

The exam is worth 100 points. Some of the equations are given below.

1 dimensional kinematic Equations:

$$v = v_0 + at$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$x = x_0 + v_0t + \frac{1}{2}at^2$$

$$x = x_0 + \frac{1}{2}(v + v_0)t$$

Projectile Motion

$$v_{0x} = v_0 \cos \theta$$

$$v_y = v_{0y} + a_y t$$

$$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$$

$$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$y = y_0 + \frac{1}{2}(v_y + v_{0y})t$$

$$v_{0y} = v_0 \sin \theta$$

$$v_x = v_{0x}$$

$$x = x_0 + v_{0x}t$$

Newtons Law

$$\Sigma F_x = ma_x$$

$$\Sigma F_y = ma_y$$

The multiple choice questions are 3 points each. (24 points)

1. The work done by a gravity on a moving mass is
 - a) Always zero
 - b) Never zero.
 - c) Always positive
 - d) None of the above..

2. Which of the following is true of an object moving in the x direction?
 - a) For zero acceleration, the X vs t graph is a straight line with non-zero slope.
 - b) For a constant acceleration, the X vs t graph is a horizontal line.
 - c) For a zero acceleration, the V vs t graph is a straight line with non zero slope.
 - d) For a constant acceleration the V vs t graph is a straight line of zero slope.

3. What are the dimensions of Kinetic Energy?
 - a) $\text{kg} \cdot \text{m}^2/\text{s}^2$
 - b) $\text{M L}/\text{T}^2$
 - c) $\text{M L}^2/\text{T}^2$
 - d) None of the above

4. An object is thrown at an angle of +30 degrees from the top of the building. Which of the following is true?
 - a) The velocity of the object at the top most point of the trajectory is zero.
 - b) The y component of the velocity of the object increases on its way up.
 - c) The x component of the velocity of the object decreases on its way up.
 - d) The X vs t for this object is a straight line of non-zero slope.

5. Which of the following is an impossible situation?
- a) A body having velocity east and acceleration west
 - b) A body having velocity west and acceleration west.
 - c) A body having a constant acceleration and variable velocity.
 - d) A body having a constant velocity and variable acceleration
6. When you add two vectors, which of the following is true?
- a) The magnitude of the resultant is always equal to the sum of the magnitudes of the individual vectors.
 - b) The magnitude of the resultant is always less than the magnitude of the individual vectors.
 - c) The magnitude of the resultant is more than or equal to the algebraic sum of the magnitudes of the individual vectors.
 - d) The magnitude of the resultant is always less than the algebraic sum of the magnitudes of the individual vectors.
7. A river is flowing east. A boat is trying to cross it from south to north straight across the river. The captain has to point the ship
- a) East b) West c) some degrees North-west d) Some degrees north east.
8. An elevator is on its way down and slowing down. Which of the following is true?
- a) The acceleration is positive and velocity is positive.
 - b) The acceleration is positive and speed is positive.
 - d) The velocity is positive and the acceleration is negative
 - e) The velocity is negative and the acceleration is positive.

Problem # 1.

A motorist drives along a straight road at a constant speed of 15.0 m/s. A parked motorcycle police officer notices her speeding. He begins to move with an acceleration of 2.00 m/s^2 one second after the motorist passes him and catches up with her.

a) How long does the police officer travel for before reaching the motorist? How long has the motorist traveled for when the police officer catches up with her? (6)

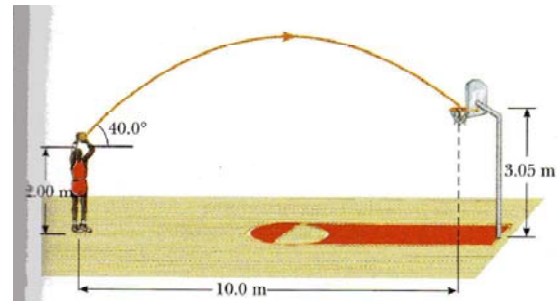
b) Find the speed and displacement of the officer when he reaches the motorist. (6)

c) Draw the velocity time graph of the motorist and the police officer in the same graph. (4)

c) Draw the distance -time graph of the motorist and the police officer in the same graph. (6)

Problem # 2

a) A basketball player who is 2.00 m tall is standing on the floor 10.0 m from the basket as shown in the figure. If he shoots the ball at 40.0° angle with the horizontal, at what initial speed must he throw so that it goes through the hoop without striking the backboard. The basket height is 3.05 m. (8)

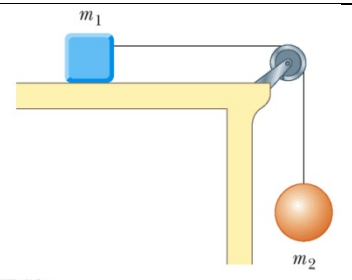


b) What is the maximum height attained by the ball? What is its velocity at maximum height?(6)

Problem # 3

In the figure shown, m_1 weighs 100 N and m_2 weighs 60 N. The coefficients of friction are $\mu_s = 0.4$ and $\mu_k = 0.25$. Find the acceleration of the system.

a) Draw the free body diagram of m_1 & m_2 . (4)



b) Find the acceleration of the system. Make sure to show the coordinate axes you choose for each object. (10)

c) How much weight should be added to so that the system does not move at all? (8)

In the figure shown, m_1 is being pulled with a force F so that m_2 does not move. m_1 lies on a frictionless surface.

1. Draw the free body diagram of m_1 & m_2 . (10) *(Make sure to label all forces. If a force acts between two objects, index (subscript) it with two indices for instance N_{21} is the force acting on m_2 due to m_1 . For each force explain (in words) which object feels the force and which object exerts the force)*
2. Identify the action and reaction pairs that are present in these two free body diagrams *(only)*. (4)

