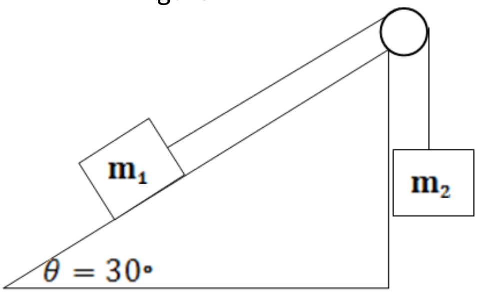
Q1.

Figure 1 shows two masses; m_1 = 4.0 kg and m_2 = 6.0 kg which are connected by a massless rope passing over a massless and frictionless pulley. Mass m_1 moves on a frictionless incline with $\theta = 30°$. Find the magnitude of the acceleration of mass m_2.

Figure 1



A) 3.9 m/s²
B) 9.8 m/s²
C) 7.9 m/s²
D) 1.2 m/s²
E) 5.5 m/s²

Ans:

$$T - m_1 g\sin 30 = m_1 a$$

$$m_2 g - T = m_2 a$$

$$\Rightarrow a = \frac{(m_2 - m_1 \sin 30)g}{m_1 + m_2} = 3.9\ m/s^2$$

Q2.

A ball is thrown vertically upward. Neglecting air resistance, which one of the following statements is **FALSE**.

A) The potential energy of the earth-ball system decreases as the ball is going up.
B) The kinetic energy of the ball decreases while the ball is going up.
C) The sum of the kinetic energy of the ball and potential energy of ball-earth system is constant.
D) The potential energy of the earth-ball system decreases as the ball is coming down.
E) The kinetic energy of the ball increases when the ball is coming down.

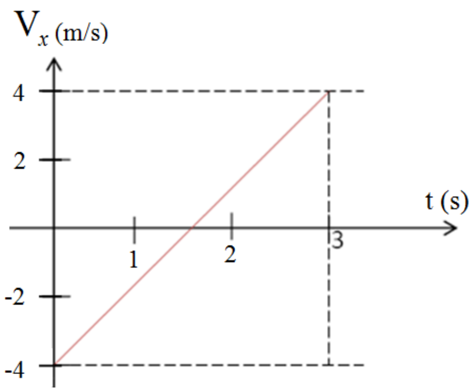
Ans:

A

Q3.

Figure 2 shows the speed V_x of a 3.00 kg mass as a function of time due two constant forces $\vec{F}_1$ and $\vec{F}_2$ causing the mass to slide on a frictionless horizontal surface. Force F_1 = 7.00 N and is along the positive *x*-direction and F_2 = 6.00 N is in the *xy*-plane. Find the angle between the direction of F_2 and the positive *x* axis.

Figure 2



A) 80.4°

B) 89.5°

C) 39.6°

D) 71.4°

E) 23.3°

Ans:

$F_1 + F_2\cos\theta = ma$

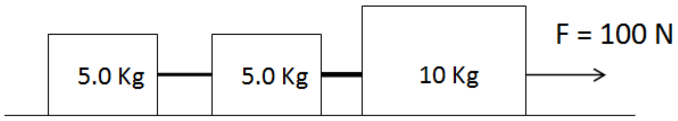
$a = 2.66 \ \mathrm{m/s^2}$

$\Rightarrow \theta = 80.4°$

Q4.

Figure 3 shows three connected blocks by two cords and being pulled across a horizontal frictionless surface by a constant horizontal force F = 100 N. Find the tension in the cord between the 5 kg and 10 kg blocks.

Figure 3



A) 50 N

B) 10 N

C) 90 N

D) 20 N

E) 0

Ans:

$$a = \frac{100}{20} = 5 \ \mathrm{m/s^2}$$

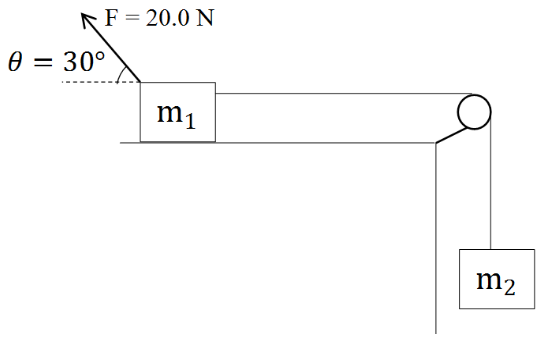
$100 - T_2 = 10 \ a$

$\Rightarrow T_2 = 50 \ \mathrm{N}$

Q5.

In **Figure 4**, two masses m_1 = 2.00 kg and m_2 = 3.00 kg are connected by a massless string passing over a massless and frictionless pulley. Mass m_1 moves on a horizontal surface having a coefficient of kinetic friction μ_k= 0.500 and is subject to a constant force F = 20.0 N. Find the magnitude of the acceleration of m_2.

Figure 4



A) 1.46 m/s²

B) 2.72 m/s²

C) 9.80 m/s²

D) 4.60 m/s²

E) 0

Ans:

$$T_1 - F\cos 30 - \mu_k(m_1 g - F\sin 30) = m_1 a$$

$$T - 17.32 - 0.5(2g - (20)(0.5) = 2R \quad \longrightarrow (1)$$

$$m_2 g - T = m_2 a$$

$$29.4 - T = 3\,a \quad \longrightarrow (2)$$

$$(1) + (2) \Rightarrow 29.4 - 22.12 = 5a$$

$$a = 1.46\ \text{m/s}^2$$

Q6.

A man riding a bicycle with a 100 kg total mass is performing horizontal circles on flat track. If the coefficient of static friction between the tires and track is 0.600, find the smallest radius the man can make when travelling at a speed of 10.0 m/s.

A) 17.0 m

B) 10.3 m

C) 13.6 m

D) 30.2 m

E) 23.5 m

Ans:

$$f_s = \mu_s mg = \frac{mv^2}{r}$$

$$r = \frac{v^2}{\mu_s g} = 17\ \text{m}$$

Q7.

A small block of mass m_1 = 1.0 kg is put on the top of a large block of mass m_2 = 4.0 kg. The large block can move on a horizontal frictionless surface while the coefficients of friction between the large and small blocks are μ_s= 0.60 and μ_k= 0.4. A horizontal force F = 5.0 N is applied to the small block (See **Figure 5**). Find the acceleration of the large block m_2.

A) 1.0 m/s^2

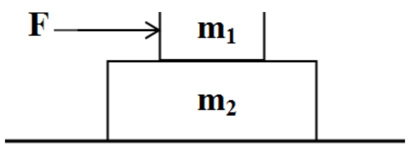
B) 2.7 m/s^2

C) 9.8 m/s^2

D) 4.6 m/s^2

E) 1.3 m/s^2

Figure 5



Ans:

$$f_s = \mu_s mg = 5.88 > 5\ \mathrm{N}$$

$$\Rightarrow m_1 \text{ is not moving}$$

$$\frac{F}{S} = (m_1 + m_2)a \Rightarrow a = 1\ \mathrm{m/s^2}$$

Q8.

In **Figure 6** two forces F_1 and F_2 are applied to a box of mass m as it slides at constant velocity over a frictionless horizontal surface. Now by decreasing the angle θ while keeping the magnitude of F_1 and the box velocity constant, then which one of the following statements is **CORRECT**.

A) The magnitude of F_2 increases while the magnitude of the Normal force increases.

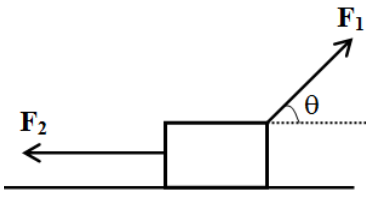
B) The magnitude of F_2 increases while the magnitude of the Normal force decreases.

C) The magnitude of F_2 decreases while the magnitude of the Normal force increases.

D) The magnitude of F_2 is constant while the magnitude of the Normal force decreases.

E) The magnitude of F_2 is constant while the magnitude of the Normal force increases.

Figure 6



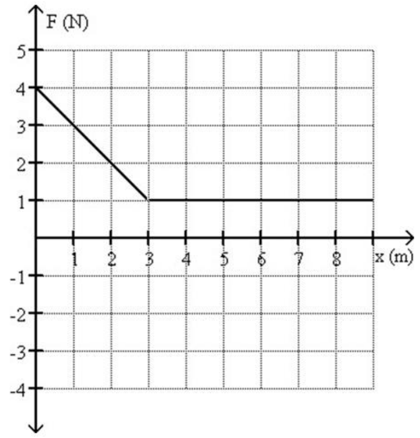
Ans:

$$N = mg - F_1 \sin 30$$

Q9.

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, find 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

Ans:

$$W = \Delta K = \text{Area} = 6.5\ \text{J}$$

$$V_f^2 = 10.58$$

$$\Longrightarrow V_f = 3.3\ \text{m/s}$$

Q10.

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

Ans:

$$W = \vec{F} \cdot \Delta\vec{d} = 0$$

$$\Delta\vec{d} = 0$$

Q11.

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

Ans:

$$W = \Delta K$$

$$\vec{F} \cdot \vec{d} = (6)(3) - (9)(1) = \frac{1}{2} m V_f^2 - 0$$

$$\Rightarrow v = 3 \text{ m/s}$$

Q12.

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) 3.83×10^{3} kg

B) 3.75×10^{4} kg

C) 3.75×10^{2} kg

D) 1.75×10^{2} kg

E) 3.37×10^{3} kg

Ans:

$$P = \vec{F} \cdot \vec{v} = mg \cdot \vec{v}$$

$$m = \frac{150 \times 10^3}{9.8 \times 4} = 3.83 \times 10^3 \text{ Kg}$$

Q13.

In **Figure 8**, A 2.00 kg block situated on a rough incline is connected to a spring of negligible mass and spring constant 100 N/m. The block is released from rest when the spring is unstretched. If the pulley is massless and frictionless and the block moves 20.0 cm down the incline before coming to rest, then find the coefficient of kinetic friction between the block and incline.

A) 0.115

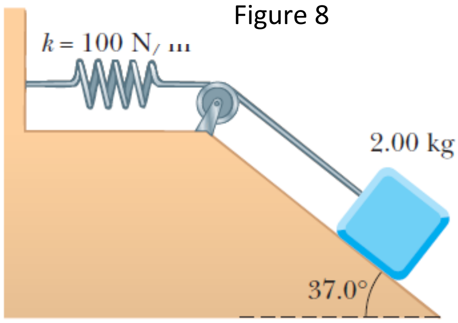
B) 0.235

C) 0.498

D) 0.403

E) 0.495

Figure 8



Ans:

$$\Delta K + \Delta U_g + \Delta U_s = W_{nc}$$

$$\Delta K = 0$$

$$\Delta U_g = -mgd\sin 37 = -2.36$$

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

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

$$W_{nc} = -\mu_k mg\cos\theta d = -3.13\,\mu_k$$

$$\Rightarrow \mu_k = 0.115$$

Q14.

A horizontal spring is fixed at one end. If it requires 6.0 J of work to stretch the spring by 2.0 cm from its equilibrium length, how much more work will be required to stretch it an additional 4.0 cm?

A) 48 J

B) 54 J

C) 6.0 J

D) 12 J

Ans:

$$U_s = 6 = \frac{1}{2}kx^2 \Rightarrow k = 3 \times 10^4\ N/m$$

$$W_s = \frac{1}{2}k\left(x_f^2 - x_i^2\right) = 48\,J$$

Q15.

A 3.00 kg box starts from rest and slides down an incline. The incline is 0.500 m high and the angle of inclination is 30.0°. If the box experiences a constant friction force of magnitude 5.00 N, then find the speed of the box as it reaches the bottom of the incline.

A) 2.54 m/s

B) 6.47 m/s

C) 3.96 m/s

D) 5.58 m/s

E) 8.76 m/s

Ans:

$$\Delta K + \Delta U_g = W_{nc}$$

$$\frac{1}{2}mv^2 - mgh = -F\frac{h}{sin30}$$

$$\Rightarrow v = 2.54\, m/s$$