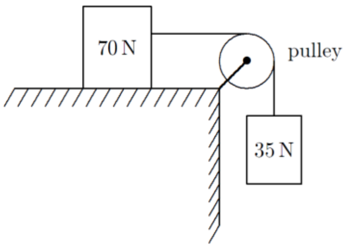
Q1.

A 70 N block and a 35 N block are connected by a massless inextendable string which is wrapped over a frictionless pulley as shown in **Figure 1**. If the pulley is massless and the surface is frictionless, find the magnitude of the acceleration of the 35 N block.

Figure 1



A) 3.3 m/s^2
B) 2.3 m/s^2
C) 1.3 m/s^2
D) 9.8 m/s^2
E) 4.9 m/s^2

Ans:

$$T - 35 = -M_{35}a = -\frac{35}{9.8}a = -3.57a \rightarrow (1)$$

$$\mathrm{T} = \mathrm{M}_{70}\mathrm{a} = \frac{70}{9.8}\ \mathrm{a} = 7.14\mathrm{a} \rightarrow (2)$$

$$(2) - (1)\text{gives } 35 = 7.14\ \mathrm{a} + 3.57\ \mathrm{a} \rightarrow \mathrm{a} = 3.3\ \mathrm{m/s^2}$$

Or: treat the two masses as one, so

$$(m_1+m_2)a=m_1g \quad \Rightarrow \quad \frac{(35+70)}{g}a = 35 \quad \Rightarrow \quad a=\frac{35\times g}{105}=3.27$$

Q2.

You stand on a spring scale on the floor of an elevator. The scale shows the **highest reading** when the elevator (choose the **CORRECT** answer):

A) Moves upward with increasing speed
B) Moves upward with decreasing speed
C) Remains stationary
D) Moves downward with increasing speed
E) Moves downward at constant speed

Ans:

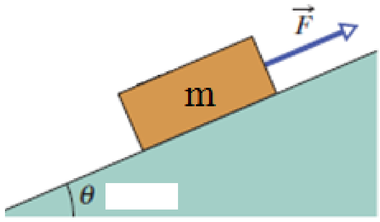
$T - 35 = -$FN = scale reading = mg + ma

So, the highest reading occurs whenever the elevator is moving up with increasing speed (positive acceleration).

Q3.

A 40.0 kg mass is pulled up by a rope along an inclined frictionless surface which makes an angle of 18.5° with the horizontal. The pulling rope is parallel to the incline and has a tension of 140 N. Assume that the mass starts from rest at the bottom of the incline; find its velocity after moving 80.0 m up the incline?

A) 7.90 m/s
B) 3.90 m/s
C) 1.39 m/s
D) 0
E) 9.80 m/s



Ans:

Along the inclined:

$$T - mgsin(18.5) = ma \Rightarrow a = \frac{T}{m} - gsin(18.5)$$

$$a = \frac{140}{40.0} - (9.8)\sin(18.5) = 0.390\ m/s^2$$

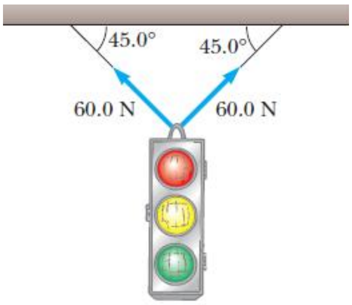
$$v = \sqrt{v_0^2 + 2a(\Delta x)} = \sqrt{0 + (2)(0.390)(80)} = 7.90\ m/s$$

Q4.

Find the resultant force exerted by the two cables supporting the traffic light as shown in **Figure 2**.

Figure 2

A) 84.9 N vertically upward
B) 60.0 N vertically upward
C) 84.9 N vertically downward
D) 120 N vertically upward
E) 120 N vertically downward



Ans:

$$\sum F_x = (60)cos(45) - (60)cos(45) = 0$$

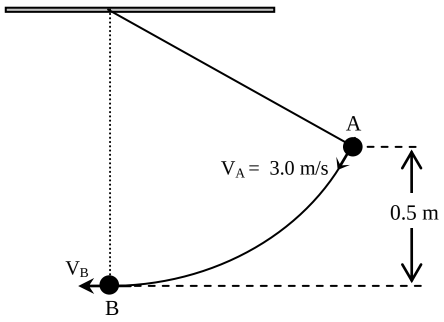
$$\sum F_y = (60)\sin(45) + (60)\sin(45) = 84.9\ N$$

$$F_R = 84.9 \text{ N vertically upward}$$

Q5.

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

Ans:

$$V_A = 3.0 \text{ m/s}, h = 0.5 \text{ m}$$

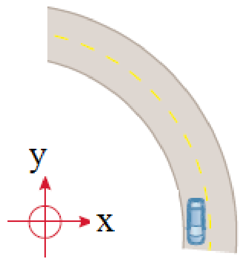
$$\Delta K + \Delta U = 0 \Rightarrow \frac{1}{2}mV_B^2 - \frac{1}{2}mV_A^2 - mgh = 0$$

$$V_B = \sqrt{V_A^2 + 2gh} \Rightarrow v = 4.3 \text{ m/s}$$

Q6.

A 55.0 kg man drives his car through a flat circular track of radius 300 m with a constant speed of 80.0 km/h. What is the magnitude of the net force exerted by the seat of the car on the man at the moment shown in **Figure 4**?

Figure 4



A) 546.5 N
B) 402.4 N
C) 300.0 N
D) 600.0 N
E) 354.4 N

Ans:

$$N = mg = 55 \times 9.8 = 539 \text{ N}$$

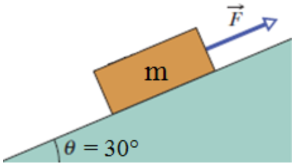
$$F_c = m\frac{v^2}{R} = 55\frac{(80 \times 1000/3600)^2}{300} = 90.53 \text{ N}$$

$$F_{net} = \sqrt{90.5^2 + 539^2} = 546.547$$

Q7.

A block, of mass m = 4.0 kg, is pulled upward an inclined rough plane with a constant force $\vec{F}$ parallel to the incline (See Figure 5). The incline makes an angle $\theta = 30°$ with the horizontal and the coefficient of the kinetic friction between the plane and the block is 0.35. What value of $\vec{F}$ is required to move the block up the incline at constant velocity?

A) 31.5 N
B) 28.0 N
C) 20.0 N
D) 44.4 N
E) 13.1 N



Ans:

$$F - mg\sin\theta - \mu_k mg\cos\theta = 0$$

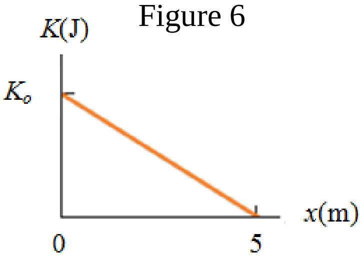
$$\Rightarrow F = mg\left(\sin\theta + \mu_k\cos\theta\right) = 31.48N$$

Q8.

An object, of mass = 8.0 kg, is moving in the positive direction of an x axis. **Figure 6** gives its kinetic energy K(J) versus position x(m) as it moves from x = 0 to x = 5.0 m; K_0 = 30.0 J. What is the magnitude of the constant force applied on the object?

A) 6.0 N
B) 8.0 N
C) 0
D) 3.7 N
E) 78 N

Figure 6



Ans:

$$F\Delta x = \Delta K = -30 \text{ J} \Rightarrow |F| = \left|\frac{-30}{5}\right| = 6 \text{ N}$$

Q9.

An elevator, fully loaded with passengers, has a mass of 4000 kg. What power must be delivered by the motor (tension in the cable) so that the elevator moves up at constant speed of 2.0 m/s?

A) 78.4 kW
B) 18.4 kW
C) 71.3 W
D) 80.0 kW
E) 98.2 kW

Ans:

$$\text{Power} = \mathbf{T} \cdot \mathbf{v} = mgv = 4000 \times 9.8 \times 2 = 78.4 \text{ kW}$$

Q10.

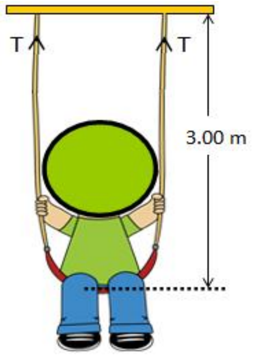
A student lifted his bag to a height *h*. The work done by both the student and the gravitational force (mg), respectively are:

A) Positive, negative
B) Negative, positive
C) Negative, negative
D) Positive, positive
E) Positive, mg does no work

Q11.

A 40.0 kg child swings in a swing supported by two chains, each 3.00 m long, as shown in **Figure 7**. The tension, T, in each chain at the lowest point of his swing is 350 N. Find the child's speeds at the lowest point of his swing.

Figure 7



A) 4.8 m/s
B) 5.3 m/s
C) 2.3 m/s
D) 6.6 m/s
E) 1.0 m/s

Ans:

$$2T - mg = m\frac{v^2}{r}$$

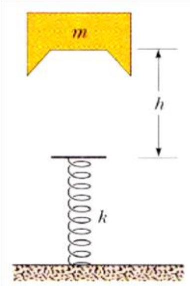
$$700 - 392 = \frac{40}{3}v^2 \Rightarrow v = 4.8 m/s$$

Q12.

Figure 8 shows a spring (with k = 1600 N/m) placed vertically with one end fixed to the floor. A block of mass m = 1.5 kg is dropped from rest onto the spring from a height h above the top of the spring. If the maximum distance that the spring will be compressed is 0.13 m, what is the value of h? [Note: Neglect the air resistance]

A) 0.79 m
B) 0.52 m
C) 0.20 m
D) 0.25 m
E) 0.02 m

Figure 8



Ans:

$k = 1600; m = 1.5; g = 9.8; x = 0.13$

$solving[-0.5k(x)^2 + mg(h + x) == 0, h] \Rightarrow h \rightarrow 0.79$

Q13.

A 2.4 kg block, on a horizontal floor, is attached to a horizontal spring of spring constant 840 N/m which is initially compressed by 0.03 m. The coefficient of kinetic friction between the floor and the block is 0.40. What is the speed of the block when it has moved a distance of 0.03 m from its initial position?

A) 0.28 m/s
B) 0.12 m/s
C) 0.98 m/s
D) 0.63 m/s
E) 0.37 m/s

Ans:

$m = 2.4$ kg, $V = ?$ m/s, $xf = 0.03$ m, $\mu = 0.4$, $xi = 0$

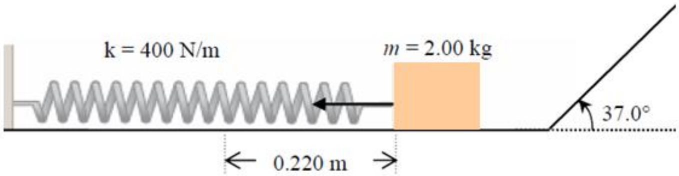
$$\Delta K + \Delta U_g + \Delta U_s = W_{nc} \Rightarrow \frac{1}{2}mV^2 + 0 - \frac{1}{2}k(xf^2 - xi^2) = -\mu mg(xf - xi)$$

$$\frac{1}{2}2.4\times V^2 = \frac{1}{2}840(0.03^2) - 0.4\times 2.4\times 9.8\times 0.03 \Rightarrow V = 0.2825 \text{ m}$$

Q14.

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

Ans:

$$\Delta u_g + \Delta u_s + \cancelto{0}{\Delta k} = 0$$

$$\Delta u_g = mgh = mgd\sin\theta = 2 \times 9.8 \times d \times \sin 37° = 11.8\, d$$

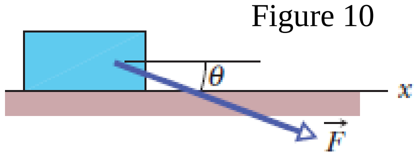
$$\Delta u_s = \frac{1}{2}kx^2 = -\frac{1}{2} \times 400 \times 0.22^2 = -9.68 \text{ J}$$

$$\Rightarrow 11.8\, d - 9.68 = 0 \Rightarrow d = 0.82\, m$$

Q15.

As shown in **Figure 10**, a box is stationary on a rough surface and the force $\vec{F}$ acting on the block makes an angle θ with the horizontal. If the angle θ is increased from 0° to 90° in the fourth quadrant (choose the **CORRECT** statement):

Figure 10



A) The magnitude of the normal force on the block increases
B) The *x*-component of the force $\vec{F}$ increases
C) The coefficient of static friction increases
D) The magnitude of the force of static friction decreases
E) The magnitude of the vertical component of the force $\vec{F}$ decreases

Ans:

A or D
