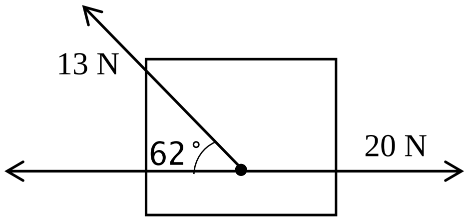
Q1.

Only two horizontal forces act on a 3.0 kg body that can move over a frictionless floor. One force is 20 N, acting due east, and the other is 13 N, acting 62° north of west. What is the magnitude of the body's acceleration?

A) 6.0 m/s^2
B) 7.1 m/s^2
C) 9.0 m/s^2
D) 1.3 m/s^2
E) 12 m/s^2



Ans:

$$F_1 - F_2\cos\theta = ma$$

$$20 - 13\cos 62° = 3a$$

$$a_x = \frac{(20 - 13\cos 62°)}{3} = 4.6$$

$$a_y = 13 sin 62° = 3.8$$

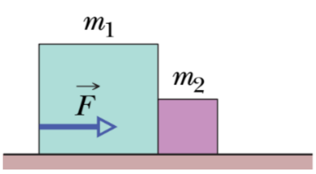
$$a = \sqrt{a_x^2 + a_y^2} = 6.0\ m/s^2$$

Q2.

Two blocks are in contact on a frictionless table. A horizontal force $\vec{F}$ is applied to the larger block, as shown in **Figure 1**. If m_1 = 2.5 kg, m_2 = 1.0 kg, and the force on the smaller block by the larger block is 2.0 N, find the magnitude of the force $\vec{F}$.

A) 7.0 N
B) 2.5 N
C) 5.0 N
D) 3.2 N
E) 9.0 N

Figure 1



Ans:

$$F = (m_1 + m_2)a = (2.5 + 1)a = 3.5\ a$$

$$F_{21} = 2.0\ N$$

$$m_2 a = 2.0 \Rightarrow a = 2.0\ m/s^2$$

$$F = 3.5 \times 2.0 = 7.0\ N$$

Q3.

A spaceship moves vertically upward from the Moon, where g = 1.6 m/s^2. If the ship has an upward acceleration of 1.2 m/s^2 as it moves, what is the magnitude of the force exerted by the ship on its pilot, who weighs 735 N on Earth?

A) 210 N
B) 340 N
C) 107 N
D) 430 N
E) 947 N

Ans:

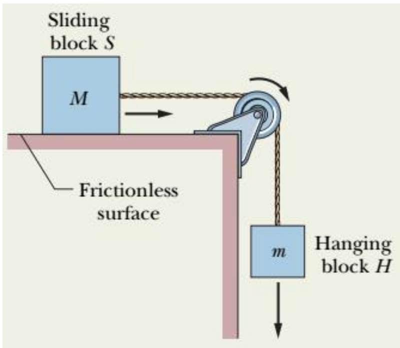
$$W = 735\ ; \quad m = \frac{735}{9.8} = 75\ kg$$

$$F_N - mg_m = ma \Rightarrow F_N = m(g_m + a) = 75 \times (1.6 + 1.21) = 210\ N$$

Q4.

A sliding block S of mass *M* = 9.0 kg and a hanging block H of mass *m* = 6.2 kg are connected by a massless string, as shown in **Figure 2**. If the pulley is massless as well as frictionless, and the surface is frictionless, the magnitude of the acceleration of the 6.2 kg block is: [Ignore the air resistance]

Figure 2



A) 4.0 m/s^2
B) 1.3 m/s^2
C) 6.0 m/s^2
D) 8.2 m/s^2
E) 2.7 m/s^2

Ans:

$$T = Ma$$

$$T - mg = -ma$$

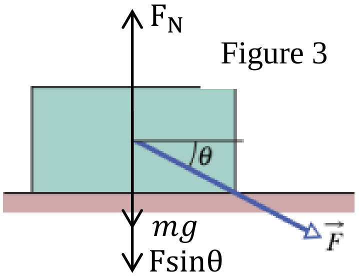
$$Ma + ma = mg$$

$$a = \left(\frac{m}{M+m}\right) g = \left(\frac{6.2}{9+6.2}\right) 9.8 = 4.0\ m/s^2$$

Q5.

A 5.00 kg block is pushed along a horizontal floor by a force $\vec{F}$ of magnitude 25.0 N at an angle $\boldsymbol{\theta}$ = 40.0° with the horizontal as shown in **Figure 3**. The coefficient of kinetic friction between the block and the floor is 0.250. Calculate the magnitude of the force of friction on the block from the floor.

Figure 3



A) 16.3 N
B) 1.30 N
C) 6.73 N
D) 28.2 N
E) 52.7 N

Ans:

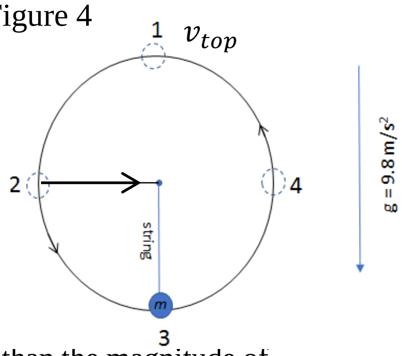
$$f = \mu F_N = \mu(mg + F\sin\theta)$$

$$f = 0.25(5 \times 9.8 + 25\sin(40°)) = 16.3 \text{ N}$$

Q6.

A body of mass *m*, tied to a massless string, rotates in a **vertical circle**. Four positions of the body in the circle at different time are shown in **Figure 4**. Which one of the following statements in regards to the tension on the string is **False**? [Ignore the air resistance]

Figure 4



A) The magnitude of tension at position 3 is smaller than the magnitude of tension at position 1.
B) The magnitude of tension at position 1 is smaller than the magnitude of tension at position 3.
C) The magnitude of tension at position 2 is greater than the magnitude of tension at position 1.
D) The magnitude of tension at position 3 is greater than the magnitude of tension at position 4.
E) The magnitude of tension at position 2 is smaller than the magnitude of tension at position 3.

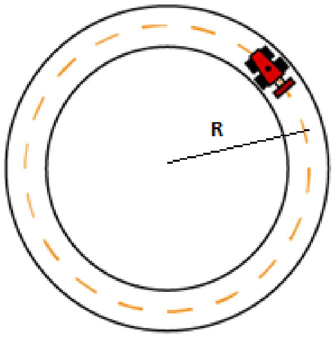
Ans:

A

Q7.

Figure 5 represents a race car of mass m = 600 kg as it travels on a flat horizontal track in a circular track of radius R = 100 m. The coefficient of static friction between the tires and the track is 0.680, and the coefficient of kinetic friction is 0.340. If the car is on the verge of sliding out of the turn, find the magnitude of the centripetal force on the race car. [Ignore the air resistance]

Figure 5



A) 4.00×10^3 N
B) 6.00×10^3 N
C) 3.00×10^3 N
D) 5.00×10^3 N
E) 2.00×10^3 N

Ans:

$$f_s = F_c$$

$$F_c = \mu_s F_N$$

$$= 0.68 \times mg = 4000 \text{ N}$$

Q8.

A single force acts on a 3.00 kg particle-like object, moving along the x-axis, whose position is given by $x = 3.00\, t - 2.00\, t^2$, with x in meters and t in seconds. Find the work done on the object by the force over the time interval t = 0 to t = 4.00 s.

A) 240 J
B) 530 J
C) 615 J
D) 131 J
E) 980 J

Ans:

$$x(t) = 3t - 2t^2 \Rightarrow a = \frac{d^2x}{dt^2} = -4 \text{ m/s}^2$$

$$W = ma\Delta x = ma\big(x(4) - x(0)\big) = 3 \times (-4) \times (12 - 32) = 240 \text{ J}$$

Q9.

Rank the following velocities according to kinetic energy a particle will have with each velocity, greatest first: (a) $\vec{v} = 4\,\hat{i} + 3\,\hat{j}$ (b) $\vec{v} = 3\,\hat{i} - 4\,\hat{j}$ (c) $5\,\hat{i}$ (d) 5 m/s at 30° to the horizontal (e) $5\,\hat{j}$:

A) all tie
B) (a, b, c, e) tie and then d
C) d and (a, b, c, e) tie
D) (a, b) tie (c, e) tie and then d
E) a, b, c, e and d

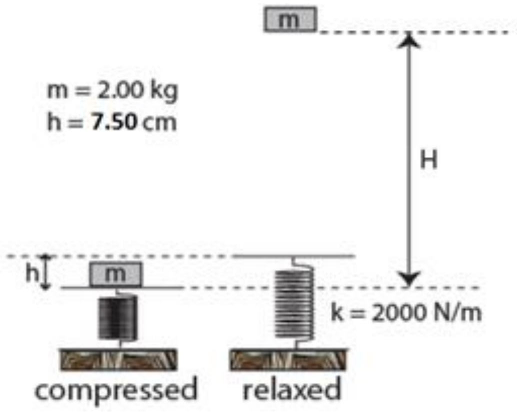
Ans:

A

Q10.

A vertical spring is compressed at distance h = 7.50 cm from its relaxed position and a 2.00 kg block is placed on top of it**.** When the spring is released, the block will move up with maximum speed v_{max} and it will stop at maximum height H. The maximum height H is measured from the compressed position of the spring as shown in **Figure 6**. Provided the spring constant $k = 2.00\times10^3$ N/m, the values of v_{max} and H **respectively** are: [Ignore air resistance]

Figure 6



A) 2.04 m/s and 28.7 cm
B) 1.05 m/s and 11.8 cm
C) 9.65 m/s and 28.7 cm
D) 5.35 m/s and 11.8 cm
E) 7.08 m/s and 77.6 cm

Ans:

$$\frac{1}{2}kh^2 = \frac{1}{2}mv_{max}^2 + mgh$$

$$v_{max} = \sqrt{\frac{k}{m}h^2 - 2gh}$$

$$v_{max} = \sqrt{\frac{2000}{2}\left(\frac{7.5}{100}\right)^2 - 2\times9.8\times\frac{7.5}{100}} = 2.04\ m/s$$

$$\frac{1}{2}kh^2 = mgH$$

$$H = \frac{1}{2}\frac{kh^2}{mg} = \frac{1}{2}\frac{2000\times\left(\frac{7.5}{100}\right)^2}{2\times9.8} = 28.7\text{ cm}$$

Q11.

A 600 kg elevator in a tall building start to move up from rest with constant acceleration and reaches the speed of 7.00 m/s in 30.0 s. The average power of the motor that drives the elevator is: [Ignore air resistance]

A) 2.11×10^4 W
B) 4.50×10^4 W
C) 1.52×10^4 W
D) 6.95×10^4 W
E) 3.71×10^4 W

Ans:

$$a = \frac{v - v_0}{t} = \frac{7}{30}$$

$$h = v_0 t + \frac{1}{2}at^2 = 0 + \frac{1}{2}\times\frac{7}{30}\times 30 = 105\ m$$

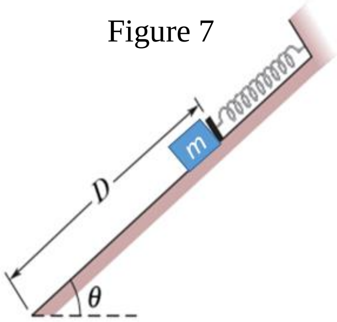
$$P_{avg} = \frac{\Delta K + \Delta U}{t} = \frac{\frac{1}{2}mv^2 + mgh}{t}$$

$$P_{avg} = \frac{\frac{1}{2}\times 600\times 7^2 + 600\times 9.8\times 105}{30} = 21070 = 2.11\times 10^4\ W$$

Q12.

In **Figure 7**, a spring with k = 550 N/m is at the top of a frictionless incline of angle θ = 37.0°. The lower end of the incline is distance D = 1.00 m from the end of the spring, which is at its relaxed length. What is the speed of the object when it reaches the lower end of the incline? [Ignore air resistance]

Figure 7



A) 4.50 m/s
B) 1.70 m/s
C) 6.13 m/s
D) 2.50 m/s
E) 7.00 m/s

Ans:

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

$$\Delta U_s + \Delta U_g + \Delta K = 0$$

$$-\frac{1}{2}kx^2 - mg\sin\theta(D + x) + \frac{1}{2}mv^2 = 0$$

$$v = \sqrt{\frac{k}{m}x^2 + 2g(D + x)\sin\theta} = \sqrt{\frac{550}{3.6}0.2^2 + 28.8(1.2)\sin 37°} = 4.5\ m/s$$

Q13.

A block of mass 27.0 kg, initially moving at 2.00 m/s, is pushed by a constant horizontal force, along a level floor and displaces it by 9.20 m. At the end of the displacement the block was moving with velocity 3.00 m/s. If the coefficient of kinetic friction between the block and the floor is 0.200, find the work done by the force. [Ignore air resistance]

A) 554 J
B) 121 J
C) 734 J
D) 44.8 J
E) 894 J

Ans:

$$W_f + W_a = \Delta K$$

$$W_a = \frac{1}{2}m(v^2 - v_0^2) + \mu_k mg\Delta x$$

$$= \frac{1}{2} \times 27(3^2 - 2^2) + 0.2 \times 27 \times 9.8 \times 9.2 = 554 \text{ J}$$

Q14.

Which one of the following statements is **True**?

A) The work done by a conservative force on a body does not depend on path followed by the body.
B) The work done by a non-conservative force on a body does not depend on path followed by the body.
C) Spring force is an example of a non-conservative force.
D) Gravitational force is an example of non-conservative force.
E) Friction force is an example of conservative force.

Ans:

A

Q15.

A 0.50 kg ball is thrown vertically upward from a point 1.1 m above the ground with a speed of 12 m/s. When it has reached a height of 2.1 m above the ground, its speed is 10 m/s. The change in mechanical energy of the ball is:

A) - 6.1 J
B) + 6.1 J
C) - 4.5 J
D) + 4.5 J
E) zero

Ans:

$$\mathrm{E}-\mathrm{E}_0 = \mathrm{K}+\mathrm{U}- K_0 - U_0$$

$$= \frac{1}{2}\mathrm{m}(v^2 - v_0^2) + mg\,(2.1-1.1)$$

$$= \frac{1}{2}\times\frac{1}{2}\,[100-144] + \frac{1}{2}\times 9.8\times 1$$

$$= -\frac{44}{4} + 4.9 = -11 + 4.9 = -6.1 \ \mathbf{J}$$