Q1.

Find the mass of a solid lead cube with an edge of 2.00 ft if the density of lead is 11.4×10^3 kg/m^3 (1.00 m is equivalent to 3.28 ft).

A) 2.58×10^3 kg
B) 9.08×10^3 kg
C) 4.57×10^2 kg
D) 6.43×10^3 kg
E) 1.29×10^3 kg

Ans:

$$V = a^3 \; ; \; a = (2.00 \text{ ft}) \left(\frac{1.0 \text{ m}}{3.28 \text{ ft}}\right) = 0.610 \text{ m}$$

$$V = (0.610)^3 \text{m}^3 = 0.227 \text{ m}^3$$

$$m = \rho V = (11.35 \times 10^3 \text{ kg/m}^3)(0.227 \text{ m}^3) = 2.58 \times 10^3 \text{ kg}$$

Q2.

The speed v in m/s of an automobile is given by $v = at^3 + bt^2$, where the time t is in seconds. The dimensions of a and b are, respectively:

A) LT^{-4} ; LT^{-3}
B) LT^{+4} ; LT^{+3}
C) LT^{+3} ; LT^{-2}
D) LT^{+4} ; LT^{-3}
E) LT^{-2} ; LT^{-1}

Ans:

$$v = at^3 + bt^2$$

Each term on the right should have the dimension of v (i.e., LT^{-1})

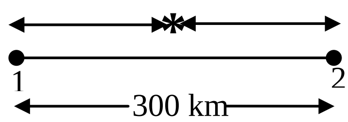
$$a = LT^{-1} \times T^{-3} = LT^{-4}$$

$$b = LT^{-1} \times T^{-2} = LT^{-3}$$

Q3.

Two automobiles are 3.00×10^2 kilometers apart and traveling toward each other. One automobile is moving at 60.0 km/h and the other is moving at 40.0 km/h. In how many hours will they meet?

A) 3.00
B) 2.00
C) 1.75
D) 5.50
E) 7.50



Ans:

Let they meet after time t at point A

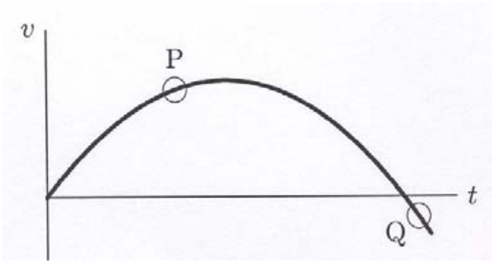
$$\left.\begin{array}{l} x_1 = v_1 t \\ x_2 = v_2 t \end{array}\right\} \Rightarrow x_1 + x_2 = v_1 t + v_2 t$$

$$300 = (60 + 40)t \Rightarrow t = \frac{300}{100} = 3.00 \text{ hours}$$

Q4.

Figure 1 shows a velocity-time graph for a car moving in a straight line. At point Q the car must be:

Fig# 1

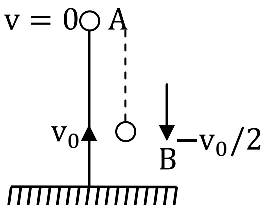


A) traveling in the opposite direction to that at point P
B) moving with zero acceleration
C) traveling downhill
D) traveling below ground-level
E) moving with a higher speed than that at point P

Q5.

A ball is thrown vertically upward with an initial velocity v_o and reaches its maximum height in 8.0 *s*. At what time, after it was thrown, will it have velocity ($-v_o/2$)?

A) 12 *s*
B) 16 *s*
C) 4.0 *s*
D) 20 *s*
E) 10 *s*



Ans:

Point A: $\cancel{v} = v_0 - gt \Rightarrow v_0 = 9.8 \times 8\ m/s = 78.4\ m/s$

Point B: $v = 0 - gt'$

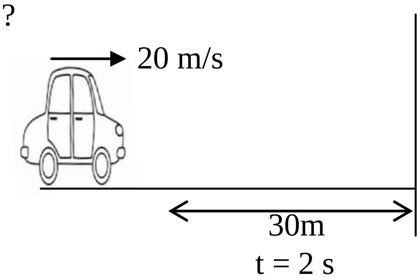
$$-v_0/2 = 0 - gt' \Rightarrow t' = \frac{v_0}{2g} = 4.0\ s$$

Time $= (8 + 4) = 12\ s$

Q6.

A car travelling at 20.0 m/s is 30.0 m from a wall when the driver applies the brakes. The car hits the wall 2.00 s later. How fast is the car travelling just before it hits the wall (assume constant acceleration)?

A) 10.0 m/s
B) 11.8 m/s
C) 20.0 m/s
D) 8.50 m/s
E) 15.0 m/s



Ans:

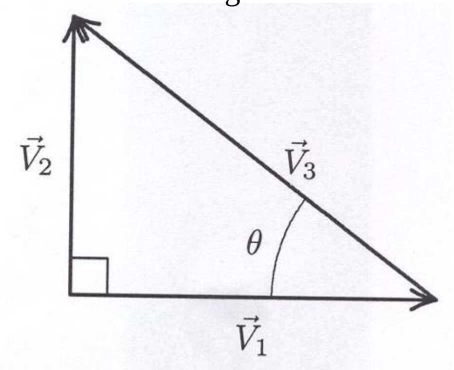
$$\Delta x = \left(\frac{v + v_0}{2}\right) t$$

$$30 = \frac{v + 20}{\cancel{2}} \times \cancel{2} \quad \Rightarrow v = 30 - 20 = 10\ m/s$$

Q7.

The vector $\vec{V}_1$ in Figure 2 is equal to:

Fig# 2



A) $\vec{V}_2 - \vec{V}_3$
B) $\vec{V}_3 - \vec{V}_2$
C) $\vec{V}_2 + \vec{V}_3$
D) $\vec{V}_3 \cos\theta$
E) $\vec{V}_3 \times \vec{V}_2$

Ans:

$$\vec{v}_1 + \vec{v}_3 = \vec{v}_2$$

$$\vec{v}_1 = \vec{v}_2 - \vec{v}_3$$

Q8.

The x component of vector $\vec{A}$ is -3.00 m and the y component is + 4.00 m. Find the magnitude of $\vec{A}$ and the angle that it makes with the positive x-axis.

A) 5.00 m; 127°
B) 5.00 m; 53.1°
C) 7.00 m; 127°
D) 7.00 m; 53.1°
E) 1.00 m; 127°

Ans:

$$\vec{A} = (-3.00\,\hat{\imath} + 4.00\,\hat{\jmath})\text{m}$$

$$|\vec{A}| = \sqrt{9+16} = 5.00 \text{ m}$$

$$\theta_x = \cos^{-1}\frac{A_x}{A} = \cos^{-1}\frac{-3}{5}$$

$$\theta_x = 126.9° \approx 127°$$

Q9.

What is the angle between the two vectors $\vec{A} = -2.0\hat{i} - 2.0\hat{j} - 2.0\hat{k}$ and $\vec{B} = 3.0\hat{i} + 3.0\hat{j} + 3.0\hat{k}$?

A) 180^{o}
B) 0^{o}
C) 270^{o}
D) 360^{o}
E) 90^{o}

Ans:

$$\cos\theta = \frac{\vec{A}.\vec{B}}{AB} = \frac{-6-6-6}{\sqrt{12}\sqrt{27}} = \frac{-18}{18} = -1$$

$$\Rightarrow \theta = 180°$$

Q10.

Find $\vec{A}.\left(\vec{B} \times \vec{A}\right)$ if $\vec{A} = 3.0\hat{i} + 3.0\hat{j} + 3.0\hat{k}$ and $\vec{B} = 4.0\hat{i} + 4.0\hat{j} + 4.0\hat{k}$

A) 0
B) 12
C) 6.0
D) 18
E) 24

Ans:

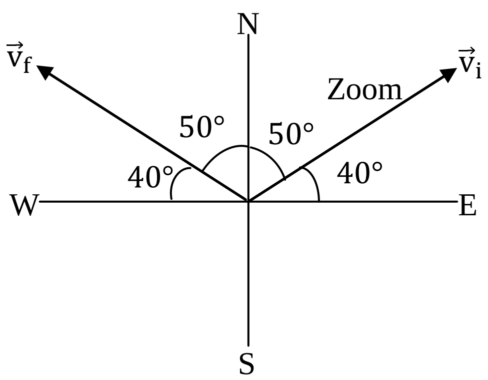
Vector $\vec{B} \times \vec{A}$ is perpendicular to both $\vec{A}$ and $\vec{B}$

So, $\vec{A}.(\vec{B} \times \vec{A}) = 0$

Q11.

A plane is initially travelling in a direction 50.0^{o} east of north at 2.00 $\times 10^{2}$ m/s. It then travels in a direction 50.0^{o} west of north at 2.00 $\times 10^{2}$ m/s. The CHANGE in its velocity is:

A) 306 m/s West
B) 306 m/s East
C) 200 m/s East
D) 200 m/s West
E) 0 m/s



Ans:

$$\vec{v}_i = 200\cos 40°\,\hat{\imath} + 200\sin 40°\,\hat{\jmath}$$

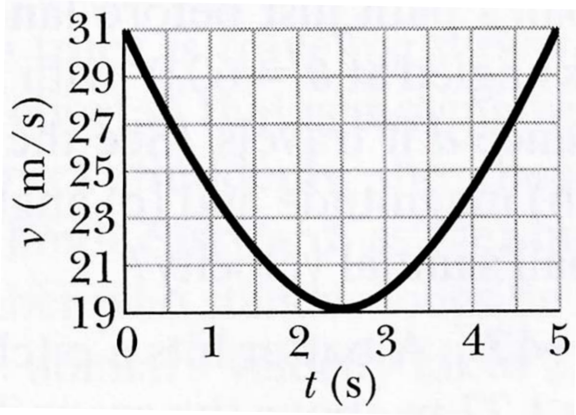
$$\vec{v}_f = -200\cos 40°\,\hat{\imath} + 200\sin 40°\,\hat{\jmath}$$

$$\vec{v}_f - \vec{v}_i = -400\cos 40°\,\hat{\imath} = (-306\ m/s)\hat{\imath}$$

Q12.

A golf ball is struck at ground level. The speed of the golf ball as a function of time is shown in Figure 3, where t = 0 at the instant the ball is struck. How far does the ball travel horizontally before returning to ground level?

Fig# 3



A) 95 m
B) 15 m
C) 42 m
D) 77 m
E) 50 m

Ans:

From the Fig: $v_x = 19.0$ m/s

t = 5.0 s

$$\Delta x = v_x t = 95.0\ m$$

Q13.

An Earth satellite moves in a circular orbit of 6.64×10^6 m radius and with a period of 60.0 minutes. What is the centripetal acceleration of the satellite?

A) 20.2 m/s^2
B) 52.8 m/s^2
C) 43.7 m/s^2
D) 18.4 m/s^2
E) 95.3 m/s^2

Ans:

$$a = \frac{v^2}{r} = \frac{\left(\frac{2\pi r}{T}\right)^2}{r} = \frac{4\pi^2 r}{T^2}$$

$$\therefore a = 4\left(\frac{22}{7}\right)^2 \times \frac{6.64 \times 10^6}{(60 \times 60)^2} = 20.2\ \mathrm{m/s^2}$$

Q14.

A man runs with a constant speed along a moving sidewalk from one end to the other, taking 2.50 s. He then runs back with the same constant speed along the sidewalk to his starting point, taking 10.0 s. What is the ratio of the man's running speed to the sidewalk's speed?

A) 1.67
B) 0.600
C) 4.00
D) 0.250
E) 2.50

Ans:

Let d is the total lenght of the moving side walk. Then

$$2.50 = \frac{d}{v + v_s} \qquad v = \text{speed of man}; \;\; v_s = \text{speed of side walk}$$

$$10.0 = \frac{d}{v - v_s}$$

$$\frac{10.0}{2.50} = \frac{v + v_s}{v - v_s} \Rightarrow 4(v - v_s) = v + v_s$$

$$3v = 5v_s \;\; \Rightarrow \frac{v}{v_s} = \frac{5}{3}$$

Q15.

A particle moves at constant velocity $\vec{v} = (3.0\, m/s)\,\hat{i} - (4.0\, m/s)\,\hat{j}$ under the effect of three forces. If two of the forces are $\vec{F}_1 = (2.0\, N)\,\hat{i} + (-6.0\, N)\,\hat{j}$ and $\vec{F}_2 = (3.0\, N)\,\hat{i} + (-4.0\, N)\,\hat{j}$. Find the third force $\vec{F}_3$.

A) $\vec{F}_3 = (-5.0\, N)\,\hat{i} + (10\, N)\,\hat{j}$
B) $\vec{F}_3 = (5.0\, N)\,\hat{i} + (-10\, N)\,\hat{j}$
C) $\vec{F}_3 = (2.0\, N)\,\hat{i} + (5.0\, N)\,\hat{j}$
D) $\vec{F}_3 = (-3.0\, N)\,\hat{i} + (-6.0\, N)\,\hat{j}$
E) $\vec{F}_3 = (-6.0\, N)\,\hat{i} + (-8.0\, N)\,\hat{j}$

Ans:

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = m\vec{a} = 0$$

$$\vec{F}_3 = -(\vec{F}_1 + \vec{F}_2)$$

$$= -(\vec{F}_1 + \vec{F}_2)$$

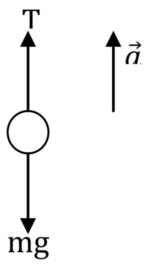
$$= -(5.0\,\hat{\imath} - 10\,\hat{\jmath})N$$

$$= (-5.0\,\hat{\imath} + 10\,\hat{\jmath})N$$

Q16.

An elevator cabin that weighs 30.0 kN moves upward. What is the tension in the cable if the cabin's speed is increasing at a rate of 1.00 m/s^2?

A) 33.1 kN
B) 35.0 kN
C) 30.0 kN
D) 31.0 kN
E) 26.9 kN



Ans:

$$m = \frac{30 \times 10^3}{9.8} = 3.06 \times 10^3 \text{ kg}$$

$$T - mg = ma$$

$$T = mg + ma$$

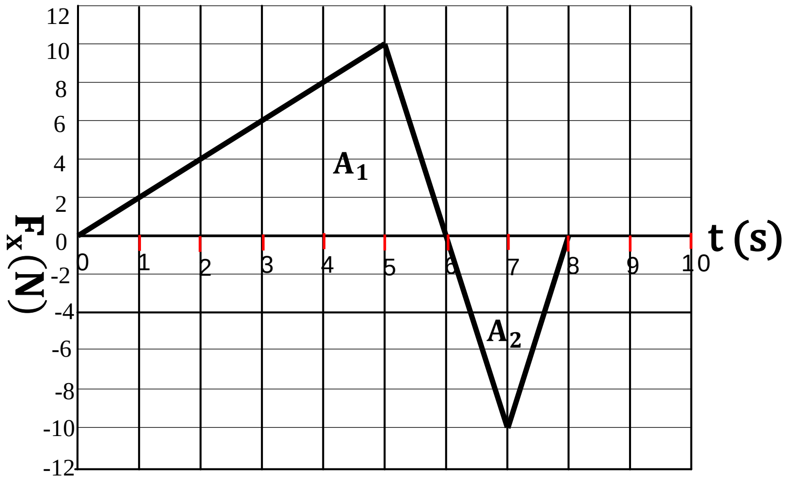
$$= 30 \text{ kN} + 3.06 \text{ kN} = 33.1 \text{ kN}$$

Q17.

Figure 4 gives, as a function of time, the force component F_x, that acts on a 3.0 kg ice block that can move along the x axis. At t = 0, the block is moving in the positive direction of the axis, with a speed of +3.0 m/s. What is its velocity at t = 8.0 s?

Fig. 4

A) +9.7 m/s
B) +6.7 m/s
C) +13 m/s
D) −9.7 m/s
E) +23 m/s



Ans:

$$\Delta V = \frac{1}{m} [\text{area } A_1 + \text{area } A_2]$$

$$= \frac{1}{3}\left[\frac{1}{2} \times 10 \times 6 + \frac{1}{2} \times (-10) \times 2\right] = \frac{20}{3} = 6.67 \text{ m/s}$$

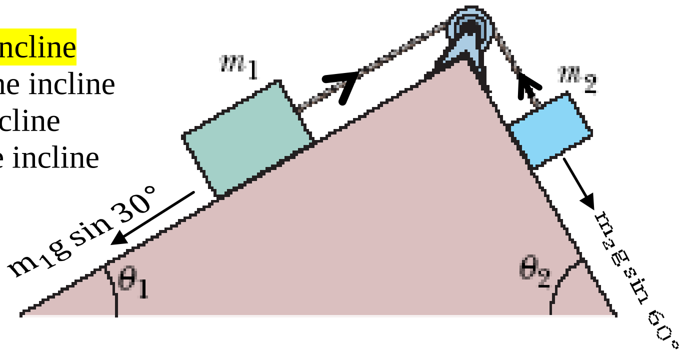
$$\Delta V = 6.67 \text{ m/s}$$

$$V_f = (v_i + 6.67) \text{m/s} = 9.7 \text{ m/s}$$

Q18.

Figure 5 shows box 1(m_1 = 4.0 kg) on a frictionless plane inclined at angle θ_1 = 30°. The box is connected via a cord of negligible mass to box 2 (m_2 = 3.0 kg) on a frictionless plane inclined at angle θ_2 = 60°. The pulley is frictionless and has negligible mass. What is the acceleration of Box 1?

Fig# 5



A) 0.84 m/s^2 up along the incline
B) 0.84 m/s^2 down along the incline
C) 4.6 m/s^2 up along the incline
D) 4.6 m/s^2 down along the incline
E) 0 m/s^2

Ans:

$$T - m_1 g \sin 30° = m_1 a$$

$$m_2 g \sin 60° - T = m_2 a$$

$$\therefore a = \frac{m_2 g \sin 60° - m_1 g \sin 30°}{m_1 + m_2}$$

$$= \frac{25.46 - 19.6}{7} \text{ m/s}^2$$

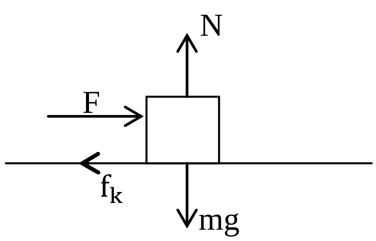
$$= 0.837 \text{ m/s}^2$$

$$= 0.84 \text{ m/s}^2$$

Q19.

A person pushes horizontally with a force of 300 N on a 60.0 kg crate to move it across a level floor. The coefficient of kinetic friction is 0.250. What is the crate's acceleration?

A) 2.55 m/s^2
B) 15.3 m/s^2
C) 4.96 m/s^2
D) 0 m/s^2
E) 1.35 m/s^2



Ans:

$$F - f_k = ma$$

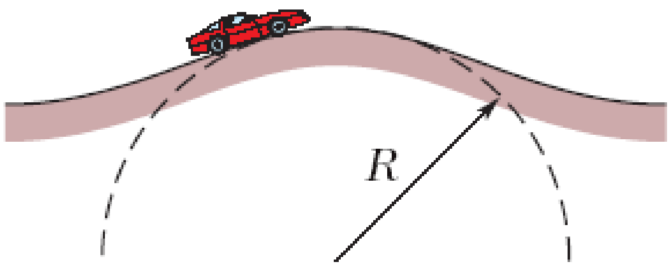
$$300 - 0.25 \times 60 \times 9.8 = 60\ a$$

$$a = 2.55 \text{ m/s}^2$$

Q20.

In Figure 6, a man drives a car over the top of a hill, the cross section of which can be approximated by a circle of radius R = 250 m. What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?

Fig# 6



A) 49.5 m/s
B) 250 m/s
C) 9.80 m/s
D) 155 m/s
E) 25.0 m/s

Ans:

$$-N + mg = \frac{mv^2}{r} \quad (N \to 0)$$

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

$$v = \sqrt{gr} = 49.5\ \text{m/s}$$