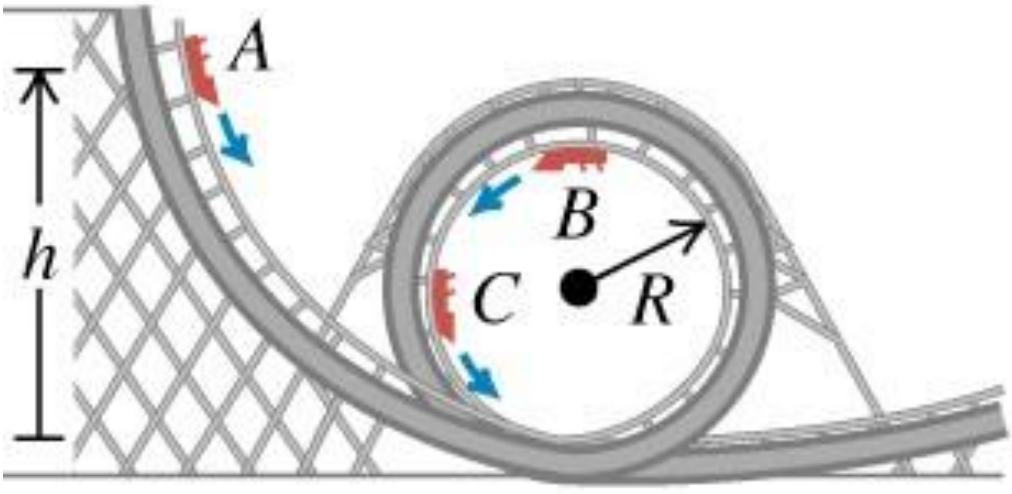
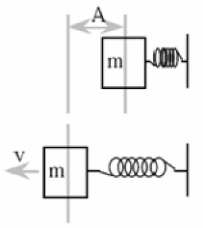
Chapter 4

Work, Power and Energy



AP Physics Multiple Choice Practice – Work-Energy

1. A mass m attached to a horizontal massless spring with spring constant k, is set into simple harmonic motion. Its maximum displacement from its equilibrium position is A. What is the masses speed as it passes through its equilibrium position?



$(A)\ 0 \quad (B)\ A\sqrt{\frac{k}{m}} \quad (C)\ A\sqrt{\frac{m}{k}} \quad (D)\ \frac{1}{A}\sqrt{\frac{k}{m}}$

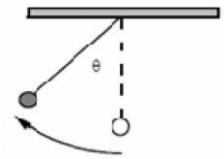
2. A force F at an angle θ above the horizontal is used to pull a heavy suitcase of weight mg a distance d along a level floor at constant velocity. The coefficient of friction between the floor and the suitcase is μ. The work done by the frictional force is:

   (A) Fd cos θ (B) μ Fd cos θ (C) μmgd (D) μ mgd cos θ

3. A 2 kg ball is attached to a 0.80 m string and whirled in a horizontal circle at a constant speed of 6 m/s. The work done on the ball during each revolution is:

   (A) 90 J (B) 72 J (D) 16 J (D) zero

4. A pendulum bob of mass m on a cord of length L is pulled sideways until the cord makes an angle θ with the vertical as shown in the figure to the right. The change in potential energy of the bob during the displacement is:

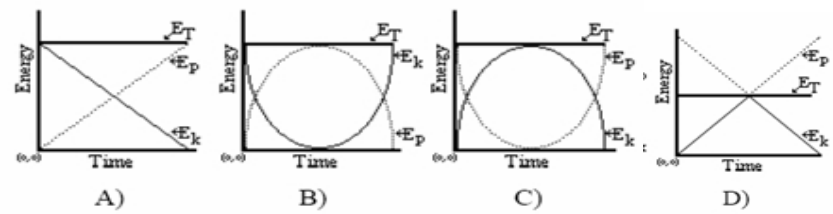


   (A) mgL (1–cos θ) (B) mgL (1–sin θ) (C) mgL sin θ (D) mgL cos θ

5. A softball player catches a ball of mass m, which is moving towards her with horizontal speed V. While bringing the ball to rest, her hand moved back a distance d. Assuming constant deceleration, the horizontal force exerted on the ball by the hand is

   (A) $mV^2/(2d)$ (B) mV^2/d (C) 2mV/d (D) mV/d

6. A pendulum is pulled to one side and released. It swings freely to the opposite side and stops. Which of the following might best represent graphs of kinetic energy (E_k), potential energy (E_p) and total mechanical energy (E_T)



Questions 7-8: A car of mass m slides across a patch of ice at a speed v with its brakes locked. It the hits dry pavement and skids to a stop in a distance d. The coefficient of kinetic friction between the tires and the dry road is μ.

7. If the car has a mass of 2m, it would have skidded a distance of
   (A) 0.5 d (B) d (C) 1.41 d (D) 2 d

8. If the car has a speed of 2v, it would have skidded a distance of
   (A) d (B) 1.41 d (C) 2 d (D) 4 d

9. A ball is thrown vertically upwards with a velocity v and an initial kinetic energy E_k. When half way to the top of its flight, it has a velocity and kinetic energy respectively of

(A) $\frac{v}{2}, \frac{E_k}{2}$ (B) $\frac{v}{\sqrt{2}}, \frac{E_k}{2}$ (C) $\frac{v}{4}, \frac{E_k}{2}$ (D) $\frac{v}{2}, \frac{E_k}{\sqrt{2}}$

10. A football is kicked off the ground a distance of 50 yards downfield. Neglecting air resistance, which of the following statements would be INCORRECT when the football reaches the highest point?

(A) all of the balls original kinetic energy has been changed into potential energy
(B) the ball's horizontal velocity is the same as when it left the kickers foot
(C) the ball will have been in the air one-half of its total flight time
(D) the vertical component of the velocity is equal to zero

11. A mass m is attached to a spring with a spring constant k. If the mass is set into motion by a displacement d from its equilibrium position, what would be the speed, v, of the mass when it returns to equilibrium position?

(A) $v = \sqrt{\frac{kd}{m}}$ (B) $v = d\sqrt{\frac{k}{m}}$ (C) $v = \frac{kd}{mg}$ (D) $v^2 = \frac{mgd}{k}$

12. A fan blows the air and gives it kinetic energy. An hour after the fan has been turned off, what has happened to the kinetic energy of the air?
(A) it disappears (B) it turns into potential energy (C) it turns into thermal energy
(D) it turns into sound energy

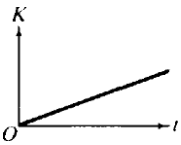
13. A rock is dropped from the top of a tall tower. Half a second later another rock, twice as massive as the first, is dropped. Ignoring air resistance,

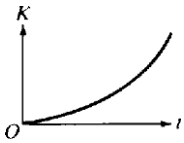
(A) the distance between the rocks increases while both are falling.
(B) the acceleration is greater for the more massive rock.
(C) they strike the ground more than half a second apart.
(D) they strike the ground with the same kinetic energy.

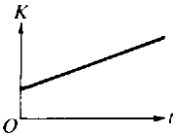
14. Which of the following is true for a system consisting of a mass oscillating on the end of an ideal spring?

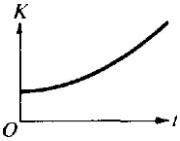
(A) The kinetic and potential energies are equal to each other at all times.
(B) The maximum potential energy is achieved when the mass passes through its equilibrium position.
(C) The maximum kinetic energy and maximum potential energy are equal, but occur at different times.
(D) The maximum kinetic energy occurs at maximum displacement of the mass from its equilibrium position

15. From the top of a high cliff, a ball is thrown horizontally with initial speed v_o. Which of the following graphs best represents the ball's kinetic energy K as a function of time t ?

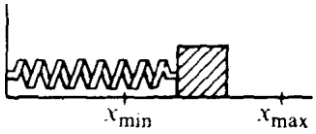
(A) 

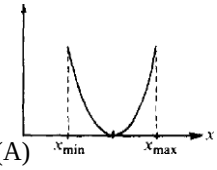
(B) 

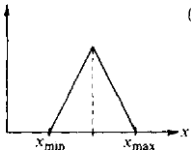
(C) 

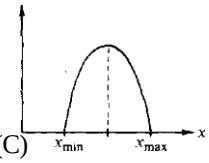
(D) 

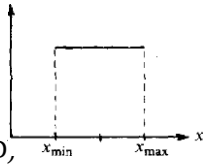
Questions 16-17: A block oscillates without friction on the end of a spring as shown. The minimum and maximum lengths of the spring as it oscillates are, respectively, x_{min} and x_{max}. The graphs below can represent quantities associated with the oscillation as functions of the length x of the spring.



(A) 

(B) 

(C) 

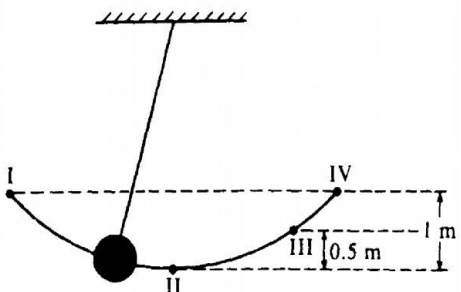
(D) 

16. Which graph can represent the total mechanical energy of the block-spring system as a function of x
(A) A (B) B (C) C (D) D

17. Which graph can represent the kinetic energy of the block as a function of x ?
(A) A (B) B (C) C (D) D

Questions 18-19

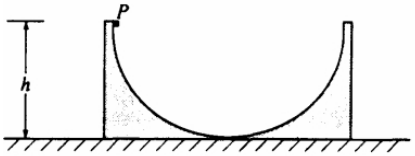
A ball swings freely back and forth in an arc from point I to point IV, as shown. Point II is the lowest point in the path, III is located 0.5 meter above II, and IV is I meter above II. Air resistance is negligible.



18. If the potential energy is zero at point II, where will the kinetic and potential energies of the ball be equal?
(A) At point II (B) At some point between II and III
(C) At point III (D) At some point between III and IV

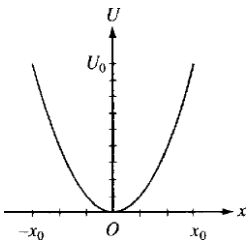
19. The speed of the ball at point II is most nearly
(A) 3.0 m/s (B) 4.5 m/s (C) 9.8 m/s (D) 14 m/s

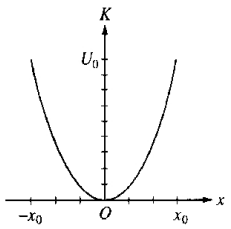
20. The figure shows a rough semicircular track whose ends are at a vertical height h. A block placed at point P at one end of the track is released from rest and slides past the bottom of the track. Which of the following is true of the height to which the block rises on the other side of the track?

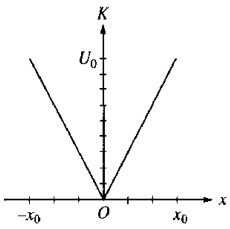


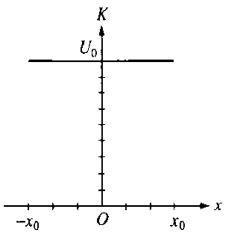
(A) It is equal to h/4
(B) It is equal to h/2
(C) It is equal to h
(D) It is between zero and h; the exact height depends on how much energy is lost to friction.

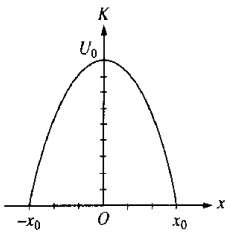
21. The graph shown represents the potential energy *U* as a function of displacement *x* for an object on the end of a spring moving back and forth with amplitude x_0. Which of the following graphs represents the kinetic energy *K* of the object as a function of displacement *x* ?



(A)


(B)


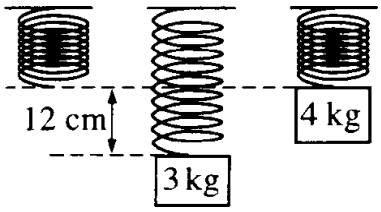
(C)


(D)


22. A child pushes horizontally on a box of mass *m* which moves with constant speed *v* across a horizontal floor. The coefficient of friction between the box and the floor is μ. At what rate does the child do work on the box?

(A) μmgv (B) mgv (C) $\mu mg/v$ (D) $\mu mg/v$

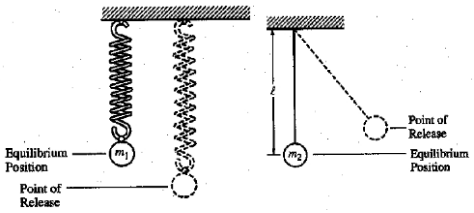
23. A block of mass 3.0 kg is hung from a spring, causing it to stretch 12 cm at equilibrium, as shown. The 3.0 kg block is then replaced by a 4.0 kg block, and the new block is released from the position shown, at which the spring is unstretched. How far will the 4.0 kg block fall before its direction is reversed?



(A) 18 cm (B) 24 cm
(C) 32 cm (D) 48 cm

24. What is the kinetic energy of a satellite of mass m that orbits the Earth, of mass M, in a circular orbit of radius R?

(A) $\frac{1}{2}\frac{GMm}{R}$ (B) $\frac{1}{4}\frac{GMm}{R}$ (C) $\frac{1}{2}\frac{GMm}{R^2}$ (D) $\frac{GMm}{R^2}$



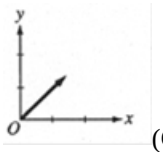
25. A sphere of mass m_1, which is attached to a spring, is displaced downward from its equilibrium position as shown above left and released from rest. A sphere of mass m_2, which is suspended from a string of length L, is displaced to the right as shown above right and released from rest so that it swings as a simple pendulum with small amplitude. Assume that both spheres undergo simple harmonic motion Which of the following is true for both spheres?
(A) The maximum kinetic energy is attained as the sphere passes through its equilibrium position.
(B) The minimum gravitational potential energy is attained as the sphere passes through its equilibrium position.
(C) The maximum gravitational potential energy is attained when the sphere reaches its point of release.
(D) The maximum total energy is attained only as the sphere passes through its equilibrium position.

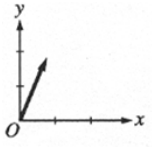
Questions 26-27

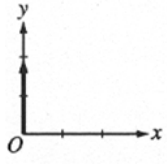
An object of mass m is initially at rest and free to move without friction in any direction in the xy-plane. A constant net force of magnitude F directed in the +x direction acts on the object for 1 s. Immediately thereafter a constant net force of the same magnitude F directed in the +y direction acts on the object for 1 s. After this, no forces act on the object.

26. Which of the following vectors could represent the velocity of the object at the end of 3 s, assuming the scales on the x and y axes are equal?

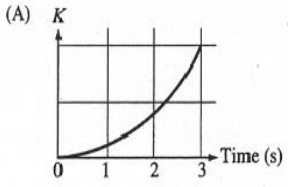
(A) 

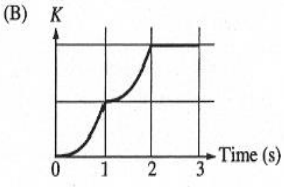
(B) 

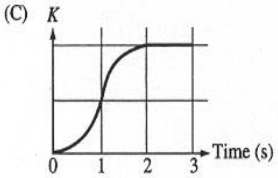
(C) 

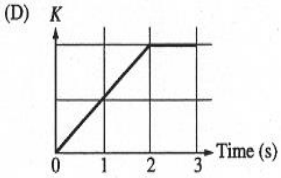
(D) 

27. Which of the following graphs best represents the kinetic energy K of the object as a function of time?

(A) 

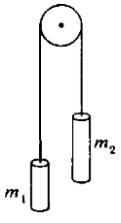
(B) 

(C) 

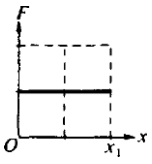
(D) 

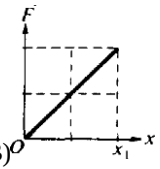
28. A system consists of two objects having masses m_l and m_2 ($m_l < m_2$). The objects are connected by a massless string, hung over a pulley as shown, and then released. When the object of mass m_2 has descended a distance h, the potential energy of the system has decreased by

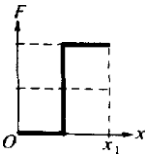
(A) $(m_2 - m_l)gh$ (B) m_2gh (C) $(m_1 + m_2)gh$ (D) $\frac{1}{2}(m_l + m_2)gh$

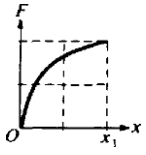


29. The following graphs, all drawn to the same scale, represent the net force F as a function of displacement x for an object that moves along a straight line. Which graph represents the force that will cause the greatest change in the kinetic energy of the object from x = 0 to x = x_1?

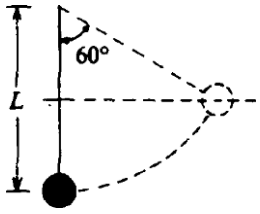
a) 

(B) 

(C) 

(D) 

30. A pendulum consists of a ball of mass m suspended at the end of a massless cord of length L as shown. The pendulum is drawn aside through an angle of 60° with the vertical and released. At the low point of its swing, the speed of the pendulum ball is

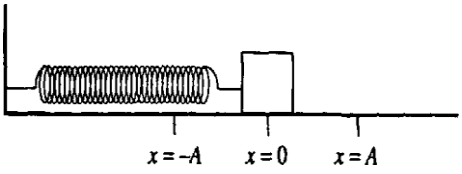


(A) $\sqrt{gL}$ (B) $\sqrt{2gL}$ (C) ½gL (D) gL

31. A rock is lifted for a certain time by a force F that is greater in magnitude than the rock's weight W. The change in kinetic energy of the rock during this time is equal to the

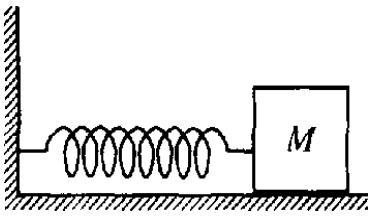
(A) work done by the net force (F - W)
b) work done by F alone
c) work done by W alone
d) difference in the potential energy of the rock before and after this time.

32. A block on a horizontal frictionless plane is attached to a spring, as shown. The block oscillates along the x-axis with amplitude A. Which of the following statements about energy is correct?



(A) The potential energy of the spring is at a minimum at x = 0.
(B) The potential energy of the spring is at a minimum at x = A.
(C) The kinetic energy of the block is at a minimum at x =0.

33. The kinetic energy of the block is at a maximum at x = AAn ideal massless spring is fixed to the wall at one end, as shown. A block of mass M attached to the other end of the spring oscillates with amplitude A on a frictionless, horizontal surface. The maximum speed of the block is v_m. The force constant of the spring is

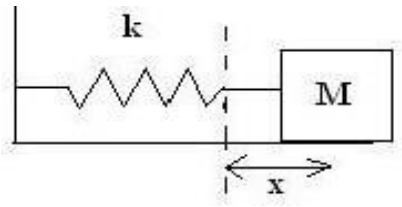


(A) $\frac{MgVm}{2A}$ (B) $\frac{MVm^2}{2A}$ (C) $\frac{MVm^2}{A^2}$ (D) $\frac{MVm^2}{2A^2}$

34. A person pushes a block of mass M = 6.0 kg with a constant speed of 5.0 m/s straight up a flat surface inclined 30.0° above the horizontal. The coefficient of kinetic friction between the block and the surface is $\mu = 0.40$. What is the net force acting on the block?

(A) 0 N (B) 21 N (C) 30 N (D) 51 N

35. A block of mass *M* on a horizontal surface is connected to the end of a massless spring of spring constant *k* . The block is pulled a distance *x* from equilibrium and when released from rest, the block moves toward equilibrium. What coefficient of kinetic friction between the surface and the block would allow the block to return to equilibrium and stop?



(A) $\frac{kx^2}{2Mg}$ (B) $\frac{kx}{Mg}$ (C) $\frac{kx}{2Mg}$ (D) $\frac{Mg}{2kx}$

36. An object is projected vertically upward from ground level. It rises to a maximum height H. If air resistance is negligible, which of the following must be true for the object when it is at a height H/2 ?

(A) Its speed is half of its initial speed.
(B) Its kinetic energy is half of its initial kinetic energy.
(C) Its potential energy is half of its initial potential energy.
(D) Its total mechanical energy is half of its initial value.