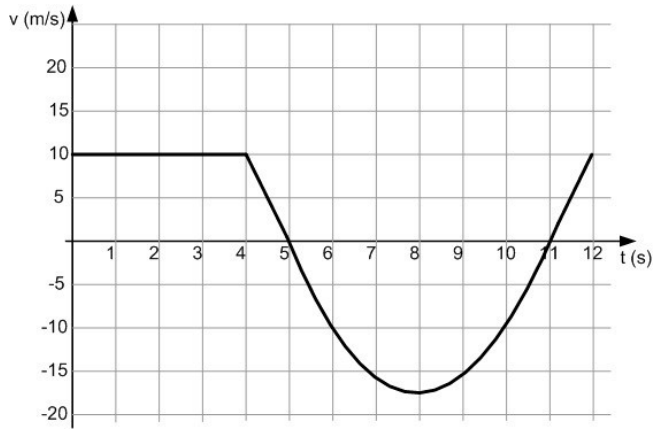
SN1 Final Exam includes 16 Multiple Choice questions and Problems worth 64 marks for a total of 80 marks.

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

PART A: MULTIPLE CHOICE QUESTIONS

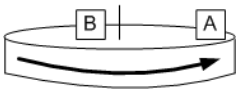


1. In the velocity-time graph above, when is the particle moving in the negative direction?
   a. Only from t=4s to t=8s
   b. Only from t=5s to t=11s
   c. Only from t=8s to t=12s
   d. Only from t=4s to t=12s
   e. Only from t=5s to t=8s

2. 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.

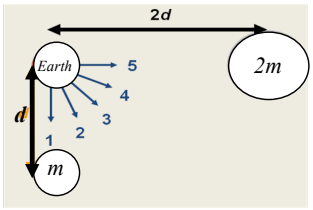
Commented [ZS1]: Redundancy with 1? Maybe keep this one instead?

3. 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

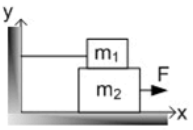


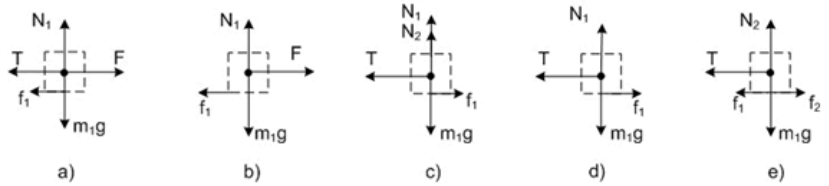
4. A planet of mass m is a distance d from Earth, while a second planet of mass 2m is a distance 2d from Earth in a perpendicular direction.
Which force vector on the diagram best represents the direction of the net gravitational force on the Earth from these two planets?

a. 1
b. 2
c. 3
d. 4
e. 5



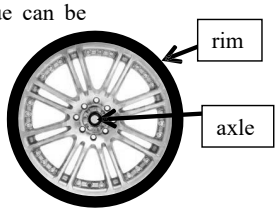
5. Two blocks are placed on top of each other. Block m_2 is pulled to the right by force F while m_1 is held in place by a rope. All surfaces are rough. Which of the free body diagrams below best describes the forces acting <u>on block m_1</u>? Note: the vectors are **not** drawn to scale; they merely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





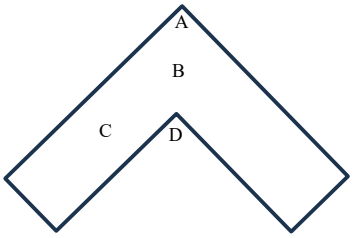
6. A force with a given magnitude is to be applied to a wheel. The torque can be maximized by

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.



7. A V-shaped block of uniform density is suspended freely from the point marked A. When the block is given a push it swings for a short time and comes to rest as shown here. Which point best shows the location of the centre-of-mass of this block?

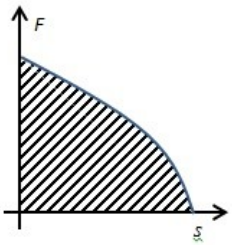
a. A
b. B
c. C
d. D
e. Cannot be determined without more information



8 As a block is pushed by someone down a rough incline;

a. only friction does negative work on the block.
b. only gravity does negative work on the block.
c. only 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.

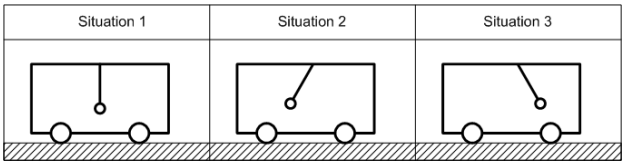
9. A changing force is exerted on an object as the object moves a distance *s*. The force is at all times in the same direction as the motion. The graph of this force as it changes with *s* is shown. The area of this graph is:



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.

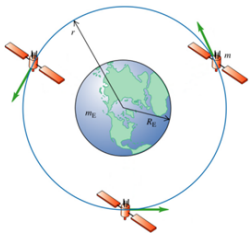
10 A car travelling at 30 km/h has kinetic energy K. If it reverses direction and speeds up to 60 km/h, what will be its kinetic energy?
a. K
b. 2K
c. 4K
d. -K
e. -4K

11. 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).



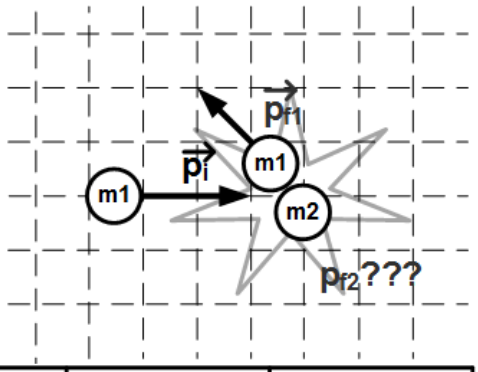
a. In situation 2, the train car is moving to the right at constant speed.
b. In situation 1, the car may be moving at constant speed to the left or to the right, we cannot tell which.
c. In situation 3, the car is moving to the left at constant speed
d. In situation 3, the car is moving to the right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

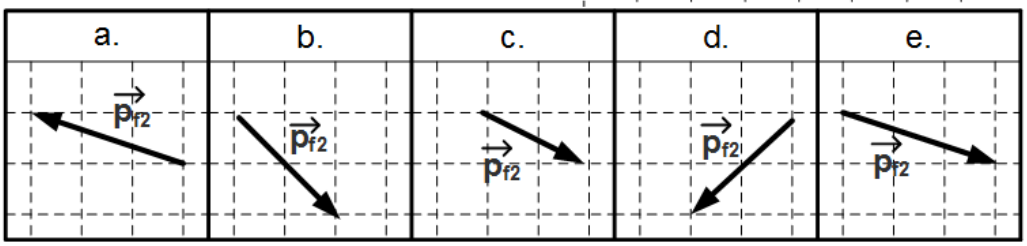
12. The value of *g* (acceleration due to Earth's gravity) at the height of the International Space Station's orbit (above the Earth's atmosphere) is
a. 9.81 m/s^2.
b. less than 9.81 m/s^2.
c. greater than 9.81 m/s^2.
d. exactly zero.
e. We cannot tell without numbers



13 A solid cylinder and a hollow cylinder, both with the same mass and radius, roll down an inclined plane without slipping, starting from rest at the same height. Which cylinder reaches the bottom first?
a. The solid cylinder
b. The hollow cylinder
c. Both cylinders arrive at the bottom at the same time
d. The answer depends on the ratio of masses for the two cylinders
e. If the cylinders cannot slip, they cannot roll.

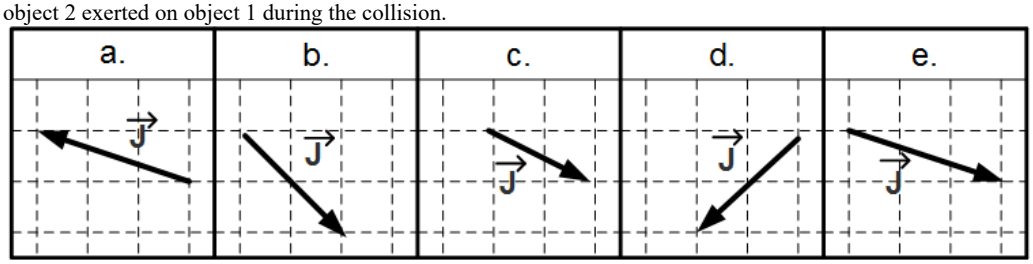
14. This picture shows an object, m1, colliding with m2, an object of equal mass that was initially at rest. The arrows illustrate the initial and final momenta of m1. Choose the vector that best represents the final momentum of m2.





15. Choose the term that best describes the collision in Question 14:
a. An elastic collision
b. A completely elastic collision
c. An explosion
d. A completely inelastic collision
e. An inelastic collision

16. Consider once more the collision in Question 14. Choose the vector that best represents the impulse $\vec{J}$ that object 2 exerted on object 1 during the collision.



PART B : PROBLEMS

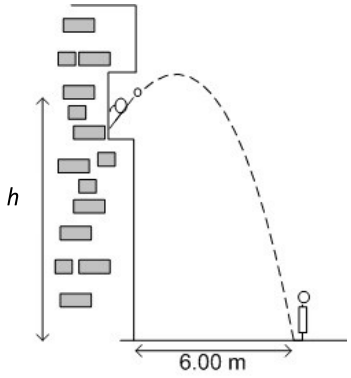
PROBLEM-1

A ball is moving with a velocity $v_0 = (2.50t - 5.00j)\frac{m}{s}$. 4.00 seconds later it has a velocity $v = (-5.00t)\frac{m}{s}$. If the acceleration is constant,

a) What is the acceleration of the object? Give an answer in polar notation. [2]
b) Sketch a vector diagram to illustrate the relationship between the initial velocity, the final velocity and the average acceleration. [1]
c) What is the displacement of the object during the four second interval? Give an answer in component form. [2]
d) Sketch the position-time graph in the x- and in the y-direction. [1]

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 velocity 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. How many revolutions does the tub turn through in these last 12.0s? [2]

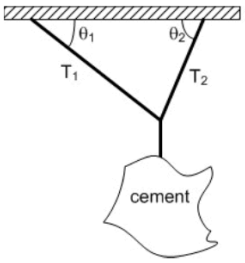
d. The tub of the washer has a radius of 20.0 cm. For a point on the edge of the tub at the instant **immediately before** you open the lid of the machine determine:

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

ii. The magnitude of the tangential acceleration [1]

Commented [ZS2]: Why is this bolded? Is it to indicate this is asking for the vector and only the magnitude? I'd lean toward asking for the magnitude of the total acceleration instead

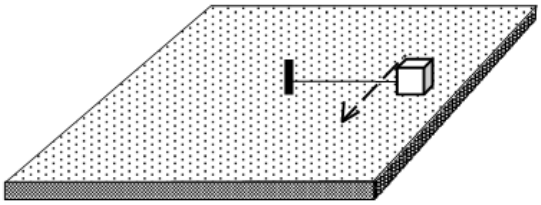
PROBLEM-4



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

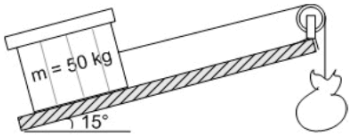


A 0.350 kg block is attached by a string to a post in the centre of a horizontal frictionless air table. The block revolves around the post with a constant speed of 5.00 m/s and takes 1.20 s for each rotation.

a. Draw a fully labelled free body diagram of the block as it revolves. [2]
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-6

At your warehouse job, 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 $I = 10.0\ \text{kg}\cdot\text{m}^2$ 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.

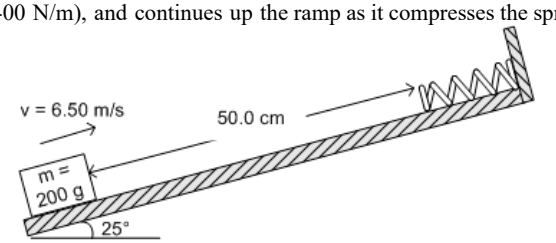


However, your boss is worried that the acceleration of the package will make it too difficult to handle at the top of the ramp and tells you to calculate the acceleration of the package. Running some tests you determine that the coefficient of kinetic friction between the package and the ramp is $\mu_k = 0.510$

a) What will be the acceleration of the package up the ramp? [7]
b) What is the magnitude of the instantaneous power exerted by the tension in the rope attached to the counterweight one second after the system has been released from rest? [2]

PROBLEM 7

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 until it comes to a stop.

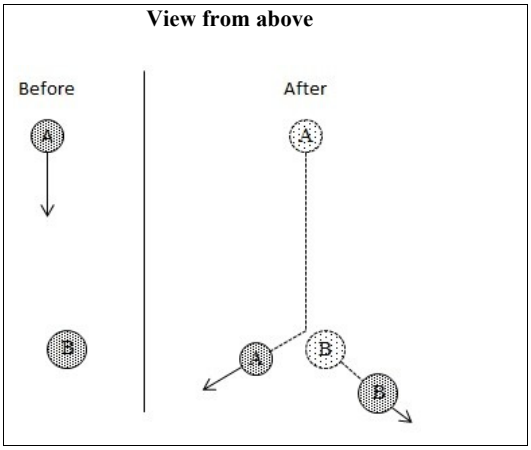


What is the maximum compression of the spring? [8]

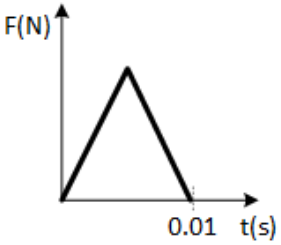
PROBLEM-8

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 in polar form (magnitude and direction) of the puck B after the collision? [6]

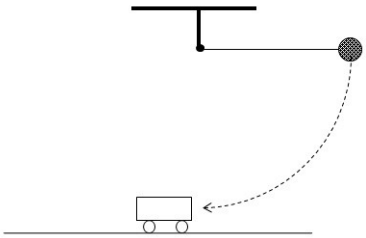


b. The pucks were in contact for a period of 0.010 s, with a changing force between them that can be represented with the simplified graph below. Using this graph, what was the maximum force between them during the collision? [2]



PROBLEM-9

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-10

A small playground merry-go-round has a radius of 170 cm and a mass of 173 kg. The merry-go-round can be modeled as a disk rotating around a vertical axis through its centre, and the Moment of Inertia is $I = 1/2\ MR^2$. A 25 kg child pushes the merry-go-round and gets it rotating at 10.0 rev/min. The child is facing the axle as the merry-go-round keeps rotating and the child suddenly hops vertically onto it.

Commented [ZS3]: Hops up onto it?

a) What is the new angular speed, in SI units, of this merry-go-round with the child now on the edge? [3]
b) By how much does the kinetic energy of the system change when the child hops onto the marry-go-round? [2]