CHAPTER 4 REVIEW QUESTIONS

SECTION I: MULTIPLE CHOICE

1. A force **F** of strength 20 N acts on an object of mass 3 kg as it moves a distance of 4 m. If **F** is perpendicular to the 4 m displacement, the work it does is equal to

   (A) 0 J
   (B) 60 J
   (C) 80 J
   (D) 600 J
   (E) 2400 J

2. Under the influence of a force, an object of mass 4 kg accelerates from 3 m/s to 6 m/s in 8 s. How much work was done on the object during this time?

   (A) 27 J
   (B) 54 J
   (C) 72 J
   (D) 96 J
   (E) Cannot be determined from the information given

3. A box of mass m slides down a frictionless inclined plane of length L and vertical height h. What is the change in its gravitational potential energy?

   (A) $-mgL$
   (B) $-mgh$
   (C) $-mgL/h$
   (D) $-mgh/L$
   (E) $-mghL$

4. An object of mass m is traveling at constant speed v in a circular path of radius r. How much work is done by the centripetal force during one-half of a revolution?

   (A) πmv^2
   (B) $2\pi mv^2$
   (C) 0
   (D) πmv^2r
   (E) $2\pi mv^2r$

5. While a person lifts a book of mass 2 kg from the floor to a tabletop, 1.5 m above the floor, how much work does the gravitational force do on the book?

   (A) −30 J
   (B) −15 J
   (C) 0 J
   (D) 15 J
   (E) 30 J

6. A block of mass 3.5 kg slides down a frictionless inclined plane of length 6 m that makes an angle of 30° with the horizontal. If the block is released from rest at the top of the incline, what is its speed at the bottom?

   (A) 4.9 m/s
   (B) 5.2 m/s
   (C) 6.4 m/s
   (D) 7.7 m/s
   (E) 9.1 m/s

7. A block of mass 3.5 kg slides down an inclined plane of length 6 m that makes an angle of 60° with the horizontal. The coefficient of kinetic friction between the block and the incline is 0.3. If the block is released from rest at the top of the incline, what is its speed at the bottom?

   (A) 4.9 m/s
   (B) 5.2 m/s
   (C) 6.4 m/s
   (D) 7.7 m/s
   (E) 9.2 m/s

8. As a rock of mass 4 kg drops from the edge of a 40-meter-high cliff, it experiences air resistance, whose average strength during the descent is 20 N. At what speed will the rock hit the ground?

   (A) 8 m/s
   (B) 10 m/s
   (C) 12 m/s
   (D) 16 m/s
   (E) 20 m/s

9. An astronaut drops a rock from the top of a crater on the Moon. When the rock is halfway down to the bottom of the crater, its speed is what fraction of its final impact speed?

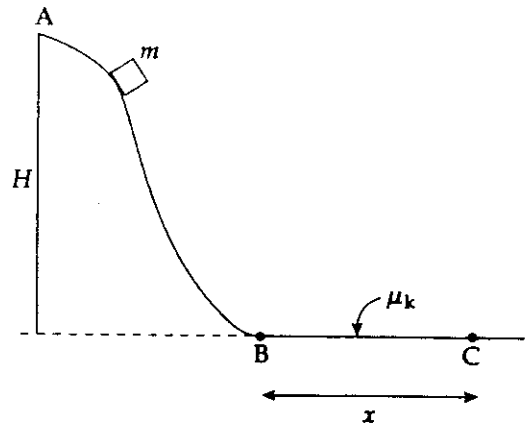
(A) $1/4\sqrt{2}$
(B) $1/4$
(C) $1/2\sqrt{2}$
(D) $1/2$
(E) $1/\sqrt{2}$

10. A force of 200 N is required to keep an object sliding at a constant speed of 2 m/s across a rough floor. How much power is being expended to maintain this motion?

(A) 50 W
(B) 100 W
(C) 200 W
(D) 400 W
(E) Cannot be determined from the information given

SECTION II: FREE RESPONSE

1. A box of mass m is released from rest at Point A, the top of a long, frictionless slide. Point A is at height H above the level of Points B and C. Although the slide is frictionless, the horizontal surface from Point B to C is not. The coefficient of kinetic friction between the box and this surface is μ_k, and the horizontal distance between Points B and C is x.



(a) Find the speed of the box when its height above Point B is $\frac{1}{2}H$.

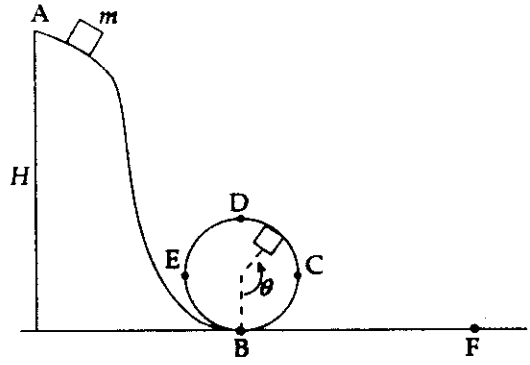
(b) Find the speed of the box when it reaches Point B.

(c) Determine the value of μ_k so that the box comes to rest at Point C.

(d) Now assume that Points B and C were not on the same horizontal level. In particular, assume that the surface from B to C had a uniform upward slope so that Point C were still at a horizontal distance of x from B but now at a vertical height of y above B. Answer the question posed in part (c).

(e) If the slide were not frictionless, determine the work done by friction as the box moved from Point A to Point B if the speed of the box as it reached Point B were half the speed calculated in part (b).

2. The diagram below shows a roller-coaster ride which contains a circular loop of radius r. A car (mass m) begins at rest from Point A and moves down the frictionless track from A to B where it then enters the vertical loop (also frictionless), traveling once around the circle from B to C to D to E and back to B, after which it travels along the flat portion of the track from B to F (which is not frictionless).



(a) Find the centripetal acceleration of the car when it is at Point C.

(b) Determine the speed of the car when its position relative to Point B is specified by the angle θ shown in the diagram.

(c) What is the minimum cut-off speed v_c that the car must have as it enters the loop at Point B to make it around the loop?

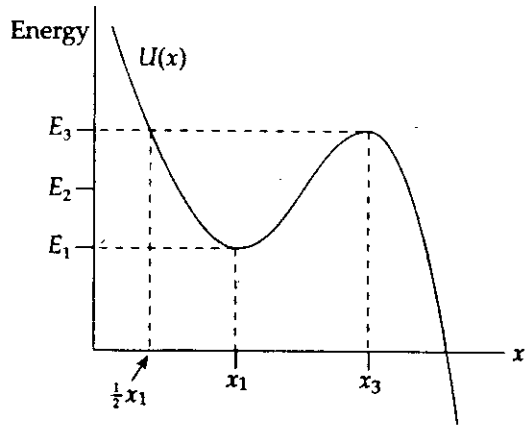
(d) What is the minimum height H necessary to ensure that the car makes it around the loop?

(e) If $H = 6r$ and the coefficient of friction between the car and the flat portion of the track from B to F is 0.5, how far along this flat portion of the track will the car travel before coming to rest at Point F?

3. [C] A particle of mass $m = 3$ kg has the potential energy function

$$U(x) = 3(x - 1) - (x - 3)^3$$

where x is measured in meters and U in joules. The following graph is a sketch of this potential energy function.



The energies indicated on the vertical axis are evenly spaced; that is, $E_3 - E_2 = E_2 - E_1$. The energy E_1 is equal to $U(x_1)$, and the energy E_3 is equal to $U(x_3)$.

(a) Determine the numerical values of x_1 and x_3.

(b) Describe the motion of the particle if its total energy is E_2.

(c) What is the particle's speed at $x = x_1$ if its total energy, E, equals 58 J?

(d) Sketch the graph of the particle's acceleration as a function of x. Be sure to indicate x_1 and x_3 on your graph.

(e) The particle is released from rest at $x = \frac{1}{2}x_1$. Find its speed as it passes through $x = x_1$.