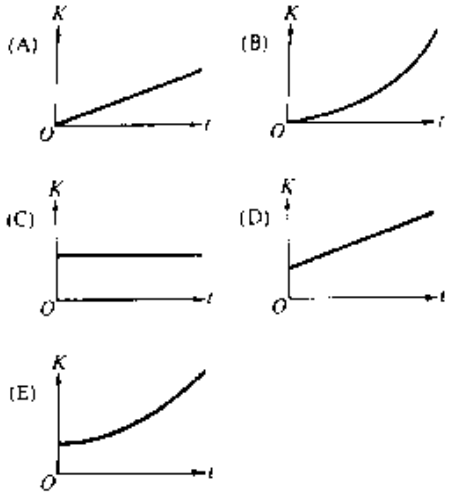
Work, Energy & Power

1. From the top of a high cliff, a ball is thrown horizontally with initial speed v_0. Which of the following graphs best represents the ball's kinetic energy ***K*** as a function of time *t*?



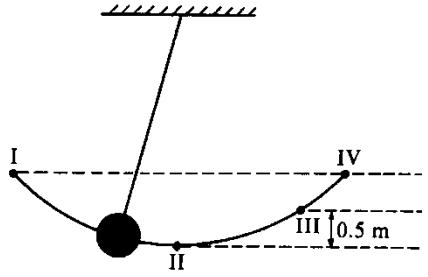
2. A person pushes a box across a horizontal surface at a constant speed of 0.5 meter per second. The box has a mass of 40 kilograms, and the coefficient of sliding friction is 0.25. The power supplied to the box by the person is
   (A) 0.2 W
   (B) 5 W
   (C) 50 W
   (D) 100 W
   (E) 200 W

3. Which of the following quantities is a scalar that is always positive or zero?

   (A) Power
   (B) Work
   (C) Kinetic energy
   (D) Linear momentum
   (F.) Annular momentum

4. A horizontal force F is used to pull a 5-kilogran block across a floor at a constant speed of 3 meters per second. The frictional force between the block and the floor is 10 newtons. The work done by the force F in 1 minute is most nearly

   (A) 0 J
   (B) 30 J
   (C) 600 J
   (D) 1,350 J
   (E) 1,800 J

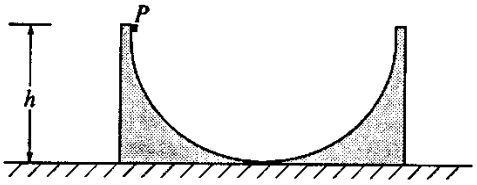


A ball swings freely back and forth in an arc from point I to point IV, as shown above. Point II is the lowest point in the path, III is located 0.5 meter above II, and IV is l meter above II. Air resistance is negligible

5. 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
   (E) At point IV

6. 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) l4 m/s
   (E) 20 m/s



7. The figure above 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?

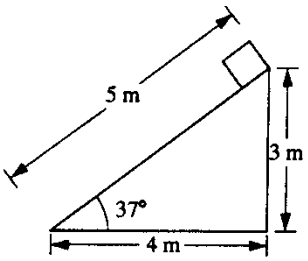
   (A) It is equal to h/2 π .
   (B) It is equal to h/4.
   (C) It is equal to h/2.
   (D) It is equal to h.
   (E) It is between zero and h; the exact height depends on how much energy is lost to friction.

8. A weight lifter lifts a mass m at constant speed to a height *h* in time *t*. What is the average power output of the weight lifter?

   (A) *mg*
   (B) *mh*
   (C) *mgh*
   (D) *mght*

(E) *mgh/t*

Questions 9



A plane 5 meters in length is inclined at an angle of 37°, as shown above. A block of weight 20 newtons is placed at the top of the plane and allowed to slide down.

9. The work done on the block by the gravitational force during the 5-meter slide down the plane is most nearly

(A) 20 J
(B) 60 J
(C) 80 J
(D) 100 J
(E) 130 J

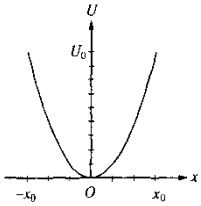
10. A student weighing 700 N climbs at constant speed to the top of an 8 m vertical rope in 10 s. The average power expended by the student to overcome gravity is most nearly

(A) 1.1 W
(B) 87.5 W
(C) 560 W
(D) 875 W
(E) 5,600 W

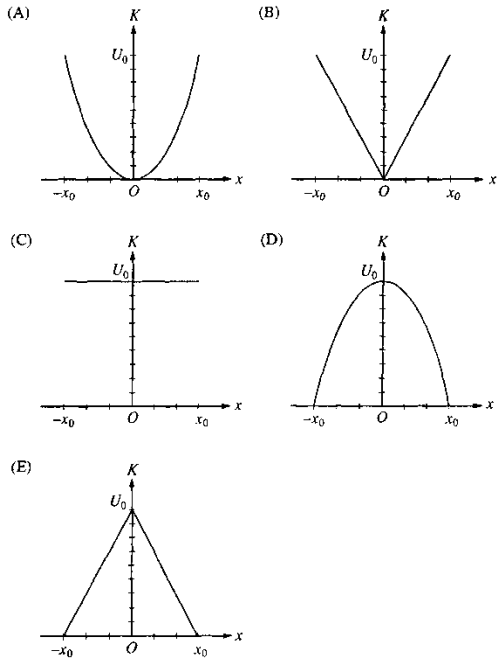
11. Units of power include which of the following?

I. Watt
II. Joule per second
III. Kilowatt-hour

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

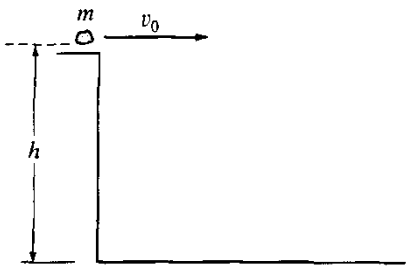


12. The graph above represents the potential energy *U* as a function of displacement *x* for an object on the end of a spring oscillating in simple harmonic motion with amplitude x_0. Which of the following graphs represents the kinetic energy **K** of the object as a function of displacement *x*?



13. A child pushes horizontally on a box of mass *m* which moves with constant speed υ 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?

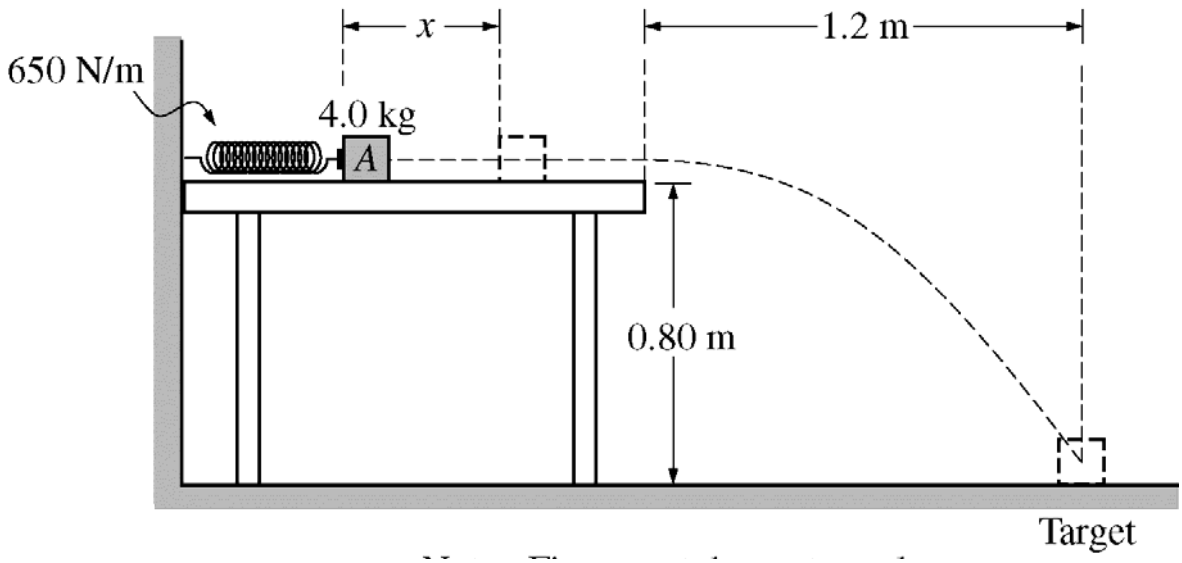
(A) μ*mg*υ
(B) *mg*υ
(C) υ/μ*mg*
(D) μ*mg*/υ
(E) μ*m*υ^2



A rock of mass *m* is thrown horizontally off a building from a height *h*, as shown above. The speed of the rock as it leaves the thrower's hand at the edge of the building is υ_0.

14. What is the kinetic energy of the rock just before it hits the ground?

(A) mgh
(B) $\frac{1}{2}m\upsilon_0^2$
(C) $\frac{1}{2}m\upsilon_0^2 - mgh$
(D) $\frac{1}{2}mv^2 + mgh$
(E) $mgh - \frac{1}{2}mv^2$



1. (15 points)

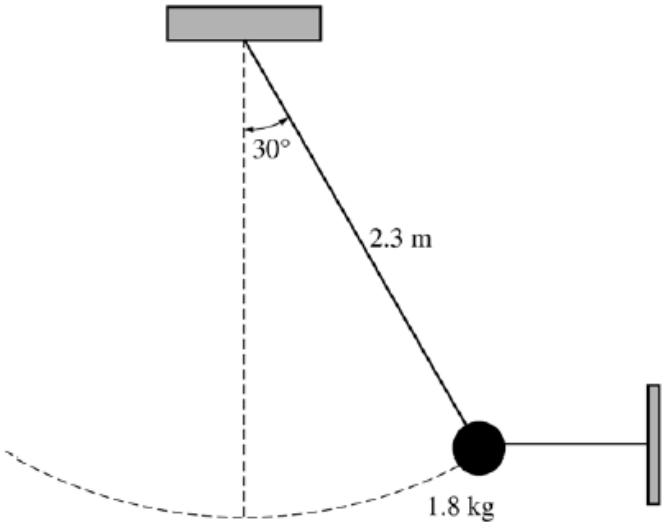
Block A of mass 4.0 kg is on a horizontal, frictionless tabletop and is placed against a spring of negligible mass and spring constant $650\ \text{N/m}$. The other end of the spring is attached to a wall. The block is pushed toward the wall until the spring has been compressed a distance x, as shown above. The block is released and follows the trajectory shown, falling 0.80 m vertically and striking a target on the floor that is a horizontal distance of 1.2 m from the edge of the table. Air resistance is negligible.

(a) Calculate the time elapsed from the instant block A leaves the table to the instant it strikes the floor.

(b) Calculate the speed of the block as it leaves the table.

(c) Calculate the distance x the spring was compressed.

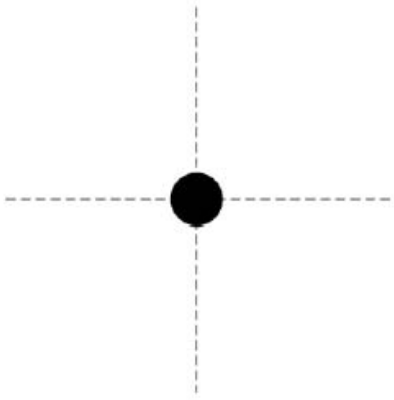
AP® PHYSICS B FREE-RESPONSE QUESTIONS



2. (10 points)

A simple pendulum consists of a bob of mass 1.8 kg attached to a string of length 2.3 m. The pendulum is held at an angle of 30° from the vertical by a light horizontal string attached to a wall, as shown above.

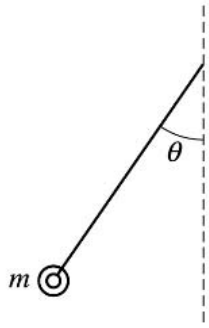
(a) On the figure below, draw a free-body diagram showing and labeling the forces on the bob in the position shown above.



(b) Calculate the tension in the horizontal string.

(c) The horizontal string is now cut close to the bob, and the pendulum swings down. Calculate the speed of the bob at its lowest position.

AP® PHYSICS B FREE-RESPONSE QUESTIONS (Form B)



1. (15 points)
An airplane accelerates uniformly from rest. A physicist passenger holds up a thin string of negligible mass to which she has tied her ring, which has a mass m. She notices that as the plane accelerates down the runway, the string makes an angle θ with the vertical as shown above.

   (a) In the space below, draw a free-body diagram of the ring, showing and labeling all the forces present.

The plane reaches a takeoff speed of 65 m/s after accelerating for a total of 30 s.

(b) Determine the minimum length of the runway needed.

(c) Determine the angle θ that the string makes with the vertical during the acceleration of the plane before it leaves the ground.

(d) What additional information would be needed in order to estimate the mechanical energy of the airplane at the instant of takeoff? Explain your answer.