

JEE Main 2024 Paper 1 (B.E./B.Tech) 6 April 2024 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) 2024 - Session 2**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 6 April 2024, 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. If the function

$$f(x) = \left(\frac{1}{x}\right)^{2x}; x > 0$$

attains the maximum value at

$$x = \frac{1}{e}$$

then :

- (A) $e^\pi < \pi^e$
 (B) $e^{2\pi} < (2\pi)^e$
 (C) $(2e)^\pi > \pi^{(2e)}$
 (D) $e^\pi > \pi^e$

2. If z_1, z_2 are two distinct complex number such that

$$\left| \frac{z_1 - 2z_2}{\frac{1}{2} - z_1 \bar{z}_2} \right| = 2$$

, then

- (A) either z_1 lies on a circle of radius $\frac{1}{2}$ or z_2 lies on a circle of radius 1.
 (B) z_1 lies on a circle of radius $\frac{1}{2}$ and z_2 lies on a circle of radius 1.
 (C) either z_1 lies on a circle of radius 1 or z_2 lies on a circle of radius $\frac{1}{2}$.
 (D) both z_1 and z_2 lie on the same circle.

3. Let

$$A = \{1, 2, 3, 4, 5\}$$

. Let R be a relation on A defined by xRy if and only if $4x \leq 5y$. Let m be the number of elements in R and n be the minimum number of elements from $A \times A$ that are required to be added to R to make it a symmetric relation. Then $m + n$ is equal to :

- (A) 23
 (B) 26
 (C) 25
 (D) 24

4. Let

$$f(x) = \frac{1}{7 - \sin 5x}$$

be a function defined on $\mathbf{R}$. Then the range of the function $f(x)$ is equal to :

- (A) $\left[\frac{1}{8}, \frac{1}{5}\right]$
 (B) $\left[\frac{1}{7}, \frac{1}{6}\right]$
 (C) $\left[\frac{1}{7}, \frac{1}{5}\right]$
 (D) $\left[\frac{1}{8}, \frac{1}{6}\right]$

5.

$$\lim_{n \rightarrow \infty}$$

$$\frac{(1^2 - 1)(n - 1) + (2^2 - 2)(n - 2) + \dots + ((n - 1)^2 - (n - 1)) \cdot 1}{(1^3 + 2^3 + \dots + n^3) - (1^2 + 2^2 + \dots + n^2)}$$

is equal to :

- (A) $\frac{2}{3}$
 (B) $\frac{1}{2}$
 (C) $\frac{3}{4}$
 (D) $\frac{1}{3}$

6. If A is a square matrix of order 3 such that

$$\det(A) = 3$$

and

$$\det\left(\operatorname{adj}\left(-4 \operatorname{adj}\left(-3 \operatorname{adj}\left(3 \operatorname{adj}\left((2A)^{-1}\right)\right)\right)\right)\right) = 2^m 3^n$$

, then $m + 2n$ is equal to :

- (A) 2
 (B) 4
 (C) 3
 (D) 6

7. If three letters can be posted to any one of the 5 different addresses, then the probability that the three letters are posted to exactly two addresses is :

- (A) $\frac{18}{25}$
 (B) $\frac{12}{25}$
 (C) $\frac{6}{25}$
 (D) $\frac{4}{25}$

8. Let

$$\vec{a} = 2\hat{i} + \hat{j} - \hat{k}, \vec{b} = ((\vec{a} \times (\hat{i} + \hat{j})) \times \hat{i}) \times \hat{i}$$

. Then the square of the projection of $\vec{a}$ on $\vec{b}$ is:

- (A) $\frac{1}{3}$
 (B) $\frac{1}{5}$
 (C) 2
 (D) $\frac{2}{3}$

9. Let

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

and

$$\vec{b} = \hat{i} + \hat{j}$$

. If $\vec{c}$ is a vector such that

$$|\vec{c}| \geq 6, \vec{a} \cdot \vec{c} = 6|\vec{c}|, |\vec{c} - \vec{a}| = 2\sqrt{2}$$

and the angle between $\vec{a} \times \vec{b}$ and $\vec{c}$ is 60° , then $|(\vec{a} \times \vec{b}) \times \vec{c}|$ is equal to:

- (A) $\frac{3}{2}\sqrt{6}$
 (B) $\frac{9}{2}(6 - \sqrt{6})$
 (C) $\frac{9}{2}(6 + \sqrt{6})$
 (D) $\frac{3}{2}\sqrt{3}$

10. If the area of the region

$$\left\{ (x, y) : \frac{a}{x^2} \leq y \leq \frac{1}{x}, 1 \leq x \leq 2, 0 < a < 1 \right\}$$

is

$$(\log_e 2) - \frac{1}{7}$$

then the value of $7a - 3$ is equal to :

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

11. Let $P(\alpha, \beta, \gamma)$ be the image of the point $Q(3, -3, 1)$ in the line

$$\frac{x-0}{1} = \frac{y-3}{1} = \frac{z-1}{-1}$$

and R be the point $(2, 5, -1)$. If the area of the triangle PQR is λ and

$$\lambda^2 = 14K$$

, then K is equal to :

- (A) 18 (B) 81
 (C) 72 (D) 36

12. Let ABC be an equilateral triangle. A new triangle is formed by joining the middle points of all sides of the triangle ABC and the same process is repeated infinitely many times. If P is the sum of perimeters and Q is the sum of areas of all the triangles formed in this process, then :

- (A) $P^2 = 72\sqrt{3} Q$
 (B) $P^2 = 36\sqrt{3} Q$
 (C) $P = 36\sqrt{3} Q^2$
 (D) $P^2 = 6\sqrt{3} Q$

13. Suppose the solution of the differential equation

$$\frac{dy}{dx} = \frac{(2 + \alpha)x - \beta y + 2}{\beta x - 2\alpha y - (\beta y - 4\alpha)}$$

represents a circle passing through origin. Then the radius of this circle is :

- (A) $\sqrt{17}$
 (B) 2
 (C) $\frac{\sqrt{17}}{2}$
 (D) $\frac{1}{2}$

14. A software company sets up m number of computer systems to finish an assignment in 17 days. If 4 computer systems crashed on the start of the second day, 4 more computer systems crashed on the start of the third day and so on, then it took 8 more days to finish the assignment. The value of m is equal to:

- (A) 125 (B) 160
 (C) 150 (D) 180

15. If P(6, 1) be the orthocentre of the triangle whose vertices are A(5, -2), B(8, 3) and C(h, k), then the point C lies on the circle :

- (A) $x^2 + y^2 - 74 = 0$
 (B) $x^2 + y^2 - 65 = 0$
 (C) $x^2 + y^2 - 61 = 0$
 (D) $x^2 + y^2 - 52 = 0$

16. If all the words with or without meaning made using all the letters of the word "NAGPUR" are arranged as in a dictionary, then the word at 315th position in this arrangement is :

- (A) NRAPUG (B) NRAGUP
 (C) NRAPGU (D) NRAGPU

17. Suppose for a differentiable function h , $h(0) = 0$, $h(1) = 1$

and

$$h'(0) = h'(1) = 2$$

. If

$$g(x) = h(e^x)e^{h(x)}$$

, then $g'(0)$ is equal to:

- (A) 4 (B) 5
 (C) 3 (D) 8

18. Let $0 \leq r \leq n$. If

$${}^{n+1}C_{r+1} : {}^nC_r : {}^{n-1}C_{r-1} = 55 : 35 : 21$$

, then $2n + 5r$ is equal to :

- (A) 62 (B) 60
 (C) 55 (D) 50

19. If

$\int \frac{1}{a^2 \sin^2 x + b^2 \cos^2 x} dx = \frac{1}{12} \tan^{-1}(3 \tan x) + \text{constant}$, then the maximum value of $a \sin x + b \cos x$, is :

- (A) $\sqrt{41}$
 (B) $\sqrt{39}$
 (C) $\sqrt{40}$
 (D) $\sqrt{42}$

20. If the locus of the point, whose distances from the point (2, 1) and (1, 3) are in the ratio 5 : 4, is

$$ax^2 + by^2 + cxy + dx + ey + 170 = 0$$

, then the value of $a^2 + 2b + 3c + 4d + e$ is equal to :

- (A) 37
 (B) -27
 (C) 437
 (D) 5

21. Let $[t]$ denote the greatest integer less than or equal to t . Let $f : [0, \infty) \rightarrow \mathbf{R}$ be a function defined by

$$f(x) = \left[\frac{x}{2} + 3 \right] - [\sqrt{x}]$$

. Let S be the set of all points in the interval $[0, 8]$ at which f is not continuous. Then

$$\sum_{a \in S} a$$

is equal to _____.

22. In a triangle

$$ABC, BC = 7, AC = 8, AB = \alpha \in \mathbf{N}$$

and

$$\cos A = \frac{2}{3}$$

. If

$$49 \cos(3C) + 42 = \frac{m}{n}$$

, where

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

, then $m + n$ is equal to _____.

23. Let $[t]$ denote the largest integer less than or equal to t . If

$$\int_0^3 \left([x^2] + \left[\frac{x^2}{2} \right] \right) dx = a + b\sqrt{2} - \sqrt{3} - \sqrt{5} + c\sqrt{6} - \sqrt{7}$$

, where $a, b, c \in \mathbf{Z}$, then $a + b + c$ is equal to _____.

24. If the solution $y(x)$ of the given differential equation

$$(e^y + 1) \cos x \, dx + e^y \sin x \, dy = 0$$

passes through the point

$$\left(\frac{\pi}{2}, 0 \right)$$

, then the value of

$$e^{y\left(\frac{\pi}{6}\right)}$$

is equal to _____.

25. If the shortest distance between the lines

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

and

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

is

$$\frac{44}{\sqrt{30}}$$

, then the largest possible value of $|\lambda|$ is equal to _____.

26. The length of the latus rectum and directrices of hyperbola with eccentricity e are 9 and

$$x = \pm \frac{4}{\sqrt{3}}$$

, respectively. Let the line

$$y - \sqrt{3}x + \sqrt{3} = 0$$

touch this hyperbola at (x_0, y_0) . If m is the product of the focal distances of the point (x_0, y_0) , then $4e^2 + m$ is equal to _____.

27. Let α, β be roots of

$$x^2 + \sqrt{2}x - 8 = 0$$

. If

$$U_n = \alpha^n + \beta^n$$

, then

$$\frac{U_{10} + \sqrt{2}U_9}{2U_8}$$

is equal to _____.

28. If the system of equations

$$2x + 7y + \lambda z = 3$$

$$3x + 2y + 5z = 4$$

$$x + \mu y + 32z = -1$$

has infinitely many solutions, then $(\lambda - \mu)$ is equal to _____ :

29. If

$$S(x) = (1+x) + 2(1+x)^2 + 3(1+x)^3 + \dots + 60(1+x)^{60}, x \neq 0$$

, and

$$(60)^2 S(60) = a(b)^b + b$$

, where $a, b \in N$, then $(a+b)$ equal to _____.

30. From a lot of 12 items containing 3 defectives, a sample of 5 items is drawn at random. Let the random variable X denote the number of defective items in the sample. Let items in the sample be drawn one by one without replacement. If variance of X is $\frac{m}{n}$, where

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

, then $n - m$ is equal to _____.

Physics - Section A · Multiple Choice Questions

31. A car of 800 kg is taking turn on a banked road of radius 300 m and angle of banking 30° . If coefficient of static friction is 0.2 then the maximum speed with which car can negotiate the turn safely:

$$(g = 10 \text{ m/s}^2, \sqrt{3} = 1.73)$$

- (A) 51.4 m/s (B) 102.8 m/s
(C) 70.4 m/s (D) 264 m/s

32. A body projected vertically upwards with a certain speed from the top of a tower reaches the ground in t_1 . If it is projected vertically downwards from the same point with the same speed, it reaches the ground in t_2 . Time required to reach the ground, if it is dropped from the top of the tower, is :

- (A) $\sqrt{t_1 + t_2}$
(B) $\sqrt{t_1 t_2}$
(C) $\sqrt{\frac{t_1}{t_2}}$
(D) $\sqrt{t_1 - t_2}$

33. Given below are two statements:

Statement (I) : Dimensions of specific heat is $[L^2 T^{-2} K^{-1}]$.

Statement (II) : Dimensions of gas constant is $[ML^2 T^{-1} K^{-1}]$.

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

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

34. A body of weight 200 N is suspended from a tree branch through a chain of mass 10 kg. The branch pulls the chain by a force equal to (if

$$g = 10 \text{ m/s}^2$$

) :

- (A) 300 N (B) 100 N
(C) 150 N (D) 200 N

35. The number of electrons flowing per second in the filament of a 110 W bulb operating at 220 V is : (Given

$$e = 1.6 \times 10^{-19} \text{ C}$$

)

- (A) 1.25×10^{19}
(B) 31.25×10^{17}
(C) 6.25×10^{18}
(D) 6.25×10^{17}

36. The acceptor level of a p-type semiconductor is 6 eV. The maximum wavelength of light which can create a hole would be : Given

$$hc = 1242 \text{ eV nm}$$

- (A) 407 nm (B) 103.5 nm
(C) 414 nm (D) 207 nm

37. In a vernier calliper, when both jaws touch each other, zero of the vernier scale shifts towards left and its 4th division coincides exactly with a certain division on main scale. If 50 vernier scale divisions equal to 49 main scale divisions and zero error in the instrument is 0.04 mm then how many main scale divisions are there in 1 cm ?

- (A) 5 (B) 40
(C) 10 (D) 20

38. In a coil, the current changes from -2 A to $+2\text{ A}$ in 0.2 s and induces an emf of 0.1 V . The self inductance of the coil is :

- (A) 4 mH (B) 2.5 mH
(C) 1 mH (D) 5 mH

39. Energy of 10 non rigid diatomic molecules at temperature T is :

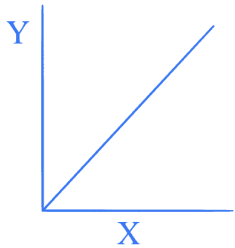
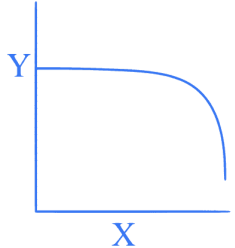
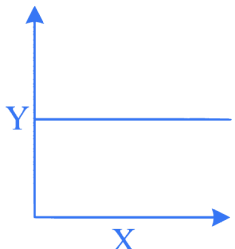
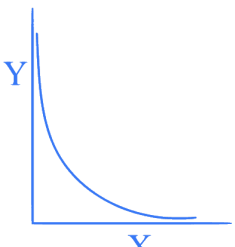
- (A) $35 RT$ (B) $\frac{7}{2} RT$
(C) $70 K_B T$ (D) $35 K_B T$

40. When UV light of wavelength 300 nm is incident on the metal surface having work function 2.13 eV , electron emission takes place. The stopping potential is :

(Given $hc = 1240\text{ eV nm}$)

- (A) 4 V (B) 2 V
(C) 4.1 V (D) 1.5 V

41. Match List I with List II:

	LIST I (Y vs X)		LIST II (Shape of Graph)
A.	Y-magnetic susceptibility X = magnetising field	I.	
B.	Y = magnetic field X = distance from centre of a current carrying wire for $x < a$ (where a = radius of wire)	II.	
C.	Y = magnetic field X = distance from centre of a current carrying wire for $x > a$ (where a = radius of wire)	III.	
D.	Y = magnetic field inside solenoid X = distance from centre	IV.	

Choose the correct answer from the options given below :

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

42. For the thin convex lens, the radii of curvature are at 15 cm and 30 cm respectively. The focal length the lens is 20 cm. The refractive index of the material is :

- (A) 1.2 (B) 1.5
(C) 1.4 (D) 1.8

43. Two identical conducting spheres P and S with charge Q on each, repel each other with a force 16 N. A third identical uncharged conducting sphere R is successively brought in contact with the two spheres. The new force of repulsion between P and S is :

- (A) 1 N (B) 6 N
(C) 12 N (D) 4 N

44. The longest wavelength associated with Paschen series is : (Given

$R_H = 1.097 \times 10^7 \text{ SI unit}$)

- (A) $2.973 \times 10^{-6} \text{ m}$
(B) $1.876 \times 10^{-6} \text{ m}$
(C) $1.094 \times 10^{-6} \text{ m}$
(D) $3.646 \times 10^{-6} \text{ m}$

45. A total of 48 J heat is given to one mole of helium kept in a cylinder. The temperature of helium increases by 2°C . The work done by the gas is: Given,

$$R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$$

- (A) 23.1 J (B) 48 J
(C) 24.9 J (D) 72.9 J

46. When kinetic energy of a body becomes 36 times of its original value, the percentage increase in the momentum of the body will be :

- (A) 60% (B) 500%
(C) 6% (D) 600%

47. Pressure inside a soap bubble is greater than the pressure outside by an amount : (given :

$R =$
Radius of bubble,
 $S =$
Surface tension of bubble)

- (A) $\frac{S}{R}$
(B) $\frac{4S}{R}$
(C) $\frac{4R}{S}$
(D) $\frac{2S}{R}$

48. Assuming the earth to be a sphere of uniform mass density, a body weighed 300 N on the surface of earth. How much it would weigh at $R/4$ depth under surface of earth ?

- (A) 75 N (B) 375 N
(C) 300 N (D) 225 N

49. In finding out refractive index of glass slab the following observations were made through travelling microscope 50 vernier scale division
= 49 MSD; 20

divisions on main scale in each cm

For mark on paper

$$\text{MSR} = 8.45 \text{ cm, VC} = 26$$

For mark on paper seen through slab

$$\text{MSR} = 7.12 \text{ cm, VC} = 41$$

For powder particle on the top surface of the glass slab

$$\text{MSR} = 4.05 \text{ cm, VC} = 1$$

(MSR = Main Scale Reading, VC = Vernier Coincidence)

Refractive index of the glass slab is :

- (A) 1.52 (B) 1.35
(C) 1.24 (D) 1.42

50. In the given electromagnetic wave

$$E_y = 600 \sin(\omega t - kx) \text{ V m}^{-1}$$

, intensity of the associated light beam is (in W/m^2 : (Given

$$\epsilon_0 = 9 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

)

- (A) 486 (B) 729
(C) 243 (D) 972

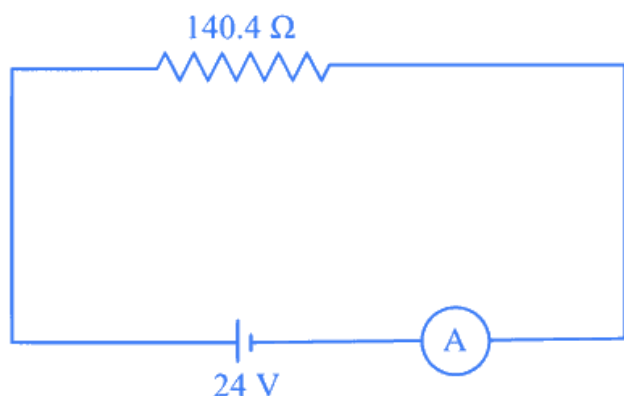
51. For a given series LCR circuit it is found that maximum current is drawn when value of variable capacitance is 2.5 nF . If resistance of 200Ω and 100 mH inductor is being used in the given circuit. The frequency of ac source is _____ $\times 10^3 \text{ Hz}$ (given

$$a^2 = 10$$

)

52. Three balls of masses 2 kg , 4 kg and 6 kg respectively are arranged at centre of the edges of an equilateral triangle of side 2 m . The moment of inertia of the system about an axis through the centroid and perpendicular to the plane of triangle, will be _____ kg m^2 .

53. In the given figure an ammeter A consists of a 240Ω coil connected in parallel to a 10Ω shunt. The reading of the ammeter is _____ mA .



54. A coil having 100 turns, area of $5 \times 10^{-3} \text{ m}^2$, carrying current of 1 mA is placed in uniform magnetic field of 0.20 T such a way that plane of coil is perpendicular to the magnetic field. The work done in turning the coil through 90° is _____ μJ .

55. A capacitor of $10\mu\text{F}$ capacitance whose plates are separated by 10 mm through air and each plate has area 4 cm^2 is now filled equally with two dielectric media of $K_1 = 2, K_2 = 3$ respectively as shown in figure. If new force between the plates is 8 N . The supply voltage is _____ V .



56. A particle moves in a straight line so that its displacement x at any time t is given by $x^2 = 1 + t^2$. Its acceleration at any time t is x^{-n} where

$$n =$$

_____.

57. Two coherent monochromatic light beams of intensities I and $4I$ are superimposed. The difference between maximum and minimum possible intensities in the resulting beam is xI . The value of x is _____.

58. Two open organ pipes of lengths 60 cm and 90 cm resonate at 6th and 5th harmonics respectively. The difference of frequencies for the given modes is _____ Hz. (Velocity of sound in air = 333 m/s)

)

59. In Franck-Hertz experiment, the first dip in the current-voltage graph for hydrogen is observed at 10.2 V. The wavelength of light emitted by hydrogen atom when excited to the first excitation level is _____ nm. (Given $hc = 1245 \text{ eV nm}$, $e = 1.6 \times 10^{-19} \text{ C}$).

60. A wire of cross sectional area A , modulus of elasticity $2 \times 10^{11} \text{ Nm}^{-2}$ and length 2 m is stretched between two vertical rigid supports. When a mass of 2 kg is suspended at the middle it sags lower from its original position making angle

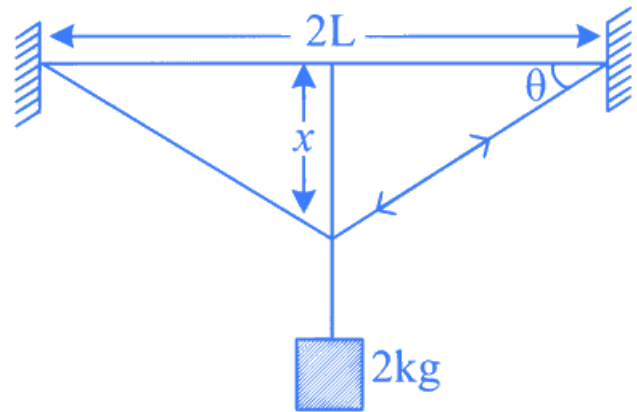
$$\theta = \frac{1}{100}$$

radian on the points of support. The value of A is _____ $\times 10^{-4} \text{ m}^2$ (consider $x \ll L$).

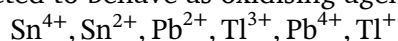
(given :

$$g = 10 \text{ m/s}^2$$

)

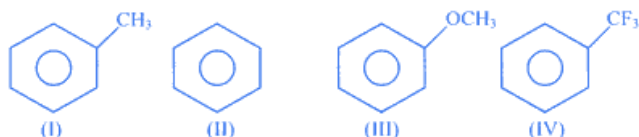


61. The number of ions from the following that are expected to behave as oxidising agent is :



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

62.



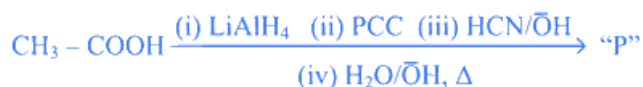
The correct arrangement for decreasing order of electrophilic substitution for above compounds is :

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

63. During the detection of acidic radical present in a salt, a student gets a pale yellow precipitate soluble with difficulty in NH_4OH solution when sodium carbonate extract was first acidified with dil. HNO_3 and then AgNO_3 solution was added. This indicates presence of :

- (A) I^-
(B) CO_3^{2-}
(C) Cl^-
(D) Br^-

64. Consider the given reaction, identify the major product P



- (A) $\text{CH}_3 - \overset{\text{OH}}{\underset{|}{\text{CH}}} - \text{COOH}$
(B) $\text{CH}_3 - \text{CH}_2 - \overset{\text{O}}{\parallel} \text{C} - \text{NH}_2$
(C) $\text{CH}_3 - \overset{\text{O}}{\parallel} \text{C} - \text{CH}_2\text{CH}_3$
(D) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}$

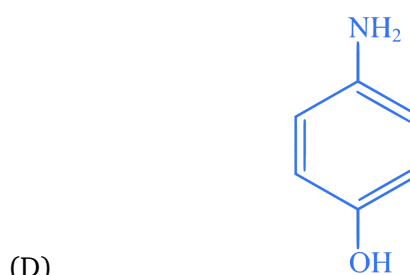
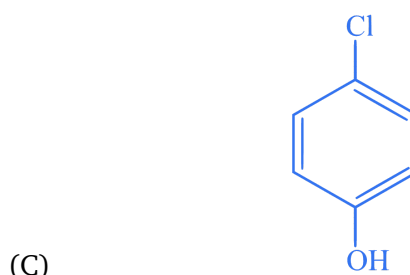
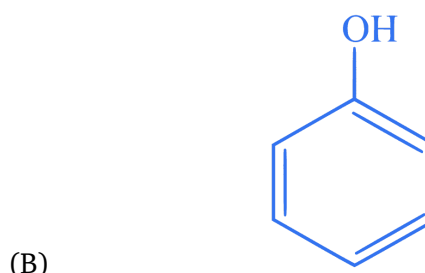
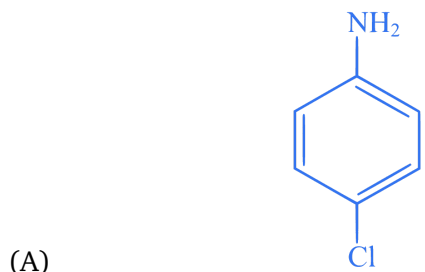
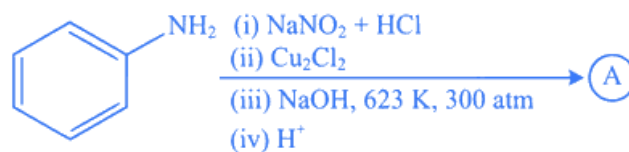
65. Match List I with List II.

	LIST I Reaction		LIST II Type of redox reaction
A.	$\text{N}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{(g)}$	I.	Decomposition
B.	$2\text{Pb}(\text{NO}_3)_{2(s)} \rightarrow 2\text{PbO}_{(s)} + 4\text{NO}_{2(g)} + \text{O}_{2(g)}$	II.	Displacement
C.	$2\text{Na}_{(s)} + 2\text{H}_2\text{O}_{(l)} \rightarrow 2\text{NaOH}_{(aq.)} + \text{H}_{2(g)}$	III.	Disproportionation
D.	$2\text{NO}_{2(g)} + 2^-\text{OH}(\text{aq.}) \rightarrow \text{NO}_{2(aq.)}^- + \text{NO}_3^-(\text{aq.}) + \text{H}_2\text{O}_{(l)}$	IV.	Combination

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)-(II), (C)-(I), (D)-(IV)

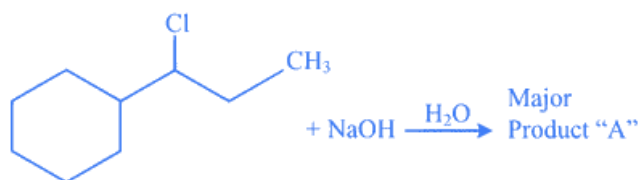
66. Identify the product A in the following reaction.



67. The correct statement among the following, for a "chromatography" purification method is :

- (A) R_f of a polar compound is smaller than that of a non-polar compound. (B) Non-polar compounds are retained at top and polar compounds come down in column chromatography.
- (C) Organic compounds run faster than solvent in the thin layer chromatographic plate. (D) R_f is an integral value.

68.



Consider the above chemical reaction. Product "A" is :

- (A)
- (B)
- (C)
- (D)

69. How can an electrochemical cell be converted into an electrolytic cell ?

- (A) Applying an external opposite potential greater than E_{cell}^0 (B) Exchanging the electrodes at anode and cathode.
 (C) Applying an external opposite potential lower than E_{cell}^0 (D) Reversing the flow of ions in salt bridge.

70. Given below are two statements :

Statement I :

PF_5
and BrF_5 both exhibit $\text{sp}^3 \text{d}$ hybridisation.

Statement II : Both SF_6 and $[\text{Co}(\text{NH}_3)_6]^{3+}$ exhibit $\text{sp}^3 \text{d}^2$ hybridisation.

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

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

71. Match List I with List II.

	LIST I Tetrahedral Complex		LIST II Electronic configuration
A.	TiCl_4	I.	e^2, t_2^0
B.	$[\text{FeO}_4]^{2-}$	II.	e^4, t_2^3
C.	$[\text{FeCl}_4]^-$	III.	e^0, t_2^0
D.	$[\text{CoCl}_4]^{2-}$	IV.	e^2, t_2^3

Choose the correct answer from the options given below :

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

72. Molality (m) of 3M aqueous solution of NaCl is : (Given : Density of solution

$$= 1.25 \text{ g mL}^{-1}$$

, Molar mass in g mol^{-1} : Na – 23, Cl – 35.5)

- (A) 2.90 m (B) 3.85 m
 (C) 1.90 m (D) 2.79 m

73. Evaluate the following statements related to group 14 elements for their correctness.

(A) Covalent radius decreases down the group from C to Pb in a regular manner.

(B) Electronegativity decreases from C to Pb down the group gradually.

(C) Maximum covalance of C is 4 whereas other elements can expand their covalance due to presence of d orbitals.

(D) Heavier elements do not form $p\pi - p\pi$ bonds.

(E) Carbon can exhibit negative oxidation states. Choose the correct answer from the options given below :

(A) (A), (B) and (C) (B) (A) and (B) Only

(C) (C), (D) and (E) (D) (C) and (D) Only

74. Arrange the following elements in the increasing order of number of unpaired electrons in it.

(A) Sc

(B) Cr

(C) V

(D) Ti

(E) Mn

Choose the correct answer from the options given below :

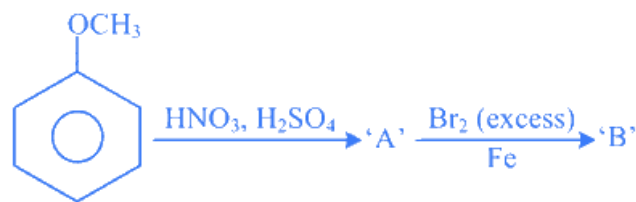
(A) (A) < (D) < (C) < (B) < (E)

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

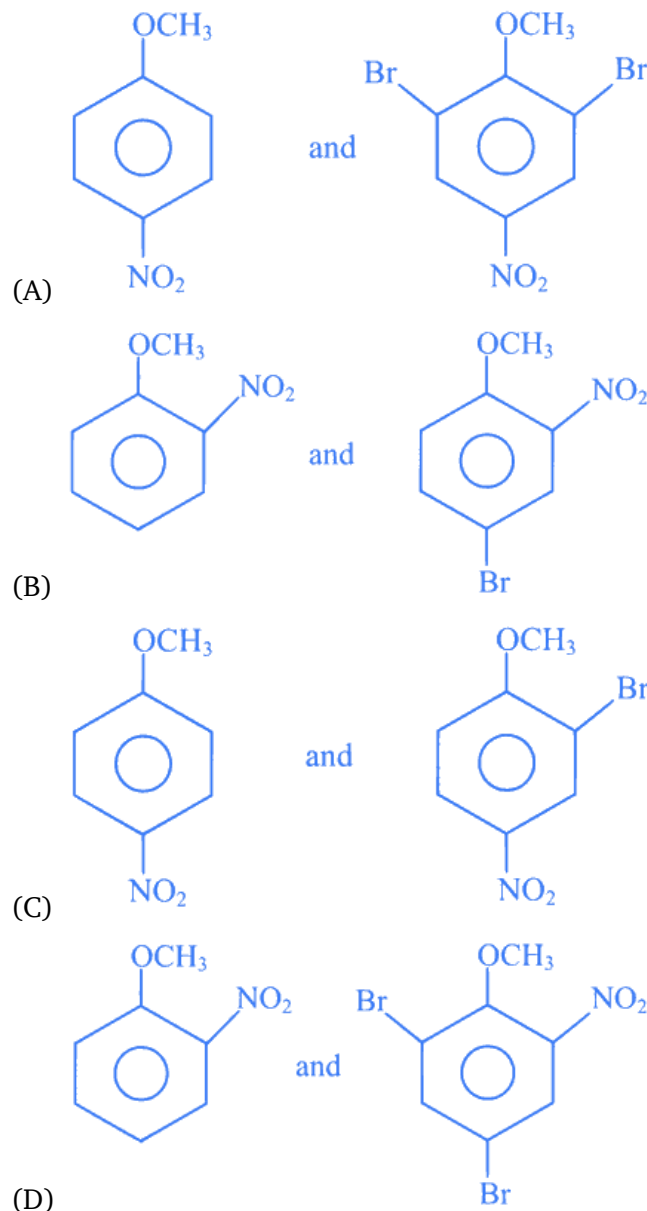
(C) (B) < (C) < (D) < (E) < (A)

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

75. The major products formed :



A and B respectively are :



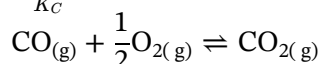
76. The incorrect statements regarding enzymes are :

- (A) Enzymes are biocatalysts.
- (B) Enzymes are non-specific and can catalyse different kinds of reactions.
- (C) Most Enzymes are globular proteins.
- (D) Enzyme - oxidase catalyses the hydrolysis of maltose into glucose.

Choose the correct answer from the option given below :

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

77. The ratio $\frac{K_p}{K_c}$ for the reaction :



is :

- (A) 1
- (B) $(RT)^{1/2}$
- (C) RT
- (D) $\frac{1}{\sqrt{RT}}$

78. The correct IUPAC name of $[\text{PtBr}_2(\text{PMe}_3)_2]$ is :

- (A) bis(trimethylphosphine)dibromoplatinum(II)
- (B) dibromodi(trimethylphosphine)platinum(II)
- (C) dibromobis(trimethylphosphine)platinum(II)
- (D) bis[bromo(trimethylphosphine)]platinum(II)

79. The incorrect statement regarding the geometrical isomers of 2-butene is :

- (A) cis-2-butene and trans-2-butene are not interconvertible at room temperature.
- (B) trans-2-butene is more stable than cis-2-butene.
- (C) cis-2-butene has less dipole moment than trans-2-butene.
- (D) cis-2-butene and trans-2-butene are stereoisomers.

80. Match List I with List II.

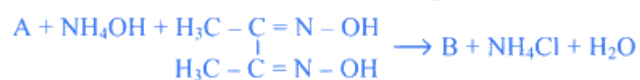
	LIST I Alkali Metal		LIST II Emission Wavelength in nm
A.	Li	I.	589.2
B.	Na	II.	455.5
C.	Rb	III.	670.8
D.	Cs	IV.	780.0

Choose the correct answer from the options given below :

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

Chemistry - Section B · Numerical Value Questions

81. Consider the following reactions



The number of protons that do not involve in hydrogen bonding in the product B is _____.

82. For the reaction at

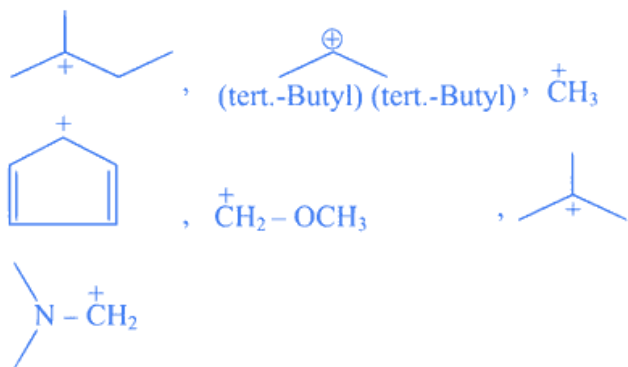


and

$$\Delta S = 0.2 \text{ kJ mol}^{-1} \text{ K}^{-1}$$

. The reaction will become spontaneous above _____ K.

83. Number of carbocations from the following that are not stabilized by hyperconjugation is _____.



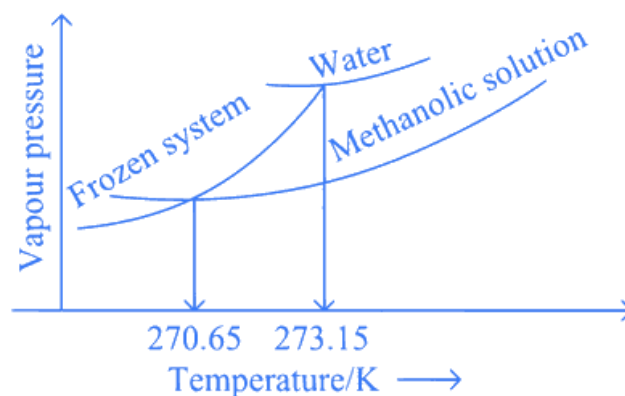
84. When ' x ' $\times 10^{-2}$ mL methanol (molar mass = 32 g

' density

$$= 0.792 \text{ g/cm}^3$$

) is added to 100 mL. water (density = 1 g/cm³

), the following diagram is obtained.

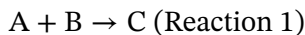


$x =$ _____ (nearest integer).

[Given : Molal freezing point depression constant of water at 273.15 K is 1.86 K kg mol⁻¹]

85. For hydrogen atom, energy of an electron in first excited state is -3.4 eV, K.E. of the same electron of hydrogen atom is x eV. Value of x is _____ $\times 10^{-1}$ eV. (Nearest integer)

86. Consider the two different first order reactions given below



The ratio of the half life of Reaction 1 : Reaction 2 is $5 : 2$. If t_1 and t_2 represent the time taken to complete $2/3^{\text{rd}}$ and $4/5^{\text{th}}$ of Reaction 1 and Reaction 2, respectively, then the value of the ratio $t_1 : t_2$ is _____ $\times 10^{-1}$ (nearest integer). [Given :

$$\log_{10}(3) = 0.477$$

and

$$\log_{10}(5) = 0.699$$

]

87. An amine (X) is prepared by ammonolysis of benzyl chloride. On adding p-toluenesulphonyl chloride to it the solution remains clear. Molar mass of the amine (X) formed is _____ gmol^{-1} .

(Given molar mass in gmol^{-1} : C : 12, H : 1, O : 16, N : 14)

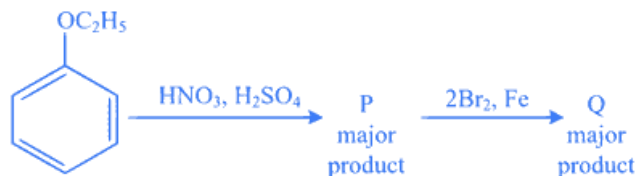
88. Among VO_2^+ , MnO_4^- and $\text{Cr}_2\text{O}_7^{2-}$, the spin-only magnetic moment value of the species with least oxidising ability is _____ BM (Nearest integer).

(Given atomic member

V = 23, Mn = 25, Cr = 24

)

89.



The ratio of number of oxygen atoms to bromine atoms in the product Q is _____ $\times 10^{-1}$.

90. Total number of species from the following with central atom utilising sp^2 hybrid orbitals for bonding is _____.

NH_3 , SO_2 , SiO_2 , BeCl_2 , C_2H_2 , C_2H_4 , BCl_3 , HCHO , C_6H_6 , BF_3 , $\text{C}_2\text{H}_4\text{Cl}_2$

- End of Question Paper -