Q1.
Express the speed of sound, 330 m/s in miles/h .(Take 1 mile = 1609 m )
**Answer:**

$$330\frac{\text{m}}{\text{s}} = 330\frac{1\text{m}\ \frac{1\text{mile}}{1609\text{m}}}{1\text{s}\ \frac{1\text{hour}}{3600\text{s}}} = 330\times\frac{3600}{1609}\frac{\text{mile}}{\text{h}} = 738\frac{\text{mile}}{\text{h}}$$

A) 738 miles/h
B) 330 miles/h
C) 147 miles/h
D) 0.205 miles/h
E) 980 miles/h

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Q2.
What is the dimension of the constant *G* in the equation: $F = G\frac{m_1 m_2}{r^2}$ , where *F* is force, $m_1$ and $m_2$ are masses and *r* is the distance between the two masses.
**Answer:**

$$\text{G} = \frac{\text{r}^2}{\text{m}_1\text{m}_2}\text{F} = \frac{\text{L}^2}{\text{M}^2}\text{MLT}^{-2} = \text{L}^3\text{M}^{-1}\text{T}^{-2}.$$

A) $L^3M^{-1}T^{-2}$
B) $LM^{-2}$
C) $L^2M^{-3}$
D) $MTL^{-2}$
E) $ML^2T^{-1}$

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Q3.
A vector $\vec{A}$ is added to the sum of two vectors $\vec{B} = 3.0\hat{i} - 2.0\hat{j} - 2.0\hat{k}$ and $\vec{C} = 2.0\,\hat{i} - \hat{j} + 3.0\hat{k}$ such that $\vec{A} + \vec{B} + \vec{C} = \hat{k}$. The vector $\vec{A}$ is:
**Answer:**

$$\vec{A} + \vec{B} + \vec{C} = \hat{k} \quad \Rightarrow \quad \vec{A} + 3.0\hat{i} - 2.0\hat{j} - 2.0\hat{k} + 2.0\,\hat{i} - \hat{j} + 3.0\hat{k} = \hat{k}$$

$$\Rightarrow \quad \vec{A} + 5.0\hat{i} - 3\hat{j} = 0$$

A) $-5.0\,\hat{i} + 3.0\,\hat{j}$
B) $5.0\,\hat{i} - 3.0\,\hat{j}$
C) $-3.0\,\hat{i} - 1.0\,\hat{j}$
D) $-1.0\,\hat{i} + 3.0\,\hat{j}$
E) $3.0\,\hat{j}$

Q4.

Consider the vector $\vec{A} = 3.0\,\hat{i} + 4.0\,\hat{j}$. Which of the following vectors is perpendicular to vector $\vec{A}$:

**Answer:**

$$\vec{A}\cdot\vec{B} = 0 \quad \Rightarrow \quad A_x B_x + A_y B_y = 0 \quad \Rightarrow \quad \frac{B_y}{B_x} = -\frac{A_x}{A_y} = \frac{-3}{4}\,\text{or}\,\frac{3}{-4}.$$

A) $4.0\,\hat{i} - 3.0\,\hat{j}$

B) $3.0\,\hat{i} - 4.0\,\hat{j}$

C) $4.0\,\hat{i} + 3.0\,\hat{j}$

D) $-3.0\,\hat{i} - 4.0\,\hat{j}$

E) $3.0\,\hat{i} + 4.0\,\hat{j}$

Q5.

Find the sum of the following two vectors: $\vec{A}$: 8.66 in +*x*-direction, $\vec{B}$: 10.0 , at 60° from +*y*-axis measured counterclockwise.

**Answer:**

$$\vec{A} + \vec{B} = 8.66\,\hat{i} + 10.0\sin 150^{o}\,\hat{j} + 10.0\cos 15^{o}\,\hat{i} \;= 5.00\,\hat{j}.$$

A) $5.00\,\hat{j}$

B) $3.00\,\hat{i} + 4.00\,\hat{j}$

C) $6.00\,\hat{i} + 8.00\,\hat{j}$

D) $8.66\,\hat{i} + 10.0\,\hat{j}$

E) $\hat{i} + 16.7\,\hat{j}$

Q6.

Starting at time *t* = 0, an object moves along a straight line. Its coordinate in meters is given by $x(t) = 75t - 1.0t^3$, where *t* is in seconds. When it momentarily stops, its position is:

**Answer:**

$$x(t) = 75\,t - 1.0\,t^3 \quad \Rightarrow \quad v(t) = 75 - 3t^2 = 0 \quad \Rightarrow \quad t = 5\text{ s}$$

$$\Rightarrow \quad x(t) = 75\times 5 - 1.0\times 5^3 = 250\text{ m}$$

A) $x =$ 250 m
B) $x =$ 150 m
C) $x =$ 300 m
D) $x =$ 75 m
E) $x =$ 350 m

Q7.
An object starts from rest at the origin and moves along the $x$ axis with a constant acceleration of 4.0 m/s$^2$. Its average velocity as it goes from $x$ = 2.0 m to $x$ = 18.0 m is:
**Answer:**

$$v^2(t) = v_o^2\,t + 2ad \quad \Rightarrow \quad v^2(2) = 0 + 2\times4\times2 = 16\ (\text{m/s})^2$$

$$\Rightarrow \quad v^2(18) = 0 + 2\times4\times18 = 144\ (\text{m/s})^2$$

$$\Rightarrow \quad v_{ave} = \frac{v(2)+v(18)}{2} = \frac{4+12}{2} = 8\ \text{m/s}$$

A) 8.0 m/s
B) 6.0 m/s
C) 3.0 m/s
D) 5.0 m/s
E) 1.0 m/s

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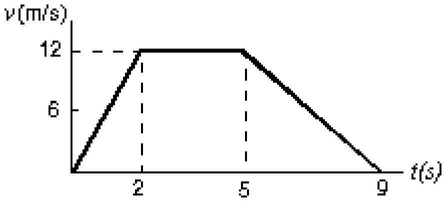
Q8.
A ball is thrown vertically upward. After 4.00 s the ball returned back to its initial position. The maximum height above the initial position of the ball is:
**Answer:**
Going up takes ½ the total time.

$$d = vt - \frac{1}{2}at^2 \quad \Rightarrow \quad d = 0 + \frac{1}{2}9.8\times2^2 = 19.6\ \text{m}$$

A) 19.6 m
B) 4.90 m
C) 9.8 m
D) 11.0 m
E) 15.0 m

Q9.
**Figure 1** represents the straight line motion of a car. Which of the following statements is true?

Fig#




**Answer:**

Acceleration in the first two seconds is the slope in this interval = $\frac{12-0}{2-0} = 6\ \text{m/s}^2$. Thus the Answer is A

A) The car accelerates at 6 $\text{m/s}^2$ for the first 2 s
B) The car accelerates, stops, and reverses
C) The car is moving for a total time of 12 s
D) The car decelerates at 12 $\text{m/s}^2$ for the last 4 s
E) The car returns to its starting point when t = 9 s

Q10.
At $t = 0$, a car moves with initial velocity $\vec{v}_i = (3.0\,\hat{i} + 5.0\,\hat{j})\text{m/s}$. At $t = 2.0\ \text{s}$, the velocity becomes $\vec{v}_f = (8.0\,\hat{i} - 7.0\,\hat{j})\text{m/s}$. What is the direction of the average acceleration of the car for the time interval from $t = 0$ to $t = 2.0\ \text{s}$?

**Answer:**

With $\Delta t = 2\ \text{s}$, one finds:

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{5.0\,\hat{i} - 12.0\,\hat{j}}{2} = 2.5\,\hat{i} - 6.0\,\hat{j}$$

The direction is $\tan^{-1}(\frac{-6}{2.5}) = -\,67°$ from the x-axis

A) − 67° from the x-axis
B) 67° from the x-axis
C) 33° from the x-axis
D) − 33° from the x-axis
E) 52° from the x-axis

Q11.

A particle moves in the *xy*-plane with a constant acceleration given by $\vec{a} = \left(-4.0\,\hat{j}\right)$ m/s$^2$. At $t$ = 0 its position vector and velocity are $\vec{r}_o = \left(10\ \hat{i}\right)$ m and $\vec{v}_o = \left(-2.0\ \hat{i} + 8.0\ \hat{j}\right)$ m/s, respectively. What is the distance of the particle from the origin at $t$ = 2.0 s?

**Answer:**

With t = 2, one finds:

$$r = r_o + vt + \frac{1}{2}at^2 = \left(10\,\hat{i}\right) + \left(-2.0\,\hat{i} + 8.0\,\hat{j}\right)2 + \frac{1}{2}\left(-4.0\,\hat{j}\right)2^2 = 6\,\hat{i} + 8.0\,\hat{j}$$

$$\text{Distance} = \sqrt{100} = 10$$

A) 10 m
B) 6.4 m
C) 8.9 m
D) 2.0 m
E) 6.2 m

Q12.

A particle moves in the *xy*-plane in a circle centered on the origin. At a certain instant the velocity and acceleration of the particle are $\left(4.0\,\hat{j}\right)$ m/s and $\left(-3.0\,\hat{i}\right)$ m/s$^2$, respectively. What is the radius of the circle?

**Answer:**

$$a = \frac{v^2}{R} \Rightarrow R = \frac{v^2}{a} = \frac{4^2}{3} = 5.333 \text{ m}$$

A) $x$ = 5.3 m
B) $x$ = 4.4 m
C) $x$ = 1.3 m
D) $x$ = 3.1 m
E) $x$ = 2.2 m

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Q13.

: A projectile is fired with an initial speed $v_o$ directed at an angle $\theta_o$ above the horizontal. If the speed at maximum height is $\frac{v_o}{2}$, find the angle $\theta_o$.

**Answer:**

$$v_{max} = v_o \cos\theta_o = \frac{v_o}{2} \quad \Rightarrow \quad \cos\theta_o = \frac{1}{2} \quad \Rightarrow \quad \theta_o = 60^o$$

A) 60°
B) 76°
C) 30°
D) 45°
E) 55°

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Q14.

: Relative to the air, a plane flies eastward at a speed of 156 m/s. A wind is blowing southward at a speed of 20.0 m/s, relative to the ground. The velocity of the plane relative to the ground is:

**Answer:**

$\rightarrow V_{PA}$

$V_{PG}$ □ $\quad \downarrow V_{AG}$

$$\vec{V}_{PA} = \vec{V}_{PG} - \vec{V}_{AG}$$

$$V_{pG} = \sqrt{V_{AG}^2 + V_{PA}^2} = \sqrt{156^2 + 20^2} = 157 \text{ m/s} \quad \Rightarrow \quad \tan^{-1}\left(\frac{20}{156}\right) = 7.31^o \text{ South of east}$$

A) 157 m/s at an angle 7.31° south of east.
B) 157 m/s at an angle 7.31° east of south
C) 155 m/s at an angle 7.36° south of east
D) 155 m/s at an angle 7.36° east of south
E) 157 m/s at an angle 7.36° south of east

Q15.

A ball of mass 0.50 kg attains acceleration, $\vec{a} = (4.0\,\hat{i} + 6.0\,\hat{j})\,\text{m/s}^2$ as a result of two forces $\vec{F}_1$ and $\vec{F}_2$. If $\vec{F}_1 = (A\,\hat{i} - B\,\hat{j})\,\text{N}$, and $\vec{F}_2 = (B\,\hat{i})\,\text{N}$, where A and B are constants, find the value of A.

**Answer:**

$$m\vec{a} = \vec{F}_1 + \vec{F}_2 \quad \Rightarrow \quad 0.5(4.0\,\hat{i} + 6.0\,\hat{j}) = (A\,\hat{i} - B\,\hat{j}) + (B\,\hat{i})$$

$$\Rightarrow \quad 2.0\,\hat{i} = A\,\hat{i} + B\,\hat{i}; \quad 3.0\,\hat{j} = -B\,\hat{j}$$

$$\Rightarrow \quad B = -3, \quad A + B = 2 \quad \Rightarrow \quad A = 5\text{ N}$$

A) 5.0 N
B) 2.0 N
C) 4.0 N
D) 6.0 N
E) 0.50 N

Q16.

A 70.0 kg person stands on a scale in an elevator. If the scale reading was 826 N, what is the acceleration of the elevator?

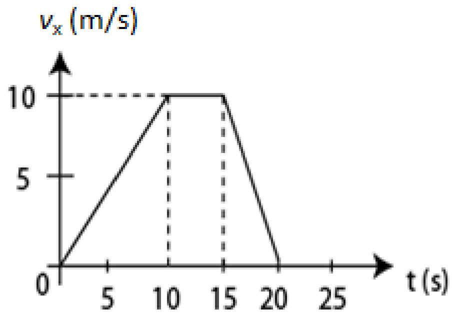
**Answer:** Since N (826 N) > mg (70 9.8=686 N), thus the direction of the acceleration is upward.

$$ma = N - mg \Rightarrow a = \frac{N - mg}{m} = \frac{826 - 70 \times 9.8}{70} = 2.0\text{ m/s}^2 \quad \text{upward}$$

A) 2.00 m/s$^2$ upward
B) 2.00 m/s$^2$ downward
C) Zero
D) 5.00 m/s$^2$ upward
E) 5.00 m/s$^2$ downward

Q17.

A 20 kg ball is travelling in a frictionless track along positive *x*-direction and its velocity/time graph is shown in **Figure 2**. The force experienced by the ball at $5^{th}$ second is:
(Force is taken positive if it acts along positive *x*-axis)



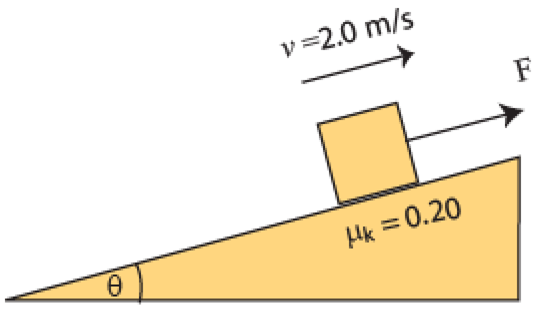

**Answer:**

$$F = m\frac{dv}{dt} = 20\left(\frac{10}{10}\right) = 20 \text{ N}$$

A) 20 N
B) − 40 N
C) Zero
D) 5 N
E) − 10N

Q18.

A block of mass 5.0 kg is pushed up in a θ = 30° incline plane with a force, F, parallel to a rough plane of coefficient of kinetic friction $\mu_k = 0.20$, as shown in **Figure 3**. What value of F is required to move the block up the plane at constant speed of $v = 2.0$ m/s?




**Answer:**

$$ma = F - mg\sin 30^o - \mu mg\cos 30^o = 0$$

$$\Rightarrow F = mg(\sin 30^o + \mu\cos 30^o) = 5\times 9.8(0.5 + 0.2\times 0.866) = 33 \text{ N}$$

A) 33 N
B) 47 N
C) 98 N
D) 42 N
E) 8.5 N

Q19.
A car, travelling on a circular horizontal road of radius 200 m, is almost about to slip. If the static coefficient of the road is 0.150, the speed of the car is:

**Answer:**

$$m\frac{v^2}{R} = \mu_s mg \quad \Rightarrow \quad v = \sqrt{\mu_s Rg} = \sqrt{0.15 \times 200 \times 9.8} = 17.1 \text{ m/s}$$

A) 17.1 m/s
B) 294 m/s
C) 27.3 m/s
D) 9.45 m/s
E) 29.4 m/s

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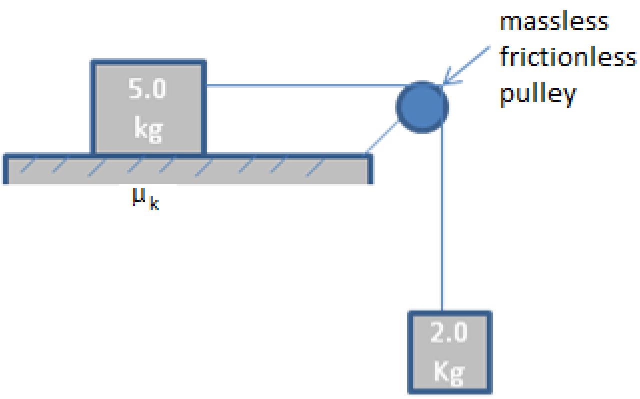
Q20.
**Figure 4** shows two masses, of 5.0 kg and 2.0 kg, are tied together with a string that goes over a massless / frictionless pulley. The 5.0 kg body moves over a rough surface with coefficient of kinetic friction $\mu_k$. If the system moves with constant speed 2.0 m/s, find the value of $\mu_k$.




**Answer:**
The tension is the same in both masses, so

$$2g = 5\mu_k g \quad \Rightarrow \quad \mu_k = \frac{2}{5} = 0.4$$

A) 0.40
B) 0.25
C) 0.71
D) 0.31
E) 0.13