

Q1.

A 500-kg elevator cab accelerates upward at 4.2 m/s^2 . The tension force of the cable on the elevator cab is:

A) 7.0 kN

B) 2.8 kN

C) 4.9 kN

D) 2.1 kN

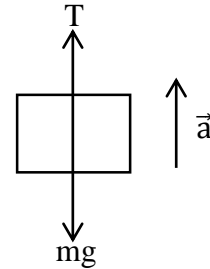
E) 2.5 kN

Ans:

$$ma = T - mg$$

$$T = m(g + a)$$

$$= 500(9.8 + 4.2) = 7000 \text{ N}$$

**Q2.**

In **Figure 1**, the three blocks, $m_1 = 1.0 \text{ kg}$, $m_2 = 2.0 \text{ kg}$, and $m_3 = 3.0 \text{ kg}$, move on a frictionless surface, where a 42 N horizontal force acts on the 3.0 kg block (see **Figure 1**). Blocks m_1 and m_3 are connected with a light cord. What is the force exerted by m_1 on m_2 ?

A) 14 N

B) 42 N

C) 21 N

D) 28 N

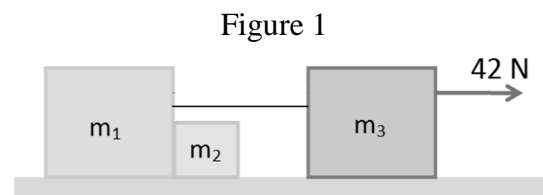
E) 0 N

Ans:

$$F = (m_1 + m_2 + m_3)a$$

$$a = \frac{F}{m_1 + m_2 + m_3} \Rightarrow a = \frac{42}{6} = 7 \text{ m/s}^2$$

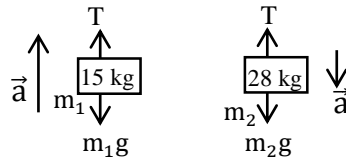
$$f = m_2 a = 2 \times 7 = 14 \text{ N}$$



Q3.

Two objects of masses 15.0 kg and 28.0 kg are connected by a massless string passing over a massless and frictionless pulley, as shown in **Figure 2**. What is the tension in the string?

- A) 191 N
 B) 274 N
 C) 147 N
 D) 421 N
 E) 127 N



Ans:

$$m_1 a = T - m_1 g \rightarrow (1)$$

$$m_2 a = m_2 g - T \rightarrow (2)$$

Adding (1) and (2)

$$(m_1 + m_2)a = (m_2 - m_1)g$$

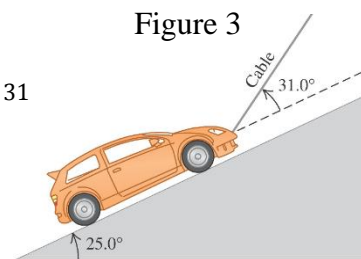
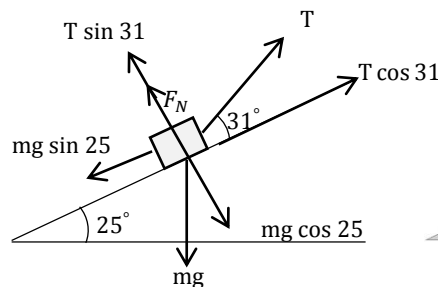
$$a = \left(\frac{m_2 - m_1}{m_1 + m_2} \right) g = 2.96$$

$$\text{From (1)} \Rightarrow T = m_1 (a + g) = 191 \text{ N}$$

Q4.

A 1130-kg car is held in place by a light cable on a frictionless ramp, as shown in **Figure 3**. The cable makes an angle 31.0° above the surface of the ramp. The ramp itself makes an angle of 25.0° with the horizontal. What is the normal force exerted on the car by the ramp surface?

- A) $7.2 \times 10^3 \text{ N}$
 B) $1.1 \times 10^4 \text{ N}$
 C) $4.8 \times 10^2 \text{ N}$
 D) $1.0 \times 10^3 \text{ N}$
 E) $2.4 \times 10^3 \text{ N}$



Ans:

x - axis:

$$T \cos 31 = mg \sin 25$$

$$T = mg \frac{\sin 25}{\cos 31} \rightarrow (1)$$

y - axis:

$$mg \cos 25 = T \sin 31 + F_N \Rightarrow F_N = mg \cos 25 - T \sin 31 \rightarrow (2)$$

$$\text{From (1)} F_N = mg \cos 25 - mg \tan 31 \sin 25 = 7.2 \times 10^3 \text{ N}$$

Q5.

Blocks A and B are placed as in **Figure 4** and connected by a rope of negligible mass. Both A and B weigh 25.0 N each, and the coefficient of kinetic friction between each block and the surface is 0.35. Block B moves with constant velocity while applying a Force **F**. The pulley is massless and frictionless. What is the tension in the rope connecting blocks A and B?

A) 8.80 N

B) 14.7 N

C) 20.2 N

D) 25.0 N

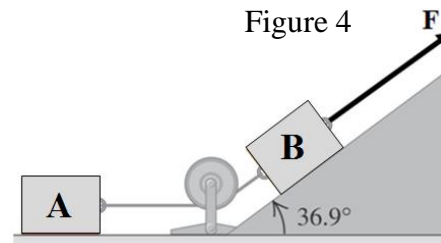
E) 10.1 N

Ans:

Applying Newton's 2nd Law on Block A

$$T - f_k = 0 \Rightarrow T - \mu_k mg = 0$$

$$T = \mu_k mg = 0.35 \times 25 = 8.80 \text{ N}$$



Q6.

Two objects of masses $m_1 = 10.0 \text{ kg}$ and $m_2 = 5.00 \text{ kg}$ are connected by a light string that passes over a frictionless pulley, as shown in **Figure 5**. The object m_1 sits on a rough horizontal surface. When the system starts moving from rest, m_2 falls 1.00 m in 1.20 s. What is the coefficient of kinetic friction between m_1 and the surface?

A) 0.287

B) 0.142

C) 1.00

D) 0.345

E) 0.735

Ans:

$$x = v_0 t + \frac{1}{2} a t^2$$

$$1 = 0 + \frac{1}{2} a (1.2)^2 \Rightarrow a = 1.39$$

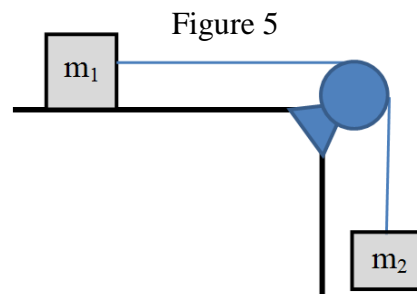
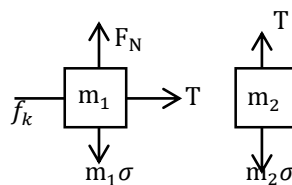
$$m_2 a = m_2 g - T \rightarrow (1)$$

$$m_1 a = T - f_k$$

$$m_1 a = T - \mu_k m_1 g \rightarrow (2)$$

$$\text{Adding (1) and (2); } (m_1 + m_2)a = m_2 g - \mu_k m_1 g$$

$$\mu_k = \frac{m_2 g - (m_1 + m_2)a}{m_1 g} = 0.287$$



Q7.

A small object of mass $m = 5.0$ kg is suspended from a string of length L . The object rotates with constant speed v in a horizontal circle of radius $r = 60$ cm, as shown in **Figure 6**. The angle between the string and the vertical is $\theta = 30^\circ$. What is the speed v ?

A) 1.8 m/s

B) 3.2 m/s

C) 1.2 m/s

D) 7.0 m/s

E) 2.6 m/s

Ans:

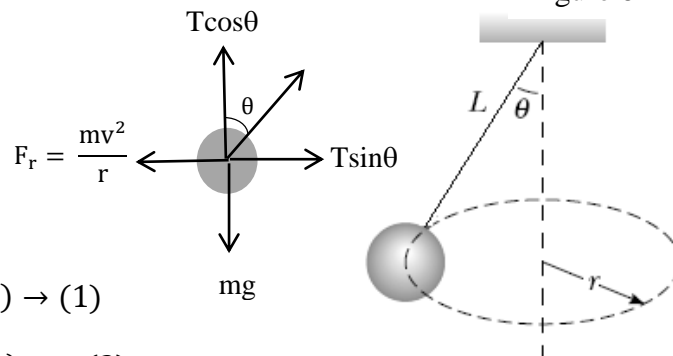
$$T \sin \theta = \frac{mv^2}{r} \quad (\text{x axis}) \rightarrow (1)$$

$$T \cos \theta = mg \quad (\text{y axis}) \rightarrow (2)$$

Dividing (1) by (2)

$$\tan \theta = \frac{v^2}{gr}$$

$$v^2 = gr \tan \theta \Rightarrow v = 1.8 \text{ m/s}$$



Q8.

A 25.0-kg box is initially moving with a velocity that has magnitude 3.50 m/s in a direction 37.0° west of north. How much work must be done to change its velocity to 5.60 m/s in a direction 63.0° south of east?

A) 239 J

B) 263 J

C) 245 J

D) 114 J

E) 290 J

Ans:

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

$$= \frac{1}{2} (25) [(5.6)^2 - (3.5)^2] = 239 \text{ J}$$

Q9.

In the three cases shown in **Figure 7**, an object is released from rest at the top, and experiences no friction or air resistance. Rank the cases according to the speed of the object at the bottom, **greatest first**. (m in the figure represents mass).

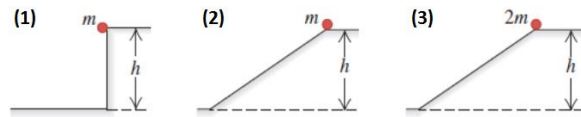
A) All tie

B) (1 and 2 tie), then 3

C) 3 then (1 and 2 tie)

D) (2 and 3 tie), then 1

E) 1 then (2 and 3 tie)



Ans:

$$v_f = \sqrt{2gh}, \quad \text{all tie}$$

Q10.

A particle moves along the x -axis. The net force on the particle increases as a function of x according to the formula $F = Bx$, where $B = 120 \text{ N/m}$, F is in newtons and x is in meters. How much work does this force do on the particle as it moves from $x = 0$ to $x = 0.50 \text{ m}$?

A) 15 J

B) 7.5 J

C) 30 J

D) 60 J

E) 120 J

Ans:

$$F_{\text{av}} = \frac{120 \times 0.5}{2} = 30 \text{ N}$$

$$W = F_{\text{av}} \Delta x = 30 \times 0.5 = 15 \text{ J}$$

Q11.

A 15.0-kg box, initially moving at 8.00 m/s, slides into a rough horizontal surface. The coefficient of kinetic friction between the box and the surface is 0.200. What is the absolute value of average power produced by the force of friction if the box stops after 4.08 s?

A) 118 W

B) 408 W

C) 196 W

D) 73.2 W

E) 40.7 W

Ans:

$$W_{\text{net}} = \Delta K = -K_i$$

$$= -\frac{1}{2} m v_i^2 = 0.5 \times 15 \times 64 = -480 \text{ J}$$

$$\Delta t = 4.08 \text{ s}$$

$$P_{\text{avg}} = \frac{W_{\text{net}}}{\Delta t} = \frac{480}{4.08} = 118 \text{ W}$$

Q12.

A 2.5-kg block rests on a rough horizontal floor where it compresses a horizontal spring by a distance of 0.030 m. The force constant of the spring is 850 N/m. The block is then released and slides on the floor. The coefficient of kinetic friction between the block and floor is 0.40. What is the speed of the block after it has moved a distance of 0.020 m?

A) 0.34 m/s

B) 0.26 m/s

C) 0.54 m/s

D) 0.11 m/s

E) 0.29 m/s

Ans:

$$\Delta K + \Delta U = W_f$$

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

$$v_f = \sqrt{\frac{k}{m} x_i^2 - k x_f^2 - 2\mu_k g d} = 0.34$$

Q13.

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.

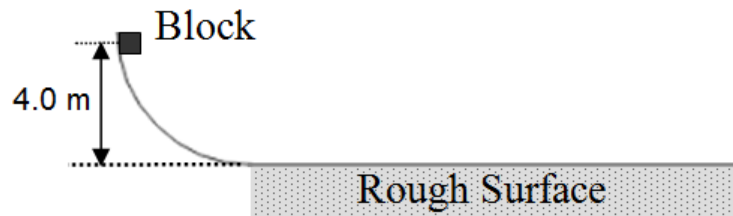
- A) 20.0 m
- B) 15.0 m
- C) 10.0 m
- D) 18.2 m
- E) 23.5 m

Ans:

$$\Delta K + \Delta U = W_f$$

$$mgh = \mu_k mgd$$

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

**Q14.**

Which ONE of the following statements is TRUE?

- A) The power due to a force is the rate at which that force does work on the object.
- B) The gravitational force and the spring force are examples of non-conservative forces.
- C) The change in the mechanical energy of a system is always positive.
- D) The change in the mechanical energy of a system is always negative.
- E) The work done by a conservative force on a particle moving between two points depend on the path taken by the particle.

Ans:

A

Q15.

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) 4.9×10^2 J

B) 5.2×10^2 J

C) 62 J

D) Zero

E) 2.4×10^3 J

Ans:

$$F = f_k = \mu_k F_N$$

$$F_N = mg$$

$$f_k = \mu_k mg$$

$$\Delta E_{th} = f_k d = \mu_k mgd = 0.2 \times 27 \times 9.8 \times 9.2 = 486.9 \text{ J}$$
