Q1.

A hectare is a unit of area that is equal to $1.0\times10^4\,\text{m}^2$. If water of volume 0.020 km^3 covers 30 hectares of flat land, find the depth of the water.

A) 67 m
B) 26 m
C) 45 m
D) 30 m
E) 87 m

Ans:

$$V = Ad$$

$$\Longrightarrow d = \frac{V}{A} = \frac{0.02\times10^9}{30\times10^4} = \mathbf{67\ m}$$

Q2.

Consider the following equation: $x = At^2 + \dfrac{B}{(v+\alpha)}t$, where x is the distance, t is the time and v is the speed. Find the dimensions of B:

A) L^2T^{-2}
B) L^2T
C) $L\,T^{-1}$
D) $L\,T^2$
E) L

Ans:

$$\left[\frac{xv}{t}\right] = B \Longrightarrow m\cdot\frac{m}{s}\cdot\frac{1}{s} = \frac{m^2}{s^2} = \mathbf{L^2T^{-2}}$$

Q3.

Figure 1 gives the acceleration of a particle as a function of time. In which of the time intervals indicated does the particle move with constant speed?

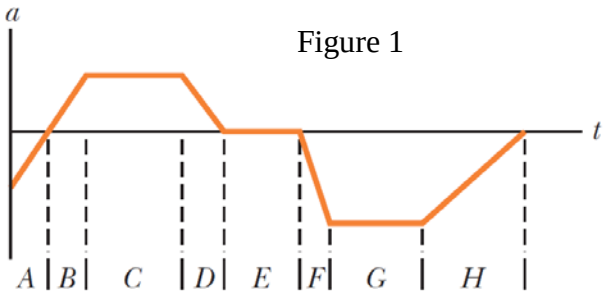

Figure 1

A) E
B) C, G
C) C, E, G
D) A, B, H
E) D, F,

Ans:

Constant speed $\Longrightarrow$ Zero acceleration $\Longrightarrow$ E region

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Q4.

At time *t* = 0, a particle had a speed of 20 m/s in the positive *x* direction. At time *t* = 2.5 s, its speed was 40 m/s in the opposite direction. Find the average acceleration of the particle during the 2.5 s interval.

A) -24 m/s^2
B) +18 m/s^2
C) -8.0 m/s^2
D) +20 m/s^2
E) -30 m/s^2

Ans:

$$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} = \frac{-40-(+20)}{2.5} = \mathbf{-24\ m/s^2}$$

Q5.

A car travels in a straight line. First, it starts from rest at point A and accelerates at a rate of 5.00 m/s^2 until it reaches a speed of 100 m/s at point B. The car then slows down at a constant rate of 8.00 m/s^2 until it stops at point C. Find the time the car takes for this trip (from point A to point C).

A) 32.5 s
B) 25.0 s
C) 10.5 s
D) 15.0 s
E) 45.0 s

Ans:

$t_{tot} = t_{AB} + t_{BC}$

$t_{AB} \Longrightarrow v_B = v_A + at_{AB} \Longrightarrow 100 = 0 + 5t_{AB} \Longrightarrow t_{AB} = 20\ s$

$t_{BC} \Longrightarrow v_C = v_B + at_{BC} \Longrightarrow 0 = 100 - 8t_{BC} \Longrightarrow t_{BC} = 12.5\ s$

$\Longrightarrow t_{tot} = 20\ s + 12.5\ s = \mathbf{32.5\ s}$

Q6.

A parachutist jumps from an airplane at an altitude of 5.0×10^3 m. He falls with an acceleration g = 9.8 m/s^2 for the first 10 s. Then he opens his parachute and falls with a net vertical upward acceleration of 50 m/s^2 until his downward speed reaches 20 m/s. How far does he fall vertically downward when his net upward acceleration was 50 m/s^2?

A) 92 m
B) 50 m
C) 75 m
D) 67 m
E) 45 m

Ans:

During Free Fall $v = 0 - gt \Longrightarrow v = -98\ m/s$
When opening Parachute $v^2 = v_0^2 + 2a\Delta y$
$(20)^2 = (-98)^2 + (2)(50)(-\Delta y) \Longrightarrow \Delta y = \mathbf{92.04\ m}$

Q7.

Two vectors are given by $\vec{A} = 2.00\hat{i} + 2.00\hat{j}$ and $\vec{B} = -2.00\hat{i} + 4.00\hat{j}$, find the angle between $\vec{A}$ and $\vec{B}$.

A) 71.6°
B) 45.0°
C) 56.1°
D) 18.4°
E) 24.5°

Ans:

$\vec{A} \cdot \vec{B} = |\vec{A}|\,|\vec{B}| \cos\phi$

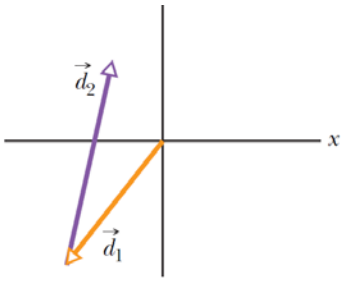
$(2)(-2) + (2)(4) = \sqrt{4+4}\sqrt{4+16}\cos\phi$

$\cos\phi = \frac{4}{\sqrt{8}\sqrt{20}} \Rightarrow \phi = \mathbf{71.6°}$

Q8.

The two vectors shown in **Figure 2** lie in an *xy* plane. What are the signs of the *x* and *y* components, respectively, of the vector $(\vec{d}_2 - \vec{d}_1)$?

Figure 2



A) +,+
B) +, -
C) -, +
D) -, -
E) None of the other answers is correct.

Ans:

Drag $\vec{d}_2$ to orgin then reverse. $\vec{d}_1$ and drag it to tip of $\vec{d}_2$

Q9.

For the following three vectors, find $\vec{C} \cdot (2\vec{A} \times \vec{B})$

$\vec{A} = 2.00\hat{i} + 3.00\hat{j}$

$\vec{B} = -3.00\hat{i} + 4.00\hat{j}$

$\vec{C} = 7.00\hat{i} + 3.00\hat{k}$

A) 102
B) -14.0
C) 0
D) 56.0
E) 78.0

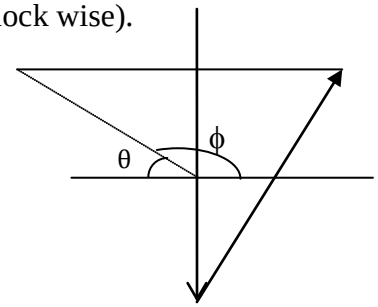
Ans:

$2\vec{A} \times \vec{B} = (2)[8\,\hat{k} + 9\,\hat{k}] = 34\,\hat{k}$

$\vec{C} \cdot (2\vec{A} \times \vec{B}) = (3)(34) = 102$

Q10.

A man makes three successive displacements; 3.50 m south, 8.20 m northeast, and 15.0 m west, respectively. Find the resultant displacement (both the magnitude and direction relative to the east and measured counter-clock wise).



A) 9.48 m, 166°
B) 9.48 m, 45.0°
C) 9.48 m, 225°
D) 5.80 m, 45.0°
E) 5.80 m, 225°

Ans:

$R = \sqrt{(9.2)^2 + (2.3)^2} = \mathbf{9.48\ m}$

$\tan\theta = \frac{2.3}{9.2} \Rightarrow \theta = 14.0°$

$\Rightarrow \Phi = 180° - 14° = \mathbf{166°}$

Q11.

A ship sails due north at 4.50 m/s relative to the ground while a boat heads northwest with a speed of 5.20 m/s relative to the ground. Find the speed of the ship relative to the boat.

A) 3.77 m/s
B) 2.39 m/s
C) 7.95 m/s
D) 1.25 m/s
E) 6.11 m/s

Ans:

$\vec{v}_{so} = \vec{v}_{bo} + \vec{v}_{bs}$

$4.5\,\hat{j} = -3.68\,\hat{i} + 3.68\,\hat{j} + \vec{v}_{bs}$

$\vec{v}_{bs} = 3.68\,\hat{i} + 0.823\,\hat{j}$

$\vec{v}_{bs} = \sqrt{(3.68)^2 + (0.823)^2} = \mathbf{3.77\ m/s}$

Q12.

A student throws a red ball from the balcony of a tall building with an initial horizontal speed of 10 m/s. At the same time, a second student drops a blue ball from the same balcony. Neglecting air resistance, which statement is true?

A) The two balls reach the ground at the same instant.
B) The blue ball reaches the ground first.
C) The red ball reaches the ground first.
D) Both balls hit the ground with the same speed.
E) The blue ball hits the ground with larger speed.

Ans:

Vertical motions are affected by the same constant accelaration; So The two balls reach the ground at the same

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instant

Q13.

A stone is tied to the end of a string and is rotated in a horizontal circle at 400 revolutions per minute. If the magnitude of its acceleration is 1.5×10^3 m/s^2, what is the radius of the circle?

A) 0.85 m
B) 0.35 m
C) 0.64 m
D) 0.71 m
E) 0.53 m

Ans:

$$a_r = 1.5 \times 10^3 = \frac{v^2}{r} \Rightarrow v = 38.7\sqrt{r}$$

$$T = \frac{2\pi r}{v} = \frac{1}{f} = \frac{1}{\frac{400}{60}} = \frac{2\pi r}{v}$$

$$0.15\ s = T = \frac{2\pi r}{38.7\sqrt{r}} \Rightarrow \mathbf{r = 0.85\ m}$$

Q14.

A ball is thrown straight upward and returns to the thrower's hand (at the same initial level) after 3.00 s. A second ball thrown from the same height at an angle of 37.0° with the horizontal reaches the same maximum height as the first ball. With what speed was the second ball thrown?

A) 24.4 m/s
B) 14.7 m/s
C) 29.1 m/s
D) 49.3 m/s
E) 35.2 m/s

Ans:

For 1st ball $\Rightarrow v_{yf} = 0 v_{0y} - gt$

$\Rightarrow v_{oy} = (9.8)(1.5) = 14.7$ m/s

maximum height $\Rightarrow v_{fy}^2 = v_{oy}^2 - 2g(\Delta y)$

$0 = (14.7)^2 - (2)(9.8)(\Delta y)$

$\Delta y = 11.0$ m

<u>2nd ball</u>

$v_{fy}^2 = 0 = v_{oy}^2 \sin^2(37) - (2)(9.8)(11)$

$v_{oy} = \mathbf{24.4\ m/s}$

Q15.

A particle starts from the origin of an *xy* plane. Its acceleration is given by $\vec{a} = (2.0\hat{i} + 4.0\,\hat{j})\ \text{m/s}^2$. At time t = 0, the velocity is $-4.0\hat{i}$ m/s. What is the particle's velocity if the y-component of its displacement is +18 m?

A) $(2.0\hat{i} + 12\,\hat{j})$ **m/s**

B) $(4.0\hat{i} - 6.0\,\hat{j})$ m/s

C) $(2.0\hat{i} + 2.0\,\hat{j})$ m/s

D) $(3.0\hat{i} + 12\,\hat{j})$ m/s

E) $(4.0\hat{i} - 4.0\,\hat{j})$ m/s

Ans:

$$\Delta y = v_{oy}t + \frac{1}{2}a_y t^2$$

$$18 = 0 + \frac{1}{2}(4)\,t^2$$

$$\Rightarrow t = 3\ \text{s}$$

$$v_x = v_{ox} + a_{xt} = -4 + (2)(3) = \mathbf{2\ m/s}$$

$$v_y = v_{oy} + a_{yt} = 0 + (4)(3) = \mathbf{12\ m/s}$$