

# JEE Main 2023 Paper 1 (B.E./B.Tech) 10 April 2023 Shift 2 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) 2023 - Session 2**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 10 April 2023, Shift 2. 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

$$S = \left\{ z = x + iy : \frac{2z - 3i}{4z + 2i} \text{ is a real number} \right\}$$

. Then which of the following is NOT correct?

- (A)  $y + x^2 + y^2 \neq -\frac{1}{4}$   
 (B)  $(x, y) = \left(0, -\frac{1}{2}\right)$   
 (C)  $x = 0$   
 (D)  $y \in \left(-\infty, -\frac{1}{2}\right) \cup \left(-\frac{1}{2}, \infty\right)$

2. Eight persons are to be transported from city A to city B in three cars of different makes. If each car can accommodate at most three persons, then the number of ways, in which they can be transported, is :

- (A) 560 (B) 1680  
 (C) 3360 (D) 1120

3. Let the number  $(22)^{2022} + (2022)^{22}$  leave the remainder  $\alpha$  when divided by 3 and  $\beta$  when divided by 7. Then  $(\alpha^2 + \beta^2)$  is equal to :

- (A) 13 (B) 10  
 (C) 20 (D) 5

4. Let

$$g(x) = f(x) + f(1 - x)$$

and

$$f''(x) > 0, x \in (0, 1)$$

. If  $g$  is decreasing in the interval  $(0, a)$  and increasing in the interval  $(a, 1)$ , then

$$\tan^{-1}(2\alpha) + \tan^{-1}\left(\frac{1}{\alpha}\right) + \tan^{-1}\left(\frac{\alpha + 1}{\alpha}\right)$$

is equal to :

- (A)  $\frac{3\pi}{4}$   
 (B)  $\pi$   
 (C)  $\frac{5\pi}{4}$   
 (D)  $\frac{3\pi}{2}$

5. If the coefficients of  $x$  and  $x^2$  in  $(1 + x)^p(1 - x)^q$  are 4 and  $-5$  respectively, then  $2p + 3q$  is equal to :

- (A) 66 (B) 60  
 (C) 69 (D) 63

6. Let  $f$  be a continuous function satisfying

$$\int_0^{t^2} (f(x) + x^2) dx = \frac{4}{3}t^3, \forall t > 0$$

. Then

$$f\left(\frac{\pi^2}{4}\right)$$

is equal to :

- (A)  $-\pi\left(1 + \frac{\pi^3}{16}\right)$   
 (B)  $\pi\left(1 - \frac{\pi^3}{16}\right)$   
 (C)  $-\pi^2\left(1 + \frac{\pi^2}{16}\right)$   
 (D)  $\pi^2\left(1 - \frac{\pi^2}{16}\right)$

7. For  $\alpha, \beta, \gamma, \delta \in \mathbb{N}$ , if

$$\int \left( \left(\frac{x}{e}\right)^{2x} + \left(\frac{e}{x}\right)^{2x} \right) \log_e x dx = \frac{1}{\alpha} \left(\frac{x}{e}\right)^{\beta x} - \frac{1}{\gamma} \left(\frac{e}{x}\right)^{\delta x} + C$$

, where

$$e = \sum_{n=0}^{\infty} \frac{1}{n!}$$

and  $C$  is constant of integration, then  $\alpha + 2\beta + 3\gamma - 4\delta$  is equal to :

- (A)  $-8$   
 (B)  $-4$   
 (C) 1  
 (D) 4

8. Let  $\mu$  be the mean and  $\sigma$  be the standard deviation of the distribution

| $x_i$ | 0     | 1    | 2       | 3       | 4       | 5     |
|-------|-------|------|---------|---------|---------|-------|
| $f_i$ | $k+2$ | $2k$ | $k^2-1$ | $k^2-1$ | $k^2+1$ | $k-3$ |

where

$$\sum f_i = 62$$

. If  $[x]$  denotes the greatest integer  $\leq x$ , then  $[\mu^2 + \sigma^2]$  is equal to :

- (A) 9 (B) 8  
(C) 6 (D) 7

9. Let

$$\vec{a} = 2\hat{i} + 7\hat{j} - \hat{k}, \vec{b} = 3\hat{i} + 5\hat{k}$$

and

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

. Let  $\vec{d}$  be a vector which is perpendicular to both  $\vec{a}$  and  $\vec{b}$ , and

$$\vec{c} \cdot \vec{d} = 12$$

. Then  $(-\hat{i} + \hat{j} - \hat{k}) \cdot (\vec{c} \times \vec{d})$  is equal to :

- (A) 24 (B) 42  
(C) 44 (D) 48

10. If the points P and Q are respectively the circumcenter and the orthocentre of a  $\triangle ABC$ , then  $\vec{PA} + \vec{PB} + \vec{PC}$  is equal to :

- (A)  $\vec{QP}$   
(B)  $\vec{PQ}$   
(C)  $2\vec{PQ}$   
(D)  $2\vec{QP}$

11. Let A be the point (1, 2) and B be any point on the curve  $x^2 + y^2 = 16$ . If the centre of the locus of the point P, which divides the line segment AB in the ratio 3 : 2 is the point  $C(\alpha, \beta)$ , then the length of the line segment AC is :

- (A)  $\frac{3\sqrt{5}}{5}$   
(B)  $\frac{6\sqrt{5}}{5}$   
(C)  $\frac{2\sqrt{5}}{5}$   
(D)  $\frac{4\sqrt{5}}{5}$

12. Let

$$A = \{2, 3, 4\}$$

and

$$B = \{8, 9, 12\}$$

. Then the number of elements in the relation

$$R = \{ ((a_1, b_1), (a_2, b_2)) \in (A \times B, A \times B) : a_1 \text{ divides } b_2 \text{ and } a_2 \text{ divides } b_1 \}$$

is :

- (A) 18 (B) 24  
(C) 36 (D) 12

13. The statement  $\sim [p \vee (\sim (p \wedge q))]$  is equivalent to :

- (A)  $(\sim (p \wedge q)) \wedge q$   
(B)  $\sim (p \vee q)$   
(C)  $(p \wedge q) \wedge (\sim p)$   
(D)  $\sim (p \wedge q)$

14. If

$$S_n = 4 + 11 + 21 + 34 + 50 + \dots$$

to  $n$  terms, then

$$\frac{1}{60} (S_{29} - S_9)$$

is equal to :

- (A) 227 (B) 226  
(C) 220 (D) 223

15. Let a die be rolled  $n$  times. Let the probability of getting odd numbers seven times be equal to the probability of getting odd numbers nine times. If the probability of getting even numbers twice is  $\frac{k}{2^{15}}$ , then  $k$  is equal to :

- (A) 15 (B) 60  
(C) 30 (D) 90

16. Let the image of the point  $P(1, 2, 6)$  in the plane passing through the points  $A(1, 2, 0)$ ,  $B(1, 4, 1)$  and  $C(0, 5, 1)$  be  $Q(\alpha, \beta, \gamma)$ . Then  $(\alpha^2 + \beta^2 + \gamma^2)$  is equal to :

- (A) 76 (B) 62  
(C) 70 (D) 65

17. Let the line

$$\frac{x}{1} = \frac{6-y}{2} = \frac{z+8}{5}$$

intersect the lines

$$\frac{x-5}{4} = \frac{y-7}{3} = \frac{z+2}{1}$$

and

$$\frac{x+3}{6} = \frac{3-y}{3} = \frac{z-6}{1}$$

at the points  $A$  and  $B$  respectively. Then the distance of the mid-point of the line segment  $AB$  from the plane  $2x - 2y + z = 14$  is :

- (A) 3  
(B)  $\frac{10}{3}$   
(C) 4  
(D)  $\frac{11}{3}$

18. Let

$$S = \left\{ x \in \left( -\frac{\pi}{2}, \frac{\pi}{2} \right) : 9^{1 - \tan^2 x} + 9^{\tan^2 x} = 10 \right\}$$

and

$$\beta = \sum_{x \in S} \tan^2 \left( \frac{x}{3} \right)$$

, then

$$\frac{1}{6}(\beta - 14)^2$$

is equal to :

- (A) 16 (B) 32  
(C) 8 (D) 64

19. Let a circle of radius 4 be concentric to the ellipse

$$15x^2 + 19y^2 = 285$$

. Then the common tangents are inclined to the minor axis of the ellipse at the angle :

- (A)  $\frac{\pi}{4}$   
(B)  $\frac{\pi}{3}$   
(C)  $\frac{\pi}{6}$   
(D)  $\frac{\pi}{12}$

20. If

$$A = \frac{1}{5!6!7!} \begin{bmatrix} 5! & 6! & 7! \\ 6! & 7! & 8! \\ 7! & 8! & 9! \end{bmatrix}$$

, then  $|\text{adj}(\text{adj}(2A))|$  is equal to :

- (A)  $2^{12}$   
(B)  $2^{20}$   
(C)  $2^8$   
(D)  $2^{16}$

21. Let the tangent at any point P on a curve passing through the points (1, 1) and

$$\left(\frac{1}{10}, 100\right)$$

, intersect positive  $x$ -axis and  $y$ -axis at the points A and B respectively. If

$$PA : PB = 1 : k$$

and

$$y = y(x)$$

is the solution of the differential equation

$$e^{\frac{dy}{dx}} = kx + \frac{k}{2}, y(0) = k$$

, then  $4y(1) - 6 \log_e 3$  is equal to \_\_\_\_\_.

22. If the area of the region  $\{(x, y) : |x^2 - 2| \leq y \leq x\}$  is A, then  $6A + 16\sqrt{2}$  is equal to \_\_\_\_\_.

23. The sum of all the four-digit numbers that can be formed using all the digits 2, 1, 2, 3 is equal to \_\_\_\_\_.

24. Let S be the set of values of  $\lambda$ , for which the system of equations

$$6\lambda x - 3y + 3z = 4\lambda^2$$

,

$$2x + 6\lambda y + 4z = 1$$

,

$$3x + 2y + 3\lambda z = \lambda$$

has no solution. Then

$$12 \sum_{i \in S} |\lambda|$$

is equal to \_\_\_\_\_.

25. If the domain of the function

$$f(x) = \sec^{-1}\left(\frac{2x}{5x+3}\right)$$

is  $[\alpha, \beta) \cup (\gamma, \delta]$ , then  $|3\alpha + 10(\beta + \gamma) + 21\delta|$  is equal to \_\_\_\_\_.

26. Let the equations of two adjacent sides of a parallelogram ABCD be  $2x - 3y = -23$  and  $5x + 4y = 23$ . If the equation of its one diagonal AC is  $3x + 7y = 23$  and the distance of A from the other diagonal is d, then  $50d^2$  is equal to \_\_\_\_\_.

27. Let the foot of perpendicular from the point A(4, 3, 1) on the plane

$$P : x - y + 2z + 3 = 0$$

be N. If  $B(5, \alpha, \beta), \alpha, \beta \in \mathbb{Z}$  is a point on plane P such that the area of the triangle ABN is  $3\sqrt{2}$ , then  $\alpha^2 + \beta^2 + \alpha\beta$  is equal to \_\_\_\_\_.

28. Suppose  $a_1, a_2, 2, a_3, a_4$  be in an arithmetico-geometric progression. If the common ratio of the corresponding geometric progression is 2 and the sum of all 5 terms of the arithmetico-geometric progression is  $\frac{49}{2}$ , then  $a_4$  is equal to \_\_\_\_\_.

29. Let the quadratic curve passing through the point  $(-1, 0)$  and touching the line  $y = x$  at  $(1, 1)$  be

$$y = f(x)$$

. Then the  $x$ -intercept of the normal to the curve at the point  $(\alpha, \alpha + 1)$  in the first quadrant is \_\_\_\_\_.

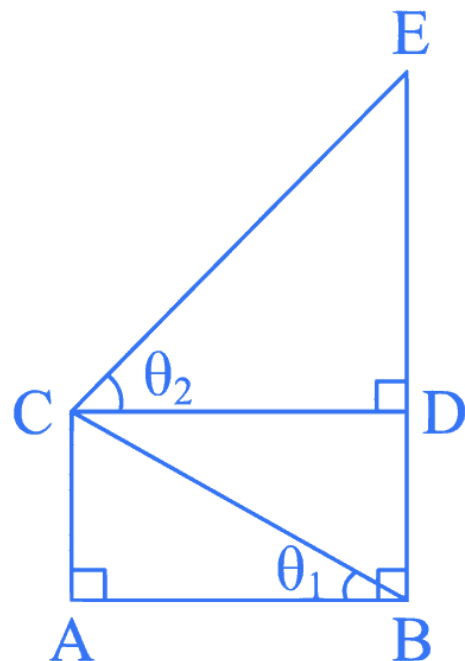
30. In the figure,

$$\theta_1 + \theta_2 = \frac{\pi}{2}$$

and

$$\sqrt{3} (BE) = 4(AB)$$

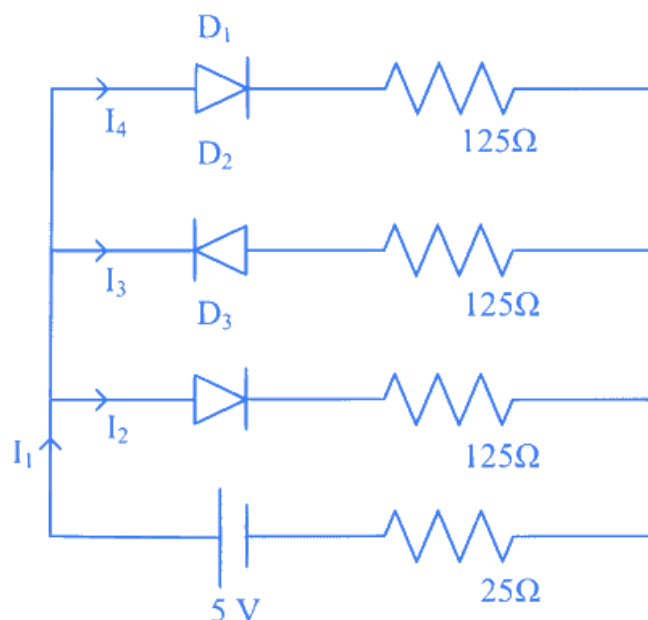
. If the area of  $\triangle CAB$  is  $2\sqrt{3} - 3$  unit<sup>2</sup>, when  $\frac{\theta_2}{\theta_1}$  is the largest, then the perimeter (in unit) of  $\triangle CED$  is equal to \_\_\_\_\_.



31. A person travels  $x$  distance with velocity  $v_1$  and then  $x$  distance with velocity  $v_2$  in the same direction. The average velocity of the person is  $v$ , then the relation between  $v$ ,  $v_1$  and  $v_2$  will be.

- (A)  $V = V_1 + V_2$   
 (B)  $V = \frac{v_1 + v_2}{2}$   
 (C)  $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$   
 (D)  $\frac{2}{V} = \frac{1}{v_1} + \frac{1}{v_2}$

32. If each diode has a forward bias resistance of  $25\ \Omega$  in the below circuit,



Which of the following options is correct :

- (A)  $\frac{I_3}{I_4} = 1$   
 (B)  $\frac{I_1}{I_2} = 2$   
 (C)  $\frac{I_2}{I_3} = 1$   
 (D)  $\frac{I_1}{I_2} = 1$

33. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason **R**

Assertion A : An electric fan continues to rotate for some time after the current is switched off.

Reason R : Fan continues to rotate due to inertia of motion.

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

- (A) A is not correct but R is correct  
 (B) A is correct but R is not correct  
 (C) Both A and R are correct and R is the correct explanation of A  
 (D) Both A and R are correct but R is NOT the correct explanation of A

34. In a metallic conductor, under the effect of applied electric field, the free electrons of the conductor

- (A) move in the straight line paths in the same direction  
 (B) move with the uniform velocity throughout from lower potential to higher potential  
 (C) drift from higher potential to lower potential.  
 (D) move in the curved paths from lower potential to higher potential

35. A gas mixture consists of 2 moles of oxygen and 4 moles of neon at temperature  $T$ . Neglecting all vibrational modes, the total internal energy of the system will be,

- (A)  $4RT$   
 (B)  $16RT$   
 (C)  $8RT$   
 (D)  $11RT$

36. A bar magnet is released from rest along the axis of a very long vertical copper tube. After some time the magnet will

- (A) move down with almost constant speed  
 (B) move down with an acceleration equal to  $g$   
 (C) move down with an acceleration greater than  $g$   
 (D) oscillate inside the tube

37. Two projectiles are projected at  $30^\circ$  and  $60^\circ$  with the horizontal with the same speed. The ratio of the maximum height attained by the two projectiles respectively is:

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

38. A gas is compressed adiabatically, which one of the following statement is NOT true.

- (A) There is no heat supplied to the system  
 (B) The temperature of the gas increases.  
 (C) There is no change in the internal energy  
 (D) The change in the internal energy is equal to the work done on the gas.

39. For a periodic motion represented by the equation

$$y = \sin \omega t + \cos \omega t$$

the amplitude of the motion is

- (A) 1  
 (B)  $\sqrt{2}$   
 (C) 0.5  
 (D) 2

40. The amplitude of magnetic field in an electromagnetic wave propagating along y-axis is  $6.0 \times 10^{-7}$  T. The maximum value of electric field in the electromagnetic wave is

- (A)  $6.0 \times 10^{-7} \text{ Vm}^{-1}$   
 (B)  $5 \times 10^{14} \text{ Vm}^{-1}$   
 (C)  $180 \text{ Vm}^{-1}$   
 (D)  $2 \times 10^{15} \text{ Vm}^{-1}$

41. The time period of a satellite, revolving above earth's surface at a height equal to R will be

(Given

$$g = \pi^2 \text{ m/s}^2, R = \text{radius of earth})$$

- (A)  $\sqrt{32R}$   
 (B)  $\sqrt{4R}$   
 (C)  $\sqrt{8R}$   
 (D)  $\sqrt{2R}$

42. Given below are two statements:

Statement I : For diamagnetic substance,  
 $-1 \leq \chi < 0$

, where  $\chi$  is the magnetic susceptibility.

Statement II : Diamagnetic substances when placed in an external magnetic field, tend to move from stronger to weaker part of the field.

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

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

43. The ratio of intensities at two points P and Q on the screen in a Young's double slit experiment where phase difference between two waves of same amplitude are  $\pi/3$  and  $\pi/2$ , respectively are

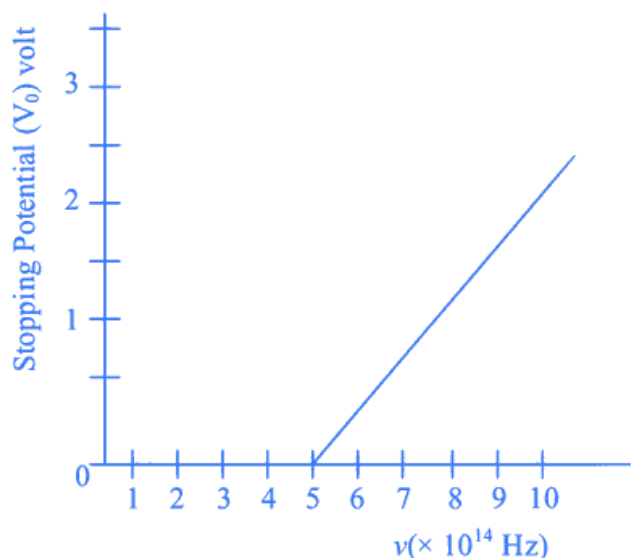
- (A) 2 : 3  
 (B) 1 : 3  
 (C) 3 : 1  
 (D) 3 : 2

44. Young's moduli of the material of wires A and B are in the ratio of 1 : 4, while its area of cross sections are in the ratio of 1 : 3. If the same amount of load is applied to both the wires, the amount of elongation produced in the wires A and B will be in the ratio of

[Assume length of wires A and B are same]

- (A) 1 : 12  
 (B) 1 : 36  
 (C) 12 : 1  
 (D) 36 : 1

45. The variation of stopping potential ( $V_0$ ) as a function of the frequency ( $\nu$ ) of the incident light for a metal is shown in figure. The work function of the surface is



- (A) 1.36 eV                      (B) 18.6 eV  
(C) 2.98 eV                      (D) 2.07 eV

46. Given below are two statements:

Statement I : Rotation of the earth shows effect on the value of acceleration due to gravity ( $g$ )

Statement II : The effect of rotation of the earth on the value of ' $g$ ' at the equator is minimum and that at the pole is maximum.

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

- (A) Statement I is false but statement II is true      (B) Statement I is true but statement II is false  
(C) Both Statement I and Statement II are true      (D) Both Statement I and Statement II are false

47. In an experiment with vernier callipers of least count 0.1 mm, when two jaws are joined together the zero of vernier scale lies right to the zero of the main scale and 6th division of vernier scale coincides with the main scale division. While measuring the diameter of a spherical bob, the zero of vernier scale lies in between 3.2 cm and 3.3 cm marks, and 4th division of vernier scale coincides with the main scale division. The diameter of bob is measured as

- (A) 3.18 cm  
(B) 3.22 cm  
(C) 3.26 cm  
(D) 3.25 cm

48. The distance between two plates of a capacitor is  $d$  and its capacitance is  $C_1$ , when air is the medium between the plates. If a metal sheet of thickness  $\frac{2d}{3}$  and of the same area as plate is introduced between the plates, the capacitance of the capacitor becomes  $C_2$ . The ratio

$$\frac{C_2}{C_1}$$

is

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

49. The half life of a radioactive substance is  $T$ . The time taken, for disintegrating  $\frac{7}{8}$ th part of its original mass will be:

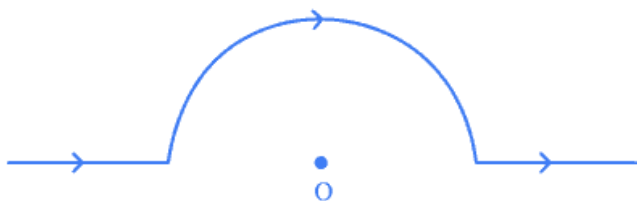
- (A)  $8T$                       (B)  $3T$   
(C)  $T$                       (D)  $2T$

50. A message signal of frequency 3 kHz is used to modulate a carrier signal of frequency 1.5 MHz. The bandwidth of the amplitude modulated wave is

- (A) 6 MHz  
(B) 6 kHz  
(C) 3 MHz  
(D) 3 kHz

51. A force of  $-P\hat{k}$  acts on the origin of the coordinate system. The torque about the point  $(2, -3)$  is  $P(a\hat{i} + b\hat{j})$ , The ratio of  $\frac{a}{b}$  is  $\frac{x}{2}$ . The value of  $x$  is \_\_\_\_\_.

52. A straight wire carrying a current of 14 A is bent into a semi-circular arc of radius 2.2 cm as shown in the figure. The magnetic field produced by the current at the centre (O) of the arc, is \_\_\_\_\_  $\times 10^{-4}$  T



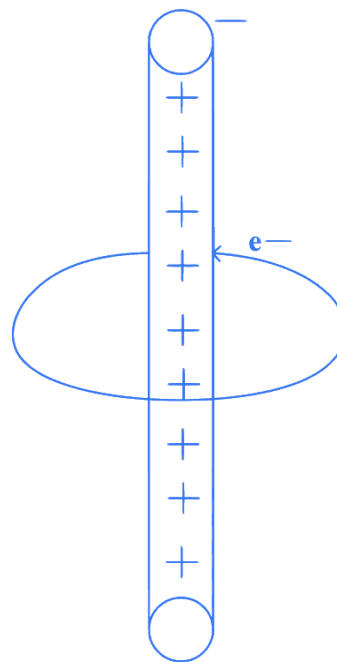
53. A rectangular block of mass 5 kg attached to a horizontal spiral spring executes simple harmonic motion of amplitude 1 m and time period 3.14 s. The maximum force exerted by spring on block is \_\_\_\_\_ N

54. A square loop of side 2.0 cm is placed inside a long solenoid that has 50 turns per centimetre and carries a sinusoidally varying current of amplitude 2.5 A and angular frequency 700 rad s<sup>-1</sup>. The central axes of the loop and solenoid coincide. The amplitude of the emf induced in the loop is  $x \times 10^{-4}$  V. The value of  $x$  is \_\_\_\_\_.  
(Take,  $\pi = \frac{22}{7}$ )

55. If the maximum load carried by an elevator is 1400 kg ( 600 kg - Passengers + 800 kg - elevator), which is moving up with a uniform speed of 3 m s<sup>-1</sup> and the frictional force acting on it is 2000 N, then the maximum power used by the motor is \_\_\_\_\_ kW ( $g = 10 \text{ m/s}^2$ )

56. An electron revolves around an infinite cylindrical wire having uniform linear charge density  $2 \times 10^{-8} \text{ C m}^{-1}$  in circular path under the influence of attractive electrostatic field as shown in the figure. The velocity of electron with which it is revolving is \_\_\_\_\_  $\times 10^6 \text{ m s}^{-1}$ . Given mass of electron

$$= 9 \times 10^{-31} \text{ kg}$$

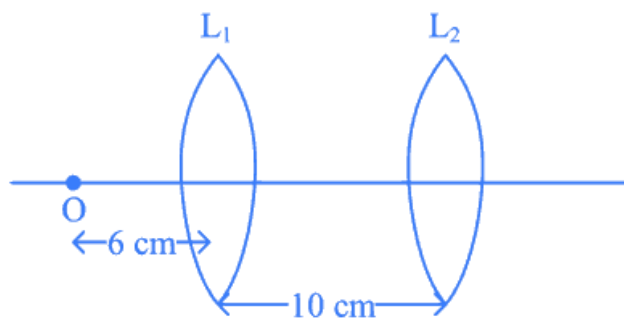


57. A rectangular parallelepiped is measured as  $1 \text{ cm} \times 1 \text{ cm} \times 100 \text{ cm}$ . If its specific resistance is  $3 \times 10^{-7} \Omega \text{m}$ , then the resistance between its two opposite rectangular faces will be \_\_\_\_\_  $\times 10^{-7} \Omega$ .

58. Figure below shows a liquid being pushed out of the tube by a piston having area of cross section  $2.0 \text{ cm}^2$ . The area of cross section at the outlet is  $10 \text{ mm}^2$ . If the piston is pushed at a speed of  $4 \text{ cm s}^{-1}$ , the speed of outgoing fluid is \_\_\_\_\_  $\text{cm s}^{-1}$



59. A point object, 'O' is placed in front of two thin symmetrical coaxial convex lenses  $L_1$  and  $L_2$  with focal length  $24 \text{ cm}$  and  $9 \text{ cm}$  respectively. The distance between two lenses is  $10 \text{ cm}$  and the object is placed  $6 \text{ cm}$  away from lens  $L_1$  as shown in the figure. The distance between the object and the image formed by the system of two lenses is \_\_\_\_\_  $\text{cm}$ .

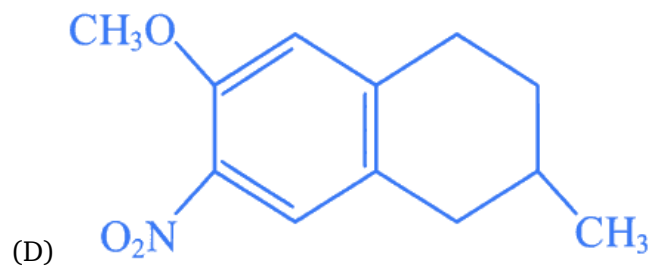
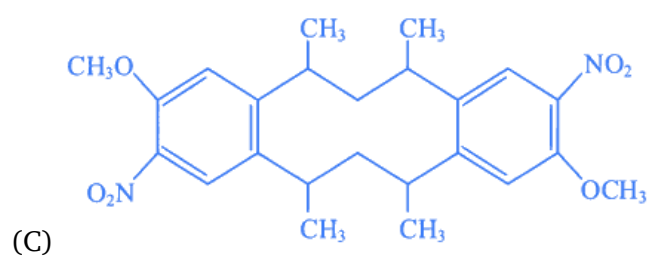
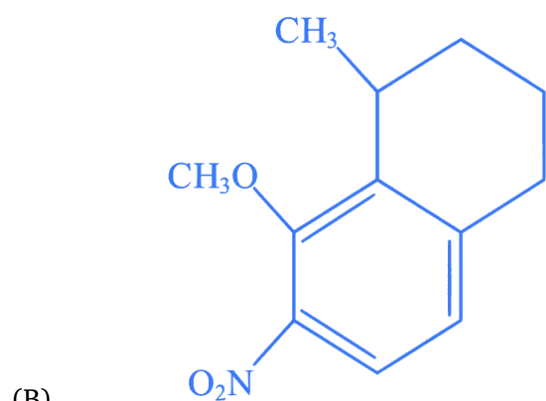
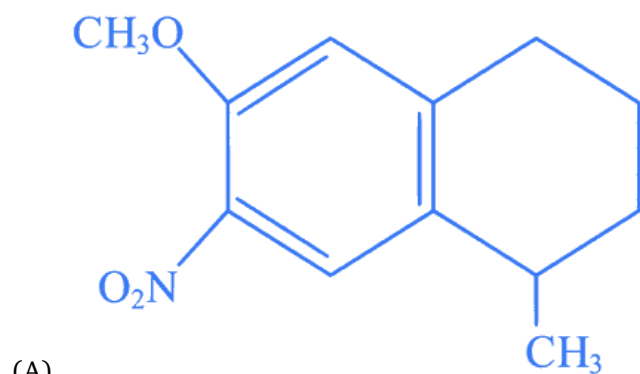
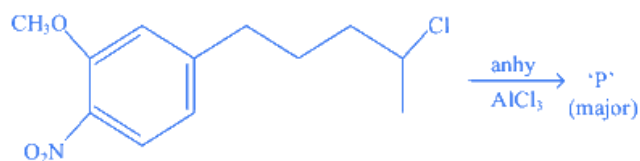


60. If  $917$

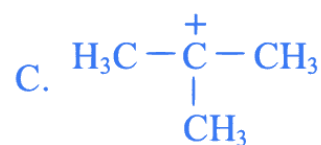
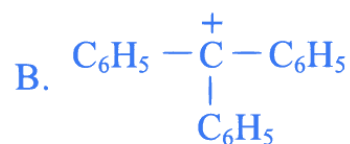
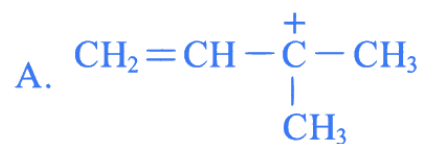
be the lowest wavelength of Lyman series then the lowest wavelength of Balmer series will be

\_\_\_\_\_  $\text{\AA}$

61. The major product 'P' formed in the given reaction is:



62. The decreasing order of hydride affinity for following carbocations is:



Choose the correct answer from the options given below:

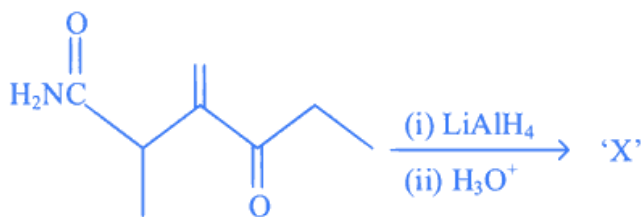
(A) A, C, D, B

(B) C, A, B, D

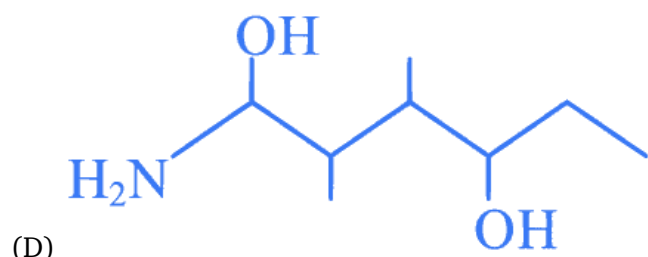
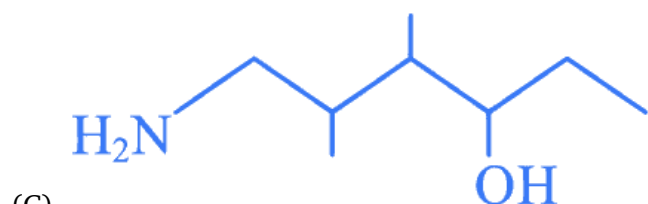
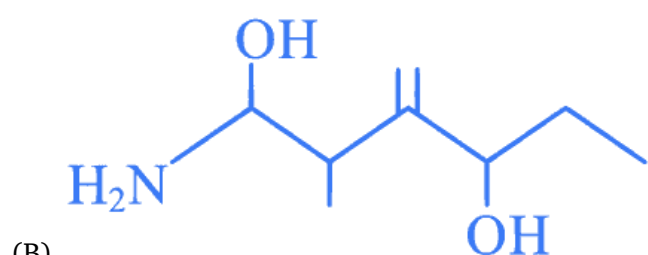
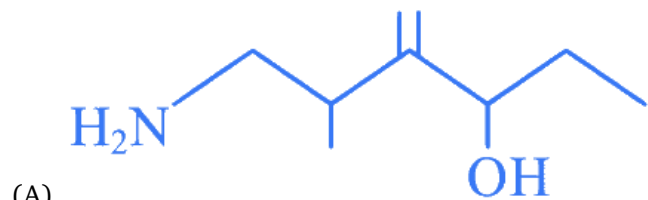
(C) A, C, B, D

(D) C, A, D, B

63. In the reaction given below:



The product 'X' is:



64. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason **R**

Assertion **A** : The energy required to form  $\text{Mg}^{2+}$  from  $\text{Mg}$  is much higher than that required to produce  $\text{Mg}^+$

Reason **R** :  $\text{Mg}^{2+}$  is small ion and carry more charge than  $\text{Mg}^+$

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

- (A) A is false but R is true  
(B) Both A and R are correct but R is NOT the correct explanation of A  
(C) Both A and R are correct and R is the correct explanation of A  
(D) A is true but R is false

65. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason **R**

Assertion **A** :

3.1500 g of hydrated oxalic acid dissolved in water to make 250.0 mL solution will result in 0.1 M oxalic acid solution.

Reason **R** : Molar mass of hydrated oxalic acid is  $126 \text{ g mol}^{-1}$

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

- (A) Both A and R are true but R is NOT the correct explanation of A  
(B) A is true but R is false  
(C) Both A and R are true and R is the correct explanation of A  
(D) A is false but R is true

66. The correct order of the number of unpaired electrons in the given complexes is

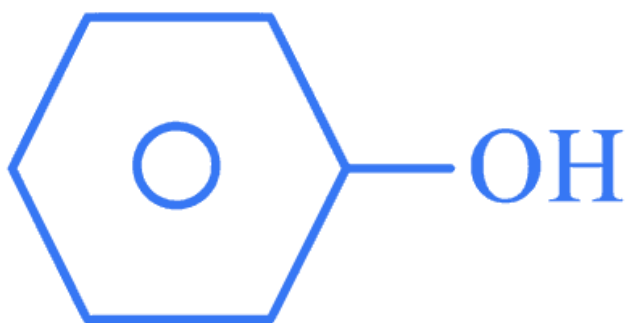
- A.  $[\text{Fe}(\text{CN})_6]^{3-}$   
 B.  $[\text{FeF}_6]^{3-}$   
 C.  $[\text{CoF}_6]^{3-}$   
 D.  $[\text{Cr}(\text{oxalate})_3]^{3-}$   
 E.  $[\text{Ni}(\text{CO})_4]$

Choose the correct answer from the options given below:

- (A)  $E < A < B < D < C$  (B)  $A < E < D < C < B$   
 (C)  $A < E < C < B < D$  (D)  $E < A < D < C < B$

67. The correct order for acidity of the following hydroxyl compound is :

- A.  $\text{CH}_3\text{OH}$   
 B.  $(\text{CH}_3)_3\text{COH}$   
 C.



D.



E.



Choose the correct answer from the options given below:

- (A)  $E > C > D > A > B$  (B)  $D > E > C > A > B$   
 (C)  $E > D > C > B > A$  (D)  $C > E > D > B > A$

68. Incorrect method of preparation for alcohols from the following is:

- (A) Hydroboration-oxidation of alkene. (B) Reaction of Ketone with  $\text{RMgBr}$  followed by hydrolysis.  
 (C) Ozonolysis of alkene. (D) Reaction of alkyl halide with aqueous  $\text{NaOH}$ .

69. Match List I with List II

|    | List - I<br>Complex                      |      | List - II<br>Crystal Field splitting energy ( $\Delta_0$ ) |
|----|------------------------------------------|------|------------------------------------------------------------|
| A. | $[\text{Ti}(\text{H}_2\text{O})_6]^{2+}$ | I.   | -1.2                                                       |
| B. | $[\text{V}(\text{H}_2\text{O})_6]^{2+}$  | II.  | -0.6                                                       |
| C. | $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$ | III. | 0                                                          |
| D. | $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ | IV.  | -0.8                                                       |

Choose the correct answer from the options given below:

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

70. In Carius tube, an organic compound 'X' is treated with sodium peroxide to form a mineral acid 'Y'.

The solution of  $\text{BaCl}_2$  is added to 'Y' to form a precipitate 'Z'. 'Z' is used for the quantitative estimation of an extra element. 'X' could be

- (A) Cytosine (B) Methionine  
 (C) Chloroxylene (D) A nucleotide

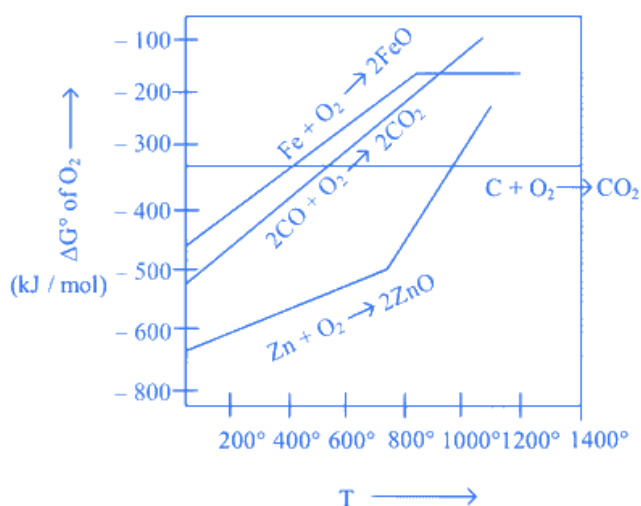
71. Match List I with List II

|    | List - I                     |      | List - II ( $\Delta_0$ )        |
|----|------------------------------|------|---------------------------------|
| A. | 16 g of $\text{CH}_4$ (g)    | I.   | Weighs 28 g                     |
| B. | 1 g of $\text{H}_2$ (g)      | II.  | $60.2 \times 10^{23}$ electrons |
| C. | 1 mole of $\text{N}_2$ (g)   | III. | Weighs 32 g                     |
| D. | 0.5 mol of $\text{SO}_2$ (g) | IV.  | Occupies 11.4 L volume of STP   |

Choose the correct answer from the options given below:

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

72. Gibbs energy vs T plot for the formation of oxides is given below.



For the given diagram, the correct statement is -

- (A) At 600°C, C can reduce FeO      (B) At 600°C, C can reduce ZnO  
(C) At 600°C, CO can reduce ZnO      (D) At 600°C, CO cannot reduce FeO

73. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason **R**

Assertion A : Physical properties of isotopes of hydrogen are different.

Reason R : Mass difference between isotopes of hydrogen is very large.

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**

74. The correct order of metallic character is :

- (A)  $\text{K} > \text{Be} > \text{Ca}$       (B)  $\text{Ca} > \text{K} > \text{Be}$   
(C)  $\text{K} > \text{Ca} > \text{Be}$       (D)  $\text{Be} > \text{Ca} > \text{K}$

75. Buna-S can be represented as:

- (A)  $\left[ \text{CH}_2 - \text{CH} = \text{CH} - \text{CH}_2 - \overset{\text{C}_6\text{H}_5}{\underset{|}{\text{CH}}} - \text{CH}_2 \right]_n$   
(B)  $\left[ \text{CH}_2 - \text{CH} = \overset{\text{C}_6\text{H}_5}{\underset{|}{\text{C}}} - \text{CH} = \text{CH} - \text{CH}_2 \right]_n$   
(C)  $\left[ \text{CH}_2 - \text{CH} = \text{CH} - \text{CH} = \overset{\text{C}_6\text{H}_5}{\underset{|}{\text{C}}} - \text{CH}_2 \right]_n$   
(D)  $\left[ \text{CH} = \text{CH} - \text{CH} = \text{CH} - \overset{\text{C}_6\text{H}_5}{\underset{|}{\text{CH}}} - \text{CH}_2 \right]_n$

76. Ferric chloride is applied to stop bleeding because -

- (A)  $\text{FeCl}_3$  reacts with the constituents of blood which is a positively charged sol.  
(B) Blood absorbs  $\text{FeCl}_3$  and forms a complex.  
(C)  $\text{Cl}^-$  ions cause coagulation of blood.  
(D)  $\text{Fe}^{3+}$  ions coagulate blood which is a negatively charged sol.

77. The correct relationships between unit cell edge length ' $a$ ' and radius of sphere ' $r$ ' for face-centred and body-centred cubic structures respectively are :

- (A)  $r = 2\sqrt{2} a$   
and  $\sqrt{3} r = 4a$   
(B)  $r = 2\sqrt{2} a$   
and  $4r = \sqrt{3} a$   
(C)  $2\sqrt{2} r = a$   
and  $\sqrt{3} r = 4a$   
(D)  $2\sqrt{2} r = a$   
and  $4r = \sqrt{3} a$

78. Number of water molecules in washing soda and soda ash respectively are :

- (A) 1 and 0 (B) 10 and 1  
(C) 1 and 10 (D) 10 and 0

79. The reaction used for preparation of soap from fat is :

- (A) an addition reaction (B) alkaline hydrolysis reaction  
(C) reduction reaction (D) an oxidation reaction

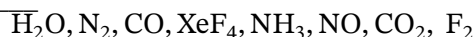
80. The delicate balance of  $\text{CO}_2$  and  $\text{O}_2$  is NOT disturbed by :

- (A) Burning of Coal (B) Burning of petroleum  
(C) Respiration (D) Deforestation

## Chemistry - Section B · Numerical Value Questions

81. An aqueous solution of volume  $300 \text{ cm}^3$  contains  $0.63 \text{ g}$  of protein. The osmotic pressure of the solution at  $300 \text{ K}$  is  $1.29 \text{ mbar}$ . The molar mass of the protein is \_\_\_\_\_  $\text{g mol}^{-1}$   
Given :  $R = 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1}$

82. The number of molecules from the following which contain only two lone pair of electrons is \_\_\_\_\_



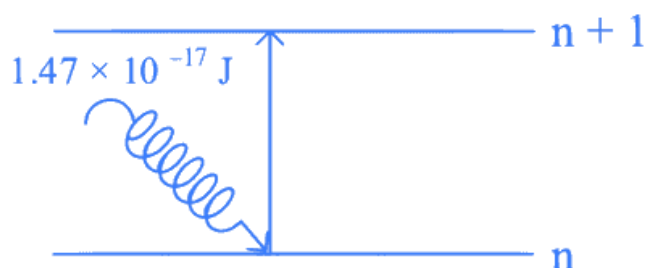
83. For a metal ion, the calculated magnetic moment is  $4.90 \text{ BM}$ . This metal ion has \_\_\_\_\_ number of unpaired electrons.

84. In alkaline medium, the reduction of permanganate anion involves a gain of \_\_\_\_\_ electrons.

85. The number of **incorrect** statement/s from the following is \_\_\_\_\_

- A. The successive half lives of zero order reactions decreases with time.
- B. A substance appearing as reactant in the chemical equation may not affect the rate of reaction
- C. Order and molecularity of a chemical reaction can be a fractional number
- D. The rate constant units of zero and second order reaction are  $\text{mol L}^{-1} \text{ s}^{-1}$  and  $\text{mol}^{-1} \text{ L s}^{-1}$  respectively

86.



The electron in the  $n^{\text{th}}$  orbit of  $\text{Li}^{2+}$  is excited to  $(n + 1)$  orbit using the radiation of energy  $1.47 \times 10^{-17} \text{ J}$  (as shown in the diagram). The value of  $n$  is \_\_\_\_\_

Given:

$$R_H = 2.18 \times 10^{-18} \text{ J}$$

87. The number of endothermic process/es from the following is \_\_\_\_\_.

- A.  $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$
- B.  $\text{HCl}(\text{g}) \rightarrow \text{H}(\text{g}) + \text{Cl}(\text{g})$
- C.  $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
- D.  $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
- E. Dissolution of ammonium chloride in water

88.



For the given reaction, if the initial pressure is  $450 \text{ mm Hg}$  and the pressure at time  $t$  is  $720 \text{ mm Hg}$  at a constant temperature  $T$  and constant volume  $V$ . The fraction of  $\text{A}(\text{g})$  decomposed under these conditions is  $x \times 10^{-1}$ . The value of  $x$  is \_\_\_\_\_ (nearest integer)

89. The specific conductance of  $0.0025 \text{ M}$  acetic acid is  $5 \times 10^{-5} \text{ S cm}^{-1}$  at a certain temperature. The dissociation constant of acetic acid is \_\_\_\_\_  $\times 10^{-7}$  (Nearest integer)

Consider limiting molar conductivity of  $\text{CH}_3\text{COOH}$  as  $400 \text{ S cm}^2 \text{ mol}^{-1}$

90. The difference in the oxidation state of  $\text{Xe}$  between the oxidised product of  $\text{Xe}$  formed on complete hydrolysis of  $\text{XeF}_4$  is \_\_\_\_\_

- End of Question Paper -