

Q1.

Van der Waals' equation of state for gases is given by

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

Where, P is the pressure ($\text{kg/m}\cdot\text{s}^2$), V is the volume (m^3) and T is the temperature (K). a , b and R are constants. The dimension of " a " is

- A) ML^5T^{-2}
- B) L^2T^{-2}
- C) L^6
- D) $\text{ML}^{-1}\text{T}^{-2}$
- E) ML^2T^{-2}

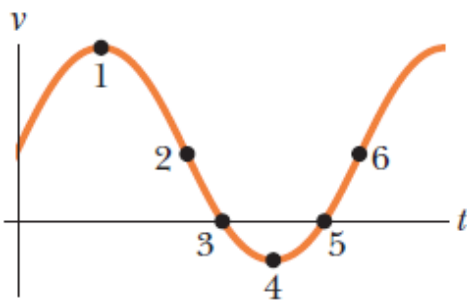
Q2.

Which ONE of the following statements is TRUE?

- A) The instantaneous velocity of a particle is always directed along the tangent to the particle's path at the particle's position.
- B) If the "velocity versus time" graph of an object is a horizontal line, that object is accelerating.
- C) It is physically impossible for an object to have a negative acceleration and yet be speeding up.
- D) Average speed is always less than the magnitude of average velocity.
- E) In projectile motion, the vertical acceleration is zero at the maximum height.

Q3.

Figure 1 gives the velocity as a function of time for a particle moving along an x-axis. Dot **1** is at the highest point on the curve, dot **4** is at the lowest point, and dots **2** and **6** are at the same height. At which point(s) does the particle change its direction?



- A) 3 and 5
- B) 1 and 4
- C) 2 and 6
- D) 3 only
- E) 1 only

Q4.

From $t = 0$ to $t = 5.00$ min, a man stands still, and from $t = 5.00$ min to $t = 10.0$ min, he walks in a straight line at a constant speed of 2.20 m/s. What is the average velocity v_{avg} in the time interval 3.00 min to 9.00 min?

- A) 1.47 m/s
- B) 2.20 m/s
- C) 1.83 m/s
- D) 3.67 m/s
- E) 4.40 m/s

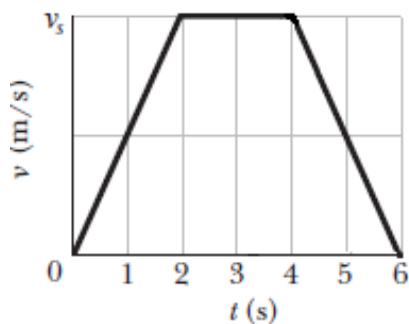
Q5.

An object falls a distance h from rest. If it travels $0.50 h$ in the last 1.00 s, the height h of its fall is

- A) 57.1 m
- B) 32.6 m
- C) 1.68 m
- D) 85.1 m
- E) 4.90 m

Q6.

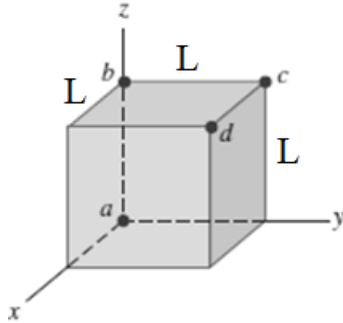
A particle starts from the origin at $t = 0$ and moves along the positive x -axis. A graph of the velocity of the particle as a function of the time is shown in **Figure 2**; where the v -axis scale is set by $v_s = 4.0$ m/s. What is the average acceleration of the particle between $t = 1.0$ s and $t = 4.0$ s?



- A) 0.67 m/s²
- B) 11 m/s²
- C) 2.0 m/s²
- D) zero
- E) 6.0 m/s²

Q7.

A cube of edge length L is placed so that one corner is at the origin and three edges are along the x -, y -, and z -axes of a coordinate system (see **Figure 3**). What is the angle between the edge along the z -axis (line ab) and the diagonal from the origin to the opposite corner (line ad)?



- A) 54.7°
 B) 45.0°
 C) 60.0°
 D) 22.5°
 E) 30.0°

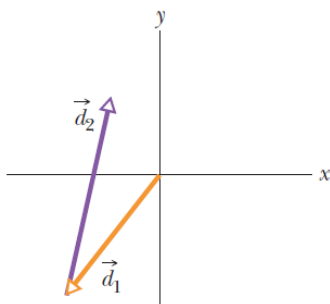
Q8.

If $\vec{A} = 1.0\hat{i} + 4.0\hat{j}$, $\vec{B} = -1.0\hat{j} + 2.0\hat{k}$ and $\vec{C} = 5.0\hat{i} - 1.0\hat{k}$. What is $2\vec{A} \cdot [(\vec{B} \times \vec{A}) + \vec{C}]$?

- A) 10
 B) Zero
 C) 28
 D) 1.0
 E) -32

Q9.

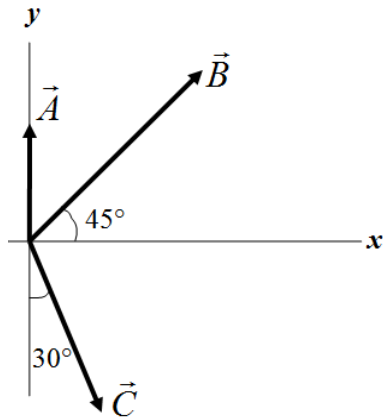
The two vectors \vec{d}_1 and \vec{d}_2 lie in an x - y plane, as shown in **Figure 4**. What is the sign of the y component of $(\vec{d}_1 + \vec{d}_2)$, $(\vec{d}_1 - \vec{d}_2)$, and $(\vec{d}_2 - \vec{d}_1)$, respectively?



- A) positive, negative, positive
 B) negative, negative, positive
 C) positive, positive, positive
 D) positive, positive, negative
 E) negative, positive, negative

Q10.

Three displacement vectors (\vec{A} , \vec{B} and \vec{C}) are shown in **Figure 5**, where the magnitude of the vectors are $A = 20.0$ cm, $B = 40.0$ cm and $C = 30.0$ cm. Find the resultant vector.



- A) $(43.3 \hat{i} + 22.3 \hat{j})$ cm
 B) $(54.3 \hat{i} + 18.3 \hat{j})$ cm
 C) $(54.3 \hat{i} + 28.3 \hat{j})$ cm
 D) $(28.3 \hat{i} + 28.3 \hat{j})$ cm
 E) $(60.0 \hat{i} + 20.0 \hat{j})$ cm

Q11.

You are to launch a rocket, from just above the ground, with the following five initial velocities. Which one of them gives the rocket maximum horizontal range?

- A) $(20.0 \hat{i} + 20.0 \hat{j})$ m/s
 B) $(10.2 \hat{i} + 26.4 \hat{j})$ m/s
 C) $(15.0 \hat{i} + 24.0 \hat{j})$ m/s
 D) $(25.0 \hat{i} + 13.3 \hat{j})$ m/s
 E) $(4.80 \hat{i} + 27.9 \hat{j})$ m/s

Q12.

A particle leaves the origin with an initial velocity $\vec{v}_o = 2.0 \hat{i}$ and a constant acceleration $\vec{a} = (-1.0 \hat{i} + 2.0 \hat{j}) \text{ m/s}^2$. By the time it reaches its maximum x coordinate, what is its average speed along y -direction?

- A) 2.0 m/s
 B) 3.6 m/s
 C) 1.0 m/s
 D) 1.6 m/s
 E) 0.6 m/s

Q13.

At $t_1 = 2.0$ s, the acceleration of a particle in counterclockwise circular motion is $(6.0\hat{i} + 4.0\hat{j})\text{m/s}^2$. It moves at constant speed. At time $t_2 = 5.0$ s, the particle's acceleration is $(4.0\hat{i} - 6.0\hat{j})\text{m/s}^2$. What is the radius of the path taken by the particle if $t_2 - t_1$ is less than one period?

- A) 2.9 m
- B) 6.5 m
- C) 7.2 m
- D) 1.6 m
- E) 0.2 m

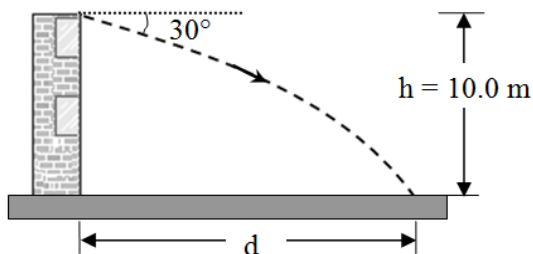
Q14.

After flying for 15 min in a wind blowing 44 km/h at an angle of 30° south of east, an airplane pilot is over a town that is 55 km due north of the starting point. What is the speed of the airplane relative to the wind?

- A) 245 km/h
- B) 38.1 km/h
- C) 202 km/h
- D) 220 km/h
- E) 44.0 km/h

Q15.

You throw a ball from a window at a height $h = 10.0$ m above the ground, with an initial speed of 20 m/s at an angle 30° below the horizontal, see **Figure 6**. At what horizontal distance d will the ball hit the ground? Ignore air resistance.



- A) 12.7 m
- B) 34.6 m
- C) 22.4 m
- D) 10.0 m
- E) 20.0 m