Max Marks: 720 | **JR_WEEK-6 (20-07-2026)** | **Time: 180 mins**

Physics

1. A force vector has a magnitude of $30\ \text{N}$. If the force is in the direction of $\vec{B}$, find the force in vector form, where $\vec{B} = \hat{i} + \hat{j}$.

A) $15\hat{i} + 15\hat{j}\ \text{N}$
B) $30\hat{i} + 30\hat{j}\ \text{N}$
C) $15\sqrt{2}\hat{i} + 15\sqrt{2}\hat{j}\ \text{N}$
D) $30\sqrt{2}\hat{i} + 30\sqrt{2}\hat{j}\ \text{N}$

2. A velocity vector has a magnitude of $50\ \text{m/s}$. If the velocity is in the direction of $\vec{C}$, find the velocity in vector form, where $\vec{C} = 3\hat{i} + 4\hat{j}$.

A) $30\hat{i} + 40\hat{j}\ \text{m/s}$
B) $15\hat{i} + 20\hat{j}\ \text{m/s}$
C) $3\hat{i} + 4\hat{j}\ \text{m/s}$
D) $50\hat{i} + 50\hat{j}\ \text{m/s}$

3. Find the component of $\vec{A} = 4\hat{i} + 2\hat{j}$ along $\vec{B} = \hat{i} + \hat{j}$.

A) Scalar: $\frac{6}{\sqrt{2}}$, Vector: $3(\hat{i} + \hat{j})$
B) Scalar: $\frac{2}{\sqrt{2}}$, Vector: $\hat{i} + \hat{j}$
C) Scalar: 6, Vector: $6(\hat{i} + \hat{j})$
D) Scalar: 3, Vector: $3(\hat{i} + \hat{j})$

4. Find the component of $\vec{A} = 7\hat{i} + \hat{j}$ along $\vec{B} = 3\hat{i} + 4\hat{j}$.

A) Scalar: 5, Vector: $3\hat{i} + 4\hat{j}$
B) Scalar: 25, Vector: $15\hat{i} + 20\hat{j}$
C) Scalar: $\frac{1}{5}$, Vector: $\frac{3}{25}\hat{i} + \frac{4}{25}\hat{j}$
D) Scalar: 5, Vector: $15\hat{i} + 20\hat{j}$

5. A particle moves with a speed of $15\ \text{m/s}$ in the direction of a vector $\vec{A} = 3\hat{i} + 4\hat{j}$. Find the velocity of the particle in vector form.

A) $3\hat{i} + 4\hat{j}\ \text{m/s}$
B) $6\hat{i} + 8\hat{j}\ \text{m/s}$
C) $9\hat{i} + 12\hat{j}\ \text{m/s}$
D) $12\hat{i} + 16\hat{j}\ \text{m/s}$

6. A drone flies with a speed of $26\ \text{m/s}$ in the direction of a vector $\vec{B} = 5\hat{i} + 12\hat{j}$. Find the velocity of the drone in vector form.

A) $5\hat{i} + 12\hat{j}\ \text{m/s}$
B) $10\hat{i} + 24\hat{j}\ \text{m/s}$
C) $13\hat{i} + 13\hat{j}\ \text{m/s}$
D) $25\hat{i} + 144\hat{j}\ \text{m/s}$

7. If $\vec{A} = 2\hat{i} + \hat{j}$ and $\vec{B} = \hat{i} + \hat{j}$, find the component of $\vec{A}$ perpendicular to $\vec{B}$.

A) $\frac{\hat{i} - \hat{j}}{2}$
B) $\frac{\hat{i} + \hat{j}}{2}$
C) $\frac{-\hat{i} + \hat{j}}{2}$
D) $\frac{2\hat{i} - \hat{j}}{2}$

8. If $\vec{A} = 5\hat{i} + 5\hat{j}$ and $\vec{B} = 3\hat{i} + 4\hat{j}$, find the component of $\vec{A}$ perpendicular to $\vec{B}$.

A) $\frac{4\hat{i} - 3\hat{j}}{5}$
B) $\frac{-4\hat{i} + 3\hat{j}}{5}$
C) $\frac{21\hat{i} + 28\hat{j}}{5}$
D) $\frac{4\hat{i} + 3\hat{j}}{5}$

9. For the vectors $\vec{A} = 2\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{B} = 4\hat{i} - 2\hat{j} + 6\hat{k}$, determine the relationship between them.

A) The vectors are parallel
B) The vectors are anti-parallel
C) The vectors are perpendicular
D) The vectors are equal

10. For the vectors $\vec{A} = 3\hat{i} + 2\hat{j} - \hat{k}$ and $\vec{B} = \hat{i} - 2\hat{j} - \hat{k}$, determine the relationship between them.

A) The vectors are parallel
B) The vectors are anti-parallel
C) The vectors are perpendicular
D) The vectors are equal

11. If $\vec{A} = 2\hat{i} + 3\hat{j}$ and $\vec{B} = 4\hat{i} + 3\hat{j}$, find the component of $\vec{A}$ perpendicular to $\vec{B}$.

A) $\frac{-18\hat{i} + 24\hat{j}}{25}$
B) $\frac{68\hat{i} + 51\hat{j}}{25}$
C) $\frac{18\hat{i} - 24\hat{j}}{25}$
D) $\frac{50\hat{i} + 75\hat{j}}{25}$

12. If $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = \hat{i} - 2\hat{j}$, find the component of $\vec{A}$ perpendicular to $\vec{B}$.

A) $4\hat{i} + 2\hat{j}$
B) $-\hat{i} + 2\hat{j}$
C) $3\hat{i} + 4\hat{j}$
D) $\hat{i} - 2\hat{j}$

13. If $\vec{A} = 3\hat{i} + 4\hat{j} + 12\hat{k}$, find its direction cosines.

A) $\cos\alpha = \frac{3}{13}, \cos\beta = \frac{4}{13}, \cos\gamma = \frac{12}{13}$
B) $\cos\alpha = \frac{3}{\sqrt{13}}, \cos\beta = \frac{4}{\sqrt{13}}, \cos\gamma =$
C) $\cos\alpha = \frac{4}{13}, \cos\beta = \frac{3}{13}, \cos\gamma = \frac{12}{13}$
D) $\cos\alpha = \frac{13}{3}, \cos\beta = \frac{13}{4}, \cos\gamma = \frac{1}{1}$

14. If $\vec{B} = \hat{i} + 2\hat{j} + 2\hat{k}$, find its direction cosines.

A) $\cos\alpha = 1, \cos\beta = 2, \cos\gamma =$
B) $\cos\alpha = \frac{1}{3}, \cos\beta = \frac{2}{3}, \cos\gamma = \frac{2}{3}$
C) $\cos\alpha = \frac{1}{\sqrt{5}}, \cos\beta = \frac{2}{\sqrt{5}}, \cos\gamma = \frac{2}{\sqrt{5}}$
D) $\cos\alpha = \frac{1}{5}, \cos\beta = \frac{2}{5}, \cos\gamma = \frac{2}{5}$

15. If $\vec{A} = 12\hat{i} + 4\hat{j} + 3\hat{k}$, find its direction cosines and components along the x, y, and z axes.

A) Direction cosines: $\cos\alpha = \frac{12}{13}, \cos\beta = \frac{4}{13}, \cos\gamma = \frac{3}{13}$; Components: $12\hat{i}, 4\hat{j}, 3\hat{k}$

B) Direction cosines: $\cos\alpha = \frac{12}{13}, \cos\beta = \frac{4}{5}, \cos\gamma = \frac{3}{5}$; Components: $12\hat{i}, 4\hat{j}, 3\hat{k}$

C) Direction cosines: $\cos\alpha = \frac{4}{13}, \cos\beta = \frac{12}{13}, \cos\gamma = \frac{3}{13}$; Components: $4\hat{i}, 12\hat{j}, 3\hat{k}$

D) Direction cosines: $\cos\alpha = \frac{1}{13}, \cos\beta = \frac{1}{12}, \cos\gamma = \frac{1}{3}$; Components: $\hat{i}, \hat{j}, \hat{k}$

16. If $\vec{A} = 2\hat{i} + 6\hat{j} + 3\hat{k}$, find its direction cosines and components along the x, y, and z axes.

A) Direction cosines: $\cos\alpha = \frac{2}{7}, \cos\beta = \frac{6}{7}, \cos\gamma = \frac{3}{7}$; Components: $2\hat{i}, 6\hat{j}, 3\hat{k}$

B) Direction cosines: $\cos\alpha = \frac{2}{11}, \cos\beta = \frac{6}{11}, \cos\gamma = \frac{3}{11}$; Components: $2\hat{i}, 6\hat{j}, 3\hat{k}$

C) Direction cosines: $\cos\alpha = \frac{6}{7}, \cos\beta = \frac{2}{7}, \cos\gamma = \frac{3}{7}$; Components: $6\hat{i}, 2\hat{j}, 3\hat{k}$

D) Direction cosines: $\cos\alpha = \frac{7}{2}, \cos\beta = \frac{7}{6}, \cos\gamma = \frac{7}{3}$; Components: $\hat{i}, \hat{j}, \hat{k}$

17. Find the cross product $\vec{a} \times \vec{b}$ if $\vec{a} = 5\hat{i} + 2\hat{j}$ and $\vec{b} = 3\hat{i} + 4\hat{j}$.

A) $14\hat{k}$ **B)** $-14\hat{k}$

C) $26\hat{k}$ **D)** $6\hat{k}$

18. Find the cross product $\vec{a} \times \vec{b}$ if $\vec{a} = 2\hat{i} + 3\hat{j}$ and $\vec{b} = 4\hat{i} + 1\hat{j}$.

A) $10\hat{k}$ **B)** $-10\hat{k}$

C) $14\hat{k}$ **D)** $-14\hat{k}$

19. Find the cross product $\vec{a} \times \vec{b}$ if $\vec{a} = 5\hat{i} + 2\hat{j}$ and $\vec{b} = 3\hat{i} + 4\hat{j}$.

A) $14\hat{k}$ **B)** $-14\hat{k}$

C) $23\hat{k}$ **D)** $26\hat{k}$

20. Find the cross product $\vec{a} \times \vec{b}$ if $\vec{a} = 3\hat{i} + 2\hat{j}$ and $\vec{b} = 1\hat{i} + 4\hat{j}$.

A) $10\hat{k}$ **B)** $-10\hat{k}$

C) $14\hat{k}$ **D)** $-14\hat{k}$

21. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If the magnitude of $\vec{A} - \vec{B}$ is x times the magnitude of $\vec{A} + \vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ is:

A) $\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$ **B)** $\cos^{-1}\left(\frac{x^2-1}{x^2+1}\right)$

C) $\sin^{-1}\left(\frac{1-x^2}{1+x^2}\right)$ **D)** $\tan^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

22. Two vectors $\vec{P}$ and $\vec{Q}$ have equal magnitudes. If the magnitude of $\vec{P} + \vec{Q}$ is $\sqrt{n}$ times the magnitude of $\vec{P} - \vec{Q}$, then the angle between $\vec{P}$ and $\vec{Q}$ is:

A) $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$ **B)** $\cos^{-1}\left(\frac{n-1}{n+1}\right)$

C) $\sin^{-1}\left(\frac{n-1}{n+1}\right)$ **D)** $\tan^{-1}\left(\frac{n-1}{n+1}\right)$

23. If $\vec{P} = 2\hat{i} + \hat{j} + 3\hat{k}$ and $\vec{Q} = \hat{i} + \hat{j} + 3\hat{k}$, then the unit vector along $\vec{P} + \vec{Q}$ is:

A) $\frac{3\hat{i}+2\hat{j}+6\hat{k}}{6}$ **B)** $\frac{3\hat{i}+2\hat{j}+6\hat{k}}{7}$

C) $\frac{3\hat{i}+2\hat{j}+6\hat{k}}{\sqrt{38}}$ **D)** $3\hat{i} + 2\hat{j} + 6\hat{k}$

24. If $\vec{A} = \hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = 2\hat{i} + 2\hat{j} + \hat{k}$, then the unit vector along $\vec{A} + \vec{B}$ is:

A) $\frac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{3}}$ **B)** $\frac{3\hat{i}+3\hat{j}+3\hat{k}}{3}$

C) $\frac{\hat{i}+\hat{j}+\hat{k}}{3}$ **D)** $\frac{3\hat{i}+3\hat{j}+3\hat{k}}{\sqrt{27}}$

25. If $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{B} = 2\hat{i} - \hat{j} + \hat{k}$, then the cosine of the angle between $\vec{A}$ and $\vec{A} + \vec{B}$ is:

A) $\frac{17}{\sqrt{364}}$ **B)** $\frac{15}{\sqrt{364}}$

C) $\frac{17}{2\sqrt{91}}$ **D)** $\frac{1}{\sqrt{2}}$

26. If $\vec{P} = 3\hat{i} + 4\hat{j}$ and $\vec{Q} = 5\hat{i} + 12\hat{j}$, then the cosine of the angle between $\vec{P}$ and $\vec{P} + \vec{Q}$ is:

A) $\frac{11}{5\sqrt{5}}$ **B)** $\frac{88}{5\sqrt{5}}$

C) $\frac{11}{25}$ **D)** $\frac{1}{\sqrt{2}}$

27. Given two vectors $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 4\hat{i} - 3\hat{j}$, match the terms in Column-I with Column-II:

Column-I:	Column-II:
(A) $\frac{\vec{A}\cdot\vec{B}}{\lvert\vec{A}\rVert\vec{B}\rvert}$	(1) $-\hat{k}$
(B) $\frac{\vec{A}\times\vec{B}}{25}$	(2) $\frac{7\hat{i}+\hat{j}}{5\sqrt{2}}$
(C) Unit vector along $(\vec{A}+\vec{B})$	(3) 0
(D) Unit vector along $(\vec{A}-\vec{B})$	(4) $\frac{-\hat{i}+7\hat{j}}{5\sqrt{2}}$

A) (A) to (1); (B) to (3); (C) to (4); (D) to (2)

B) (A) to (3); (B) to (1); (C) to (2); (D) to (4)

C) (A) to (3); (B) to (2); (C) to (1); (D) to (4)

D) (A) to (4); (B) to (1); (C) to (2); (D) to (3)

28. Given two vectors $\vec{P} = 2\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{Q} = \hat{i} - 2\hat{j} + 2\hat{k}$, match the terms in Column-I with Column-II:

Column-I:	Column-II:
(A) $\frac{\vec{P}\cdot\vec{Q}}{\lvert\vec{Q}\rvert}$	(1) $\frac{\hat{i}+\hat{k}}{\sqrt{2}}$
(B) $\frac{\vec{P}+\vec{Q}}{\lvert\vec{P}+\vec{Q}\rvert}$	(2) 9
(C) $\frac{\vec{P}\times\vec{Q}}{9}$	(3) 0
(D) $\lvert\vec{P}\times\vec{Q}\rvert$	(4) $\frac{2\hat{i}-\hat{j}-2\hat{k}}{3}$

A) (A) to (3); (B) to (1); (C) to (4); (D) to (2)
B) (A) to (1); (B) to (3); (C) to (2); (D) to (4)
C) (A) to (3); (B) to (4); (C) to (1); (D) to (2)
D) (A) to (2); (B) to (1); (C) to (3); (D) to (4)

29. The component of vector $\vec{a} = 4\hat{i} + 2\hat{j}$ along the vector $\hat{i} + \hat{j}$ is

A) $6\sqrt{2}$
B) $3\sqrt{2}$
C) 6
D) 3

30. The component of vector $\vec{a} = 7\hat{i} - \hat{j}$ along the vector $\hat{i} + \hat{j}$ is

A) $3\sqrt{2}$
B) $6\sqrt{2}$
C) 6
D) 3

31. What is the area of the triangle with vertices at coordinates $P(1, 2, 3)$, $Q(4, 2, 1)$, and $R(1, 5, 2)$?

A) $\sqrt{31.5}$ units
B) 31.5units
C) $\sqrt{63}$units
D) 63units

32. The area of the triangle formed by vectors $\vec{A} = 2\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = \hat{i} + \lambda\hat{j} + \hat{k}$ and their resultant is $\frac{3\sqrt{2}}{2}$ square units. If $\lambda > 0$, what is the value of λ?

A) 1
B) 2
C) 3
D) 4

33. If $\vec{A} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{B} = \hat{i} + \hat{j} - 2\hat{k}$, then which of the following is correct?

A) $\vec{A}\cdot\vec{B} = 1$
B) $\lvert\vec{A}\times\vec{B}\rvert = \sqrt{35}$
C) The angle between $\vec{A}$ and $\vec{B}$ is 45°
D) $\lvert\vec{A}\rvert = \sqrt{5}$

34. If vectors $\vec{A} = 2\hat{i} + \lambda\hat{j} + 3\hat{k}$ and $\vec{B} = 3\hat{i} + 2\hat{j} - 2\hat{k}$ are perpendicular, then which of the following is correct?

A) $\lambda = 3$
B) $\lvert\vec{A}\rvert = \sqrt{13}$
C) $\vec{A}\cdot\vec{B} = 6$
D) $\lvert\vec{B}\rvert = 5$

35. The vector $\vec{C} = 39\hat{i} + \lambda\hat{j} + 60\hat{k}$ bisects the angle between the vectors $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 5\hat{j} + 12\hat{k}$. What is the value of λ?

A) 52
B) 65
C) 77
D) 85

36. The vector $\vec{v} = \alpha\hat{i} + \hat{j} + \beta\hat{k}$ lies in the plane of vectors $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = \hat{j} + \hat{k}$ and bisects the angle between them. What are the values of α and β?

A) $\alpha = 1, \beta = 1$
B) $\alpha = \frac{1}{2}, \beta = \frac{1}{2}$
C) $\alpha = 2, \beta = 1$
D) $\alpha = 1, \beta = 2$

37. A vector $\vec{X}$, when added to two vectors $\vec{A} = 2\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{B} = -\hat{i} + 2\hat{j} - \hat{k}$, gives a vector of magnitude 10 along the direction of the vector $\vec{C} = 3\hat{i} + 4\hat{j}$. Find the vector $\vec{X}$.

A) $5\hat{i} + 7\hat{j} - 2\hat{k}$
B) $5\hat{i} + 7\hat{j} + 2\hat{k}$
C) $-5\hat{i} - 7\hat{j} + 2\hat{k}$
D) $6\hat{i} + 8\hat{j}$

38. A vector $\vec{X}$ parallel to $\vec{A} = \hat{i} + 2\hat{j} + 2\hat{k}$ is added to the vector $\vec{B} = 3\hat{i} - \hat{j} + \hat{k}$. If the resultant vector is perpendicular to $\vec{C} = \hat{i} - \hat{j} - \hat{k}$, find the vector $\vec{X}$.

A) $\hat{i} + 2\hat{j} + 2\hat{k}$
B) $2\hat{i} + 4\hat{j} + 4\hat{k}$
C) $-\hat{i} - 2\hat{j} - 2\hat{k}$
D) $3\hat{i} + 6\hat{j} + 6\hat{k}$

39. Given two vectors $\overrightarrow{A} = 2\hat{i} - 5\hat{j} + 2\widehat{k}$and $\overrightarrow{B} = 4\hat{i} - 10\hat{j} + c\widehat{k}$. What should be the value of C so that the vector $\overrightarrow{A}\,and\,\overrightarrow{B}$would become parallel to each other?

A) 1
B) 2
C) 3
D) 4

40. The unit vector, which is perpendicular to both $\overrightarrow{A} = \hat{i} + 2\hat{j} + 3\widehat{k}\,and\,\overrightarrow{B} = \hat{i} - 2\hat{j} - 3\widehat{k}$is equal to

A) $\frac{\hat{i}+2\hat{j}+3\widehat{k}}{6}$
B) $\frac{6\hat{j}-4\widehat{k}}{\sqrt{52}}$
C) $\frac{6\hat{i}+4\widehat{k}}{4\sqrt{52}}$
D) $\frac{2\hat{i}-\hat{j}}{\sqrt{5}}$

41. With respect to a rectangular cartesian coordinate system, three vectors are expressed as $\vec{a} = 4\hat{i} - \hat{j}, \vec{b} = -3\hat{i} + 2\hat{j}$ and $\vec{c} = -\hat{k}$where $\hat{i}, \hat{j}, \hat{k}$ are unit vectors, along the X, Y and Z-axis respectively. The unit vectors r along the direction of sum of these vectors is

A) $\hat{r} = \frac{1}{\sqrt{3}}\left(\hat{i} + \hat{j} - \hat{k}\right)$
B) B)$\hat{r} = \frac{1}{\sqrt{2}}\left(\hat{i} + \hat{j} - \hat{k}\right)$
C) C)$\hat{r} = \frac{1}{3}\left(\hat{i} - \hat{j} + \hat{k}\right)$
D) $\hat{r} = \frac{1}{\sqrt{2}}\left(\hat{i} + \hat{j} + \hat{k}\right)$

42. **A particle moves from position $3\hat{i}+2\hat{j}-6\hat{k}$ to $14\hat{i}+13\hat{j}+9\hat{k}$ due to a uniform force of $\left(4\hat{i}+\hat{j}+3\hat{k}\right)N$. If the displacement in meters then work done will be**

A) 100 J **B)** 200 J
C) $300J$ **D)** 250 J

43. **A particle moves with a velocity $6\hat{i}-4\hat{j}+3\hat{k}\mathrm{m/s}$ under the influence of a constant force $\vec{F}=20\hat{i}+15\hat{j}-5\hat{k}N$. The instantaneous power applied to the particle is**

A) $35\mathrm{J/s}$ **B)** $45\mathrm{J/s}$
C) $25\mathrm{J/s}$ **D)** $195\mathrm{J/s}$

44. **If a particle of mass m is moving with constant velocity v parallel to x-axis in $x-y$ plane as shown in fig. Its angular momentum with respect to origin at any time t will be**

A) $mvb\hat{k}$ **B)** $-mvb\hat{k}$
C) $mvb\hat{i}$ **D)** $mv\hat{i}$

45. **Given two vectors $\vec{P}=3\hat{i}-6\hat{j}+9\hat{k}$ and $\vec{Q}=\hat{i}-2\hat{j}+m\hat{k}$. What should be the value of m so that the vector $\vec{P}$ and $\vec{Q}$ would become parallel to each other?**

A) 1 **B)** 2
C) 3 **D)** 4

Chemistry

46. **The molecular formula of chloride of Eka-Aluminium and Eka-Silicon respectively are:**

A) $GaCl_3$ and SiO_4 **B)** $GaCl_3$ and $AlCl_3$
C) $AlCl_3$ and $SiCl_4$ **D)** $GaCl_3$ and $GeCl_4$

47. **The element $Z=114$ has been discovered recently. It will belong to which of the following family group and electronic configuration?**

A) Halogen family $[Rn]5f^{14}6d^{10}7s^27p^5$ **B)** Carbon family $[Rn]5f^{14}6d^{10}7s^27p^2$
C) Oxygen family $[Rn]5f^{14}6d^{10}7s^27p^4$ **D)** Nitrogen family $[Rn]5f^{14}6d^{10}7s^27p^3$

48. **Element with atomic number 47 belongs to the period .....and the group .....**

A) 4th, 12th **B)** 4th, 11th
C) 5th, 12th **D)** 5th, 11th

49. **The sixth period contains 32 elements and successive electrons enter in the orbitals of:**

A) 5s, 4f, 5d and 4p **B)** 6s, 3f, 4d and 5p
C) 5s, 4f, 6d and 6p **D)** 6s, 4f, 5d and 6p

50. **Assertion: Mendeleev periodic table had left the gap under aluminium and a gap under silicon, and called these elements Eka-Aluminium and Eka-Silicon.**
Reason: The elements gallium and germanium were known at that time Mendeleev published his periodic table.

A) Both A and R are true and R is the correct explanation of A **B)** Both A and R are true but R is not the correct explanation of A
C) A is true but R is false **D)** Both A and R are false

51. **A plot of $\sqrt{v}$ against atomic number (Z) gave a straight line and not the plot of $\sqrt{v}$ against atomic mass. Which of the following scientist observed such regularities in the characteristics X-ray spectra of the element?**

A) Dmitri Mendeleev **B)** Henry Moseley
C) A. H. B. de Chancourtois **D)** Alexander Newlands

52. **Which of the following set of atomic number represents only representative elements?**

A) 55, 12, 48, 53 **B)** 13, 23, 54, 83
C) 3, 33, 53, 87 **D)** 22, 33, 55, 66

53. **The electronic configuration of inner transition elements is:**

A) ns^1 **B)** $ns^2np^5nd^{10}$
C) $ns^{0-2}(n-1)d^{1-10}(n-2)f^{1-14}$ **D)** $ns^2(n-1)d^{0-1}(n-2)f^{1-14}$

54. **Identify the incorrect match.**

Name	IUPAC OfficialName
(A) Unnilunium	(i) Mendelevium
(B) Unniltrium	(ii) Lawrencium
(C) Unnilhexium	(iii) Seaborgium
(D) Unununnium	(iv) Darmstadtium

A) (B), (ii) **B)** (C), (iii)
C) (D), (iv) **D)** (A), (i)

55. **Match List-I (Atomic number) with List-II (Block of periodic table):**

LIST-I (Atomic number)	LIST-II (Block of periodictable)
(A) 37	I. p-block
(B) 78	II. d-block
(C) 52	III. f-block
(D) 65	IV. s-block

A) A-II, B-IV, C-I, D-III **B)** A-I, B-III, C-IV, D-II
C) A-IV, B-III, C-II, D-I **D)** A-IV, B-II, C-I, D-III

56. Atomic radii of fluorine and neon in Angstrom units are respectively given by:

A) 0.72, 1.60 **B)** 1.60, 1.60
C) 0.72, 0.72 **D)** None of these

57. Ionic radii of:

A) $Ti^{4+} < Mn^{7+}$ **B)** $^{35}Cl^{-} <^{37} Cl^{-}$
C) $K^{+} > Cl^{-}$ **D)** $P^{3+} > P^{5+}$

58. The ions $O^{2-}, F^{-}, Na^{+}, Mg^{2+}$ and Al^{3+} are isoelectronic. Their ionic radii show:

A) a significant increase from O^{2-} to Al^{3+} **B)** a significant decrease from O^{2-} to Al^{3+}
C) an increase from O^{2-} to F^{-} and then decrease from Na^{+} to Al^{3+} **D)** a decrease from O^{2-} to F^{-} and then increase from Na^{+} to Al^{3+}

59. The ionic radii (in $\overset{0}{A}$) of N^{3-}, O^{2-} and F^{-} are respectively:

A) 1.71, 1.40 and 1.36 **B)** 1.71, 1.36 and 1.40
C) 1.36, 1.40 and 1.71 **D)** 1.36, 1.71 and 1.40

60. The ionic radii of F^{-} and O^{2-} respectively are $1.33\overset{0}{A}$ and $1.4\overset{0}{A}$, while the covalent radius of N is $0.74\overset{0}{A}$. The correct statement for the ionic radius of N^{3-} from the following is:

A) It is smaller than F^{-} and N **B)** It is bigger than O^{2-} and F^{-}
C) It is bigger than F^{-} and N, but smaller than of O^{2-} **D)** It is smaller than O^{2-} and F^{-}, but bigger than of N

61. Read the following statement and explanation and answer as per the options given below: Statement I: The first ionization energy of Be is greater than that of B. Statement II: 2p orbital is lower in energy than 2s.

A) Both Statement I and Statement II are correct **B)** Both Statement I and Statement II are incorrect
C) Statement I is correct but Statement II is incorrect **D)** Statement I is incorrect but Statement II is correct

62. The first ionisation potential in electron volts of nitrogen and oxygen atoms are respectively given by:

A) 14.6, 13.6 **B)** 13.6, 14.6
C) 13.6, 13.6 **D)** 14.6, 14.6

63. Amongst the following elements (whose electronic configurations are given below), the one having the highest ionization energy is:

A) $[Ne]3s^2 3p^1$ **B)** $[Ne]3s^2 3p^3$
C) $[Ne]3s^2 3p^2$ **D)** $[Ne]3d^{10}4s^2 4p^3$

64. The electronic configuration with the highest ionization enthalpy is:

A) $[Ne]3s^2 3p^1$ **B)** $[Ne]3s^2 3p^2$
C) $[Ne]3s^2 3p^3$ **D)** $[Ar]3d^{10}4s^2 4p^3$

65. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si respectively, are:

A) 496, 737, 577, 786 **B)** 496, 577, 737, 786
C) 786, 737, 577, 496 **D)** 496, 577, 786, 7370

66. The electron gain enthalpy (in kJ/mol) of fluorine, chlorine, bromine and iodine, respectively, are:

A) $-296, -325, -333$ and -349 **B)** $-349, -333, -325$ and -296
C) $-333, -349, -325$ and -296 **D)** $-333, -325, -349$ and -296

67. The process that is NOT endothermic in nature is:

A) $Ar(g) + e^{-} \rightarrow Ar^{-}(g)$ **B)** $H(g) + e^{-} \rightarrow H^{-}(g)$
C) $O^{-}(g) + e^{-} \rightarrow O^{2-}(g)$ **D)** $Na(g) \rightarrow Na^{+}(g) + e^{-}$

68. The electron affinity of chlorine is $3.7\ \text{eV}$. $1\ \text{gram}$ of chlorine is completely converted to Cl^{-} ion in a gaseous state. ($1\ \text{eV} = 23.06\ \text{kcal/mol}$) Energy released in the process is:

A) $4.8\ \text{kcal}$ **B)** $7.2\ \text{kcal}$
C) $8.2\ \text{kcal}$ **D)** $2.4\ \text{kcal}$

69. When the first electron gain enthalpy ($\Delta_{eg}H$) of oxygen is $-141\ \text{kJ/mol}$, its second electron gain enthalpy is:

A) a more negative value than the first **B)** almost the same as that of the first
C) negative, but less negative than the first **D)** a positive value

70. For electron gain enthalpies of the elements denoted as $\Delta_{eg}H$, the incorrect option is:

A) $\Delta_{eg}H(Cl) < \Delta_{eg}H(F)$ **B)** $\Delta_{eg}H(Se) < \Delta_{eg}H(S)$
C) $\Delta_{eg}H(I) < \Delta_{eg}H(At)$ **D)** $\Delta_{eg}H(Te) < \Delta_{eg}H(Po)$

71. The correct order of electronegativity for given elements is:

A) $Br > C > At$ **B)** $C > P > At > Br$
C) $Br > P > At > C$ **D)** $Br > C > At > P$

72. The correct option with respect to the Pauling electronegativity values of the elements is:

A) $Te > Se$ **B)** $Ga < Ge$
C) $Si < Al$ **D)** $P > S$

73. Arrange the following elements in increasing order of electronegativity: N, O, F, C, Si. Choose the correct answer from the options given below:

A) $Si < C < N < O < F$ **B)** $Si < C < O < N < F$
C) $O < F < N < C < Si$ **D)** $F < O < N < C < Si$

74. Which one of the following arrangements represents the correct order of least negative to most negative electron gain enthalpy for C, Ca, Al, F and O?

A) $Al < Ca < O < C < F$ **B)** $Al < O < C < Ca < F$
C) $C < F < O < Al < Ca$ **D)** $Ca < Al < C < O < F$

75. Pauling's electronegativity values for elements are useful in predicting:

A) polarity of the molecules **B)** position in the E.M.F. series
C) coordination numbers **D)** dipole moments

76. Which of the following elements is considered as a metalloid?

A) Sc **B)** Pb
C) Bi **D)** Te

77. Given below are two statements : Assertion (A): Metallic character decreases and non-metallic character increases on moving from left to right in a period. Reason (R): It is due to increase in ionisation enthalpy and decrease in electron gain enthalpy, when one moves from left to right in a period. In the light of the above statements, choose the most appropriate answer from the options given below.

A) (A) is false but (R) is true. **B)** (A) is true but (R) is false.
C) Both (A) and (R) are correct and (R) is the correct explanation of (A). **D)** Both (A) and (R) are correct but (R) is not the correct explanation of (A).

78. One of the characteristic properties of non-metals is that they:

A) are reducing agents **B)** form basic oxides
C) form cations by electron gain **D)** are electronegative

79. In the periodic table, with the increase in atomic number, the metallic character of an element:

A) decreases in a period and increases in a group **B)** increases in a period and decreases in a group
C) increases both in a period and the group **D)** decreases in a period and the group

80. The correct decreasing order for metallic character is:

A) $Na > Mg > Be > Si > P$ **B)** $P > Si > Be > Mg > Na$
C) $Si > P > Be > Na > Mg$ **D)** $Be > Na > Mg > Si > P$

81. Match the following Oxide to its Nature: Which of the following is correct option?

Oxide	Nature
(A) CO	(i) Basic
(B) BaO	(ii) Neutral
(C) Al_2O_3	(iii) Acidic
(D) Cl_2O_7	(iv) Amphoteric

A) A-ii, B-i, C-iv, D-iii **B)** A-iii, B-iv, C-i, D-ii
C) A-iv, B-iii, C-ii, D-i **D)** A-i, B-ii, C-iii, D-iv

82. Group-13 elements react with O_2 in amorphous form to form oxides of type M_2O_3 ($M = \text{element}$). Which among the following is the most basic oxide?

A) Al_2O_3 **B)** Ga_2O_3
C) Tl_2O_3 **D)** B_2O_3

83. Which pair of oxides is acidic in nature?

A) B_2O_3, CaO **B)** B_2O_3, SiO_2
C) N_2O, BaO **D)** CaO, SiO

84. The acidic, basic and amphoteric oxides, respectively, are:

A) Na_2O, SO_3, Al_2O_3 **B)** Cl_2O, CaO, P_4O_{10}
C) N_2O_3, Li_2O, Al_2O_3 **D)** MgO, Cl_2O, Al_2O_3

85. The option(s) with only amphoteric oxides is (are):

A) Cr_2O_3, BeO, SnO, SnO_2 **B)** Cr_2O_3, CrO, SnO, PbO
C) NO, B_2O_3, PbO, SnO_2 **D)** ZnO, Al_2O_3, PbO, PbO_2

86. Which of the following statements are not correct? (1) The electron gain enthalpy of F is more negative than that of Cl. (2) Ionization enthalpy decreases in a group of periodic table. (3) The electronegativity of an atom depends upon the atoms bonded to it. (4) Al_2O_3 and NO are examples of amphoteric oxides. Choose the most appropriate answer from the options given below:

A) A, C and D Only **B)** B and D Only
C) A, B and D Only **D)** A, B, C and D

87. In which of the following options the order of arrangement does not agree with the variation of property indicated against it?

A) $I < Br < Cl < F$ (increasing electron gain enthalpy magnitude) **B)** $Li < Na < K < Rb$ (increasing metallic radius)
C) $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$ (increasing ionic size) **D)** $B < C < N < O$ (increasing first ionisation enthalpy)

88. Which statement is wrong?

A) Bond energy of $F_2 > Cl_2$ **B)** Electronegativity of $F > Cl$
C) F is more oxidising than Cl **D)** Electron affinity of$Cl > F$

89. In which of the following arrangements, the order is NOT according to the property indicated against it?

A) $Li < Na < K < Rb$ (Increasing metallic radius) **B)** $I < Br < F < Cl$ (Increasing electron gain enthalpy magnitude)
C) $B < C < N < O$ (Increasing first ionization enthalpy) **D)** $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$ (Increasing ionic size)

90. The following statements concern elements in the periodic table. Which of the following is true?

A) For Group 15 elements, the stability of +5 oxidation state increases down the group.

B) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.

C) The Group 13 elements are all metals.

D) All the elements in Group 17 are gases.

Botany

91. Co-enzymes NAD and NADP contain which of the following essential vitamins?

A) Riboflavin (B_2)

B) Thiamine (B_1)

C) Niacin (B_3)

D) Pyridoxine (B_6)

92. Which class of enzymes catalyzes the breakdown of bonds without using water, frequently leaving behind a double bond?

A) Hydrolases

B) Lyases

C) Transferases

D) Isomerases

93. Select the option that correctly matches the enzyme cofactor with its associated enzyme:

A) Magnesium (Mg^{2+}) $\rightarrow$ Carboxypeptidase

B) Haem (Prosthetic group) $\rightarrow$ Peroxidase / Catalase

C) Zinc (Zn^{2+}) $\rightarrow$ Rubisco

D) Niacin $\rightarrow$ Succinate dehydrogenase

94. What happens to the energy profile of a biochemical reaction when an enzyme is added?

A) The free energy of activation decreases, and the free energy of the products decreases.

B) The free energy of activation increases, and the free energy of the reactants remains unchanged.

C) The free energy of activation decreases, while the overall free energy change (ΔG) remains unchanged.

D) The transition state energy level is pushed higher to force the reaction forward.

95. Which of the following sequence correctly depicts the step-by-step mechanism of enzyme action?

A)
$E + S \rightarrow EP \rightarrow ES \rightarrow E + P$

B)
$E + S \rightleftharpoons ES \rightarrow EP \rightarrow E + P$

C)
$E + P \rightarrow EP \rightarrow ES \rightarrow E + S$

D)
$E + S \rightarrow ES \rightleftharpoons EP \rightleftharpoons E + P$

96. At the "transition state" during an enzyme-catalyzed reaction, the substrate molecules are in an state that is physically:

A) Permanent and chemically highly stable

B) Transient and structurally highly unstable

C) Low energy and completely unreactive

D) Identical in structure to the final product

97. The rate of a physical or chemical reaction doubles or halves for every _____ change in temperature in either direction, within a physiological range.

A) $1^{\circ}\mathrm{C}$

B) $5^{\circ}\mathrm{C}$

C) $10^{\circ}\mathrm{C}$

D) $20^{\circ}\mathrm{C}$

98. Carbonic anhydrase is considered one of the fastest enzymes in biological systems. In its absence, only about 200 molecules of carbonic acid H_2CO_3 are formed per hour. However, with the enzyme, the reaction accelerates to produce:

A) 6,000 molecules per second

B) 600,000 molecules per second

C) 60,000 molecules per second

D) 600,000 molecules per minute

99. If the energy level of the final product (P) in a chemical reaction graph is at a lower potential energy level than the initial substrate (S), the reaction is characterized as:

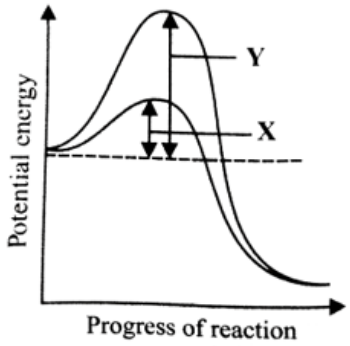
A) Endothermic reaction

B) Spontaneous reaction

C) Exothermic reaction

D) Both A and B

100.
Look at the typical potential energy profile diagram for an enzyme-catalyzed reaction. What do the peaks 'X' and 'Y' specifically denote?



A) X = Transition state with enzyme; Y = Transition state without enzyme

B) X = Activation energy with enzyme; Y = Activation energy without enzyme

C) X = Transition state without enzyme; Y = Transition state with enzyme

D) X = Endothermic path; Y = Exothermic path

101.
Digestive enzymes like pepsin, trypsin, amylase, and lipases catalyze the cleavage of ester, ether, peptide, or glycosidic bonds by utilizing water molecules. They are classified as:

A) Lyases

B) Hydrolases

C) Transferases

D) Ligases

102.
Enzymes that catalyze the linking together of two chemical compounds, such as forming C—O, C—S, C—N, or P—O bonds, explicitly coupled with the consumption of ATP energy, are called:

A) Lyases

B) Transferases

C) Ligases

D) Hydrolases

103.
Enzymes that catalyze the interconversion of optical, geometric, or positional configurations within a single substrate molecule belong to which class?

A) Transferases
B) Lyases
C) Isomerases
D) Ligases

104.
What is the protein-only, catalytically inactive part of a complex enzyme called when its non-protein component is removed?

A) Holoenzyme
B) Apoenzyme
C) Co-enzyme
D) Isozyme

105.
Which of the following statements correctly distinguishes a prosthetic group from a co-enzyme?

A) Prosthetic groups are inorganic ions, whereas co-enzymes are organic molecules.
B) Prosthetic groups are tightly bound to the apoenzyme, while co-enzymes are only transiently attached during catalysis.
C) Co-enzymes are tightly bound to the apoenzyme, whereas prosthetic groups are loosely attached.
D) Prosthetic groups always contain vitamins, whereas co-enzymes never do.

106.
Haem is a critical prosthetic group present at the active site of which of the following enzymes?

A) Carboxypeptidase and Carbonic anhydrase
B) Peroxidase and Catalase
C) Succinate dehydrogenase and Ribozyme
D) Hexokinase and Rubisco

107.
The co-enzymes Nicotinamide Adenine Dinucleotide (NAD) and NADP are structurally derived from which water-soluble vitamin?

A) Thiamine (Vitamin B_1)
B) Riboflavin (Vitamin B_2)
C) Niacin (Vitamin B_3)
D) Pyridoxine (Vitamin B_6)

108.
Zinc (Zn^{2+}) serves as an essential inorganic co-factor for the optimal functioning of which proteolytic digestive enzyme?

A) Pepsin
B) Trypsin
C) Carboxypeptidase
D) Amylase

109.
Activation energy can be best defined as the minimum amount of energy required to:

A) Release the final products from the enzyme-product complex.
B) Convert the stable substrate molecules into their highly unstable transition state structure.
C) Initiate the permanent thermal denaturation of the apoenzyme protein.
D) Drive an exothermic chemical reaction completely backward.

110.
When an enzyme catalyzes a biochemical reaction, it accelerates the reaction velocity primarily by:

A) Lowering the potential energy level of the original substrates.
B) Raising the potential energy level of the final products.
C) Lowering the activation energy required to cross the transition state barrier.
D) Generating an endothermic pathway that releases supplementary thermal energy.

111.
If an enzyme-catalyzed reaction is highly exothermic, what is the correct relationship between the potential energy of the Substrate (S), Product (P), and the Transition State (T)?

A) $P > S > T$
B) $T > S > P$
C) $T > P > S$
D) $S > P > T$

112.
According to the International Union of Biochemistry and Molecular Biology (IUBMB), enzymes are divided into how many major classes, and what is the correct sequence?

A) 4 classes; Hydrolases, Lyases, Ligases, Isomerases
B) 6 classes; Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases
C) 6 classes; Oxidoreductases, Lyases, Hydrolases, Transferases, Ligases, Isomerases
D) 5 classes; Dehydrogenases, Transferases, Hydrolases, Isomerases, Synthetases

113.
An enzyme catalyzes the following chemical reaction:
$S\,(\text{Reduced}) + S'\,(\text{Oxidized}) \rightarrow S\,(\text{Oxidized}) + S'\,(\text{Reduced}$
. This enzyme belongs to which official IUBMB class?

A) Transferases
B) Oxidoreductases / Dehydrogenases
C) Hydrolases
D) Isomerases

114.
Assertion (A): The organic cofactors NAD and NADP are classified as prosthetic groups. Reason (R): Many coenzymes are organic compounds whose association with the apoenzyme is transient and usually occurs during the course of catalysis.

A) Both (A) and (R) are true, and (R) is the correct explanation of (A).
B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
C) (A) is false, but (R) is true.
D) Both (A) and (R) are false.

115.
Assertion (A): An enzyme with a low Michaelis constant (K_m) value has a higher affinity for its substrate. Reason (R): Km is numerically defined as the specific substrate concentration at which the velocity of the reaction is exactly half of the maximum velocity ($V_{\max}$/2).

A) Both (A) and (R) are true, and (R) is the correct explanation of (A).
B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
C) (A) is true, but (R) is false.
D) Both (A) and (R) are false.

116.
Statement 1: All enzymes present inside a biological cell are chemically classified as tertiary proteins.
Statement 2: Ribozymes are catalytic RNA molecules that function without a protein backbone.

A) Both statements are true.
B) Statement 2 is true, but statement 1 is false.
C) Statement 1 is true, but statement 2 is false.
D) Both statement 1 and statement 2 are false.

117.
When plotting the velocity of an enzyme-catalyzed reaction against changes in temperature or pH, the resulting graphical curve is always:

A) Hyperbolic
B) Bell-shaped
C) Linear and directly proportional
D) Sigmoidal

118.
Low temperatures preserve an enzyme in a temporarily inactive state, whereas high temperatures destroy its catalytic activity. This distinction occurs because high temperatures:

A) Decrease the kinetic energy of the substrate.
B) Cause permanent denaturation of the protein structure.
C) Force the co-factor to bind permanently to the allosteric site.
D) Mathematically reduce the Michaelis constant (K_m) to zero.

119.
Why does the velocity of an enzyme reaction reach a maximum plateau (V_{max}) and stop rising, even if you continue to add more substrate?

A) The excess substrate molecules begin to denature the apoenzyme.
B) The product molecules start a competitive feedback loop.
C) The enzyme molecules become fully saturated as all active sites are occupied.
D) High substrate concentration lowers the activation energy to zero.

120.
The Michaelis-Menten constant (K_m) is a direct measure of an enzyme's affinity for its substrate. Graphically, (K_m) is calculated as the:

A) Substrate concentration at which the reaction velocity reaches (V_{max})
B) Enzyme concentration required to double the rate of reaction.
C) Substrate concentration at which the reaction velocity is exactly half of (V_{max})
D) Total product concentration generated at the end of 10 minutes.

121.
In the inhibition of succinate dehydrogenase by malonate, malonate acts as an inhibitor because:

A) It binds covalently to the enzyme's inorganic zinc co-factor.
B) It chemically denatures the protein structure of the apoenzyme.
C) It closely resembles the substrate succinate in its molecular structure.
D) It hydrolyzes the active site using water molecules.

122.
Which of the following statements correctly describes the effect of temperature changes on an enzyme?

A) High temperature preserves the enzyme in a temporarily inactive state, while low temperature destroys it.
B) Low temperature preserves the enzyme in a temporarily inactive state, while high temperature destroys it.
C) Both high and low temperatures cause irreversible denaturation of the enzyme's tertiary structure.
D) Temperature variations alter the primary peptide sequence of the enzyme permanently.

123.
The Michaelis-Menten constant (K_m) is defined as the substrate concentration at which the reaction velocity reaches:

A) Complete saturation point (V_{max})
B) Half of the maximum velocity ($\frac{1}{2}V_{max}$)
C) Twice the maximum velocity ($2V_{max}$)
D) Zero velocity due to feedback inhibition

124.
In competitive inhibition, how are the kinetic parameters K_m and V_{max} affected?

A) K_m decreases and V_{max} decreases
B) K_m remains unchanged but V_{max} decreases
C) K_m increases but V_{max} remains unchanged
D) Both K_m and V_{max} remain entirely unchanged

125.
A non-competitive inhibitor decreases the rate of an enzyme-catalyzed reaction by:

A) Competing directly with the substrate for the active site.
B) Irreversibly breaking down the substrate molecules into basic elements.
C) Binding to an allosteric site, which changes the shape of the active site.
D) Decreasing the concentration of the active apoenzyme by precipitation.

126.
A complete, catalytically active enzyme consisting of both its protein core and bound non-protein components is termed a/an:

A) Apoenzyme
B) Holoenzyme
C) Coenzyme
D) Isoenzyme

127.
If the non-protein cofactor is removed from a functional holoenzyme, what is the immediate effect on the remaining protein part?

A) The catalytic activity remains unaffected.
B) The protein part starts acting as an inhibitor.
C) The catalytic activity of the enzyme is completely lost.
D) The enzyme changes its substrate specificity to form different products.

128.
Which of the following correctly defines a prosthetic group?

A) An organic compound that is tightly and permanently bound to the apoenzyme.
B) An inorganic metal ion that forms transient coordinate bonds with the substrate.
C) An organic compound whose association with the apoenzyme is only transient.
D) A lipid molecule that stabilizes the secondary structure of the enzyme.

129.
Most coenzymes have an essential chemical composition that includes which of the following dietary components?

A) Essential fatty acids
B) Macrominerals like Calcium and Magnesium
C) Vitamins
D) Essential amino acids

130.
Statement I: The catalytic activity of an enzyme is completely lost when the cofactor is removed from the apoenzyme. Statement II: Every holoenzyme is composed entirely of a protein parts folded into a tertiary conformation.

A) Both Statement I and Statement II are correct.
B) Statement I is correct but Statement II is incorrect.
C) Statement I is incorrect but Statement II is correct.
D) Both Statement I and Statement II are incorrect.

131.
Statement I: In competitive inhibition, the inhibitor binds to an allosteric site and changes the shape of the active site. Statement II: The dramatic effect of a competitive inhibitor can be completely reversed by increasing the substrate concentration.

A) Both Statement I and Statement II are correct.
B) Statement I is incorrect but Statement II is correct.
C) Statement I is correct but Statement II is incorrect.
D) Both Statement I and Statement II are incorrect.

132.
Match Column I (Type of Cofactor) with Column II (Description).

Column I (Cofactor Type)	Column II (Description / Example)
p. Prosthetic Group	1. Transient organic compounds, often derived from vitamins
q. Coenzyme	2. Forms coordinate bonds with both the active site and substrate
r. Metal Ion Activator	3. Tightly and permanently bound organic component (e.g., Haem)

A) p-1, q-2, r-3
B) p-2, q-1, r-3
C) p-3, q-1, r-2
D) p-3, q-2, r-1

133.
Match Column I (Enzyme/Reaction) with Column II (Specific Modifier/Cofactor).

Column I (Enzyme / Reaction)	Column II (Specific Modifier / Cofactor)
p. Carboxypeptidase	1. Malonate (Competitive Inhibitor)
q. Succinate dehydrogenase	2. Haem (Prosthetic Group)
r. Peroxidase	3. Zinc (Zn+2)Metal Ion)

A) p-1, q-2, r-3
B) p-3, q-1, r-2
C) p-2, q-3, r-1
D) p-3, q-2, r-1

134.
Which of the following groups of coenzymes correctly matches with their parent vitamin component?

A) FAD – Niacin; NAD – Thiamine
B) NAD – Niacin; NADP – Niacin
C) Coenzyme A – Riboflavin; FAD – Niacin
D) NAD – Riboflavin; FMN – Niacin

135.
Which of the following changes occurs in the kinetic properties of an enzyme during non-competitive inhibition?

A) V_{max} increases, K_m remains unchanged
B) V_{max} remains unchanged, K_m increases
C) V_{max} decreases, K_m remains unchanged
D) Both V_{max} and K_m decrease simultaneously

Zoology

136.
Statement I: Frogs possess the ability to change their body colour to hide from enemies, a phenomenon known as camouflage. Statement II: This protective coloration exhibited by frogs is also termed mimicry in biological terms.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

137.

Statement I: The skin of a frog is always maintained in a moist condition and feels highly slippery due to the presence of microscopic scales and mucus. Statement II: A frog never drinks water but fulfills its water requirements by absorbing it directly through the skin.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

138.

Statement I: The body of a frog is distinctly divisible into a head, a short neck, and a trunk. Statement II: Frogs possess bulging eyes that are covered by a nictitating membrane to protect them while in water.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

139.

Statement I: Frogs exhibit sexual dimorphism, where male frogs can be distinguished by the presence of sound-producing vocal sacs. Statement II: In addition to vocal sacs, male frogs also possess a copulatory pad on the second digit of their forelimbs.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

140.

Statement I: The hind limbs of a frog end in five digits and are larger and more muscular than the forelimbs. Statement II: The forelimbs of a frog end in four digits and feature webbed digits that assist significantly in swimming.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

141.

Statement I: During peak summer and winter, frogs take shelter in deep burrows to protect themselves from extreme environmental conditions. Statement II: The summer sleep is known as hibernation, whereas the winter sleep is termed aestivation.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

142.

Statement I: The alimentary canal of a frog is relatively short in length. Statement II: This reduction in the length of the intestine is an evolutionary adaptation directly linked to their carnivorous diet.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

143.

Statement I: In the frog's digestive system, the oesophagus opens into the stomach, which in turn continues as the intestine and rectum. Statement II: The rectum finally opens to the exterior through a specialized posterior opening called the anus.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

144.

Statement I: In frogs, food is captured by a highly specialized, single-lobed sticky tongue. Statement II: The stomach walls secrete hydrochloric acid (HCl) and gastric juices to facilitate the initial digestion of the captured food.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

145.

Statement I: The partially digested food in the stomach of a frog is referred to as chyme. Statement II: This chyme is subsequently passed from the stomach directly into the ileum of the small intestine.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

146.

Statement I: The duodenum of a frog receives bile from the gall bladder and pancreatic juices from the pancreas. Statement II: These two digestive secretions enter the duodenum through two separate, independent ducts.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

147.

Statement I: Inside the intestine of a frog, bile primarily acts to emulsify carbohydrates and proteins. Statement II: The final digestion of food takes place in the intestine, and the nutrients are absorbed by numerous finger-like folds called villi and microvilli.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

148.

Statement I: In water, the skin of a frog acts as the sole aquatic respiratory organ, a process known as cutaneous respiration. Statement II: During cutaneous respiration, dissolved oxygen in the water is exchanged through the skin primarily by the mechanism of active transport.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

149.

Statement I: While on land, a frog relies exclusively on its lungs for the exchange of gases. Statement II: The lungs of a frog are a pair of elongated, pink-coloured, sac-like structures situated in the upper part of the trunk region.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

150.

Statement I: Air enters the respiratory system of a terrestrial frog through the nostrils, passes into the buccal cavity, and then moves directly into the lungs. Statement II: During the extreme states of aestivation and hibernation, gaseous exchange is restricted solely to the skin.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

151.

Statement I: The vascular system of a frog is of a well-developed closed type, accompanied by a separate lymphatic system. Statement II: The lymphatic system in frogs consists of lymph, lymph channels, and lymph nodes.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

152.

Statement I: The heart of a frog is a muscular organ located in the upper part of the body cavity and consists of three chambers: two atria and one ventricle. Statement II: The heart is entirely enclosed and protected by a membranous covering called the peritoneum.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

153.

Statement I: A triangular structure known as the sinus venosus joins the right atrium of the frog's heart and receives blood through the vena cava. Statement II: The single ventricle of the heart opens into a sac-like conus arteriosus located on the dorsal surface of the heart.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

154.

Statement I: Frogs possess a special venous connection between the liver and the intestine called the hepatic portal system. Statement II: Another special venous connection exists between the kidney and the lower parts of the body, termed the renal portal system.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

155.

Statement I: The blood of a frog is composed of plasma, nucleated red blood cells (erythrocytes), white blood cells (leucocytes), and platelets. Statement II: The lymph in frogs is biochemically identical to blood, containing the exact same profile of proteins and red blood cells.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

156.

Statement I: The excretory system of a frog consists of a pair of dark red, bean-like kidneys situated a little posteriorly in the body cavity. Statement II: Each kidney is composed of several structural and functional units known as uriniferous tubules or nephrons.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

157.

Statement I: In male frogs, two ureters emerge from the kidneys and function exclusively for the passage of urine. Statement II: These ureters act as a urinogenital duct that eventually opens into the cloaca.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

158.

Statement I: In female frogs, the ureters and the oviduct join together to form a common duct before opening into the cloaca. Statement II: A thin-walled urinary bladder is present ventral to the rectum, which also opens into the cloaca.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

159.

Statement I: Frogs primarily excrete ammonia and are therefore classified as ammonotelic animals. Statement II: Excretory wastes are carried by the blood into the kidney, where they are separated and excreted.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

160.

Statement I: The cloaca in frogs is a large, laterally placed chamber. Statement II: It serves a common passageway used to expel faecal matter, urine, and sperms to the exterior.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

161.

Statement I: The chemical coordination of various organs in a frog is achieved exclusively by hormones secreted from the pituitary and thyroid glands. Statement II: The prominent endocrine glands in a frog include the pituitary, thyroid, parathyroid, thymus, pineal body, pancreatic islets, adrenals, and gonads.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

162.

Statement I: The central nervous system of a frog comprises the brain and the spinal cord. Statement II: The peripheral nervous system is formed solely by the cranial nerves, which consist of exactly twelve pairs arising from the brain.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

163.

Statement I: The forebrain of a frog includes the olfactory lobes, paired cerebral hemispheres, and a paired diencephalon. Statement II: The midbrain is structurally characterized by the presence of a pair of optic lobes.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

164.

Statement I: The hind-brain of a frog consists of the cerebellum and the medulla oblongata. Statement II: The medulla oblongata exits the skull through the foramen magnum and continues posteriorly as the spinal cord.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

165.

Statement I: In frogs, the organs of touch are called sensory papillae, while the organs of taste are known as taste buds. Statement II: Out of all the sense organs in a frog, only the eyes and internal ears are well-organized structures, while the rest are mere cellular aggregations around nerve endings.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

166.

Statement I: The eyes of a frog are simple eyes (possessing only one unit) and are situated in the orbit of the skull. Statement II: Frogs possess a highly developed external ear with a distinct pinna to capture sound waves efficiently.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

167.

Statement I: The tympanum in frogs serves exclusively as an organ of hearing. Statement II: Balancing (equilibrium) in frogs is managed by a completely separate organ unrelated to the ear.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

168.

Statement I: The male reproductive organs of a frog consist of a pair of yellowish, ovoid testes. Statement II: These testes are adhered to the upper part of the kidneys by a single fold of peritoneum called the mesorchium.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

169.

Statement I: In a male frog, exactly 10 to 12 vasa efferentia arise from the testes. Statement II: These vasa efferentia enter the kidneys on their respective sides and open directly into the cloaca.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

170.

Statement I: Bidder’s canal in male frogs finally communicates with the urinogenital duct that comes out of the kidneys. Statement II: The urinogenital duct opens into the cloaca, allowing the passage of both urine and sperms.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

171.

Statement I: The female reproductive organs include a pair of ovaries that are situated near the kidneys. Statement II: Unlike the male reproductive system, there is no functional connection between the ovaries and the kidneys in female frogs.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

172.

Statement I: A mature female frog can lay approximately 5000 to 6000 ova at one time. Statement II: The ova are transported to the cloaca through a pair of oviducts that arise from the ovaries and open into the cloaca separately.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

173.

Statement I: Fertilisation in frogs is internal and takes place within the female's oviduct. Statement II: Post-fertilisation, the development involves a larval stage called a tadpole, which directly resembles the adult frog.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

174.

Statement I: The tadpole stage of a frog undergoes a process called metamorphosis to transform into an adult frog. Statement II: Frogs are considered beneficial to mankind as they maintain ecological balance by acting as an important link in the food chain and food web.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

175.

Statement I: In some countries, the highly developed, muscular forelimbs of the frog are used as a food source for humans. Statement II: Frogs help protect agricultural crops because their diet primarily consists of insects.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

176.

Statement I: Frogs possess an open circulatory system paired with a highly complex lymphatic system. Statement II: The RBCs of a frog differ from human RBCs because they are nucleated and contain the red-coloured pigment haemoglobin.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

177.

Statement I: The frog's brain is enclosed in a bony structure called the cranium, and the spinal cord is enclosed in the vertebral column. Statement II: While the brain is divided into fore-brain, mid-brain, and hind-brain, the mid-brain uniquely contains the olfactory lobes.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

178.

Statement I: The cloaca in both male and female frogs serves as a common exterior opening for the digestive, excretory, and reproductive tracts. Statement II: However, in female frogs, the ureters and oviducts open into the cloaca separately, whereas in males, the ureters act as a common urinogenital duct.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

179.

Statement I: A frog respires through its moist skin only when it is in water, and relies entirely on pulmonary respiration when on land. Statement II: The frog's skin is highly vascularized, allowing dissolved oxygen in water to be exchanged via diffusion.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

180.

Statement I: The systemic circulation in a frog features a specialized venous connection between the kidney and the intestine called the renal portal system. Statement II: The heart of the frog features two atria and one ventricle, pumping blood that eventually carries nutrients, gases, and water to respective sites.

A) Both Statement I and Statement II are correct.
B) Both Statement I and Statement II are incorrect.
C) Statement I is correct but Statement II is incorrect.
D) Statement I is incorrect but Statement II is correct.

ANSWER KEY

Physics

1.	**3**	13.	**1**	25.	**3**	37.	**1**
2.	**1**	14.	**2**	26.	**1**	38.	**1**
3.	**1**	15.	**1**	27.	**2**	39.	**4**
4.	**1**	16.	**1**	28.	**1**	40.	**2**
5.	**3**	17.	**1**	29.	**2**	41.	**1**
6.	**2**	18.	**2**	30.	**1**	42.	**1**
7.	**1**	19.	**1**	31.	**1**	43.	**2**
8.	**1**	20.	**1**	32.	**2**	44.	**2**
9.	**1**	21.	**1**	33.	**2**	45.	**3**
10.	**3**	22.	**2**	34.	**2**		
11.	**1**	23.	**2**	35.	**3**		
12.	**1**	24.	**1**	36.	**2**		

Chemistry

46.	**4**	58.	**2**	70.	**2**	82.	**3**
47.	**2**	59.	**1**	71.	**4**	83.	**2**
48.	**4**	60.	**2**	72.	**2**	84.	**3**
49.	**4**	61.	**3**	73.	**1**	85.	**4**
50.	**3**	62.	**1**	74.	**4**	86.	**1**
51.	**2**	63.	**2**	75.	**1**	87.	**4**
52.	**3**	64.	**3**	76.	**4**	88.	**1**
53.	**4**	65.	**1**	77.	**2**	89.	**3**
54.	**3**	66.	**3**	78.	**4**	90.	**2**
55.	**1**	67.	**2**	79.	**1**		
56.	**1**	68.	**4**	80.	**1**		
57.	**4**	69.	**4**	81.	**1**		

Botany

91.	**3**	103.	**3**	115.	**1**	127.	**3**
92.	**2**	104.	**2**	116.	**3**	128.	**1**
93.	**2**	105.	**2**	117.	**2**	129.	**3**
94.	**3**	106.	**2**	118.	**2**	130.	**2**
95.	**2**	107.	**3**	119.	**3**	131.	**2**
96.	**2**	108.	**3**	120.	**3**	132.	**3**
97.	**3**	109.	**2**	121.	**3**	133.	**2**
98.	**2**	110.	**3**	122.	**2**	134.	**2**
99.	**3**	111.	**2**	123.	**2**	135.	**3**
100.	**1**	112.	**2**	124.	**3**		
101.	**2**	113.	**2**	125.	**3**		
102.	**3**	114.	**3**	126.	**2**		

Zoology

136.	**1**	139.	**3**	142.	**1**	145.	**3**
137.	**4**	140.	**3**	143.	**3**	146.	**3**
138.	**4**	141.	**3**	144.	**4**	147.	**4**

148.	**3**	157.	**4**	166.	**3**	175.	**4**
149.	**4**	158.	**4**	167.	**2**	176.	**4**
150.	**1**	159.	**4**	168.	**3**	177.	**3**
151.	**1**	160.	**4**	169.	**3**	178.	**1**
152.	**3**	161.	**4**	170.	**1**	179.	**4**
153.	**3**	162.	**3**	171.	**1**	180.	**4**
154.	**1**	163.	**4**	172.	**4**		
155.	**3**	164.	**1**	173.	**2**		
156.	**1**	165.	**1**	174.	**1**		

SOLUTIONS

Q1.

Answer: C

Explanation:

First, find the magnitude of the direction vector $\vec{B} = \hat{i} + \hat{j}$, which is $|\vec{B}| = \sqrt{1^2 + 1^2} = \sqrt{2}$. Next, determine the unit vector $\hat{u} = \frac{\vec{B}}{|\vec{B}|} = \frac{\hat{i}+\hat{j}}{\sqrt{2}}$. Finally, multiply the given magnitude (30) by the unit vector:$\vec{F} = 30\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right) = \frac{30}{\sqrt{2}}\hat{i} + \frac{30}{\sqrt{2}}\hat{j}$. Rationalizing the denominator gives $15\sqrt{2}\hat{i} + 15\sqrt{2}\hat{j}$.

Q2.

Answer: A

Explanation:

First, find the magnitude of the direction vector $\vec{C} = 3\hat{i} + 4\hat{j}$, which is $|\vec{C}| = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$. Next, determine the unit vector $\hat{u} = \frac{3\hat{i}+4\hat{j}}{5}$. Finally, multiply the given magnitude (50) by the unit vector:
$\vec{v} = 50\left(\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\right) = 30\hat{i} + 40\hat{j}$.

Q3.

Answer: A

Explanation:

First, calculate the dot product $\vec{A} \cdot \vec{B} = (4)(1) + (2)(1) = 6$.
Then find the magnitude of $\vec{B}$, which is $|\vec{B}| = \sqrt{1^2 + 1^2} = \sqrt{2}$.
The scalar component is $\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|} = \frac{6}{\sqrt{2}}$. The vector component is the scalar component multiplied by the unit vector of $\vec{B}$:
$\left(\frac{6}{\sqrt{2}}\right)\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right) = \frac{6}{2}(\hat{i} + \hat{j}) = 3(\hat{i} + \hat{j})$.

Q4.

Answer: A

Explanation:
Calculate the dot product
$\vec{A} \cdot \vec{B} = (7)(3) + (1)(4) = 21 + 4 = 25$. Find the magnitude $|\vec{B}| = \sqrt{3^2 + 4^2} = \sqrt{25} = 5$. The scalar component is $\frac{25}{5} = 5$. The vector component is the scalar component times the unit vector of $\vec{B}$: $5 \cdot \left(\frac{3\hat{i}+4\hat{j}}{5}\right) = 3\hat{i} + 4\hat{j}$.

Q5.

Answer: C

Explanation:

First, find the magnitude of the direction vector $\vec{A}$, which is $|\vec{A}| = \sqrt{3^2 + 4^2} = 5$. The unit vector in the direction of $\vec{A}$ is $\hat{u} = \frac{3\hat{i}+4\hat{j}}{5}$. Multiply the speed (15) by the unit vector:
$\vec{v} = 15\left(\frac{3\hat{i}+4\hat{j}}{5}\right) = 3(3\hat{i} + 4\hat{j}) = 9\hat{i} + 12\hat{j}$.

Q6.

Answer: B

Explanation:

Calculate the magnitude of $\vec{B}$:
$|\vec{B}| = \sqrt{5^2 + 12^2} = \sqrt{25 + 144} = \sqrt{169} = 13$. The unit vector is $\hat{u} = \frac{5\hat{i}+12\hat{j}}{13}$. Multiply the speed (26) by the unit vector:
$\vec{v} = 26\left(\frac{5\hat{i}+12\hat{j}}{13}\right) = 2(5\hat{i} + 12\hat{j}) = 10\hat{i} + 24\hat{j}$.

Q7.

Answer: A

Explanation:

The perpendicular component is given by $\vec{A}_\perp = \vec{A} - \text{proj}_{\vec{B}}\vec{A}$.
First, find the projection of $\vec{A}$ onto $\vec{B}$: $\text{proj}_{\vec{B}}\vec{A} = \left(\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|^2}\right)\vec{B}$.
$\vec{A} \cdot \vec{B} = (2)(1) + (1)(1) = 3$. $|\vec{B}|^2 = 1^2 + 1^2 = 2$. So, $\text{proj}_{\vec{B}}\vec{A} = \frac{3}{2}(\hat{i} + \hat{j})$. Finally,
$\vec{A}_\perp = (2\hat{i} + \hat{j}) - \left(\frac{3}{2}\hat{i} + \frac{3}{2}\hat{j}\right) = \frac{1}{2}\hat{i} - \frac{1}{2}\hat{j} = \frac{\hat{i}-\hat{j}}{2}$.

Q8.

Answer: A

Explanation:

First, calculate the projection of $\vec{A}$ onto $\vec{B}$.
$\vec{A} \cdot \vec{B} = (5)(3) + (5)(4) = 35$. $|\vec{B}|^2 = 3^2 + 4^2 = 25$. The parallel component is $\frac{35}{25}(3\hat{i} + 4\hat{j}) = \frac{7}{5}(3\hat{i} + 4\hat{j}) = \frac{21}{5}\hat{i} + \frac{28}{5}\hat{j}$.
The perpendicular component is
$\vec{A} - \text{parallel component} = (5\hat{i} + 5\hat{j}) - (\frac{21}{5}\hat{i} + \frac{28}{5}\hat{j}) = \frac{4}{5}\hat{i} - \frac{3}{5}\hat{j} =$
.

Q9.

Answer: A

Explanation:
Check if one vector is a scalar multiple of the other. Compare the ratios of corresponding components: $\frac{B_x}{A_x} = \frac{4}{2} = 2$,
$\frac{B_y}{A_y} = \frac{-2}{-1} = 2$, $\frac{B_z}{A_z} = \frac{6}{3} = 2$. Since the ratios are equal and positive ($\vec{B} = 2\vec{A}$), the vectors are parallel.

Q10.

Answer: C

Explanation:

Calculate the dot product $\vec{A} \cdot \vec{B}$. If the dot product is zero, the vectors are perpendicular.
$\vec{A} \cdot \vec{B} = (3)(1) + (2)(-2) + (-1)(-1) = 3 - 4 + 1 = 0$.
Since the dot product is zero, the vectors are perpendicular (orthogonal).

Q11.

Answer: A

Explanation:
The perpendicular component is found by subtracting the parallel projection from the original vector: $\vec{A}_\perp = \vec{A} - \text{proj}_{\vec{B}}\vec{A}$. First, calculate the projection: $\text{proj}_{\vec{B}}\vec{A} = \left(\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|^2}\right)\vec{B}$. Here,
$\vec{A} \cdot \vec{B} = (2)(4) + (3)(3) = 17$ and $|\vec{B}|^2 = 4^2 + 3^2 = 25$. So, $\text{proj}_{\vec{B}}\vec{A} = \frac{17}{25}(4\hat{i} + 3\hat{j}) = \frac{68}{25}\hat{i} + \frac{51}{25}\hat{j}$. Finally, subtract this from $\vec{A}$: $(2\hat{i} + 3\hat{j}) - (\frac{68}{25}\hat{i} + \frac{51}{25}\hat{j}) = \frac{-18\hat{i}+24\hat{j}}{25}$.

Q12.

Answer: A

Explanation:

Use the formula $\vec{A}_{\perp} = \vec{A} - \left(\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|^2}\right)\vec{B}$. Calculate the dot product: $\vec{A}\cdot\vec{B} = (3)(1) + (4)(-2) = 3 - 8 = -5$. Calculate magnitude squared: $|\vec{B}|^2 = 1^2 + (-2)^2 = 5$. The projection is $\frac{-5}{5}(\hat{i} - 2\hat{j}) = -(\hat{i} - 2\hat{j}) = -\hat{i} + 2\hat{j}$. Subtract this from $\vec{A}$: $(3\hat{i} + 4\hat{j}) - (-\hat{i} + 2\hat{j}) = 4\hat{i} + 2\hat{j}$.

Q13.

Answer: A

Explanation:
First, calculate the magnitude of the vector $|\vec{A}| = \sqrt{3^2 + 4^2 + 12^2} = \sqrt{9 + 16 + 144} = \sqrt{169} = 13$. The direction cosines are the components divided by the magnitude: $\cos\alpha = \frac{3}{13}$, $\cos\beta = \frac{4}{13}$, and $\cos\gamma = \frac{12}{13}$.

Q14.

Answer: B

Explanation:
Calculate the magnitude $|\vec{B}| = \sqrt{1^2 + 2^2 + 2^2} = \sqrt{1 + 4 + 4} = \sqrt{9} = 3$. The direction cosines are the components divided by the magnitude: $\cos\alpha = \frac{1}{3}$, $\cos\beta = \frac{2}{3}$, and $\cos\gamma = \frac{2}{3}$.

Q15.

Answer: A

Explanation:
Calculate the magnitude $|\vec{A}| = \sqrt{12^2 + 4^2 + 3^2} = \sqrt{144 + 16 + 9} = \sqrt{169} = 13$. The direction cosines are the components divided by the magnitude: $\frac{12}{13}$, $\frac{4}{13}$, $\frac{3}{13}$. The components along the axes are $12\hat{i}, 4\hat{j}, 3\hat{k}$.

Q16.

Answer: A

Explanation:
First, calculate the magnitude of the vector $|\vec{A}| = \sqrt{2^2 + 6^2 + 3^2} = \sqrt{4 + 36 + 9} = \sqrt{49} = 7$. The direction cosines are the components divided by the magnitude: $\frac{2}{7}$, $\frac{6}{7}$, $\frac{3}{7}$. The components along the axes are simply the vector parts: $2\hat{i}, 6\hat{j}, 3\hat{k}$.

Q17.

Answer: A

Explanation:
The cross product of two vectors in the xy-plane is given by $(a_xb_y - a_yb_x)\hat{k}$. Here, $a_x = 5, a_y = 2, b_x = 3, b_y = 4$. Calculation: $(5)(4) - (2)(3) = 20 - 6 = 14$. So, $\vec{a}\times\vec{b} = 14\hat{k}$.

Q18.

Answer: B

Explanation:

Using the formula $(a_xb_y - a_yb_x)\hat{k}$. Here, $a_x = 2, a_y = 3, b_x = 4, b_y = 1$. Calculation: $(2)(1) - (3)(4) = 2 - 12 = -10$. So, $\vec{a}\times\vec{b} = -10\hat{k}$.

Q19.

Answer: A

Explanation:

The cross product for 2D vectors is calculated as $(a_xb_y - a_yb_x)\hat{k}$. Substituting the values: $(5)(4) - (2)(3) = 20 - 6 = 14$.

Therefore, the result is $14\hat{k}$.

Q20.

Answer: A

Explanation:

The cross product of two 2D vectors $\vec{a} = a_x\hat{i} + a_y\hat{j}$ and $\vec{b} = b_x\hat{i} + b_y\hat{j}$ is given by $(a_xb_y - a_yb_x)\hat{k}$. Substituting the values: $(3)(4) - (2)(1) = 12 - 2 = 10$. Thus, the result is $10\hat{k}$.

Q21.

Answer: A

Explanation:

Let $|\vec{A}| = |\vec{B}| = A$. The condition is $|\vec{A} - \vec{B}| = x|\vec{A} + \vec{B}|$.
Squaring both sides gives $|\vec{A} - \vec{B}|^2 = x^2|\vec{A} + \vec{B}|^2$. Expanding the dot products:
$A^2 + A^2 - 2A^2\cos\theta = x^2(A^2 + A^2 + 2A^2\cos\theta)$. Simplifying:
$2A^2(1 - \cos\theta) = x^2 2A^2(1 + \cos\theta)$.
$1 - \cos\theta = x^2(1 + \cos\theta) \Rightarrow 1 - x^2 = \cos\theta(1 + x^2)$.
$\cos\theta = \frac{1-x^2}{1+x^2}$. Thus, $\theta = \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$.

Q22.

Answer: B

Explanation:

Let $|\vec{P}| = |\vec{Q}| = P$. The condition is $|\vec{P} + \vec{Q}| = \sqrt{n}|\vec{P} - \vec{Q}|$.
Squaring both sides gives $|\vec{P} + \vec{Q}|^2 = n|\vec{P} - \vec{Q}|^2$. Expanding:
$P^2 + P^2 + 2P^2\cos\theta = n(P^2 + P^2 - 2P^2\cos\theta)$. Simplifying:
$2P^2(1 + \cos\theta) = n2P^2(1 - \cos\theta)$.
$1 + \cos\theta = n(1 - \cos\theta) \Rightarrow 1 + \cos\theta = n - n\cos\theta$.
$\cos\theta(1 + n) = n - 1 \Rightarrow \cos\theta = \frac{n-1}{n+1}$. Thus, $\theta = \cos^{-1}\left(\frac{n-1}{n+1}\right)$.

Q23.

Answer: B

Explanation:
First, find the sum $\vec{P} + \vec{Q} = (2 + 1)\hat{i} + (1 + 1)\hat{j} + (3 + 3)\hat{k} = 3\hat{i} + 2\hat{j} + 6\hat{k}$.
Next, calculate the magnitude:
$|\vec{P} + \vec{Q}| = \sqrt{3^2 + 2^2 + 6^2} = \sqrt{9 + 4 + 36} = \sqrt{49} = 7$. The unit vector is $\frac{3\hat{i}+2\hat{j}+6\hat{k}}{7}$.

Q24.

Answer: A

Explanation:
First, find the sum $\vec{A} + \vec{B} = (1 + 2)\hat{i} + (1 + 2)\hat{j} + (2 + 1)\hat{k} = 3\hat{i} + 3\hat{j} + 3\hat{k}$.
Next, calculate the magnitude:
$|\vec{A} + \vec{B}| = \sqrt{3^2 + 3^2 + 3^2} = \sqrt{27} = 3\sqrt{3}$. The unit vector is $\frac{3\hat{i}+3\hat{j}+3\hat{k}}{3\sqrt{3}} = \frac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{3}}$.

Q25.

Answer: C

Explanation:

First, find the resultant vector $\vec{R} = \vec{A} + \vec{B} = 3\hat{i} + \hat{j} + 4\hat{k}$. Calculate magnitudes: $|\vec{A}| = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{14}$ and $|\vec{R}| = \sqrt{3^2 + 1^2 + 4^2} = \sqrt{26}$. Calculate dot product: $\vec{A} \cdot \vec{R} = (1)(3) + (2)(1) + (3)(4) = 3 + 2 + 12 = 17$. Use the cosine formula: $\cos\theta = \frac{17}{\sqrt{14}\sqrt{26}} = \frac{17}{\sqrt{364}}$. Simplifying the denominator $\sqrt{364} = \sqrt{4 \times 91} = 2\sqrt{91}$.

Q26.

Answer: A

Explanation:

First, find $\vec{R} = \vec{P} + \vec{Q} = 8\hat{i} + 16\hat{j}$. Magnitudes: $|\vec{P}| = \sqrt{3^2 + 4^2} = 5$ and $|\vec{R}| = \sqrt{8^2 + 16^2} = \sqrt{64 + 256} = \sqrt{320} = 8\sqrt{5}$. Dot product: $\vec{P} \cdot \vec{R} = (3)(8) + (4)(16) = 24 + 64 = 88$. Cosine formula: $\cos\theta = \frac{88}{5 \cdot 8\sqrt{5}} = \frac{11}{5\sqrt{5}}$.

Q27.

Answer: B

Explanation:

(A) The dot product of perpendicular vectors (slopes $4/3$ and $-3/4$) is 0. So result is 0 (matches 3). (B) $\vec{A} \times \vec{B} = (3)(-3)\hat{k} - (4)(4)\hat{k} = -25\hat{k}$. Divided by 25 gives $-\hat{k}$ (matches 1). (C) $\vec{A} + \vec{B} = 7\hat{i} + \hat{j}$. Magnitude is $\sqrt{49 + 1} = \sqrt{50} = 5\sqrt{2}$. Unit vector is $\frac{7\hat{i} + \hat{j}}{5\sqrt{2}}$ (matches 2). (D) $\vec{A} - \vec{B} = -\hat{i} + 7\hat{j}$. Magnitude is $5\sqrt{2}$. Unit vector is $\frac{-\hat{i} + 7\hat{j}}{5\sqrt{2}}$ (matches 4).

Q28.

Answer: A

Explanation:

(A) $\vec{P} \cdot \vec{Q} = 2(1) + 2(-2) + 1(2) = 2 - 4 + 2 = 0$. Result is 0 (matches 3). (B) $\vec{P} + \vec{Q} = 3\hat{i} + 3\hat{k}$. Magnitude is $\sqrt{9 + 9} = 3\sqrt{2}$. Unit vector is $\frac{3(\hat{i} + \hat{k})}{3\sqrt{2}} = \frac{\hat{i} + \hat{k}}{\sqrt{2}}$ (matches 1). (C) $\vec{P} \times \vec{Q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 2 & 1 \\ 1 & -2 & 2 \end{vmatrix} = (4 - (-2))\hat{i} - (4 - 1)\hat{j} + (-4 - 2)\hat{k} = 6\hat{i} - 3\hat{j} - 6\hat{k}$. Divide by 9: $\frac{2\hat{i} - \hat{j} - 2\hat{k}}{3}$ (matches 4). (D) Magnitude of cross product calculated above is $\sqrt{36 + 9 + 36} = \sqrt{81} = 9$ (matches 2).

Q29.

Answer: B

Explanation:

Using the formula $\frac{\vec{a} \cdot \vec{b}}{|\vec{b}|}$: $\vec{a} \cdot \vec{b} = (4)(1) + (2)(1) = 6$. $|\vec{b}| = \sqrt{1^2 + 1^2} = \sqrt{2}$. Component = $\frac{6}{\sqrt{2}}$. Rationalizing the denominator gives $\frac{6\sqrt{2}}{2} = 3\sqrt{2}$.

Q30.

Answer: A

Explanation:

The scalar component of vector $\vec{a}$ along vector $\vec{b}$ is given by $\frac{\vec{a} \cdot \vec{b}}{|\vec{b}|}$. Here, $\vec{a} = 7\hat{i} - \hat{j}$ and $\vec{b} = \hat{i} + \hat{j}$. Dot product $\vec{a} \cdot \vec{b} = (7)(1) + (-1)(1) = 6$. Magnitude $|\vec{b}| = \sqrt{1^2 + 1^2} = \sqrt{2}$. Therefore, the component is $\frac{6}{\sqrt{2}}$, which simplifies to $3\sqrt{2}$.

Q31.

Answer: A

Explanation:

(Short Explanation with direct maths steps): First, determine the vectors forming two sides of the triangle, for example, $\vec{PQ}$and $\vec{PR}$. $\vec{PQ} = (4 - 1)\hat{i} + (2 - 2)\hat{j} + (1 - 3)\hat{k} = 3\hat{i} - 2\hat{k}$. $\vec{PR} = (1 - 1)\hat{i} + (5 - 2)\hat{j} + (2 - 3)\hat{k} = 3\hat{j} - \hat{k}$. The area is given by $\frac{1}{2}|\vec{PQ} \times \vec{PR}|$. $\vec{PQ} \times \vec{PR} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & -2 \\ 0 & 3 & -1 \end{vmatrix} = (0 - (-6))\hat{i} - (-3 - 0)\hat{j} + (9 - 0)\hat{k} =$. Magnitude $= \sqrt{6^2 + 3^2 + 9^2} = \sqrt{36 + 9 + 81} = \sqrt{126}$. Area $= \frac{\sqrt{126}}{2} = \sqrt{\frac{126}{4}} = \sqrt{31.5}$.

Q32.

Answer: B

Explanation:

The area of the triangle is $\frac{1}{2}|\vec{A} \times \vec{B}|$. $\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & 2 \\ 1 & \lambda & 1 \end{vmatrix} = (1 - 2\lambda)\hat{i} - (2 - 2)\hat{j} + (2\lambda - 1)\hat{k}$. The magnitude is $\sqrt{(1 - 2\lambda)^2 + 0 + (2\lambda - 1)^2} = \sqrt{2(2\lambda - 1)^2} = |2\lambda - 1|\sqrt{2}$. Given Area $= \frac{3\sqrt{2}}{2}$, we have $\frac{1}{2}|2\lambda - 1|\sqrt{2} = \frac{3\sqrt{2}}{2}$. This simplifies to $|2\lambda - 1| = 3$. Since $\lambda > 0$, $2\lambda - 1 = 3 \Rightarrow 2\lambda = 4 \Rightarrow \lambda = 2$.

Q33.

Answer: B

Explanation:

Calculate the cross product $\vec{A} \times \vec{B}$. $\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -1 & 1 \\ 1 & 1 & -2 \end{vmatrix} = (2 - 1)\hat{i} - (-4 - 1)\hat{j} + (2 - (-1))\hat{k} = \hat{i}$. The magnitude is $|\vec{A} \times \vec{B}| = \sqrt{1^2 + 5^2 + 3^2} = \sqrt{1 + 25 + 9} = \sqrt{35}$.

Q34.

Answer: B

Explanation:

Since the vectors are perpendicular, their dot product is zero: $\vec{A} \cdot \vec{B} = 0$. $(2)(3) + (\lambda)(2) + (3)(-2) = 0 \Rightarrow 6 + 2\lambda - 6 = 0 \Rightarrow 2\lambda = 0 \Rightarrow \lambda =$. Substitute $\lambda = 0$ into $\vec{A}$: $\vec{A} = 2\hat{i} + 3\hat{k}$. Calculate magnitude $|\vec{A}| = \sqrt{2^2 + 0^2 + 3^2} = \sqrt{4 + 9} = \sqrt{13}$.

Q35.

Answer: C

Explanation:

The angle bisector of two vectors $\vec{A}$ and $\vec{B}$ is parallel to $|\vec{B}|\vec{A}+|\vec{A}|\vec{B}$. $|\vec{A}|=\sqrt{3^2+4^2}=5$. $|\vec{B}|=\sqrt{5^2+12^2}=13$.
Bisector direction
$\vec{D}=13(3\hat{i}+4\hat{j})+5(5\hat{j}+12\hat{k})=39\hat{i}+52\hat{j}+25\hat{j}+60\hat{k}=39\hat{i}+77\hat{j}+60\hat{k}$
. Comparing with $\vec{C}$, $\lambda=77$.

Q36.

Answer: B

Explanation:

The bisector direction is along $\frac{\vec{a}}{|\vec{a}|}+\frac{\vec{b}}{|\vec{b}|}$. $|\vec{a}|=\sqrt{2}, |\vec{b}|=\sqrt{2}$.

Direction $\propto(\hat{i}+\hat{j})+(\hat{j}+\hat{k})=\hat{i}+2\hat{j}+\hat{k}$. Given
$\vec{v}=\alpha\hat{i}+\hat{j}+\beta\hat{k}$. Comparing ratios: $\frac{\alpha}{1}=\frac{1}{2}=\frac{\beta}{1}$.
$\alpha=0.5, \beta=0.5$.

Q37.

Answer: A

Explanation:

First, find the sum $\vec{S}=\vec{A}+\vec{B}=\hat{i}+\hat{j}+2\hat{k}$. The resultant vector $\vec{R}$ has magnitude 10 along $\vec{C}$. The unit vector along $\vec{C}$ is $\hat{c}=\frac{3\hat{i}+4\hat{j}}{\sqrt{3^2+4^2}}=\frac{3\hat{i}+4\hat{j}}{5}$. So, $\vec{R}=10\hat{c}=2(3\hat{i}+4\hat{j})=6\hat{i}+8\hat{j}$.
Since $\vec{X}+\vec{S}=\vec{R}$, then
$\vec{X}=\vec{R}-\vec{S}=(6\hat{i}+8\hat{j})-(\hat{i}+\hat{j}+2\hat{k})=5\hat{i}+7\hat{j}-2\hat{k}$.

Q38.

Answer: A

Explanation:

Since $\vec{X}$ is parallel to $\vec{A}$, let $\vec{X}=k(\hat{i}+2\hat{j}+2\hat{k})$. The resultant $\vec{R}=\vec{X}+\vec{B}=(k+3)\hat{i}+(2k-1)\hat{j}+(2k+1)\hat{k}$. Since $\vec{R}$ is perpendicular to $\vec{C}$, their dot product is zero: $\vec{R}\cdot\vec{C}=0$.
$(k+3)(1)+(2k-1)(-1)+(2k+1)(-1)=0$.
$k+3-2k+1-2k-1=0\Rightarrow -3k+3=0\Rightarrow k=1$.
Therefore, $\vec{X}=1(\hat{i}+2\hat{j}+2\hat{k})$.

Q39.

Answer: D

Explanation:

$$\overrightarrow{A}\,and\,\overrightarrow{B}=0\Rightarrow\begin{vmatrix}\hat{i}&\hat{j}&\widehat{k}\\1&-5&2\\0&-10&c\end{vmatrix}=0$$

$\hat{i}(-5c+20)-\hat{j}(2c-8)+\widehat{k}(-20+20)$2c-8=0 $\Rightarrow$c=4

Q40.

Answer: B

Explanation:

$$\overrightarrow{A}\times\overrightarrow{B}=\begin{vmatrix}\hat{i}&\hat{j}&\widehat{k}\\1&2&3\\1&-2&-3\end{vmatrix}=\hat{i}(0)=\hat{j}(-6)+\widehat{k}(-4)$$

$\overrightarrow{A}\times\overrightarrow{B}=6\hat{j}-4\widehat{k}\widehat{n}=\frac{6\hat{j}-4\widehat{k}}{\sqrt{52}}$

Q41.

Answer: A

Explanation:

$\vec{r}=\vec{a}+\vec{b}+\vec{c}=4\hat{i}-\hat{j}-3\hat{i}+2\hat{j}-\hat{k}=\hat{i}+\hat{j}-\hat{k}$
$\hat{r}=\frac{\vec{r}}{|r|}=\frac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{1^2+1^2+(-1)^2}}=\frac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{3}}$

Q42.

Answer: A

Explanation:

$S=\overrightarrow{r_2}-\overrightarrow{r_1}$
$W=\vec{F}\cdot\vec{S}=\left(4\hat{i}+\hat{j}+3\hat{k}\right)\cdot\left(11\hat{i}+11\hat{j}+15\hat{k}\right)$
$=(4\times11+1\times11+3\times15)=100\mathrm{J}.$

Q43.

Answer: B

Explanation:

$P=\vec{F}\cdot\vec{v}=20\times6+15\times(-4)+(-5)\times3$
$=120-60-15=120-75=45\mathrm{J/s}$

Q44.

Answer: B

Explanation:

We know that, Angular momentum $\vec{L}=\vec{r}\times\vec{p}$ in terms of component becomes $\vec{L}=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\x&y&z\\p_x&p_y&p_z\end{vmatrix}$ $\underset{O}{\overset{\Delta}{\rightarrow}}$ $\overset{\Delta}{\rightarrow}\vec{v}$ As motion is in $x-y$ plane $(z=0$ and $P_z=0)$, so $\vec{L}=\vec{k}\,(xp_y-yp_x)$ Here $x=vt, y=b, p_x=mv$ and $p_y=0$
$\therefore\vec{L}=\vec{k}\,[vt\times0-bmv]=-mvbk$

Q45.

Answer: C

Explanation:
For two vectors to be parallel, their cross product must be zero ($\vec{P}\times\vec{Q}=0$). Alternatively, their corresponding components must be proportional. Using the proportionality method: $\frac{3}{1}=\frac{-6}{-2}=\frac{9}{m}$. Solving for m: $3=\frac{9}{m}\Rightarrow3m=9\Rightarrow m=3$.

Q46.

Answer: D

Explanation:
Mendeleev predicted the existence of elements called Eka-Aluminium and Eka-Silicon, which were later discovered as Gallium (Ga) and Germanium (Ge) respectively.

Q47.

Answer: B

Explanation:
Element 114 (Flerovium) follows the completion of the 6d subshell and falls into the second position of the 7p subshell, placing it in the Carbon family (Group 14).

Q48.

Answer: D

Explanation:
Atomic number 47 corresponds to Silver (Ag), which is located in the 5th period and belongs to Group 11 (d-block).

Q49.

Answer: D

Explanation:
In the sixth period ($n = 6$), the filling of subshells follows the $(n)s, (n-2)f, (n-1)d, (n)p$ order.

Q50.

Answer: C

Explanation:

While Mendeleev correctly predicted the gaps, Gallium and Germanium were discovered significantly after he published his periodic table.

Q51.

Answer: B

Explanation:

Henry Moseley performed X-ray spectroscopic studies that proved atomic number, not atomic mass, is the fundamental property of elements.

Q52.

Answer: C

Explanation:
Representative elements are those in the s and p blocks (Groups 1, 2, and 13–17).

Q53.

Answer: D

Explanation:
Inner transition elements (f-block) are characterized by the filling of the $(n-2)f$ subshell while the outer shells remain mostly constant.

Q54.

Answer: C

Explanation:

According to the IUPAC official names for elements with $Z > 100$, Unununnium ($Z = 111$) is Roentgenium, while Darmstadtium is element 110.

Q55.

Answer: A

Q56.

Answer: A

Explanation:

Fluorine's radius is measured as its covalent radius, whereas Neon, being a noble gas, is measured by its significantly larger Van der Waals radius.

Q57.

Answer: D

Explanation:
For ions of the same element, the radius decreases as the positive charge increases because the nucleus pulls the remaining electrons more strongly.

Q58.

Answer: B

Explanation:
For isoelectronic species, as the nuclear charge (Z) increases, the attraction for the electrons increases, causing the ionic radius to decrease.

Q59.

Answer: A

Explanation:
These ions are isoelectronic; the radius increases as the negative charge increases because the nuclear charge is lower relative to the number of electrons.

Q60.

Answer: B

Explanation:

N^{3-}, O^{2-}, and F^{-} are isoelectronic. Since Nitrogen ($Z = 7$) has the smallest nuclear charge among them, its ion N^{3-} has the largest radius.

Q61.

Answer: C

Explanation:

Beryllium (Be) has a higher first ionization energy than Boron (B) because its valence electrons are in a stable, fully-filled2s subshell, whereas B has its lone valence electron in a higher-energy 2p subshell.

Q62.

Answer: A

Explanation:

Nitrogen has a higher ionization potential than Oxygen because Nitrogen possesses a stable, half-filledpsubshell ($2p^3$), which requires more energy to disrupt.

Q63.

Answer: B

Explanation:
The configuration $[Ne]3s^2 3p^3$ (Phosphorus) has the highest ionization energy due to its stable, half-filled 3p subshell and smaller atomic size compared to elements further down the same group.

Q64.

Answer: C

Explanation:
The configuration $[Ne]3s^2 3p^3$ represents a half-filled p subshell, which provides maximum stability and thus the highest ionization enthalpy among the listed choices.

Q65.

Answer: A

Explanation:
In Period 3, the first ionization energy generally increases, but Magnesium (737) is higher than Aluminum (577) because Magnesium has a stable, fully-filled$3s^2$ orbital.

Q66.

Answer: C

Explanation:
Chlorine has the highest negative electron gain enthalpy because Fluorine's extremely small size leads to high inter-electronic repulsions in its 2psubshell, making it slightly less favorable to add an electron than in Chlorine.

Q67.

Answer: B

Explanation:
The addition of an electron to a neutral Hydrogen atom is exothermic (releases energy) as it reaches a stable Helium-like configuration, whereas the other processes require energy input due to noble gas stability, electrostatic repulsion, or ionization.

Q68.

Answer: D

Explanation:
The total energy released is calculated by determining the number of moles of Chlorine in $1\ \mathrm{gram}$ and multiplying it by the molar electron affinity converted to kcal.

Q69.

Answer: D

Explanation:
Adding a second electron to an already negative ion (O^{-}) involves significant electrostatic repulsion, which requires energy input to overcome, resulting in a positive enthalpy value.

Q70.

Answer: B

Explanation:
In algebraic terms, electron gain enthalpy becomes less negative (increases) down a group; therefore, $\Delta_{eg}H(S)$ is more negative (smaller algebraically) than $\Delta_{eg}H(Se)$.

Q71.

Answer: D

Explanation:
Electronegativity generally increases across a period and decreases down a group; Br and At are halogens, while C and P are non-metals in groups 14 and 15.

Q72.

Answer: B

Explanation:
Electronegativity increases from left to right across a period; since Germanium is to the right of Gallium in the same period, it has a higher electronegativity value.

Q73.

Answer: A

Explanation:
Electronegativity increases left to right across a period and decreases down a group.

Q74.

Answer: D

Explanation:
Magnitude of negative electron gain enthalpy generally increases across a period, but Group 2 elements like Ca have very low magnitudes due to stable filled subshells.

Q75.

Answer: A

Explanation:
The difference in electronegativity (ΔEN) between two bonded atoms is a primary indicator of bond polarity and the percentage of ionic character.

Q76.

Answer: D

Explanation:
Tellurium (Te) is classified as a metalloid because it is located along the zig-zag boundary of the periodic table and exhibits properties of both metals and non-metals.

Q77.

Answer: B

Explanation:

Metallic character decreases across a period because ionization enthalpy increases, making electron loss harder; however, the reason is false because electron gain enthalpy becomes more negative (increases in magnitude) across a period.

Q78.

Answer: D

Explanation:
Non-metals have a high tendency to attract electrons toward themselves, which means they possess high electronegativity values.

Q79.

Answer: A

Explanation:
Metallic character (electropositive nature) decreases across a period due to stronger nuclear pull and increases down a group as atomic size increases and electrons are easier to remove.

Q80.

Answer: A

Explanation:
Sodium is the most metallic as a Group 1 metal, while Phosphorus is the least metallic as a Group 15 non-metal; metallic character also decreases going up a group ($Mg > Be$).

Q81.

Answer: A

Explanation:

This matching is based on the chemical nature of oxides: non-metal oxides are typically acidic, metallic oxides are basic, and certain specific oxides are neutral or amphoteric.

Q82.

Answer: C

Explanation:
In Group 13, the character of oxides changes from acidic to basic down the group as the metallic character of the elements increases.

Q83.

Answer: B

Explanation:
Acidic oxides are generally formed by non-metals. Both Boron and Silicon are non-metals/metalloids that form acidic oxides.

Q84.

Answer: C

Explanation:
The correct sequence requires an acidic oxide followed by a basic oxide and then an amphoteric oxide.

Q85.

Answer: D

Explanation:
Amphoteric oxides are those that can react with both acids and bases. The oxides of Zn, Al, and Pb in various states exhibit this property.

Q86.

Answer: A

Explanation:

Statement A is wrong because Cl has a more negative electron gain enthalpy than F. Statement C is incorrect as electronegativity is an inherent property (Pauling scale). Statement D is wrong because NO is a neutral oxide, not amphoteric.

Q87.

Answer: D

Explanation:
The order for ionization enthalpy is incorrect because Nitrogen ($2p^3$) has a stable half-filled subshell, making its first ionization energy higher than that of Oxygen ($2p^4$).

Q88.

Answer: A

Explanation:
Cl_2 has a higher bond dissociation energy than F_2 because the extremely small size of F leads to strong lone-pair repulsions that weaken the F-F bond.

Q89.

Answer: C

Explanation:
Nitrogen (N) has a higher first ionization enthalpy than Oxygen (O) because N has a stable half- filled $2p^3$ configuration.

Q90.

Answer: B

Explanation:
Group 15 elements have higher ionization enthalpies than Group 16 because they possess stable, half-filled p^3 subshells.

Q91.

Answer: C

Q92.

Answer: B

Q93.

Answer: B

Q94.

Answer: C

Q95.

Answer: B

Q96.

Answer: B

Q97.

Answer: C

Q98.

Answer: B

Q99.

Answer: C

Q100.

Answer: A

Q101.

Answer: B

Q102.

Answer: C

Q103.

Answer: C

Q104.

Answer: B

Q105.

Answer: B

Q106.

Answer: B

Q107.

Answer: C

Q108.

Answer: C

Q109.

Answer: B

Q110.

Answer: C

Q111.

Answer: B

Q112.

Answer: B

Q113.

Answer: B

Q114.

Answer: C

Q115.

Answer: A

Q116.

Answer: C

Q117.
Answer: B

Q118.
Answer: B

Q119.
Answer: C

Q120.
Answer: C

Q121.
Answer: C

Q122.
Answer: B

Q123.
Answer: B

Q124.
Answer: C

Q125.
Answer: C

Q126.
Answer: B

Q127.
Answer: C

Q128.
Answer: A

Q129.
Answer: C

Q130.
Answer: B

Q131.
Answer: B

Q132.
Answer: C

Q133.
Answer: B

Q134.
Answer: B

Q135.
Answer: C

Q136.
Answer: A

Q137.
Answer: D

Q138.
Answer: D

Q139.
Answer: C

Q140.
Answer: C

Q141.
Answer: C

Q142.
Answer: A

Q143.
Answer: C

Q144.
Answer: D

Q145.
Answer: C

Q146.
Answer: C

Q147.
Answer: D

Q148.
Answer: C

Q149.
Answer: D

Q150.
Answer: A

Q151.
Answer: A

Q152.
Answer: C

Q153.
Answer: C

Q154.
Answer: A

Q155.
Answer: C

Q156.
Answer: A

Q157.
Answer: D

Q158.
Answer: D

Q159.
Answer: D

Q160.
Answer: D

Q161.
Answer: D

Q162.
Answer: C

Q163.
Answer: D

Q164.
Answer: A

Q165.
Answer: A

Q166.
Answer: C

Q167.
Answer: B

Q168.
Answer: C

Q169.
Answer: C

Q170.
Answer: A

Q171.
Answer: A

Q172.
Answer: D

Q173.
Answer: B

Q174.
Answer: A

Q175.
Answer: D

Q176.
Answer: D

Q177.
Answer: C

Q178.
Answer: A

Q179.
Answer: D

Q180.
Answer: D