

PHYSICS 2020

Homework #2

(Due Oct. 13, 2025)

1. (Serway 5-3) A 3.00-kg object undergoes an acceleration given by $\mathbf{a} = (2.00\mathbf{i} + 5.00\mathbf{j}) \text{ m/s}^2$. Find (a) the resultant force acting on the object and (b) the magnitude of the resultant force.
2. A force $\mathbf{F}$ applied to an object of mass m_1 produces an acceleration of 3.00 m/s^2 . The same force applied to a second object of mass m_2 produces an acceleration of 1.00 m/s^2 . (a) What is the value of the ratio m_1/m_2 ? (b) If m_1 and m_2 are combined into one object, find its acceleration under the action of the force $\mathbf{F}$.
3. A block slides down a frictionless plane having an inclination of $\theta = 15.0^\circ$. The block starts from rest at the top, and the length of the incline is 2.00 m. (a) Draw a free-body diagram of the block. Find (b) the acceleration of the block and (c) its speed when it reaches the bottom of the incline.
4. A balloon is descending with a constant acceleration a , less than the acceleration due to gravity g . The weight of the balloon, with its basket and contents, is w . What weight, W , of ballast should be released so that the balloon will begin to be accelerated upward with constant acceleration a ? Neglect air resistance.
5. A space station, in the form of a wheel 120 m in diameter, rotates to provide an “artificial gravity” of 3.00 m/s^2 for persons who walk around on the inner wall of the outer rim. Find the rate of the wheel’s rotation in revolutions per minute that will produce this effect.
6. A roller coaster at the Six Flags Great America amusement park in Gurnee, Illinois, incorporates some clever design technology and some basic physics. Each vertical loop, instead of being circular, is shaped like a teardrop (Fig. P6.17 in the textbook). The cars ride on the inside loop at the top, and the speeds are fast enough to ensure the cars remain on the track. The biggest loop is 40.0 m high. Suppose the speed at the top of the loop is 13.0 m/s and the corresponding centripetal acceleration of the riders

is $2g$. (a) What is the radius of the arc of the teardrop at the top? (b) If the total mass of a car plus the riders is M , what force does the rail exert on the car at the top? (c) Suppose the roller coaster had a circular loop of radius 20.0 m . If the cars have the same speed, 13.0 m/s at the top, what is the centripetal acceleration of the riders at the top? (d) Comment on the normal force at the top in the situation described in part (c).

7. If it takes 4.00 J of work to stretch a Hooke's-law spring 10.0 cm from its unstressed length, determine the extra work required to stretch it an additional 10.0 cm .

8. A baseball outfielder throws a 0.150-kg baseball at a speed of 40.0 m/s and at an initial angle of 30.0° to the horizontal. What is the kinetic energy of the baseball at the highest point of its trajectory?

9. An inclined plane of angle θ has a spring of force constant k fastened securely at the bottom so that the spring is parallel to the surface. A block of mass m is placed on the plane at a distance d from the spring. From this position, the block is projected downward toward the spring with speed v as shown in Figure P7.63 of the text. By what distance is the spring compressed when the block momentarily comes to rest?

10. A bead slides without friction around a loop-the-loop (see figure given in class). The bead is released from a height $h = 3.50R$. (a) What is its speed at point A ? (b) How large is the normal force on the bead at point A if its mass is 5.00 g ?

11. (Serway 8-12) A sled of mass m is given a kick on a frozen pond. The kick imparts to the sled an initial speed of 2.00 m/s . The coefficient of kinetic friction between sled and ice is 0.100 . Use energy considerations to find the distance the sled moves before it stops.