Q1.

The density of aluminum is 2700 kg/m^3. Find the mass of a uniform solid aluminum cylinder of radius 10.00 cm and height 30.48 cm.

A) 25.85 kg
B) 31.30 kg
C) 45.20 kg
D) 21.77 kg
E) 18.90 kg

Ans:

$$V = \pi r^2 h = \pi(10\times10^{-2})^2\ (30.48\times10^{-2}) = 0.00957$$

$$\Rightarrow \text{mass} = \rho V = \left(2700\,\frac{\text{kg}}{\text{m}^3}\right)(0.00957\text{m}^3) = 25.85\text{ kg}$$

Q2.

During a short interval of time the speed *v* (m/s) of a car is given by $v = ct^2 + bt^3$, where the time *t* is in seconds. The units of *c* and *b* are respectively:

A) m/s^3 ; m/s^4
B) m/s^2 ; m/s^4
C) m/s^3 ; m/s^3
D) ms^3 ; ms^4
E) ms^3 ; m/s^4

Ans:

$$\frac{L}{T} = cT^2 + bT^3$$

$$\Rightarrow c = \frac{L}{T^3} \text{ or } m/s^3$$

$$\Rightarrow b = \frac{L}{T^4} \text{ or } m/s^4$$

Q3.

A stone is released from rest from the top of a tower of height H meters above the ground. It takes *t* seconds for the stone to reach the ground. What is the height of the stone at 0.5*t* seconds above the ground? [Ignore air resistance]

A) 0.75H
B) 0.50H
C) 0.25H
D) The position of the stone depends on its mass
E) The position of the stone depends on its density

Ans:

$$H = (0.5)(9.8)t^2$$

$$H' = (0.5)(9.8)\frac{t^2}{4} = \frac{H}{4}$$

$$\text{Above ground} = H - \frac{H}{4} = 0.75\text{ H}$$

Q4.

An object is thrown straight downward with an initial speed of 4.0 m/s from a window which is 8.0 m above the ground. The time it takes the object to reach the ground is: [Ignore air resistance]

A) 0.93 s
B) 1.90 s
C) 0.40 s
D) 1.10 s
E) 0.77 s

Ans:

$$-8 = -4\text{t} - \frac{1}{2}(9.8)t^2$$

$$\Rightarrow 4.9\text{t}^2 + 4\text{t} - 8 = 0$$

$$\text{t} = 0.93, -1.75 \text{ s}$$

$$\text{t} = 0.93 \text{ s}$$

Q5.

A man drives north for 35.0 minutes at 85.0 km/h and then stops for 15.0 minutes. He then continues north, traveling 130 km in 2.00 h. Find the man's average speed?

A) 63.5 km/hr
B) 35.6 km/hr
C) 85.0 km/hr
D) 15.3 km/hr
E) 45.8 km/hr

Ans:

$$\vec{\text{v}}_{\text{avg}} = \frac{\Delta\text{x}}{\Delta\text{t}} \Rightarrow \Delta\text{x} = \frac{35}{60} \times 85 + 130 = 179.6 \text{ km}$$

$$\Delta\text{t} = 35 + 15 + 120 = 170 \text{ min} = 2.83 \text{ h}$$

$$\Rightarrow \text{v}_{\text{avg}} = \frac{179.6}{2.83} = 63.5 \text{ km/hr}$$

Q6.

The coordinate of a particle is given by $x(t) = 16t - 3.0t^3$, where x is in meters and t is in seconds. Find the time when the particle is momentarily at rest?

A) 1.3 s
B) 0.0 s
C) 1.5 s
D) 1.0 s
E) 2.3 s

Ans:

$$\text{v} = \frac{\text{dx}}{\text{dt}} = 16 - 9\text{t}^2 = 0 \Rightarrow \text{t} = 1.3 \text{ s}$$

Q7.

A car travels 20.0 km due north and then 35.0 km due west. Find the car's resultant displacement relative to the starting point?

A) 40.3 km, 60.3° west of north
B) 45.3 km, 30.3° north of west
C) 65.0 km, 65° north
D) 30.5 km, 45.0° west of south
E) 65.8 km, 25.0° east

Ans:

$\Delta\vec{r} = 20\hat{j} - 35\,\hat{i}$

$|\Delta\vec{r}| = \sqrt{(20)^2 + (-35)^2} = 40.3\text{ km}$

$\theta = \tan^{-1}\left(\frac{20}{-35}\right) = -29.74$

$= 90 - 29.74 = 60.3°$ west of north

Q8.

If $\vec{A} = 2.0\hat{i} + 3.0\hat{j}$, $\vec{B} = -3.0\hat{i} + 4.0\hat{j}$ and $\vec{C} = 7.0\hat{i} + 3.0\hat{j}$, find $\vec{C} \times (2\vec{A} - \vec{B})$?

A) $-7.0\hat{k}$
B) $7.0\hat{k}$
C) $2.0\hat{i} + 1.0\hat{j}$
D) 0
E) $-6.0\hat{j}$

Ans:

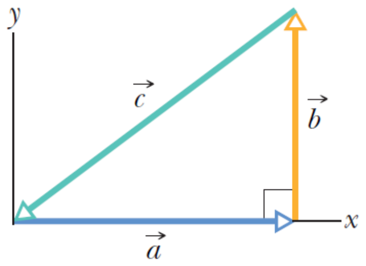
$2\vec{A} - \vec{B} = 7\hat{i} + 2\hat{j}$

$\vec{C} \times (2\vec{A} - \vec{B}) = 14\hat{k} - 21\hat{k} = -7\hat{k}$

Q9.

In **Figure 1**, the magnitudes of vector $\vec{a} = 4.0\,\text{m}$, $\vec{b} = 3.0$ m, and $\vec{c} = 5.0\,\text{m}$. If the + z axis is out of the page, find the magnitude and direction of $\vec{c} \times \vec{b}$?

Figure 1



A) 12 m, along the – z axis
B) 9.0 m, along the + y axis
C) 12 m, along the –y axis
D) 12 m, along the + z axis
E) 9.0 m, along the + z axis

Ans:

$|\vec{C} \times \vec{b}| = |\vec{c}||\vec{b}| \sin(126.9) = 12$

Use Right Hand Rule the direction is into the page or $-$ z

Q10.

A car travels along a highway due west with a speed of 24 m/s. Then, the car leaves the highway and continues travelling. After 4.0 s, its instantaneous velocity is 16 m/s at an angle of 45° north of west. What is the magnitude of the average acceleration of the car during the four-second interval?

A) 4.3 m/s^2
B) 2.4 m/s^2
C) 1.2 m/s^2
D) 11 m/s^2
E) 17 m/s^2

Ans:

$$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{4}$$

$\vec{v}_i = -24\,\hat{i}$

$\vec{v}_f = -11.3\hat{i} + 11.3\,\hat{j} \;\Rightarrow \vec{a}_{avg} = 3.17\hat{i} + 2.83\hat{j}$

$|\vec{a}_{avg}| \cong 4.3\; m/s^2$

Q11.

A tennis ball is thrown from ground level with initial velocity $\vec{v}_o$ directed 30° above the horizontal. If the ball reaches the top of the trajectory after 0.30 s, what is the magnitude of the initial velocity? [Ignore air resistance]

A) 5.9 m/s
B) 9.8 m/s
C) 11.3 m/s
D) 19.6 m/s
E) 34.4 m/s

Ans:

$$v_{iy} = v_0 \sin 30 = \frac{v_0}{2}$$

$$v_{fy} = 0 = v_{iy} - gt \Rightarrow v_{iy} = \frac{v_0}{2} = gt$$

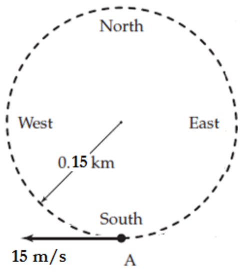
$$\Rightarrow v_{iy} = 2.94 \text{ s}$$

$$v_0 = 2 \times 2.94 = 5.9 \text{ m/s}$$

Q12.

A car travels clockwise around a flat (horizontal) circle of radius 0.15 km at a constant speed of 15 m/s. When the car is at point A as shown in the **Figure 2**, what is the car's acceleration? [Ignore air resistance]

Figure 2



A) 1.5 m/s^2, due north
B) Zero
C) 1.5 m/s^2, due south
D) 1.6 m/s^2, due east
E) 1.6 m/s^2, due west

Ans:

$$a_r = \frac{v^2}{R} = \frac{(15)^2}{150} = 1.5 \text{ m/s}^2 \text{ due north}$$

Q13.

A plane is headed westward at a speed of 165 m/s. A wind with a speed of 25.0 m/s is blowing southward at the same time as the plane is flying. The velocity of the plane relative to the ground is:

A) 167 m/s at an angle 8.62° south of west
B) 167 m/s at an angle 8.62° west of south
C) 167 m/s at an angle 5.31° south of east
D) 167 m/s at an angle 5.31° east of south
E) 107 m/s at an angle 7.31° south of east

Ans:

$$\vec{v}_{pg} = \vec{v}_{pw} + \vec{v}_{wg} = -165\hat{\imath} - 25\hat{\jmath}$$

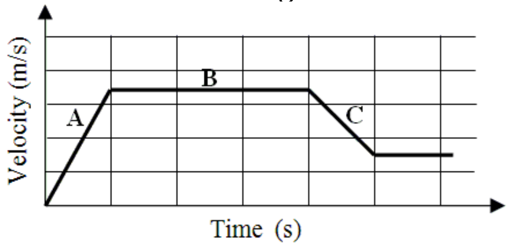
$$\vec{v}_{pg} = \sqrt{(-165)^2 + (-25)^2} \cong 167 \text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{25}{165}\right) = 8.62°$$

Q14.

Figure 3 shows the velocity versus time curve for a car traveling along a straight line. Which of the following statements is **False**?

Figure 3



A) The magnitude of the net force acting during interval A is less than that during interval C
B) Net forces act on the car during intervals A and C
C) Opposing forces may be acting on the car during interval B
D) Opposing forces may be acting on the car during interval C
E) No net force acts on the car during interval B

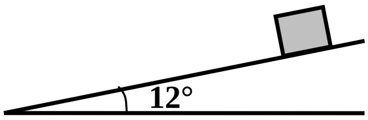
Ans:

Slope of v V_st is acceleration; $\sum \vec{F} = m\vec{a}$, slope of interval A is greater than slope of interval B.

Q15.

A box slide down a rough incline plane at a constant acceleration of 0.20 m/s^2 (see **Figure 4**). The incline plane makes an angle of 12° with the horizontal. What is coefficient of kinetic friction between the box surface and the incline surface? [Ignore air resistance]

Figure 4



A) 0.19
B) 0.14
C) 0.11
D) 0.24
E) 0.25

Ans:

$$-mg\sin\theta + \mu_k mg\cos\theta = -ma$$

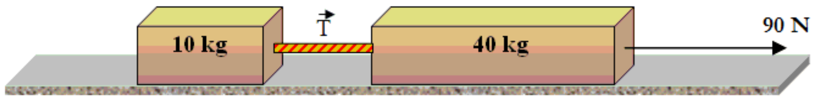
$$\Rightarrow \mu_k = \frac{g\sin\theta - a}{g\cos\theta}$$

$$\Rightarrow \mu_k = \frac{(9.8)(\sin 12) - 0.2}{(9.8)(\cos 12)} = 0.19$$

Q16.

A 10 kg block is connected to a 40-kg block through a massless rope, as shown in **Figure 5**. A force of 90 N pulls the blocks to the right on a frictionless surface. What is the magnitude of the tension $\vec{T}$ in the rope that connects the two blocks?

Figure 5



A) 18 N
B) 11 N
C) 22 N
D) 23 N
E) 12 N

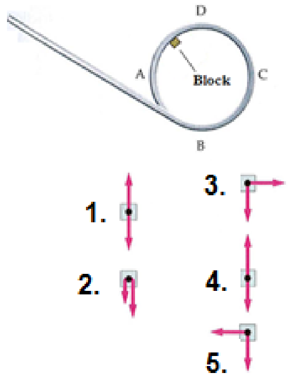
Ans:

$$|a| = \frac{90}{50} = 1.8\frac{m}{s^2} \Rightarrow T = 10 \times 1.8 = 18\ N$$

Q17.

A block is sliding on a frictionless surface along a vertical loop-the-loop as shown in **Figure 6**. The block is moving fast enough that it never loses contact with the track. Its positions at different times are marked as A, B, C and D. Out of the following five free- body diagrams, which one corresponds to block position A? [Ignore air resistance]

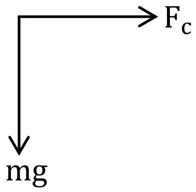
Figure 6



A) 3
B) 5
C) 1
D) 2
E) 4

Ans:

A



Q18.

A 71.0 kg man stands on a bathroom scale in an elevator. What does the scale read if the elevator is moving upward with an increasing velocity and at constant acceleration of 3.00 m/s^2?

A) 909 N
B) 482 N
C) 699 N
D) 833 N
E) 999 N

Ans:

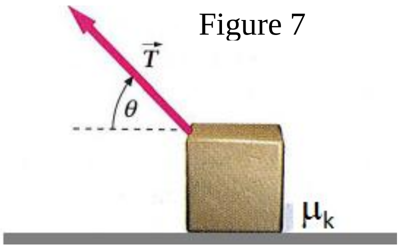
$$F_N - mg = ma$$

$$F_N = m(g + a) = 71(9.8 + 3) \cong 909 \text{ N}$$

Q19.

A 5.5 kg box is pulled by a string over a rough horizontal surface at a constant velocity. The string makes an angle of $\theta = 37°$ with the horizontal, as shown in **Figure 7**. If coefficient of kinetic friction between the box and the horizontal surface is 0.15, find the magnitude of tension in the string T.

Figure 7



A) 9.1 N
B) 4.8 N
C) 11 N
D) 16 N
E) 1.9 N

Ans:

$$f_k = T\cos\theta = \mu_k N$$

$$N + T\sin\theta - mg = 0$$

$$N = mg - T\sin\theta$$

$$T\,(\cos\theta + \mu_k \sin\theta) = \mu_k mg$$

$$T = \frac{\mu_k mg}{\cos\theta + \mu_k \sin\theta} = \frac{0.15 \times 5.5 \times 9.8}{\cos37 + 0.15 + \sin37} \Rightarrow T = 9.1\ \text{N}$$

Q20.

Two blocks with masses $m_1 = 2.0$ kg and $m_2 = 6.0$ kg are in contact on a frictionless horizontal surface. The blocks are accelerated by a horizontal force *F* applied to the block m_1 as shown in **Figure 8**. Find the magnitude of the force $\vec{F}$ if the contact force between the blocks is 1.1 N.

Figure 8

A) 1.5 N
B) 1.1 N
C) 3.2 N
D) 2.3 N
E) 3.1 N

Ans:

$$1.1 = m_2 a$$

$$a = \frac{1.1}{m_2} = \frac{1.1}{6} = 0.18\ \text{m/s}^2$$

$$F = a(m_1 + m_2) = (0.18)(2 + 6) \cong 1.5\ \text{N}$$