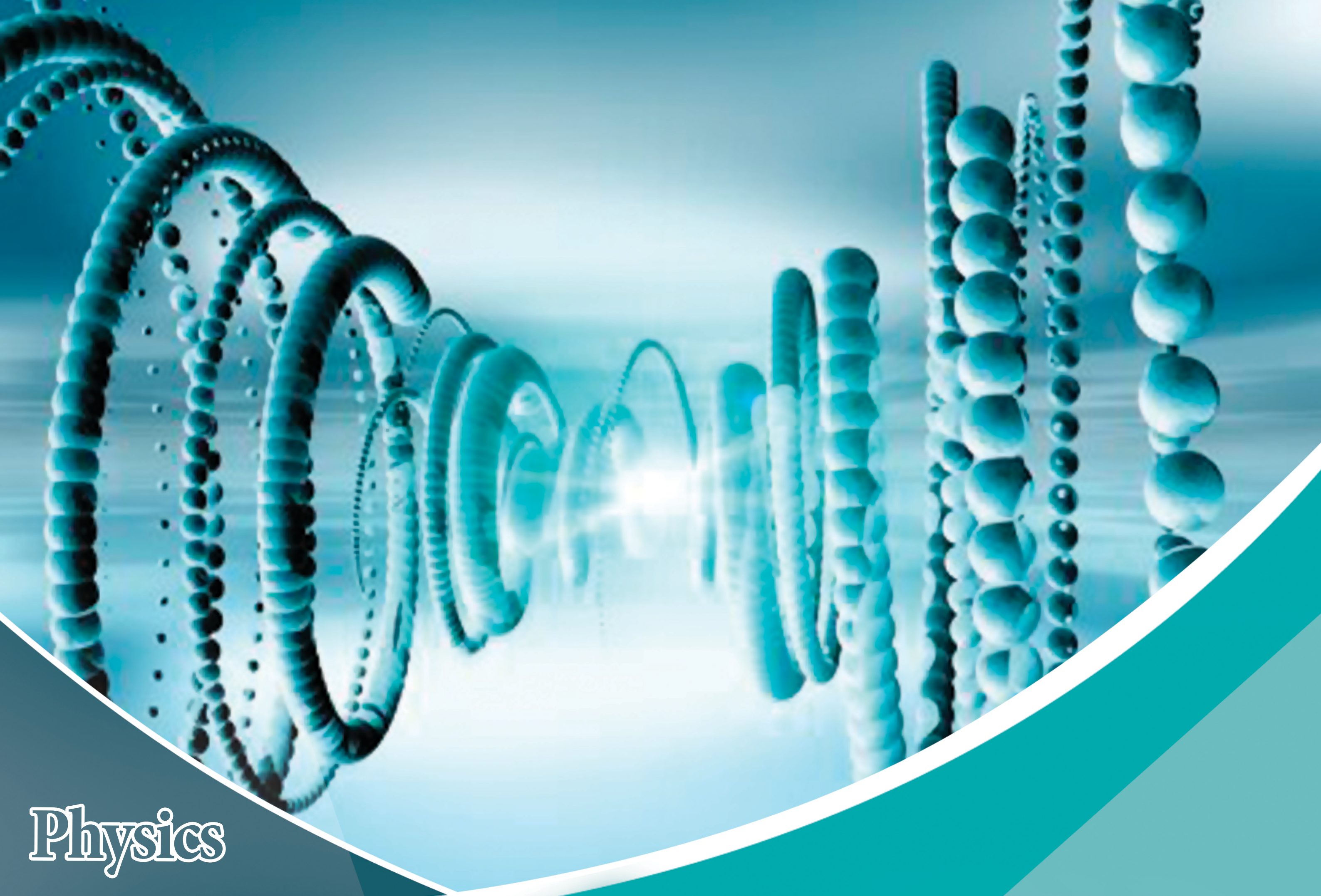


Physics

# دليل الفزكس

## 101

Old Exams

☎ 0502010680

# CHAPTER

# 7

2- A force $\mathbf{F}= (4.0\ \mathbf{i} + 3.0\ \mathbf{j})$ N acts on a particle as it moves in the x-y plane from the point (0,10 m) to (10 m,0).Calculate the work done on the article by this force. [10 J]

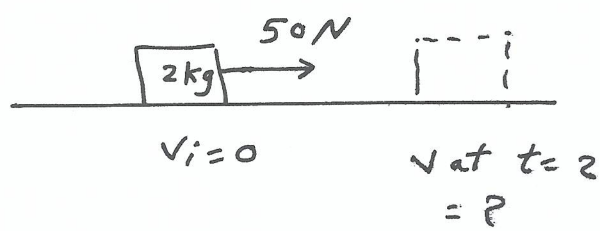
$$\vec{d} = (10-0)\hat{i} + (0-10)\hat{j}$$
$$= 10\hat{i} - 10\hat{j}$$

$$W = \vec{F} \cdot \vec{d}$$

$$= (4.0 i + 3.0 j) \cdot (10 i - 10 j)$$
$$= (4)(10) + (3)(-10)$$
$$= 40 - 30$$
$$= 10\ J$$

1- A net horizontal force of 50 N acts on a 2-kg block which starts from rest on a horizontal frictionless surface. The rate at which the work is being done by this force at t = 2 s is: [2500 W]

$$a = \frac{F}{m}$$
$$= \frac{50}{2} = 25\ m/s^2$$




$$V = V_0 + at$$
$$= 0 + 25(2$$
$$= 50\ m/s$$

$$P = FV = (50)(50) = 2500\ W$$

4- A 1500 kg car accelerates uniformly from rest to 10 m/s in 3.0 s. The average power delivered by the engine of the car in the first 3.0 s is: [25 kW]

$$a = \frac{10-0}{3} = \frac{10}{3}$$

$$d = V_o t + \frac{1}{2} a t^2$$

$$= 0 + \frac{1}{2} \cdot \left(\frac{10}{3}\right)(3)^2$$

$$= 15 \text{ m}$$

$$W = F \cdot d$$

$$= (1500)\left(\frac{10}{3}\right)(15)$$

$$= 75000 \text{ J.}$$

$$P = \frac{W}{t}$$

$$= \frac{75000}{3} = 25000 \text{ J.}$$

$$= 25 \text{ kJ.}$$

5- A box is moving with a speed of 9.10 m/s to the right. After it has moved a distance = d on a rough horizontal surface (muk = 0.6) its speed is reduced to 3.69 m/s. Find the value of d. [5.88 m]

$$W = -F_k d$$

$$\frac{1}{2} \cancel{m} (V_f^2 - V_i^2) = -\mu_k \cancel{m} g \, d$$

$$(3.69)^2 - (9.10)^2 = -(2)(0.6)(9.8)(d)$$

$$d = \frac{-69.19}{-11.76} = 5.883 \text{ m}$$

6- A particle moves 5 m in the positive x-direction while being acted upon by a constant force F=(4 i + 2 j) N, where i and j are unit vectors along the x-axis and the y-axis, respectively. What is the work done on the particle by this force? [+20 J]

$$\vec{d} = 5i$$

$$\therefore W = \vec{F} \cdot \vec{d}$$

$$= (4i + 2j) \cdot (5i)$$

$$= 20 \text{ J}$$

8- A 6-kg block initially at rest is pulled to the right along a horizontal rough surface (muk = 0.15) by a constant force of 12 N. Find the speed of the block after it has moved 3 m. [1.8 m/s]

$$\frac{1}{2} m (v_f^2 - v_i^2) = \Sigma F \cdot d$$

$$\left(\frac{1}{2}\right)(6)\, v_f^2 = (3)\left(12 - (0.15)(9.8)(6)\right)$$

$$v_f^2 = \frac{(3.18)\cancel{(3)}}{\cancel{3}}$$

$$= 3.18$$

$$\therefore v_f = 1.78 \text{ m/s}$$

7- A 6-kg block initially at rest is pulled to the right along a horizontal frictionless surface by a constant force of 12 N. Find the speed of the block after it has moved 3 m. [3.5 m/s]

$$W = F \cdot d = \frac{1}{2} m (v_f^2 - v_i^2)$$

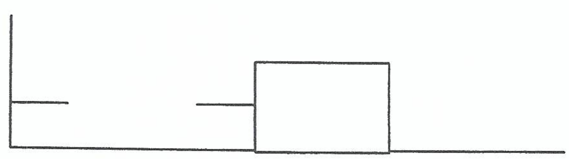
$$= (12)(3) = 36 \text{ J.}$$

$$36 = \frac{1}{2}(6)(v_f^2 - 0)$$

$$v_f^2 = 12$$

$$v_f = 3.464 \text{ m/s}$$

9- A 3.0-kg is attached to a spring of force constant 20 N/m (see the figure) and rests on a frictionless surface. The block is pulled 2.0 m to the right and released from rest. What is its kinetic energy when it is 1.0 m from the equilibrium position? [30 J]

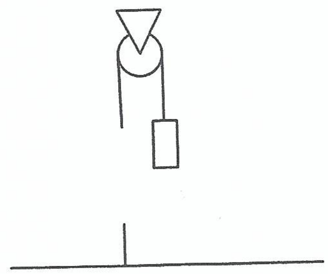


$$\Delta K = \frac{1}{2} k (x_i^2 - x_f^2)$$

$$\underbrace{\left(\frac{1}{2}\right)(m)(v_f^2)}_{K_f} = \left(\frac{1}{2}\right)(20)(2^2 - 1^2)$$

$$= 30 \text{ J.}$$

10- A 20-kg mass is attached to a spring (k=380 N/m) that passes over a pulley as shown in the figure. The pulley is frictionless and massless. The mass is released from rest with the spring unstretched. What is the speed of the mass at the instant when it has dropped a vertical distance of 0.4 m? [2.2 m/s]



$$\Sigma W = \Delta K$$

$$W_s + W_g = \Delta K$$

$$\frac{1}{2} k (x_i^2 - x_f^2) + mgh = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$\left(\frac{1}{2}\right)(380)(0 - (0.4)^2) + (20)(9.8)(0.4) = \frac{1}{2}(20)(v_f)^2$$

$$-30.4 + 78.4 = 10\, v_f^2$$

$$v_f^2 = 4.8$$

$$v_f = 2.19 \text{ m/s}$$

A constant force $\vec{F} = (7.0\hat{i} - 2.0\hat{j})N$ acts on a 2.0 kg block, initially at rest, on a frictionless horizontal surface. If the force causes the block to be displaced by $\vec{d} = (4.0\hat{i} + 6.0\hat{j})m$, find the block's final speed.

A) 4.0 m/s
B) 5.0 m/s
C) 0 m/s
D) 3.0 m/s
E) 2.0 m/s

$W = \vec{F} \cdot \vec{d} = 7(4) - 2(6) = 16$

$W = \frac{1}{2} m (v_f^2 - v_i^2)$

$16 = \frac{1}{2}(2)(v_f^2 - 0)$

$v_f^2 = 16 \Longrightarrow V = 4 \text{ m/s}$

A 15.0 N force with a fixed direction does work on a particle as the particle moves through the three-dimensional displacement $\vec{d} = (2.00\hat{i} - 4.00\hat{j} + 3.00\hat{k})m$. What is the angle between the force and the displacement if the change in the particle's kinetic energy is 50.0 J.

A) 51.8°
B) 62.3°
C) 43.9°
D) 69.1°
E) 37.2°

$\Delta K = W = F d \cos\theta$

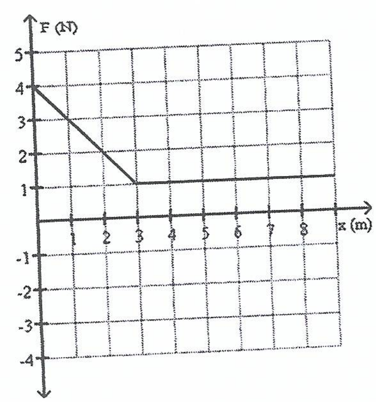
$\Rightarrow 50 = 15 \sqrt{2^2 + (-4)^2 + 3^2} \cos\theta$

$\cos\theta = \dfrac{50}{15\sqrt{29}}$

$\Rightarrow \theta = 51.8$

**Figure 7** shows the force on a 3.0 kg object as a function of position. If an object is moving at 2.5 m/s when it is located at $x = 2.0$ m, nd its speed when located at $x = 8.0$ m.

Figure 7




A) 3.3 m/s

B) 2.7 m/s

C) 5.4 m/s

D) 0

E) 1.9 m/s

$W = \text{area} = \Delta K$

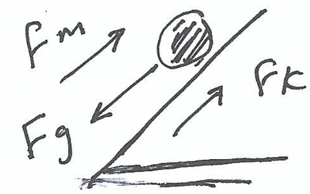
$\frac{1}{2} + 6 = \frac{1}{2}(3)(v_8^2 - 2.5^2)$

$\Rightarrow v_8^2 = 10.6$

$v_8 = 3.3 \text{ m/s}$

A block is sliding down on a rough inclined plane. A man applies a force to reduce the acceleration of the block. Let $W_f$ be the work done by the friction force, $W_m$ the work done by the man, and $W_g$ the work done by the gravitational force. While the block is sliding down, which of the following is TRUE?

A) $W_f < 0$, $W_m < 0$, $W_g > 0$
B) $W_f < 0$, $W_m > 0$, $W_g < 0$
C) $W_f < 0$, $W_m < 0$, $W_g < 0$
D) $W_f < 0$, $W_m > 0$, $W_g > 0$
E) $W_f > 0$, $W_m > 0$, $W_g > 0$




$W_f < 0$ always.

because $F_f$ decreasing speed

$W_m < 0$

because $F_m$ decreasing speed

$W_g > 0$

because downward motion

Q3.
A rough inclined plane has a height of 1.00 m, and makes an angle of 45.0° above the horizontal. An object of mass 1.00 kg is released from rest at the top of the incline, and has a speed of 3.50 m/s at the bottom of the incline. Calculate the magnitude of the work done by the frictional force.

A) 3.68 J
B) 5.31 J
C) 8.21 J
D) 2.50 J
E) 4.94 J

$W_g + W_K = \frac{1}{2} m (v_f^2 - v_i^2)$ $V_0 = 0$

$mgh + W_K = \frac{1}{2}(1)(3.5^2 - 0)$

$W_K = 6.125 - 9.8$

$= 3.68$ J

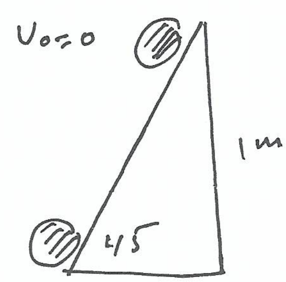
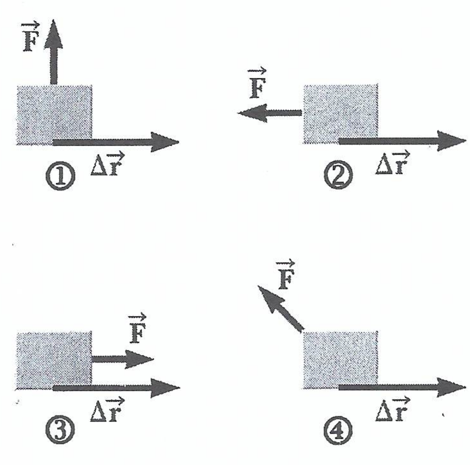



**FIGURE 2** shows four situations in which a force is applied to an object. In all four cases, the force has the same magnitude, and the displacement of the object is to the right and of the same magnitude. Rank the situations in order of the work done by the force, from most positive to most negative.

3, 1, 4, 2

W = + 0 − −



A man pushes a 500 kg block along the $x$ axis by a constant force $\vec{F} = (100N)\hat{i} - (200N)\hat{j}$. Find the power required to maintain a speed of 5.00 m/s.

A) 500 W
B) 2500 W
C) 1000 W
D) 750 W
E) 300 W

$V = 5\hat{i}$ m/s

$\Rightarrow P = \vec{F} \cdot \vec{V} = 100(5) = 500\,W$

A 15.0-kg box slides on a rough horizontal surface with an initial speed of 8.00 m/s and finally stops due to friction after moving for 3.10 s. What average power is produced by friction as the box stops?

A) 155 W
B) 480 W
C) 131 W
D) 326 W
E) 271 W

$W_K = \frac{1}{2} m (V_f^2 - V_i^2)$

$= \frac{1}{2}(15)(0 - 8^2) = 480\,J$

$P = \frac{W_K}{t} = \frac{480}{3.10} = 155\,W$

An elevator cab is moving upward at a constant speed of 4.00 m/s. The power of the motor driving the elevator cab is 150 kW. Find the mass of the elevator cab.

A) $3.83 \times 10^3$ kg

B) $3.75 \times 10^4$ kg

C) $3.75 \times 10^2$ kg

D) $1.75 \times 10^2$ kg

E) $3.37 \times 10^3$ kg

V is constant

$\Rightarrow P = F \cdot V$

$= mg \cdot V$

$150(10^3) = m(9.8)(4)$

$\Rightarrow m = 3.83 \times 10^3$ kg

The loaded cab of an elevator has a mass of $3.0 \times 10^3$ kg and moves 150 m upward in 10 s at constant speed. At what average rate does the force from the cable do work on the cab? [Ignore air resistance]

A) $4.4 \times 10^5$ W
B) $2.0 \times 10^5$ W
C) $2.7 \times 10^5$ W
D) $2.7 \times 10^3$ W
E) 0 W

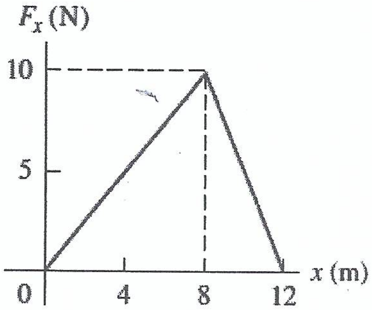
$V = \frac{d}{t} = \frac{150}{10} = 15\,m/s$

$P = F \cdot V = mg\,V$

$= 3 \times 10^3 (9.8)(15)$

$= 4.4 \times 10^5\,W$

A force $F_x$ is applied to a 5.0-kg box moving it along the $x$-axis. The force varies with distance as shown in **FIGURE 1**. If the box starts from rest at the origin, what is its speed at $x$ = 12 m?




W = area under Curve

$$\tfrac{1}{2}(5)(v_{12}^2 - v_0^2) = \tfrac{1}{2}(12)(10)$$

$$v_{12}^2 = 24$$

$$v_{12} = 4.9 \text{ m/s}$$

A) 4.9 m/s
B) 4.0 m/s
C) 2.8 m/s
D) zero
E) 3.9 m/s

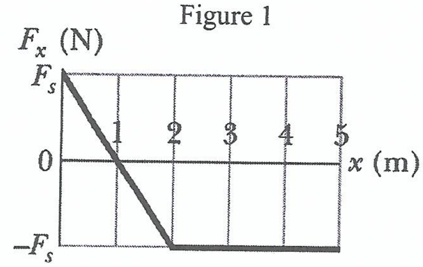
The only force acting on a 2.0 kg body as the body moves along an $x$ axis varies as shown in **Figure 1**. The scale of the figure's vertical axis is set by $F_s$= 5.0 N. The speed of the body at $x$ = 0 is 5.0 m/s. At what value of $x$ will the body have a kinetic energy of 15 J?

A) 4.0 m
B) 1.0 m
C) 3.0 m
D) 5.0 m
E) 2.0 m

$$K_0 = \tfrac{1}{2}(2)(5)^2$$

$$= 25$$

Figure 1

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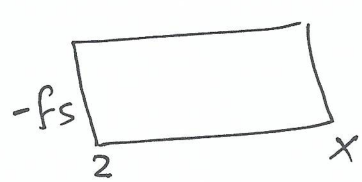
والذي عرضه -fs




$$\Longrightarrow \quad K_x - K_0 = \text{area}$$

$$15 - 25 = -5(x-2)$$

$$-10 = -5(x-2)$$

$$2 = x-2$$

$$x = 4 \text{ m}$$

The force acting along the $x$ axis on an 8 kg object varies as shown in **Figure 5**. The speed of the object at $x = 0$ is zero. The speed of the object at $x = 5.0$ m is

A) 40 m/s
B) 30 m/s
C) 160 m/s
D) 80 m/s
E) zero

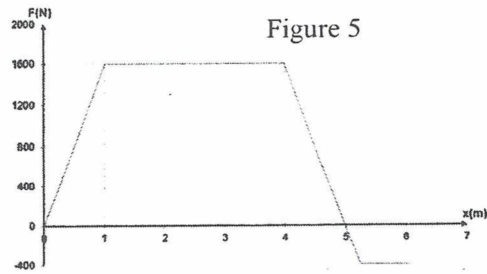


Figure 5

$\frac{1}{2}m(v_5^2 - v_0^2) =$ area under curve

$\frac{1}{2}(8)(v_5^2 - 0) = \frac{5+3}{2}(1600)$

$v_5^2 = 1600 \Longrightarrow v_5 = 40$ m/s

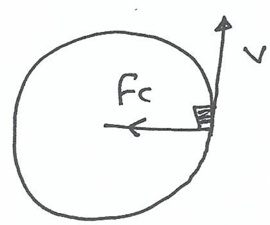
An object of mass 10 kg is moving in a horizontal circular path of radius 0.50 m with a constant speed of 4.0 m/s. Find the work done by the centripetal force on that object during one full cycle.

A) 0
B) 10 J
C) 60 J
D) 40 J
E) 80 J

$\vec{d} = 0$

$W = 0$

during one full cycle




A constant force $\vec{F} = (6.0\hat{i} - 9.0\hat{j})$ N acts on a 2.0 kg block placed on a frictionless horizontal surface. Initially the block is at rest at point **A** having coordinates (1.0 m, 3.0 m). If the force causes the block to be displaced from point **A** to point **B** having coordinates (4.0 m, 4.0 m) on an *xy*-coordinate system, find the block's final speed.

A) 3.0 m/s
B) 5.0 m/s
C) 7.0 m/s
D) 4.0 m/s
E) 2.0 m/s

$\vec{d} = (4-1)\hat{i} + (4-3)\hat{j}$

$= 3\hat{i} + \hat{j}$

$W = \vec{F} \cdot \vec{d} = 18 - 9 = 9$ joule

$\Rightarrow W = \frac{1}{2}m(v_f^2 - v_i^2)$

$9 = \frac{1}{2}(2)(v_f^2 - 0)$

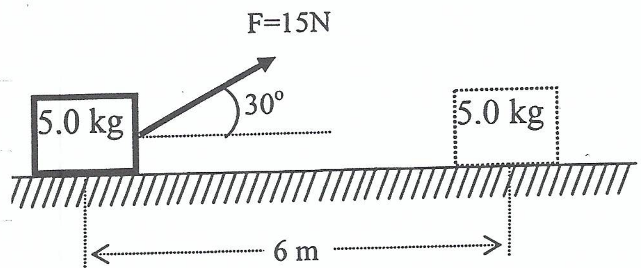
$\Longrightarrow v_f = 3$ m/s

x
1

EXAM2-022

Q1 Q0 A 5.0-kg object is pulled along a rough horizontal surface at
7 Q0 constant speed by a 15 N force acting 30 degrees above the
Q0 horizontal (see Fig.1). How much work is done by the friction
Q0 force as the object moves 6.0 m?
Q0
A1 -78 J
A2 -82 J
A3 -85 J
A4 -75 J
A5 0 J

FIGURE 1



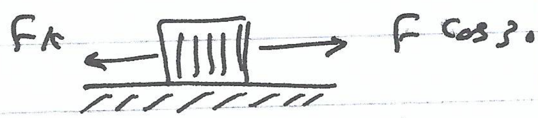

$m = 5\,kg$

$\theta = 30°$

$F = 15\,N$

$d = 6\,m$

At constant speed




$f_k = F\cos 30$

$= 15\cos 30$

$= 12.99\,N$

$\Longrightarrow$ work of friction

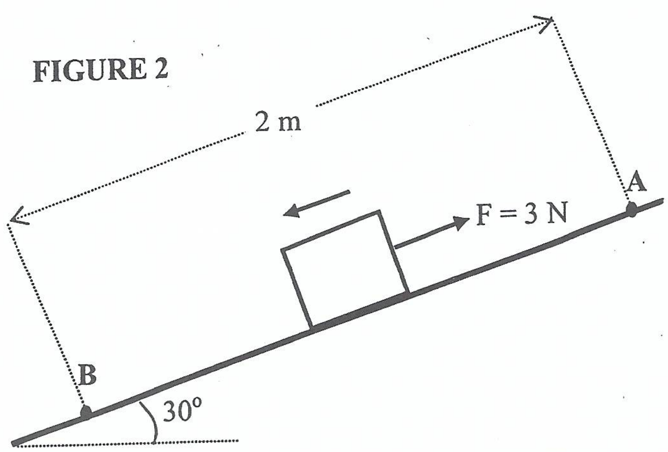
$W_k = -f_k d$

$= -12.99(6)$

$= -77.94$

Q0
Q2 Q0 A 2.0-kg block slides 2.0 m down a frictionless incline from
7 Q0 point A to point B. A force (magnitude F =3.0 N) acts on the
Q0 block between A and B, as shown in Fig.2. If the kinetic energy
Q0 of the block at A is 10 J, what is its kinetic energy at B?
Q0
A1 24 J
A2 20 J
A3 27 J
A4 17 J
A5 37 J

FIGURE 2



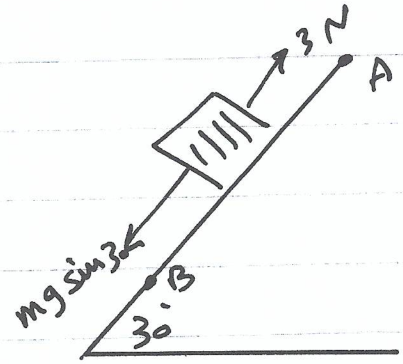

$m = 2\,kg$

$d = 2\,m$

$F = 3\,N$

$K_i = 10\,J$

x 2




$$W = \Delta K$$
$$= K_f - K_i$$

$$W_{net} = \Sigma F \cdot d$$
$$= (mg \sin 30 - 3)(2)$$
$$= \left[2(9.8)\left(\tfrac{1}{2}\right) - 3\right](2)$$
$$= 13.6 \text{ J}$$

$$\Longrightarrow \quad 13.6 = K_f - 10$$

$$K_f = 13.6 + 10$$
$$= 23.6 \text{ J}$$

```
   Q0
Q3 Q0 A 2.0-kg object moves along the +x-axis with a speed of 5 m/s
7  Q0 under the influence of a force F= (3i+4j) N. What is the power
   Q0 delivered by this force?
   Q0
   A1 15 W
   A2 20 W
   A3 25 W
   A4 35 W
   A5 30 W
```

$$\vec{v} = 5i$$
$$F = (3i + 4j) \text{ N}$$

$$P = \vec{F} \cdot \vec{v}$$
$$= (3i + 4j) \cdot (5i)$$
$$= 15 \text{ watt}$$

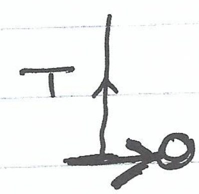
x
3

```
   Q0
7 Q3 Q0 A helicopter lifts a 72 kg man 15 m vertically
     Q0 by means of a cable. The acceleration of the man is
     Q0 1.20 m/s**2. How much work is done on the man by
     Q0 the tension of the cable?
     Q0
     A1 12   kJ
     A2 10   kJ
     A3 0    kJ
     A4 14   kJ
     A5 16   kJ
```

$m = 72\ kg$

$d = 15\ m$

$a\uparrow = 1.2$



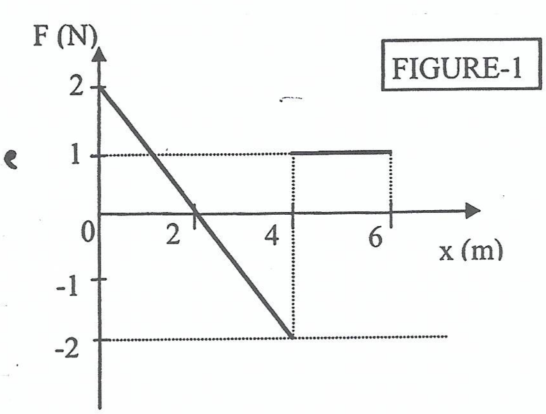

$$T = m(g+a)$$
$$= 72(9.8+1.2)$$
$$= 792\ N$$

$$\Rightarrow W = Td$$
$$= (792)(15)$$
$$= 11880\ J$$



```
   Q0
7 Q2 Q0 An object is pushed by a variable force, plotted in Fig 1,
     Q0 as a function of position, x.
     Q0 How much work has the force done on the object when it
     Q0 has moved from x=0 to x=+6 m?
     Q0
     A1   2  J
     A2   10 J
     A3   -6 J
     A4   0  J
     A5   12 J
```

$$W = \Sigma \text{ area under curve}$$
$$= \tfrac{1}{2}(2)(2) + 2(1)$$
$$- \tfrac{1}{2}(2)(2)$$
$$= 2\ J$$



Q3.

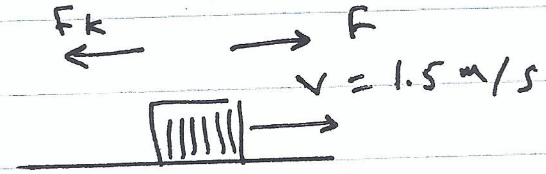
072 A person pushes horizontally a 10 kg box at a constant velocity 1.5 m/s. The coefficient of kinetic friction between the box and the horizontal floor is 0.30. What is the rate of work that the person does in pushing the box?

A) 44 W
B) 23 W
C) 54 W
D) 16 W
E) 0 W

$v = 1.5\ m/s$

$\mu_k = 0.3$

$m = 10\ kg$




$$F_k = \mu_k m g$$
$$= (0.3)(10)(9.8)$$
$$= 29.4\ N$$

$$F = F_k$$

$$\Longrightarrow \quad P = \vec{F} \cdot \vec{v}$$
$$= (29.4)(1.5)$$
$$= 44.1\ W$$

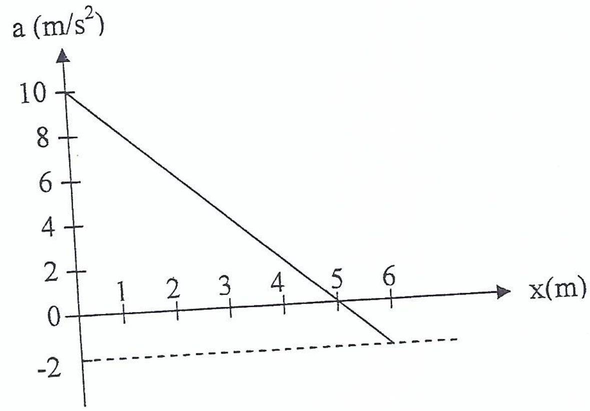
Q4.

072 A worker does 500 J of work in moving a 20 kg box a distance *D* on a rough horizontal floor. The box starts from rest and its final velocity after moving the distance *D* is 4.0 m/s. Find the work done by the friction between the box and the floor in moving the distance *D*.

A) −340 J
B) −500 J
C) −160 J
D) − 98 J
E) 0 J

$$W_{net} = W_k + W_{ap}$$
$$\tfrac{1}{2}(20)(4^2 - 0) = W_k + 500$$
$$160 = W_k + 500$$
$$W_k = -340\ J$$

Q1.
Figure 1 shows the acceleration of a 2 kg particle as a single force acts on it along the x-axis, from x = 0 to x = 6 m. Find the work done by the force on the particle.




A) 48 J
B) 52 J
C) 0.0 J
D) 26 J
E) 36 J

$$W = \vec{F}\cdot\vec{d}$$
$$= m\vec{a}\cdot\vec{d}$$
$$= 2(\vec{a}\cdot\vec{d})$$
المساحة تحت منحنى
$$= 2\left[\tfrac{1}{2}(5)(10) - \tfrac{1}{2}(2)(1)\right]$$
$$= (2)(24)$$
$$= 48\ J.$$

Q2.
A 0.2-kg stone tied to a string is rotated in a horizontal circle of radius 0.5 m. The speed of the stone is kept constant at 1.0 m/s. Find the work done by the tension of the string on the stone in one rotation.

A) 0.0 J
B) 0.4 J
C) 1.3 J
D) 6.2 J
E) 0.6 J

6

$W = \vec{T} \cdot \vec{d}$

in one rotation

$\vec{d} = 0$

$\Rightarrow W = 0$

Q3.
A 60-kg boy runs from the 1st floor to the 2nd floor, using the stairs, in 12 s. The stairs are made up of 30 steps, each 10 cm high. Calculate the average power required by the boy.

A) 147 W
B) 980 W
C) 55.0 W
D) 588 W
E) 49.0 W



$W_g = mgd$
$= 60(9.8)(30)(0.1)$
$= 1764$ J

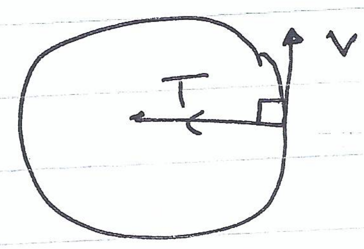
$\Rightarrow P = \frac{W_g}{t} = \frac{1764}{12} = 147$ W



Q1.
An object moves in a circle at constant speed. The work done by the centripetal force is zero because:

A) the centripetal force is perpendicular to the velocity.
B) the change in kinetic energy of the object is not zero.
C) the centripetal force is parallel to the velocity.
D) the object is moving with constant velocity.
E) the centripetal force does not change velocity.

$T \perp v$



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Q2.
A 4.0-kg cart starts up an incline with a speed of 3.0 m/s and comes to rest 2.0 m up the incline. The net work done on the cart is:

A) –18 J
B) +18 J
C) +12 J
D) –12 J
E) +1.0 J

$m = 4\,kg$

$v_i = 3\,m/s$

$v_f = 0$

$$W_{net} = \frac{1}{2} m (v_f^2 - v_i^2)$$
$$= \frac{1}{2}(4)(0 - 3^2)$$
$$= -18\,J$$

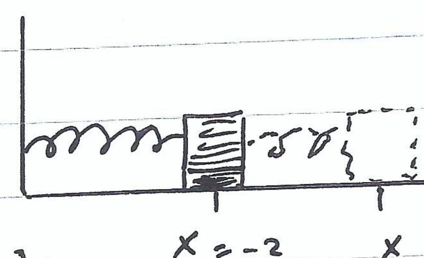
Q3.
A block of mass 1.6 kg, resting on a horizontal frictionless surface, is attached to a horizontal spring fixed at one end. The spring, having a spring constant of 1.0 x $10^3$ N/m, is compressed to x = -2.0 cm (x = 0.0 is the equilibrium position) and the block is released from rest. The speed of the block as it passes through the position x = - 1.0 cm is:

A) 0.43 m/s
B) 0.91 m/s
C) 0.73 m/s
D) 0.22 m/s
E) 0.10 m/s

$v_i = 0$

$k = 10^3\,N/m$

$x_i = -2\,cm$, $x_f = -1\,cm$




$$W_s = \frac{1}{2} m (v_f^2 - v_i^2)$$
$$\frac{1}{2} k (x_i^2 - x_f^2) = \frac{1}{2} m (v_f^2 - v_i^2)$$
$$\frac{1}{2}(10^3)(0.02^2 - 0.01^2) = \frac{1}{2}(1.6)(v_f^2 - 0)$$
$$\Longrightarrow v_f = 0.433\,m/s$$

Q4.
A 3.0-kg mass has an initial velocity $\mathbf{v}_0 = (6.0\ \mathbf{i} - 2.0\ \mathbf{j})$ m/s. A single force **F** is applied for 5.0 s which changes its velocity to $\mathbf{v} = (8.0\ \mathbf{i} + 4.0\ \mathbf{j})$ m/s. Find the average power delivered by the force in this interval.

A) 12 W
B) 25 W
C) 9.8 W
D) 6.6 W
E) 28 W



$t = 5\ s$

$$V_o = \sqrt{6^2 + (-2)^2} = \sqrt{40}\ m/s$$

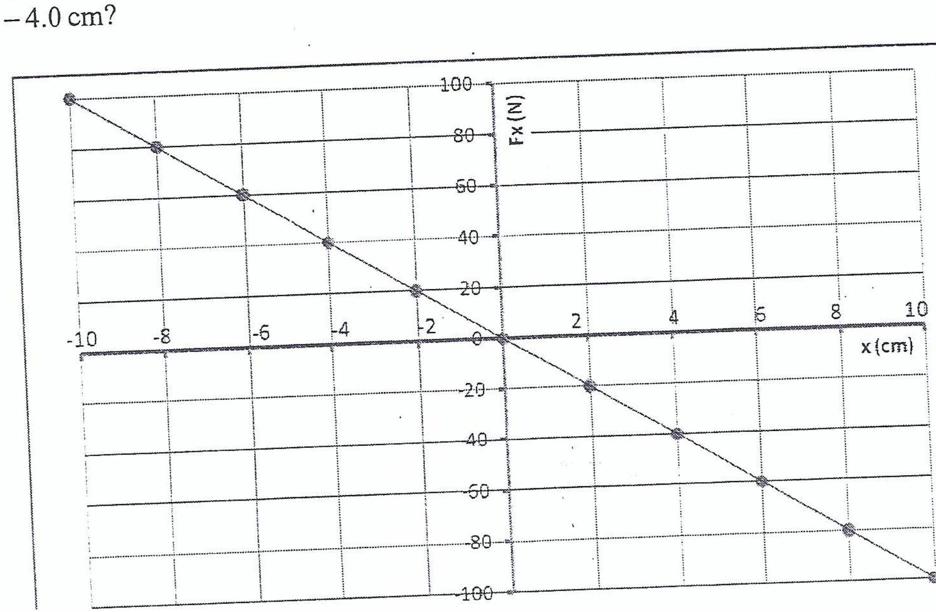
$$V_f = \sqrt{8^2 + 4^2} = \sqrt{80}\ m/s$$

$$W_{net} = \frac{1}{2} m (V_f^2 - V_i^2)$$
$$= \frac{1}{2}(3)(80 - 40)$$
$$= 60\ J$$

$$\Rightarrow \text{Power } P = \frac{W}{t} = \frac{60}{5} = 12\ W$$

Q2.
**Figure 1** shows the spring force $F_x$ as a function of position $x$ for a spring-block system resting on a frictionless table. The block is released at $x = +10$ cm. How much work (in Joules) does the spring do on the block when the block moves from $x_i = +8.0$ cm to $x_f = -4.0$ cm?

Fig#



A) +2.4
B) −2.4
C) +3.2
D) −3.2
E) +5.8

From graph $\Rightarrow$ $F = 20N$
when $x = -2$ cm

apply Hook's law

$$F = -kx$$
$$20 = -k(-0.02)$$
$$1000 = k$$

$$\Rightarrow W_s = \frac{1}{2}k(x_i^2 - x_f^2)$$
$$= \frac{1}{2}(1000)((0.08)^2 - (-0.04)^2)$$
$$= 2.4 \text{ J}$$

Q3.
A particle is acted on by a constant force $\vec{F} = (2.0\text{ N})\hat{i} - (5.0\text{ N})\hat{j}$ and is displaced from an initial position of $\vec{d}_i = (0.50\text{ m})\hat{i} + (0.80\text{ m})\hat{j}$ at time $t = 0$ s to a final position of $\vec{d}_f = (3.5\text{ m})\hat{i} + (9.8\text{ m})\hat{j}$ at time $t = 10$ s. Find the average power (in Watts) on the particle due to this force in this time interval.

A) −3.9
B) +3.9
C) −6.6
D) +6.6
E) −39

displacement $= d_f - d_i$
$$= (3.5 - 0.5)i + (9.8 - 0.8)j$$
$$= 3i + 9j$$

$$W = \vec{F}\cdot\vec{d} = (2i - 5j)\cdot(3i + 9j)$$
$$= 6 - 45 = -39 \text{ J}$$

$$\text{Power} \Rightarrow P = \frac{W}{t}$$

$$= \frac{-39}{10} = -3.9 \text{ W}$$

Q4.
A single force acts on a 5.0 kg object. The position of the object as a function of time is given by $x = 10\,t - 5.0\,t^2$, where $x$ is in meters and $t$ is in seconds. Find the work done by this force on the object in the interval from $t = 0$ s to $t = 5.0$ s.

A) $3.8 \times 10^3$ J
B) $3.0 \times 10^2$ J
C) $2.5 \times 10^3$ J
D) $1.7 \times 10^4$ J
E) $5.8 \times 10^3$ J

$$m = 5 \text{ kg}$$

$$x = 10t - 5t^2$$

$$\Rightarrow \quad v = \frac{dx}{dt}$$

$$= 10 - 10t$$

$$v\Big|_{t=0} = 10 \text{ m/s}$$

$$v\Big|_{t=5} = 10 - 50 = -40 \text{ m/s}$$

$$W = \frac{1}{2} m (v_f^2 - v_i^2)$$

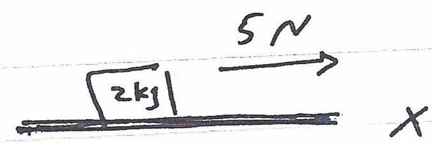
$$= \frac{1}{2}(5)((-40)^2 - (10)^2) = 3750 \text{ J}$$

$$= 3.8 \times 10^3 \text{ J}$$

7

Q26.
A 2.0 *kg* box has an initial velocity of 10 *m/s* in the positive *x*-direction. A net force of 5.0 *N* caused the box to move with a velocity of 10 *m/s* in the positive *y*-direction. The work done on the box by this force is:

A) 0
B) 10 *J*
C) 50 *J*
D) 25 *J*
E) 5 *J*




$W = \Delta K$

$= \frac{1}{2} m (v_f^2 - v_i^2)$

$= \frac{1}{2}(2)(10^2 - 10^2)$

$= 0$



Q1.
An 800 kg car is traveling at velocity $(12\,\hat{i})$m/s . When the brakes are applied, the car changes its velocity to $(12\,\hat{j})$m/s in 4.0 s. What is the change in kinetic energy of the car in this time period?

A) 0 J
B) $2.9\times 10^4$ J
C) $5.8\times 10^4(\hat{j}-\hat{i})$ J
D) $4.8\times 10^4$ J
E) $(12\hat{i}-12\hat{j})$ J

$v_i = 12$ m/s

$v_f = 12$ m/s

$\Delta K = \frac{1}{2} m (v_f^2 - v_i^2)$

$= \frac{1}{2}(800)(12^2 - 12^2) = 0$

7

Q2.
An ideal spring is hung vertically from the ceiling. When a 2.0 kg mass hangs at rest from it, the spring is extended 6.0 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 10 cm. While the spring is being extended by the external force, the work done by the spring is:

A) −3.6 J
B) −3.3 J
C) −1.0 J
D) 1.8 J
E) 3.6 J

$$F = mg$$
$$= 2(9.8) = 19.6 \quad N$$
$$x = 0.06 \text{ m}$$

$$k = \frac{F}{x}$$
$$= \frac{19.6}{0.06} = 326.7 \text{ N/m}$$

$$x_i = 0.06$$
$$x_f = 0.16\text{m}$$

$$W = \frac{1}{2}k(x_i^2 - x_f^2)$$
$$= \frac{1}{2}(326.7)(0.06^2 - (0.16)^2)$$
$$= -3.59 \text{ J}$$

7

Q4.
A 2000 kg elevator moves 20 m upward in 4.9 sec at a constant speed. At what average rate does the force from the cable do the work on the elevator?

A) 80000 W
B) 25000 W
C) 75000 W
D) 10000 W
E) 150 W

$h = 20\ m$

$m = 2000\ kg.$

$t = 4.9$

$W = mgh$

$= 2000(9.8)(20) = 392000\ J$

$P = \frac{W}{t}$

$= \frac{392000}{4.9} = 8000\ W$

Q3.
A single force acts on a 5.0 kg object in such a way that the position of the object as a function of time is given by $x = 10.0t - 5.0t^2$, with $x$ is in meters and $t$ is in seconds. Find the work done on the object from $t = 0$ to $t = 4.0$ s.

A) 2000 J
B) 900 J
C) 4000 J
D) 400 J
E) 500 J

$x = 10t - 5t^2$

$v = \frac{dx}{dt} = 10 - 10t$

4 7

$$v\Big|_{t=0} = 10 - 0 = 10 \text{ m/s}$$

$$v\Big|_{t=4} = 10 - 10(4) = -30 \text{ m/s}$$

$$W = \Delta K$$



$$= \frac{1}{2} m \left( v_4^2 - v_0^2 \right)$$

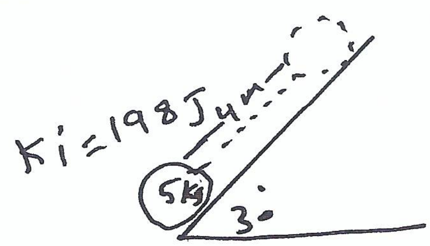
$$= \frac{1}{2}(5)\left( (-30)^2 - 10^2 \right)$$

$$= 2000 \text{ J}$$

---

1 Q7.
A 5.0 kg block starts up a 30° incline with 198 J of kinetic energy. The block slides up the incline and stops after traveling 4.0 m. The work done by the force of friction between the block and the incline is:

A) -100 J
B) -198 J
C) -98 J
D) -298 J
E) 0 J




$$W_{net} = W_g + W_K$$

$$K_f - K_i = -mgd\sin\theta + W_K$$

$$0 - 198 = -5(9.8)(4)\sin 30 + W_K$$

$$-198 = -98 + W_K$$

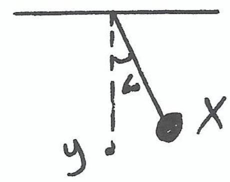
$$W_K = -100 \text{ J}$$

# CHAPTER

# 8

1- A simple pendulum consists of a 2.0 kg mass attached to a string of length = 1.0 m. It is released from rest at X as shown in Fig. Its speed at the lowest point Y is:

a. 3.1 m/s
b. 4.4 m/s
c. 1.6 m/s
d. 5.2 m/s
e. 0.0 m/s




K at X = PE at X

$\frac{1}{2} m v^2 = m g h$

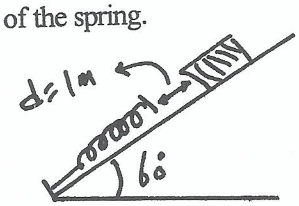
$v^2 = 2 (9.8) ( 1-(1)\cos 60)$

$v^2 = 9.8$

$v = 3.13$ m/s

2- A 3.0 kg mass starts from rest and slides a distance d = 1.0 m down a frictionless 60 deg incline, where it contacts an unstressed spring as in Fig. The mass slides an additional 35 cm as it is brought momentarily to rest by compressing the spring. Find the spring constant of the spring.

a. 561 N/m
b. 262 N/m
c. 363 N/m
d. 664 N/m
e. 465 N/m




$\Delta K_{block} + \Delta U_s + \Delta U_{block} = 0$

$0 + \frac{1}{2} k ((0.35)^2 - 0) + (3)(9.8)(-1.35 \sin 60) = 0$

$k = \frac{68.745}{(0.35)^2}$

$= 561.18$ N/m

3- A projectile of mass 0.50 kg is fired with an initial speed of 10 m/s at an angle of 60 deg above the horizontal. The total mechanical energy (relative to ground level) of the projectile at its highest point is:

a. 25.0 J  b. 18.8 J  c. 6.25 J  d. 50.0 J  e. 0.0 J

$$H = \frac{V_0^2 \sin^2\theta_0}{2g}$$

$$= \frac{(10)^2 \sin^2 60}{2(9.8)} = 3.82 \text{ m}$$

V at highest point $= V_0 \cos 60 = 10(\frac{1}{2}) = 5 \text{ m/s}$

$$M_E = mgh + \frac{1}{2} m v^2$$

$$= (0.5)(9.8)(3.8) + \frac{1}{2}(0.5)(5)^2$$

$$= 25 \text{ J}$$

6- A 2.5 kg hangs at rest from the free end of a vertical spring attached by one end to the ceiling. What is the change in elastic potential energy of the spring when the mass is lifted straight up until the spring reaches its unstretched position? (k=240 N/m)

a. -1.25 J  b. 2.50 J  c. -4.60 J  d. 1.80 J  e. -3.90 J

$$F = k\Delta x$$

$$\Delta x = \frac{F}{k}$$

$$= \frac{mg}{k} = \frac{(2.5)(9.8)}{240} = 0.102 \text{ m}$$

$$\Delta PE = \frac{1}{2} k (x_f^2 - x_i^2)$$

$$= \frac{1}{2}(240)(0 - (0.102)^2)$$

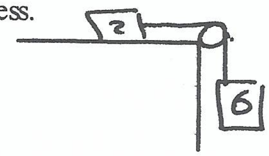
$$= -1.25 \text{ J}$$

7- Which of the following quantities CANNOT be used as a unit of potential energy?
a. kg*m/s**2 b. watt*second c. Joule d. kg*m**2/s**2 e. N*m

$$\text{watt}\cdot\text{second} = \text{Joule} = kg\cdot m^2/s^2$$
$$= N\cdot m$$

a Ans $kg\cdot m/s^2 \neq \text{Joule}$

8- Two masses are connected as shown in fig. The coefficient of kinetic friction between the 2.0-kg mass and the surface is 0.400. The system starts from rest. What is the speed of the 6.0-kg mass at the instant when it has fallen 1.5 m? Assume that the pulley is massless and frictionless.




a. 4.37 m/s
b. 3.74 m/s
c. 5.00 m/s
d. 5.05 m/s
e. 5.42 m/s

For the system:

$$\Delta K + \Delta U = -f_k d$$
$$\frac{1}{2}(2+6)v^2 + (6)(9.8)(-1.5) = -(0.4)(2)(9.8)(1.5)$$
$$4v^2 = 88.2 - 11.76$$
$$v^2 = 19.09 \Rightarrow v = 4.37 \text{ m/s}$$

9- A 2.0-kg block is pushed on a rough horizontal plane by a 12-N force acting parallel to the plane. If the block moves with a constant speed of 1.5 m/s, how much power is lost due to the frictional force ?
a. +18 W b. +11 W c. -11 W d. +29 W e. -29 W

$$P = F\cdot v$$
$$= 12\cdot(1.5)$$
$$= 18 \text{ W}$$

10- Which of the following bodies has the largest kinetic energy ?

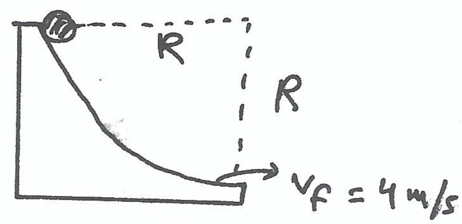
a. Mass 2M and speed 3V .
b. Mass 3M and speed V .
c. Mass 3M and speed 2V .
d. Mass M and speed 4V .
e. Mass 4M and speed 2V .

$K = \frac{1}{2} m v^2$

The largest $KE = \frac{1}{2}(2M)(3v)^2$
$= 9v^2M$

11- A block of mass 2.0 kg is released from rest and slides down a rough track of radius R = 1.0 m, as shown in the Fig. If the speed of the block at the bottom is 4.0 m/s, What is the energy dissipated by the frictional force acting on the block?

a. 3.6 J
b. 3.6 J
c. 19.6 J
d. 19.6 J
e. 16.0 J




$\Delta K + \Delta U = -f_k d$

$\frac{1}{2}(2)(4^2) + (2)(9.8)(-1) = -f_k d$

$16 - 19.6 = -f_k d$

$-3.6 = -f_k d$

$f_k d = 3.6 \, J.$

12- A stone is thrown up at an angle with a speed of 30.0 m/s from the top of a building which is 50 m high, as shown in the Fig. Find the speed of the stone when it is 20 m above the ground.

a. 38.6 m/s
b. 49.7 m/s
c. 27.3 m/s
d. 20.2 m/s
e. 12.5 m/s

$\Delta K + \Delta U = 0$

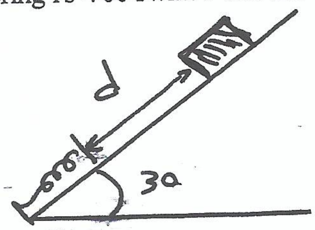
$\frac{1}{2} \cancel{m}(v_f^2 - v_i^2) + \cancel{m} g \Delta h = 0$

$\frac{1}{2}(v_f^2 - 30^2) + (9.8)(-30) = 0$

$v_f^2 = 1488 \Rightarrow v_f = 38.57 \, m/s$

13- A 3-kg block starts at rest and slides a distance d down a smooth 30-deg Incline, where it contacts a spring of negligible mass, as shown in the Fig. It slides an additional 0.2 m as it is brought momentarily to rest by compressing the spring. The force constant of the spring is 400 N/m. Find the initial separation d between the mass and the spring.

a. 0.344 m
b. 0.566 m
c. 0.211 m
d. 0.722 m
e. 0.435 m




$$\Delta K_b + \Delta U_b + \Delta U_s = 0$$

$$0 - (3)(9.8)(d + 0.2)\sin 30^\circ + \frac{1}{2}(400)(0.2)^2 = 0$$

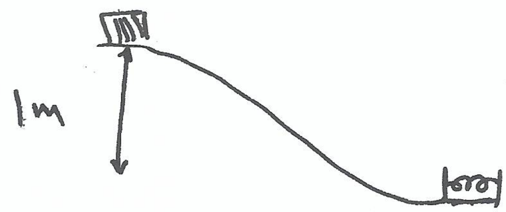
$$14.7(d + 0.2) = 8$$

$$d + 0.2 = \frac{8}{14.7} = 0.544$$

$$d = 0.344 \text{ m}$$

15- A block of mass 1 kg is released from rest and slides down a frictionless track of height 1 m above a table. At the bottom of the track, where the surface is horizontal, the block strikes and compresses a spring constant 400 N/m (see Fig). Find the maximum distance through which the spring is compressed.

a. 0.221 m
b. 0.532 m
c. 0.710 m
d. 0.615 m
e. 0.935 m



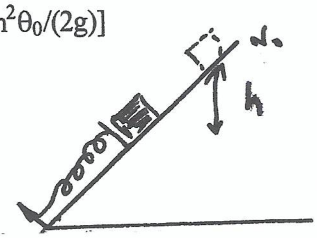

$$\Delta K_b + \Delta U_b + \Delta U_s = 0$$

$$0 - (1)(9.8)(1) + \frac{1}{2}(400)(x^2) = 0$$

$$x^2 = \frac{9.8}{200} \Rightarrow x = 0.221 \text{ m}$$

14- A spring of force constant 100 N/m rests on an inclined plane that has the same length as the spring. The inclined plane makes an angle of 45 deg with the horizontal. A block of mass 0.1 kg is pressed against the spring, compressing it a distance of 0.2 m, and then released. Find the maximum height the block reaches above the point at which it leaves the spring. [$Y_{max}=V_0^2 \sin^2\theta_0/(2g)$]

a. 0.95 m
b. 5.30 m
c. 1.02 m
d. 0.55 m
e. 1.30 m




$$\Delta K_b + \Delta U_b + \Delta U_s = 0$$

$$0 = \frac{1}{2}(0.1)v^2 + (0.1)(9.8)(0.2 \sin 45^\circ) - \frac{1}{2}(100)(0.2)^2$$

$$0 = \frac{1}{2}(0.1)v^2 + 0.1385 - 2$$

$$v^2 = 37.2$$

$$H = \frac{(37.2)(\sin 45^\circ)^2}{(2)(9.8)} = 0.95 \text{ m}$$

Calculus
Physics
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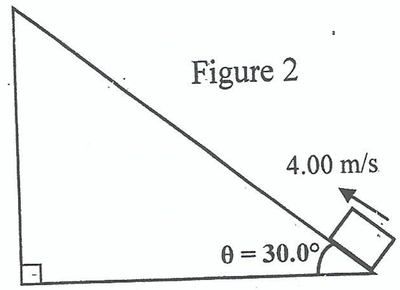
In **Figure 2,** a 6.00 kg block is projected up a frictionless plane at a speed of 4.00 m/s. The plane is inclined at an angle $\theta = 30.0°$ with the horizontal. How far up along the inclined plane does the block move before coming to stop? [Ignore air resistance]

A) 1.63 m
B) 0.850 m
C) 4.00 m
D) 1.00 m
E) 1.05 m




مبدأ حفظ الطاقة

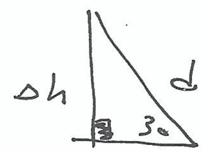
$$\Delta U + \Delta K = 0$$

$$mg\Delta h + \frac{1}{2} m \left(v_f^2 - v_i^2\right) = 0$$

$$6(9.8)\Delta h + \frac{1}{2}(6)(0 - 4^2) = 0$$

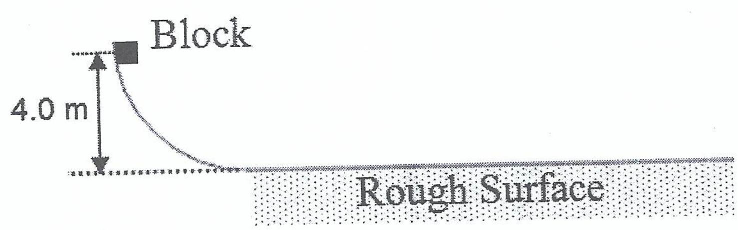
$$\Delta h = 0.815 \text{ m}$$

$$d = \frac{\Delta h}{\sin 30} = 1.63 \text{ m}$$




A 2.00-kg block slides on the surface shown in **Figure 8**. The curved surface is frictionless, but the horizontal surface is rough and has a coefficient of kinetic friction of 0.200 with the block. The block starts from rest 4.00 m above the rough surface. What is the distance travelled by the block on the rough surface before coming to rest.

A) 20.0 m
B) 15.0 m
C) 10.0 m
D) 18.2 m
E) 23.5 m




التغير في الطاقة الميكانيكية يعادل الشغل المبذول
بواسطة الاحتكاك

$$\Delta U + \Delta K = -f_k d$$

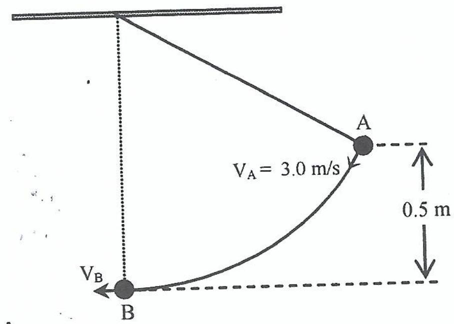
$$-\cancel{mg}\Delta h + 0 = -\mu_k \cancel{mg} d$$

$$(4) = 0.2 d$$

$$d = \frac{4}{0.2} = 20 \text{ m}$$

The pendulum, shown in **Figure 3**, is pulled aside until the ball has risen 0.50 m above the lowest position (B). It is then given an initial speed of $V_A = 3.0$ m/s. The speed (in m/s) of the ball $V_B$ at its lowest position (B) is: [Note: Neglect the air resistance]

Figure 3




A) 4.3
B) 3.0
C) 2.1
D) 5.3
E) 6.6

مبدأ حفظ الطاقة
الميكانيكية

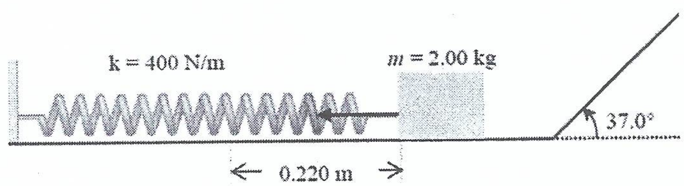
$$\Delta U + \Delta K = 0$$

$$\cancel{m} g \Delta h + \frac{1}{2}\cancel{m}(v_B^2 - v_A^2) = 0$$

$$-9.81(0.5) + \frac{1}{2}(v_B^2 - 3^2) = 0 \implies v_B = 4.3 \text{ m/s}$$

A 2.00 kg block is pushed against a spring, of force constant k = 400 N/m, compressing it by 0.220 m. When the block is released, it moves along a frictionless, horizontal surface and then up a frictionless incline with angle 37° (see **Figure 9**). How far does the block travel up the incline before coming to a stop?

Figure 9




A) 0.821 m
B) 0.234 m
C) 0.533 m
D) 0.115 m
E) 0.271 m

لاحظ أن النظام يحتوي على نابض

$$\Delta U_s + \Delta U_b + \cancel{\Delta K_b} = 0$$

$$\frac{1}{2}k(x_f^2 - x_i^2) + mg\,d\sin 37^\circ = 0$$

$$\frac{1}{2}(400)(0 - 0.22^2) + 2(9.8)\,d\sin 37 = 0$$

$$\implies d = 0.821 \text{ m}$$

A worker pushed a 27 kg block 9.2 m along a horizontal floor at a constant speed with a horizontal force. What is the increase in thermal energy of the block–floor system if the coefficient of kinetic friction between the block and floor is 0.20?

A) $4.9\times10^2$ J
B) $5.2\times10^2$ J
C) 62 J
D) Zcro
E) $2.4\times10^3$ J

$$\Delta E_{thermal} = f_k d = \mu_k m g d$$

$$= 0.2(27)(9.8)(9.2) = 4.9\times10^2 \text{ J}$$

MSK

SICS 101 - MAJOR EXAM 2 (031) - KFUPM, PHYSICS

8

Q0 Two balls, with masses m and 2m, are dropped
Q0 to the ground from the roof of a building. (Assume no air
Q0 resistance.) Just before hitting the ground, the heavier
Q0 ball has:
Q0
A1 two times as much kinetic energy as the lighter one.
A2 as much kinetic energy as the lighter one.
A3 half as much kinetic energy as the lighter one.
A4 four times as much kinetic energy as the lighter one.
A5 a kinetic energy that is impossible to determine.

Kinetic energy at ground is equal to potential energy up the building for each ball

for ball 1

$K_1 = mgd$

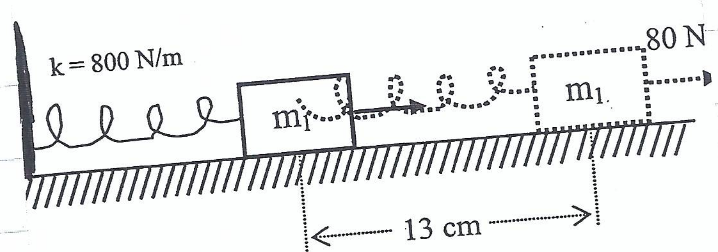
for ball 2

$K_2 = 2mgd$

$\Longrightarrow K_2 = 2K_1$

Q0
Q4 Q0 A 12-kg block is resting on a horizontal frictionless surface.
8✓ Q0 The block is attached to an unstretched spring (k= 800 N/m) (see
Q0 Fig.3). A force F = 80 N parallel to the surface is applied to
Q0 the block. What is the speed of the block when it is displaced
Q0 by 13 cm from its initial position?
Q0
A1 0.78 m/s
A2 0.85 m/s
A3 1.1 m/s
A4 0.58 m/s
A5 0.64 m/s

FIGURE 3




$m = 12\ kg$

$F = 80\ N$

$k = 800\ N/m$

$x_f = 0.13\ m$

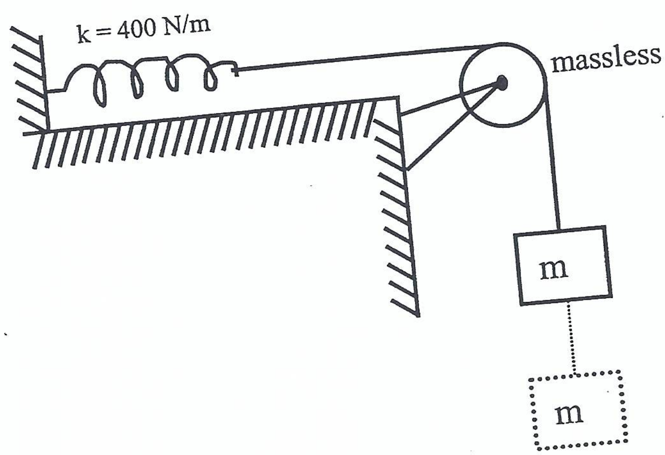
$\Longrightarrow \Delta U_s + \Delta K_b = W_{ap}$

$\frac{1}{2}(800)((0.13)^2 - 0) + \frac{1}{2}(12)(v^2) = 80(0.13)$

[illegible] m/s

lock of mass m = 10 kg is connected to unstretched spring
400 N/m) (see Fig. 4). The block is released from rest. If
pulley is ~~massless and frictionless~~, what is ~~the maximum~~
:ension of the spring?

**FIGURE 4**




cm
cm
cm
cm
cm

$m = 10\ kg$

$k = 400\ N/m$

$x_i = 0$

$x_f = ?$

$$\Delta U_s + \cancel{\Delta K_b}^{0} + \Delta U_b = 0$$

$$\frac{1}{2} k (x_f^2 - x_i^2) + -mg\,x_f = 0$$

$$\frac{1}{2}(400)(x_f^2 - 0) - 10(9.8)\,x_f = 0$$

$$200\,x_f^2 - 98\,x_f = 0$$

$$x_f\,(200\,x_f - 98) = 0$$

$$200\,x_f = 98 \implies x_f = \frac{98}{200} = 0.49\,m$$

Q0
Q6 Q0 A 0.6-kg ball is suspended from the ceiling at the end of a
8 Q0 2.0-m string. As this ball swings, it has a speed of 4.0 m/s at
Q0 the lowest point of its path. What maximum angle does the string

Q0 make with the vertical as the ball swings?
Q0
A1 54 degrees
A2 61 degrees
A3 69 degrees
A4 77 degrees
A5 47 degrees



$l = 2\,m$

8
3

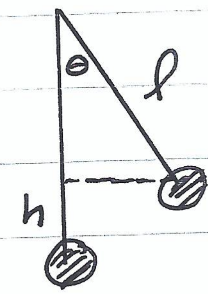
$U_{up} = K_{down}$

$mgh = \frac{1}{2} m v^2$

$\Longrightarrow v = \sqrt{2gh}$

$4 = \sqrt{2gh}$

$16 = 2gh \Longrightarrow h = \frac{16}{2g} = 0.82$




$\Longrightarrow h = l(1 - \cos\theta)$

$0.82 = 2(1 - \cos\theta)$

$0.41 = 1 - \cos\theta$

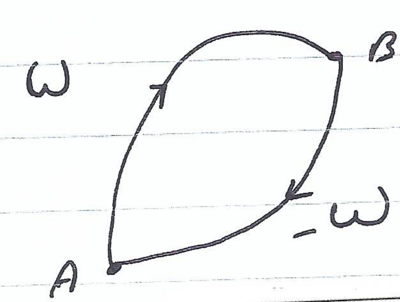
$\cos\theta = 1 - 0.41$

$= 0.5918$

$\Longrightarrow \theta = 54°$

Q7 Q0 When applied to a single object, a force is conservative if:
8 Q0
A1 its work done for motion in closed paths is equal to zero. ✓
A2 its work done for motion in closed paths is greater than zero.
A3 it is parallel to the displacement always.
A4 it does equal work in equal displacement.
A5 its work done for motion in closed paths is less than zero.

under conservative force in path ABA



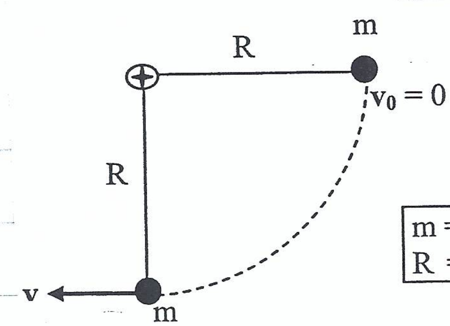

$\Longrightarrow W_{net} = W + -W$

$= 0$

8
4

Q0
Q5 Q0 A simple pendulum consists of a 2.0 kg mass attached
Q0 to a string of length R=1.5 m. It is pulled up until
Q0 the string is horizontal, and then released from rest
Q0 (see Fig 3). Its speed (v) at the lowest point is
Q0
A1 5.4 m/s
A2 4.1 m/s
A3 9.8 m/s
A4 8.5 m/s
A5 2.0 m/s

FIGURE-3




$m = 2\ kg$

$R = 1.5\ m$

$h = R(1 - \cos 90) = R$

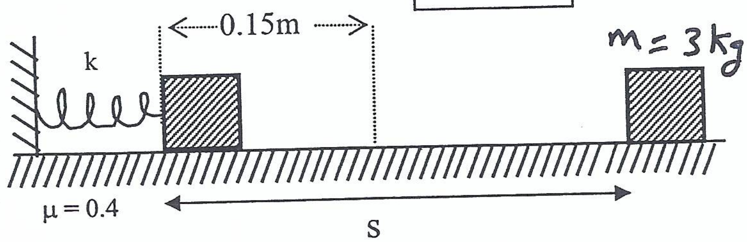
$v = \sqrt{2gR}$

$= \sqrt{2(9.8)(1.5)}$

$= 5.42\ m/s$

Q0 by 0.15 m, as shown in Fig. 2. When the block is
Q0 released, it travels a distance S on a horizontal
Q0 rough surface (mu=0.4) before stopping.
Q0 Calculate the distance S.
Q0
A1 0.48 m
A2 2.1 m
A3 3.2 m
A4 1.9 m
A5 0.15 m

FIGURE-2




$\mu_K = 0.4$

$X_i = 0.15\ m$

$K = 500\ N/m$

$m = 3\ kg$

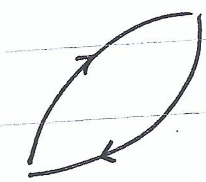
$\Delta U_s + \cancel{\Delta K_b}^{0} = -f_K d$

$\frac{1}{2}(500)(0 - (0.15)^2 = -\mu_K mg S$

$-5.625 = -(0.4)(3)(9.8) S$

Q0
Q0 A force acting on a particle is conservative if
Q0
A1 its work is zero when the particle moves
A1 around any closed path.
A2 its work depends on the path between the end
A2 points of the motion.
A3 its work equals the change in linear momentum of
A3 the particle.
A4 it must be perpendicular to the velocity of the particle
A4 on which it acts.
A5 it is a frictional force.

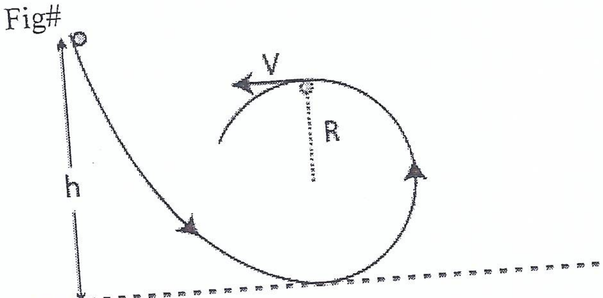
Conservative force $\Longrightarrow$



$W_{net} = 0$

Q2.
A ball slides without friction around a loop-the-loop (see Fig 2). A ball is released, from rest, at a height $h$ from the left side of the loop of radius $R$. What is the ratio ($h/R$) so that the ball has a speed $V = \sqrt{Rg}$ at the highest point of the loop? (g = acceleration due to gravity)

Fig#






A) (5/2)
B) (3/2)
C) (2/1)
D) (7/2)
E) (9/2)

$U_i + K_i = U_f + K_f$

$mgh + 0 = mg(2R) + \frac{1}{2} m \left(\sqrt{Rg}\right)^2$

$gh = 2gR + \frac{1}{2} gR$

$h = 2R + \frac{1}{2} R$

$h = \frac{5}{2} R \Longrightarrow \frac{h}{R} = \frac{5}{2}$

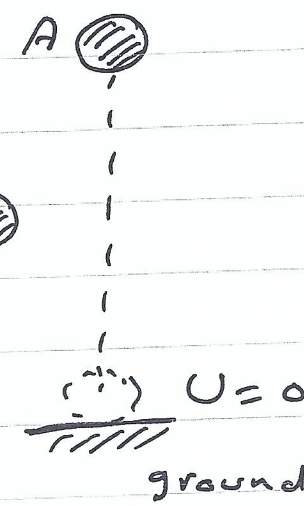
8/6

Q5.
A 2.0 kg block is released from rest 60 m above the ground. Take the gravitational potential energy of the block to be zero at the ground. At what height above the ground is the kinetic energy of the block equal to half its gravitational potential energy?
(Ignore air resistance).

A) 40 m
B) 30 m
C) 20 m
D) 10 m
E) 25 m

$m = 2\ kg$

$h = 60\ m$




$E_{mech}$ at A = $E_{mech}$ at B

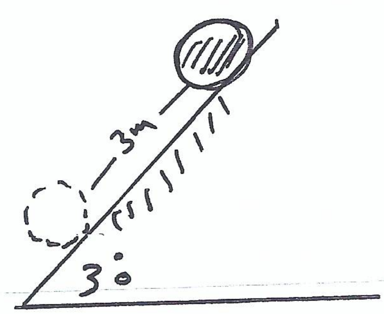
$U_A + \cancel{K_A}^{0} = U_B + K_B$

$mgh_A = mgh_B + \frac{1}{2} mgh_B$

$60 = \frac{3}{2} h_B \Rightarrow h_B = 40\ m$

Q6.
A 2.2 kg block starts from rest on a rough inclined plane that makes an angle of 30° above the horizontal. The coefficient of kinetic friction is 0.25. As the block moves 3.0 m down the plane, the change in the mechanical energy of the block is:

A) −14 J
B) −9.8 J
C) 9.8 J
D) −18 J
E) 18 J




$\Delta E_{mech} = -f_k d$

$= -\mu_k mg \cos 30\, d$

$= -0.25(2.2)(9.8)(3) \cos 30$

8
7

Q7.
A 0.50 kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. The speed of the block is 0.50 m/s, when the spring is stretched by 4.0 cm. The maximum speed the block can have is:

A) 0.71 m/s
B) 0.32 m/s
C) 0.55 m/s
D) 0.23 m/s
E) 0.93 m/s

$m = 0.5$ kg

$k = 80$ N/m

$v_i = 0.5$ m/s

$x_i = 0.04$ m

$x_f = 0$

$$\Delta U_s + \cancel{\Delta U_b}^{0} + \Delta K_b = 0$$

$$\frac{1}{2}k(x_f^2 - x_i^2) + \frac{1}{2}m(v_f^2 - v_i^2) = 0$$

$$\frac{1}{2}(80)(0 - (0.04)^2) + \frac{1}{2}(0.5)(v_f^2 - (0.5)^2) = 0$$

$$-0.064 + 0.25\, v_f^2 - 0.0625 = 0$$

$$v_f = 0.71 \text{ m/s}$$

Q4.
A 2-kg block slides across a horizontal frictionless floor with a speed of 2.0 m/s. It then runs into and compresses a spring of spring constant k = 800 N/m. The block comes momentarily to rest after compressing the spring a distance d. Find the distance d.

A) 10 cm
B) 20 cm
C) 30 cm
D) 5.0 cm
E) 25 cm

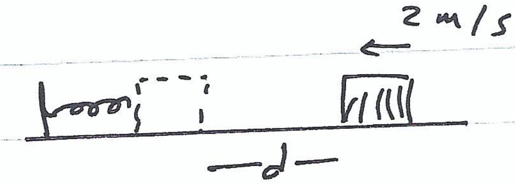
8
8

$m = 2\,kg$

$v_i = 2\,m/s$

$v_f = 0\,m/s$

$k = 800\,N/m$




$\Rightarrow \Delta U_s + \Delta K_b = 0$

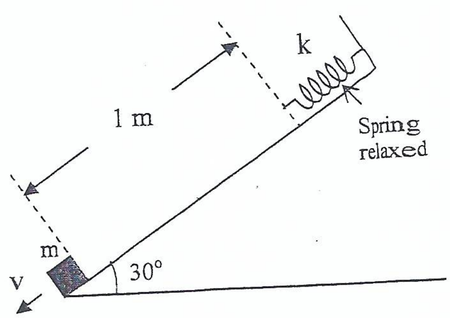
$\frac{1}{2} k (x_f^2 - x_i^2) + \frac{1}{2} m (v_f^2 - v_i^2) = 0$

$\frac{1}{2}(800)(d^2 - 0) + \frac{1}{2}(2)(0 - 2^2) = 0$

$400 d^2 - 4 = 0$

$d^2 = \frac{4}{400} = \frac{1}{100} \Rightarrow d = 0.1\,m$

Q6.
A spring with spring constant k = 106 N/m is attached to the top of a frictionless $30^0$ incline as shown in Figure 2. The distance between the lower end of the incline and the relaxed end of the spring is 1 m. A 1-kg block is pushed against the spring until the spring is compressed by 0.2 m and released from rest. Find the speed of the block when it reaches the lower end of the incline. (ignore the size of the block).






A) 4.0 m/s
B) 2.7 m/s
C) 3.7 m/s
D) 2.3 m/s
E) 0.0 m/s

8
9

$K = 106\ N/m$ $\quad m = 1kg$

$\theta = 30°$

$v_i = 0$

$v_f = ?$

$\Delta U_s + \Delta U_b + \Delta K_b = 0$

$\frac{1}{2}K(x_f^2 - x_i^2) - mgd\sin 30 + \frac{1}{2}m(v_f^2 - v_i^2) = 0$

$\frac{1}{2}(106)(0 - (0.2)^2) - (1)(9.8)(1.2)\sin 30 + \frac{1}{2}(1)v_f^2 = 0$

$-2.12 - 5.88 + \frac{1}{2}v_f^2 = 0$

$v_f^2 = 16 \implies v = 4\ m/s$

Q5.
A 2-kg object is dropped vertically from rest. After falling a distance of 50 m, it has a speed of 25 m/s. Calculate the work done by the air resistance on the object during this fall.

A) – 355 J
B) – 230 J
C) – 105 J
D) – 1200 J
E) 0.0 J

$m = 2kg$, $\Delta h = -50m$,

$W = \Delta E_{mech} = \Delta U + \Delta K$

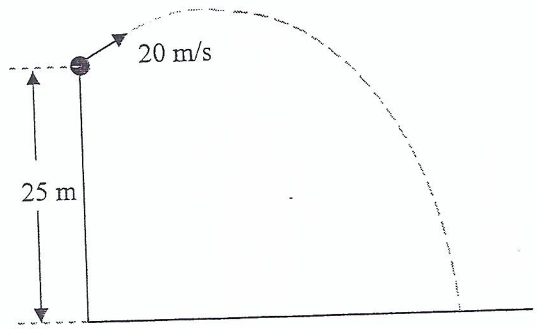
$= -2(9.8)(50) + \frac{1}{2}(2)(25)^2$

$= -355$

8
10



A projectile is fired from a height of 25 m with a speed of 20 m/s as shown in Figure 3. Find its speed when it hits the ground. Ignore air resistance.




A) 30 m/s
B) 20 m/s
C) 10 m/s
D) 40 m/s
E) 50 m/s

$$\Delta K + \Delta U = 0$$

$$\frac{1}{2} m(v_f^2 - v_i^2) + mg\Delta h = 0$$

$$\frac{1}{2}(v_f^2 - (20)^2) - 9.8(25) = 0$$

$$\frac{1}{2} v_f^2 - 200 - 245 = 0$$

$$\frac{1}{2} v_f^2 = 445 \Longrightarrow v_f^2 = 890$$

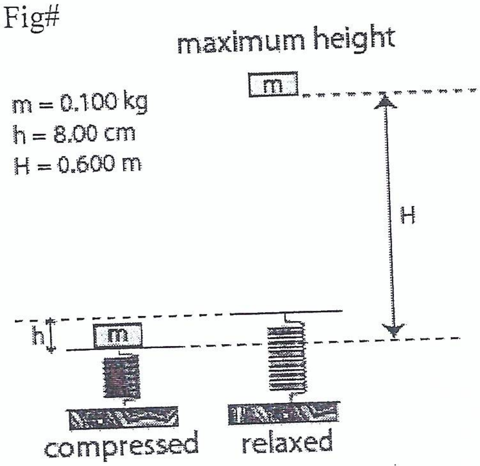
$$\Longrightarrow v = 29.83 \text{ m/s}$$

8
11



A block (mass = 0.100 kg) is pushed against a vertical spring compressing the spring a distance of h = 8.00 cm (see Fig 3). The block is not attached to the spring. When released from rest, the block rises to a maximum height of H = 0.600 m. Calculate the spring constant.

Fig#




A) 184 N/m
B) 155 N/m
C) 131 N/m
D) 115 N/m
E) 198 N/m



$K = ?$

$x_i = -0.08$ m

$x_f = 0$

$H = 0.6$ m

$m = 0.1$ kg

$\Delta U_s + \Delta U_b = 0$

$\frac{1}{2} k (x_f^2 - x_i^2) + mgH = 0$

$\frac{1}{2} k (0 - (0.08)^2) + 0.1 (9.8)(0.6) = 0$

$-\frac{1}{2} (0.08)^2 = -0.588$

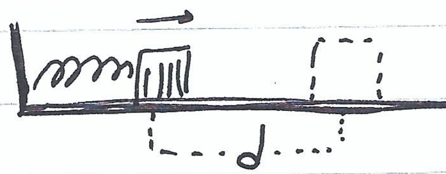
$K = 183.75$ N/m

8
12

Q6.
A 0.500-kg block is pushed against a horizontal spring fixed at one end (the block is NOT attached to the spring), compressing the spring 10.0 cm. The spring has a spring constant of $1.00 \times 10^2$ N/m. The block lies on a horizontal floor having a coefficient of kinetic friction $\mu_k = 0.200$. Find the total distance traveled by the block after being released from rest.

A) 51.0 cm
B) 20.0 cm
C) 10.0 cm
D) 6.00 cm
E) 80.0 cm

$m = 0.5$ kg
$K = 100$ N/m
$\mu_k = 0.2$
$x_i = -10$ cm
$x_f = 0$
$d = ?$



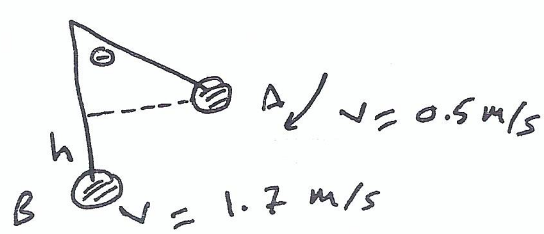

$\Delta U_s + \cancel{\Delta U_b}^{0} + \Delta K_b = -f_k d$

$\frac{1}{2} k (x_f^2 - x_i^2) + \frac{1}{2} m (v_f^2 - v_i^2) = -\mu_k m g d$

$\frac{1}{2}(100)(0 - (0.1)^2) + \frac{1}{2}(0.5)(0\ ) = -0.2(0.5)(9.8) d$

$d = 0.51$ m

Q7.
A simple pendulum consists of a 2.00 kg mass attached to a 1.00 m long light string. It is given an initial speed of 0.500 m/s at A where the pendulum makes an angle θ with the vertical as shown in Fig.1. If its speed at the lowest point B is 1.70 m/s, find the value of the angle θ.




A) 30.1 degrees
B) 45.2 degrees
C) 20.7 degrees
D) 15.9 degrees
E) 10.7 degrees

8
13

$$U_A + K_A = U_B + K_B$$

$$mgh + \frac{1}{2} m v_A^2 = 0 + \frac{1}{2} m v_B^2$$

$$(9.8)h + \frac{1}{2}(0.5)^2 = \frac{1}{2}(1.7)^2$$

$$9.8h = 1.445 - 0.125$$

$$9.8h = 1.32 \Rightarrow h = 0.135$$

$$h = l(1 - \cos\theta)$$

$$0.135 = (1)(1 - \cos\theta)$$

$$\cos\theta = 1 - 0.135$$

$$= 0.8653$$

$$\Rightarrow \theta = 30.082^\circ$$

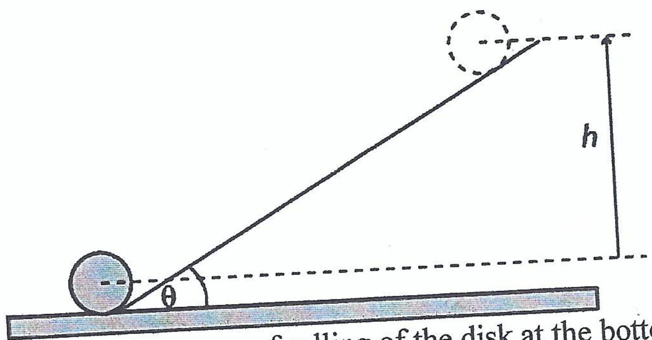
Q8.
A ball of mass m, attached at one end of a massless string of length L, rotates in a vertical circle fast enough to prevent the string from going loose at the top of the circle. Neglecting air resistance, during this motion, which ONE of the following statements is **WRONG:**

A) Change in mechanical energy is not zero.
B) The speed of the ball at the bottom of the circle is maximum.
C) The work done by the tension is zero.
D) Kinetic energy is not conserved.
E) Gravitational potential energy is not conserved.

8

Q4.
A uniform disk is rolling smoothly down a rough incline starting from rest from a height $h$ as shown in the Fig. 3. Which one of the following statement is correct?

Fig#     #:




A) Kinetic energy of rolling of the disk at the bottom of the incline is $mgh$
B) Mechanical energy is not conserved because there is friction
C) Rotational kinetic energy $\left(\frac{1}{2}I_{com}\omega^2\right)$ is equal to the translational kinetic energy $\left(\frac{1}{2}mv_{com}^2\right)$ at the bottom.
D) No change in rotational kinetic energy
E) Work done by static friction force is not zero.

$\omega_i = 0 \Rightarrow v_i = 0$ , $h_f = 0$

$K_i + U_i = K_f + U_f$

$0 + mgh = K_f + 0$

$K_f = mgh$

Calculus
Physics
0502010680

Q25.
A force of 120 $N$ stretches a certain spring a distance of 0.10 $m$. What is the elastic potential energy of the spring when it is compressed 0.10 $m$?

A) 6.0 $J$
B) 2.0 $J$
C) 4.0 $J$
D) 8.0 $J$
E) 10 $J$

$F = kx$

$120 = k(0.1) \Rightarrow k = 1200$ N/m

$U_s = \frac{1}{2}kx^2$

$= \frac{1}{2}(1200)(0.1)^2 = 6J$

8

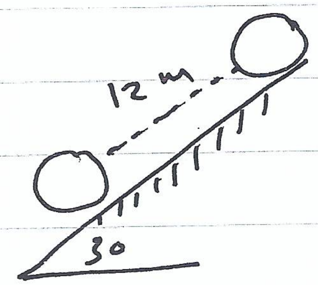
A box of mass = 10.0 kg is placed at the top of a 30.0° inclined plane. The box starts from rest and slides down the incline. The frictional force on the box during the slide is 25.0 *N*. After traveling 12.0 *m*, its kinetic energy is:

A) 288 *J*
B) 144 *J*
C) 980 *J*
D) 490 *J*
E) 0 *J*

$m = 10\ kg$

$f_k = 25\ N$

$d = 12\ m$




$$\Delta U_b + \Delta K_b = -f_k d$$

$$-mgd\sin 30 + K_f - 0 = -f_k d$$

$$-10(9.8)(12)\sin 30° + K_f = -25(12)$$

$$-588 + K_f = -300$$

$$K_f = -300 + 588$$

$$= 288\ J$$

Q5.
A 10.0 kg block is released from rest 100 m above the ground. When it has fallen 50 m, its kinetic energy is:

A) 4900 J
B) 9800 J
C) 1200 J
D) 120 J
E) 60 J

$v_0 = 0 \Rightarrow K_i = 0$

$\Delta K + \Delta U = 0$

$\Delta K = -\Delta U$



$K_f = -\Delta U$

$= -mg\Delta h$

$= -(10)(9.8)(-50)$

$= 4900\ J$

Q6.
A 4.0 kg block is initially moving to the right on a horizontal frictionless surface at a speed of 5.0 m/s. It then compresses a horizontal spring of spring constant 200 N/m. At the instant when the kinetic energy of the block is equal to the potential energy of the spring, the mechanical energy of the block-spring system is:

A) 50 J
B) 10 J
C) 25 J
D) 75 J
E) 15 J

$E_{mech\,i} = E_{mech\,f}$

$K_{bi} + U_{si} = E_{mech}$


$\frac{1}{2} m v_i^2 + 0 = E_{mech}$

$\frac{1}{2}(4)(5)^2 = E_{mech}$