JEE Main 2025 Jan 24 Shift 1 Question Paper

Time Allowed :3 Hour	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 75 questions. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 25 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 5 questions. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

Mathematics

Section - A

1. Let $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = 3\hat{i} + \hat{j} - \hat{k}$ and $\vec{c}$ be three vectors such that $\vec{c}$ is coplanar with $\vec{a}$ and $\vec{b}$. If the vector $\vec{c}$ is perpendicular to $\vec{b}$ and $\vec{a} \cdot \vec{c} = 5$, then $|\vec{c}|$ is equal to:

(1) $\frac{1}{\sqrt{3}}$

(2) 18

(3) 16

(4) $\sqrt{\frac{11}{6}}$

---

2. In $I(m,n) = \int_0^1 x^{m-1}(1-x)^{n-1}\,dx$, where $m, n > 0$, then $I(9,14) + I(10,13)$ is:

(1) $I(9,1)$

(2) $I(19,27)$

(3) $I(1,13)$

(4) $I(9,13)$

---

3. Let $f : \mathbb{R} - \{0\} \to \mathbb{R}$ be a function such that

$$f(x) - 6f\left(\frac{1}{x}\right) = \frac{35}{3x} - \frac{5}{2}.$$

If $\lim_{x\to 0}\left(\frac{1}{\alpha x} + f(x)\right) = \beta$, then $\alpha, \beta \in \mathbb{R}$, and $\alpha + 2\beta$ is equal to:

(A) 3

(B) 5

(C) 4

(D) 6

---

4. Let $S_n = \frac{1}{2} + \frac{1}{6} + \frac{1}{12} + \frac{1}{20} + \ldots$ up to n terms. If the sum of the first six terms of an A.P. with first term $-p$ and common difference p is $\sqrt{2026 S_{2025}}$, then the absolute difference between the 20th and 15th terms of the A.P. is:

(1) 25

(2) 90

(3) 20

(4) 45

---

5. Let $f(x) = \frac{2^{x+2}+16}{2^{2x+1}+2^{x+4}+32}$. Then the value of

$$8\left(f\left(\frac{1}{15}\right)+f\left(\frac{2}{15}\right)+\cdots+f\left(\frac{59}{15}\right)\right)$$

is equal to:

(1) 118

(2) 92

(3) 102

(4) 108

---

6. If α and β are the roots of the equation $2z^2 - 3z - 2i = 0$, where $i = \sqrt{-1}$, then

$$16 \cdot \text{Re}\left(\frac{\alpha^{19}+\beta^{19}+\alpha^{11}+\beta^{11}}{\alpha^{15}+\beta^{15}}\right) \cdot \text{Im}\left(\frac{\alpha^{19}+\beta^{19}+\alpha^{11}+\beta^{11}}{\alpha^{15}+\beta^{15}}\right)$$

is equal to:

(1) 398

(2) 312

(3) 409

(4) 441

---

7. Evaluate the limit:

$$\lim_{x\to 0} \csc x \left(\sqrt{2\cos^2 x + 3\cos x} - \sqrt{\cos^2 x + \sin x + 4}\right)$$

is equal to:

(1) 0

(2) $\frac{1}{2\sqrt{5}}$

(3) $\frac{1}{\sqrt{15}}$

(4) $-\frac{1}{2\sqrt{5}}$

8. Let in a $\triangle ABC$, the length of the side AC is 6, the vertex B is $(1, 2, 3)$ and the vertices A, C lie on the line

$$\frac{x-6}{3} = \frac{y-7}{2} = \frac{z-7}{-2}.$$

Then the area (in sq. units) of $\triangle ABC$ is:

(1) 42

(2) 21

(3) 56

(4) 17

---

9. Let $y = y(x)$ be the solution of the differential equation

$$\left(xy - 5x^2\sqrt{1+x^2}\right)dx + (1+x^2)dy = 0, \quad y(0) = 0.$$

Then $y(\sqrt{3})$ is equal to:

(1) $\frac{5\sqrt{3}}{2}$

(2) $\sqrt{\frac{14}{3}}$

(3) $2\sqrt{2}$

(4) $\sqrt{\frac{15}{2}}$

---

10. Let the product of the focal distances of the point

$$\left(\sqrt{3}, \frac{1}{2}\right)$$

on the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, \quad (a > b),$$

be $\frac{7}{4}$. Then the absolute difference of the eccentricities of two such ellipses is:

(1) $\frac{3-2\sqrt{2}}{3\sqrt{2}}$

(2) $\frac{1-\sqrt{3}}{\sqrt{2}}$

(3) $\frac{3-2\sqrt{2}}{2\sqrt{3}}$

(4) $\frac{1-2\sqrt{2}}{\sqrt{3}}$

---

11. A and B alternately throw a pair of dice. A wins if he throws a sum of 5 before B throws a sum of 8, and B wins if he throws a sum of 8 before A throws a sum of 5. The probability that A wins if A makes the first throw is:

(1) $\frac{9}{17}$

(2) $\frac{9}{19}$

(3) $\frac{8}{17}$

(4) $\frac{8}{19}$

---

12. Consider the region

$$R = \left\{(x, y) : x \leq y \leq 9 - \frac{11}{3}x^2, x \geq 0\right\}.$$

The area of the largest rectangle of sides parallel to the coordinate axes and inscribed in R is:

(1) $\frac{625}{111}$

(2) $\frac{730}{119}$

(3) $\frac{567}{121}$

(4) $\frac{821}{123}$

---

13. The area of the region

$$\{(x, y) : x^2 + 4x + 2 \leq y \leq |x| + 2\}$$

is equal to:

(1) 7

(2) $\frac{24}{5}$

(3) $\frac{20}{3}$

(4) 5

---

14. For a statistical data $x_1, x_2, \ldots, x_{10}$ of 10 values, a student obtained the mean as 5.5 and

$$\sum_{i=1}^{10} x_i^2 = 371.$$

He later found that he had noted two values in the data incorrectly as 4 and 5, instead of the correct values 6 and 8, respectively. The variance of the corrected data is:

(1) 7

(2) 4

(3) 9

(4) 5

---

15. Let circle C be the image of

$$x^2 + y^2 - 2x + 4y - 4 = 0$$

in the line

$2x - 3y + 5 = 0$ and A be the point on C such that OA is parallel to the x-axis and A lies on the right-hand side of the centre O of C.

If B(α, β), with $\beta < 4$, lies on C such that the length of the arc AB is $\frac{1}{6}$ of the perimeter of C, then $\beta - \sqrt{3}\alpha$ is equal to:

(1) 3

(2) $3 + \sqrt{3}$

(3) $4 - \sqrt{3}$

(4) 4

---

16. For some $n \neq 10$, let the coefficients of the 5th, 6th, and 7th terms in the binomial expansion of $(1 + x)^{n+4}$ be in A.P. Then the largest coefficient in the expansion of $(1 + x)^{n+4}$ is:

(1) 70

(2) 35

(3) 20

(4) 10

---

17. The product of all the rational roots of the equation

$$(x^2 - 9x + 11)^2 - (x - 4)(x - 5) = 3,$$

is equal to:

(1) 14

(2) 7

(3) 28

(4) 21

---

18. Let the line passing through the points $(-1, 2, 1)$ and parallel to the line

$$\frac{x-1}{2} = \frac{y+1}{3} = \frac{z}{4}$$

intersect the line

$$\frac{x+2}{3} = \frac{y-3}{2} = \frac{z-4}{1}$$

at the point P. Then the distance of P from the point Q(4, -5, 1) is:

(1) 5

(2) 10

(3) $5\sqrt{6}$

(4) $5\sqrt{5}$

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19. Let the lines

$$3x - 4y - \alpha = 0, \quad 8x - 11y - 33 = 0, \quad 2x - 3y + \lambda = 0$$

be concurrent. If the image of the point $(1, 2)$ in the line

$2x - 3y + \lambda = 0$ is $\left(\frac{57}{13}, \frac{-40}{13}\right)$, then $|\alpha\lambda|$ is equal to:

(1) 84

(2) 91

(3) 113

(4) 101

---

20. If the system of equations

$$2x - y + z = 4,$$

$$5x + \lambda y + 3z = 12,$$

$$100x - 47y + \mu z = 212,$$

has infinitely many solutions, then $\mu - 2\lambda$ **is equal to:**

(1) 56

(2) 59

(3) 55

(4) 57

Section - B

21. Let f **be a differentiable function such that**

$$2(x+2)^2 f(x) - 3(x+2)^2 = 10\int_0^x (t+2)f(t)dt,$$

for $x \geq 0$. **Then** $f(2)$ **is equal to:**

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22. If for some α, β**;** $\alpha \leq \beta$**,** $\alpha + \beta = 8$ **and**

$$\sec^2(\tan^{-1}\alpha) + \csc^2(\cot^{-1}\beta) = 36,$$

then $\alpha^2 + \beta$ **is:**

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23. The number of 3-digit numbers, that are divisible by 2 and 3, but not divisible by 4 and 9, is.

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24. Let A be a 3×3 matrix such that $X^T AX = 0$ for all nonzero 3×1 matrices $X = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$.

$$A = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 4 \\ -5 \end{bmatrix}, A = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \\ -8 \end{bmatrix}$$

If $\det(\text{adj}(2(A+I))) = 2^\alpha 3^\beta 5^\gamma$, $\alpha, \beta, \gamma \in \mathbb{N}$, then $\alpha^2 + \beta^2 + \gamma^2$ is:

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25. Let $S = \{p_1, p_2, \ldots, p_{10}\}$ be the set of the first ten prime numbers. Let $A = S \cup P$, where P is the set of all possible products of distinct elements of S. Then the number of all ordered pairs (x, y), where $x \in S$, $y \in A$, and x divides y, is ____.

Physics

Section - A

26. Consider a parallel plate capacitor of area A (of each plate) and separation d between the plates. If E is the electric field and ϵ_0 is the permittivity of free space between the plates, then the potential energy stored in the capacitor is:

(1) $\frac{1}{2}\epsilon_0 E^2 Ad$

(2) $\frac{3}{4}\epsilon_0 E^2 Ad$

(3) $\frac{1}{4}\epsilon_0 E^2 Ad$

(4) $\epsilon_0 E^2 Ad$

---

27. What is the relative decrease in focal length of a lens for an increase in optical power by 0.1 D from 2.5 D? ('D' stands for dioptre).

(1) 0.04

(2) 0.40

(3) 0.1

(4) 0.01

28. An air bubble of radius 0.1 cm lies at a depth of 20 cm below the free surface of a liquid of density 1000 kg/m^3. If the pressure inside the bubble is 2100 N/m^2 greater than the atmospheric pressure, then the surface tension of the liquid in SI units is (use $g = 10\,\mathbf{m/s^2}$).

(1) 0.02

(2) 0.1

(3) 0.25

(4) 0.05

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29. For an experimental expression $y = \frac{32.3 \times 1125}{27.4}$, where all the digits are significant. Then to report the value of y, we should write:

(1) $y = 1326.2$

(2) $y = 1326.19$

(3) $y = 1326.186$

(4) $y = 1330$

---

30. During the transition of an electron from state A to state C of a Bohr atom, the wavelength of emitted radiation is 2000 Å, and it becomes 6000 Å when the electron jumps from state B to state C. Then the wavelength of the radiation emitted during the transition of electrons from state A to state B is:

(1) 3000 Å

(2) 6000 Å

(3) 4000 Å

(4) 2000 Å

---

31. Consider the following statements:

A. The junction area of a solar cell is made very narrow compared to a photodiode.

B. Solar cells are not connected with any external bias.

C. LED is made of lightly doped p-n junction.

D. Increase of forward current results in a continuous increase in LED light intensity.

E. LEDs have to be connected in forward bias for emission of light.

(1) B, D, E Only

(2) A, C Only

(3) A, C, E Only

(4) B, E Only

---

32. The amount of work done to break a big water drop of radius R into 27 small drops of equal radius is 10 J. The work done required to break the same big drop into 64 small drops of equal radius will be:

(1) 15 J

(2) 10 J

(3) 20 J

(4) 5 J

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33. An object of mass m is projected from the origin in a vertical xy-plane at an angle 45° with the x-axis with an initial velocity v_0. The magnitude and direction of the angular momentum of the object with respect to the origin, when it reaches the maximum height, will be:

(1) $\frac{mv_0^3}{2\sqrt{2}g}$ along negative z-axis

(2) $\frac{mv_0^3}{2\sqrt{2}g}$ along positive z-axis

(3) $\frac{mv_0^3}{4\sqrt{2}g}$ along positive z-axis

(4) $\frac{mv_0^3}{4\sqrt{2}g}$ along negative z-axis

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34. The Young's double slit interference experiment is performed using light consisting of 480 nm and 600 nm wavelengths to form interference patterns. The least number of the bright fringes of 480 nm light that are required for the first coincidence with the bright fringes formed by 600 nm light is:

(1) 4

(2) 8

(3) 6

(4) 5

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35. A car of mass m moves on a banked road having radius r and banking angle θ. To avoid slipping from the banked road, the maximum permissible speed of the car is v_0. The coefficient of friction μ between the wheels of the car and the banked road is:

(1) $\mu = \frac{v_0^2 + rg\tan\theta}{rg - v_0^2\tan\theta}$

(2) $\mu = \frac{v_0^2 + rg\tan\theta}{rg + v_0^2\tan\theta}$

(3) $\mu = \frac{v_0^2 - rg\tan\theta}{rg + v_0^2\tan\theta}$

(4) $\mu = \frac{v_0^2 - rg\tan\theta}{rg - v_0^2\tan\theta}$

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36. A uniform solid cylinder of mass m and radius r rolls along an inclined rough plane of inclination 45°. If it starts to roll from rest from the top of the plane, then the linear acceleration of the cylinder axis will be:

(1) $\frac{1}{\sqrt{2}}g$

(2) $\frac{1}{3\sqrt{2}}g$

(3) $\frac{\sqrt{2}g}{3}$

(4) $\sqrt{2}g$

---

37. A thin plano-convex lens made of glass of refractive index 1.5 is immersed in a liquid of refractive index 1.2. When the plane side of the lens is silver coated for complete reflection, the lens immersed in the liquid behaves like a concave mirror of focal length 0.2 m. The radius of curvature of the curved surface of the lens is:

(1) 0.15 m

(2) 0.10 m

(3) 0.20 m

(4) 0.25 m

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38. A particle is executing simple harmonic motion with a time period of 2 s and amplitude 1 cm. If D and d are the total distance and displacement covered by the particle in 12.5 s, then the ratio $\frac{D}{d}$ is:

(1) $\frac{15}{4}$

(2) 25

(3) 10

(4) $\frac{16}{5}$

---

39. A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius $1.03R$. The time period of revolution of the second satellite is larger than the first one approximately by:

(1) 3 %

(2) 4.5 %

(3) 9 %

(4) 2.5 %

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40. A plano-convex lens having radius of curvature of first surface 2 cm exhibits focal length of f_1 in air. Another plano-convex lens with first surface radius of curvature 3 cm has focal length of f_2 when it is immersed in a liquid of refractive index 1.2. If both the lenses are made of the same glass of refractive index 1.5, the ratio of f_1 and f_2 will be:

(1) $3 : 5$

(2) $1 : 3$

(3) $1 : 2$

(4) $2 : 3$

---

41. An alternating current is given by

$$I = I_A \sin \omega t + I_B \cos \omega t.$$

The r.m.s. current will be:

(1) $\sqrt{I_A^2 + I_B^2}$

(2) $\frac{\sqrt{I_A^2+I_B^2}}{2}$

(3) $\sqrt{\frac{I_A^2+I_B^2}{2}}$

(4) $\frac{|I_A+I_B|}{\sqrt{2}}$

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42. An electron of mass m with an initial velocity $\vec{v} = v_0\hat{i}(v_0 > 0)$ enters an electric field $\vec{E} = -E_0\hat{k}$. If the initial de Broglie wavelength is λ_0, the value after time t would be:

(1) $\lambda_0 \sqrt{\frac{1}{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

(2) $\lambda_0 \sqrt{\frac{1}{1-\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

(3) λ_0

(4) $\lambda_0 \left(1 + \frac{e^2E_0^2t^2}{m^2v_0^2}\right)$

---

43. A parallel plate capacitor was made with two rectangular plates, each with a length of $l = 3$ cm and breadth of $b = 1$ cm. The distance between the plates is $d = 3\,\mu$m. Out of the following, which are the ways to increase the capacitance by a factor of 10?

A. $l = 30$ cm, $b = 1$ cm, $d = 1\,\mu$m

B. $l = 3$ cm, $b = 1$ cm, $d = 30\,\mu$m

C. $l = 6$ cm, $b = 5$ cm, $d = 3\,\mu$m

D. $l = 1$ cm, $b = 1$ cm, $d = 10\,\mu$m

E. $l = 5$ cm, $b = 2$ cm, $d = 1\,\mu$m

(1) C and E only

(2) B and D only

(3) A only

(4) C only

---

44. A force $F = \alpha + \beta x^2$ acts on an object in the x-direction. The work done by the force is 5 J when the object is displaced by 1 m. If the constant $\alpha = 1$ N, then β will be:

(1) 15 N/m²

(2) 10 N/m²

(3) 12 N/m²

(4) 8 N/m²

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45. An ideal gas goes from an initial state to final state. During the process, the pressure of the gas increases linearly with temperature.

A. The work done by gas during the process is zero.

B. The heat added to the gas is different from the change in its internal energy.

C. The volume of the gas is increased.

D. The internal energy of the gas is increased.

E. The process is isochoric (constant volume process).

Choose the correct answer from the options given below:

(1) A, B, C, D Only

(2) A, D, E Only

(3) E Only

(4) A, C Only

Section - B

46. A square loop of sides $a = 1$ m is held normally in front of a point charge $q = 1$ C. The flux of the electric field through the shaded region is $\frac{5}{p} \times \frac{1}{\varepsilon_0}$ Nm^2/C, where the value of p is:

(1) 15 N/m²

(2) 10 N/m²

(3) 12 N/m²

(4) 8 N/m²

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47. The least count of a screw gauge is 0.01 mm. If the pitch is increased by 75% and the number of divisions on the circular scale is reduced by 50%, the new least count will be:

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48. A wire of resistance $9\,\Omega$ is bent to form an equilateral triangle. Then the equivalent resistance across any two vertices will be:

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49. A current of 5A exists in a square loop of side $\frac{1}{\sqrt{2}}$ m. Then the magnitude of the magnetic field B at the centre of the square loop will be $p \times 10^{-6}$ T. Where, value of p is:

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50. The temperature of 1 mole of an ideal monoatomic gas is increased by 50°C at constant pressure. The total heat added and change in internal energy are E_1 and E_2, respectively. If $\frac{E_1}{E_2} = \frac{x}{9}$, then the value of x is:

Section - Chemistry

Section - A

51. For the given cell:

$$\text{Fe}^{2+}(aq) + \text{Ag}^{+}(aq) \rightarrow \text{Fe}^{3+}(aq) + \text{Ag}(s)$$

The standard cell potential of the above reaction is given. The standard reduction potentials are given as:

$$\text{Ag}^{+} + e^{-} \rightarrow \text{Ag} \quad E^{\circ} = x\,\text{V}$$

$$\text{Fe}^{2+} + 2e^{-} \rightarrow \text{Fe} \quad E^{\circ} = y\,\text{V}$$

$$\text{Fe}^{3+} + 3e^{-} \rightarrow \text{Fe} \quad E^{\circ} = z\,\text{V}$$

The correct answer is:

(1) $x + y - z$

(2) $x + 2y - 3z$

(3) $y - 2x$

(4) $x + 2y$

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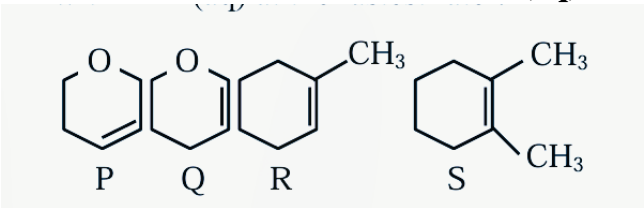
52. Following are the four molecules "P", "Q", "R" and "S". Which one among the four molecules will react with H-Br(aq) at the fastest rate?



Molecules:

P : Cyclic compound with two *O* groups attached to the ring.

Q : Cyclic compound with one *O* group and one *CH3* group attached to the ring.

R : Cyclic compound with one *O* group attached to the ring and one *CH3* group attached to the ring.

S : Cyclic compound with one *CH3* group attached to the ring.

(1) S

(2) Q

(3) R

(4) P

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53. One mole of the octahedral complex compound $Co(NH_3)_5Cl_3$ gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with excess of $AgNO_3$ solution to yield two moles of $AgCl(s)$. The structure of the complex is:

(1) $[Co(NH_3)_5Cl]Cl_2$

(2) $[Co(NH_3)_4Cl] \cdot Cl_2NH_3$

(3) $[Co(NH_3)_4Cl_2]Cl \cdot NH_3$

(4) $[Co(NH_3)_3Cl] \cdot Cl_3 \cdot 2NH_3$

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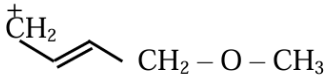
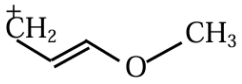
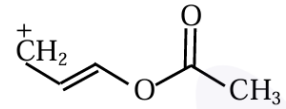
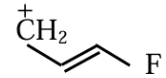
54. Which one of the carbocations from the following is most stable?

(1) 

(2) 

(3) 

(4) 

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55. Which of the following linear combinations of atomic orbitals will lead to the formation of molecular orbitals in homonuclear diatomic molecules (internuclear axis in z-direction)?

(1) $2p_z$ and $2p_x$

(2) $2s$ and $2p_x$

(3) $3d_{xy}$ and $3d_{x^2-y^2}$

(4) $2s$ and $2p_z$

(5) $2p_z$ and $3d_{x^2-y^2}$

(1) E only

(2) A and B only

(3) D only

(4) C and D only

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56. Which of the following ions is the strongest oxidizing agent? (Atomic Number of Ce = 58, Eu = 63, Tb = 65, Lu = 71)

(1) Lu^{3+}

(2) Eu^{2+}

(3) Tb^{4+}

(4) Ce^{3+}

---

57. Ksp for $Cr(OH)_3$ is 1.6×10^{-30}. What is the molar solubility of this salt in water?

(1) $s = \sqrt[4]{\frac{1.6\times10^{-30}}{27}}$

(2) $\frac{1.8\times10^{-30}}{27}$

(3) $\sqrt[5]{1.8 \times 10^{-30}}$

(4) $\frac{2\sqrt{1.6\times10^{-30}}}{27}$

---

58. Let us consider an endothermic reaction which is non-spontaneous at the freezing point of water. However, the reaction is spontaneous at the boiling point of water. Choose the correct option.

(1) Both ΔH and ΔS are (+ve)

(2) ΔH is (-ve) but ΔS is (+ve)

(3) ΔH is (+ve) but ΔS is (-ve)

(4) Both ΔH and ΔS are (-ve)

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59. Given below are two statements I and II.

Statement I: Dumas method is used for estimation of "Nitrogen" in an organic compound.

Statement II: Dumas method involves the formation of ammonium sulfate by heating the organic compound with concentrated H_2SO_4.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are true

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are false

(4) Statement I is true but Statement II is false

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60. Which of the following Statements are NOT true about the periodic table?

A. The properties of elements are a function of atomic weights.

B. The properties of elements are a function of atomic numbers.

C. Elements having similar outer electronic configuration are arranged in the same period.

D. An element's location reflects the quantum numbers of the last filled orbital.

E. The number of elements in a period is the same as the number of atomic orbitals available in the energy level that is being filled.

(1) A, C, and E Only

(2) D and E Only

(3) A and E Only

(4) B, C, and E Only

---

61. The carbohydrates "Ribose" present in DNA is A. A pentose sugar B. Present in pyranose form C. In "D" configuration D. A reducing sugar, when free E. In α-anomeric form

(1) A, C and D Only

(2) A, B and E Only

(3) B, D and E Only

(4) A, D and E Only

---

62. Preparation of potassium permanganate from MnO_2 involves two-step process in which the 1st step is a reaction with KOH and KNO_3 to produce:

(1) $K_4[Mn(OH)_6]$

(2) K_3MnO_4

(3) $KMnO_4$

(4) K_2MnO_4

---

63. The large difference between the melting and boiling points of oxygen and sulphur may be explained on the basis of

(1) Atomic size

(2) Atomicity

(3) Electronegativity

(4) Electron gain enthalpy

---

64. For a reaction,

$$N_2O_5(g) \rightarrow 2NO_2(g) + \frac{1}{2}O_2(g)$$

in a constant volume container, no products were present initially. The final pressure of the system when

(1) $\frac{7}{2}$ times of initial pressure

(2) 5 times of initial pressure

(3) $\frac{5}{2}$ times of initial pressure

(4) $\frac{7}{4}$ times of initial pressure

---

65. Which of the following arrangements with respect to their reactivity in nucleophilic addition reaction is correct?

(1) benzaldehyde < acetophenone < p-nitrobenzaldehyde < p-tolualdehyde

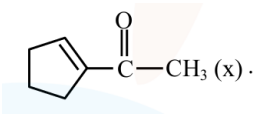
(2) acetophenone < benzaldehyde < p-tolualdehyde < p-nitrobenzaldehyde

(3) acetophenone < p-tolualdehyde < benzaldehyde < p-nitrobenzaldehyde

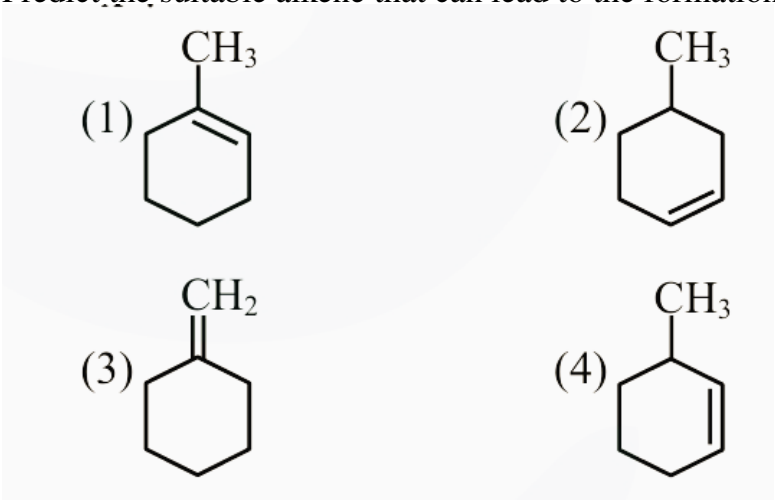
(4) p-nitrobenzaldehyde < benzaldehyde < p-tolualdehyde < acetophenone

---

66. Aman has been asked to synthesise the molecule:



using an aldol condensation reaction. He found a few cyclic alkenes in his laboratory. He thought of performing ozonolysis reaction on alkene to produce a dicarbonyl compound followed by aldol reaction to prepare ”x”. Predict the suitable alkene that can lead to the formation of ”x”.



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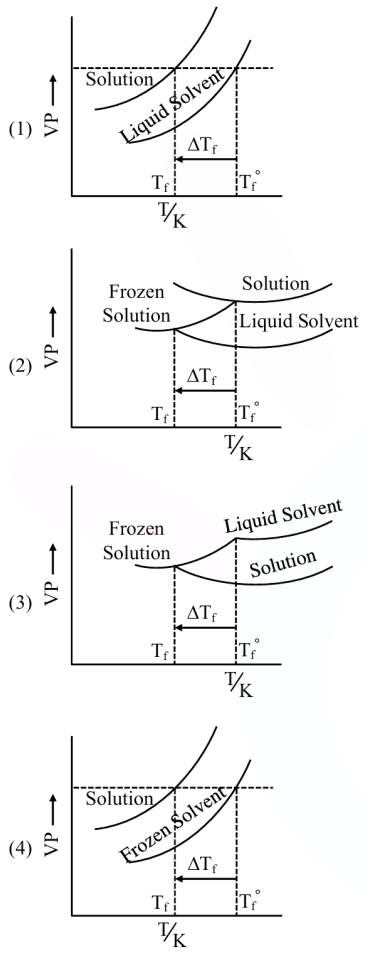
67. Consider the given plots of vapor pressure (VP) vs temperature (T/K). Which amongst the following options is the correct graphical representation showing ΔT_f depression in the freezing point of solvent in a solution?



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68. Which of the following statement is true with respect to H_2O, NH_3 and CH_4?

(A) The central atoms of all the molecules are sp^3 hybridized.

(B) The H–O–H, H–N–H and H–C–H angles in the above molecules are 104.5°, 107.5° and 109.5° respectively.

(C) The increasing order of dipole moment is CH_4 ¡ NH_3 ¡ H_2O.

(D) Both H_2O and NH_3 are Lewis acids and CH_4 is a Lewis base.

(E) A solution of NH_3 in H_2O is basic. In this solution NH_3 and H_2O act as Lowry-Bronsted acid and base respectively.

(1) A, B, and C only

(2) C, D, and E only

(3) A, D, and E only

(4) A, B, C, and E only

---

69. Given below are two statements:

Statement I: The conversion proceeds well in a less polar medium.

$$CH_3CH_2CH_2CH_2Cl \xrightarrow{HO^-} CH_3CH_2CH_2CH_2OH + Cl^-$$

Statement II: The conversion proceeds well in a more polar medium.

$$CH_3CH_2CH_2CH_2Cl \xrightarrow{R_3N} CH_3CH_2CH_2CH_2NH_2 + Cl^-$$

In the light of the above statements, choose the correct answer from the options given below:

(1) Both statement I and statement II are true

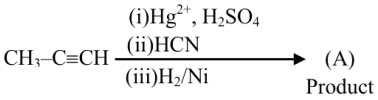
(2) Both statement I and statement II are false

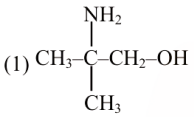
(3) Statement I is false but statement II is true

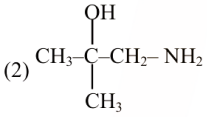
(4) Statement I is true but statement II is false

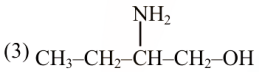
---

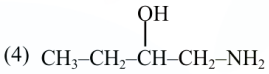
70. The product (A) formed in the following reaction sequence is:



(1) 

(2) 

(3) 

(4) 

Section - B

71. 37.8 g $N_2O_5$was taken in a 1 L reaction vessel and allowed to undergo the following reaction at 500 K:

$$2N_2O_5(g) \rightarrow 2N_2O_4(g) + O_2(g)$$

The total pressure at equilibrium was found to be 18.65 bar. Then, K_p is:

Given:

$$R = 0.082 \,\text{bar L mol}^{-1}\text{K}^{-1}$$

---

72. Standard entropies of X_2, Y_2 and XY_5 are 70, 50, and 110 J K^{-1} mol^{-1} respectively. The temperature in Kelvin at which the reaction

$$\frac{1}{2}X_2 + \frac{5}{2}Y_2 \rightarrow XY_5 \quad \Delta H = -35\,\text{kJ mol}^{-1}$$

will be at equilibrium is (nearest integer):

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73. X g of benzoic acid on reaction with aqueous $NaHCO_3$ release CO_2 that occupied 11.2 L volume at STP. X is ____ g.

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74. Among the following cations, the number of cations which will give characteristic precipitate in their identification tests with K_4[Fe(CN)$_6$] is :

Cu^{2+}, Fe^{3+}, Ba^{2+}, Ca^{2+}, NH_4^+, Mg^{2+}, Zn^{2+}
