PART A: MULTIPLE CHOICE (10 MARKS)

Choose the best response in each case and place your answer in the appropriate space on your answer sheet.

1. Which of the following is an energy unit?
   (a) joule (b) joule/second
   (c) watt (d) newton-second

2. You are trying to drag an object 5.0 m along a straight path. You are pulling with a force of 40 N along a rope that is inclined 30° to the horizontal. How much work do you do?
   (a) 0 J (b) 100 J
   (c) 173 J (d) 200 J

3. A body moves in a circle at constant speed. The work done by the centripetal force on this body is zero, because:
   (a) the centripetal force on the body and the direction of its motion are perpendicular at every instant.
   (b) the net displacement of the body after each revolution is zero.
   (c) the average force on the body over each revolution is zero.
   (d) the magnitude of the acceleration of the body is zero.

4. Which object below has the least kinetic energy?
   (a) A 2 kg object moving at 30 m/s.
   (b) A 10 kg object moving at 20 m/s.
   (c) A 100 kg object moving at 3 m/s.
   (d) A 500 kg object moving at 1 m/s.

5. In which of the following examples is gravitational potential energy being transformed into kinetic energy?
   (a) A stone thrown up into the air.
   (b) A body falling freely.
   (c) A car accelerating on a level road.
   (d) A student climbing a set of stairs.

6. Which object below has the greatest potential energy relative to the base level indicated?
   (a) A 100 kg object 1.0 m above base level.
   (b) A 5 kg object 15 m above base level.
   (c) A 50 kg object 3 m above base level.
   (d) A 8 kg object 12 m above base level.

7. A ball is dropped from a certain height onto a concrete sidewalk. When it bounces up again it does not quite reach the height from which it was dropped because:
   (a) momentum is not conserved.
   (b) some of the ball's energy is converted to heat energy.
   (c) the force of gravity slows down the ball.
   (d) the general law of conservation of energy is only approximately true.

8. The engine of a rocket exerts a constant force F (N) upward on a rocket of mass m (kg) for a vertical distance of d (m), giving the rocket a velocity of v (m/s) upward. Which of the following expressions summarizes the total work done on the rocket? (Assume g is constant.)
   (a) $Fd = mgd$
   (b) $Fd = \frac{1}{2}mv^2$
   (c) $Fd = \frac{1}{2}mv^2 - mgd$
   (d) $Fd = \frac{1}{2}mv^2 + mgd$

9. A crossbow archer wants to shoot an arrow of mass 0.02 kg to a vertical height of 25 m. The force constant "k" of the bow is 50 N/m. Assuming "k" remains constant, how far must the string in the bow be drawn back?
   (a) 0.28 m (b) 0.40 m
   (c) 0.44 m (d) 0.63 m

10. Consider the following situation: cart X makes a slow elastic collision with cart Y which is at rest. If the masses of the two carts are equal then which of the following statements is not correct?
    (a) Some kinetic energy disappears temporarily during the collision.
    (b) Cart X and Y have the same velocity at minimum separation.
    (c) The kinetic energy, which disappears during the collision, is stored as potential energy.
    (d) The total momentum before the collision is greater than the momentum after the collision.

PART B: MATCH (5 MARKS)

Match the definition from the 1st column to the best term in the 2nd column and place the matching letter in the appropriate space on your answer sheet.

1. Law which states that the applied force is directly proportional to the amount of extension or compression of a spring.
2. Material that does not return precisely to its original form after the applied force is removed.
3. Form of energy that accumulates when an elastic object is bent, stretched, or compressed.
4. Force that does work on an object in such a way that the amount of work done is dependent on the path taken.
5. Form of energy possessed by an object due to its motion.

A) conservative force
B) elastic potential energy
C) gravitational potential energy
D) Hooke's law
E) kinetic energy
F) non-conservative force
G) plastic
H) restoring force
I) spring constant
J) work

PART A: MULTIPLE CHOICE (10 MARKS)

1	2	3	4	5	6	7	8	9	10

PART B: MATCH (5 MARKS)

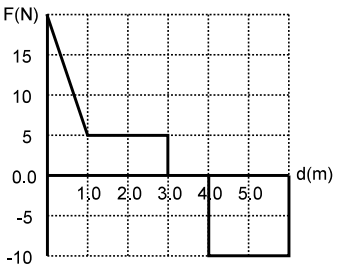
1	2	3	4	5

PART C: SHORT ANSWER (15 MARKS)

Answer the following questions in the space provided.

{6} 1. Calculate the amount of work done by the appropriate agent in each of the following:
(a) A 20 N force accelerates a block from rest to 12 m/s in a time of 2.5 s.
(b) A 12 kg crate is lifted from the floor to a platform 3.0 m above floor level.
(c) A 5.0 kg hammer drives a stake 4.2 m into the ground.

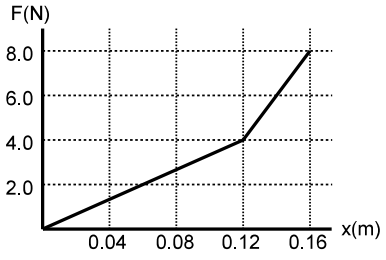
{9} 2. A 5.0 kg block is pushed from rest along a frictionless surface with a horizontal force given by the graph below.
(a) How much work is done in moving the block the first 3.0 m?
(b) What is the block's kinetic energy after it has moved 6.0 m?
(c) What is the block's velocity at the 6.0 m mark?



PART D: PROBLEMS (35 MARKS)

Answer the following questions on a separate sheet of paper. You may use the back of this sheet if you wish.

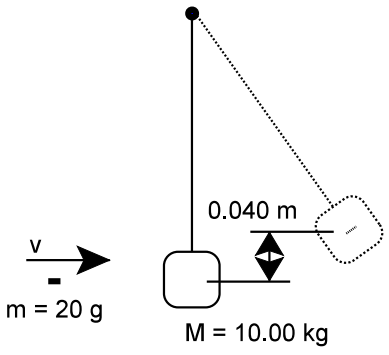
1. The force-deformation graph for a non-Hooke's Law spring is shown to the right.



{3} (a) How much work must be done to compress the spring 0.16 m?
{2} (b) How much potential energy is stored in the spring at this compression?
{3} (c) What speed would a 1.0 kg mass acquire if it were placed next to this compressed spring, an a smooth, horizontal surface, and then released?

2. A 4.0 kg cart moving at 5.0 m/s[R] collides head-on with a 2.0 kg cart moving at 4.0 m/s[L]. Their collision is cushioned by a linear elastic spring between them.
{4} (a) What is the total energy of the system before the collision?
{3} (b) At minimum separation, what is the velocity of each cart? (Hint: @ min. sep. $v_1' = v_2' = v_{min}$)
{3} (c) Calculate the total kinetic energy at minimum separation.
{4} (d) If the force constant of the spring is 900 N/m, what is its maximum compression during the collision?

3. A bullet's speed may be determined by firing it into a sandbag pendulum, and measuring the vertical height to which the pendulum rises, as shown. (The bullet stays in the sandbag.)



{3} (a) What is the change in gravitational potential energy of the sandbag and bullet during the swing?
{4} (b) What is the velocity of the sandbag-bullet combination at the start of the swing?
{4} (c) What is the original velocity of the bullet?
{2} (d) Explain why the collision between the bullet and the sandbag is inelastic?