Max Marks: 300 | **JR_WEEK-6 (20-07-2026)** | **Time: 180 mins**

Chemistry

1. 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 $GeCl_4$

2. 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 $[Rn]5f^{14}6d^{10}7s^27p^3$

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

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

4. 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

5. 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

6. 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

7. 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

8. 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)

9. 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

10. 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

11. Ionic radii of:

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

12. 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+}

13. 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

14. 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)** $Na(g) \rightarrow Na^+(g) + e^-$

15. 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)** $\Delta_{eg}H(Te) < \Delta_{eg}H(Po)$

16. 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)** $F < O < N < C < Si$

17. 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)** $Be > Na > Mg > Si > P$

18. 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

19. 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)

20. 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)

21. How many of the following element are metalloids? Be, Al, Ga, Si, Ge, As, Sb, Se, Te

22. How many oxides of the following are neutral?
CO, N_2O, NO, ZnO, Al_2O_3, $NO_2, N_2O_3, V_2O_5, Cr_2O_3, MnO_2$

23. How many of the following oxides are amphoteric?
$BeO, Al_2O_3, SiO_2, GeO_2, SnO_2, PbO, Cr_2O_3, V_2O_3, MnO, Mn_2O_3$

24. Total number element present in gaseous state is

25. The electron affinity of chlorine is 3.7 eV. 1 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:___kcal

Maths

26. Period of $\cos\left(x + \frac{x}{3} + \frac{x}{3^2} + \ldots\right)$ is

A) $\frac{\pi}{3}$ **B)** $\frac{2\pi}{3}$
C) π **D)** $\frac{4\pi}{3}$

27. Period of $\cos^6 x + \sin^6 x$ is

A) $\frac{\pi}{2}$ **B)** π
C) $\frac{3\pi}{2}$ **D)** 2π

28. Period of $\sin x \sin(120° - x) \sin(120° + x)$ is

A) $\frac{\pi}{3}$ **B)** $\frac{2\pi}{3}$
C) π **D)** $\frac{\pi}{2}$

29. The period of $f(x) = \sin x + \{x\}$, where $\{x\}$ is the fractional part of x, is

A) 0 **B)** 1
C) 2π **D)** Does not exist

30. Period of $\tan\left(\frac{3\pi x}{4}\right) - 2\sec\left(\frac{\pi x}{3}\right) + 5\sin\left(\frac{2\pi x}{5}\right)$ is

A) 20 **B)** 30
C) 60 **D)** 80

31. The period of $f(x) = \sin\frac{\pi x}{n!} - \cos\frac{\pi x}{(n+1)!}$ is

A) $(n+1)!$ **B)** $2(n+1)!$
C) $2(n!)$ **D)** $\frac{n+1}{2!}$

32. The period of the function $\left|\sin^3\frac{x}{2}\right| + \left|\cos^5\frac{x}{2}\right|$ is

A) 2π **B)** 5π
C) 8π **D)** 5π

33. The period of the function $f(x) = [6x + 7] + \cos \pi x - 6x$, where [.]denotes the greatest integer function, is

A) 3 **B)** 2π
C) 2 **D)** π

34. The function $\sin\left(x^2\right) + \cos\sqrt{x}$ is

A) Periodic with period π **B)** Periodic with period 2π
C) Periodic with period 0 **D)** Not a Periodic function

35. Period of $\sin x \cos\left(x + \frac{\pi}{4}\right)$ is

A) $\frac{\pi}{2}$ **B)** π
C) $\frac{3\pi}{2}$ **D)** 2π

36. If $n \in \mathbb{N}$, and the period of $\cos(nx)\sin\left(\frac{x}{n}\right)$ is 4π, then $n =$

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

37. The minimum and maximum values of $8\cos 3x - 15\sin 3x$ are

A) $-7, 7$ **B)** $-23, 23$
C) $-17, 17$ **D)** $-15, 8$

38. The maximum value of $\frac{3}{5\sin x - 12\cos x + 19}$

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

39. The range of $\sin^6 x + \cos^6 x$

A) $[-1/4, 1/4]$ **B)** $[1/4, 1/2]$
C) $[1/4, 1]$ **D)** $[-1/2, -1/4]$

40. The minimum and maximum values of $\sin^2(60^\circ - x) + \sin^2(60^\circ + x)$ are

A) $-1/2, 1/2$ **B)** $1, 1/2$
C) $1/2, 3/2$ **D)** $2, 3/2$

41. Maximum value of $\frac{1}{\sqrt{7}\sin x + \sqrt{29}\cos x + 7}$

A) 13 **B)** 1
C) $\frac{1}{13}$ **D)** 49

42. The minimum and maximum values of $\sin^4 x + \cos^4 x$ are

A) $\left[\frac{3}{2}, \frac{1}{2}\right]$ **B)** $\left[1, \frac{1}{2}\right]$
C) $\left[\frac{3}{2}, 1\right]$ **D)** 1, 2

43. $\cos^2(60^\circ - x) + \cos^2(60^\circ + x) \in$

A) $\left[-\frac{1}{2}, \frac{1}{2}\right]$ **B)** $\left[1, \frac{1}{2}\right]$
C) $\left[\frac{3}{2}, \frac{1}{2}\right]$ **D)** $\left[2, \frac{3}{2}\right]$

44. Extreme values of $4\cos\left(x^2\right).\cos\left(\frac{\pi}{3} + x^2\right).\cos\left(\frac{\pi}{3} - x^2\right)$ over R.

A) $-1, 1$ **B)** $-2, 2$
C) $-3, 3$ **D)** $-4, 4$

45. If $A = \sin^8\theta + \cos^{14}\theta$, then for all values of θ

A) $0 < A \leq 1$ **B)** $1 < A \leq 2$
C) $A \geq 1$ **D)** $10 \leq A \leq 2$

46. The minimum value of $27\tan^2\theta + 3\cot^2\theta$ is

47. Minimum value of $9\sec^2\theta + 4\mathrm{cosec}^2\theta + 7$ is

48. Period of $\frac{\sin(2\pi x + a)}{\sin(2\pi x + b)}$ is

49. Period of $\sin\frac{3\pi x}{2} + \cos\frac{\pi x}{2}$ is

50. Period of $\cos\frac{\pi x}{4} - 2\mathrm{cosec}\frac{\pi x}{6} + 5\tan\frac{\pi x}{3}$ is

Physics

51. A force vector has a magnitude of $30\ \mathrm{N}$. If the force is in the direction of $\vec{B}$, find the force in vector form, where $\vec{B} = \hat{\imath} + \hat{\jmath}$.

A) $15\hat{\imath} + 15\hat{\jmath}\ \mathrm{N}$ **B)** $30\hat{\imath} + 30\hat{\jmath}\ \mathrm{N}$
C) $15\sqrt{2}\hat{\imath} + 15\sqrt{2}\hat{\jmath}\ \mathrm{N}$ **D)** $30\sqrt{2}\hat{\imath} + 30\sqrt{2}\hat{\jmath}\ \mathrm{N}$

52. Find the component of $\vec{A} = 4\hat{\imath} + 2\hat{\jmath}$ along $\vec{B} = \hat{\imath} + \hat{\jmath}$.

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

53. A particle moves with a speed of $15\ \mathrm{m/s}$ in the direction of a vector $\vec{A} = 3\hat{\imath} + 4\hat{\jmath}$. Find the velocity of the particle in vector form.

A) $3\hat{\imath} + 4\hat{\jmath}\ \mathrm{m/s}$ **B)** $6\hat{\imath} + 8\hat{\jmath}\ \mathrm{m/s}$
C) $9\hat{\imath} + 12\hat{\jmath}\ \mathrm{m/s}$ **D)** $12\hat{\imath} + 16\hat{\jmath}\ \mathrm{m/s}$

54. If $\vec{A} = 2\hat{\imath} + \hat{\jmath}$ and $\vec{B} = \hat{\imath} + \hat{\jmath}$, find the component of $\vec{A}$ perpendicular to $\vec{B}$.

A) $\frac{\hat{\imath} - \hat{\jmath}}{2}$ **B)** $\frac{\hat{\imath} + \hat{\jmath}}{2}$
C) $\frac{-\hat{\imath} + \hat{\jmath}}{2}$ **D)** $\frac{2\hat{\imath} - \hat{\jmath}}{2}$

55. For the vectors $\vec{A} = 2\hat{\imath} - \hat{\jmath} + 3\hat{k}$ and $\vec{B} = 4\hat{\imath} - 2\hat{\jmath} + 6\hat{k}$, 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

56. If $\vec{A} = 3\hat{\imath} + 4\hat{\jmath} + 12\hat{k}$, 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) $\cos\alpha = \frac{13}{3}, \cos\beta = \frac{13}{4}, \cos\gamma = \frac{1}{1}$

57. If $\vec{A} = 2\hat{\imath} + 6\hat{\jmath} + 3\hat{k}$, 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: $2\hat{\imath}, 6\hat{\jmath}, 3\hat{k}$
B) Direction cosines: $\cos\alpha = \frac{2}{11}, \cos\beta = \frac{6}{11}, \cos\gamma =$; Components: $2\hat{\imath}, 6\hat{\jmath}, 3\hat{k}$
C) Direction cosines: $\cos\alpha = \frac{6}{7}, \cos\beta = \frac{2}{7}, \cos\gamma = \frac{3}{7}$; Components: $6\hat{\imath}, 2\hat{\jmath}, 3\hat{k}$
D) Direction cosines: $\cos\alpha = \frac{7}{2}, \cos\beta = \frac{7}{6}, \cos\gamma = \frac{7}{3}$; Components: $\hat{\imath}, \hat{\jmath}, \hat{k}$

58. Find the cross product $\vec{a} \times \vec{b}$ if $\vec{a} = 5\hat{\imath} + 2\hat{\jmath}$ and $\vec{b} = 3\hat{\imath} + 4\hat{\jmath}$.

A) $14\hat{k}$ **B)** $-14\hat{k}$
C) $26\hat{k}$ **D)** $6\hat{k}$

59. **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)** $\tan^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

60. **If $\vec{P}=2\hat{\imath}+\hat{\jmath}+3\hat{k}$ and $\vec{Q}=\hat{\imath}+\hat{\jmath}+3\hat{k}$, 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)** $3\hat{\imath}+2\hat{\jmath}+6\hat{k}$

61. **If $\vec{A}=\hat{\imath}+2\hat{\jmath}+3\hat{k}$ and $\vec{B}=2\hat{\imath}-\hat{\jmath}+\hat{k}$, 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)** $\frac{1}{\sqrt{2}}$

62. **If $\vec{P}=3\hat{\imath}+4\hat{\jmath}$ and $\vec{Q}=5\hat{\imath}+12\hat{\jmath}$, 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)** $\frac{1}{\sqrt{2}}$

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

Column-I:	Column-II:
(A) $\frac{\vec{A}\cdot\vec{B}}{\lvert\vec{A}\rvert\lvert\vec{B}\rvert}$	(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)

64. **Given two vectors $\vec{P}=2\hat{\imath}+2\hat{\jmath}+\hat{k}$ and $\vec{Q}=\hat{\imath}-2\hat{\jmath}+2\hat{k}$, 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)

65. **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

66. **If $\vec{A}=2\hat{\imath}-\hat{\jmath}+\hat{k}$ and $\vec{B}=\hat{\imath}+\hat{\jmath}-2\hat{k}$, then which of the following is correct?**

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

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

A) $5\hat{\imath}+7\hat{\jmath}-2\hat{k}$ **B)** $5\hat{\imath}+7\hat{\jmath}+2\hat{k}$
C) $-5\hat{\imath}-7\hat{\jmath}+2\hat{k}$ **D)** $6\hat{\imath}+8\hat{\jmath}$

68. **The unit vector, which is perpendicular to both $\overrightarrow{A}=\hat{\imath}+2\hat{\jmath}+3\hat{k}\ and\ \overrightarrow{B}=\hat{\imath}-2\hat{\jmath}-3\hat{k}$is equal to**

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

69. **With respect to a rectangular cartesian coordinate system, three vectors are expressed as $\vec{a}=4\hat{\imath}-\hat{\jmath},\vec{b}=-3\hat{\imath}+2\hat{\jmath}$ and $\vec{c}=-\hat{k}$where $\hat{\imath},\hat{\jmath},\hat{k}$ 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)** $\hat{r}=\frac{1}{\sqrt{2}}\left(\hat{i}+\hat{j}-\hat{k}\right)$
C) $\hat{r}=\frac{1}{3}\left(\hat{i}-\hat{j}+\hat{k}\right)$ **D)** $\hat{r}=\frac{1}{\sqrt{2}}\left(\hat{i}+\hat{j}+\hat{k}\right)$

70. 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) $mv\hat{i}$

71. 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?

72. 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?

73. 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?

74. 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---J

75. 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___J/s

ANSWER KEY

Chemistry

1.	**4**	8.	**3**	15.	**2**	22.	**3**
2.	**2**	9.	**1**	16.	**1**	23.	**5**
3.	**4**	10.	**1**	17.	**1**	24.	**11**
4.	**4**	11.	**4**	18.	**3**	25.	**2.4**
5.	**3**	12.	**2**	19.	**4**		
6.	**2**	13.	**1**	20.	**3**		
7.	**3**	14.	**2**	21.	**5**		

Maths

26.	**4**	33.	**3**	40.	**3**	47.	**32**
27.	**1**	34.	**4**	41.	**2**	48.	**1**
28.	**2**	35.	**2**	42.	**2**	49.	**4**
29.	**4**	36.	**3**	43.	**3**	50.	**24**
30.	**3**	37.	**3**	44.	**1**		
31.	**2**	38.	**2**	45.	**1**		
32.	**2**	39.	**3**	46.	**18**		

Physics

51.	**3**	58.	**1**	65.	**1**	72.	**77**
52.	**1**	59.	**1**	66.	**2**	73.	**4**
53.	**3**	60.	**2**	67.	**1**	74.	**100**
54.	**1**	61.	**3**	68.	**2**	75.	**45**
55.	**1**	62.	**1**	69.	**1**		
56.	**1**	63.	**2**	70.	**2**		
57.	**1**	64.	**1**	71.	**2**		

SOLUTIONS

Q1.

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.

Q2.

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).

Q3.

Answer: D

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

Q4.

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.

Q5.

Answer: C

Explanation:

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

Q6.

Answer: B

Explanation:

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

Q7.

Answer: C

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

Q8.

Answer: C

Explanation:

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

Q9.

Answer: A

Q10.

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.

Q11.

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.

Q12.

Answer: B

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

Q13.

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.

Q14.

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.

Q15.

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 $\Delta_{eg}H(Se)$.

Q16.

Answer: A

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

Q17.

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 ($Mg > Be$).

Q18.

Answer: C

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

Q19.

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 ($2p^4$).

Q20.

Answer: C

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

Q21.

Answer: 5

Explanation:
Metalloids are elements with properties intermediate between metals and nonmetals. The commonly accepted metalloids in the given list are Si, Ge, As, Sb, and Te.

Q22.

Answer: 3

Explanation:
Neutral oxides are oxides that are neither acidic nor basic. Among the given compounds, CO, NO, and N_2O are neutral oxides.

Q23.

Answer: 5

Explanation:
Amphoteric oxides react with both acids and bases. The amphoteric oxides here are BeO, $AlO,\ SnO,\ PbO,\ and\ CrO.$

Q24.

Answer: 11

Explanation:
Elements that exist in the gaseous state at room temperature are H, N, O, F, Cl and the noble gases (He, Ne, Ar, Kr, Xe, Rn).

Q25.

Answer: 2.4

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.

Q26.

Answer: D

Explanation:
The function contains an infinite geometric series as its argument. By finding the sum of this series, the function simplifies to a standard trigonometric form $\cos(ax)$, where the period is calculated as $T = \frac{2\pi}{|a|}$.

Q27.

Answer: A

Explanation:
Using the identity $\cos^6 x + \sin^6 x = 1 - 3\sin^2 x \cos^2 x = 1 - \frac{3}{4}\sin^2(2x)$, and since $\sin^2(2x)$ has period $\frac{\pi}{2}$, the given function also has period $\frac{\pi}{2}$.

Q28.

Answer: B

Explanation:
Using the trigonometric product identity, the expression $\sin x \sin(60^\circ - x)\sin(60^\circ + x)$ or its variants like 120° simplifies to $\frac{1}{4}\sin 3x$. The fundamental period of $\sin 3x$ is then determined by dividing 2π by the coefficient 3.

Q29.

Answer: D

Explanation:
The fundamental period of a sum of functions is the L.C.M. of their individual periods. For the L.C.M. to exist, the ratio of the periods must be a rational number. Since one period is irrational and the other is rational, the period for the combined function does not exist.

Q30.

Answer: C

Explanation:
The period of a linear combination of trigonometric functions is the L.C.M. of the periods of the individual terms. By calculating the period for each term and finding their least common multiple using rational fraction rules, the result is determined.

Q31.

Answer: B

Explanation:
For a function composed of a difference of sine and cosine terms, the period is the L.C.M. of the periods of those terms. Since $(n+1)!$ is a multiple of n!, the L.C.M. is simply the larger period.

Q32.

Answer: B

Q33.

Answer: C

Explanation:
The function $[6x+7] - 6x$ has period $\frac{1}{6}$, while $\cos(\pi x)$ has period 2. The least common period is 2.

Q34.

Answer: D

Explanation:
Neither $\sin(x^2)$ nor $\cos\sqrt{x}$ has a constant period. Hence, their sum is not periodic.

Q35.

Answer: B

Explanation:
By converting the product of the trigonometric functions into a sum using standard identities, the function is reduced to a variable term and a constant. The period is then determined by the variable term, resulting in π.

Q36.

Answer: C

Explanation:
The fundamental period of a combination of trigonometric functions is the L.C.M. of their individual periods. By calculating the periods of the two components and setting their L.C.M. to 4π, the integer value of n is found to be 2.

Q37.

Answer: C

Explanation:
For a trigonometric function of the form $a\cos\theta + b\sin\theta$, the extreme values are given by the formula $\pm\sqrt{a^2+b^2}$.

Q38.

Answer: B

Explanation:
To find the maximum value of a fraction with a positive constant numerator, we must find the minimum value of the denominator. The minimum value of $a\sin x + b\cos x + c$ is $c - \sqrt{a^2+b^2}$.

Q39.

Answer: C

Explanation:
The expression $\sin^6 x + \cos^6 x$ can be simplified using algebraic identities to $1 - \frac{3}{4}\sin^2 2x$. The range is then determined by evaluating the maximum and minimum possible values of $\sin^2 2x$.

Q40.

Answer: C

Explanation:
By using power reduction formulas and sum-to-product identities, the expression simplifies to $1 + \frac{1}{2}\cos 2x$. The range of the cosine function then determines the extreme values.

Q41.

Answer: B

Explanation:
To maximize the reciprocal, minimize the denominator. Using $a\sin x + b\cos x \in \left[-\sqrt{a^2+b^2}, \sqrt{a^2+b^2}\right]$, the minimum denominator is $7 - \sqrt{7+29} = 7 - 6 = 1$. Hence the maximum value is 1 Taking the reciprocal gives 1

Q42.

Answer: B

Explanation:
The expression can be rewritten as a function of $\sin^2 2x$. By evaluating the range of the sine squared function, we determine the extreme values of the sum.

Q43.

Answer: C

Explanation:
Using power reduction and sum-to-product identities, the function simplifies to a variable cosine term shifted by a constant. The range is then derived from the standard range of the cosine function.

Q44.

Answer: A

Explanation:
The product of three cosines with arguments spaced by 60° $(\pi/3)$ simplifies to a single cosine of the triple angle.

Q45.

Answer: A

Explanation:
Higher even powers of sine and cosine are always less than or equal to their squared values because the absolute value of these functions is at most 1. Consequently, the sum of these higher powers is bounded by the identity $\sin^2\theta + \cos^2\theta = 1$.

Q46.

Answer: 18

Explanation:
Using the Arithmetic Mean - Geometric Mean (AM-GM) inequality, the minimum value of a sum of two reciprocal-based terms can be found.

Q47.

Answer: 32

Explanation:
Using the standard result for extreme values, the minimum of $b^2\sec^2\theta + a^2\mathrm{cosec}^2\theta$ is $(a+b)^2$. Adding the constant 7 to this result gives the total minimum.

Q48.

Answer: 1

Explanation:
Both the numerator and denominator contain the argument $2\pi x$, whose period is 1. Hence, their quotient also has period 1 (where the denominator is nonzero).

Q49.

Answer: 4

Explanation:
The period of a sum of functions is the L.C.M. (Least Common Multiple) of their individual periods. By calculating the periods of the sine and cosine terms separately and finding their L.C.M., the final result is obtained.

Q50.

Answer: 24

Explanation:
The period for this multi-term function is found by calculating the periods of each of the three trigonometric components and then determining their overall L.C.M..

Q51.

Answer: C

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

Q52.

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 $\vec{B}$: $\left(\frac{6}{\sqrt{2}}\right)\left(\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}\right) = \frac{6}{2}(\hat{\imath}+\hat{\jmath}) = 3(\hat{\imath}+\hat{\jmath})$.

Q53.

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 $\hat{u} = \frac{3\hat{\imath}+4\hat{\jmath}}{5}$. Multiply the speed (15) by the unit vector: $\vec{v} = 15\left(\frac{3\hat{\imath}+4\hat{\jmath}}{5}\right) = 3(3\hat{\imath}+4\hat{\jmath}) = 9\hat{\imath}+12\hat{\jmath}$.

Q54.

Answer: A

Explanation:

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

Q55.

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.

Q56.

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 $\cos\gamma = \frac{12}{13}$.

Q57.

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: $2\hat{\imath}, 6\hat{\jmath}, 3\hat{k}$.

Q58.

Answer: A

Explanation:

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

Q59.

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, $\theta = \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$.

Q60.

Answer: B

Explanation:

First, find the sum
$\vec{P} + \vec{Q} = (2+1)\hat{\imath} + (1+1)\hat{\jmath} + (3+3)\hat{k} = 3\hat{\imath} + 2\hat{\jmath} + 6\hat{k}$.
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 $\frac{3\hat{\imath}+2\hat{\jmath}+6\hat{k}}{7}$.

Q61.

Answer: C

Explanation:

First, find the resultant vector $\vec{R} = \vec{A} + \vec{B} = 3\hat{\imath} + \hat{\jmath} + 4\hat{k}$. 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 $\sqrt{364} = \sqrt{4 \times 91} = 2\sqrt{91}$.

Q62.

Answer: A

Explanation:

First, find $\vec{R} = \vec{P} + \vec{Q} = 8\hat{\imath} + 16\hat{\jmath}$. 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: $\cos\theta = \frac{88}{5 \cdot 8\sqrt{5}} = \frac{11}{5\sqrt{5}}$.

Q63.

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) $\vec{A} + \vec{B} = 7\hat{\imath} + \hat{\jmath}$. Magnitude is $\sqrt{49 + 1} = \sqrt{50} = 5\sqrt{2}$. Unit vector is $\frac{7\hat{\imath}+\hat{\jmath}}{5\sqrt{2}}$ (matches 2). (D) $\vec{A} - \vec{B} = -\hat{\imath} + 7\hat{\jmath}$. Magnitude is $5\sqrt{2}$. Unit vector is $\frac{-\hat{\imath}+7\hat{\jmath}}{5\sqrt{2}}$ (matches 4).

Q64.

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).

Q65.

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 $\frac{1}{2}|\vec{PQ}\times\vec{PR}|$.

$$\vec{PQ}\times\vec{PR} = \begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 3 & 0 & -2\\ 0 & 3 & -1\end{vmatrix} = (0-(-6))\hat{i} - (-3-0)\hat{j} + (9-0)\hat{k} = 6\hat{i} + 3\hat{j} + 9\hat{k}$$

. Magnitude $= \sqrt{6^2+3^2+9^2} = \sqrt{36+9+81} = \sqrt{126}$. Area $= \frac{\sqrt{126}}{2} = \sqrt{\frac{126}{4}} = \sqrt{31.5}$.

Q66.

Answer: B

Explanation:

Calculate the cross product $\vec{A}\times\vec{B}$.

$$\vec{A}\times\vec{B} = \begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & -1 & 1\\ 1 & 1 & -2\end{vmatrix} = (2-1)\hat{i} - (-4-1)\hat{j} + (2-(-1))\hat{k} = \hat{i} + 5\hat{j} + 3\hat{k}$$

. The magnitude is
$|\vec{A}\times\vec{B}| = \sqrt{1^2+5^2+3^2} = \sqrt{1+25+9} = \sqrt{35}$.

Q67.

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
$\vec{X} = \vec{R}-\vec{S} = (6\hat{i}+8\hat{j}) - (\hat{i}+\hat{j}+2\hat{k}) = 5\hat{i}+7\hat{j}-2\hat{k}$.

Q68.

Answer: B

Explanation:

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

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

Q69.

Answer: A

Explanation:

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

Q70.

Answer: B

Explanation:

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

Q71.

Answer: 2

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 $\lambda > 0$,
$2\lambda - 1 = 3 \Rightarrow 2\lambda = 4 \Rightarrow \lambda = 2$.

Q72.

Answer: 77

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
$\vec{D} = 13(3\hat{i}+4\hat{j}) + 5(5\hat{j}+12\hat{k}) = 39\hat{i}+52\hat{j}+25\hat{j}+60\hat{k} = 39\hat{i}+$
. Comparing with $\vec{C}$, $\lambda = 77$.

Q73.

Answer: 4

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 ⇒c=4

Q74.

Answer: 100

Explanation:

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

Q75.

Answer: 45

Explanation:

$$P = \vec{F} \cdot \vec{v} = 20 \times 6 + 15 \times (-4) + (-5) \times 3$$
$$= 120 - 60 - 15 = 120 - 75 = 45\,\mathrm{J/s}$$