

JEE Main 2024 Paper 1 (B.E./B.Tech) 8 April 2024 Shift 1 Question Paper



Conducted by the National Testing Agency (NTA)

Time Allowed: 3 Hours

Paper 1: B.E./B.Tech.

Maximum Marks: 300

General Instructions

- (i) This paper is **Paper 1 (B.E./B.Tech.)** of **JEE (Main) 2024 - Session 2**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 8 April 2024, Shift 1. The total duration is **3 hours**.
- (ii) The paper has **90 questions**, of which **75 are to be attempted**, and a maximum of **300 marks**: Mathematics, Physics and Chemistry carry 30 questions (100 marks) each, in that order.
- (iii) Each subject has **two sections**. **Section A** has **20 multiple choice questions** (MCQs) with four options each. Select the most appropriate answer. **Section B** has **10 numerical value questions**; attempt **any 5** of them.
- (iv) **All Section A questions are compulsory**. Attempt only the specified number of Section B questions. For Section B, the answer is an integer value; the answer should be **rounded off to the nearest integer**. Use only the constants given in the question while calculating.
- (v) **Marking scheme** (Sections A and B): **+4** for a correct answer, **-1** for an incorrect answer, and **0** for an unanswered or marked-for-review question.
- (vi) All calculations and rough work are to be done on the rough sheets only. Calculators, log tables, slide rules and electronic gadgets are not allowed.

1. Let

$$A = \begin{bmatrix} 2 & a & 0 \\ 1 & 3 & 1 \\ 0 & 5 & b \end{bmatrix}$$

. If $A^3 = 4A^2 - A - 21I$, where I is the identity matrix of order 3×3 , then $2a + 3b$ is equal to

- (A) -10
(B) -12
(C) -13
(D) -9

2. The value of $k \in \mathbb{N}$ for which the integral

$$I_n = \int_0^1 (1 - x^k)^n dx, n \in \mathbb{N}$$

, satisfies

$$147I_{20} = 148I_{21}$$

is

- (A) 8 (B) 14
(C) 7 (D) 10

3. Let

$$f(x) = 4\cos^3 x + 3\sqrt{3}\cos^2 x - 10$$

. The number of points of local maxima of f in interval $(0, 2\pi)$ is

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

4. The set of all α , for which the vectors

$$\vec{a} = \alpha\hat{i} + 6\hat{j} - 3\hat{k}$$

and

$$\vec{b} = t\hat{i} - 2\hat{j} - 2\alpha t\hat{k}$$

are inclined at an obtuse angle for all $t \in \mathbb{R}$, is

- (A) $[0, 1)$
(B) $\left(-\frac{4}{3}, 0\right]$
(C) $(-2, 0]$
(D) $\left(-\frac{4}{3}, 1\right)$

5. Let the circles

$$C_1 : (x - \alpha)^2 + (y - \beta)^2 = r_1^2$$

and

$$C_2 : (x - 8)^2 + \left(y - \frac{15}{2}\right)^2 = r_2^2$$

touch each other externally at the point $(6, 6)$. If the point $(6, 6)$ divides the line segment joining the centres of the circles C_1 and C_2 internally in the ratio $2 : 1$, then $(\alpha + \beta) + 4(r_1^2 + r_2^2)$ equals

- (A) 130 (B) 110
(C) 145 (D) 125

6. Let $f(x)$ be a positive function such that the area bounded by

$$y = f(x), y = 0$$

from $x = 0$ to $x = a > 0$ is $e^{-a} + 4a^2 + a - 1$. Then the differential equation, whose general solution is

$$y = c_1 f(x) + c_2$$

, where c_1 and c_2 are arbitrary constants, is

- (A) $(8e^x + 1) \frac{d^2 y}{dx^2} - \frac{dy}{dx} = 0$
(B) $(8e^x + 1) \frac{d^2 y}{dx^2} + \frac{dy}{dx} = 0$
(C) $(8e^x - 1) \frac{d^2 y}{dx^2} - \frac{dy}{dx} = 0$
(D) $(8e^x - 1) \frac{d^2 y}{dx^2} + \frac{dy}{dx} = 0$

7. Let

$$H : \frac{-x^2}{a^2} + \frac{y^2}{b^2} = 1$$

be the hyperbola, whose eccentricity is $\sqrt{3}$ and the length of the latus rectum is $4\sqrt{3}$. Suppose the point

$$(\alpha, 6), \alpha > 0$$

lies on H . If β is the product of the focal distances of the point $(\alpha, 6)$, then $\alpha^2 + \beta$ is equal to

- (A) 170 (B) 171
(C) 169 (D) 172

8. The number of critical points of the function
 $f(x) = (x - 2)^{2/3}(2x + 1)$
 is

- (A) 2 (B) 1
 (C) 0 (D) 3

9. Let

$y = y(x)$
 be the solution of the differential equation
 $(1 + y^2)e^{\tan x} dx + \cos^2 x(1 + e^{2 \tan x}) dy = 0,$
 $y(0) = 1$

. Then

$$y\left(\frac{\pi}{4}\right)$$

is equal to

- (A) $\frac{1}{e^2}$
 (B) $\frac{2}{e^2}$
 (C) $\frac{2}{e}$
 (D) $\frac{1}{e}$

10. Let the sum of two positive integers be 24. If the probability, that their product is not less than $\frac{3}{4}$ times their greatest possible product, is $\frac{m}{n}$, where

$$\gcd(m, n) = 1$$

, then $n-m$ equals

- (A) 10 (B) 11
 (C) 9 (D) 8

11. For the function

$$f(x) = (\cos x) - x + 1, x \in \mathbb{R}$$

, between the following two statements
 (S1)

$$f(x) = 0$$

for only one value of x in $[0, \pi]$.

(S2) $f(x)$ is decreasing in

$$\left[0, \frac{\pi}{2}\right]$$

and increasing in

$$\left[\frac{\pi}{2}, \pi\right]$$

.

- (A) Both (S1) and (S2) are incorrect. (B) Only (S1) is correct.
 (C) Only (S2) is correct. (D) Both (S1) and (S2) are correct.

12. Let $P(x, y, z)$ be a point in the first octant, whose projection in the xy -plane is the point Q . Let

$$OP = \gamma$$

; the angle between OQ and the positive x -axis be θ ; and the angle between OP and the positive z -axis be ϕ , where O is the origin. Then the distance of P from the x -axis is

- (A) $\gamma \sqrt{1 - \sin^2 \phi \cos^2 \theta}$
 (B) $\gamma \sqrt{1 + \cos^2 \theta \sin^2 \phi}$
 (C) $\gamma \sqrt{1 + \cos^2 \phi \sin^2 \theta}$
 (D) $\gamma \sqrt{1 - \sin^2 \theta \cos^2 \phi}$

13. Let z be a complex number such that

$$|z + 2| = 1$$

and

$$\operatorname{Im}\left(\frac{z+1}{z+2}\right) = \frac{1}{5}$$

. Then the value of $|\operatorname{Re}(\overline{z+2})|$ is

- (A) $\frac{2\sqrt{6}}{5}$
 (B) $\frac{24}{5}$
 (C) $\frac{\sqrt{6}}{5}$
 (D) $\frac{1 + \sqrt{6}}{5}$

14. The sum of all the solutions of the equation

$$(8)^{2x} - 16 \cdot (8)^x + 48 = 0$$

is :

- (A) $1 + \log_8(6)$
 (B) $1 + \log_6(8)$
 (C) $\log_8(6)$
 (D) $\log_8(4)$

15. The equations of two sides AB and AC of a triangle ABC are $4x + y = 14$ and $3x - 2y = 5$, respectively. The point

$$\left(2, -\frac{4}{3}\right)$$

divides the third side BC internally in the ratio $2 : 1$, the equation of the side BC is

- (A) $x + 6y + 6 = 0$
 (B) $x - 3y - 6 = 0$
 (C) $x + 3y + 2 = 0$
 (D) $x - 6y - 10 = 0$

16. If

$$\sin x = -\frac{3}{5}$$

, where

$$\pi < x < \frac{3\pi}{2}$$

, then $80(\tan^2 x - \cos x)$ is equal to

- (A) 109 (B) 108
 (C) 19 (D) 18

17. Let $[t]$ be the greatest integer less than or equal to t . Let A be the set of all prime factors of 2310 and $f : A \rightarrow \mathbb{Z}$ be the function

$$f(x) = \left[\log_2 \left(x^2 + \left\lceil \frac{x^3}{5} \right\rceil \right) \right]$$

. The number of one-to-one functions from A to the range of f is

- (A) 20 (B) 120
 (C) 25 (D) 24

18. If the set

$R = \{(a, b) : a + 5b = 42, a, b \in \mathbb{N}\}$ has m elements and

$$\sum_{n=1}^m (1 - i^{n!}) = x + iy$$

, where

$$i = \sqrt{-1}$$

, then the value of $m + x + y$ is

- (A) 12 (B) 4
 (C) 8 (D) 5

19. If the shortest distance between the lines

$$L_1 : \vec{r} = (2 + \lambda)\hat{i} + (1 - 3\lambda)\hat{j} + (3 + 4\lambda)\hat{k}, \quad \lambda \in \mathbb{R}$$

$$L_2 : \vec{r} = 2(1 + \mu)\hat{i} + 3(1 + \mu)\hat{j} + (5 + \mu)\hat{k}, \quad \mu \in \mathbb{R}$$

is

$$\frac{m}{\sqrt{n}}$$

, where

$$\gcd(m, n) = 1$$

, then the value of $m + n$ equals

- (A) 384 (B) 387
 (C) 390 (D) 377

20. Let

$$I(x) = \int \frac{6}{\sin^2 x (1 - \cot x)^2} dx$$

. If

$$I(0) = 3$$

, then

$$I\left(\frac{\pi}{12}\right)$$

is equal to

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

21. If the orthocentre of the triangle formed by the lines

$$2x + 3y - 1 = 0, x + 2y - 1 = 0$$

and $ax + by - 1 = 0$, is the centroid of another triangle, whose circumcentre and orthocentre respectively are $(3, 4)$ and $(-6, -8)$, then the value of $|a - b|$ is _____.

22. If the range of

$$f(\theta) = \frac{\sin^4 \theta + 3 \cos^2 \theta}{\sin^4 \theta + \cos^2 \theta}, \theta \in \mathbb{R}$$

is $[\alpha, \beta]$, then the sum of the infinite G.P., whose first term is 64 and the common ratio is $\frac{\alpha}{\beta}$, is equal to _____.

23. Let

$$\vec{a} = 9\hat{i} - 13\hat{j} + 25\hat{k}, \vec{b} = 3\hat{i} + 7\hat{j} - 13\hat{k}$$

and

$$\vec{c} = 17\hat{i} - 2\hat{j} + \hat{k}$$

be three given vectors. If $\vec{r}$ is a vector such that

$$\vec{r} \times \vec{a} = (\vec{b} + \vec{c}) \times \vec{a}$$

and

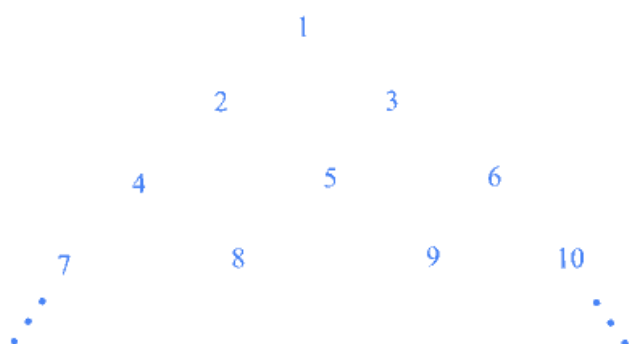
$$\vec{r} \cdot (\vec{b} - \vec{c}) = 0$$

, then

$$\frac{|593\vec{r} + 67\vec{a}|^2}{(593)^2}$$

is equal to _____.

24. Let the positive integers be written in the form :



If the k^{th} row contains exactly k numbers for every natural number k , then the row in which the number 5310 will be, is _____.

25. The number of 3-digit numbers, formed using the digits 2, 3, 4, 5 and 7, when the repetition of digits is not allowed, and which are not divisible by 3, is equal to _____.

26. Three balls are drawn at random from a bag containing 5 blue and 4 yellow balls. Let the random variables X and Y respectively denote the number of blue and yellow balls. If $\bar{X}$ and $\bar{Y}$ are the means of X and Y respectively, then $7\bar{X} + 4\bar{Y}$ is equal to _____.

27. Let

$$\alpha = \sum_{r=0}^n (4r^2 + 2r + 1)^n C_r$$

and

$$\beta = \left(\sum_{r=0}^n \frac{n C_r}{r+1} \right) + \frac{1}{n+1}$$

. If

$$140 < \frac{2\alpha}{\beta} < 281$$

, then the value of n is _____.

28. Let

$$A = \begin{bmatrix} 2 & -1 \\ 1 & 1 \end{bmatrix}$$

. If the sum of the diagonal elements of A^{13} is 3^n , then n is equal to _____.

29. Let the area of the region enclosed by the curve

$$y = \min\{\sin x, \cos x\}$$

and the x axis between $x = -\pi$ to $x = \pi$ be A . Then A^2 is equal to _____.

30. The value of

$$\lim_{x \rightarrow 0} 2 \left(\frac{1 - \cos x \sqrt{\cos 2x} \sqrt[3]{\cos 3x} \dots \sqrt[10]{\cos 10x}}{x^2} \right)$$

is _____.

Physics - Section A · Multiple Choice Questions

31. A stationary particle breaks into two parts of masses m_A and m_B which move with velocities v_A and v_B respectively. The ratio of their kinetic energies ($K_B : K_A$) is :

- (A) $v_B : v_A$
 (B) $1 : 1$
 (C) $m_B v_B : m_A v_A$
 (D) $m_B : m_A$

32. Two charged conducting spheres of radii a and b are connected to each other by a conducting wire. The ratio of charges of the two spheres respectively is:

- (A) ab
 (B) $\frac{b}{a}$
 (C) $\frac{a}{b}$
 (D) $\sqrt{ab}$

33. Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii respectively. If angular momentum of A is L and that of B is $3L$, the ratio of time period

$$\left(\frac{T_A}{T_B} \right)$$

is:

- (A) $\left(\frac{r_2}{r_1} \right)^{\frac{3}{2}}$
 (B) $27 \left(\frac{m_1}{m_2} \right)^3$
 (C) $\left(\frac{r_1}{r_2} \right)^3$
 (D) $\frac{1}{27} \left(\frac{m_2}{m_1} \right)^3$

34. Average force exerted on a non-reflecting surface at normal incidence is 2.4×10^{-4} N. If 360 W/cm^2 is the light energy flux during span of 1 hour 30 minutes, Then the area of the surface is:

- (A) 20 m^2
 (B) 0.2 m^2
 (C) 0.1 m^2
 (D) 0.02 m^2

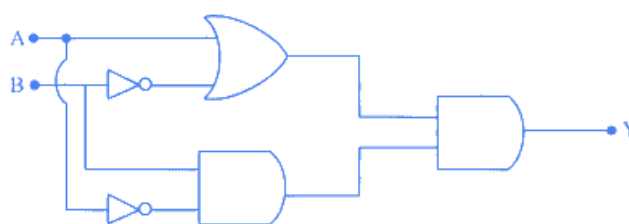
35. In an expression $a \times 10^b$:

- (A) a is order of magnitude for $b \leq 5$
 (B) b is order of magnitude for $a \leq 5$
 (C) b is order of magnitude for $a \geq 5$
 (D) b is order of magnitude for $5 < a \leq 10$

36. A clock has 75 cm, 60 cm long second hand and minute hand respectively. In 30 minutes duration the tip of second hand will travel x distance more than the tip of minute hand. The value of x in meter is nearly (Take $\pi = 3.14$) :

- (A) 118.9
 (B) 140.5
 (C) 139.4
 (D) 220.0

37. The output Y of following circuit for given inputs is :



- (A) $A \cdot B$
 (B) $\bar{A} \cdot B$
 (C) $A \cdot B(A + B)$
 (D) 0

38. A player caught a cricket ball of mass 150 g moving at a speed of 20 m/s. If the catching process is completed in 0.1 s, the magnitude of force exerted by the ball on the hand of the player is:

- (A) 150 N (B) 3 N
(C) 30 N (D) 300 N

39. Three bodies A, B and C have equal kinetic energies and their masses are 400 g, 1.2 kg and 1.6 kg respectively. The ratio of their linear momenta is :

- (A) $1 : \sqrt{3} : 2$
(B) $\sqrt{3} : \sqrt{2} : 1$
(C) $1 : \sqrt{3} : \sqrt{2}$
(D) $\sqrt{2} : \sqrt{3} : 1$

40. Young's modulus is determined by the equation given by

$$Y = 49000 \frac{\text{m dyne}}{\text{l cm}^2}$$

where M is the mass and l is the extension of wire used in the experiment. Now error in Young modules (Y) is estimated by taking data from $M - l$ plot in graph paper. The smallest scale divisions are 5 g and 0.02 cm along load axis and extension axis respectively. If the value of M and l are 500 g and 2 cm respectively then percentage error of Y is :

- (A) 2% (B) 0.02%
(C) 0.5% (D) 0.2%

41. Paramagnetic substances:

- A. align themselves along the directions of external magnetic field.
B. attract strongly towards external magnetic field.
C. has susceptibility little more than zero.
D. move from a region of strong magnetic field to weak magnetic field.

Choose the most appropriate answer from the options given below:

- (A) A, B, C Only (B) A, C Only
(C) A, B, C, D (D) B, D Only

42. A mixture of one mole of monoatomic gas and one mole of a diatomic gas (rigid) are kept at room temperature (27°C). The ratio of specific heat of gases at constant volume respectively is:

- (A) $\frac{3}{2}$
(B) $\frac{3}{5}$
(C) $\frac{7}{5}$
(D) $\frac{5}{3}$

43. A LCR circuit is at resonance for a capacitor C, inductance L and resistance R. Now the value of resistance is halved keeping all other parameters same. The current amplitude at resonance will be now:

- (A) halved (B) same
(C) Zero (D) double

44. The diameter of a sphere is measured using a vernier caliper whose 9 divisions of main scale are equal to 10 divisions of vernier scale. The shortest division on the main scale is equal to 1 mm. The main scale reading is 2 cm and second division of vernier scale coincides with a division on main scale. If mass of the sphere is 8.635 g, the density of the sphere is:

- (A) 2.2 g/cm^3
(B) 2.0 g/cm^3
(C) 1.7 g/cm^3
(D) 2.5 g/cm^3

45. Critical angle of incidence for a pair of optical media is 45° . The refractive indices of first and second media are in the ratio:

- (A) 1 : 2
(B) $1 : \sqrt{2}$
(C) 2 : 1
(D) $\sqrt{2} : 1$

46. A proton and an electron are associated with same de-Broglie wavelength. The ratio of their kinetic energies is:

(Assume $h = 6.63$

$$\times 10^{-34} \text{ J s, } m_e = 9.0 \times 10^{-31} \text{ kg}$$

and

$$m_p = 1836$$

times m_e)

- (A) $1 : \frac{1}{1836}$
 (B) $1 : \sqrt{1836}$
 (C) $1 : 1836$
 (D) $1 : \frac{1}{\sqrt{1836}}$

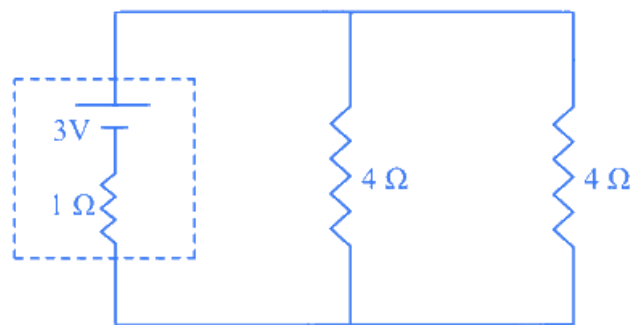
47. Correct Bernoulli's equation is (symbols have their usual meaning) :

- (A) $P + \frac{1}{2}\rho gh + \frac{1}{2}\rho v^2 =$
 constant
 (B) $P + mgh + \frac{1}{2}mv^2 =$
 constant
 (C) $P + \rho gh + \rho v^2 =$
 constant
 (D) $P + \rho gh + \frac{1}{2}\rho v^2 =$
 constant

48. Binding energy of a certain nucleus is $18 \times 10^8 \text{ J}$. How much is the difference between total mass of all the nucleons and nuclear mass of the given nucleus:

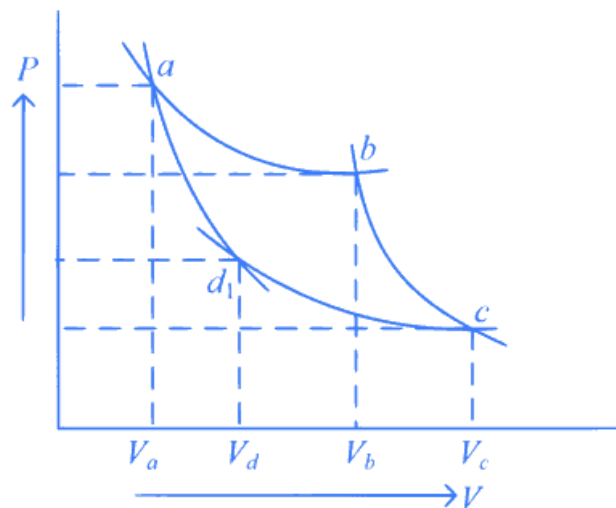
- (A) $20 \mu\text{g}$ (B) $2 \mu\text{g}$
 (C) $10 \mu\text{g}$ (D) $0.2 \mu\text{g}$

49. In the given circuit, the terminal potential difference of the cell is :



- (A) 3 V (B) 4 V
 (C) 2 V (D) 1.5 V

50. Two different adiabatic paths for the same gas intersect two isothermal curves as shown in P-V diagram. The relation between the ratio $\frac{V_b}{V_d}$ and the ratio $\frac{V_a}{V_c}$ is:



- (A) $\frac{V_a}{V_d} \neq \frac{V_b}{V_c}$
 (B) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{-1}$
 (C) $\frac{V_a}{V_d} = \frac{V_b}{V_c}$
 (D) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^2$

51. A closed and an open organ pipe have same lengths. If the ratio of frequencies of their seventh overtones is

$$\left(\frac{a-1}{a}\right)$$

then the value of a is _____.

52. An electric field,

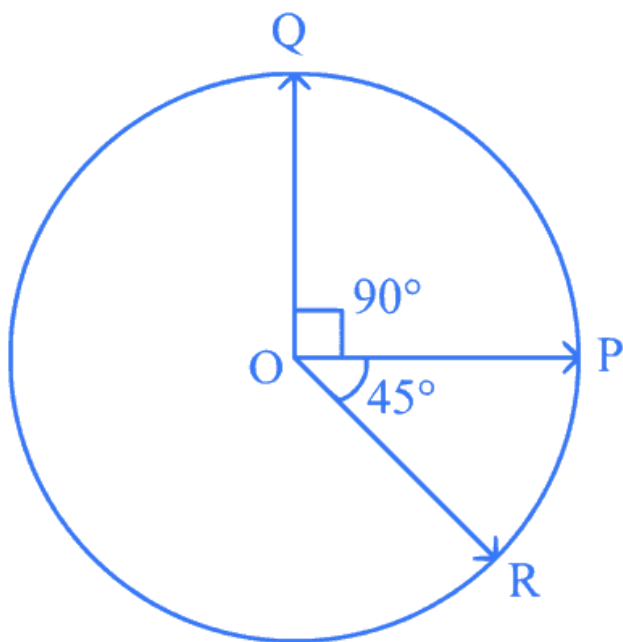
$$\vec{E} = \frac{2\hat{i} + 6\hat{j} + 8\hat{k}}{\sqrt{6}}$$

passes through the surface of 4 m^2 area having unit vector

$$\hat{n} = \left(\frac{2\hat{i} + \hat{j} + \hat{k}}{\sqrt{6}}\right)$$

. The electric flux for that surface is _____ Vm.

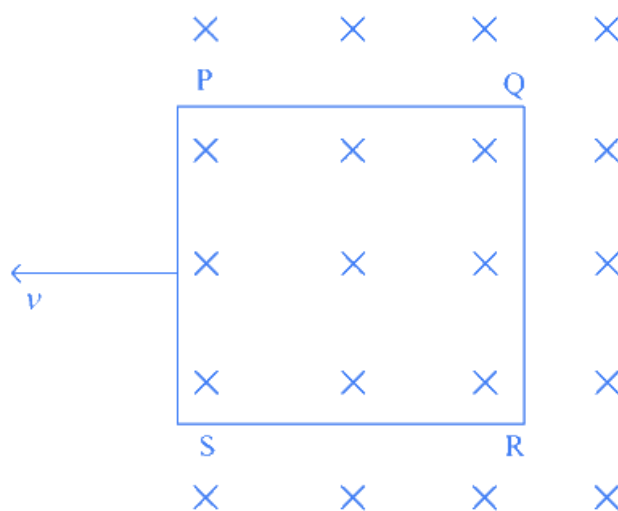
53. Three vectors $\vec{OP}$, $\vec{OQ}$ and $\vec{OR}$ each of magnitude A are acting as shown in figure. The resultant of the three vectors is $A\sqrt{x}$. The value of x is _____.



54. A square loop PQRS having 10 turns, area $3.6 \times 10^{-3} \text{ m}^2$ and resistance 100Ω is slowly and uniformly being pulled out of a uniform magnetic field of magnitude

$$B = 0.5 \text{ T}$$

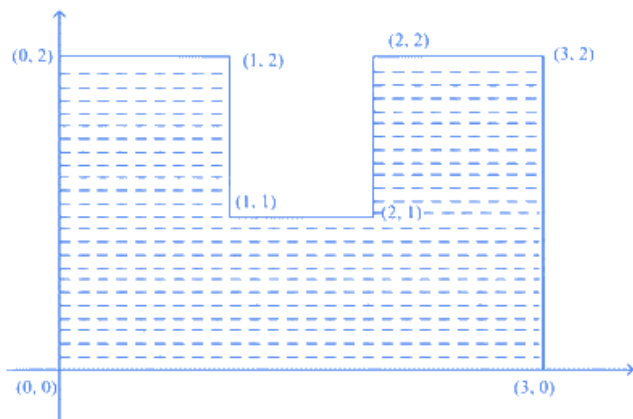
as shown. Work done in pulling the loop out of the field in 1.0 s is _____ $\times 10^{-6} \text{ J}$.



55. A liquid column of height 0.04 cm balances excess pressure of a soap bubble of certain radius. If density of liquid is $8 \times 10^3 \text{ kg m}^{-3}$ and surface tension of soap solution is 0.28 Nm^{-1} , then diameter of the soap bubble is _____ cm. (if $g = 10 \text{ m s}^{-2}$)

)

56. A uniform thin metal plate of mass 10 kg with dimensions is shown. The ratio of x and y coordinates of center of mass of plate in $\frac{n}{9}$. The value of n is _____.



57. Resistance of a wire at 0°C , 100°C and $t^\circ\text{C}$ is found to be 10Ω , 10.2Ω and 10.95Ω respectively. The temperature t in Kelvin scale is _____.

58. A parallel beam of monochromatic light of wavelength 600 nm passes through single slit of 0.4 mm width. Angular divergence corresponding to second order minima would be _____ $\times 10^{-3}$ rad.

59. An electron with kinetic energy 5 eV enters a region of uniform magnetic field of $3\mu\text{T}$ perpendicular to its direction. An electric field E is applied perpendicular to the direction of velocity and magnetic field. The value of E , so that electron moves along the same path, is _____ NC^{-1} .

(Given, mass of electron
 $= 9 \times 10^{-31} \text{ kg}$
 , electric charge
 $= 1.6 \times 10^{-19} \text{ C}$
)

60. In an alpha particle scattering experiment distance of closest approach for the α particle is $4.5 \times 10^{-14} \text{ m}$. If target nucleus has atomic number 80, then maximum velocity of α -particle is _____ $\times 10^5 \text{ m/s}$ approximately.

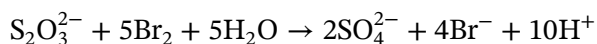
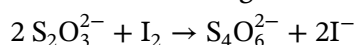
(
 $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ SI}$
 unit, mass of α particle
 $= 6.72 \times 10^{-27} \text{ kg}$
)

61. Combustion of glucose ($C_6H_{12}O_6$) produces CO_2 and water. The amount of oxygen (in g) required for the complete combustion of 900 g of glucose is :

[Molar mass of glucose in $g\ mol^{-1} = 180$]

- (A) 32 (B) 480
(C) 800 (D) 960

62. Thiosulphate reacts differently with iodine and bromine in the reactions given below:



Which of the following statement justifies the above dual behaviour of thiosulphate?

- (A) Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reactions
(B) Bromine is a weaker oxidant than iodine
(C) Bromine is a stronger oxidant than iodine
(D) Bromine undergoes oxidation and iodine undergoes reduction in these reactions

63. Give below are two statements: One is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: The stability order of +1 oxidation state of Ga, In and Tl is $Ga < In < Tl$.

Reason R: The inert pair effect stabilizes the lower oxidation state down the group.

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

- (A) A is true but R is false.
(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 true and R is the correct explanation of A.

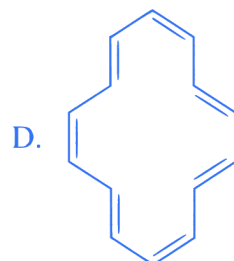
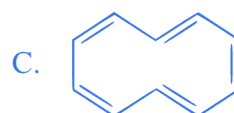
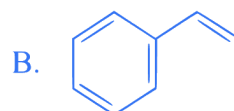
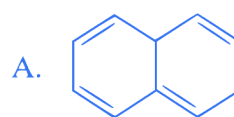
64. Iron (III) catalyses the reaction between iodide and persulphate ions, in which

- A. Fe^{3+} oxidises the iodide ion
B. Fe^{3+} oxidises the persulphate ion
C. Fe^{2+} reduces the iodide ion
D. Fe^{2+} reduces the persulphate ion

Choose the most appropriate answer from the options given below:

- (A) B and C only (B) A only
(C) A and D only (D) B only

65. Which of the following are aromatic?



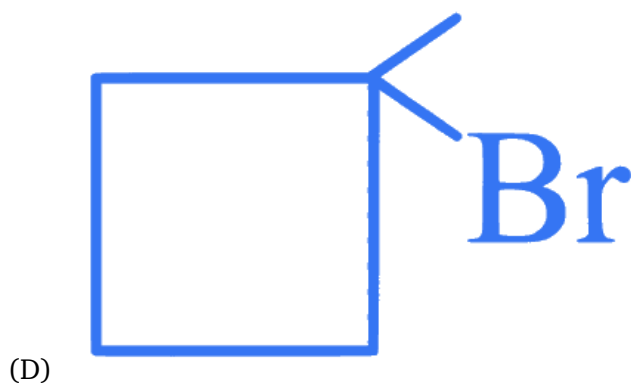
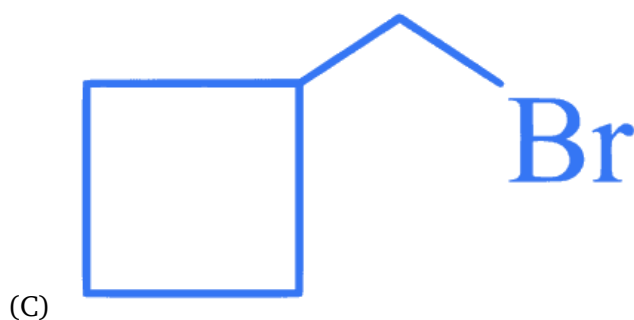
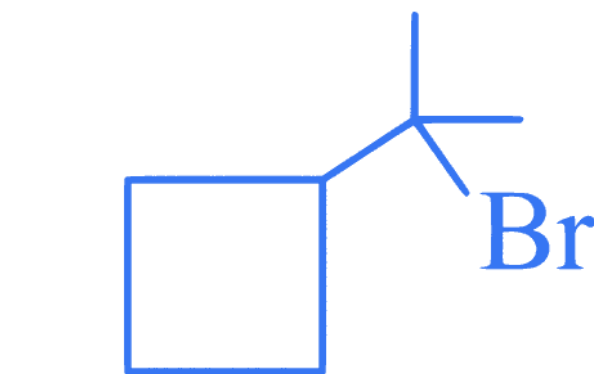
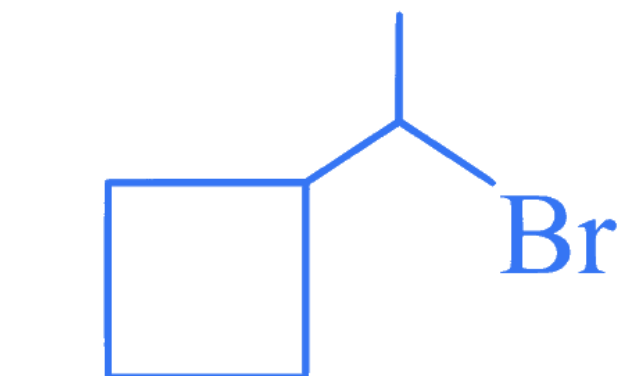
- (A) B and D only (B) A and C only
(C) C and D only (D) A and B only

66. Among the following halogens F_2 , Cl_2 , Br_2 and I_2

Which can undergo disproportionation reactions?

- (A) F_2 and Cl_2 (B) Cl_2 , Br_2 and I_2
(C) Only I_2 (D) F_2 , Cl_2 and Br_2

67. Which among the following compounds will undergo fastest S_N2 reaction.



68. Match List I with List II

	LIST I (Molecule)		LIST II (Shape)
A.	NH_3	I.	Square pyramid
B.	BrF_5	II.	Tetrahedral
C.	PCl_5	III.	Trigonal pyramidal
D.	CH_4	IV.	Trigonal bipyramidal

Choose the correct answer from the options given below:

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

69. Match List I with List II

	LIST I (Elements)		LIST II (Properties in their respective groups)
A.	Cl, S	I.	Elements with highest electronegativity
B.	Ge, As	II.	Elements with largest atomic size
C.	Fr, Ra	III.	Elements which show properties of both metals and non-metal
D.	F, O	IV.	Elements with highest negative electron gain enthalpy

Choose the correct answer from the options given below:

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

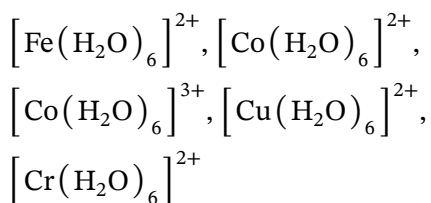
70. Match List I with List II

	LIST I (Name of the test)		LIST II (Reaction sequence involved) [M is metal]
A.	Borax bead test	I.	$\begin{array}{c} \text{MCO}_3 \rightarrow \text{MO} \\ \text{Co(NO}_3)_2 \\ \xrightarrow{+\Delta} \text{CoO} \\ \cdot \text{MO} \end{array}$
B.	Charcoal cavity test	II.	$\begin{array}{c} \text{MCO}_3 \rightarrow \text{MCl}_2 \\ \rightarrow \text{M}^{2+} \end{array}$
C.	Cobalt nitrate test	III.	$\begin{array}{c} \text{MSO}_4 \xrightarrow[\Delta]{\text{Na}_2\text{B}_4\text{O}_7} \text{M} \\ (\text{BO}_2)_2 \rightarrow \text{MBO}_2 \\ \rightarrow \text{M} \end{array}$
D.	Flame test	IV.	$\begin{array}{c} \text{MSO}_4 \xrightarrow[\Delta]{\text{Na}_2\text{CO}_3} \\ \text{MCO}_3 \rightarrow \text{MO} \\ \rightarrow \text{M} \end{array}$

Choose the correct answer from the options given below:

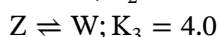
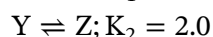
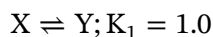
- (A) A-III, B-I, C-IV, D-II (B) A-III, B-IV, C-I, D-II
(C) A-III, B-II, C-IV, D-I (D) A-III, B-I, C-II, D-IV

71. Number of Complexes with even number of electrons in t_{2g} orbitals is -



- (A) 3 (B) 2
(C) 1 (D) 5

72. For the given hypothetical reactions, the equilibrium constants are as follows :



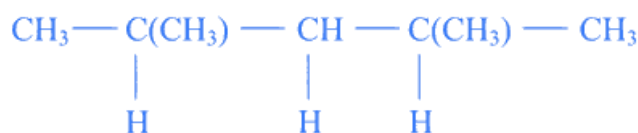
The equilibrium constant for the reaction $\text{X} \rightleftharpoons \text{W}$ is

- (A) 12.0 (B) 8.0
(C) 6.0 (D) 7.0

73. An octahedral complex with the formula $\text{CoCl}_3 \cdot n\text{NH}_3$ upon reaction with excess of AgNO_3 solution gives 2 moles of AgCl . Consider the oxidation state of Co in the complex is 'x'. The value of " $x + n$ " is _____.

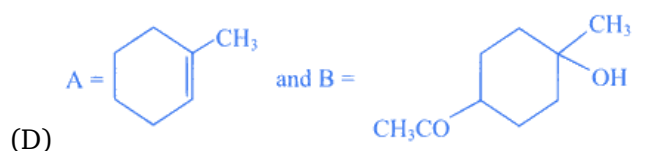
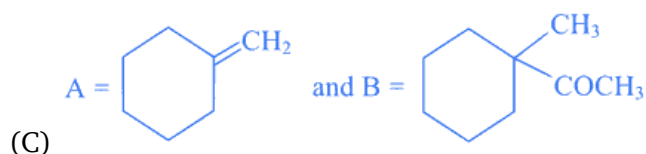
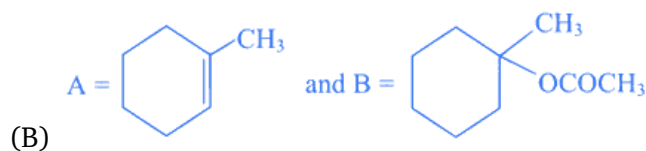
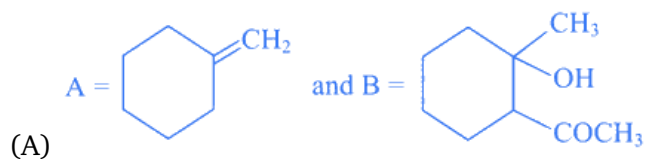
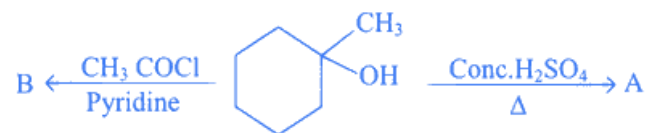
- (A) 6 (B) 5
(C) 3 (D) 8

74. In the given compound, the number of 2° carbon atom/s is _____.

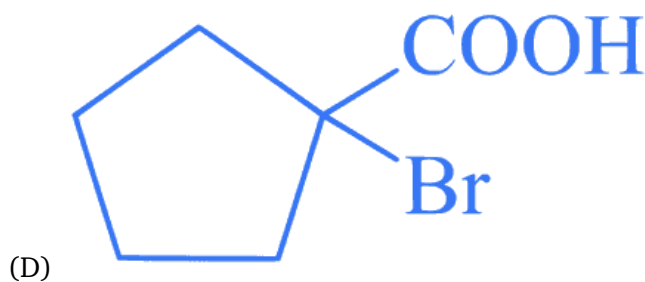
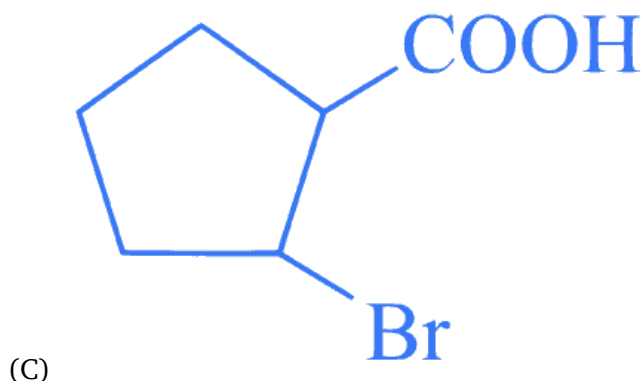
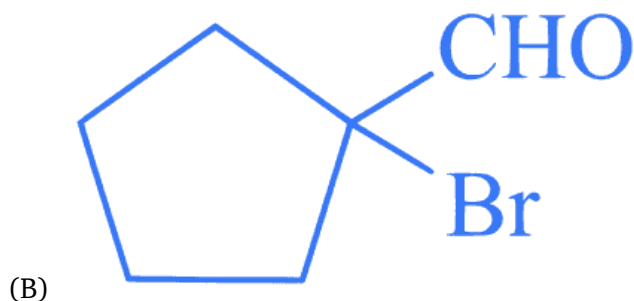
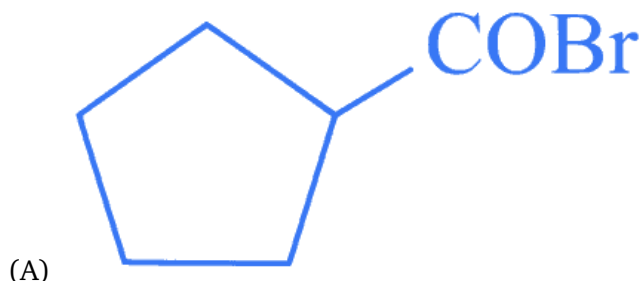
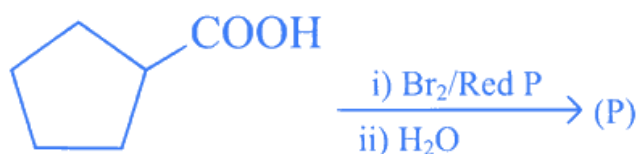


- (A) Two (B) Three
(C) Four (D) One

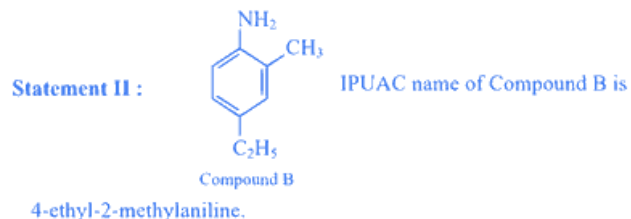
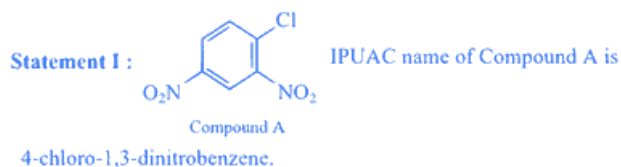
75. Identify the major products A and B respectively in the following set of reactions.



76. Identify the product (P) in the following reaction:



77. Given below are two statements :



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

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

78. Given below are two statements:

Statement I:



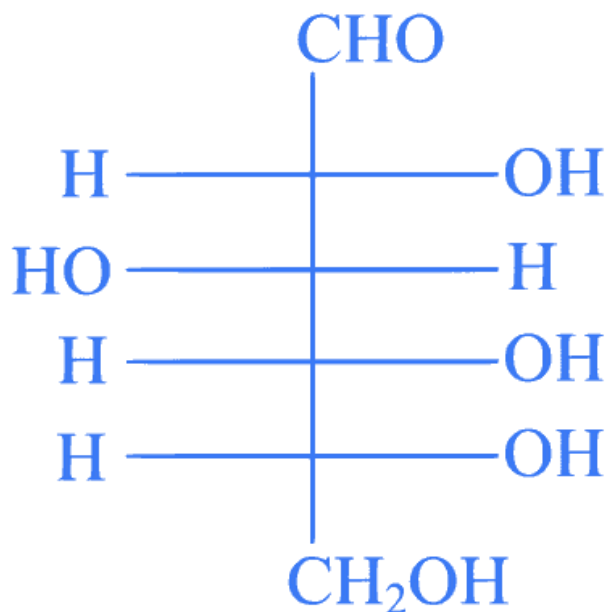
and $\text{P}(\text{CH}_3)_3$ can act as ligands to form transition metal complexes.

Statement II: As N and P are from same group, the nature of bonding of $\text{N}(\text{CH}_3)_3$ and $\text{P}(\text{CH}_3)_3$ is always same with transition metals.

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

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

79.



The incorrect statement regarding the given structure is

- (A) can be oxidized to a dicarboxylic acid with Br_2 water (B) despite the presence of $-\text{CHO}$ does not give Schiff's test
- (C) will coexist in equilibrium with 2 other cyclic structure (D) has 4 asymmetric carbon atom

80. Match List I with List II

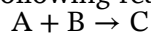
	LIST I (Compound)		LIST II (Colour)
A.	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \cdot x \text{H}_2\text{O}$	I.	Violet
B.	$[\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$	II.	Blood Red
C.	$[\text{Fe}(\text{SCN})]^{2+}$	III.	Prussian Blue
D.	$(\text{NH}_4)_3\text{PO}_4 \cdot 12 \text{MoO}_3$	IV.	Yellow

Choose the correct answer from the options given below:

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

81. If 279 g of aniline is reacted with one equivalent of benzenediazonium chloride, the maximum amount of aniline yellow formed will be _____ g. (nearest integer)
(consider complete conversion).

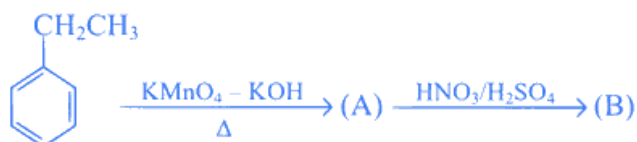
82. Consider the following reaction



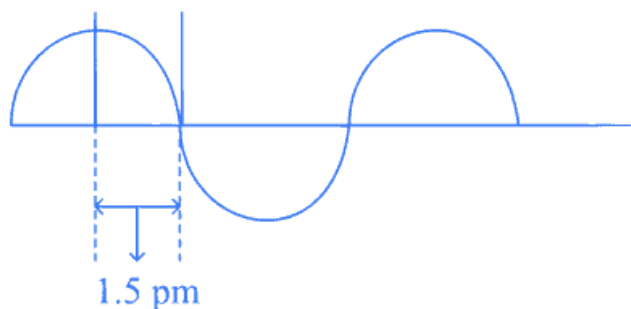
The time taken for A to become $1/4^{\text{th}}$ of its initial concentration is twice the time taken to become $1/2$ of the same. Also, when the change of concentration of B is plotted against time, the resulting graph gives a straight line with a negative slope and a positive intercept on the concentration axis.

The overall order of the reaction is _____.

83. Major product B of the following reaction has _____ π -bond.

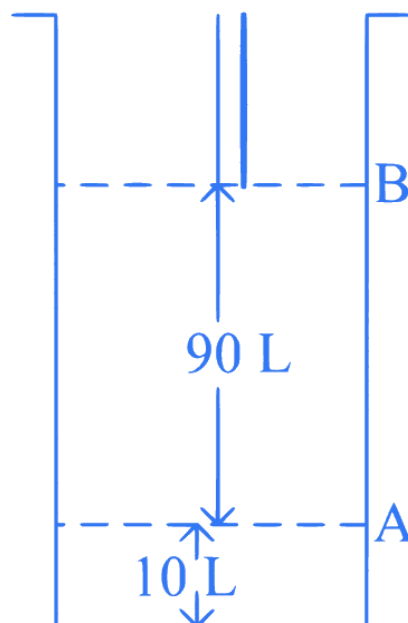


84. A hypothetical electromagnetic wave is shown below.



The frequency of the wave is $x \times 10^{19}$ Hz.
_____ (nearest integer)

85.



Consider the figure provided.

1 mol of an ideal gas is kept in a cylinder, fitted with a piston, at the position A, at 18°C . If the piston is moved to position B, keeping the temperature unchanged, then 'x' L atm work is done in this reversible process.

_____ L atm. (nearest integer)

[Given : Absolute temperature
= $^\circ\text{C} + 273.15$, $R = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$
]

86. A solution containing 10 g of an electrolyte AB_2 in 100 g of water boils at 100.52°C . The degree of ionization of the electrolyte (α) is _____ $\times 10^{-1}$. (nearest integer)

[Given : Molar mass of

$$AB_2 = 200 \text{ g mol}^{-1}, K_b$$

(molal boiling point elevation const. of water)

$$= 0.52 \text{ K kg mol}^{-1}$$

, boiling point of water

$$= 100^\circ\text{C}; AB_2$$

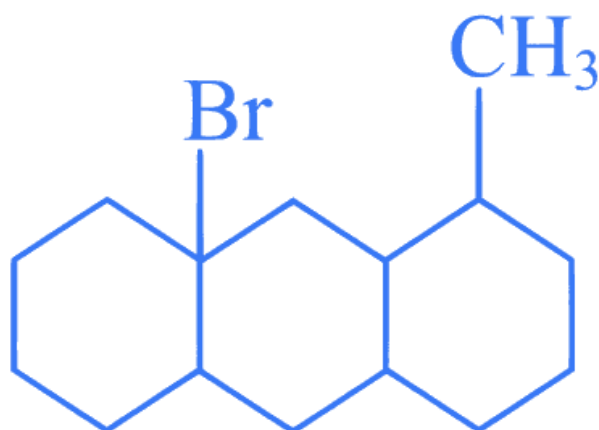
ionises as $AB_2 \rightarrow A^{2+} + 2 B^-$]

87. Number of molecules from the following which are exceptions to octet rule is _____.

$\text{CO}_2, \text{NO}_2, \text{H}_2\text{SO}_4, \text{BF}_3, \text{CH}_4, \text{SiF}_4, \text{ClO}_2, \text{PCl}_5,$

$\text{BeF}_2, \text{C}_2\text{H}_6, \text{CHCl}_3, \text{CBr}_4$

88. The number of optical isomers in following compound is : _____.



89. The 'spin only' magnetic moment value of MO_4^{2-} is _____ BM. (Where M is a metal having least metallic radii. among Sc, Ti, V, Cr, Mn and Zn).

(Given atomic number:

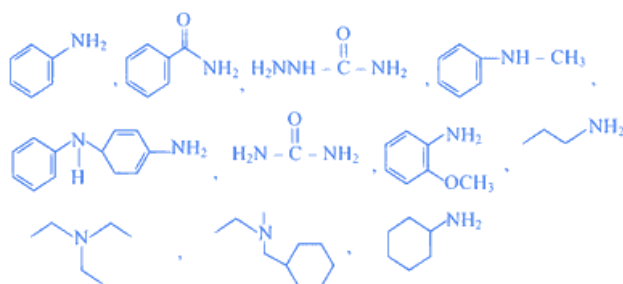
Sc = 21, Ti = 22, V = 23, Cr = 24, Mn = 25

and

Zn = 30

)

90. Number of amine compounds from the following giving solids which are soluble in NaOH upon reaction with Hinsberg's reagent is _____.



- End of Question Paper -