JEE MAIN 2026

Sample Paper - 12

Time Allowed: 3 hours **Maximum Marks:** 300

General Instructions:

1. The test consists of total 75 questions.

2. Each subject (PCM) has 25 questions.

3. Each subject divided into two sections. Section A consists of 20 multiple-choice questions & Section B consists of 5 numerical value-type questions.

4. Marking Scheme:

- Section A (MCQs): +4 marks for each correct answer, -1 mark for each incorrect answer, 0 marks for unattempted.
- Section B (Numerical): +4 marks for each correct answer, 0 marks for incorrect or unattempted.

5. Any textual, printed, or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.

6. All calculations/written work should be done in the rough sheet is provided with the Question Paper.

MATHEMATICS **Max Marks: 100**

SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. The domain of f(x) is (0, 1), therefore, the domain of $y = f\left(e^x\right) + f\left(\ln|x|\right)$ is :

1) $\left(\frac{1}{e}, 1\right)$ **2)** $(-e, -1)$ **3)** $\left(-1, -\frac{1}{e}\right)$ **4)** $(-e, -1) \cup (1, e)$

2. $\lim\limits_{x\to\infty} \frac{3}{x}\left[\frac{x}{4}\right] = \frac{p}{q}$ (where [.] denotes greatest integer function), then $p+q$ (where p, q are relative prime) is :

1) 2 **2)** 7 **3)** 5 **4)** 6

3. If f(x) is a continuous function $\forall x \in R$ and the range of f(x) is $\left(2, \sqrt{26}\right)$ and $g(x) = \left[\frac{f(x)}{C}\right]$ is continuous $\forall x \in R$, then the least positive integral value of 'C' is : (where [.] denotes the greatest integer function)

1) 3 **2)** 5 **3)** 6 **4)** 7

4. If $f(x) = \lim\limits_{n\to\infty}\left(\prod\limits_{i=1}^{n} \cos\left(\frac{x}{2^i}\right)\right)$ then $f'(x)$ is equal to :

1) $\frac{\sin x}{x}$ **2)** $\frac{x}{\sin x}$ **3)** $\frac{x\cos x - \sin x}{x^2}$ **4)** $\frac{\sin x - x\cos x}{\sin^2 x}$

5. Let $f(x) = \begin{cases} 2-|x^2+5x+6| & x \neq -2 \\ b^2+1 & x = -2 \end{cases}$

Has relative maximum at x = -2, then complete set of values 'b' can take is:

1) $|b| \geq 1$ **2)** $|b| < 1$ **3)** $b > 1$ **4)** $b < 1$

6. If A is a square matrix of order 3 such that $\det(A)=3$ and $\det(adj(-4adj(-3adj(3adj((2A)^{-1})))))=2^m3^n$ .Then $m+2n$ is equal to:

1) 2 **2)** 3 **3)** 6 **4)** 4

7. Let p, q, r are positive real numbers, such that $27pqr \geq (p+q+r)^3$ and $3p+4q+5r=12$, then $p^3+q^4+r^5=$

1) 3 **2)** 6 **3)** 2 **4)** 4

8. The number of distinct real values of 'K' such that the system of equations $x + 2y + z = 1$, $x + 3y + 4z = K$, $x + 5y + 10z = K^2$ has infinitely many solutions is :

1) 0 **2)** 4 **3)** 2 **4)** 3

9. If A is matrix of order 3 such that $|A| = 5$ and B = adj A, then the value of $\left|\,|A^{-1}|(AB)^T\right|$ is equal to (where $|A|$ denotes determinant of matrix A. A^T denotes transpose of matrix A, A^{-1} denotes inverse of matrix A, adj A denotes adjoint of matrix A)

1) 5 **2)** 1 **3)** 25 **4)** $\frac{1}{25}$

10. The point P(3, 3) is reflected across the line y = -x. Then it is translated horizontally 3 units to the left and vertically 3 units up. Finally, it is reflected across the line y = x. What are the coordinates of the point after these transformations?

1) $(0,-6)$ **2)** $(0,0)$ **3)** $(-6,6)$ **4)** $(-6,0)$

11. **Statement–I** : A variable line drawn through a fixed point cuts the coordinate axes at A and B. The locus of mid-point of AB is a circle.

Statement–II : Through 3 non-collinear points in a plane, only one circle can be drawn.

1) Both statement 1 and statement 2 are true

2) Both statement 1 and statement 2 are false

3) Statement 1 is true, Statement 2 is false

4) Statement 1 is false, Statement 2 is true

12. The exact value of $\operatorname{cosec}10^0 + \operatorname{cosec}50^0 - \operatorname{cosec}70^0$ is :

1) 4 **2)** 5 **3)** 6 **4)** 8

13. If the equation $x^3 + bx^2 + cx + 1 = 0\ (b < c)$ has only one real root α. Then the value of $2\tan^{-1}(\operatorname{cosec}\alpha) + \tan^{-1}(2\sin\alpha\sec^2\alpha)$ is :

1) $-\frac{\pi}{2}$ **2)** $-\pi$ **3)** $\frac{\pi}{2}$ **4)** π

14. 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:

1) $x^2 + y^2 - 61 = 0$ **2)** $x^2 + y^2 - 52 = 0$

3) $x^2 + y^2 - 65 = 0$ **4)** $x^2 + y^2 - 74 = 0$

15. Match the following Column – I with Column – II

	Column-I		**Column-II**
(A)	$\lim\limits_{x\to\infty}\left(\frac{x^2+2x-1}{2x^2-3x-2}\right)^{\frac{2x+1}{2x-1}} =$	(P)	$\frac{1}{2}$
(B)	$\lim\limits_{x\to 0}\frac{\log_{\sec x/2}\cos x}{\log_{\sec x}\cos\frac{x}{2}} =$	(Q)	2
(C)	Let $f(x) = max.(cosx,\ x,\ 2x-1)$ where $x \geq 0$ then number of points of non-differentiability of f(x) is	(R)	5
(D)	If $f(x) = [2 + 3\sin x],\ 0 < x < \pi$ then number of points at which the function is discontinuous, is	(S)	16

1) A-P, B-S, C-Q, D-R **2)** A-S, B-Q, C-P, D-R

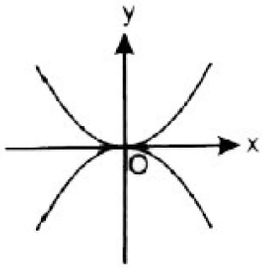
3) A-P, B-Q, C-S, D-R **4)** A-P, B-S, C-R, D-Q

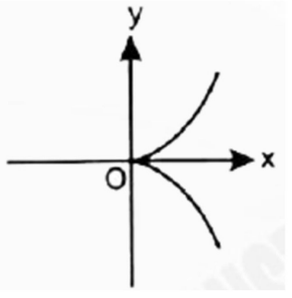
16. Find the locus of a point whose distance from x-axis is twice the distance from the point (1, -1, 2) :

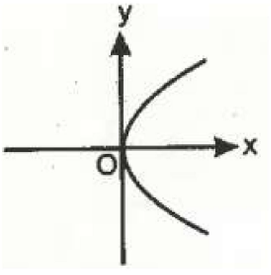
1) $y^2 + 2x - 2y - 4z + 6 = 0$ **2)** $x^2 + 2x - 2y - 4z + 6 = 0$

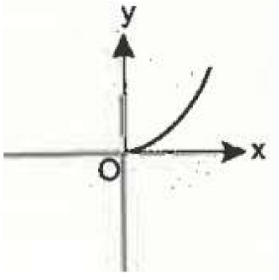
3) $x^2 - 2x + 2y - 4z + 6 = 0$ **4)** $z^2 - 2x + 2y - 4z + 6 = 0$

17. Which of the following is the graph of the curve $\sqrt{|y|} = x$ is ?

1) 

2) 

3) 

4) 

18. If $\log_{12} 27 = a$, then $\log_6 16 =$

1) $2\left(\frac{3-a}{3+a}\right)$ **2)** $3\left(\frac{3-a}{3+a}\right)$ **3)** $4\left(\frac{3-a}{3+a}\right)$ **4)** $4\left(\frac{2-a}{2+a}\right)$

19. Let $f(x) = x^2 + bx + c$, minimum value of f(x) is -5, then absolute value of the difference of the roots of f(x) is :

1) 5 **2)** $\sqrt{20}$ **3)** $\sqrt{15}$ **4)** Can't be determined

20. If a straight line having negative slope passing through the point P=(8,2) meets the x-axis at A y-axis at B respectively. Then the minimum value of OA+OB (O being origin) is ____

1) 20 **2)** 18 **3)** 10 **4)** 15

SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11).**

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases.

21. Let the maximum value of expression $y = \frac{x^4 - x^2}{x^6 + 2x^3 - 1}$ for $x > 1$ is $\frac{p}{q}$, where 'p' and 'q' are relatively prime natural numbers, then p + q =

22. If $\sum_{r=1}^{n}\left(\frac{\tan 2^{r-1}}{\cos 2^r}\right) = \tan p^n - \tan q$, then find the value of (p + q)

23. Let OA, OB, OC be coterminous edges of a cuboid. If *l*, m, n be the shortest distance between the sides OA, OB, OC and their respective skew body diagonals to them, respectively, then find $\frac{\left(\frac{1}{l^2} + \frac{1}{m^2} + \frac{1}{n^2}\right)}{\left(\frac{1}{OA^2} + \frac{1}{OB^2} + \frac{1}{OC^2}\right)}$

24. If $f(x) = x^2 + ax + 3$ and $g(x) = x + b$, where $F(x) = \lim_{n\to\infty} \frac{f(x) + (x^2)^n g(x)}{1 + (x^2)^n}$. If F(x) is continuous at x = 1 and x = -1 then find the value of $(a^2 + b^2)$

25. The set of natural numbers is divided into array of rows and columns in the form of matrices as $A_1 = [1]$, $A_2 = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$, $A_3 = \begin{bmatrix} 6 & 7 & 8 \\ 9 & 10 & 11 \\ 12 & 13 & 14 \end{bmatrix}$ and so on. Let the trace of A_{10} be λ. Find unit digit of λ?

PHYSICS **Max Marks: 100**

SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

26. The force of interaction between two atoms is given by $F = \alpha\beta\exp\left(-\frac{x^2}{\alpha kT}\right)$; where 'x' is the distance, 'k' is the Boltzmann constant and T is temperature and α and β are two constants. The dimensions of β is :

1) $M^0L^2T^{-4}$ **2)** M^2LT^{-4} **3)** MLT^{-2} **4)** $M^2L^2T^{-2}$

27. In a car race on straight road, car A takes a time 't' less than car B at the finish and passes finishing point with a speed 'v' more than of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then 'v' is equal to:

1) $\frac{2a_1a_2}{a_1+a_2}$ **2)** $\sqrt{2a_1a_2}t$ **3)** $\sqrt{a_1a_2}t$ **4)** $\frac{a_1+a_2}{2}t$

28. A goods train accelerating uniformly on a straight railway track, approaches an electric pole standing on the side of track. Its engine passes the pole with velocity u and the guard's room passes with velocity v. The middle wagon of the train passes the pole with a velocity.

1) $\frac{u+v}{2}$ **2)** $\frac{1}{2}\sqrt{u+v^2}$ **3)** $\sqrt{uv}$ **4)** $\sqrt{\left(\frac{u^2+v^2}{2}\right)}$

29. A ball projected from ground at an angle of 45^0 just clears a wall in front. If point of projection is 4 m from the foot of wall and ball strikes the ground at a distance of 6 m on the other side of the wall, the height of the wall is:

1) 4.4 m **2)** 2.4 m **3)** 3.6 m **4)** 1.6 m

30. From a sphere of mass M and radius R, a smaller sphere of radius $\frac{R}{2}$ is carved out such that the cavity made in the original sphere is between its centre and the periphery (See figure). For the configuration in the figure where the distance between the centre of the original sphere and the removed sphere is 3R, the gravitational force between the two sphere is:

1) $\frac{41GM^2}{3600R^2}$ **2)** $\frac{41GM^2}{450R^2}$ **3)** $\frac{59GM^2}{450R^2}$ **4)** $\frac{GM^2}{225R^2}$

31. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-1 : For a mass *M* kept at the centre of a cube of side '*a*', the flux of gravitational field passing through its sides $4\pi GM$ and

Statement-2: If the direction of a field due to a point source is radial and its dependence on the distance '*r*' from the source is given as $\frac{1}{r^2}$, its flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface.

1) Statement -1 is false, Statement-2 is true
2) Statement -1 is true, Statement-2 is true; Statement -2 is a correct explanation for Statement-1
3) Statement -1 is true, Statement-2 is true; Statement - 2 is not a correct explanation for Statement-1
4) Statement -1 is true, Statement-2 is false

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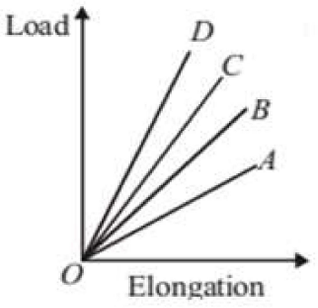
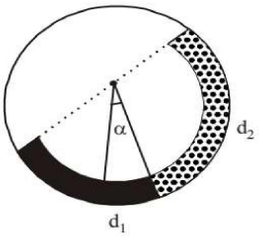
32. The load versus elongation graphs for four wires of same length and made of the same material are shown in the figure. The thinnest wire is represented by the line



1) OA **2)** OC **3)** OD **3)** OB

33. There is a circular tube in a vertical plane. Two liquids which do not mix and of densities d_1 and d_2 are filled in the tube. Each liquid subtends 90^0 angle at centre. Radius joining their interface makes an angle α with vertical. Ratio $\frac{d_1}{d_2}$ is



1) $\frac{1+\sin\alpha}{1-\sin\alpha}$ **2)** $\frac{1+\cos\alpha}{1-\cos\alpha}$ **3)** $\frac{1+\tan\alpha}{1-\tan\alpha}$ **4)** $\frac{1+\sin\alpha}{1-\cos\alpha}$

34. Spherical balls of radius 'R' are falling in a viscous fluid of viscosity 'η' with a velocity 'v'. The retarding viscous force acting on the spherical ball is

1) inversely proportional to both radius 'R' and velocity 'v'

2) directly proportional to both radius 'R' and velocity 'v'

3) directly proportional to 'R' but inversely proportional to 'v'

4) inversely proportional to 'R' but directly proportional to velocity 'v'

35. This question has Statement-1 and Statement-2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement-1: A capillary is dipped in a liquid and liquid rises to a height h in it. As the temperature of the liquid is raised, the height h increases (if the density of the liquid and the angle of contact remain the same).

Statement-2: Surface tension of a liquid decreases with the rise in its temperature.

1) Statement-1 is true, Statement-2 is true; Statement-2 is **not** the correct explanation for Statement-1.

2) Statement-1 is false, Statement-2 is true.

3) Statement-1 is true, Statement-2 is false.

4) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation for Statement-1

36. Match the thermodynamic processes taking place in a system with the correct conditions. In the table : ΔQ is the heat supplied, ΔW is the work done and ΔU is change in internal energy of the system.

Process	**Condition**
I) Adiabatic	A) $\Delta W = 0$
II) Isothermal	B) $\Delta Q = 0$
III) Isochoric	C) $\Delta U \neq 0, \Delta W \neq 0, \Delta Q \neq 0$
IV) Isobaric	D) $\Delta U = 0$

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

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

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

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

37. A gas is compressed from a volume of $2m^3$ to a volume of $1m^3$ at a constant pressure of 100 N/m^2. Then it is heated at constant volume by supplying 150 J of energy. As a result, the internal energy of the gas:

1) increases by 250 J **2)** decreases by 250 J

3) increases by 50 J **4)** decreases by 50 J

38. One mole of an ideal gas passes through a process where pressure and volume obey the relation $P = P_0\left[1-\frac{1}{2}\left(\frac{V_0}{V}\right)^2\right]$. Here P_0 and V_0 are constants. Calculate the charge in the temperature of the gas if its volume changes from V_0 to $2V_0$

1) $\frac{1}{2}\frac{P_0V_0}{R}$ **2)** $\frac{5}{4}\frac{P_0V_0}{R}$ **3)** $\frac{3}{4}\frac{P_0V_0}{R}$ **4)** $\frac{1}{4}\frac{P_0V_0}{R}$

39. The number density of molecules of a gas depends on their distance '*r*' from the origin as, $n(r) = n_0e^{-\alpha r^4}$. Then the total number of molecules is proportional to :

1) $n_0\alpha^{-3/4}$ **2)** $\sqrt{n_0}\alpha^{1/2}$ **3)** $n_0\alpha^{1/4}$ **4)** $n_0\alpha^{-3}$

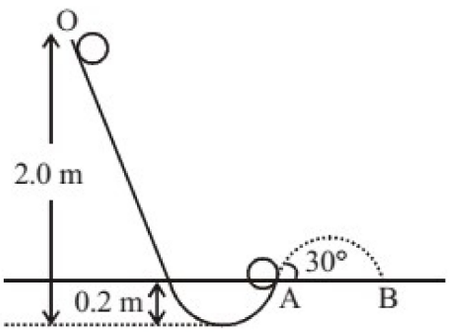
40. A thermally insulated vessel contains an ideal gas of molecular mass *M* and ratio of specific heats γ. It is moving with speed *v* and it's suddenly brought to rest. Assuming no heat is lost to the surroundings, its temperature increases by :

1) $\frac{(\gamma-1)}{2\gamma R}Mv^2K$ **2)** $\frac{\gamma M^2v}{2R}K$ **3)** $\frac{(\gamma-1)}{2R}Mv^2K$ **4)** $\frac{(\gamma-1)}{2(\gamma+1)R}Mv^2K$

41. In a process, temperature and volume of one mole of an ideal monoatomic gas are varied according to the relation VT = K, where K is a constant. In this process the temperature of the gas is increased by ΔT. The amount of heat absorbed by gas is (R is gas constant) :

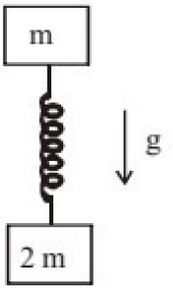
1) $\frac{1}{2}R\Delta T$ **2)** $\frac{1}{2}KR\Delta T$ **3)** $\frac{3}{2}R\Delta T$ **4)** $\frac{2K}{3}\Delta T$

42. A tennis ball (treated as hollow spherical shell) starting from O rolls down a hill. At point A the ball becomes air borne leaving at an angle of 30^0 with the horizontal. The ball strikes the ground at B. What is the value of the distance AB? (Moment of inertia of a spherical shell of mass *m* and radius *R* about its diameter = $\frac{2}{3}mR^2$)



1) 1.87 m **2)** 2.08 m **3)** 1.57 m **4)** 1.77 m

43. Two bodies of mass m and 2m connected by an unextended spring of spring constant 'k' are allowed to fall simultaneously in a uniform gravitational field g. The extension 'x' in the spring when the bodies A and B are falling



1) varies with time as $x = A \sin(\omega t + \phi)$

2) is constant and has value $\sqrt{\frac{2mg}{k}}$

3) is zero

4) increases linearly with time

44. Assertion (A) : A solid sphere and hollow sphere when released from the top of a smooth and fixed inclined plane, reach the ground simultaneously

Reason (R) : Acceleration while sliding is independent of mass and dimension of the body

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) & (R) are true but (R) is not correct explanation of (A)

3) (A) is true and (R) is false

4) (A) is false but (R) is true

45. Assertion (A) : A body of mass m_1 collies head on elastically with another body of mass m_2 at rest the ratio of the final energy of the first body to the final energy of the second body is $\frac{(m_1 - m)^2}{4m_1 m_2}$

Reason (R) : The collision is perfectly elastic and the coefficient of restitution is 1.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) & (R) are true but (R) is not correct explanation of (A)

3) (A) is true and (R) is false

4) Both (A) (R) are false

SECTION-II (NUMERICAL VALUE TYPE)

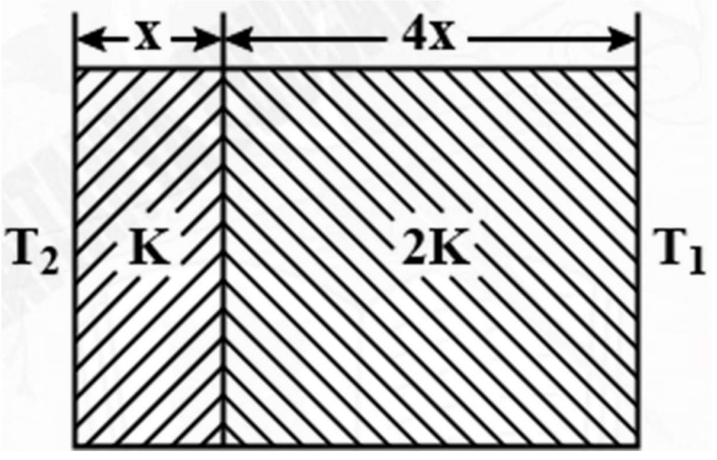
This section contains **5 Numerical Value Type Questions**. The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11**).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

46. A particle starts S.H.M. from the mean position. Its amplitude is a and total energy E. At one instant its kinetic energy is 3E/4, its displacement at this instant is $y = \frac{a}{x}$. Find the value of '*x*'.

47. A uniform thin rod AB of length L has linear mass density $\mu(x) = a + \frac{bx}{L}$, where 'x' is measured from A. If the CM of the rod lies at a distance of $\left(\frac{7}{12}\right)L$ from A, then *a* and *b* are related as b = xa. Find the value of 'x'.

48. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity *K* and 2*K* and thickness *x* and 4*x*, respectively, are T_2 and $T_1(T_2 > T_1)$. The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2 - T_1)K}{x}\right)f$. Find the value of 100 f.



49. A block of mass 2 kg rests on a rough inclined plane making an angle of 30^0 with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is ..... N $\left(\text{take } g = 10 \text{ m/s}^2\right)$

50. A moving particle of mass *m*, makes a head on elastic collision with another particle of mass 2*m*, which is initially at rest. The percentage loss in energy of the colliding particle on collision, is close to .....

CHEMISTRY **Max Marks: 100**

SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

51. Consider the following statements

A) BF_3 does not have a proton but still acts as an acid

B) Strong acids have very strong conjugate bases

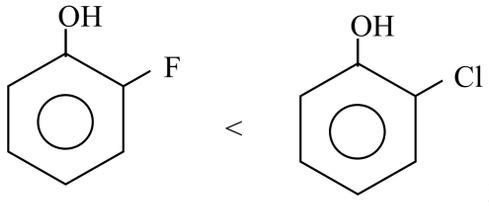
C) Stronger acid donates a proton to the stronger base

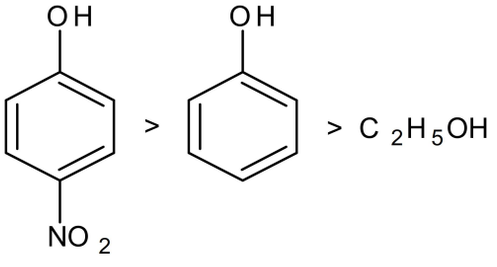
Incorrect statement(s) is/are

1) (A) only **2)** (B) only

3) (A) and (B) only **4)** (A) and (C) only

52. Which of the following incorrectly represent the acidic strength of given acids?

1) 

2) 

3) $CH_2FCOOH > CH_2NO_2COOH$ **4)** $CH_3COOH > CH_3CH_2OH$

53. An electron practically at rest, is initially accelerated through a potential difference of 100 volts. It then has a de Broglie wavelength $= \lambda_1 A^0$. It then get retarted through 19 volts and then has a wavelength $\lambda_2 A^0$. It further retardation through 32 volts changes the wavelength to $\lambda_3\ A^0$. What is the value of $\frac{\lambda_3 - \lambda_2}{\lambda_1}$?

1) $\frac{20}{41}$ **2)** $\frac{10}{63}$ **3)** $\frac{20}{63}$ **4)** $\frac{10}{41}$

54. Consider the following equilibrium at 300K and 400K with their equilibrium constants and choose the correct statement

	Reactions	300K	400K
I	$A(g) \rightleftharpoons 2B(g)$	$K_{eq} = 10$	$K_{eq} = 5$
II	$C(g) \rightleftharpoons D(g)$	$K_{eq} = 2$	$K_{eq} = 5$

1) I is endothermic, II is exothermic **2)** I is exothermic, II is endothermic

3) I and II both are endothermic **4)** I & II both are exothermic

55. The solubilities of AgCl in water, 0.01M $CaCl_2$, 0.01M NaCl and 0.05M $AgNO_3$ are denoted by S_1, S_2, S_3 and S_4 respectively. Which of the following relationships is correct?

1) $S_1 > S_2 > S_3 > S_4$ **2)** $S_1 > S_3 > S_2 > S_4$

3) $S_1 > S_2 = S_3 > S_4$ **4)** $S_1 > S_3 > S_4 > S_2$

56. In which of the following reaction, the underlined substance has been reduced?

1) $\underline{CO} + CuO \rightarrow \underline{CO_2} + Cu$

2) $\underline{CuO} + 2HCl \rightarrow \underline{CuCl_2} + H_2O$

3) $\underline{4H_2O(g)} + 3Fe \rightarrow \underline{4H_2}(g) + Fe_3O_4$

4) $\underline{C} + 4HNO_3 \rightarrow \underline{CO_2} + 2H_2O + 4NO_2$

57. A sample of hydrate of barium chloride weighing 61 g was heated until all the water of hydration is removed. The dried sample weighed 52g. The formula of the hydrated salt is: (atomic mass of Ba = 137 amu, Cl = 35.5 amu)

1) $BaCl_2 . H_2O$ **2)** $BaCl_2 . 3H_2O$

3) $BaCl_2 . 4H_2O$ **4)** $BaCl_2 . 2H_2O$

58. Which of the following reaction(s) has a positive entropy change?

I) $Ag^{+}(aq)+Cl^{-}(aq)\rightarrow AgCl(s)$ II) $NH_4Cl(s)\rightarrow NH_3(g)+HCl(g)$

III) $2NH_3(g)\rightarrow N_2(g)+3H_2(g)$

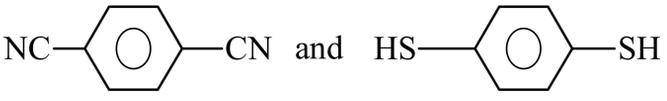
1) I and II **2)** III only **3)** II & III **4)** II only

59. Which of the following pairs have similar shape?

1) $N(CH_3)_3, N(SiH_3)_3$ **2)** NF_3, BF_3

3) SO_3, CO_3^{-2} **4)** CH_4, XeF_4

60. **Assertion (A):**



both compounds will have zero dipole moment.

Reason (R) : –CN group is linear but –SH group is non linear with benzene ring.

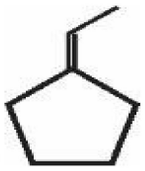
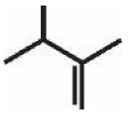
1) Assertion (A) is True, **Reason (R)** is True; **Reason (R)** is **a Correct** explanation for **Assertion (A)**

2) Assertion (A) is True, **Reason (R)** is True; **Reason (R)** is **NOT a Correct** explanation for **Assertion (A)**

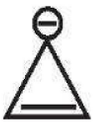
3) Assertion (A) is True, **Reason (R)**is False

4) Assertion (A) is False, **Reason (R)** is True

61. Which of the following alkenes does not give acetaldehyde as one of the products on reductive ozonolysis?

1)  **2)**  **3)**  **4)** 

62. Aromatic species among the following is

1)  **2)**  **3)**  **4)** 

63. Consider the following statements about propyne

A) It decolourises the colour of Baeyer's reagent

B) It liberates hydrogen gas on reaction with sodium

C) On reaction with $HgSO_4$ and dilute H_2SO_4 it forms propanal as major product

The correct statements are

1) (A) and (B) only **2)** (B) and (C) only

3) (A) and (C) only **4)** (A), (B) and (C)

64. Consider the following statements

A) Methane can be prepared by Kolbe's electrolytic method

B) Ethane has infinite number of conformations

C) Magnitude of torsional strain in ethane depends upon the angle of rotation about C – C bond

D) n-hexane undergoes isomerisation reaction in presence of anhyd. $AlCl_3$ and HCl

The correct statements are

1) (A), (B) and (C) only **2)** (A), (C) and (D) only

3) (A), (B), (C) and (D) **4)** (B), (C) and (D) only

65. Which is not correct in case of Be and Al?

1) Both are rendered passive by conc. HNO_3

2) Both give hydroxides which are basic

3) Carbides of both give methane on hydrolysis

4) Both give covalent chlorides

66. Which of the following statement is incorrect

1) Tl^{+3} is an oxidizing agent **2)** In^{+1} is reducing agent

3) Tl form M_2O type oxide **4)** Pb^{+4} is a reducing agent

67. Correct order of IP_1 is

1) B > Al > Ga > In > Tl **2)** B > Tl > Ga > Al > In

3) B > Ga > Al > Tl > In **4)** B > Al > Ga > Tl > In

68. **Assertion (A)**: In water, orthoboric acid behaves as weak monobasic acid
Reason (R): In water, orthoboric acid acts as proton donor.

1) Assertion (A) is True, **Reason (R)** is True; **Reason (R)** is **a Correct** explanation for **Assertion (A)**

2) Assertion (A) is True, **Reason (R)** is True; **Reason (R)** is **NOT a Correct** explanation for **Assertion (A)**

3) Assertion (A) is True, **Reason (R)**is False

4) Assertion (A) is False, **Reason (R)** is True

69. Which of the following order is not correct?

1) $AlCl_3 > MgCl_2 > NaCl$[cov *alent character*]

2) B > Al > Tl > In > Ga [melting point]

3) $AlCl_3 > MgCl_2 > NaCl$[*melting po* int]

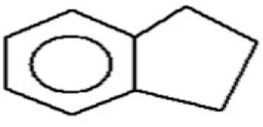
4) C > Ge > Si > Pb > Sn (3^{rd} ionization enthalpy)

70. Consider the following sequence of reactions and identify the final product(Z)

$$C_6H_6 + CH_2 = CHCH_2Cl \xrightarrow{AlCl_3} (X) \xrightarrow[(ii)H_2O_2,OH^-]{(i)BH_3,THF} (Y) \xrightarrow{BF_3} (Z)(C_9H_{10})$$

Major

1) $PhCH_2CH = CH_2$ **2)** $PhCH = CH - CH_3$

3)  **4)** $PhC(CH_3) = CH_2$

SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11).**

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

71. The maximum number of electrons that can have principal quantum number, n = 3, and spin quantum number $m_s = -\frac{1}{2}$, is :

72. For the equilibrium $\underset{(g)}{AB} \rightleftharpoons \underset{(g)}{A} + \underset{(g)}{B}$, at a given temperature $\frac{1}{3}$rd of AB is dissociated, then $\frac{P}{K_p}$ will be numerically equal to …… (P = Pressure of the mixture at equilibrium)

73. 6×10^{-3} mole $M_2O_7^{2-}$ reacts completely with 9×10^{-3} mole X^{n+} to give XO_3^- and M^{3+}. The value of 'n' is (M = metal)

74. Consider the following data $\Delta_f H^0(N_2H_4, l) = 50$ kJ / mol, $\Delta_f H^0(NH_3, g) = -46$ kJ / mol B.E (N – H) = 393 kJ/mol and B.E (H – H) = 436 kJ/mol, $\Delta_{vap}H(N_2H_4, l) = 18$ kJ / mol. The N – N bond energy in N_2H_4 is (kJ/mol)

75. The first and second ionization potentials of an element M (atomic weight= 25) are 800 and 1500 Kj/mol respectively. Calculate the percentage of M^{+2} (g) ions formed if 5 g of M(g) absorbs 250 kJ of energy.

ANSWER KEY

MATHEMATICS

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

PHYSICS

26	**2**	27	**3**	28	**4**	29	**2**	30	**1**
31	**2**	32	**1**	33	**3**	34	**2**	35	**2**
36	**4**	37	**1**	38	**2**	39	**1**	40	**3**
41	**1**	42	**1**	43	**3**	44	**1**	45	**1**
46	**2**	47	**2**	48	**33**	49	**10**	50	**89**

CHEMISTRY

51	**2**	52	**3**	53	**3**	54	**2**	55	**2**
56	**3**	57	**4**	58	**3**	59	**3**	60	**4**
61	**3**	62	**4**	63	**1**	64	**4**	65	**2**
66	**4**	67	**2**	68	**3**	69	**3**	70	**3**
71	**9**	72	**8**	73	**1**	74	**190**	75	**30**

SOLUTION
MATHEMATICS

1. $y = f\left(e^x\right) + f\left(\ln|x|\right)$

   domain $f(x) = (0, 1)$ $\quad \Rightarrow 0 < e^x < 1 \Rightarrow \ x < 0 \ \ .....(1)$

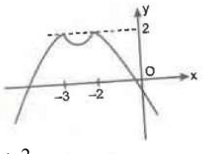
   and $\ 0 < \ln|x| < 1 \Rightarrow 1 < |x| < e \Rightarrow x \in (-e, -1) \cup (1, e) \ .....(2)$

   Taking intersection $x \in (-e, -1)$

2. $\lim\limits_{x\to\infty} \dfrac{3}{x}\left(\dfrac{x}{4} - \left\{\dfrac{x}{4}\right\}\right) = \dfrac{3}{4} - 0 = \dfrac{3}{4} \quad \Rightarrow p + q = 7$

3. $c > \sqrt{26}$

4. $f(x) = \lim\limits_{n\to\infty}\left(\cos\dfrac{}{2}.\cos\dfrac{x}{2^2}.\cos\dfrac{x}{2^3}.....\cos\dfrac{}{2^n}\right) = \lim\limits_{n\to\infty} \dfrac{}{\dfrac{1}{2^n}\sin\left(\dfrac{x}{2^n}\right)} = \dfrac{}{x}$

5. 

   $b^2 + 1 \geq 2$

   $|A| = 3$

   $|\text{adj}(-4\,\text{adj}(-3\,\text{adj}(3\,\text{adj}((2\,A)^{-1}))))|$

   $|-4\,\text{adj}\left(-3\,\text{adj}(3\,\text{adj}(2\,A)^{-1})\right|^2$

   $4^6|\text{adj}(-3\,\text{adj}(3\,\text{adj}(2\,A)^{-1}))|^2$

   $2^{12} \cdot 3^{12}|3\,\text{adj}(2\,A)^{-1}|^8$

   $2^{12} \cdot 3^{12} \cdot 3^{24}|\text{adj}(2\,A)^{-1}|^8$

   $2^{12} \cdot 3^{36}|(2\,A)^{-1}|^{16}$

   $2^{12} \cdot 3^{36}\frac{1}{|2\,A|^{16}}$

   $2^{12} \cdot 3^{36}\frac{1}{2^{48}|\,A|^{16}}$

   $2^{12} \cdot 3^{36}\frac{1}{2^{48}.3^{16}}$

   $\frac{3^{20}}{2^{36}} = 2^{-36} \cdot 3^{20}$

   $m = -36 \quad n = 20$

6. $m + 2n = 4$

7. A.M = G.M only when p = q = r

8. $D = \begin{vmatrix} 1 & 2 & 1 \\ 1 & 3 & 4 \\ 1 & 5 & 10 \end{vmatrix} = 0 \qquad D_1 = \begin{vmatrix} 1 & 2 & 1 \\ K & 3 & 4 \\ K^2 & 5 & 10 \end{vmatrix} = 5\left(K^2 - 3K + 2\right) = 5(K-1)(K-2)$

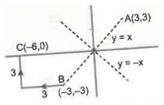
   $D_2 = \begin{vmatrix} 1 & 1 & 1 \\ 1 & K & 4 \\ 1 & K^2 & 10 \end{vmatrix} = -3\left(K^2 - 3K + 2\right) = -3(K-2)(K-1)$

$$D_3=\begin{vmatrix}1 & 2 & 1\\ 1 & 3 & K\\ 1 & 5 & K^2\end{vmatrix}=K^2-3K+2=(K-2)(K-1)$$

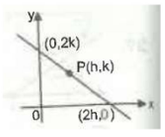
9. $\left|A^{-}\right|=\dfrac{1}{|A|}=\dfrac{1}{5}$ $\quad\left|(AB)^T\right|=|AB|=\left|A.(\text{adj } A)\right|=|A|.|\text{adj. }(A)|=5\times5^2=5^3$

$$\therefore\left|A^{-1}\right|(AB)^T\left|=\left|\frac{1}{5}(AB)^T\right|=\frac{1}{5^3}|AB|=1\right.$$

10.



11. Equation of line is $\dfrac{x}{2h}+\dfrac{y}{2k}=1$



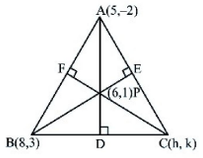
If it passes through fixed point (x_1, y_1) $\quad\dfrac{x_1}{2h}+\dfrac{y_1}{2k}=1$

12. $\cos ec\,\theta+\cos ec\left(60^0-\theta\right)-\cos ec\left(60^0+\theta\right)$ where $\theta=10^0$

13. $x^3+bx^2+cx+1=0$ $\quad f(-1)=b-c<0$ $\quad f(0)=1>0$ $\quad B\in(0,1)$

$$y=-2\tan^{-1}(\cos ecB)-\tan^{-1}\left(\frac{2\sin B}{\cos^2 B}\right)=-\left(\pi+\tan^{-1}\frac{2\cos B}{1-\cos ec^2 B}\right)-\tan^{-1}\frac{2\sin B}{\cos^2 B}=-\pi$$

14.



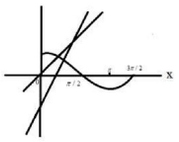
Slope of AD =3, $\quad$ Slope of BC $=-\dfrac{1}{3}$, $\quad$ Equation of BC =3y+x-17=0

Slope of BE =1, $\quad$ Slope of AC =-1, $\quad$ Equation of AC is x+y-3=0 , $\quad$ point C is (-4, 7)

15. (A) $\lim\limits_{x\to\infty}\left(\dfrac{x^2+2x-1}{2x^2-3x-2}\right)^{\frac{2x+1}{2x-1}}=\dfrac{1}{2}$

(B) $\lim\limits_{x\to0}\dfrac{\log_{\sec x/2}\cos x}{\log_{\sec x}\cos\dfrac{x}{2}}=\lim\limits_{x\to0}\left(\log_{\sec\frac{x}{2}}\cos x\right)^2=\lim\limits_{x\to0}\left(\dfrac{In\cos x}{In\sec x/2}\right)^2=2$

(C)



(D) $\sin x\neq\dfrac{1}{3},\dfrac{2}{3},\dfrac{3}{3}$

16. Let the point $P\ x_p, y_p, z_p$ be the required point,

the distance of the point from x-axis is $\sqrt{y_p^2+z_p^2}$, The distance from the point (1, -1, 2) is

$\Rightarrow y_p^2+z_p^2=(x_p-1)^2+(y_p+1)^2+(z_p-2)^2 \Rightarrow x_p^2-2x_p+2y_p-4z_p+6=0$

Therefore, the locus of point P is $x^2-2x+2y-4z+6=0$

17. $g(x)=\dfrac{1}{f(|x|)}$ $g(x)\Rightarrow$ even functions $\Rightarrow$ symmetric about y-axis

$\Rightarrow x\to\infty\ f(x)\to 0$ at $x=x_1\ f(x)=0\Rightarrow g(x_1)\to\infty$

18. $a=\dfrac{3}{1+2\log_3 2}\Rightarrow \log_3 2=\dfrac{3-a}{2a};\ \log_6 16=\dfrac{4\log_3 2}{1+\log_3 2}$

19. Minimum value $\dfrac{-D}{4}=-5\Rightarrow D=20 \quad |\alpha-\beta|=\dfrac{\sqrt{D}}{1}=\sqrt{20}$

20. Equation of line is $y-2=m(x-8)$, $OA=8+\dfrac{2}{(-m)}$ and $OB=8(-m)+2$

$OA+OB=10+8(-m)+\dfrac{2}{(-m)}\geq 18\ (AM\geq GM)$

21. $y=\dfrac{x-\frac{1}{x}}{x^3-\frac{1}{x^3}+2}$ Let $t=x-\dfrac{1}{x}>0$ for $x>1$, $y=\dfrac{t}{t(t^2+3)+2}$ $x^3-\dfrac{1}{x^3}=t(t^2+3)$

$=\dfrac{1}{t^2+\frac{2}{t}+}\left\{\begin{array}{l} t^2+\frac{2}{t}=t^2+\frac{1}{t}+\frac{1}{t}\geq 3 \\ \therefore t^2+\frac{2}{t}+3\geq 6(AM\geq GM)\end{array}\right.$, $y_{max}=\dfrac{1}{\left(t^2+\frac{2}{t}+3\right)_{min}}=\dfrac{1}{6}$ $p=1, q=6$

22. $\displaystyle\sum_{r=1}^{n}\frac{\sin(2^r-2^{r-1})}{\cos 2^r\cos 2^{r-1}}=\sum_{r=1}^{n}(\tan 2^r-\tan 2^{r-1})=\tan 2^n-\tan 1$

23. Let $l=m=n=\dfrac{1}{\sqrt{2}}$

24. $F(x)=f(x)$ $x>1$ $=\dfrac{f(x)+g(x)}{2}$ $x=1$

$=f(x)$ $-1<x<1$ $=\dfrac{f(x)+g(x)}{2}$ $x=-1$

$=g(x)$ $x<-1$

If f(x) is continuous at $x=1$ $F(1^+)=F(1)=F(1^-)$ $b=a+3$

$F(-1^-)=F(-1)=F(-1^+)$ $a+b=5$

25. First element of matrix $A_{10}=286$ (10^{th} of sequence 1, 2, 6, 15, …….)

Trace of $A_{10}=286+297+308+319+.....+385=3055$

26. Force of interaction between two atoms,

$F = \alpha\beta e^{\left(\frac{-x^2}{\alpha kT}\right)}$

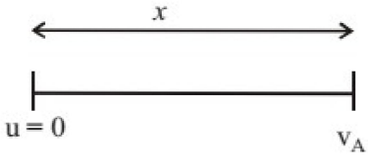
Since exponential terms are dimensionless $\therefore \alpha\beta e^{\left(\frac{-x^2}{\alpha kT}\right)}$

$[F] = [\alpha][\beta]$

$MLT^{-2} = M^{-1}T^2[\beta] \quad \Rightarrow [\beta] = M^2LT^{-4}$

27. Let time taken by A to reach finishing point is t_0

$\therefore$ Time taken by B to reach finishing point $= t_0 + t$



$v_A = a_1 t_0$

$v_B = a_2(t_0 + t)$

$\Rightarrow \sqrt{a\ t_0} = \sqrt{a_2}(t_0 + t) \quad \Rightarrow \left(\sqrt{a_1} - \sqrt{a_2}\right)t_0 = \sqrt{a_2 t} \quad \Rightarrow t_0 = \dfrac{\sqrt{a_2 t}}{\sqrt{a_1} - \sqrt{a_2}}$

$= \left(\sqrt{a_1} + \sqrt{a_2}\right)\sqrt{a_2 t} - \quad = \sqrt{a_1 a\ t} + \quad -$

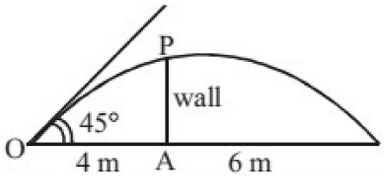
28. Let '*S*' be the distance between two ends '*a*' be the constant acceleration

As we know $v^2 - u^2 = 2aS$

Let *v* be velocity at mid point.

$\text{therefore, } v_c^2 - u^2 = 2a\dfrac{S}{2} \quad v_c^2 = u^2 + \dfrac{v^2 - u^2}{2} \quad v_c = \sqrt{\dfrac{+v^2}{2}}$

29.



As ball is projected at an angle 45^0 to the horizontal therefore Range = 4H

$\text{or } 10 = 4H \Rightarrow H = \dfrac{10}{4} = 2.5 \text{ m}$

$\text{Height of wall PA } = OA\tan\theta - \dfrac{1}{2}\dfrac{g(OA)^2}{u^2\cos^2\theta} = 4 - \dfrac{1}{2} \times \dfrac{10 \times 16}{10 \times 10 \times \frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}}} = 2.4 \text{ m}$

30. Volume of removed sphere

$V_{remo} = \dfrac{4}{3}\pi\left(\dfrac{R}{2}\right)^3 = \dfrac{4}{3}\pi R^3\left(\dfrac{1}{8}\right)$

Volume of the sphere (remaining)

$$V_{remain} = \frac{4}{3}\pi R^3 - \frac{4}{3}\pi R^3\left(\frac{1}{8}\right) = \frac{4}{3}\pi R^3\left(\frac{7}{8}\right)$$

Therefore mass of sphere carved and remaining sphere

Are at respectively $\frac{1}{8}M$ and $\frac{7}{8}M$

Therefore, gravitational force between these two sphere $\simeq \frac{41}{3600}\frac{GM^2}{R^2}$

31. Gravitational field, $E = -\frac{GM}{r^2}$

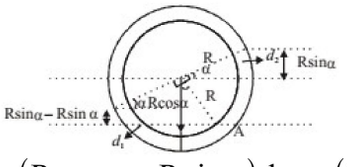
Flux, $\phi = \int \vec{E}_g . \vec{dS} = | E . 4\pi r^2 | = -4\pi GM$

Where, M = mass enclosed in the closed surface

This relationship is valid when $\left|\vec{E}_g\right| - \propto \frac{1}{r^2}$

32. From the graph, it is clear that for the same value of load, elongation is maximum for wire *OA*. Hence *OA* is the thinnest wire among the four wires.

33. Pressure at interface A must be same from both the sides to be in equilibrium



$$\therefore (R\cos\alpha + R\sin\alpha)d_2 g = (R\cos\alpha - R\sin\alpha)d_1 g$$

$$\Rightarrow \frac{d_1}{d_2} = \frac{\cos\alpha + \sin\alpha}{\cos\alpha - \sin\alpha} = \frac{1+\tan\alpha}{1-\tan\alpha}$$

34. From Stoke's law, force of viscosity acting on a spherical body is

$F = 6\pi\eta rv$

hence *F* is directly proportional to radius & velocity.

35. Surface tension of a liquid decreases with the rise in temperature. At the boiling point of liquid, surface tension is zero. Capillary rise $h = \frac{2T\cos\theta}{rdg}$

As surface tension T decreases with rise in temperature

hence capillary rise also decreases

36. I) Adiabatic process : No exchange of heat takes place with surroundings. $\Rightarrow \Delta Q = 0$

II) Isothermal process : Temperature remains constant

$$\therefore \Delta T = 0 \Rightarrow \Delta U = \frac{f}{2} n R\Delta T \Rightarrow \Delta U = 0$$

No change in internal energy [D*U* = 0].

III) Isochoric process volume remains constant

$$\Delta V = 0 \Rightarrow W = \int P . dV = 0$$

Hence work done is zero.

IV) In isobaric process pressure remains constant

$$\Delta U = \frac{f}{2} nR\Delta T = \frac{f}{2}[P\Delta V] \neq 0 \qquad \therefore \Delta Q = nC_p \Delta T \neq 0$$

37. As we know,

$\Delta Q = \Delta u + \Delta w$ (I^{st} law of thermodynamics) $\Rightarrow \Delta Q = \Delta u + P\Delta v$

or $150 = \Delta u + 100(1-2) \;\; = \Delta u = 100 \;\; \therefore \Delta u = 150 + 100 = 250 J$

38. We have given, $P = P_0\left[1 + \frac{1}{2}\left(\frac{V_0}{V}\right)^2\right]$

When $V_1 = V_0 \qquad \Rightarrow P_1 = P_0\left[1 - \frac{1}{2}\right] = \frac{P_0}{2}$

When $V_2 = 2V_0$

$$\Delta T = \left|\left(\frac{1}{nR}\right)(P_1V_1 - P_2V_2)\right| = \left(\frac{1}{nR}\right)\left|\left(\frac{P_0V_0}{2} - \frac{7P_0V_0}{4}\right)\right| = \frac{5P_0V_0}{4nR} = \frac{5P_0V_0}{4R} \;\; (\because n = 1)$$

39. $N = \int \rho(dv) = \int_0^r n_0 e^{-\alpha r^4} \times 4\pi r^2 dr = 4p\, n_0 \int_0^r r^2\left(e^{-\alpha r^4}\right)dr \qquad \propto n_0 a^{-3/4}$

40. As, work done is zero.

So, loss in kinetic energy = heat gain by the gas

$$\frac{1}{2}mv^2 = nC_v\Delta T = n\frac{R}{\gamma - 1}\Delta T \qquad \frac{1}{2}mv^2 = \frac{m}{M}\frac{R}{\gamma - 1}\Delta T \qquad \therefore \Delta T = \frac{Mv^2(\gamma - 1)}{2R}K$$

41. According to question VT = K

We also know that PV = nRT $\Rightarrow T = \left(\frac{PV}{nR}\right)$

$$\Rightarrow V\left(\frac{PV}{nR}\right) = k \Rightarrow PV^2 = K$$

$$C = \frac{R}{1-2} + \frac{3R}{2} = \frac{R}{2} \qquad \therefore \Delta Q = nC\,\Delta T \qquad = \frac{R}{2} \times \Delta T \;[\text{here, } n = 1 \text{ mole}]$$

42. Velocity of the tennis ball on the surface the earth or ground

$v = \sqrt{\frac{2gh}{1 + \frac{k^2}{R^2}}}$ (where k = radius of gyration of spherical shell $= \sqrt{\frac{2}{3}}R$

Horizontal range AB $= \frac{v^2 \sin 2\theta}{g} \qquad \frac{\left(\sqrt{\frac{2gh}{1 + k\ /R^2}}\right)^2 \sin\left(2 \times 30^0\right)}{g} = 1.87 \text{ m}$

43. Both fall with equal acceleration g, have equal displacements in time t; therefore Extension = 0.

44. Conceptual

45. $K.E_1 = \frac{1}{2v}m_1v_1^2;\; E.K_2 = \frac{1}{2}m_2v_2^2$

$$\frac{K.E_1}{K.E_2}=\frac{\frac{1}{2}\left(\frac{m-m_2}{m_1+m_2}\right)u_1^2}{\frac{1}{2}m_2\left(\frac{2m_1}{m_1+m_2}\right)^2u_1^2}=\frac{(m_1-m_2)^2}{4m_1m_2}$$

For perfectly elastic collision, e = 1

46. Total energy, $E=\frac{1}{2}m\omega^2a^2$;

$$K.E.=\frac{3E}{4}=\frac{1}{2}m\omega^2\left(a^2-y^2\right).$$

So, $\frac{3}{4}=\frac{a^2-y^2}{a^2}$ or $y^2=\frac{a^2}{4}$ or $y=\frac{a}{2}$

47. Centre of mass of the rod is given by :

$$x_{cm}=\frac{\int_0^L\left(ax+\frac{bx^2}{L}\right)dx}{\int_0^L\left(a+\frac{bx}{L}\right)dx}=\frac{\frac{aL^2}{2}+\frac{bL^2}{3}}{aL+\frac{bL}{2}}=\frac{L\left(\frac{a}{2}+\frac{b}{3}\right)}{a+\frac{b}{2}}$$

Now $\frac{7L}{12}=\frac{\frac{a}{2}+\frac{b}{3}}{a+\frac{b}{2}}$, On solving we get, b = 2a

48. The thermal resistance is given by

$$\frac{x}{KA}+\frac{4x}{2KA}=\frac{x}{KA}+\frac{2x}{KA}=\frac{3x}{KA}$$

$$\therefore\frac{dQ}{dt}=\frac{\Delta T}{\frac{3x}{KA}}=\frac{(T_2-T_1)KA}{3x}=\frac{1}{3}\left\{\frac{A(T_2-T_1)K}{x}\right\}\qquad\therefore f=\frac{1}{3}$$

49. Since $\mu mg\cos\theta>mg\sin\theta$

So block is in rest.

Force of friction is $f=mg\sin\theta$

$$=2\times10\times\sin30=10\,N$$

50. Fractional decrease in kinetic energy of mass 'm'

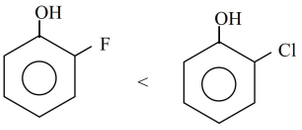
$$=1-\left(\frac{m_2-m_1}{m_2+m_1}\right)^2=1-\left(\frac{2-1}{2+1}\right)^2=1-\left(\frac{1}{3}\right)^2=1-\frac{1}{9}=\frac{8}{9}$$

Percentage loss in energy $=\frac{8}{9}\times100\simeq89\%$

CHEMISTRY

51. (Reference NCERT Page No. 216, 217

52. 1, 2, 4 are correct



$K_a = 15\times10^{-10}$ $K_a = 77\times10^{-10}$, Phenols are more acidic than alcohol

Carboxylic acids are more acidic than alcohols and phenols

53. $\lambda = \frac{h}{\sqrt{2meV}}, \lambda_1 = \frac{h}{\sqrt{2me(100)}} = \frac{h}{10\sqrt{2me}} = \frac{k}{10}, k = \frac{h}{\sqrt{2me}}$

$\lambda_2 = \frac{h}{\sqrt{2me(81)}} = \frac{k}{9}, \lambda_3 = \frac{h}{\sqrt{2me(49)}} = \frac{k}{7}$ $\frac{\lambda_3 - \lambda_2}{\lambda_1} = \frac{\frac{k}{7} - \frac{k}{9}}{\frac{k}{10}} = \frac{\left(\frac{2k}{63}\right)}{\left(\frac{k}{10}\right)} = \frac{20}{63}$

54. I is exothermic, II is endothermic

55. Solubility of AgCl in water: $AgCl = Ag^+ + Cl^-$

$K_{sp} = \left[Ag^+\right]\left[Cl^-\right] = (S_1)(S_1) = S_1^2$ $\therefore S_1 = \sqrt{K_{sp}} = 1.34\times10^{-5}$ mole/litre

Solubility of AgCl in 0.01 M $CaCl_2$

$\left[Ag^+\right] = S_2; \left[Cl^-\right] = (2\times0.0 + S_2)$ $K_{sp} = \left[Ag^+\right]\left[Cl^-\right]$ $\therefore S_2 = 9\times10^{-9}$ mole/litre

Solubility of AgCl in 0.01 M NaCl

$\left[Ag^+\right] = S_3; \left[Cl^-\right] = (0.01 + S_3)$ $\therefore 1.8\times10^{-10} = S_3(0.01 + S_3)$ $\therefore S_3 = 1.8\times10^{-8}$ mole/litre

Solubility of AgCl in 0.05 M $AgNO_3$

$\left[Ag^+\right] = (0.05 + S_4); \left[Cl^-\right] = S_4$ $\therefore S_4 = 3.6\times10^{-9}$ mole/litre

From the values of solubility we get $S_1 > S_3 > S_2 > S_4$

56. 1) $\overset{+2}{CO} \rightarrow \overset{+4}{CO_2}$ 2) $\overset{+2}{CuO} \rightarrow \overset{+2}{CuCl_2}$ 3) $\overset{+1}{H_2O} \rightarrow \overset{0}{H_2}$ 4) $\overset{0}{C} \rightarrow \overset{+4}{CO_2}$, Only in (3), O.N. of hydrogen decreases from + 1 to 0 and hence H_2O gets reduced to H_2

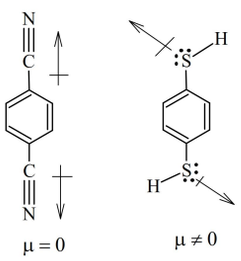
57. $BaCl_2.xH_2O \rightarrow BaCl_2 + x\,H_2O, (137 + 2\times35.5 + 18x) = (208 + 18x)\,g/mole$

$\frac{208+18x}{208} = \frac{61}{52}$,$10816 + 936x = 12688$, $936x = 1872$, $x = 2$, Formula is $BaCl_2.2H_2O$

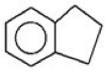
58. In (I)– solid formed. In others more number of moles of gases are formed, $\Delta S = +ve$.

59. SO_3 & CO_3^{-2} central atoms are undergoes sp^2Hyb . With zero L.P .Hence trigonal planar shape

60.

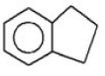


$\mu = 0$ $\mu \neq 0$

61. Reference NCERT. XI Page No.391
62. Reference NCERT. XI Page No.399
63. Reference NCERT. XI Page No.394, 395
64. Reference NCERT. XI Page No.379, 382, 383
65. Both give hydroxides which are Amphoteric oxides
66. Inert pair effect
67. B > Tl > Ga > Al > In
    801 589 579 577 558 (K J /mol)
68. S – I is true & S – II is false
69. $AlCl_3 < MgCl_2 < NaCl$ [*melting point*]
    $IE_3C > Ge > Si > Pb > Sn$, B > Al > Tl > In > Ga
70. $(X)PhCH_2CH=CH_2$
    $(Y)PhCH_2CH_2CH_2OH$ and
    (Z) 

$$C_6H_6 + CH_2=CHCH_2Cl \xrightarrow{AlCl_3} PhCH_2CH=CH_2$$

(X)

$$\xrightarrow[(II)H_2O_2,OH^-]{(I)BH_3/THF} PhCH_2CH_2CH_2OH \xrightarrow[\Delta]{H^+}$$ 

(Y)

71. With principal 'n' the total number of electrons can present is given as "$2n^2$"
    $\therefore$ If n = 3 total electrons can be $2.3^2 = 18$.
    Out of them half can have $m_s = -\frac{1}{2}$
72. Sol $\underset{(g)}{AB} \rightleftharpoons \underset{(g)}{A} + \underset{(g)}{B}$

to :	1	0	0
t_{eq}:	1-1/3	1/3	1/3
i.e.	2/3	1/3	1/3

    $\therefore$ mole ratio of mixture = 2 : 1 : 1 $\quad \therefore K_p = \frac{P_A P_B}{P_{AB}} = \frac{P}{8} \therefore \frac{P}{K_P} = 8$
73. $M_2O_7^{2-} + X^{n+} \rightarrow X^{5+}O_3^- + M^{3+}$ $\quad 6X10^{-3}X6 = (5-n)X9X10^{-3} \Rightarrow n = 1$
74. 190 kJ/mol
    $\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$, *Let* $B.EN \equiv N$ *is* $x - 46 = \frac{x}{2} + \frac{3}{2} \times 436 - 3 \times 393$, $x = 958, N_2H_4 \rightarrow N_2 + 2H_2$
    $\Delta H = \left[\Delta H_{vap}(N_2H_4) + 4 \times B.E(N-H) + B.E(N-N)\right] - B.E\ of\ N \equiv N + 2B.E(H_{B.E})$
75. $M \longrightarrow M^+ + e^-$ Number of moles $\frac{5}{25} = 0.2$
    Energy required to form M^+ ions $= 0.2 \times 800 = 160$ KJ mol^{-1}
    Remaining energy = 90 KJ, This is used to convert M^+ to M^{+2}
    Number of moles of M^{+2} formed $= \frac{90}{1500} = 0.06$ $\quad \%M^{+2} = \frac{0.06}{0.2} \times 100 = 30\%$