.
   d. Statements a and b are true.

10. A 10-kg piece of aluminum (which has a specific heat of 900 J/kg·°C) is warmed so that its temperature increases by 5.0 C°. How much heat was transferred into it?

    a. 4.5×10^4 J
    b. 9.0×10^4 J
    c. 1.4×10^5 J
    d. 2.0×10^5 J

11. Sea breezes that occur near the shore are attributed to a difference between land and water with respect to what property?

    a. mass density
    b. coefficient of volume expansion
    c. specific heat
    d. emissivity

12. On a sunny day at the beach, the reason the sand gets so hot and the water stays relatively cool is attributed to the difference in which property between water and sand?

    a. mass density
    b. specific heat
    c. temperature
    d. thermal conductivity

13. Marc attaches a falling 500-kg object with a rope through a pulley to a paddle wheel shaft. He places the system in a well-insulated tank holding 25 kg of water. When the object falls, it causes the paddle wheel to rotate and churn the water. If the object falls a vertical distance of 100 m at constant speed, what is the temperature change of the water? (1 kcal = 4 186 J, the specific heat of water is 4 186 J/kg·°C, and $g = 9.8\ m/s^2$)

    a. 19 600 C°
    b. 4 700 C°
    c. 4.7 C°
    d. 0.8 C°

14. An inventor develops a stationary cycling device by which an individual, while pedaling, can convert all of the energy expended into heat for warming water. How much mechanical energy is required to increase the temperature of 300 g of water (enough for 1 cup of coffee) from 20°C to 95°C? (1 cal = 4.186 J, the specific heat of water is 4 186 J/kg·°C)

    a. 94 000 J
    b. 22 000 J
    c. 5 400 J
    d. 14 J

15. An inventor develops a stationary cycling device by which an individual, while pedaling, can convert all of the energy expended into heat for warming water. What minimum power must be generated if 300 g water (enough for 1 cup of coffee) is to be heated in 10 min from 20°C to 95°C? (1 cal = 4.186 J, the specific heat of water is 4 186 J/kg·°C)

    a. 9 400 W
    b. 590 W
    c. 160 W
    d. 31 W

16. A 3.00-g lead bullet is traveling at a speed of 240 m/s when it embeds in a wood post. If we assume that half of the resultant heat energy generated remains with the bullet, what is the increase in temperature of the embedded bullet? (specific heat of lead = 0.030 5 kcal/kg·°C, 1 kcal = 4 186 J)

    a. 113°C
    b. 137°C
    c. 226°C
    d. 259°C

17. A swimming pool heater has to be able to raise the temperature of the 40 000 gallons of water in the pool by 10.0 C°. How many kilowatt-hours of energy are required? (One gallon of water has a mass of approximately 3.8 kg and the specific heat of water is 4 186 J/kg·°C.)

    a. 1 960 kWh
    b. 1 770 kWh
    c. 330 kWh
    d. 216 kWh

18. A solar heated house loses about 5.4×10^7 cal through its outer surfaces on a typical 24-h winter day. What mass of storage rock is needed to provide this amount of heat if it is brought up to initial temperature of 62°C by the solar collectors and the house is maintained at 20°C? (Specific heat of rock is 0.21 cal/g·°C.)

    a. 163 kg
    b. 1 230 kg
    c. 6 100 kg
    d. 12 700 kg

19. A 0.2-kg aluminum plate, initially at 20°C, slides down a 15-m-long surface, inclined at a 30° angle to the horizontal. The force of kinetic friction exactly balances the component of gravity down the plane so that the plate, once started, glides down at constant velocity. If 90% of the mechanical energy of the system is absorbed by the aluminum, what is its temperature increase at the bottom of the incline? (Specific heat for aluminum is 900 J/kg·°C.)

    a. 0.16 C°
    b. 0.07 C°
    c. 0.04 C°
    d. 0.03 C°

20. A waterfall is 145 m high. What is the increase in water temperature at the bottom of the falls if all the initial potential energy goes into heating the water? (g = 9.8 m/s^2, c_w = 4 186 J/kg·°C)

    a. 0.16°C
    b. 0.34°C
    c. 0.69°C
    d. 1.04°C

21. What is the temperature increase of 4.0 kg of water when heated by an 800-W immersion heater for 10 min? (c_w = 4 186 J/kg·°C)
    a. 56°C
    b. 51°C
    c. 29°C
    d. 14°C

22. A solar heating system has a 25.0% conversion efficiency; the solar radiation incident on the panels is 1 000 W/m^2. What is the increase in temperature of 30.0 kg of water in a 1.00-h period by a 4.00-m^2-area collector? (c_w = 4 186 J/kg·°C)

a. 14.3°C
b. 22.4°C
c. 28.7°C
d. 44.3°C

23. A machine gear consists of 0.10 kg of iron and 0.16 kg of copper. How much total heat is generated in the part if its temperature increases by 35 C°? (Specific heats of iron and copper are 450 and 390 J/kg·°C, respectively.)

a. 910 J
b. 3 800 J
c. 4 000 J
d. 4 400 J

24. As I use sandpaper on some rusty metal, the sandpaper gets hot because:

a. heat is flowing from the sandpaper into the metal.
b. heat is flowing from the metal into the sandpaper.
c. frictional processes increase the internal energy of the sandpaper.
d. heat is flowing from my hand into the sandpaper.

25. If a 1000-kg car was moving at 30 m/s, what would be its kinetic energy expressed in the unusual (for kinetic energy) units of calories? (1 cal = 4.186 J)

a. 3.0×10^4
b. 9.0×10^5
c. 3.8×10^6
d. 1.1×10^5

26. A 2.00-kg copper rod is 50.00 cm long at 23°C. If 40 000 J are transferred to the rod by heat, what is its change in length? c_{copper} = 387 J/kg·°C and $\alpha_{copper} = 17 \times 10^{-6}$/°C.

a. 0.022 cm
b. 0.044 cm
c. 0.059 cm
d. More information is needed.

27. A piece of copper of mass 100 g is being drilled through with a $^1/_2$" electric drill. The drill operates at 40.0 W and takes 30.0 s to bore through the copper. If all the energy from the drill heats the copper, find the copper's increase in temperature. c_{copper} = 387 J/kg·°C.

a. 40.6 C°
b. 34.7 C°
c. 31.0 C°
d. 27.3 C°

28. A slice of bread contains about 100 kcal. If specific heat of a person were 1.00 kcal/kg·°C, by how many °C would the temperature of a 70.0-kg person increase if all the energy in the bread were converted to heat?

a. 2.25°C
b. 1.86°C
c. 1.43°C
d. 1.00°C

11.3 Calorimetry

29. A hot (70°C) lump of metal has a mass of 250 g and a specific heat of 0.25 cal/g·°C. John drops the metal into a 500-g calorimeter containing 75 g of water at 20°C. The calorimeter is constructed of a material that has a specific heat of 0.10 cal/ g·°C. When equilibrium is reached, what will be the final temperature? c_{water} = 1.00 cal/g·°C.

a. 114°C
b. 72°C
c. 64°C
d. 37°C

30. An 80.0-g piece of copper, initially at 295°C, is dropped into 250 g of water contained in a 300-g aluminum calorimeter; the water and calorimeter are initially at 10.0°C. What is the final temperature of the system? (Specific heats of copper and aluminum are 0.092 0 and 0.215 cal/g·°C, respectively. c_w = 1.00 cal/g°C)

a. 12.8°C
b. 16.5°C
c. 28.4°C
d. 32.1°C

31. A 120-g block of copper is taken from a kiln and quickly placed into a beaker of negligible heat capacity containing 300 g of water. The water temperature rises from 15°C to 35°C. Given c_{Cu} = 0.10 cal/g·°C, and c_{water} = 1.00 cal/g·°C, what was the temperature of the kiln?

a. 500°C
b. 360°C
c. 720°C
d. 535°C

32. Find the final equilibrium temperature when 10.0 g of milk at 10.0°C is added to 160 g of coffee at 90.0°C. (Assume the specific heats of coffee and milk are the same as water and neglect the heat capacity of the container.) c_{water} = 1.00 cal/g·°C = 4186 J/kg·°C

a. 85.3°C
b. 77.7°C
c. 71.4°C
d. 66.7°C

33. Twenty grams of a solid at 70°C is place in 100 grams of a fluid at 20°C. Thermal equilibrium is reached at 30°C. The specific heat of the solid:

a. is equal to that of the fluid.
b. is less than that of the fluid.
c. is more than that of the fluid.

d. cannot be compared to that of a material in a different phase.

11.4 Latent Heat and Phase Change

34. Which of the following best describes a substance in which the temperature remains constant while at the same time it is experiencing an inward heat flow?

a. gas
b. liquid
c. solid
d. substance undergoing a change of state

35. A 0.003 0-kg lead bullet is traveling at a speed of 240 m/s when it embeds in a block of ice at 0°C. If all the heat generated goes into melting ice, what quantity of ice is melted? (L_f = 80 kcal/kg, the specific heat of lead = 0.03 kcal/kg·°C, and 1 kcal = 4 186 J)

a. 1.47×10^{-2} kg
b. 5.8×10^{-4} kg
c. 3.2×10^{-3} kg
d. 2.6×10^{-4} kg

36. A puddle holds 150 g of water. If 0.50 g of water evaporates from the surface, what is the approximate temperature change of the remaining water? (L_v = 540 cal/g)

a. +1.8 C°
b. –1.8 C°
c. +0.18 C°
d. –0.18 C°

37. Iced tea is made by adding ice to 1.8 kg of hot tea, initially at 80°C. How many kg of ice, initially at 0°C, are required to bring the mixture to 10°C? (L_f = 3.33 x 10^5 J/kg, c_w = 4 186 J/kg·°C)

a. 1.8 kg
b. 1.6 kg
c. 1.4 kg
d. 1.2 kg

38. A 50-g cube of ice, initially at 0.0°C, is dropped into 200 g of water in an 80-g aluminum container, both initially at 30°C. What is the final equilibrium temperature? (Specific heat for aluminum is 900 J/kg·°C, the specific heat of water is 4 186 J/kg·°C, and $L_f = 3.33 \times 10^5$ J/kg.)

    a. 17.9°C
    b. 9.5°C
    c. 12.1°C
    d. 20.6°C

39. 125 g of dry ice (solid CO_2) is dropped into a beaker containing 500 g of 66°C water. The dry ice converts directly to gas, leaving the solution. When the dry ice is gone, the final temperature of the water is 29°C. What is the heat of vaporization of solid CO_2? ($c_{\text{water}} = 1.00$ cal/g·°C)

    a. 37 cal/g
    b. 74 cal/g
    c. 111 cal/g
    d. 148 cal/g

40. In cloud formation, water vapor turns into water droplets which get bigger and bigger until it rains. This will cause the temperature of the air in the clouds to:

    a. get warmer.
    b. get cooler.
    c. will not affect the temperature of the air in the clouds.
    d. There is no air in clouds.

41. I take 1.0 kg of ice and dump it into 1.0 kg of water and, when equilibrium is reached, I have 2.0 kg of ice at 0°C. The water was originally at 0°C. The specific heat of water = 1.00 kcal/kg·°C, the specific heat of ice = 0.50 kcal/kg·°C, and the latent heat of fusion of water is 80 kcal/kg. The original temperature of the ice was:

    a. one or two degrees below 0°C.
    b. –80°C.
    c. –160°C.
    d. The whole experiment is impossible.

42. How much heat energy is required to vaporize a 1.0-g ice cube at 0°C? The heat of fusion of ice is 80 cal/g. The heat of vaporization of water is 540 cal/g, and $c_{\text{water}} = 1.00$ cal/g·°C.

    a. 620 cal
    b. 720 cal
    c. 820 cal
    d. 1 kcal

43. How much heat energy must be removed from 100 g of oxygen at 22°C to liquefy it at −183°C? (The specific heat of oxygen gas is 0.218 cal/g·°C, and its heat of vaporization is 50.9 cal/g.)

    a. 13 700 cal
    b. 9 560 cal
    c. 4 320 cal
    d. 2 160 cal

44. 100 g of liquid nitrogen at its boiling point of 77 K is stirred into a beaker containing 500 g of 15°C water. If the nitrogen leaves the solution as soon as it turns to gas, how much water freezes? The heat of vaporization of nitrogen is 48 cal/g and that of water is 80 cal/g.

    a. none
    b. 29 g
    c. 68 g
    d. 109 g

45. A 5-g lead bullet traveling in 20°C air at 300 m/s strikes a flat steel plate and stops. What is the final temperature of the lead bullet? (Assume the bullet retains all heat.) The melting point of lead is 327°C. The specific heat of lead is 0.128 J/g·°C. The heat of fusion of lead is 24.5 J/g.

    a. 227°C
    b. 260°C
    c. 293°C
    d. 327°C

46. Which of the following involves the greatest heat transfer?

    a. One gram of steam at 100°C changing to water at 100°C.
    b. One gram of ice at 0°C changing to water at 0°C.
    c. One gram of water cooling from 100°C to 0°C.
    d. One gram of ice heating from -100°C to 0°C.

11.5 Energy Transfer

47. Carly places one end of a steel bar in a Bunsen flame and the other end in an ice cube. By what factor is the rate of heat flow changed when the bar's cross-sectional area is doubled?

    a. 2
    b. 1/2
    c. 4.0
    d. 1/4

48. Dmitri places one end of a copper rod in a heat reservoir and the other end in a heat sink. By what factor is the rate of heat flow changed when the temperature difference between the reservoir and sink is tripled?

    a. 0.33
    b. 1/9
    c. 3.0
    d. 9.0

49. If one's hands are being warmed by holding them to one side of a flame, the predominant form of heat transfer is what process?

    a. conduction
    b. radiation
    c. convection
    d. vaporization

50. When a wool blanket is used to keep warm, what is the primary insulating material?

    a. wool
    b. air
    c. the trim around the edge of the blanket
    d. a thin layer of aluminum foil (usually not apparent) inside the blanket

51. The surfaces of a Dewar flask are silvered for the purpose of minimizing heat transfer by what process?

    a. conduction
    b. radiation
    c. convection
    d. vaporization

52. The use of fiberglass insulation in the outer walls of a building is intended to minimize heat transfer through the wall by what process?

    a. conduction
    b. radiation
    c. convection
    d. vaporization

53. How does the heat energy from the sun reach us through the vacuum of space?

    a. conduction
    b. radiation
    c. convection
    d. none of the above choices are valid

54. Which one of the following processes of heat transfer requires the presence of a fluid?

    a. conduction
    b. radiation
    c. convection
    d. none of the above choices are valid

55. If cooking is done using an aluminum pan over an electric burner, which of the following will not promote the rate of heat flow from burner to food?

    a. increase pan bottom thickness
    b. increase pan bottom area
    c. increase burner temperature
    d. decrease height of pan sides

56. A windowpane is half a centimeter thick and has an area of 1.0 m^2. The temperature difference between the inside and outside surfaces of the pane is 15° C. What is the rate of heat flow through this window? (Thermal conductivity for glass is 0.84 J/s·m·°C.)

    a. 50 000 J/s
    b. 2 500 J/s
    c. 1 300 J/s
    d. 630 J/s

57. A 2.0-m^2 Thermopane window is constructed, using two layers of glass 4.0 mm thick, separated by an air space of 5.0 mm. If the temperature difference is 20° C from the inside of the house to the outside air, what is the rate of heat flow through this window? (Thermal conductivity for glass is 0.84 J/s·m·°C and for air 0.023 4 J/s·m·°C.)

    a. 7 700 W
    b. 1 900 W
    c. 547 W
    d. 180 W

58. The filament temperature of a light bulb is 2 000 K when the bulb delivers 40 W of power. If its emissivity remains constant, what power is delivered when the filament temperature is 2 500 K?

    a. 105 W
    b. 62 W
    c. 98 W
    d. 50 W

59. The emissivity of an ideal reflector has which of the following values?

    a. 0
    b. 1
    c. 100
    d. infinity

60. The thermal conductivity of aluminum is 238 J/s·m·°C and of copper is 397 J/s·m·°C. A rod of each material is used as a heat conductor. If the rods have the same geometry and are used between the same temperature differences for the same time interval, what is the ratio of the heat transferred by the aluminum to the heat transferred by the copper?

    a. 0.599
    b. 1.67
    c. 0.359
    d. 2.78

61. I place a 500-g ice cube (initially at 0°C) in a Styrofoam box with wall thickness 1.0 cm and total surface area 600 cm^2. If the air surrounding the box is at 20°C and after 4 hours the ice is completely melted, what is the conductivity of the Styrofoam material? (L_f = 80 cal/g)

    a. 9.6×10^{-5} cal/s·cm·°C
    b. 2.8×10^{-6} cal/s·cm·°C
    c. 1.15×10^{-2} cal/s·cm·°C
    d. 2.3×10^{-4} cal/s·cm·°C

62. Consider two different rods. The greatest thermal conductivity will be in the rod with:

    a. electrons that are freer to move from atom to atom.
    b. the greater specific heat.
    c. the greater cross-sectional area.
    d. the greater length.

63. Which type of heating causes sunburn?

    a. conduction
    b. convection
    c. radiation
    d. all of the above

64. In winter, light-colored clothes will keep you warmer than dark-colored clothes if:

    a. you are warmer than your surroundings.
    b. you are at the same temperature as your surroundings.
    c. you are cooler than your surroundings.
    d. you are standing in sunlight.

65. A silver bar of length 30 cm and cross-sectional area 1.0 cm^2 is used to transfer heat from a 100°C reservoir to a 0°C block of ice. How much ice is melted per second? (For silver, k = 427 J/s·m·°C. For ice, L_f = 334 000 J/kg.)

    a. 4.2 g/s
    b. 2.1 g/s
    c. 0.80 g/s
    d. 0.043 g/s

66. At high noon, the sun delivers 1 000 W to each square meter of a blacktop road. What is the equilibrium temperature of the hot asphalt, assuming its emissivity $e = 1$? ($\sigma = 5.67 \times 10^{-8}$ W/m$^2\cdot$K^4) .

    a. 75°C
    b. 84°C
    c. 91°C
    d. 99°C

67. The surface of the Sun has a temperature of about 5 800 K. If the radius of the Sun is 7×10^8 m, determine the power output of the sun. (Take $e = 1$, and $\sigma = 5.67 \times 10^{-8}$ W/m$^2\cdot$K^4).

    a. 3.95×10^{26} W
    b. 5.17×10^{27} W
    c. 9.62×10^{28} W
    d. 6.96×10^{30} W

68. The tungsten filament of a light bulb has an operating temperature of about 2 100 K. If the emitting area of the filament is 1.0 cm^2, and its emissivity is 0.68, what is the power output of the light bulb? ($\sigma = 5.67 \times 10^{-8}$ W/m$^2\cdot$K^4)

    a. 100 W
    b. 75 W
    c. 60 W
    d. 40 W

69. An object at 27°C has its temperature increased to 37°C. The power then radiated by this object increases by how many percent?

    a. 3.3
    b. 14
    c. 37
    d. 253

70. What temperature increase is necessary to increase the power radiated from an object by a factor of 8?

    a. 8 K
    b. 2 K
    c. 100%
    d. about 68%

71. A metal bar is used to conduct heat. When the temperature at one end is 100°C and at the other is 20°C, heat is transferred at a rate of 16 J/s. If the temperature of the hotter end is reduced to 80°C, what will be the rate of heat transfer?

    a. 4 J/s
    b. 8 J/s
    c. 9 J/s
    d. 12 J/s

72. A metal bar is used to conduct heat. When the temperature at one end is 100°C and at the other is 20°C, heat is transferred at a rate of 16 J/s. The bar is then stretched uniformly to twice its original length. If again it has ends at 100°C and 20°C, at what rate will heat be transferred between it ends?

    a. 4 J/s
    b. 8 J/s
    c. 16 J/s
    d. 32 J/s

11.6 Global Warming and Greenhouse Gases

73. In a greenhouse, electromagnetic energy in the form of visible light enters the glass panes and is absorbed and then reradiated. What happens to this reradiated electromagnetic radiation from within the greenhouse?

    a. 100% returns to the atmosphere.
    b. It's partially blocked by glass.
    c. It's transformed into ultraviolet upon striking the glass.
    d. It's reflected as visible light upon striking the glass.

74. Of the planets with atmospheres, which is the warmest?

    a. Venus
    b. Earth
    c. Mars
    d. Jupiter

75. Which of the following produces greenhouse gases?

    a. burning fossil fuel
    b. digestive processes in cows
    c. automobile pollution
    d. all of the above

76. Carbon dioxide and water molecules in the atmosphere will absorb:

    a. infrared light.
    b. visible light.
    c. ultraviolet light.
    d. radio waves.

CHAPTER 11 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	D	1	37.	C	2
C2.	D	1	38.	B	3
C3.	A	2	39.	D	2
C4.	B	2	40.	A	2
C5.	B	2	41.	C	2
1.	B	1	42.	B	2
2.	D	1	43.	B	2
3.	D	1	44.	A	2
4.	B	1	45.	D	3
5.	A	1	46.	A	2
6.	A	1	47.	A	1
7.	B	1	48.	C	1
8.	C	2	49.	B	1
9.	C	2	50.	B	1
10.	A	2	51.	B	1
11.	C	1	52.	A	1
12.	B	1	53.	B	1
13.	C	2	54.	C	1
14.	A	2	55.	A	2
15.	C	2	56.	B	2
16.	A	3	57.	D	3
17.	B	2	58.	C	2
18.	C	2	59.	A	1
19.	B	3	60.	A	2
20.	B	2	61.	D	3
21.	C	2	62.	A	1
22.	C	2	63.	C	1
23.	B	2	64.	A	2
24.	C	1	65.	D	3
25.	D	2	66.	C	2
26.	B	3	67.	A	2
27.	C	2	68.	B	2
28.	C	2	69.	B	2
29.	D	3	70.	D	2
30.	B	3	71.	D	2
31.	D	2	72.	A	2
32.	A	2	73.	B	1
33.	C	2	74.	A	1
34.	D	1	75.	D	1
35.	D	2	76.	A	1
36.	B	2			

CHAPTER 12

Conceptual Problems

C1. On a *PV* diagram, 2 curves are plotted, both starting at the same point (P_1, V_1) and both ending at the same increased volume (V_2). One curve is for an isothermal process; the other is for an adiabatic process. Except for the common starting point, which curve is the upper one?

a. The isothermal process curve will always be the upper one.
b. The adiabatic process curve will always be the upper one.
c. Since they start at the same point and end at the same volume, they will coincide.
d. The isothermal one will start out higher, but the adiabatic one will eventually cross it.

C2. At the dice factory, sets of novelty dice are created where a side with 7 dots replaces the single dot side. The sides then range from 2 to 7 instead of the usually 1 to 6. Using such dice for a game of craps, what will be the most probable roll?

a. 7, this change in dots results in the same most probable value.
b. 7.5
c. 8
d. 9

C3. On a *PV* diagram, 2 curves are plotted, both starting at the same point and both ending at the same final increased volume. One curve is for an isothermal process; the other is for an adiabatic process. What does the area between these two curves represent?

a. Q absorbed by the isothermal process.
b. W done by the adiabatic process.
c. ΔU for the isothermal process.
d. Neither Q, W, nor ΔU for either of the processes is represented.

C4. Three Carnot engines operate between temperature reservoirs as follows: Engine A: T_h = 1 300 K, T_c = 1 000 K; Engine B: T_h = 1 000 K, T_c = 700 K; Engine C: T_h = 650 K, T_c = 500 K. Which two engines have the same thermal efficiency?

a. A and B
b. B and C
c. A and C
d. No two have the same thermal efficiency.

C5. In an isovolumetric process where the pressure increases, are the heat absorbed, work done by the system, and the change in internal energy of the system positive, negative, or zero?

a. Q is +, W is +, and ΔU is +.
b. Q is +, W is –, and ΔU is 0.
c. Q is +, W is 0, and ΔU is +.
d. Q is –, W is 0, and ΔU is –.

12.1 Work in Thermodynamic Processes

1. The volume of an ideal gas changes from 0.40 to 0.55 m^3 although its pressure remains constant at 50 000 Pa. What work is done on the system by its environment?

   a. –7 500 J
   b. –200 000 J
   c. 7 500 J
   d. 200 000 J

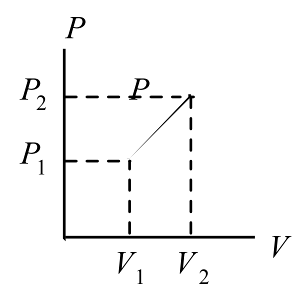
2. During an isobaric process which one of the following does not change?

   a. volume
   b. temperature
   c. internal energy
   d. pressure

3. Area on a P-V diagram has units associated with:

   a. energy.
   b. momentum.
   c. temperature.
   d. change in temperature.

4. What is the work done on the gas as it expands from pressure P_1 and volume V_1 to pressure P_2 and volume V_2 along the indicated straight line?



   a. $(P_1 + P_2)(V_1 - V_2)/2$
   b. $(P_1 + P_2)\ (V_1 - V_2)$
   c. $(P_1 + P_2)\ (V_1 - V_2)/2$
   d. $(P_1 - P_2)\ (V_1 + V_2)$

5. On a P-V diagram, an ______________ process is represented by a horizontal line.

   a. isobaric
   b. isothermal
   c. isovolumetric
   d. adiabatic

6. In an isobaric process 4.5×10^4 J of work is done on a quantity of gas while its volume changes from 2.6 m^3 to 1.1 m^3. What is the pressure during this process?

   a. 1.2×10^4 Pa
   b. 2.4×10^4 Pa
   c. 3.0×10^4 Pa
   d. 4.1×10^4 Pa

12.2 The First Law of Thermodynamics

12.3 Thermal Processes

7. A system is acted on by its surroundings in such a way that it receives 50 J of heat while simultaneously doing 20 J of work. What is its net change in internal energy?

   a. 70 J
   b. 30 J
   c. zero
   d. –30 J

8. In an isothermal process for an ideal gas system (where the internal energy doesn’t change), which of the following choices best corresponds to the value of the work done on the system?

   a. its heat intake
   b. twice its heat intake
   c. the negative of its heat intake
   d. twice the negative of its heat intake

9. According to the first law of thermodynamics, the sum of the heat gained by a system and the work done on that same system is equivalent to which of the following?

   a. entropy change
   b. internal energy change
   c. temperature change
   d. specific heat

10. If an ideal gas does positive work on its surroundings, we may assume, with regard to the gas:

   a. temperature increases.
   b. volume increases.
   c. pressure increases.
   d. internal energy decreases.

11. In an isovolumetric process by an ideal gas, the system's heat gain is equivalent to a change in:

    a. temperature.
    b. volume.
    c. pressure.
    d. internal energy.

12. A 2.0-mol ideal gas system is maintained at a constant volume of 4.0 L. If 100 J of heat is added, what is the work done on the system?

    a. zero
    b. 5.0 J
    c. –6.7 J
    d. 20 J

13. A closed 2.0-L container holds 3.0 mol of an ideal gas. If 200 J of heat is added, what is the change in internal energy of the system?

    a. zero
    b. 100 J
    c. 150 J
    d. 200 J

14. The adiabatic index of a gas is given by which of the following?

    a. C_P/C_V
    b. C_V/C_P
    c. $C_P - C_V$
    d. $C_P + C_V$

15. An adiabatic expansion refers to the fact that:

    a. no heat is transferred between a system and its surroundings.
    b. the pressure remains constant.
    c. the temperature remains constant.
    d. the volume remains constant.

16. A 4-mol ideal gas system undergoes an adiabatic process where it expands and does 20 J of work on its environment. What is its change in internal energy?

    a. –20 J
    b. –5 J
    c. zero
    d. +20 J

17. A 4-mol ideal gas system undergoes an adiabatic process where it expands and does 20 J of work on its environment. How much heat is received by the system?

    a. –20 J
    b. zero
    c. +5 J
    d. +20 J

18. A quantity of monatomic ideal gas expands adiabatically from a volume of 2.0 liters to 6.0 liters. If the initial pressure is P_0, what is the final pressure?

    a. 9.0 P_0
    b. 6.2 P_0
    c. 3.0 P_0
    d. 0.16 P_0

19. A 5-mol ideal gas system undergoes an adiabatic free expansion (a rapid expansion into a vacuum), going from an initial volume of 10 L to a final volume of 20 L. How much work is done on the system during this adiabatic free expansion?

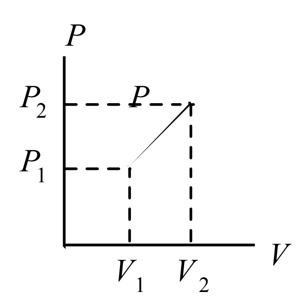
    a. –50 J
    b. –10 J
    c. zero
    d. +50 J

20. Which of the following increases the internal energy of a solid metal rod?

    a. raising it to a greater height
    b. throwing it through the air
    c. having the rod conduct heat
    d. having the rod absorb heat

21. As the ideal gas expands from pressure P_1 and volume V_1 to pressure P_2 and volume V_2 along the indicated straight line, it is possible that:

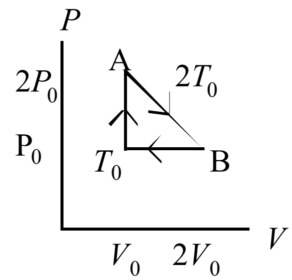
    a. the temperature stays constant.
    b. the internal energy decreases.
    c. the gas is changing state.
    d. all of the above are impossible for this particular graph.



22. Heat is applied to an ice-water mixture to melt some of the ice. In this process:

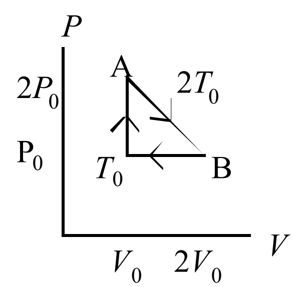
    a. work is done by the ice-water mixture.
    b. the temperature increases.
    c. the internal energy increases.
    d. all of the above are correct.

23. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy increases by $3P_0V_0/2$ going from point T_0 to point A. How much heat entered the gas from point T_0 to point A?



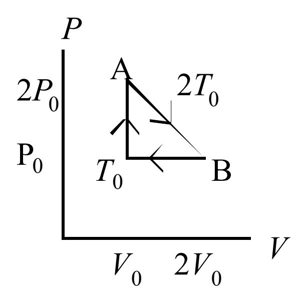
    a. 0
    b. $P_0V_0/2$
    c. 3 $P_0V_0/2$
    d. 5 $P_0V_0/2$

24. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy decreases by $3P_0V_0/2$ going from point B to point T_0. How much heat left the gas from point B to point T_0?



    a. 0
    b. $P_0V_0/2$
    c. $3P_0V_0/2$
    d. $5P_0V_0/2$

25. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy decreases by $3P_0V_0/2$ going from point B to point T_0. In going around this cycle once, which quantity equals zero?



    a. the net change in internal energy of the gas
    b. the net work done by the gas
    c. the net heat added to the gas
    d. All three are zero.

26. A cylinder containing an ideal gas has a volume of 2.0 m^3 and a pressure of 1.0×10^5 Pa at a temperature of 300 K. The cylinder is placed against a metal block that is maintained at 900 K and the gas expands as the pressure remains constant until the temperature of the gas reaches 900 K. The change in internal energy of the gas is $+6.0 \times 10^5$ J. How much heat did the gas absorb?

    a. 0
    b. 4.0×10^5 J
    c. 6.0×10^5 J
    d. 10×10^5 J

27. A thermodynamic process that happens very quickly tends to be:

    a. isobaric.
    b. isothermal.
    c. isovolumetric.
    d. adiabatic.

12.4 Heat Engines and the Second Law of Thermodynamics

28. A heat engine exhausts 3 000 J of heat while performing 1 500 J of useful work. What is the efficiency of the engine?

    a. 15%
    b. 33%
    c. 50%
    d. 60%

29. A heat engine operating between a pair of hot and cold reservoirs with respective temperatures of 500 K and 200 K will have what maximum efficiency?

    a. 60%
    b. 50%
    c. 40%
    d. 30%

30. An electrical power plant manages to send 88% of the heat produced in the burning of fossil fuel into the water-to-steam conversion. Of the heat carried by the steam, 40% is converted to the mechanical energy of the spinning turbine. Which of the following choices best describes the overall efficiency of the heat-to-work conversion in the plant (as a percentage)?

    a. greater than 88%
    b. 64%
    c. less than 40%
    d. 40%

31. According to the second law of thermodynamics, which of the following applies to the heat received from a high temperature reservoir by a heat engine operating in a complete cycle?

    a. must be completely converted to work
    b. equals the entropy increase
    c. converted completely into internal energy
    d. cannot be completely converted to work

32. The maximum theoretical thermodynamic efficiency of a heat engine operating between hot and cold reservoirs is a function of which of the following?

    a. hot reservoir temperature only
    b. cold reservoir temperature only
    c. both hot and cold reservoir temperatures
    d. None of the above choices are valid.

33. A heat engine receives 6 000 J of heat from its combustion process and loses 4 000 J through the exhaust and friction. What is its efficiency?

    a. 33%
    b. 40%
    c. 67%
    d. 73%

34. If a heat engine has an efficiency of 30% and its power output is 600 W, what is the rate of heat input from the combustion phase?

    a. 1 800 W
    b. 2 400 W
    c. 2 000 W
    d. 3 000 W

35. A turbine takes in 1 000-K steam and exhausts the steam at a temperature of 500 K. What is the maximum theoretical efficiency of this system?

    a. 24%
    b. 33%
    c. 50%
    d. 67%

36. An electrical generating plant operates at a boiler temperature of 220°C and exhausts the unused heat into a nearby river at 18°C. What is the maximum theoretical efficiency of the plant? (0°C = 273 K)

    a. 61%
    b. 32%
    c. 21%
    d. 41%

37. An electrical generating plant operates at a boiler temperature of 220°C and exhausts the unused heat into a nearby river at 19°C. If the generating plant has a power output of 800 megawatts (MW) and if the actual efficiency is 3/4 the theoretical efficiency, how much heat per second must be delivered to the boiler? (0°C = 273 K)

    a. 5 200 MW
    b. 1 810 MW
    c. 3 620 MW
    d. 2 620 MW

38. During each cycle of operation a refrigerator absorbs 55 cal from the freezer compartment and expels 85 cal to the room. If one cycle occurs every 10 s, how many minutes will it take to freeze 500 g of water, initially at 0°C? (L_v = 80 cal/g)

    a. 800 min
    b. 4 400 min
    c. 120 min
    d. 60 min

39. In which system is heat usually transferred from the cooler part to the warmer part?

    a. a stove as it heats up water
    b. a refrigerator that is running
    c. an electric fan that is running
    d. none of the above, because it is impossible to transfer heat in this manner

40. When gasoline is burned, it gives off 46 000 J/g of heat energy. If an automobile uses 13.0 kg of gasoline per hour with an efficiency of 21%, what is the average horsepower output of the engine? (1 hp = 746 W)

    a. 47 hp
    b. 110 hp
    c. 67 hp
    d. 34 hp

41. Suppose a power plant uses a Carnot engine to generate electricity, using the atmosphere at 300 K as the low-temperature reservoir. Suppose the power plant produces 1×10^6 J of electricity with the hot reservoir at 500 K during Day One and then produces 1×10^6 J of electricity with the hot reservoir at 600 K during Day Two. The thermal pollution was:

    a. greatest on Day One.
    b. greatest on Day Two.
    c. the same on both days.
    d. zero on both days.

42. The efficiency of a Carnot engine operating between 100°C and 0°C is most nearly:

    a. 7%.
    b. 15%.
    c. 27%.
    d. 51%.

43. An 800-MW electric power plant has an efficiency of 30%. It loses its waste heat in large cooling towers. Approximately how much waste heat (in MJ) is discharged to the atmosphere per second?

    a. 1 200 MJ
    b. 1 900 MJ
    c. 800 MJ
    d. 560 MJ

44. A gasoline engine with an efficiency of 30.0% operates between a high temperature T_1 and a low temperature T_2 = 320 K. If this engine operates with Carnot efficiency, what is the high-side temperature T_1?

    a. 1 070 K
    b. 868 K
    c. 614 K
    d. 457 K

45. The Carnot cycle consists of a combination of _____________ and ___________ processes.

    a. isobaric, isovolumetric
    b. isovolumetric, adiabatic
    c. isobaric, isothermal
    d. adiabatic, isothermal

46. Of the following heat engines, which has the highest efficiency?

    a. Hero's engine
    b. a Carnot engine
    c. a car's gasoline engine
    d. a truck's diesel engine

47. A Carnot engine runs between a hot reservoir at T_h and a cold reservoir at T_c. If one of the temperatures is either increased or decreased by 3.5 K, which of the following changes would increase the efficiency by the greatest amount?

    a. increasing T_h
    b. increasing T_c
    c. decreasing T_c
    d. cannot be determined from information given

48. On a P-V diagram, if a process involves a closed curve, the area inside the curve represents:

    a. internal energy.
    b. heat.
    c. work.
    d. zero.

49. The P-V diagram of a cyclic process shows a curve that encloses an area. The work done by the heat engine, represented by the enclosed area, is positive when the path around the area proceeds in which of the following fashions?

    a. clockwise
    b. counterclockwise
    c. It is always positive.
    d. It is always negative.

50. A refrigerator has a coefficient of performance of 4.0. When removing 2.4×10^4 J from inside the refrigerator, how much energy is sent into the environment?

    a. 9.6×10^4 J
    b. 3.0×10^4 J
    c. 1.8×10^4 J
    d. 0.60×10^4 J

12.5 Entropy

51. Which of the following choices best corresponds to what is required by the second law of thermodynamics for any process taking place in an isolated system?

    a. entropy decreases
    b. entropy remains constant
    c. entropy increases
    d. entropy equals work done on the system

52. Which of the following choices is an appropriate unit for measuring entropy changes?

    a. J·K
    b. N·K
    c. J/s
    d. J/K

53. If one could observe the individual atoms making up a piece of matter and note that during a process of change their motion somehow became more orderly, then one may assume which of the following in regard to the system?

    a. increases in entropy
    b. decreases in entropy
    c. gains in thermal energy
    d. positive work done on

54. A 1.0-kg chunk of ice at 0°C melts, absorbing 80 000 cal of heat in the process. Which of the following best describes what happens to this system?

    a. increased entropy
    b. lost entropy
    c. entropy maintained constant
    d. work converted to energy

55. According to the first law of thermodynamics, for any process that may occur within an isolated system, which of the following choices applies?

    a. entropy remains constant
    b. entropy increases
    c. entropy decreases
    d. None of the above choices apply.

56. A 2.00-kg block of ice is at STP (0°C, 1 atm) while it melts completely to water. What is its change in entropy? (For ice, $L_f = 3.34 \times 10^5$ J/kg)

    a. zero
    b. 584 J/K
    c. 1 220 J/K
    d. 2 450 J/K

57. One kilogram of water at 1.00 atm at the boiling point of 100°C is heated until all the water vaporizes. What is its change in entropy? (For water, $L_v = 2.26 \times 10^6$ J/kg)

    a. 12 100 J/K
    b. 6 060 J/K
    c. 3 030 J/K
    d. 1 220 J/K

58. What is the change in entropy (ΔS) when one mole of silver (108 g) is completely melted at 961°C? (The heat of fusion of silver is 8.82×10^4 J/kg.)

    a. 5.53 J/K
    b. 7.72 J/K
    c. 9.91 J/K
    d. 12.10 J/K

59. An avalanche of ice and snow of mass 1 800 kg slides a vertical distance of 160 m down a mountainside. If the temperature of the ice, snow, mountain and surrounding air are all at 0°C, what is the change in entropy of the universe?

    a. 31 000 J/K
    b. 10 000 J/K
    c. 3 200 J/K
    d. 1 100 J/K

60. A cylinder containing an ideal gas has a volume of 2.0 m^3 and a pressure of 1.0×10^5 Pa at a temperature of 300 K. The cylinder is placed against a metal block that is maintained at 900 K and the gas expands as the pressure remains constant until the temperature of the gas reaches 900 K. The change in internal energy of the gas is 6.0×10^5 J. Find the change in entropy of the block associated with the heat transfer to the gas.

    a. 0
    b. +670 J/K
    c. −440 J/K
    d. −1 100 J/K

61. The surface of the Sun is at approximately 5 700 K and the temperature of the Earth's surface is about 290 K. What total entropy change occurs when 1 000 J of heat energy is transferred from the Sun to the Earth?

    a. 2.89 J/K
    b. 3.27 J/K
    c. 3.62 J/K
    d. 3.97 J/K

62. Entropy is a measure of the ___________ of a system.

    a. disorder
    b. temperature
    c. heat
    d. internal energy

12.6 Human Metabolism

63. When considering human metabolism in terms of the 1st Law of Thermodynamics, which of the following represents the metabolic rate?

    a. $\Delta U / \Delta t$
    b. $\Delta Q / \Delta t$
    c. $W / \Delta t$
    d. $\Delta W / \Delta t$

64. On an average diet, the consumption of 10 liters of oxygen releases how much energy? (4.8 kcal are released per liter of oxygen consumed.)

    a. 48 kJ
    b. 200 kJ
    c. 4.2 kJ
    d. 4 200 kJ

65. A person consumes 2 500 kcal/day while expending 3 500 kcal/day. In a month's time, about how much weight would this person lose if the loss were essentially all from body fat? (Body fat has an energy content of about 4 100 kcal per pound.)

    a. 1 pound
    b. 2 pounds
    c. 7 pounds
    d. 15 pounds

66. A pound of body fat has an energy content of about 4 100 kcal. If a 1 400-kg automobile had an equivalent amount of translational kinetic energy, how fast would it be moving? (0.447 m/s = 1 mph, 1 kcal = 4 186 J)

    a. 3.1 mph
    b. 14 mph
    c. 75 mph
    d. 350 mph

CHAPTER 12 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	A	1	32	C	1
C2.	D	3	33.	A	2
C3.	A	3	34.	C	2
C4.	C	2	35.	C	2
C5.	C	2	36.	D	2
1.	A	2	37.	D	2
2.	D	1	38.	C	3
3.	A	1	39.	B	1
4.	A	2	40.	A	3
5.	A	1	41.	A	3
6.	C	2	42.	C	2
7.	B	2	43.	B	2
8.	C	2	44.	D	2
9.	B	1	45.	D	2
10.	B	2	46.	B	1
11.	D	2	47.	C	3
12.	A	1	48.	C	1
13.	D	1	49.	A	2
14.	A	1	50.	B	2
15.	A	1	51.	C	1
16.	A	2	52.	D	1
17.	B	1	53.	B	1
18.	D	2	54.	A	1
19.	C	2	55.	D	1
20.	D	1	56.	D	2
21.	D	2	57.	B	2
22.	C	2	58.	B	2
23.	C	3	59.	B	2
24.	D	3	60.	D	3
25.	A	2	61.	B	3
26.	D	3	62.	A	1
27.	D	1	63.	A	1
28.	B	2	64.	B	2
29.	A	2	65.	C	2
30.	C	2	66.	D	3
31.	D	1			

CHAPTER 13

Conceptual Problems

C1. A mass-spring system on a horizontal frictionless surface is set in simple harmonic motion with amplitude A. The mass is then doubled and the system is again set into simple harmonic motion with the same amplitude. Which of the following is true about the total mechanical energy of the system due to doubling the mass?

a. It has doubled.
b. It has quadrupled.
c. It has halved.
d. It has not changed.

C2. If a long spring with spring constant k is cut into 4 equal lengths, what is the spring constant of each of the 4 shorter springs?

a. It is still k.
b. It is $k/4$.
c. It is $4\,k$.
d. It is $k/16$.

C3. When an object is moving in simple harmonic motion, which of the following is at a minimum when the displacement from equilibrium is zero?

a. the magnitude of the velocity
b. the magnitude of the acceleration
c. the kinetic energy
d. the total mechanical energy

C4. A pendulum on the Earth has a period T. The acceleration of due to gravity on Mars is less than that on the Earth, and the acceleration due to gravity on the Moon is even less. Where would the period of an identical pendulum be the least?

a. on the Earth
b. on the Moon
c. on Mars
d. The period of a pendulum would be the same on the Earth, Moon, and Mars since the period depends on the pendulum's length which is the same for identical pendula.

C5. Two identical springs, each with spring constant k, are attached in parallel to a mass, which is then set into simple harmonic motion. What would be the spring constant of a single spring which would result in the same frequency of oscillation as the parallel springs?

a. k
b. $2k$
c. $k/2$
d. $\sqrt{2}k$

13.1 Hooke's Law

1. The SI base units for spring constant are which of the following?

   a. $kg \cdot s^2$
   b. kg/m^2
   c. kg/s^2
   d. $kg \cdot m^2$

2. A large spring requires a force of 150 N to compress it only 0.010 m. What is the spring constant of the spring?

   a. 125 000 N/m
   b. 15 000 N/m
   c. 15 N/m
   d. 1.5 N/m

3. A 0.20-kg object is attached to a spring with spring constant k = 10 N/m and moves with simple harmonic motion over a horizontal frictionless surface. At the instant that it is displaced from equilibrium by –0.050 m, what is its acceleration?

   a. 1 000 m/s^2
   b. –40 m/s^2
   c. 0.1 m/s^2
   d. 2.5 m/s^2

4. Tripling the weight suspended vertically from a coil spring will result in a change in the displacement of the spring's lower end by what factor?

   a. 0.33
   b. 1.0
   c. 3.0
   d. 9.0

5. Tripling the displacement from equilibrium of an object in simple harmonic motion will bring about a change in the magnitude of the object's acceleration by what factor?

   a. 0.33
   b. 1.0
   c. 3.0
   d. 9.0

6. A tiny spring, with a spring constant of 1.20 N/m, will be stretched to what displacement by a 0.005 0-N force?

   a. 4.2 mm
   b. 6.0 mm
   c. 7.2 mm
   d. 9.4 mm

7. A mass of 0.40 kg, attached to a spring with a spring constant of 80 N/m, is set into simple harmonic motion. What is the magnitude of the acceleration of the mass when at its maximum displacement of 0.10 m from the equilibrium position?

   a. zero
   b. 5 m/s^2
   c. 10 m/s^2
   d. 20 m/s^2

8. A mass of 4.0 kg, resting on a horizontal frictionless surface, is attached on the right to a horizontal spring with spring constant 20 N/m and on the left to a horizontal spring with spring constant 50 N/m. If this system is moved from equilibrium, what is the effective spring constant?

   a. 30 N/m
   b. –30 N/m
   c. 70 N/m
   d. 14 N/m

9. Suppose there is an object for which $F = +kx$. What will happen if the object is moved away from equilibrium ($x = 0$) and released?

   a. It will return to the equilibrium position.
   b. It will move further away with constant velocity.
   c. It will move further away with constant acceleration.
   d. It will move further away with increasing acceleration.

10. Which is not an example of approximate simple harmonic motion?

    a. A ball bouncing on the floor.
    b. A child swinging on a swing.
    c. A piano string that has been struck.
    d. A car's radio antenna as it waves back and forth.

11. If it takes 4.0 N to stretch a spring 6.0 cm and if the spring is then cut in half, what force does it take to stretch one of the halves 3.0 cm?

    a. 2.0 N
    b. 4.0 N
    c. 8.0 N
    d. 16 N

12. Three identical springs each have the same spring constant k. If these three springs are attached end to end forming a spring three times the length of one of the original springs, what will be the spring constant of the combination?

    a. k
    b. 3 k
    c. $k/3$
    d. 1.73 k

13.2 Elastic Potential Energy

13. A 0.20-kg object is oscillating on a spring with a spring constant of k = 15 N/m. What is the potential energy of the system when the object displacement is 0.040 m, exactly half the maximum amplitude?

    a. zero
    b. 0.006 0 J
    c. 0.012 J
    d. 2.5 J

14. A 0.20 kg object, attached to a spring with spring constant k = 10 N/m, is moving on a horizontal frictionless surface in simple harmonic motion of amplitude of 0.080 m. What is its speed at the instant when its displacement is 0.040 m? (Hint: Use conservation of energy.)

    a. 9.8 m/s
    b. 4.9 m/s
    c. 49 cm/s
    d. 24.5 cm/s

15. A mass of 0.40 kg, hanging from a spring with a spring constant of 80 N/m, is set into an up-and-down simple harmonic motion. What is the speed of the mass when moving through the equilibrium point? The starting displacement from equilibrium is 0.10 m.

    a. zero
    b. 1.4 m/s
    c. 2.0 m/s
    d. 3.4 m/s

16. A mass of 0.40 kg, hanging from a spring with a spring constant of 80 N/m, is set into an up-and-down simple harmonic motion. What is the speed of the mass when moving through a point at 0.05 m displacement? The starting displacement of the mass is 0.10 m from its equilibrium position.

    a. zero
    b. 1.4 m/s
    c. 1.7 m/s
    d. 1.2 m/s

17. A runaway railroad car, with mass 30×10^4 kg, coasts across a level track at 2.0 m/s when it collides with a spring-loaded bumper at the end of the track. If the spring constant of the bumper is 2.0×10^6 N/m, what is the maximum compression of the spring during the collision? (Assume the collision is elastic.)

    a. 0.77 m
    b. 0.58 m
    c. 0.34 m
    d. 1.07 m

18. A 0.20-kg mass is oscillating on a spring over a horizontal frictionless surface. When it is at a displacement of 2.6 cm for equilibrium it has a kinetic energy of 1.4 J and a spring potential energy of 2.2 J. What is the maximum speed of the mass during its oscillation?

    a. 3.7 m/s
    b. 4.7 m/s
    c. 6.0 m/s
    d. 6.3 m/s

19. A 0.20-kg block rests on a frictionless level surface and is attached to a horizontally aligned spring with a spring constant of 40 N/m. The block is initially displaced 4.0 cm from the equilibrium point and then released to set up a simple harmonic motion. What is the speed of the block when it passes through the equilibrium point?

    a. 2.1 m/s
    b. 1.6 m/s
    c. 1.1 m/s
    d. 0.57 m/s

20. A 0.20-kg block rests on a frictionless level surface and is attached to a horizontally aligned spring with a spring constant of 40 N/m. The block is initially displaced 4.0 cm from the equilibrium point and then released to set up a simple harmonic motion. A frictional force of 0.3 N exists between the block and surface. What is the speed of the block when it passes through the equilibrium point after being released from the 4.0-cm displacement point?

    a. 0.45 m/s
    b. 0.63 m/s
    c. 0.80 m/s
    d. 1.2 m/s

21. The oxygen molecule (O_2) may be regarded as two masses connected by a spring. In vibrational motion, each oxygen atom alternately approaches, then moves away from the center of mass of the system. If each oxygen atom of mass $m = 2.67 \times 10^{-26}$ kg has a vibrational energy of 1.6×10^{-21} J and the effective spring constant is 50 N/m, then what is the amplitude of oscillation of each oxygen atom?

    a. 3.2×10^{-11} m
    b. 1.6×10^{-11} m
    c. 1.1×10^{-11} m
    d. 8.0×10^{-12} m

22. Suppose a 0.3-kg mass on a spring that has been compressed 0.10 m has elastic potential energy of 1 J. What is the spring constant?

    a. 10 N/m
    b. 20 N/m
    c. 200 N/m
    d. 300 N/m

23. Suppose a 0.3-kg mass on a spring that has been compressed 0.10 m has elastic potential energy of 1.0 J. How much further must the spring be compressed to triple the elastic potential energy?

    a. 0.30 m
    b. 0.20 m
    c. 0.17 m
    d. 0.07 m

24. Suppose a 0.30-kg mass on a spring-loaded gun that has been compressed 0.10 m has elastic potential energy of 1.0 J. How high above the spring's equilibrium point can the gun fire the mass if the gun is fired straight up?

    a. 0.10 m
    b. 0.34 m
    c. 0.24 m
    d. 10 m

25. An ore car of mass 4 000 kg rolls downhill on tracks from a mine. At the end of the tracks, 10.0 m lower in elevation, is a spring with k = 400 000 N/m. How much is the spring compressed in stopping the ore car? Ignore friction.

    a. 0.14 m
    b. 0.56 m
    c. 1.40 m
    d. 1.96 m

13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

26. An object is attached to a spring and its frequency of oscillation is measured. Then another object is connected to the first object, and the resulting mass is four times the original value. By what factor is the frequency of oscillation changed?

    a. 1/4
    b. 1/2
    c. 1/16
    d. 4

27. By what factor must one change the weight suspended vertically from a spring coil in order to triple its period of simple harmonic motion?

    a. 1/9
    b. 0.33
    c. 3.0
    d. 9.0

28. Which one of the following quantities is at a maximum when an object in simple harmonic motion is at its maximum displacement?

    a. speed
    b. acceleration
    c. kinetic energy
    d. frequency

29. I attach a 2.0-kg block to a spring that obeys Hooke's Law and supply 16 J of energy to stretch the spring. I release the block; it oscillates with period 0.30 s. The amplitude is:

    a. 38 cm.
    b. 19 cm.
    c. 9.5 cm.
    d. 4.3 cm.

30. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 8.0 cm. If the mass of the object is 0.20 kg, what is the spring constant?

    a. 40 N/m
    b. 87 N/m
    c. 126 N/m
    d. 160 N/m

31. For a mass suspended on a spring in the vertical direction, the time for one complete oscillation will depend on:

    a. the value for g (the acceleration due to gravity).
    b. the distance the mass was originally pulled down.
    c. the maximum speed of the oscillating mass.
    d. the time doesn’t depend on any of the above.

32. A car with bad shocks bounces up and down with a period of 1.50 s after hitting a bump. The car has a mass of 1 500 kg and is supported by four springs of force constant *k*. What is *k* for each spring?

    a. 6 580 N/m
    b. 5 850 N/m
    c. 4 440 N/m
    d. 3 630 N/m

13.4 Position, Velocity, and Acceleration as a Function of Time

33. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 4.0 cm. If a timer is started when its displacement is a maximum (hence $x = 4$ cm when $t = 0$), what is the speed of the mass when $t = 3$ s?

    a. zero
    b. 0.006 5 m/s
    c. 0.015 m/s
    d. 0.024 m/s

34. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 4.0 cm. If a timer is started when its displacement is a maximum (hence $x = 4$ cm when $t = 0$), what is the acceleration magnitude when $t = 3$ s?

    a. zero
    b. 8.13 m/s^2
    c. 14.3 m/s^2
    d. 25.3 m/s^2

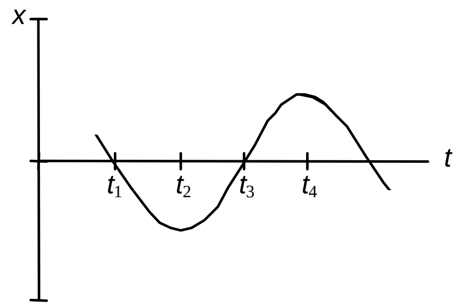
35. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 8.0 cm. If a timer is started when its displacement is a maximum (hence $x = 8$ cm when $t = 0$), what is the displacement of the mass when $t = 3.7$ s?

    a. zero
    b. 0.025 m
    c. 0.036 m
    d. 0.080 m

36. An object moving in simple harmonic motion has an amplitude of 0.020 m and a maximum acceleration of 40 m/s^2. What is the frequency of the system?

    a. 0.60 Hz
    b. 51 Hz
    c. 7.1 Hz
    d. 16 Hz

37. Consider the curve $x = A \sin(kt)$, with $A >$ 0. At which point on the graph is it possible that $t = 0$?



a. Point t_1
b. Point t_2
c. Point t_3
d. Point t_4

38. The motion of a piston in an automobile engine is nearly simple harmonic. If the 1-kg piston travels back and forth over a total distance of 10.0 cm, what is its maximum speed when the engine is running at 3 000 rpm?

a. 31.4 m/s
b. 15.7 m/s
c. 7.85 m/s
d. 3.93 m/s

39. The position of a 0.64-kg mass undergoing simple harmonic motion is given by $x = (0.160 \text{ m}) \cos(\pi t/16)$. What is its period of oscillation?

a. 100 s
b. 32 s
c. 16 s
d. 8.0 s

40. The position of a 0.64-kg mass undergoing simple harmonic motion is given by $x = (0.160 \text{ m}) \cos(\pi t/16)$. What is the maximum net force on the mass as it oscillates?

a. 3.9×10^{-3} N
b. 9.9×10^{-3} N
c. 1.3×10^{-3} N
d. 6.3 N

41. The position of a 0.64-kg mass undergoing simple harmonic motion is given by $x = (0.160 \text{ m}) \cos(\pi t/16)$. What is its position at t = 5.0 s?

a. 0.160 m
b. 0.159 m
c. 0.113 m
d. 0.089 m

13.5 Motion of a Pendulum

42. The kinetic energy of the bob on a simple pendulum swinging in simple harmonic motion has its maximum value when the displacement from equilibrium is at what point in its swing?

    a. zero displacement
    b. 1/4 the amplitude
    c. 1/2 the amplitude
    d. equal the amplitude

43. If one could transport a simple pendulum of constant length from the Earth's surface to the Moon's, where the acceleration due to gravity is one-sixth (1/6) that on the Earth, by what factor would the pendulum frequency be changed?

    a. about 6.0
    b. about 2.5
    c. about 0.41
    d. about 0.17

44. Tripling the mass of the bob on a simple pendulum will cause a change in the frequency of the pendulum swing by what factor?

    a. 0.33
    b. 1.0
    c. 3.0
    d. 9.0

45. By what factor should the length of a simple pendulum be changed if the period of vibration were to be tripled?

    a. 1/9
    b. 0.33
    c. 3.0
    d. 9.0

46. A simple pendulum has a period of 2.0 s. What is the pendulum length? (g = 9.8 m/s^2)

    a. 0.36 m
    b. 0.78 m
    c. 0.99 m
    d. 2.4 m

47. A simple pendulum of length 1.00 m has a mass of 100 g attached. It is drawn back 30.0° and then released. What is the maximum speed of the mass?

    a. 1.14 m/s
    b. 3.13 m/s
    c. 2.21 m/s
    d. 1.62 m/s

48. A simple pendulum has a mass of 0.25 kg and a length of 1.0 m. It is displaced through an angle of 30° and then released. After a time, the maximum angle of swing is only 10°. How much energy has been lost to friction?

    a. 0.29 J
    b. 0.65 J
    c. 0.80 J
    d. 1.0 J

13.6 Damped Oscillations

13.7 Waves

13.8 Frequency, Amplitude, and Wavelength

49. When car shock absorbers wear out and lose their damping ability, what is the resulting oscillating behavior?

    a. underdamped
    b. critically damped
    c. overdamped
    d. hyperdamped

50. For a wave on the ocean, the amplitude is:

    a. the distance between crests.
    b. the height difference between a crest and a trough.
    c. one half the height difference between a crest and a trough.
    d. how far the wave goes up on the beach.

51. As a gust of wind blows across a field of grain, a wave can be seen to move across the field as the tops of the plants sway back and forth. This wave is a:

    a. transverse wave.
    b. longitudinal wave.
    c. polarized wave.
    d. interference of waves.

52. Which of the following is an example of a longitudinal wave?

    a. sound wave in air
    b. wave traveling in a string
    c. both a and b
    d. neither a nor b

53. If the frequency of a traveling wave train is increased by a factor of three in a medium where the speed is constant, which of the following is the result?

    a. amplitude is one third as big
    b. amplitude is tripled
    c. wavelength is one third as big
    d. wavelength is tripled

54. The wavelength of a traveling wave can be calculated if one knows the:

    a. frequency.
    b. speed and amplitude.
    c. amplitude and frequency.
    d. frequency and speed.

55. A traveling wave train has wavelength 0.50 m, speed 20 m/s. Find the wave frequency.

    a. 0.025 Hz
    b. 20 Hz
    c. 40 Hz
    d. 10 Hz

56. A musical tone, sounded on a piano, has a frequency of 410 Hz and a wavelength in air of 0.800 m. What is the wave speed?

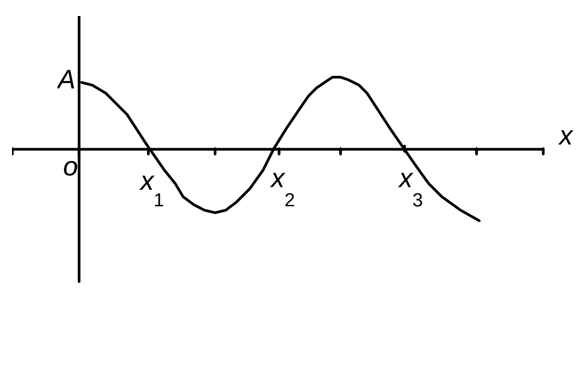
    a. 170 m/s
    b. 235 m/s
    c. 328 m/s
    d. 587 m/s

57. If a radio wave has speed 3.00×10^8 m/s and frequency 94.7 MHz, what is its wavelength?

    a. 8.78 m
    b. 1.20 m
    c. 2.50 m
    d. 3.17 m

58. Consider the curve $f(x) = A\cos(2\pi x/\lambda)$. The wavelength of the wave will be:

    a. the distance *0* to *A*.
    b. twice the distance *0* to *A*.
    c. the distance x_2 to x_3.
    d. twice the distance x_2 to x_3.



59. Bats can detect small objects such as insects that are of a size approximately that of one wavelength. If bats emit a chirp at a frequency of 60 kHz, and the speed of sound waves in air is 330 m/s, what is the smallest size insect they can detect?

    a. 1.5 mm
    b. 3.5 mm
    c. 5.5 mm
    d. 7.5 mm

60. Waves propagate at 8.0 m/s along a stretched string. The end of the string is vibrated up and down once every 1.5 s. What is the wavelength of the waves that travel along the string?

    a. 3.0 m
    b. 12 m
    c. 6.0 m
    d. 5.3 m

61. An earthquake emits both P-waves and S-waves that travel at different speeds through the Earth. A P-wave travels at 8 000 m/s and an S-wave at 4 000 m/s. If P-waves are received at a seismic station 30.0 s before an S-wave arrives, how far is the station from the earthquake center?

    a. 2 420 km
    b. 1 210 km
    c. 240 km
    d. 120 km

13.9 The Speed of Waves on Strings

62. A long string is pulled so that the tension in it increases by a factor of three. If the change in length is negligible, by what factor does the wave speed change?

    a. 3.0
    b. 1.7
    c. 0.58
    d. 0.33

63. What is the phase difference when two waves, traveling in the same medium, undergo constructive interference?

    a. 270°
    b. 180°
    c. 90°
    d. 0°

64. Tripling both the tension in a guitar string and its mass per unit length will result in changing the wave speed in the string by what factor?

    a. 0.58
    b. 1.00 (i.e., no change)
    c. 1.73
    d. 3.00

65. Tripling the mass per unit length of a guitar string will result in changing the wave speed in the string by what factor?

    a. 0.58
    b. 1.00 (i.e., no change)
    c. 1.73
    d. 3.00

66. A 2.0-m long piano string of mass 10 g is under a tension of 338 N. Find the speed with which a wave travels on this string.

    a. 130 m/s
    b. 260 m/s
    c. 520 m/s
    d. 1 040 m/s

67. Transverse waves travel with a speed of 200 m/s along a taut copper wire that has a diameter of 1.50 mm. What is the tension in the wire? (The density of copper is 8.93 g/cm^3.)

    a. 1 890 N
    b. 1 260 N
    c. 631 N
    d. 315 N

68. For a wave traveling in a string, by what factor would the tension need to be increased to double the wave speed?

    a. 1.4
    b. 2.0
    c. 4.0
    d. 16

69. A wave is traveling in a string at 60 m/s. When the tension is then increased 20%, what will be the resulting wave speed?

    a. also 60 m/s
    b. 66 m/s
    c. 72 m/s
    d. 55 m/s

70. A wave travels in a string at 60 m/s. A second string of 20% greater linear density has the same tension applied as in the first string. What will be the resulting wave speed in the second string?

    a. also 60 m/s
    b. 66 m/s
    c. 72 m/s
    d. 55 m/s

71. A string is strung horizontally with a fixed tension. A wave of frequency 100 Hz is sent along the string, and it has a wave speed of 50.0 m/s. Then a second wave, one of frequency 200 Hz, is sent along the string. What is the wave speed of the second wave?

    a. 25.0 m/s
    b. 50.0 m/s
    c. 70.7 m/s
    d. 100 m/s

13.10 Interference of Waves

13.11 Reflection of Waves

72. The superposition principle has to do with which of the following?

    a. effects of waves at great distances
    b. the ability of some waves to move very far
    c. how displacements of interacting waves add together
    d. relativistic wave behavior

73. Equal wavelength waves of amplitude 0.25 m and 0.15 m interfere with one another. What is the resulting minimum amplitude that can result?

    a. 0.15 m
    b. 0.10 m
    c. 0 m
    d. –0.40 m

74. If a wave pulse is reflected from a free boundary, which of the following choices best describes what happens to the reflected pulse?

    a. becomes inverted
    b. remains upright
    c. halved in amplitude
    d. doubled in amplitude

75. Consider two identical and symmetrical wave pulses on a string. Suppose the first pulse reaches the fixed end of the string and is reflected back and then meets the second pulse. When the two pulses overlap exactly, the superposition principle predicts that the amplitude of the resultant pulses, at that moment, will be what factor times the amplitude of one of the original pulses?

    a. 0
    b. 1
    c. 2
    d. 4

76. Two water waves meet at the same point, one having a displacement above equilibrium of 60 cm and the other having a displacement above equilibrium of 80 cm. At this moment, what is the resulting displacement above equilibrium?

    a. 140 cm
    b. 100 cm
    c. 70 cm
    d. Information about the amplitudes needs to be given to find an answer.

CHAPTER 13 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	D.	2	37.	C	1
C2.	C	1	38.	B	3
C3.	B	1	39.	B	2
C4.	A	2	40.	A	3
C5.	B	2	41.	D	2
1.	C	1	42.	A	1
2.	B	1	43.	C	2
3.	D	2	44.	B	1
4.	C	1	45.	D	2
5.	C	1	46.	C	2
6.	A	1	47.	D	2
7.	D	2	48.	A	3
8.	C	3	49.	A	1
9.	D	2	50.	C	1
10.	A	1	51.	B	1
11.	B	2	52.	A	1
12.	C	2	53.	C	2
13.	C	2	54.	D	1
14.	C	2	55.	C	1
15.	B	2	56.	C	1
16.	D	2	57.	D	1
17.	A	2	58.	D	2
18.	C	2	59.	C	2
19.	D	2	60.	B	2
20.	A	3	61.	C	2
21.	D	2	62.	B	2
22.	C	2	63.	D	1
23.	D	2	64.	B	2
24.	C	2	65.	A	2
25.	C	2	66.	B	2
26.	B	2	67.	C	3
27.	D	2	68.	C	2
28.	B	1	69.	B	3
29.	B	3	70.	D	3
30.	C	2	71.	B	2
31.	D	1	72.	C	1
32.	A	2	73.	B	2
33.	A	2	74.	B	1
34.	D	2	75.	A	2
35.	B	3	76.	A	2
36.	C	2			

CHAPTER 14

Conceptual Problems

C1. Which of the following best describes a sound level of intensity 1 W/m^2?

a. extremely loud
b. about that of a power mower
c. normal conversation
d. like a whisper

C2. How far away is a lightning bolt if it takes 10 s for the sound of the associated thunder to reach the observer?

a. 1 mile
b. 2 miles
c. 5 miles
d. 10 miles

C3. If the air temperature decreases, how does the resonant frequency in a pipe closed at one end change?

a. It increases.
b. It decreases.
c. It doesn't change since one end of the pipe is closed.
d. It doesn't change because resonance is pressure phenomenon.

C4. A buzzer with frequency f_0 is thrown straight upwards. On the buzzer's trip down, what is the frequency behavior heard by an observer below?

a. The frequency heard is still f_0.
b. The frequency is a constant one greater than $f_{0.}$
c. The frequency is an increasing one greater than $f_{0.}$
d. The frequency is a decreasing one less than $f_{0.}$

C5. The air in a pipe resonates at 150 Hz and 750 Hz, one of these resonances being the fundamental. If the pipe is open at both ends, how many resonances are between the two given ones, and if the pipe is closed at one end, how many resonances are between the two given ones?

a. open: 3; closed: 1
b. open: 1; closed: 3
c. open: 2; closed: 0
d. open: 0; closed: 2

14.1 Producing a Sound Wave

1. When a sine wave is used to represent a sound wave, the crest corresponds to:

    a. rarefaction.
    b. condensation.
    c. point where molecules vibrate at a right angle to the direction of wave travel.
    d. region of low elasticity.

2. A sound wave coming from a tuba has a wavelength of 1.50 m and travels to your ears at a speed of 345 m/s. What is the frequency of the sound you hear?

    a. 517 Hz
    b. 1/517 Hz
    c. 230 Hz
    d. 1/230 Hz

3. A series of ocean waves, 5.0 m between crests, move past at 2.0 waves/s. Find their speed.

    a. 2.5 m/s
    b. 5.0 m/s
    c. 8.0 m/s
    d. 10 m/s

4. Consider a vibrating string that makes a sound wave that moves through the air. As the guitar string moves up and down, the air molecules that are a certain horizontal distance from the string will move:

    a. up and down.
    b. toward and away from the guitar string.
    c. back and forth along the direction of the length of the string.
    d. in circles around the guitar string.

14.2 Characteristics of Sound Waves

5. When a sound wave moves through a medium such as air, the motion of the molecules of the medium is in what direction (with respect to the motion of the sound wave)?

    a. perpendicular
    b. parallel
    c. anti-parallel (in opposite direction)
    d. Both choices b and c are valid.

6. Which of the following ranges corresponds to the longest wavelengths?

    a. infrasonic
    b. audible
    c. ultrasonic
    d. all have the same wavelengths

7. The frequency separating audible waves and ultrasonic waves is considered to be 20 kHz. What wavelength in air at room temperature is associated with this frequency? (Assume the speed of sound to be 340 m/s.)

    a. 1.7 cm
    b. 5.2 cm
    c. 34 cm
    d. 55 cm

8. Assuming that the wave speed varies little when sound waves are traveling though a material that suddenly changes density by 10%, what percentage of the incident wave intensity is reflected?

    a. < 1 %
    b. 5 %
    c. 10 %
    d. 20 %

14.3 The Speed of Sound

9. The speed of sound in air is a function of which one of the following?

    a. wavelength
    b. frequency
    c. temperature
    d. amplitude

10. The speed of sound at 0°C is 331 m/s. What is the speed of sound at 25°C? (0°C = 273 K)

    a. 346 m/s
    b. 356 m/s
    c. 343 m/s
    d. 350 m/s

11. The density of a certain metal solid is 7.2×10^3 kg/m^3, and its Young's modulus is 10×10^{10} N/m^2. What is the speed of sound in this metal?

    a. 1.4×10^7 m/s
    b. 5 900 m/s
    c. 3 700 m/s
    d. 3 000 m/s

12. How far away is a lightning strike if you hear the thunderclap 3.00 s after you see the lightning bolt strike? (v_{sound} = 340 m/s, $v_{light} = 3 \times 10^8$ m/s)

    a. 113 m
    b. 340 m
    c. 680 m
    d. 1 020 m

13. A sound wave in air has a frequency of 500 Hz and a wavelength of 0.68 m. What is the air temperature?

    a. –18°C
    b. 0°C
    c. 15°C
    d. 27°C

14. Comparing the speed of sound in liquids, gases, and solids, the speed of sound is usually lowest in ________ and highest in ________.

    a. solids, liquids
    b. gases, liquids
    c. liquids, solids
    d. gases, solids

14.4 Energy and Intensity of Sound Waves

15. Tripling the power output from a speaker emitting a single frequency will result in what increase in loudness?

    a. 0.33 dB
    b. 3.0 dB
    c. 4.8 dB
    d. 9.0 dB

16. What is the intensity level of a sound with intensity of 5.0×10^{-10} W/m^2? ($I_0 = 10^{-12}$ W/m^2)

    a. 74 dB
    b. 54 dB
    c. 2.7 dB
    d. 27 dB

17. What is the intensity of a sound with a measured intensity level of 84 dB? ($I_0 = 10^{-12}$ W/m^2)

    a. 8.4×10^{-3} W/m^2
    b. 2.5×10^{-4} W/m^2
    c. 1.2×10^{-5} W/m^2
    d. 7.4×10^{-4} W/m^2

18. If one-third of the members of a symphony orchestra are absent because of head colds, thus reducing the overall intensity of sound by 33%, what will be the reduction in the decibel level?

    a. 30 dB
    b. 3 dB
    c. 48 dB
    d. 1.7 dB

19. If $I_0 = 10^{-12}$ W/m^2 is the threshold of hearing, a sound with intensity $I_1 = 10^{-11}$ W/m^2 will give a certain decibel level. Suppose a new sound has an intensity $I_2 = I_1^2/I_0$. What is the new decibel level?

    a. 2.0
    b. 20
    c. 100
    d. it will square the decibel level

20. If the intensity of a sound is increased by a factor of 100, how is the decibel level changed? The new decibel level will be:

    a. two units greater.
    b. double the old one.
    c. ten times greater.
    d. twenty units greater.

21. What is the intensity of sound from a band with a sound level of 120 dB? ($I_0 = 10^{-12}$ W/m^2)

    a. 1 W/m^2
    b. 1.2 W/m^2
    c. 10 W/m^2
    d. 12 W/m^2

22. In the afternoon, the decibel level of a busy freeway is 80 dB with 100 cars passing a given point every minute. Late at night, the traffic flow is only 5 cars per minute. What is the late-night decibel level?

    a. 77 dB
    b. 74 dB
    c. 70 dB
    d. 68 dB

23. What sound level change corresponds to a factor of two change in intensity?

    a. 0.5 dB
    b. 2 dB
    c. 3 dB
    d. 5 dB

14.5 Spherical and Plane Waves

24. Tripling the distance between sound source and a listener will change the intensity, as detected by the listener, by what factor?

    a. 1/9
    b. 0.33
    c. 3.0
    d. 9.0

25. If the distance between a point sound source and a dB detector is increased by a factor of 4, what will be the reduction in intensity level?

    a. 16 dB
    b. 12 dB
    c. 4 dB
    d. 0.5 dB

26. The intensity level of sound 20 m from a jet airliner is 120 dB. At what distance from the airplane will the sound intensity level be a tolerable 100 dB? (Assume spherical spreading of sound.)

    a. 90 m
    b. 120 m
    c. 150 m
    d. 200 m

27. A very loud train whistle has an acoustic power output of 100 W. If the sound energy spreads out spherically, what is the intensity level in dB at a distance of 100 meters from the train? ($I_0 = 10^{-12}$ W/m^2)

    a. 78.3 dB
    b. 81.6 dB
    c. 89.0 dB
    d. 95.0 dB

28. By what amount does the sound intensity decrease when the distance to the source doubles?

    a. 1.4 dB
    b. 2.0 dB
    c. 4.0 dB
    d. 6.0 dB

14.6 The Doppler Effect

29. A train station bell gives off a fundamental tone of 500 Hz as the train approaches the station at a speed of 20 m/s. If the speed of sound in air is 335 m/s, what will be the apparent frequency of the bell to an observer riding the train?

    a. 532 Hz
    b. 530 Hz
    c. 470 Hz
    d. 472 Hz

30. You stand by the railroad tracks as a train passes by. You hear a 1 000-Hz frequency when the train approaches, which changes to 800 Hz as it goes away. How fast is the train moving? The speed of sound in air is 340 m/s.

    a. 15.7 m/s
    b. 21.2 m/s
    c. 28.0 m/s
    d. 37.8 m/s

31. A sound source of frequency 1 000 Hz moves at 50.0 m/s toward a listener who is at rest. What is the apparent frequency heard by the listener? (speed of sound = 340 m/s)

    a. 853 Hz
    b. 872 Hz
    c. 1 150 Hz
    d. 1 170 Hz

32. A 500-Hz whistle is moved toward a listener at a speed of 10.0 m/s. At the same time, the listener moves at a speed of 20.0 m/s in a direction away from the whistle. What is the apparent frequency heard by the listener? (The speed of sound is 340 m/s.)

    a. 473 Hz
    b. 485 Hz
    c. 533 Hz
    d. 547 Hz

33. As a train starts from rest and then accelerates down the track, coming toward me faster and faster, the speed of the sound waves coming toward me will be:

    a. slower than the normal speed of sound in air.
    b. equal to the normal speed of sound in air.
    c. some constant speed faster than the normal speed of sound in air.
    d. faster and faster.

34. An airplane flying with a constant speed flies from a warm air mass into a cold air mass. The Mach number will:

    a. increase.
    b. decrease.
    c. stay the same.
    d. become unstable.

35. While standing at a crosswalk, you hear a frequency of 560 Hz from an approaching police car. After the police car passes, its frequency is 480 Hz. What is the speed of the police car? (speed of sound = 340 m/s)

    a. 13.1 m/s
    b. 17.4 m/s
    c. 21.1 m/s
    d. 26.2 m/s

36. A bat, flying at 5.00 m/s toward a wall, emits a chirp at 50.0 kHz. If the wall reflects this sound pulse, what is the frequency of the echo received by the bat? (v_{sound} = 340 m/s)

    a. 51.5 kHz
    b. 51.2 kHz
    c. 40.8 kHz
    d. 50.5 kHz

37. The Doppler shift of ultrasonic waves can measure the speed of blood in an artery. If the frequency of the stationary source is 100 kHz and the reflected sound has a Doppler shift of 200 Hz, what is the blood flow speed? (The speed of sound inside the body is 1 500 m/s.)

    a. 1.0 m/s
    b. 1.5 m/s
    c. 2.2 m/s
    d. 3.3 m/s

38. Two cars, one in front of the other, are traveling down the highway at 25 m/s. The car behind sounds its horn, which has a frequency of 500 Hz. What is the frequency heard by the driver of the lead car? (v_{sound} = 340 m/s)

    a. 463 Hz
    b. 540 Hz
    c. 579 Hz
    d. 500 Hz

39. A plane is traveling at Mach 0.950 through air at a temperature of 0°C. What is the plane's speed? (Speed of sound at 0ºC is 331 m/s.)

    a. 314 m/s
    b. 331 m/s
    c. 348 m/s
    d. Mach number is undefined at 0°C.

14.7 Interference of Sound Waves

40. A phase difference of 270° corresponds to what wavelength difference?

    a. 3λ
    b. 3λ/2
    c. 3λ/4
    d. 4λ/3

41. When two sound waves are out of phase by ________, destructive interference will occur.

    a. 90°
    b. 270°
    c. 540°
    d. 720°

42. Two loudspeakers are placed next to each other and driven by the same source at 500 Hz. A listener is positioned in front of the two speakers and on the line separating them, thus creating a constructive interference at the listener's ear. What minimum distance would one of the speakers be moved back away from the listener to produce destructive interference at the listener's ear? (The speed of sound = 340 m/s.)

    a. 1.36 m
    b. 0.68 m
    c. 0.34 m
    d. 0.17 m

43. Two loudspeakers are placed side by side and driven by the same source at 500 Hz. A listener is positioned in front of the two speakers and on the line separating them, thus creating a constructive interference at the listener's ear. If one of the speakers is gradually pushed toward the listener, how far must it be moved to repeat the condition of constructive interference at the listener's ear? (The speed of sound = 340 m/s.)

    a. 1.02 m
    b. 0.68 m
    c. 0.34 m
    d. 0.17 m

44. When I stand halfway between two speakers, with one on my left and one on my right, a musical note from the speakers gives me constructive interference. How far to my left should I move to obtain destructive interference?

    a. one-fourth of a wavelength
    b. half a wavelength
    c. one wavelength
    d. one and a half wavelengths

14.8 Standing Waves

45. If the tension on a guitar string is increased by a factor of 3, the fundamental frequency at which it vibrates is changed by what factor?

    a. 9
    b. 3
    c. $\sqrt{3}$
    d. $1/\sqrt{3}$

46. Doubling the tension in a guitar string will change its natural frequency by what factor?

    a. 0.71
    b. 1.0
    c. 1.4
    d. 2.0

47. If I triple the mass per unit length of guitar string, its natural frequency changes by what factor?

    a. 0.58
    b. 1.0
    c. 1.7
    d. 3.0

48. The lower A on a piano has a frequency of 27.5 Hz. If the tension in the 2.0-m-long string is 304 N and one-half wavelength occupies the string, what is the mass of the string?

    a. 100 g
    b. 25 g
    c. 37 g
    d. 50 g

49. If a guitar string has a fundamental frequency of 500 Hz, what is the frequency of its second overtone?

    a. 250 Hz
    b. 750 Hz
    c. 1 000 Hz
    d. 1 500 Hz

50. A 100-m-long high-voltage cable is suspended between two towers. The mass of the 100-m cable is 150 kg. If the tension in the cable is 30 000 N, what is the lowest frequency at which this cable can oscillate?

    a. 0.71 Hz
    b. 1.0 Hz
    c. 1.4 Hz
    d. 2.0 Hz

51. A standing wave is set up in a 200-cm string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. What is the wavelength?

    a. 10 cm
    b. 20 cm
    c. 40 cm
    d. 80 cm

52. A 1.5-m string is held fixed at both ends. When driven by a 180-Hz source, the string vibrates in 4 distinct segments. What is the natural fundamental frequency of the string?

    a. 45 Hz
    b. 90 Hz
    c. 240 Hz
    d. 600 Hz

53. A standing wave is set up in a 2.0-m string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. In how many distinct standing wave segments will the string vibrate if the tension is increased by a factor of 4?

    a. 3
    b. 10
    c. 20
    d. No standing wave pattern occurs.

54. For a standing wave on a string the wavelength must equal:

    a. the distance between adjacent nodes.
    b. the distance between adjacent antinodes.
    c. twice the distance between adjacent nodes.
    d. the distance between supports.

55. I stretch a rubber band and “plunk” it to make it vibrate in its fundamental frequency. I then stretch it to twice its length and make it vibrate in the fundamental frequency once again. The rubber band is made so that doubling its length doubles the tension and reduces the mass per unit length by a factor of 2. The new frequency will be related to the old by a factor of:

    a. 1.0.
    b. 1.4.
    c. 2.0.
    d. 4.0.

56. A C note (f = 256 Hz) is sounded on a piano. If the length of the piano wire is 1.00 m and its mass density is 2.50 g/m, what is the tension in the wire?

    a. 84 N
    b. 168 N
    c. 655 N
    d. 1 280 N

14.9 Forced Vibrations and Resonance

57. A child sits on a swing supported by ropes of length 3.0 m. With what frequency will she need to apply the driving force to maintain swinging?

    a. 0.29 Hz
    b. 0.48 Hz
    c. 2.1 Hz
    d. 3.5 Hz

14.10 Standing Waves in Air Columns

58. A 2.50-m-long organ pipe is open at one end and closed at the other. Its fundamental tone has wavelength:

    a. 1.25 m.
    b. 5.00 m.
    c. 10.0 m.
    d. 16.25 m.

59. What is the lowest frequency that will resonate in an organ pipe 2.00 m in length, closed at one end? The speed of sound in air is 340 m/s.

    a. 42.5 Hz
    b. 85.0 Hz
    c. 170 Hz
    d. 680 Hz

60. When the standing wave pattern in a pipe is NANA, the pipe has which of the following set of properties? (N stands for node, A for antinode.)

    a. It is open at both ends.
    b. It is closed at both ends.
    c. It is open at one end and closed at the other end.
    d. Any of the above could be true.

61. What is the first overtone frequency for an organ pipe 2.00 m in length, closed at one end? The speed of sound in air is 340 m/s.

    a. 42.5 Hz
    b. 85.0 Hz
    c. 128 Hz
    d. 680 Hz

62. A tuning fork is sounded above a resonating tube (one end closed), which resonates at a length of 0.200 m and again at 0.600 m. What is the frequency of the fork when the speed of sound is taken to be 340 m/s?

    a. 567 Hz
    b. 425 Hz
    c. 1 700 Hz
    d. 950 Hz

63. A tuning fork is sounded above a resonating tube (one end closed), which resonates at a length of 0.20 m and again at 0.60 m. If the tube length were extended further, at what point will the tuning fork again create a resonance condition?

    a. 0.8 m
    b. 1.0 m
    c. 1.2 m
    d. 1.6 m

64. For a standing wave in an air column in a pipe that is open at both ends, there must be at least:

    a. one node and one antinode.
    b. two nodes and one antinode.
    c. two antinodes and one node.
    d. two nodes and two antinodes.

65. If two adjacent frequencies of an organ pipe closed at one end are 550 Hz and 650 Hz, what is the length of the organ pipe? (v_{sound} = 340 m/s)

    a. 0.85 m
    b. 1.25 m
    c. 1.50 m
    d. 1.70 m

66. A flute behaves like a tube open at both ends. If its length is 65.3 cm, and the speed of sound is 340 m/s, what is its fundamental frequency in Hz?

    a. 130 Hz
    b. 159 Hz
    c. 212 Hz
    d. 260 Hz

67. The air in a tube open at both ends is sent into its fundamental resonance. One end of the tube is then closed and the air column is again set into its fundamental resonance. The resonant frequency _______________ after the end is closed.

    a. halves
    b. stays the same
    c. doubles
    d. increases by a factor of 1.4

14.11 Beats

68. What phenomenon is created by two tuning forks, side by side, emitting frequencies, which differ by only a small amount?

    a. resonance
    b. interference
    c. the Doppler effect
    d. beats

69. Two vibrating tuning forks, held side by side, will create a beat frequency of what value if the individual frequencies of the two forks are 342 Hz and 345 Hz, respectively?

    a. 687 Hz
    b. 343.5 Hz
    c. 339 Hz
    d. 3 Hz

70. A vibrating guitar string emits a tone simultaneously with one from a 500-Hz tuning fork. If a beat frequency of 5 Hz results, what is the frequency of vibration of the string?

    a. 2 500 Hz
    b. 505 Hz
    c. 495 Hz
    d. Either choice b or c is valid.

71. Two tuning forks sounding together result in a beat frequency of 3 Hz. If the frequency of one of the forks is 256 Hz, what is the frequency of the other?

    a. 262 Hz or 250 Hz
    b. 105 Hz
    c. 259 Hz or 253 Hz
    d. 85 Hz

14.12 Quality of Sound

72. The number of overtones, and their relative intensities, is associated with what property of the tone generated by a musical instrument?

    a. quality
    b. interference pattern
    c. range
    d. attack pattern

73. The term "timbre" refers to which of the following?

    a. Any musical instrument made primarily of wood.
    b. The quality of sound from instruments due to the mixture of harmonics.
    c. Instruments that have valves.
    d. An instrument made in France.

14.13 The Ear

74. Of the frequencies listed below, to which one is the human ear most sensitive?

    a. 33 Hz
    b. 330 Hz
    c. 3 300 Hz
    d. 33 000 Hz

75. In which part of the ear is the cochlea?

    a. outer ear
    b. middle ear
    c. inner ear
    d. ear canal

CHAPTER 14 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
C1.	A	1	36.	A	3
C2.	B	1	37.	B	3
C3.	B	2	38.	D	2
C4.	C	2	39.	A	1
C5	A	2	40.	C	2
1.	B	1	41.	C	2
2.	C	1	42.	C	2
3.	D	1	43.	B	2
4.	B	1	44.	A	2
5.	D	1	45.	C	2
6.	A	1	46.	C	2
7.	A	2	47.	A	2
8.	A	2	48.	D	3
9.	C	1	49.	D	2
10.	A	2	50.	A	2
11.	C	2	51.	D	2
12.	D	2	52.	A	2
13.	C	2	53.	D	3
14.	D	1	54.	C	2
15.	C	2	55.	A	3
16.	D	2	56.	C	2
17.	B	2	57.	A	2
18.	D	2	58.	C	2
19.	B	2	59.	A	2
20.	D	2	60.	C	2
21.	A	2	61.	C	2
22.	D	3	62.	B	3
23.	C	2	63.	B	2
24.	A	1	64.	C	2
25.	B	2	65.	D	2
26.	D	2	66.	D	2
27.	C	3	67.	A	2
28.	D	2	68.	D	1
29.	B	2	69.	D	1
30.	D	3	70.	D	1
31.	D	2	71.	C	1
32.	B	3	72.	A	1
33.	B	1	73.	B	1
34.	A	2	74.	C	1
35.	D	3	75.	C	1