Review problems:

This is a selection of homework and exam problems that CAPA indicated were more difficult than others. We will review these problems in class to further solidify knowledge of the course material.

1) Runner 1 is standing still. Runner 2 passes him, running with a constant speed of 4.5 m/s. Just as runner 2 passes him, runner 1 accelerates with constant acceleration of 2.11 m/s2. How far down the track does runner 1 catch up with runner 2? (19.19m)

2) A runner of mass 59.3 kg starts from rest and accelerates with a constant acceleration of 1.25 m/s2 until he reaches a velocity of 5.90 m/s. He then continues running with this constant velocity. How long does the runner take to run 142 m? (26.43s)

3) An airplane has an air speed of 92.2 m/s and flies due North, but the wind blows from the Northeast to the Southwest at 66.5 m/s. What is its actual ground speed?

4) A cannon is fired from a 180.7 m high hill at an angle of 21.2o with respect to the horizontal. If the muzzle velocity is 35.1 m/s, what is its speed of a 4.35 kg cannonball when it hits the ground 180.7 m below? (69.12 m/s)

5) A salesman is standing on the Golden Gate Bridge in a traffic jam. His car is a height of 73.2 m above the water below. He receives a call on his cell phone that makes him so mad that he throws his phone horizontally off the bridge with a speed of 19.3 m/s. How far does the cell phone travel horizontally before hitting the water? 74.6m

6) A wedge of mass m = 35.5 kg is located on a plane that is inclined by an angle θ = 21.3 with respect to the horizontal. A force F = 315.3 N in horizontal direction pushes on the wedge, as shown. The coefficient of friction between the wedge and the plane is 0.155.

What is the acceleration of m along the plane? Negative numbers for motion to the left, and positive numbers for motion to the right, please. (-2.79 m/s^2)

7) A pendulum of length 0.431 m, with a bob of mass 0.593 kg is moved to an angle of 34.6 degrees with respect to the vertical. It is then released. What is the speed of the bob at the bottom of the pendulum oscillation? (1.22 m.s)

8) A skier of mass 59.9 kg (including all of her clothing and gear) is moving across the snow with a speed of 15.5 m/s when she comes to a portion of the mountain which is sloped upward at an angle of 11.5 degrees with respect to the horizontal. Assuming that we can neglect friction forces, how long does it take her to come to a stop? 7.93 s (in s)

9) A rubber ball with a mass of 1.5 kg and a initial speed of 4.5 m/s hits a wall at an angle of 79 degrees. The angle is measured from the wall to the ball's trajectory, at 90 degrees the ball would hit the wall perpendicularly, at zero degrees the ball would move parallel to the wall. The collision is completely elastic. What is the magnitude of the impulse (in mks units) the ball receives from the wall? 13.25

10) Tarzan, King of the Jungle (mass: 75.4 kg, height: 6'2"), grabs a vine of length 14.5 m that he found hanging from a tree branch. Initially, the angle of the vine was 35.3 degrees with respect to the vertical when he grabbed it. At the lowest point of his trajectory he picks up Jane (mass: 41.4 kg, height: 5'6") and continues on his swinging motion. What angle (please quote its absolute value in degrees, also with respect to the vertical) will Tarzan and Jane reach at the highest point of their trajectory? (22.575 deg)

11) A baseball pitcher delivers a fastball that crosses the plate with an angle of 7.05 degrees relative to the horizontal and a speed of 89.9 miles/hour. The ball (mass 0.146 kg) is hit back over the head of the pitcher at an angle of 37.71 degrees with respect to the horizontal and a speed of 106.3 miles/hour. What is the magnitude of the impulse received by the bat? (11.823 kg*m/s)

12) A long thin rod lies along the x-axis. One end is at x=2.00 m and the other at x=4.00 m. Its linear mass density λ =0.400 x2+0.500, in kg/m. Calculate mass of the rod. 8.47 kg Calculate the x-coordinate of the CM of the rod. 3.19 m

13) A train has a speed of V = 121.1 km/h. If the acceleration experienced by the passengers is to be less than 0.5 g, find the smallest radius of curvature R (in m) acceptable for the track. g = 9.81 m/s2 -

14) A crate of mass 57 kg is loaded onto the back of a flatbed truck. The coefficient of static friction between the box and the truck bed is 0.56. What is the smallest radius of curvature (in m) that the truck can take, if the speed with which it is going around a circle is 20 m/s?

15) A block of mass 1.49 kg is at rest and suspended from a spring on an frictionless inclined plane with angle $\alpha = 31.7$ degrees relative to the horizontal as shown in the figure. The spring has a spring constant of 104.9 N/m and a length of 6.9 cm, if there is no mass hanging from it. To what length is the spring stretched in this situation? 14.22 cm (in cm)

16) A turntable with radius 0.67 m and mass 2.9 kg spins with 5 turns per second with the angular velocity pointing in the +y direction. A force of 2.9 N is applied at the edge in the -x direction as indicated. What is the angular velocity of the turntable after 1.894 seconds in rad/s? 25.761 (force slows down)

17) Highways are banked at an angle θ for a design speed at which friction is not required to steer the car around the curve. If the design speed is 62 mph, and the banking angle is 18 degrees, what is the radius of the curve in meters? 240.88

18) A large horizontal circular platform (M=117.1 kg, r=3.41 m) rotates about a frictionless vertical axle. A student (m=62.3 kg) walks slowly from the rim of the platform toward the center. The angular velocity ω of the system is 3.50 rad/s when the student is at the rim. Find ω (in rad/s) when the student is 2.01 m from the center. (5.27)

19) A disk of mass 0.300 kg and radius 5.10 cm rolls without slipping down an inclined plane from a height $h = 1.85$ m. The inclined plane makes an angle of $\theta = 27.0$ degrees with respect to the horizontal. How long does it take for the disk to reach the bottom? (1.66s)

20) A solid sphere with mass 4.40 kg and radius 0.214 m starts from rest at a height of $h = 3.12$ m above the base of an inclined plane and rolls under the influence of gravity. What is the linear speed v of the center of mass of the sphere just as it leaves the incline and rolls onto a horizontal surface. 6.612 m/s

21) The mass of a star is 2.50 x 1031 kg and it performs one rotation in 15.50 days. Find its new period (in days) if the diameter suddenly shrinks to 0.440 times its original size. Assume a uniform spherical mass before the collapse and a uniform spherical mass distribution after the collapse. (3.0008)

22) The Kuiper Belt is a collection of icy asteroids just beyond Neptune, reaching out to a distance of about 50 AU (AU = 1 astronomical unit = mean distance between Earth and Sun = 149.6 million km). Suppose we were to detect an asteroid with an orbital radius of 44.63 AU in the Kuiper belt, how many years would it take for this asteroid to orbit the Sun? (298.2)

23) A mass of 40 kg is suspended from a steel wire of diameter 0.7 mm and length 1.2 m. How much does the wire stretch in mm? Young's modulus for steel is 2.0 x 1011 N/m2. (6.11 mm)

24) A tube carries water on the level in a nonturbulent flow condition. The flow, F, is 0.19 · 10-4 m3/s. What is the velocity of the water in m/s when it crosses a part of the tube which has a diameter, D, of 5.8 cm?