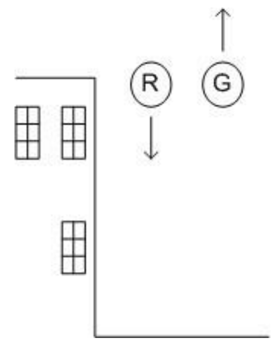
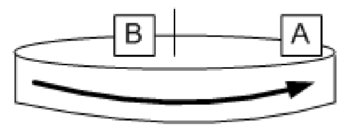
Please note: the final examination will be on legal-size paper. It has been transferred to letter for your convenience.

PART A: MULTIPLE CHOICE QUESTIONS

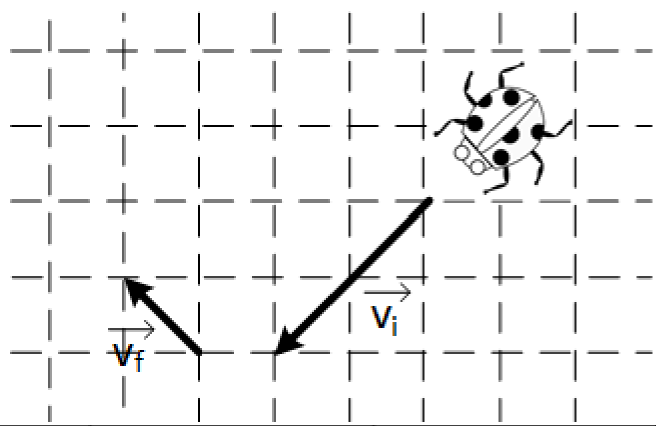
1. A red ball is dropped (from rest) off the roof of a building. At the same moment, a green ball is thrown straight up from the same point. Both balls eventually land on the ground below. Which statement(s) is/are true?
a. At all moments in the air, the red and the green ball have the same acceleration.
b. The moment they hit the ground, the red and the green ball have the same velocity.
c. The moment they hit the ground, the red and the green ball have experienced the same displacement.
d. All of the above are true.
e. Choices a) and c) are both true.

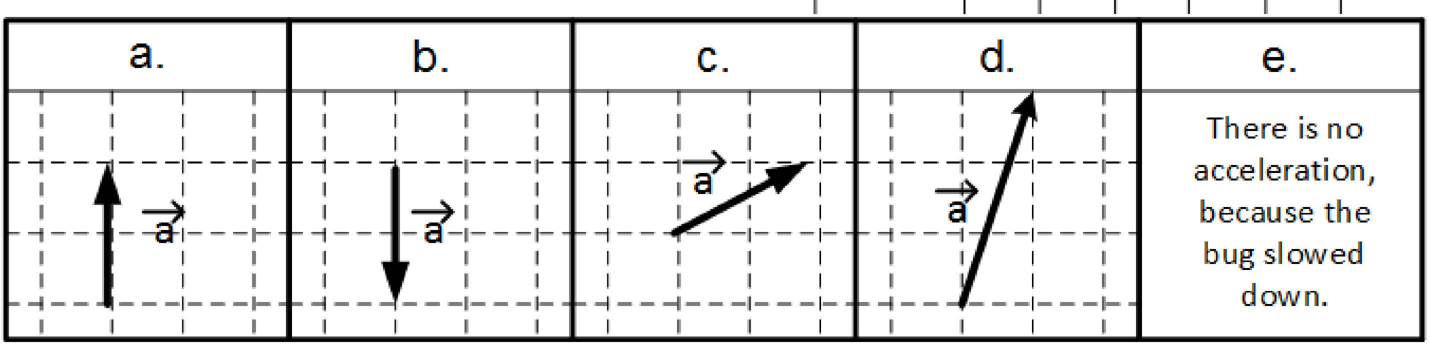


2. Two blocks are placed on a rotating disk which increases its rotational speed from 10 revolutions per minute to 20 revolutions per minute. Block B is closer to the centre than block A. Which of the following statements is true?
a. The tangential acceleration of A is greater than the tangential acceleration of B.
b. The angular acceleration of A is greater than the angular acceleration of B.
c. The angular displacement of A is greater than the angular displacement of B.
d. The angular velocity of A is greater than the angular velocity of B.
e. All of the above are true



3. The picture shows a cute bug's velocity at an initial time *i*, and at a final time *f* one second later. Choose the vector that best represents the bug's acceleration during this time interval

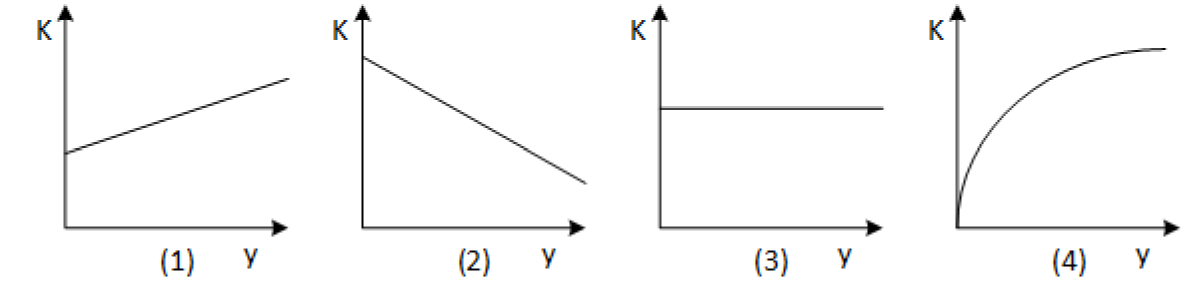




4. If each component of a vector is doubled, what happens to the direction of that vector?

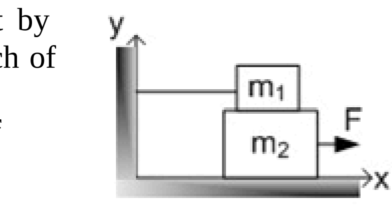
a. It doubles.
b. It increases but by less than double.
c. It does not change.
d. It is reduced by half.
e. It is reduced but not by as much as half.

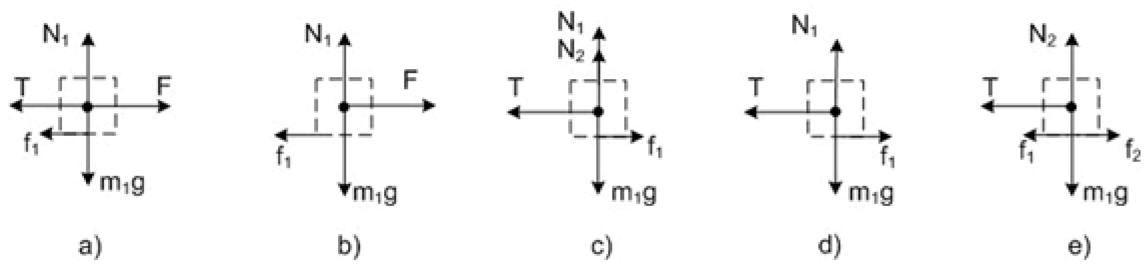
5. An object is released from rest from high altitude. If the air resistance is **NOT** neglected, which curve represents the kinetic energy of the object as a function of the distance the object has fallen?



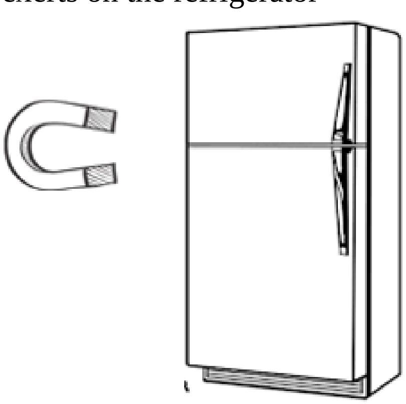
a. 1
b. 2
c. 3
d. 4
e. None of these

6. Two blocks are placed on top of each other. Block m_2 is pulled to the right by force F while m_1 is held in place by a rope. All surfaces are rough. Which of the free body diagrams below best describes the forces acting <u>on block m_1</u>? Note: the vectors are **not** drawn to scale; they merely indicate the direction of each force.





7. The picture shows a refrigerator and a magnet. Choose the set of arrows that best represents the force that the refrigerator exerts on the magnet and the force that the magnet exerts on the refrigerator

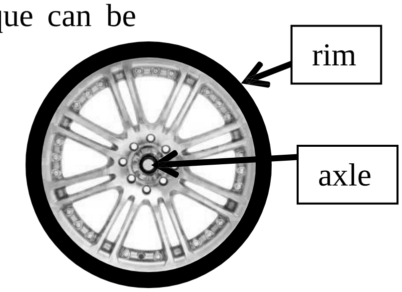


	Force of refrigerator on magnet	Force of magnet on refrigerator
a.	The refrigerator exerts no force on the magnet	⟵
b.	⟶	The magnet exerts no force on the refrigerator
c.	⟶	←
d.	→	⟵
e.	⟶	⟵

8. If a constant net torque is applied to an object, that object will

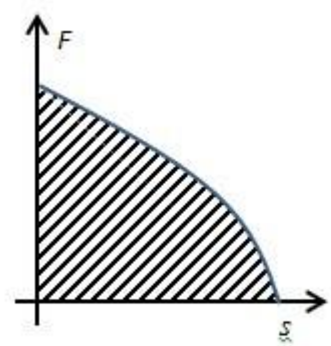
a. Rotate with constant angular position.
b. Rotate with constant angular velocity.
c. Rotate with a constant angular acceleration.
d. Have an increasing moment of inertia.
e. Have a decreasing moment of inertia.

9. A force with a given magnitude is to be applied to a wheel. The torque can be maximized by
a. Applying the force at the rim, at 45° to the tangent.
b. Applying the force at the rim, tangent to the rim.
c. Applying the force near the rim, radially outward from the axle.
d. Applying the force near the axle, radially outward from the axle.
e. Applying the force near the axle, parallel to a tangent to the wheel.



10. A projectile is launched at a 30° angle above the horizontal. Ignore air resistance. The projectile's acceleration is
a. the same (but nonzero) at all points along the trajectory
b. zero at all points along the trajectory
c. greatest at a point between the launch point and the high point of the trajectory.
d. greatest at the high point of the trajectory.
e. greatest at a point between the high point of the trajectory and where it hits the ground.

11. A changing force is exerted on an object as the object moves a distance *s*. The force is at all times in the same direction as the motion. The graph of this force as it changes with *s* is shown. The area of this graph is:



a. The work done by the force on the object.

b.The impulse on the object.
c. The acceleration of the object.
d. The velocity of the object.
e. The displacement of the object.

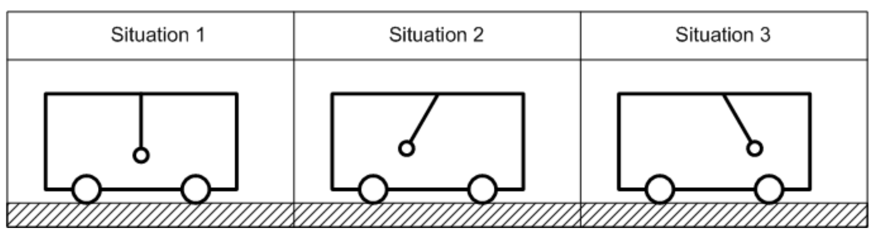
12. A 1 kg puck collides with a 2 kg puck on an icy surface. Neglect the effects of friction. Compared to the 1 kg puck, the change in momentum of the 2 kg puck is;
a. equal in magnitude and in the same direction.
b. equal in magnitude and in the opposite direction.
c. smaller in magnitude and in the same direction.
d. greater in magnitude and in the same direction.
e. neither puck has a change of momentum.

13 As a block is pushed by someone down a rough incline;
a. friction does negative work on the block.
b. gravity does negative work on the block.
c. the person pushing does negative work on the block
d. both gravity and friction do negative work on the block.
e. both friction and the person pushing do negative work on the block.

14 A car travelling at 30 km/h has kinetic energy K. If it reverses direction and speeds up to 60 km/h, what will be its kinetic energy?
a. K
b. 2K
c. 4K
d. -K
e. -4K

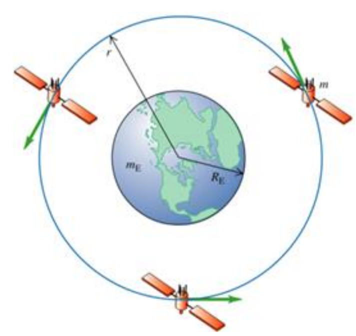
15. A coin is tossed straight up into the air. After it is released it moves upward, reaches its highest point and falls back down again. Which of the following statements best describe the force acting on the coin while the coin is moving upward after it is released? Ignore any effects of air resistance.
a. The force is down and constant.
b. The force is down and increasing.
c. The force is down and decreasing.
d. The force is up and increasing.
e. The force is up and decreasing.

16. Situations 1, 2 and 3 show a physics experiment in which a pendulum hangs from the ceiling of a train car. Choose the statement that correctly describes the motion of the car(s).

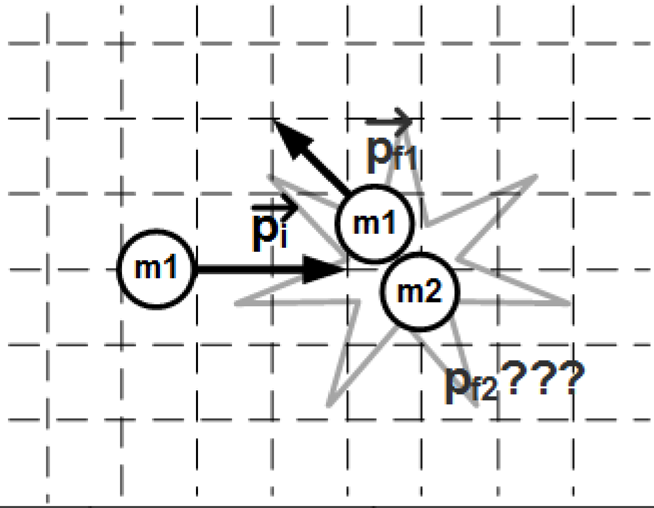


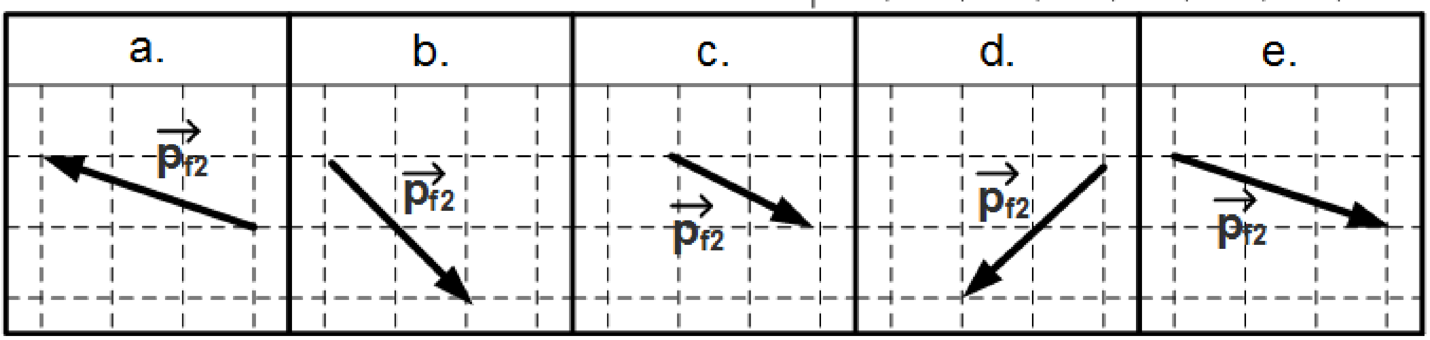
a. In situation 2, the train car is moving to the right at constant speed.
b. In situation 1, the car may be moving at constant speed to the left or to the right, we cannot tell which.
c. In situation 3, the car is moving to the left at constant speed
d. In situation 3, the car is moving to the right and speeding up.
e. Statements a. and c. are both correct.

17. The value of g at the height of the International Space Station's orbit is
a. 9.8 m/s^2.
b. slightly less than 9.8 m/s^2.
c. much less than 9.8 m/s^2 .
d. exactly zero.
e. We cannot tell without numbers



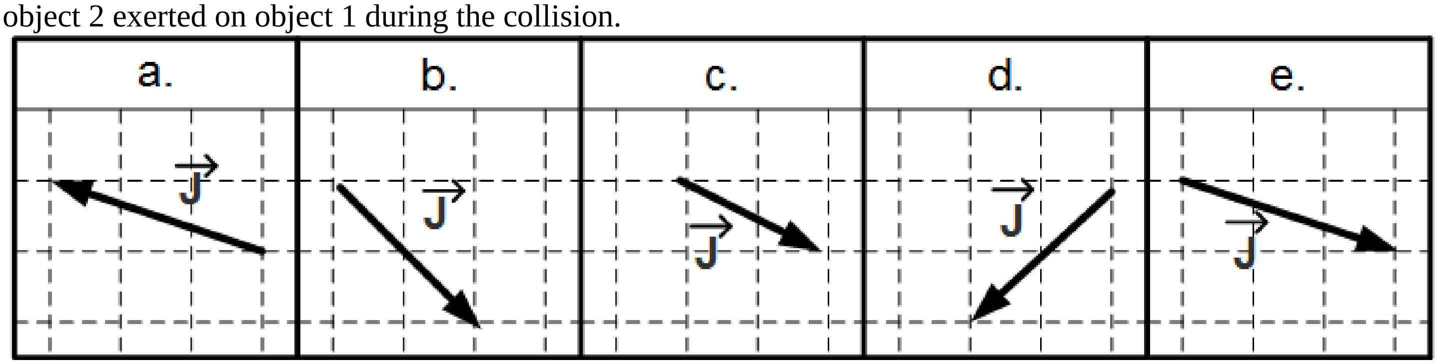
18. This picture shows an object, m1, colliding with m2, an object of equal mass that was initially at rest. The arrows illustrate the initial and final momenta of m1. Choose the vector that best represents the final momentum of m2.





19. Choose the term that best describes the collision in Question 18:
a. An elastic collision
b. A completely elastic collision
c. An explosion
d. A completely inelastic collision
e. An inelastic collision

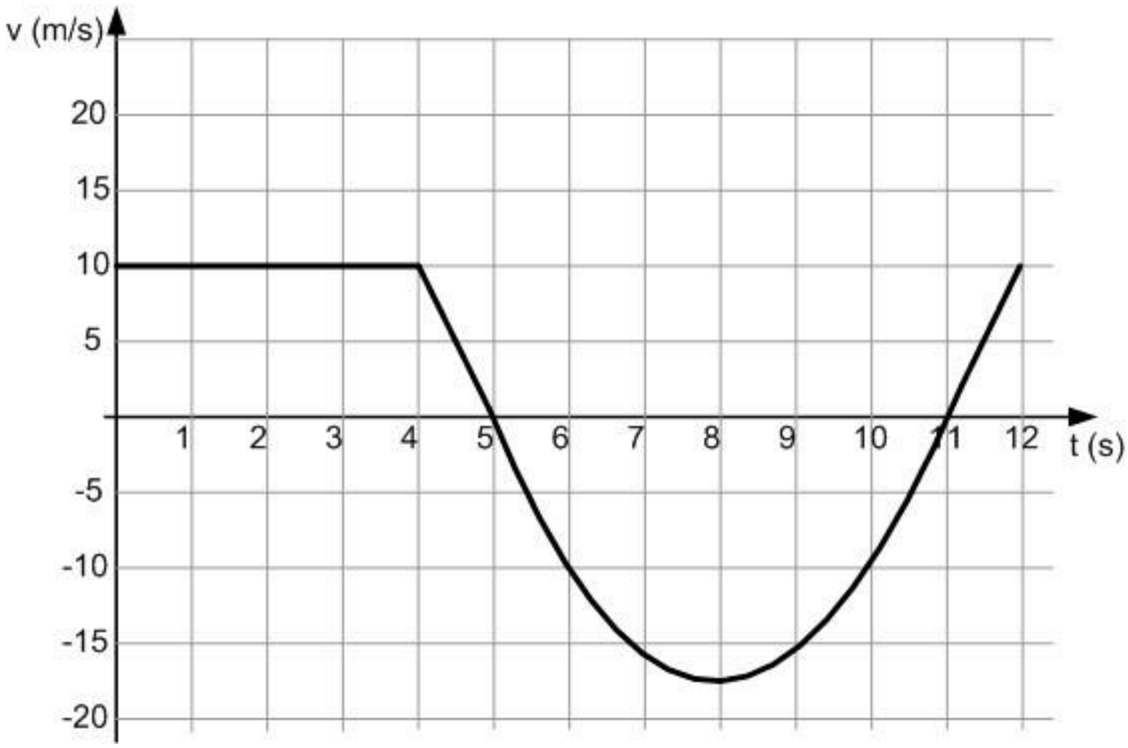
20. Consider once more the collision in Question 18 Choose the vector that best represents the impulse $\vec{J}$ that object 2 exerted on object 1 during the collision.



PART B : PROBLEMS

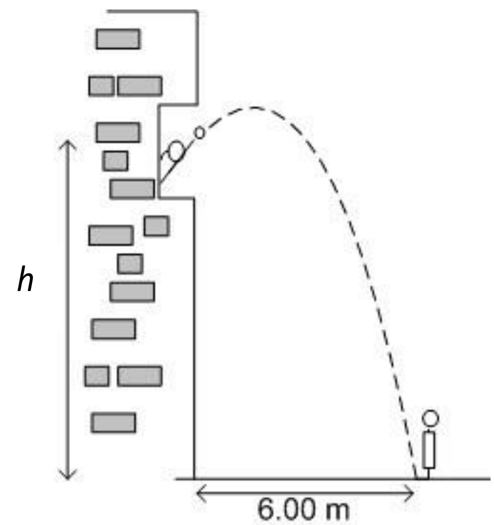
PROBLEM-1

The velocity versus time graph of a particle moving in the x-direction is shown below. At t = 0 it is passing the x = 30.0 m position.



a. What is its position at t = 6.00 s? [2]
b. When is it at rest? [1]
c. What is its acceleration at t = 11.0 s? [2]
d. Describe in sentence form the motion the particle is undergoing at t = 10.0 s. [1]
e. A second particle starts from rest at t = 0 as the first one is passing it. It moves with a constant acceleration and catches up with the first one after 4.00 s. <u>On the</u> <u>graph above</u> draw the corresponding velocity-time graph for the second particle, for the first 4.00 s. Show your calculations below. [2]

PROBLEM-2



A water balloon is thrown by Sandra out of her dormitory window at an angle of 60º. It lands at the feet of Chris, who is standing a horizontal distance of 6.00 m from the building. If it takes 2.50 s to reach Chris's feet, determine the height *h* that Sandra threw it from. [8]

PROBLEM-3

The tub of your top-loading washing machine goes into its spin cycle, starting from rest and increasing its angular speed at the rate of 8.00 rad/s^2. At the moment its angular speed reaches 5.00 revolutions per second, you open the lid and the safety switch turns it off; the tub then takes 12.0 s to come to rest with a uniform acceleration.

a. What is the angular speed in rad/s when you open the lid? [1]

b. What is the angular acceleration of the tub, in rad/s^2, for the last 12.0 s of the motion? [2]

c. Through how many revolutions does the tub turn in the last 12.0s? [3]

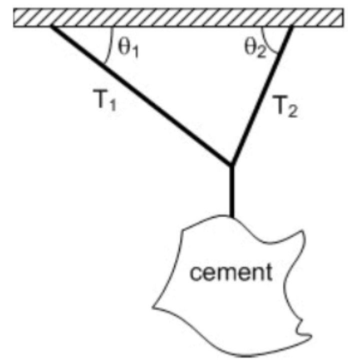
d. The tub of the washer has a radius of 20.0 cm. For a point on the edge of the tub at the instant **immediately** before you open the lid of the machine determine:

i. The radial (centripetal) acceleration, [1]

ii. The tangential acceleration, [1]

iii. The magnitude of the total (net) acceleration. [1]

PROBLEM-4

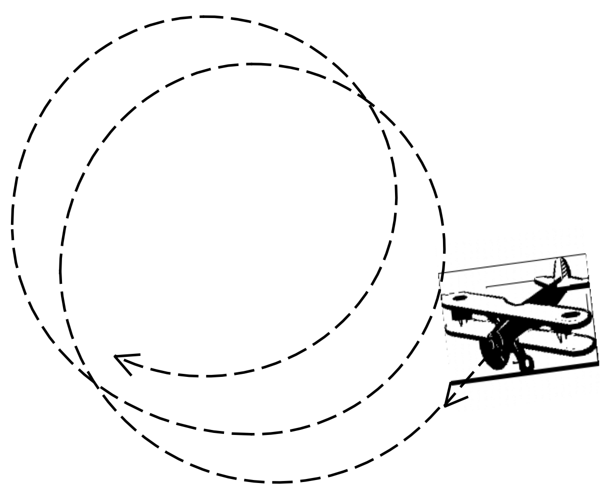


A bag of cement, of mass *m*, hangs from three wires as shown in the figure. Two of the wires make angles θ_1 and θ_2, respectively, with the horizontal. Show that if the system is in equilibrium then [3]

$$T_1 = \frac{mg}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2}$$

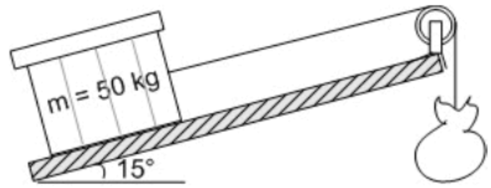
PROBLEM-5

A stunt plane does a series of vertical loop-the-loops. Assuming the pilot is moving at constant speed throughout the trajectory, at what point in the circle does the pilot feel the heaviest (have the greatest apparent weight)? Explain in sentence form. Include free-body diagrams with your explanation. [3]



PROBLEM-6

At your job at a warehouse, you have designed a method to help get heavy packages up a 15° ramp. The package is attached to a rope that runs parallel to the ramp and passes over a massive pulley with a moment of inertia I = 10.0 kg·m^2 and radius of 0.20 m, at the top of the ramp. The other end of the rope is attached to a counterweight that hangs straight down. The mass of the counterweight is always adjusted to be twice the mass of the package.

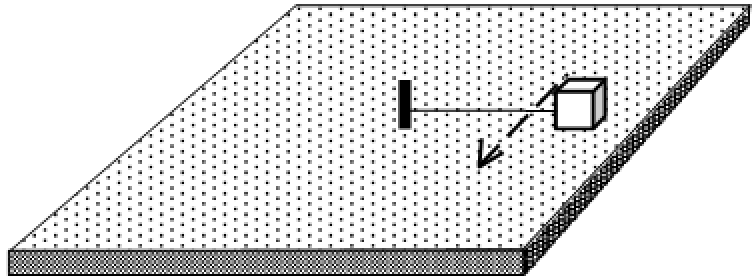


However, your boss is worried that the acceleration of the package will make it too difficult to handle at the top of the ramp and tells you to calculate the acceleration of the package.

To determine the influence of friction on the package by the ramp, you run some tests and find that using a horizontal force of 250 N, you can push a 50.0 kg package at a constant speed along a level floor made of the same material as the ramp.

What will be the acceleration of the package up the ramp? [12]

PROBLEM-7

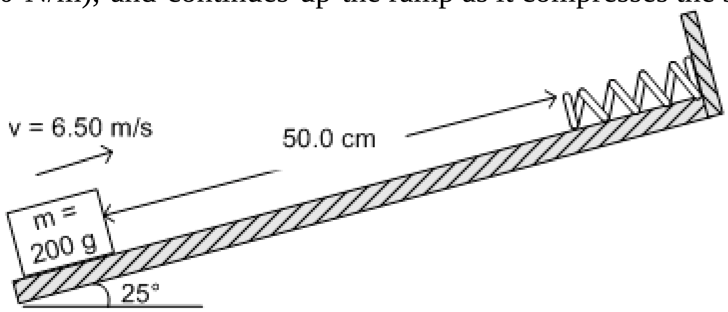


A 0.350 kg block is attached by a string to a post in the centre of a horizontal frictionless air table. The block revolves around the post with a constant speed of 5.00 m/s and takes 1.20 s for each rotation.

a. Draw a fully labelled free body diagram of the block as it revolves. [3]
b. Find the length of the string connecting the block to the centre. [1]
c. Find the tension in the string while the block is rotating. [3]

PROBLEM-8

A block of mass 200 g is sent up a 25° ramp with an initial speed of 6.50 m/s. The coefficient of friction between the block and the ramp is 0.180. After travelling up the ramp a distance of 50.0 cm, it encounters a spring (k = 400 N/m), and continues up the ramp as it compresses the spring

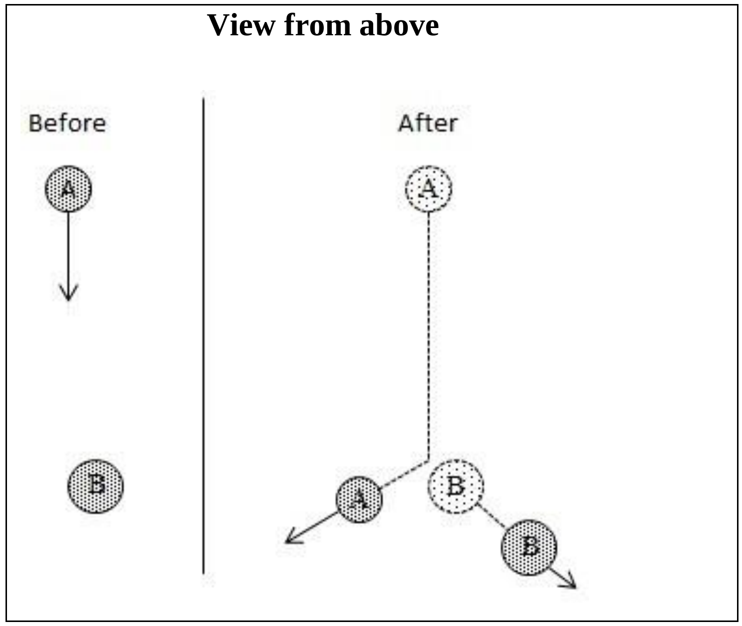


What is the maximum compression of the spring? [10]

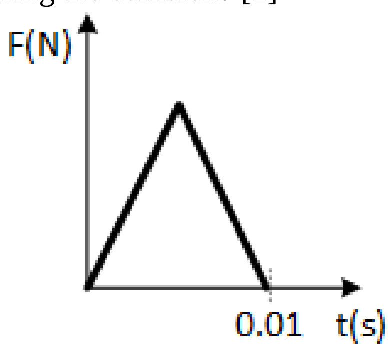
PROBLEM-9

An air puck of mass 375 g (A) on a flat horizontal table has an initial velocity of 4.00 m/s at 270° as shown. It collides with a second puck of mass 450 g (B); as a result the original puck glides away with a velocity of 2.80 m/s at 203°.

a. What is the velocity (magnitude and direction) of the 450 g puck after the collision?

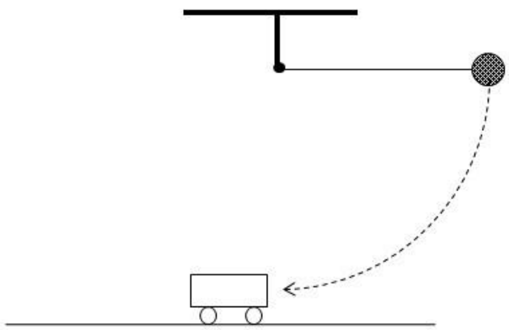


b. The pucks were in contact for a period of 0.010 s, with a changing force between them that can be represented with the simplified graph below. Using this graph, what was the maximum force between them during the collision? [2]



PROBLEM-10

A ball attached to the end of a string is held horizontal and released, hitting a cart in a collision which is not perfectly elastic. The cart then rolls away as the ball swings back. For each of the three parts of the motion (a) as the ball falls down, (b) as it hits the cart, and (c) as the two separate after collision, describe how the concept of either conservation of momentum or conservation of mechanical energy applies.



a. as the ball falls down [1]

b. as it hits the cart [1]

c. as the cart and ball move away from each other after the collision [1]

PROBLEM-11

The earth has a mass of 5.97×10^{24} kg, the moon has a mass of 7.35×10^{22} kg. A spaceship (m_{ship} = 2.60×10^{4} kg) is located in space so that it is 3.30×10^{8} m from the earth and 1.10×10^{8} m from the moon at 20° and 40° from the line joining them as shown. Calculate the magnitude of the gravitational force on the spaceship, and the angle this force makes with the line from the earth to the moon. [7]