



Name: _____ Class: _____ Date: _____ Score: / 30

Section A · Multiple Choice

Choose the correct option. Questions 1–26

- 1 Which of the following is a vector quantity?
☐ (a) Work ☐ (b) Displacement ☐ (c) Power ☐ (d) Time
- 2 Two forces of 6 N and 8 N act on a particle in mutually perpendicular directions. The magnitude of the resultant force will be:
☐ (a) 14 N ☐ (b) 12 N ☐ (c) 10 N ☐ (d) 7 N
- 3 If the magnitude of the resultant of two vectors equal in magnitude is also equal to their individual magnitude, then the angle between the two vectors will be:
☐ (a) $2\pi/3$ ☐ (b) $2\pi/2$ ☐ (c) $\pi/3$ ☐ (d) 0
- 4 If $\hat{a}$ is a unit vector in the direction of the vector $\vec{A}$, then:
☐ (a) $\hat{a} = |\vec{A}| \vec{A}$ ☐ (b) $\hat{a} = |\vec{A}|/\vec{A}$ ☐ (c) $\hat{a} = \vec{A}/\vec{A}$ ☐ (d) $\hat{a} = \vec{A}/|\vec{A}|$
- 5 Find p if $\vec{a} = p\hat{i} + 0.3\hat{j} + 0.4\hat{k}$ is a unit vector.
☐ (a) 0.5 ☐ (b) $0.5\sqrt{3}$ ☐ (c) $0.5\sqrt{2}$ ☐ (d) 0.75
- 6 If a unit vector is represented by $(0.5\hat{i} + 0.8\hat{j} + c\hat{k})$, then the value of c is:
☐ (a) 1 ☐ (b) $\sqrt{0.11}$ ☐ (c) $\sqrt{0.01}$ ☐ (d) $\sqrt{0.39}$
- 7 Two vectors $\vec{A}$ and $\vec{B}$ are mutually perpendicular if:
☐ (a) $\vec{A} \times \vec{B} = 0$ ☐ (b) $\vec{A} \cdot \vec{B} = 0$ ☐ (c) $\vec{A} + \vec{B} = 0$ ☐ (d) $\vec{A} \cdot \vec{B} = 1$
- 8 If a vector is $\vec{F} = 4\hat{i} - 3\hat{j}$, then a vector perpendicular to this direction is:
☐ (a) $4\hat{i} + 3\hat{j}$ ☐ (b) $4\hat{i} - 3\hat{j}$ ☐ (c) $7\hat{k}$ ☐ (d) $5\hat{i}$
- 9 If $\vec{A} = (\hat{i} + \hat{j})$ and $\vec{B} = \hat{i}$, find the angle between $\vec{A}$ and $\vec{B}$.
☐ (a) $\pi/6$ ☐ (b) $\pi/4$ ☐ (c) $\pi/3$ ☐ (d) $\pi/2$
- 10 If $|\vec{P} \times \vec{Q}| = \vec{P} \cdot \vec{Q}$, then the angle between $\vec{P}$ and $\vec{Q}$ will be:
☐ (a) 0 ☐ (b) $\pi/4$ ☐ (c) $\pi/2$ ☐ (d) π
- 11 The magnitudes of two vectors are 4 and 3 respectively and the magnitude of their resultant is 1. The angle between these vectors is:
☐ (a) 0 ☐ (b) $\pi/4$ ☐ (c) $\pi/2$ ☐ (d) π

- 12 The vectors $\vec{A} = (3\hat{i} - 2\hat{j} + \hat{k})$ and $(2\hat{i} + 6\hat{j} + p\hat{k})$ will be mutually perpendicular if the value of p is:
 (a) 3 (b) 6 (c) -3 (d) -6
-
- 13 If $\vec{P} = 2\hat{i} + 5\hat{k}$ and $\vec{Q} = 3\hat{j} + 4\hat{k}$, then their scalar product is:
 (a) 20 (b) 26 (c) 23 (d) $5\sqrt{29}$
-
- 14 The angle between $(\vec{A} + \vec{B})$ and $(\vec{A} \times \vec{B})$ is:
 (a) Zero (b) $\pi/4$ (c) $\pi/2$ (d) π
-
- 15 If $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors in the Cartesian coordinate system, then:
 (a) $\hat{i} \cdot \hat{i} = 0$ (b) $\hat{j} \times \hat{k} = 0$ (c) $\hat{k} \cdot \hat{j} = 1$ (d) $\hat{i} \times \hat{j} = \hat{k}$
-
- 16 What is the angle between $(\vec{P} \times \vec{Q})$ and $(\vec{Q} \times \vec{P})$?
 (a) 0 (b) $\pi/2$ (c) $2\pi/3$ (d) π
-
- 17 The magnitude of $\vec{A} \times \vec{B}$ cannot be:
 (a) Equal to AB (b) Less than AB (c) Greater than AB (d) None of these
-
- 18 The value of $(\hat{i} \times \hat{j}) \cdot \hat{j}$ will be:
 (a) 1 (b) -1 (c) Zero (d) $-\hat{k}$
-
- 19 The value of $(\hat{i} \times \hat{j}) \times \hat{k}$ will be:
 (a) Zero (b) 1 (c) -1 (d) $\hat{k}$
-
- 20 If $|\vec{V}_1 + \vec{V}_2| = |\vec{V}_1 - \vec{V}_2|$ and $\vec{V}_1, \vec{V}_2$ are non-zero, then:
 (a) $\vec{V}_1$ and $\vec{V}_2$ are parallel (b) $\vec{V}_1$ and $\vec{V}_2$ are mutually perpendicular
 (c) $|\vec{V}_1| = |\vec{V}_2|$ (d) $\vec{V}_1 = \vec{V}_2$
-
- 21 The incorrect relationship for vectors $\vec{A}$ and $\vec{B}$ is:
 (a) $\vec{A} + \vec{B} = \vec{B} + \vec{A}$ (b) $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$
 (c) $\vec{B} \times \vec{A} = -\vec{A} \times \vec{B}$ (d) $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$
-
- 22 Which vector should be added to the sum of the vectors $(\hat{i} - 2\hat{j} + 2\hat{k})$ and $(2\hat{i} + \hat{j} - \hat{k})$ so that the resultant vector is a unit vector along the x-axis?
 (a) $(2\hat{i} + 4\hat{j} - \hat{k})$ (b) $(-2\hat{i} + \hat{j} - \hat{k})$
 (c) $(2\hat{i} - \hat{j} - \hat{k})$ (d) $(-2\hat{i} - \hat{j} - \hat{k})$
-
- 23 If $\vec{A}$ and $\vec{B}$ are two vectors with an angle θ between them, then the value of $\vec{A} \cdot (\vec{A} \times \vec{B})$ is:
 (a) $A^2 B$ (b) $A^2 B \sin \theta$ (c) $A^2 B^2 \sin \theta$ (d) Zero
-
- 24 If the angular velocity of a particle is $\vec{\omega} = (3\hat{i} - 4\hat{j} + \hat{k})$ and its position vector is $\vec{r} = (5\hat{i} - 6\hat{j} + 6\hat{k})$, then its linear velocity $\vec{v}$ will be:
 (a) $(6\hat{i} + 2\hat{j} - 3\hat{k})$ (b) $(-18\hat{i} - 13\hat{j} + 2\hat{k})$
 (c) $(4\hat{i} - 13\hat{j} + 6\hat{k})$ (d) $(6\hat{i} - 2\hat{j} + 3\hat{k})$
-

25 Two forces $\vec{F}_1$ and $\vec{F}_2$ are acting on a particle with magnitudes of 5 dyne and 10 dyne respectively. The magnitude of the resultant force can be:

- (a) 12 dyne (b) 5 dyne (c) 4 dyne (d) 8 dyne

26 If $\vec{P} + \vec{Q} = \vec{R}$ and $P^2 + Q^2 = R^2$, then the angle between $\vec{P}$ and $\vec{Q}$ will be:

- (a) 0 (b) $\pi/4$ (c) $\pi/2$ (d) π

Section B • Short Answer & Numericals Show all steps. Questions 27–30

27 Three vectors $\vec{P}$, $\vec{Q}$ and $\vec{R}$ are such that $|\vec{P}| = |\vec{Q}|$, $|\vec{R}| = \sqrt{2}|\vec{P}|$ and $\vec{P} + \vec{Q} + \vec{R} = 0$. What are the angles between $\vec{P}$ and $\vec{Q}$, $\vec{Q}$ and $\vec{R}$, and $\vec{P}$ and $\vec{R}$?

28 The position of a particle is given by $\vec{r} = 3.0t\hat{i} - 2.0t^2\hat{j} + 4.0\hat{k}$ m, where t is in seconds and the coefficients have proper units for $\vec{r}$ to be in metres. (a) Find the velocity $\vec{v}$ and acceleration $\vec{a}$ of the particle. (b) What is the magnitude and direction of the velocity of the particle at $t = 2.0$ s?

29 A particle starts from the origin at $t = 0$ s with a velocity of $10.0\hat{j}$ m/s and moves in the xy-plane with a constant acceleration of $(8.0\hat{i} + 2.0\hat{j})$ m s⁻². (a) At what time is the x-coordinate of the particle 16 m? (b) What is the y-coordinate of the particle at that time? (c) What is the speed of the particle at that time?

30 If the sum of two unit vectors is a unit vector, what is the magnitude of their difference?

■ Addition of two vectors

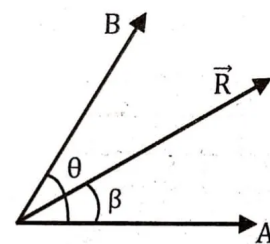
Resultant magnitude $R = \sqrt{A^2 + B^2 + 2AB \cos \theta}$

Maximum resultant $R_{\max} = A + B \quad (\theta = 0)$

Minimum resultant $R_{\min} = A - B \quad (\theta = \pi)$

Direction of resultant $\tan \beta = \frac{B \sin \theta}{A + B \cos \theta}$

Magnitude of difference $|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - 2AB \cos \theta}$



Resultant $\vec{R}$ of $\vec{A}$ and $\vec{B}$

■ Dot & cross products

Scalar (dot) product $\vec{A} \cdot \vec{B} = AB \cos \theta \Rightarrow \theta = \cos^{-1} \left(\frac{\vec{A} \cdot \vec{B}}{AB} \right)$

Vector (cross) product $|\vec{A} \times \vec{B}| = AB \sin \theta$

Area of parallelogram with sides A, B $|\vec{A} \times \vec{B}|$

Area of triangle $\frac{1}{2} |\vec{A} \times \vec{B}|$

Volume of parallelepiped $\vec{A} \cdot (\vec{B} \times \vec{C})$

Coplanar vectors $\vec{A} + \vec{B} = \vec{C}$

Perpendicular vectors $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}| \Rightarrow \theta = 90^\circ$

■ Rectangular components in 3D

Vector in 3D $\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$

Magnitude $A = \sqrt{A_x^2 + A_y^2 + A_z^2}$

Direction cosines $\cos \alpha = \frac{A_x}{A}, \quad \cos \beta = \frac{A_y}{A}, \quad \cos \gamma = \frac{A_z}{A}$

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