

Answer Key & Solution

1. (D)

2. (B)

$$\vec{A} \cdot \vec{B} = 0, \text{ then } \vec{A} \perp \vec{B}$$

$$(\hat{i} + \hat{j} + \hat{k}) \cdot (3\hat{i} + 2\hat{j} - 5\hat{k}) = 3 + 2 - 5 = 0$$

3. (D)

From the triangle law of addition

$$\vec{A} + \vec{B} + \vec{E} = 0$$

$$\vec{A} + \vec{C} = \vec{D} \Rightarrow \vec{C} - \vec{D} = -\vec{A}$$

From polygon law

$$\vec{B} + \vec{E} + \vec{D} = \vec{C} \Rightarrow \vec{B} + \vec{E} - \vec{C} = -\vec{D}$$

4. (A)

$$(\vec{A}_1 + 2\vec{A}_2) \cdot (3\vec{A}_1 - 4\vec{A}_2)$$

$$= 3A_1^2 - 4\vec{A}_1 \cdot \vec{A}_2 + 6\vec{A}_1 \cdot \vec{A}_2 - 8A_2^2$$

$$= 3A_1^2 + 2\vec{A}_1 \cdot \vec{A}_2 - 8A_2^2 \quad \dots(1)$$

$$\& \left| \vec{A}_1 + \vec{A}_2 \right| = 3$$

$$\Rightarrow A_1^2 + A_2^2 + 2\vec{A}_1 \cdot \vec{A}_2 = 9$$

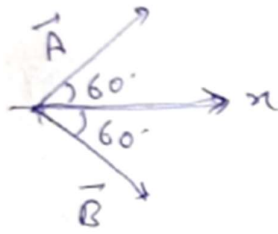
$$4 + 9 + 2\vec{A}_1 \cdot \vec{A}_2 = 9$$

$$2\vec{A}_1 \cdot \vec{A}_2 = -4 \quad \dots(2)$$

From (1) & (2)

$$(\vec{A}_1 + 2\vec{A}_2) \cdot (3\vec{A}_1 - 4\vec{A}_2) = -64$$

5. (B)



$$R = \sqrt{A^2 + B^2 + 2AB \cos 120^\circ}$$

$$= 2 \text{ cm along } +x\text{-axis}$$

6. (A)

$$F_{net}^2 = F_1^2 + F_2^2 + 2F_1F_2 \cos \theta$$

$$\frac{F}{9} = F^2 + F^2 + 2F^2 \cos \theta$$

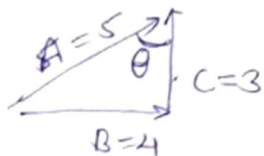
$$\theta = \cos^{-1} \left(-\frac{17}{18} \right)$$

7. (C)

$$|\vec{A}| = \sqrt{21}, |\vec{B}| = 5$$

$$A + B \geq C$$

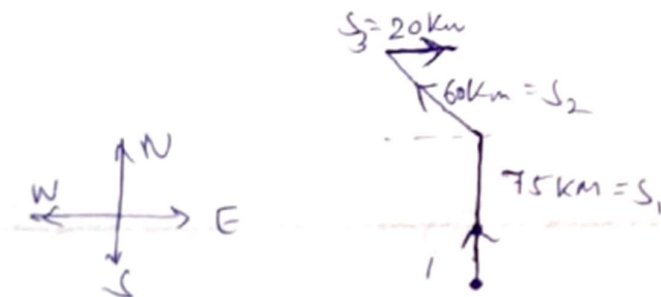
8. (A)



$$\cos \theta = \frac{3}{5}$$

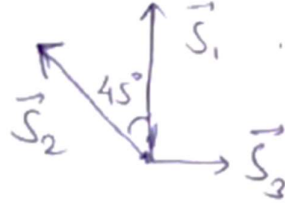
$$\theta = \cos^{-1} \left(\frac{3}{5} \right)$$

9. (C)



Total displacement

$$\begin{aligned}\vec{S} &= \vec{S}_1 + \vec{S}_2 + \vec{S}_3 \\ &= 75\hat{j} + \left(-\frac{60}{\sqrt{2}}\hat{i} + \frac{60}{\sqrt{2}}\hat{j}\right) + 20\hat{i} \\ &= (+20 - 42)\hat{i} + (75 + 42)\hat{j} \\ &= -22\hat{i} + 117\hat{j} \\ S &= \sqrt{22^2 + 117^2} \approx 119 \text{ km}\end{aligned}$$



10. (B)

$$\text{Area} = \left| \vec{A} \times \vec{B} \right|$$

$$\frac{AB}{2} = AB \sin \theta$$

$$\sin \theta = \frac{1}{2}$$

$$\theta = 30^\circ$$

11. (A)

$$\vec{A} \times \vec{B} = \vec{0}$$

12. (B)

$$\frac{2}{5} = \frac{p}{7} = \frac{q}{3} \Rightarrow p = \frac{14}{5} \text{ \& } q = \frac{6}{5}$$

13. (D)

$$b = \sqrt{3^2 + 4^2} = 5$$

$$\therefore b\vec{a} = 5 \left(\frac{\hat{i} - \hat{j}}{\sqrt{2}} \right)$$

14. (D)

$$|A - B| \leq |\vec{A} + \vec{B}| \leq A + B$$

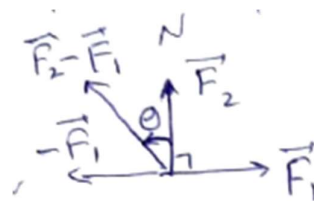
15. (A)

$$|\vec{F}_2 - \vec{F}_1| = \sqrt{(500)^2 + (250)^2}$$

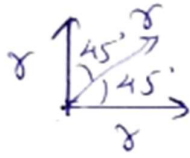
$$= 250\sqrt{5} \text{ N}$$

$$\tan \theta = \frac{F_1}{F_2} = 2$$

$$\theta = \tan^{-1}(2) \text{ W of N.}$$



16. (C)



$$R = (\sqrt{2} + 1)r$$

17. (B)

$$W = \vec{F} \cdot \vec{S} = (3\hat{i} + c\hat{j} + 2\hat{k}) \cdot (-4\hat{i} + 2\hat{j} - 3\hat{k})$$

$$\Rightarrow 6 = -12 + 2c - 6$$

$$c = 12$$

18. (C)

resulting of \vec{A} in the direction of $\vec{B} = (\vec{A} \cdot \vec{B}) \hat{B}$

$$= \left(\frac{(2\hat{i} + \hat{j} + \hat{k}) \cdot (-\hat{i} + 3\hat{j} + 2\hat{k})}{\sqrt{14}} \right) \frac{(-\hat{i} + 3\hat{j} + 2\hat{k})}{\sqrt{14}}$$

$$= \frac{3}{14}(-\hat{i} + 3\hat{j} + 2\hat{k})$$

19. (C)

$$\text{Let } \vec{b} = x\hat{i} + \hat{j} + z\hat{k}$$

$$\therefore \vec{a} \cdot \vec{b} = x + y + z = 1$$

$$\vec{a} \times \vec{b} = (z - y)\hat{i} - \hat{j}(z - x) + \hat{k}(x - y) = \hat{j} - \hat{k}$$

$$\text{i.e. } z - y = 0 \Rightarrow y = z$$

$$-(z - x) = 1 \Rightarrow x - z = 1$$

$$x - y = 1 \Rightarrow -x - y = 1$$

Solving $y = z = 0$

$$x = 1$$

$$\therefore \vec{b} = \hat{i}$$

20. (C)

$$\vec{AB} + \vec{AC} + \vec{AD} + \vec{AE} + \vec{AF}$$

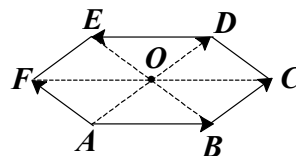
$$\text{Here } \vec{AD} = 2\vec{AO}$$

$$\vec{CD} = \vec{AF}$$

$$\vec{AB} = -\vec{DE}$$

$$= \vec{AB} + (\vec{AC} + \vec{AF}) + \vec{AD} + \vec{AD} + \vec{DE}$$

$$= 3\vec{AD} = 3(2\vec{AO}) = 6\vec{AO}$$



21.

(B)

$$\vec{A} \perp \vec{B}, \therefore \vec{A} \cdot \vec{B} = 0$$

$$\vec{A} \cdot [\vec{A} + \vec{B}] = \vec{A} \cdot \vec{A} + \vec{A} \cdot \vec{B} = A^2$$

22.

(D)

$$\vec{P} \times \vec{Q} = 3\hat{i} - 3\hat{k}$$

$$\therefore \hat{n} = \left(\frac{\hat{i} - \hat{k}}{\sqrt{2}} \right)$$

$$\therefore \vec{n} = \left(\frac{\hat{i} - \hat{k}}{\sqrt{2}} \right) \sqrt{2} = \hat{i} - \hat{k}$$

23.

(C)

$$\vec{F}_1 = 45\hat{i}, \vec{F}_2 = 20\hat{j}$$

$$\vec{F}_3 = -25 \sin 37^\circ \hat{i} + 25 \cos 37^\circ \hat{j} = -15\hat{i} + 20\hat{j}$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 30\hat{i} + 40\hat{j}$$

$$|\vec{F}| = \sqrt{30^2 + 40^2} = 50 \text{ N}$$

24.

(B)

$$\vec{A} \cdot \vec{B} = 0 \Rightarrow \vec{A} \perp \vec{B}$$

$$\vec{A} \cdot \vec{C} = 0 \Rightarrow \vec{A} \perp \vec{C}$$

$$\text{Then } \vec{A} \cdot (\vec{B} + \vec{C}) = \vec{A} \cdot \vec{B} + \vec{A} \cdot \vec{C} = 0$$

25.

(A)

$$\vec{V} = (\vec{\omega} \times \vec{r})$$

$$= -2\hat{i} + 3\hat{j} + 4\hat{k}$$

$$|\vec{V}| = \sqrt{29} \text{ units.}$$