

JEE Main 2019 Paper 1 (B.E./B.Tech) 12 April 2019 Shift 1 Question Paper



Conducted by the National Testing Agency (NTA)

Time Allowed: 3 Hours

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

Maximum Marks: 360

General Instructions

- (i) This paper is **Paper 1 (B.E./B.Tech.)** of **JEE (Main) 2019 - Session 2**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 12 April 2019, Shift 1. The total duration is **3 hours**.
- (ii) The paper has **90 questions** and a maximum of **360 marks**: Mathematics, Physics and Chemistry carry 30 questions (120 marks) each, in that order.
- (iii) Each subject has **30 multiple choice questions** (MCQs), with four options each. Select the most appropriate answer.
- (iv) **All questions are compulsory**. Use only the constants given in the question while calculating.
- (v) **Marking scheme**: **+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

$$\int_0^{\frac{\pi}{2}} \frac{\cot x}{\cot x + \operatorname{cosec} x} dx$$

= $m(\pi + n)$, then $m.n$ is equal to

(A) - 1

(B) 1

(C) $-\frac{1}{2}$

(D) $\frac{1}{2}$

2. Consider the differential equation,

$$y^2 dx + \left(x - \frac{1}{y}\right) dy = 0$$

, If value of y is 1 when $x = 1$, then the value of x for which $y = 2$, is :

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

(B) $\frac{1}{2} + \frac{1}{\sqrt{e}}$

(C) $\frac{5}{2} + \frac{1}{\sqrt{e}}$

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

3. If the angle of intersection at a point where the two circles with radii 5 cm and 12 cm intersect is 90° , then the length (in cm) of their common chord is :

(A) $\frac{13}{5}$

(B) $\frac{60}{13}$

(C) $\frac{120}{13}$

(D) $\frac{13}{2}$

4. If three of the six vertices of a regular hexagon are chosen at random, then the probability that the triangle formed with these chosen vertices is equilateral is :

(A) $\frac{1}{10}$

(B) $\frac{3}{10}$

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

(D) $\frac{1}{5}$

5. Let S_n denote the sum of the first n terms of an A.P. If $S_4 = 16$ and $S_6 = -48$, then S_{10} is equal to :

(A) - 320

(B) - 380

(C) - 460

(D) - 210

6. The value of

$$\sin^{-1}\left(\frac{12}{13}\right) - \sin^{-1}\left(\frac{3}{5}\right)$$

is equal to :

(A) $\pi - \sin^{-1}\left(\frac{63}{65}\right)$

(B) $\frac{\pi}{2} - \sin^{-1}\left(\frac{56}{65}\right)$

(C) $\frac{\pi}{2} - \cos^{-1}\left(\frac{9}{65}\right)$

(D) $\pi - \cos^{-1}\left(\frac{33}{65}\right)$

7. If m is the minimum value of k for which the function $f(x) = x\sqrt{kx - x^2}$ is increasing in the interval $[0, 3]$ and M is the maximum value of f in $[0, 3]$ when $k = m$, then the ordered pair (m, M) is equal to :

(A) $(5, 3\sqrt{6})$

(B) $(4, 3\sqrt{3})$

(C) $(4, 3\sqrt{2})$

(D) $(3, 3\sqrt{3})$

8. The integral

$$\int \frac{2x^3 - 1}{x^4 + x} dx$$

is equal to :

(Here C is a constant of integration)

- (A) $\log_e \frac{|x^3 + 1|}{x^2} + C$
 (B) $\frac{1}{2} \log_e \frac{|x^3 + 1|}{x^2} + C$
 (C) $\log_e \left| \frac{x^3 + 1}{x} \right| + C$
 (D) $\frac{1}{2} \log_e \frac{(x^3 + 1)^2}{|x^3|} + C$

9. If A is a symmetric matrix and B is a skew-symmetric matrix such that $A + B =$

$$\begin{bmatrix} 2 & 3 \\ 5 & -1 \end{bmatrix}$$

, then AB is equal to :

- (A) $\begin{bmatrix} 4 & -2 \\ 1 & -4 \end{bmatrix}$
 (B) $\begin{bmatrix} -4 & -2 \\ -1 & 4 \end{bmatrix}$
 (C) $\begin{bmatrix} -4 & 2 \\ 1 & 4 \end{bmatrix}$
 (D) $\begin{bmatrix} 4 & -2 \\ -1 & -4 \end{bmatrix}$

10. Let

$$\vec{a} = 3\hat{i} + 2\hat{j} + 2\hat{k}$$

and

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

be two vectors. If a vector perpendicular to both the vectors $\vec{a} + \vec{b}$ and $\vec{a} - \vec{b}$ has the magnitude 12 then one such vector is :

- (A) $4(2\hat{i} - 2\hat{j} - \hat{k})$
 (B) $4(-2\hat{i} - 2\hat{j} + \hat{k})$
 (C) $4(2\hat{i} + 2\hat{j} + \hat{k})$
 (D) $4(2\hat{i} + 2\hat{j} - \hat{k})$

11. If the data $x_1, x_2, \dots, x_{10}$ is such that the mean of first four of these is 11, the mean of the remaining six is 16 and the sum of squares of all of these is 2,000 ; then the standard deviation of this data is :

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

12. If

$$B = \begin{bmatrix} 5 & 2\alpha & 1 \\ 0 & 2 & 1 \\ \alpha & 3 & -1 \end{bmatrix}$$

is the inverse of a 3×3 matrix A, then the sum of all values of α for which $\det(A) + 1 = 0$, is :

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

13. The number of ways of choosing 10 objects out of 31 objects of which 10 are identical and the remaining 21 are distinct, is :

- (A) $2^{20} - 1$
 (B) 2^{20}
 (C) $2^{20} + 1$
 (D) 2^{21}

14. If α and β are the roots of the equation $375x^2 - 25x - 2 = 0$, then

$$\lim_{n \rightarrow \infty} \sum_{r=1}^n \alpha^r + \lim_{n \rightarrow \infty} \sum_{r=1}^n \beta^r$$

is equal to :

- (A) $\frac{7}{116}$
 (B) $\frac{29}{348}$
 (C) $\frac{1}{12}$
 (D) $\frac{21}{346}$

15. The equation $|z - i| = |z - 1|$, $i = \sqrt{-1}$, represents :

- (A) a circle of radius 1 (B) the line through the origin with slope -1
(C) a circle of radius $\frac{1}{2}$ (D) the line through the origin with slope 1

16. The coefficient of x^{18} in the product $(1 + x)(1 - x)^{10}(1 + x + x^2)^9$ is :

- (A) 126 (B) - 84
(C) - 126 (D) 84

17. If $e^y + xy = e$, the ordered pair $\left(\frac{dy}{dx}, \frac{d^2y}{dx^2}\right)$ at $x = 0$ is equal to :

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

18. For $x \in (0, 3/2)$, let $f(x) = \sqrt{x}$, $g(x) = \tan x$ and $h(x) =$

$\frac{1 - x^2}{1 + x^2}$. If $\phi(x) = (h \circ f \circ g)(x)$, then $\phi\left(\frac{\pi}{3}\right)$

is equal to :

- (A) $\tan \frac{7\pi}{12}$
(B) $\tan \frac{11\pi}{12}$
(C) $\tan \frac{\pi}{12}$
(D) $\tan \frac{5\pi}{12}$

19. If the area (in sq. units) of the region $\{(x, y) : y^2 \leq 4x, x + y \leq 1, x \geq 0, y \geq 0\}$ is $a\sqrt{2} + b$, then $a - b$ is equal to :

- (A) $\frac{8}{3}$
(B) $-\frac{2}{3}$
(C) 6
(D) $\frac{10}{3}$

20. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a continuously differentiable function such that $f(2) = 6$ and $f'(2) = \frac{1}{48}$. If

$$\int_6^{f(x)} 4t^3 dt = (x - 2)g(x), \text{ then } \lim_{x \rightarrow 2} g(x)$$

is equal to :

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

21. The equation $y = \sin x \sin(x + 2) - \sin^2(x + 1)$ represents a straight line lying in :

- (A) first, second and fourth quadrants (B) first, third and fourth quadrants
(C) second and third quadrants only (D) third and fourth quadrants only

22. A 2 m ladder leans against a vertical wall. If the top of the ladder begins to slide down the wall at the rate 25 cm/sec, then the rate (in cm/sec.) at which the bottom of the ladder slides away from the wall on the horizontal ground when the top of the ladder is 1 m above the ground is :

- (A) $\frac{25}{3}$
(B) 25
(C) $25\sqrt{3}$
(D) $\frac{25}{\sqrt{3}}$

23. If the volume of parallelopiped formed by the vectors $\hat{i} + \lambda\hat{j} + \hat{k}$, $\hat{j} + \lambda\hat{k}$ and $\lambda\hat{i} + \hat{k}$ is minimum, then λ is equal to :

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

24. If the normal to the ellipse $3x^2 + 4y^2 = 12$ at a point P on it is parallel to the line, $2x + y = 4$ and the tangent to the ellipse at P passes through Q(4,4) then PQ is equal to :

- (A) $\frac{\sqrt{61}}{2}$
 (B) $\frac{\sqrt{221}}{2}$
 (C) $\frac{\sqrt{157}}{2}$
 (D) $\frac{5\sqrt{5}}{2}$

25. If the truth value of the statement $p \rightarrow (\sim q \vee r)$ is false (F), then the truth values of the statements p, q, r are respectively :

- (A) T, F, T (B) F, T, T
 (C) T, T, F (D) T, F, F

26. For $x \in \mathbb{R}$, let $[x]$ denote the greatest integer $\leq x$, then the sum of the series

$$\left[-\frac{1}{3}\right] + \left[-\frac{1}{3} - \frac{1}{100}\right] + \left[-\frac{1}{3} - \frac{2}{100}\right] + \dots + \left[-\frac{1}{3} - \frac{99}{100}\right]$$

is :

- (A) - 153 (B) - 135
 (C) - 133 (D) - 131

27. The number of solutions of the equation $1 + \sin^4 x = \cos^2 3x$,

$$x \in \left[-\frac{5\pi}{2}, \frac{5\pi}{2}\right]$$

is :

- (A) 5 (B) 3
 (C) 7 (D) 4

28. Let P be the point of intersection of the common tangents to the parabola $y^2 = 12x$ and the hyperbola $8x^2 - y^2 = 8$. If S and S' denote the foci of the hyperbola where S lies on the positive x-axis then P divides SS' in a ratio :

- (A) 14 : 13 (B) 13 : 11
 (C) 5 : 4 (D) 2 : 1

29. If the line

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

intersects the plane $2x + 3y - z + 13 = 0$ at a point P and the plane $3x + y + 4z = 16$ at a point Q, then PQ is equal to :

- (A) $2\sqrt{7}$
 (B) 14
 (C) $2\sqrt{14}$
 (D) $\sqrt{14}$

30. Let a random variable X have a binomial distribution with mean 8 and variance 4. If

$$P(X \leq 2) = \frac{k}{2^{16}}$$

, then k is equal to :

- (A) 17 (B) 1
 (C) 137 (D) 121

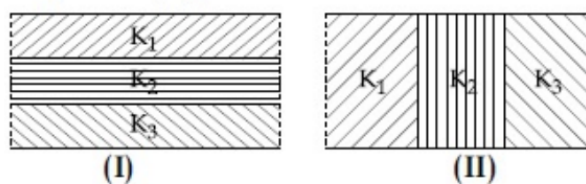
31. An excited He^+ ion emits two photons in succession, with wavelengths 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number n , corresponding to its initial excited state is (for photon of wavelength λ , energy

$$E = \frac{1240 \text{ eV}}{\lambda(\text{in nm})}$$

) :

- (A) $n = 4$ (B) $n = 7$
(C) $n = 5$ (D) $n = 6$

32. Two identical parallel plate capacitors, of capacitance C each, have plates of area A , separated by a distance d . The space between the plates of the two capacitors, is filled with three dielectrics, of equal thickness and dielectric constants K_1 , K_2 and K_3 . The first capacitor is filled as shown in fig. I, and the second one is filled as shown in fig II. If these two modified capacitors are charged by the same potential V , the ratio of the energy stored in the two, would be (E_1 refers to capacitor (I) and E_2 to capacitor (II)):



- (A) $\frac{E_1}{E_2} = \frac{(K_1 + K_2 + K_3)(K_2K_3 + K_3K_1 + K_1K_2)}{K_1K_2K_3}$
- (B) $\frac{E_1}{E_2} = \frac{K_1K_2K_3}{(K_1 + K_2 + K_3)(K_2K_3 + K_3K_1 + K_1K_2)}$
- (C) $\frac{E_1}{E_2} = \frac{(K_1 + K_2 + K_3)(K_2K_3 + K_3K_1 + K_1K_2)}{9K_1K_2K_3}$
- (D) $\frac{E_1}{E_2} = \frac{9K_1K_2K_3}{(K_1 + K_2 + K_3)(K_2K_3 + K_3K_1 + K_1K_2)}$

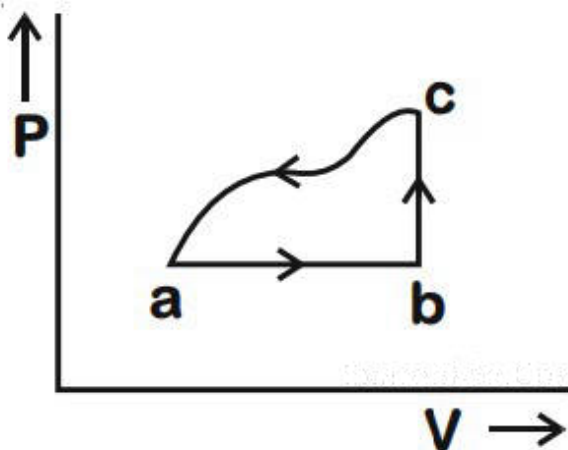
33. An electromagnetic wave is represented by the electric field

$$\vec{E} = E_0 \hat{n} \sin[\omega t + (6y - 8z)]$$

. Taking unit vectors in x, y and z directions to be $\hat{i}, \hat{j}, \hat{k}$, the direction of propagation $\hat{s}$, is :

- (A) $\hat{s} = \frac{3\hat{i} - 4\hat{j}}{5}$
 (B) $\hat{s} = \frac{-4\hat{k} + 3\hat{j}}{5}$
 (C) $\hat{s} = \left(\frac{-3\hat{j} + 4\hat{k}}{5} \right)$
 (D) $\hat{s} = \frac{4\hat{j} - 3\hat{k}}{5}$

34. A sample of an ideal gas is taken through the cyclic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is -180 J. The gas absorbs 250 J of heat along the path ab and 60 J along the path bc. The work done by the gas along the path abc is:



- (A) 120 J
 (B) 130 J
 (C) 100 J
 (D) 140 J

35. A person of mass M is, sitting on a swing of length L and swinging with an angular amplitude θ_0 . If the person stands up when the swing passes through its lowest point, the work done by him, assuming that his center of mass moves by a distance ℓ ($\ell < L$), is close to;

- (A) $mg\ell(1 + \theta_0^2)$ (B) $mg\ell$
 (C) $mg\ell(1 + \frac{\theta_0^2}{2})$ (D) $mg\ell(1 - \theta_0^2)$

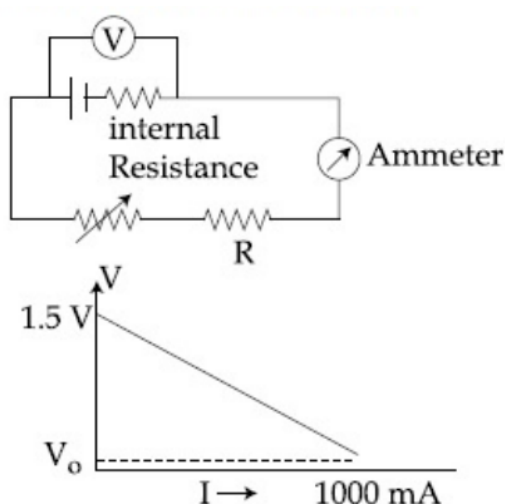
36. A galvanometer of resistance 100Ω has 50 divisions on its scale and has sensitivity of 20μ A/division. It is to be converted to a voltmeter with three ranges of 0 - 2 V, 0 - 10 V and 0 - 20 V. The appropriate circuit to do so is

- (A) $R_1 = 2000 \Omega$
 $R_2 = 8000 \Omega$
 $R_3 = 10000 \Omega$
- (B) $R_1 = 1900 \Omega$
 $R_2 = 9900 \Omega$
 $R_3 = 19900 \Omega$
- (C) $R_1 = 1900 \Omega$
 $R_2 = 8000 \Omega$
 $R_3 = 10000 \Omega$
- (D) $R_1 = 19900 \Omega$
 $R_2 = 9900 \Omega$
 $R_3 = 1900 \Omega$

37. A man (mass = 50 kg) and his son (mass = 20 kg) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of 0.70 ms^{-1} with respect to the man. The speed of the man with respect to the surface is :

- (A) 0.28 ms^{-1} (B) 0.47 ms^{-1}
(C) 0.20 ms^{-1} (D) 0.14 ms^{-1}

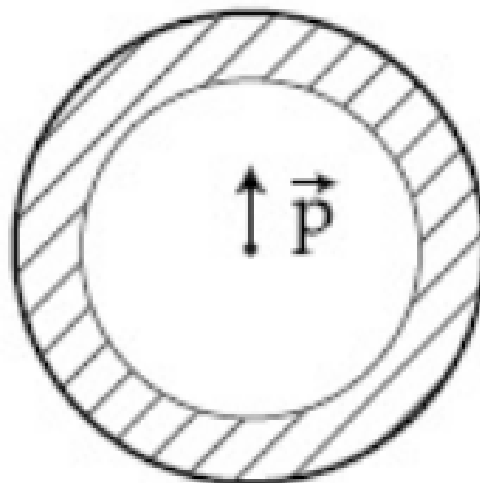
38. To verify Ohm's law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained :



If V_0 is almost zero, identify the correct statement :

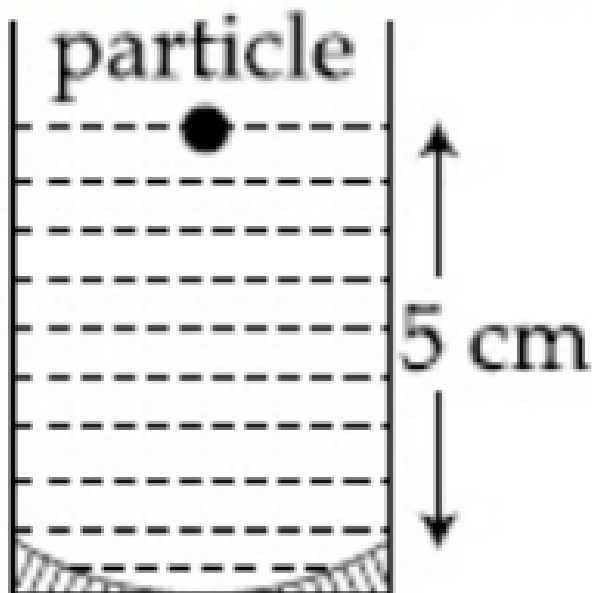
- (A) The value of the resistance R is 1.5Ω (B) The emf of the battery is 1.5 V and its internal resistance is 1.5Ω
(C) The emf of the battery is 1.5 V and the value of R is 1.5Ω (D) The potential difference across the battery is 1.5 V when it sends a current of 1000 mA

39. Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius b , and carries charge Q . At its centre is a dipole $\vec{P}$ as shown. In this case :



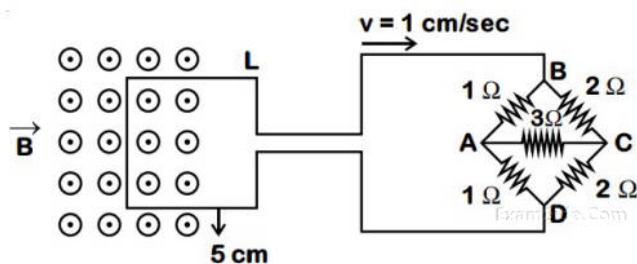
- (A) surface charge density on the inner surface is uniform and equal to $\frac{(Q/2)}{4\pi a^2}$
(B) surface charge density on the inner surface of the shell is zero everywhere
(C) surface charge density on the outer surface depends on $|\vec{P}|$
(D) electric field outside the shell is the same as that of a point charge at the centre of the shell

40. A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to: (Refractive index of water = 1.33)



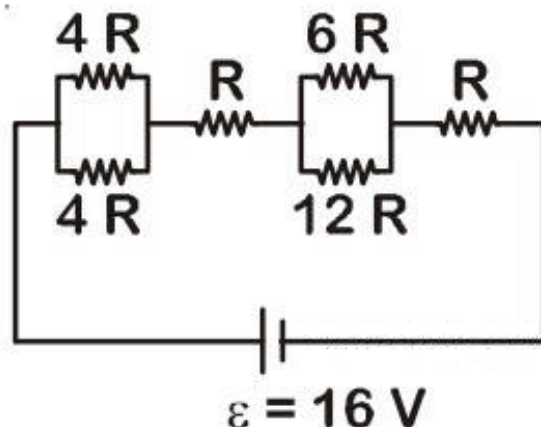
- (A) 11.7 cm (B) 6.7 cm
(C) 13.4 cm (D) 8.8 cm

41. The figure shows a square loop L of side 5 cm which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of 1 cm s^{-1} . At some instant, a part of L is in a uniform magnetic field of 1 T, perpendicular to the plane of the loop. If the resistance of L is 1.7Ω , the current in the loop at that instant will be close to :



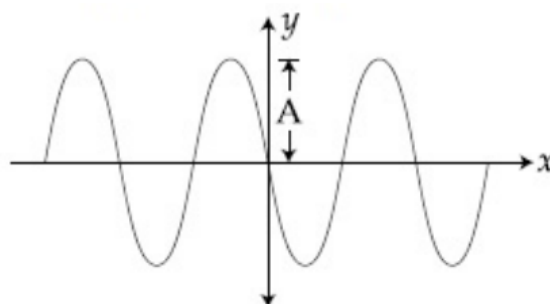
- (A) $115 \mu\text{A}$ (B) $170 \mu\text{A}$
(C) $60 \mu\text{A}$ (D) $150 \mu\text{A}$

42. The resistive network shown below is connected to a D.C. source of 16 V. The power consumed by the network is 4 Watt. The value of R is:



- (A) 16Ω (B) 1Ω
(C) 8Ω (D) 6Ω

43. A progressive wave travelling along the positive x -direction is represented by $y(x,t) = A \sin(kx - \omega t + \phi)$. Its snapshot at $t = 0$ is given in the figure.



For this wave, the phase ϕ is :

- (A) $\frac{\pi}{2}$
(B) π
(C) 0
(D) $-\frac{\pi}{2}$

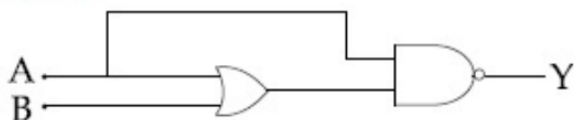
44. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of $40\pi \text{ rad s}^{-1}$ about its axis, perpendicular to its plane. If the magnetic field at its centre is $3.8 \times 10^{-9} \text{ T}$, then the charge carried by the ring is close to ($\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$).

- (A) $7 \times 10^{-6} \text{ C}$ (B) $4 \times 10^{-5} \text{ C}$
(C) $2 \times 10^{-6} \text{ C}$ (D) $3 \times 10^{-5} \text{ C}$

45. When M_1 gram of ice at -10°C (specific heat = $0.5 \text{ cal g}^{-1} ^\circ\text{C}^{-1}$) is added to M_2 gram of water at 50°C , finally no ice is left and the water is at 0°C . The value of latent heat of ice, in cal g^{-1} is :

- (A) $\frac{50M_2}{M_1} - 5$
(B) $\frac{50M_2}{M_1}$
(C) $\frac{5M_2}{M_1} - 5$
(D) $\frac{5M_1}{M_2} - 50$

46. The truth table for the circuit given in the fig. is:



- (A)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1
- (B)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0
- (C)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0
- (D)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

47. Which of the following combinations has the dimension of electrical resistance (ϵ_0 is the permittivity of vacuum and μ_0 is the permeability of vacuum)?

- (A) $\sqrt{\frac{\epsilon_0}{\mu_0}}$
(B) $\frac{\epsilon_0}{\mu_0}$
(C) $\sqrt{\frac{\mu_0}{\epsilon_0}}$
(D) $\frac{\mu_0}{\epsilon_0}$

48. A point dipole

$$\vec{p} = -p_0 \hat{x}$$

is kept at the origin. The potential and electric field due to this dipole on the y-axis at a distance d are, respectively: (Take $V = 0$ at infinity)

- (A) $\frac{|\vec{p}|}{4\pi \epsilon_0 d^2}, \frac{-\vec{p}}{4\pi \epsilon_0 d^3}$
(B) $0, \frac{\vec{p}}{4\pi \epsilon_0 d^3}$
(C) $\frac{|\vec{p}|}{4\pi \epsilon_0 d^2}, \frac{\vec{p}}{4\pi \epsilon_0 d^3}$
(D) $0, \frac{-\vec{p}}{4\pi \epsilon_0 d^3}$

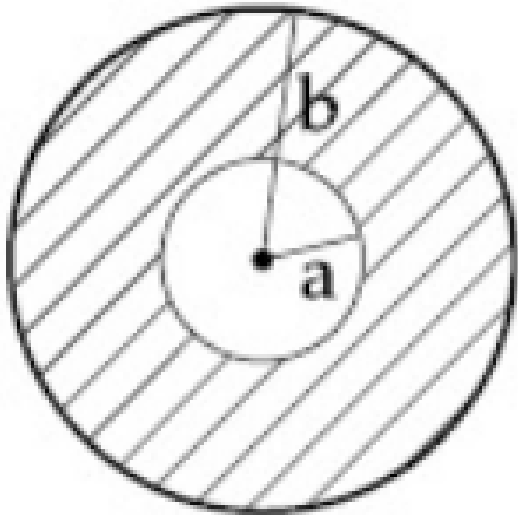
49. Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). What is the molar specific heat of mixture at constant volume ? ($R = 8.3 \text{ J/mol K}$)

- (A) 21.6 J/mol K (B) 17.4 J/mol K
(C) 15.7 J/mol K (D) 19.7 J/mol K

50. A circular disc of radius b has a hole of radius a at its centre (see figure). If the mass per unit area of the disc varies as

$$\left(\frac{\sigma_0}{r}\right)$$

, then the radius of gyration of the disc about its axis passing through the centre is:

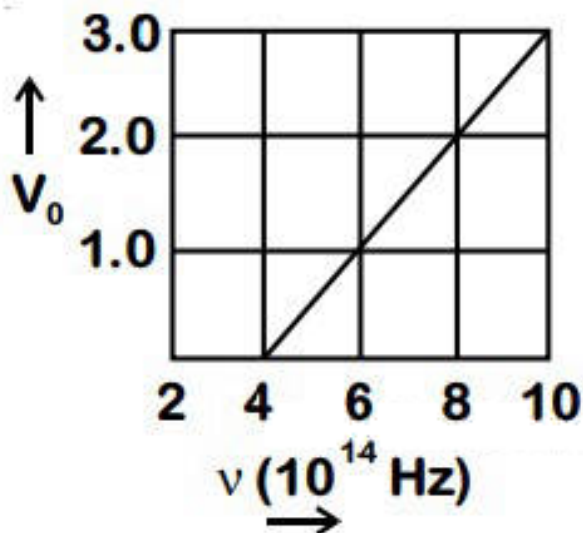


- (A) $\sqrt{\frac{a^2 + b^2 + ab}{2}}$
 (B) $\sqrt{\frac{a+b}{3}}$
 (C) $\sqrt{\frac{a^2 + b^2 + ab}{3}}$
 (D) $\sqrt{\frac{a+b}{2}}$

51. The trajectory of a projectile near the surface of the earth is given as $y = 2x - 9x^2$. If it were launched at an angle θ_0 with speed v_0 then ($g = 10 \text{ ms}^{-2}$) :

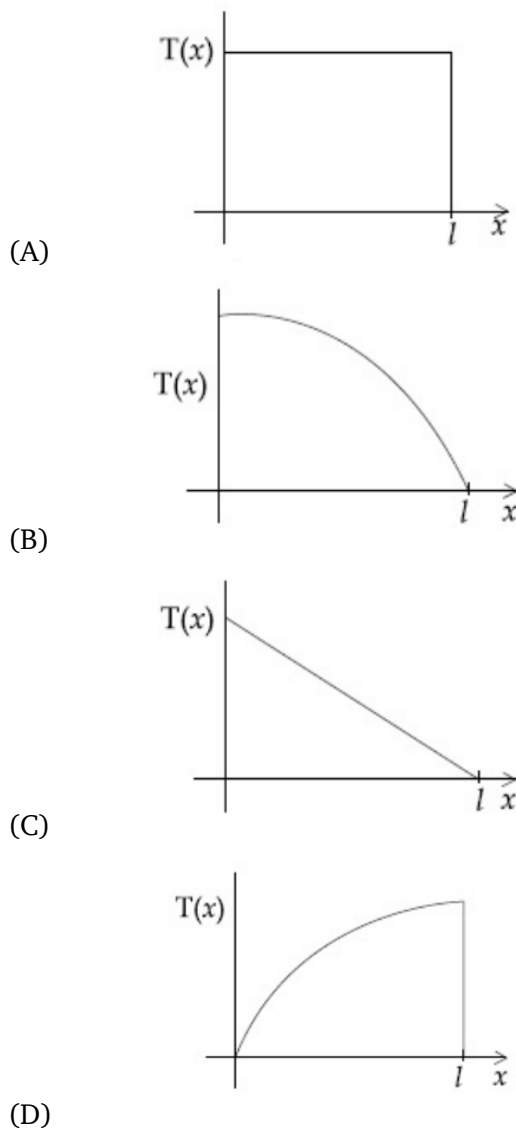
- (A) $\theta_0 = \cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$
 and $v_0 = \frac{5}{3} \text{ ms}^{-1}$
 (B) $\theta_0 = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$
 and $v_0 = \frac{3}{5} \text{ ms}^{-1}$
 (C) $\theta_0 = \sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$
 and $v_0 = \frac{3}{5} \text{ ms}^{-1}$
 (D) $\theta_0 = \sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$
 and $v_0 = \frac{5}{3} \text{ ms}^{-1}$

52. The stopping potential V_0 (in volt) as a function of frequency (ν) for a sodium emitter, is shown in the figure. The work function of sodium, from the data plotted in the figure, will be:
(Given: Planck's constant (h) = 6.63×10^{-34} Js, electron charges $e = 1.6 \times 10^{-19}$ C)



- (A) 1.95 eV (B) 2.12 eV
(C) 1.82 eV (D) 1.66 eV

53. A uniform rod of length ℓ is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is $T(x)$ at a distance x from the axis, then which of the following graphs depicts it most closely?



54. In a double slit experiment, when a thin film of thickness t having refractive index μ , is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used) :

- (A) $\frac{\lambda}{2(\mu - 1)}$
 (B) $\frac{\lambda}{(2\mu - 1)}$
 (C) $\frac{2\lambda}{(\mu - 1)}$
 (D) $\frac{\lambda}{(\mu - 1)}$

55. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product $t_1 t_2$ is -

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

56. At 40°C , a brass wire of 1 mm radius is hung from the ceiling. A small mass, M is hung from the free end of the wire. When the wire is cooled down from 40°C to 20°C it regains its original length of 0.2 m. The value of M is close to : (Coefficient of linear expansion and Young's modulus of brass are $10^{-5} / ^\circ \text{C}$ and 10^{11} N/m^2 , respectively; $g = 10 \text{ ms}^{-2}$)

- (A) 1.5 kg (B) 0.5 kg
 (C) 9 kg (D) 0.9 kg

57. The value of numerical aperture of the objective lens of a microscope is 1.25. If light of wavelength 5000

$\text{\AA}$

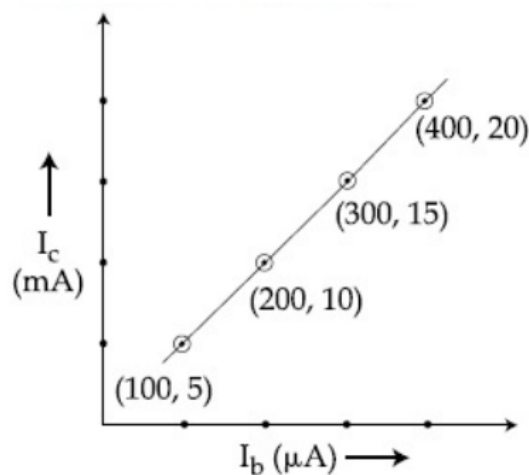
is used, the minimum separation between two points, to be seen as distinct, will be :

- (A) $0.12 \mu\text{m}$ (B) $0.38 \mu\text{m}$
 (C) $0.24 \mu\text{m}$ (D) $0.48 \mu\text{m}$

58. A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45° , and 40 times per minute where the dip is 30° . If B_1 and B_2 are respectively the total magnetic field due to the earth at the two places, then the ratio $\frac{B_1}{B_2}$ is best given by :

- (A) 1.8 (B) 2.2
 (C) 0.7 (D) 3.6

59. The transfer characteristic curve of a transistor, having input and output resistance 100Ω and $100 \text{ k}\Omega$ respectively is shown in the figure. The voltage and power gain, are respectively:



- (A) $5 \times 10^4, 5 \times 10^5$ (B) $5 \times 10^4, 5 \times 10^6$
 (C) $5 \times 10^4, 2.5 \times 10^6$ (D) $2.5 \times 10^4, 2.5 \times 10^6$

60. A submarine (A) travelling at 18 km/hr is being chased along the line of its velocity by another submarine (B) travelling at 27 km/hr. B sends a sonar signal of 500 Hz to detect A and receives a reflected sound of frequency ν . The value of ν is close to: (Speed of sound in water = 1500 ms^{-1})

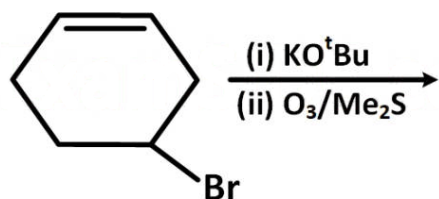
- (A) 507 Hz (B) 502 Hz
 (C) 499 Hz (D) 504 Hz

Chemistry - Multiple Choice Questions

61. The mole fraction of a solvent in aqueous solution of a solute is 0.8. The molality (in mol kg^{-1}) of the aqueous solution is :

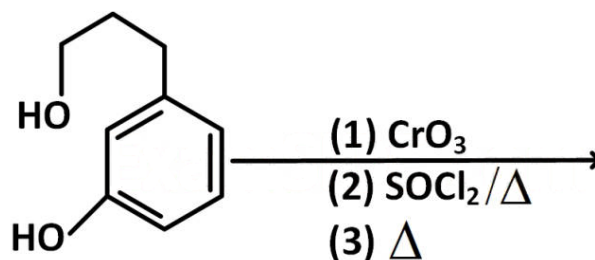
- (A) 13.88×10^{-1} (B) 13.88×10^{-3}
 (C) 13.88 (D) 13.88×10^{-2}

62. The major product(s) obtained in the following reaction is/are :



- (A) O=CCCC=O and O=CC=O
 (B) O=CCCC=CC=O
 (C) O=CC=O
 (D) O=CC(OtBu)CC=O

63. The major product of the following reaction is :



- (A) O=C1Cc2ccccc2C1O
 (B) O=C1Cc2ccccc2C1=O
 (C) O=C1Cc2ccccc2C1Cl
 (D) O=C1Cc2ccccc2C1=O

64. The group number, number of valence electrons, and valency of an element with atomic number 15, respectively, are:

- (A) 16, 6 and 3 (B) 15, 6 and 12
(C) 16, 5 and 2 (D) 15, 5 and 3

65. What is the molar solubility of $\text{Al}(\text{OH})_3$ in 0.2 M NaOH solution? Given that, solubility product of $\text{Al}(\text{OH})_3 = 2.4 \times 10^{-24}$:

- (A) 3×10^{-22} (B) 3×10^{-19}
(C) 12×10^{-21} (D) 12×10^{-22}

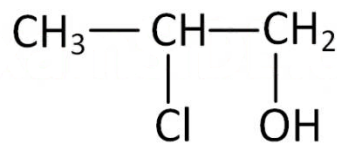
66. An ideal gas is allowed to expand from 1 L to 10 L against a constant external pressure of 1 bar. The work done in kJ is:

- (A) +10.0 (B) -0.9
(C) -2.0 (D) -9.0

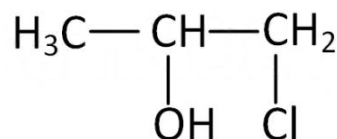
67. 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. The molar mass of A (M_A) and molar mass of B (M_B) in kg mol are:

- (A) $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$ (B) $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$
(C) $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$ (D) $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$

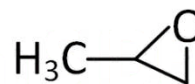
68. The major product of the following addition reaction is:



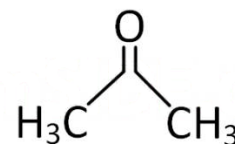
(A)



(B)



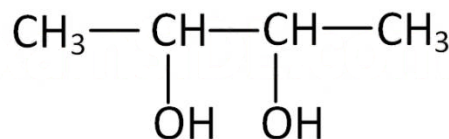
(C)



(D)

69. But-2-ene on reaction with alkaline KMnO_4 at elevated temperature followed by acidification will give:

- (A) one molecule of CH_3CHO and one molecule of CH_3COOH
(B) 2 molecules of CH_3COOH



(C)

- (D) 2 molecules of CH_3CHO

70. An organic compound 'A' is oxidized with Na_2O_2 followed by boiling with HNO_3 . The resultant solution is then treated with ammonium molybdate to yield a yellow precipitate. Based on above observation, the element present in the given compound is:

- (A) Fluorine (B) Phosphorus
(C) Nitrogen (D) Sulphur

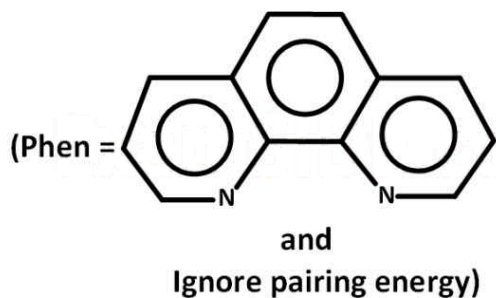
71. An example of a disproportionation reaction is :

- (A) $2\text{NaBr} + \text{Cl}_2 \rightarrow 2\text{NaCl} + \text{Br}_2$ (B) $2\text{KMnO}_4 \rightarrow 2\text{KMnO}_4 + \text{MnO}_2 + \text{O}_2$ (3) (4)
(C) $2\text{CuBr} \rightarrow \text{CuBr}_2 + \text{Cu}$ (D) $2\text{MnO}_4 + 10\text{I}^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{I}_2 + 8\text{H}_2\text{O}$

72. Glucose and Galactose are having identical configuration in all the positions except position

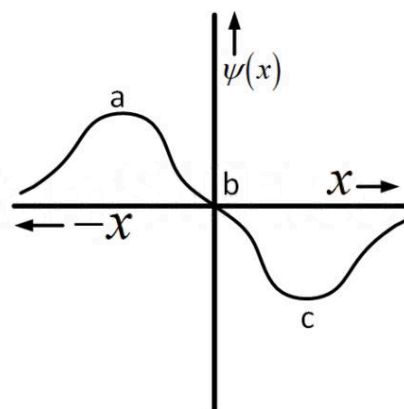
- (A) C-5 (B) C-3
(C) C-2 (D) C-4

73. The complex ion that will lose its crystal field stabilization energy upon oxidation of its metal to +3 state is :



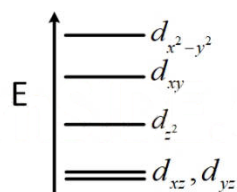
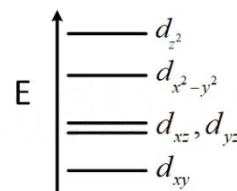
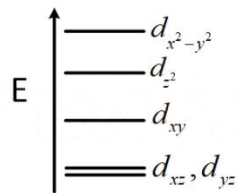
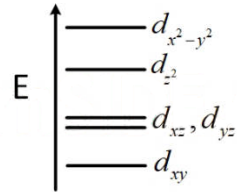
- (A) $[\text{Fe}(\text{phen})_3]^{2+}$ (B) $[\text{Zn}(\text{phen})_3]^{2+}$
(C) $[\text{Co}(\text{phen})_3]^{2+}$ (D) $[\text{Ni}(\text{phen})_3]^{2+}$

74. The electrons are more likely to be found :

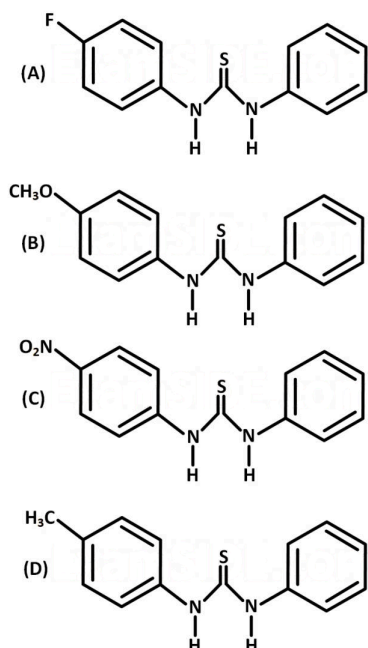


- (A) only in the region a (B) in the region a and c
(C) only in the region c (D) in the region a and b

75. Complete removal of both the axial ligands (along the z-axis) from an octahedral complex leads to which of the following splitting patterns? (relative orbital energies not on scale).

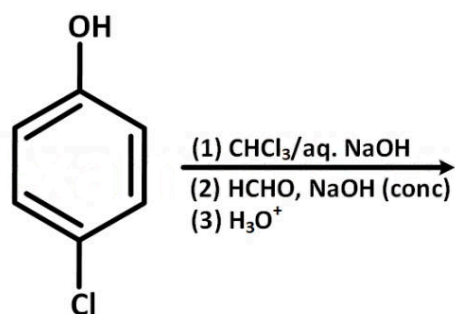
- (A) 
(B) 
(C) 
(D) 

76. The increasing order of the pK_b of the following compound is :



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

77. The major products of the following reaction are :

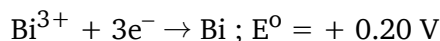
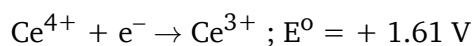
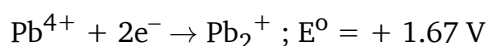
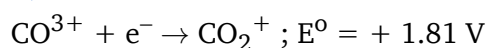


- (A)
 (B)
 (C)
 (D)

78. Enthalpy of sublimation of iodine is 24 cal g^{-1} at 200°C . If specific heat of $\text{I}_2(\text{s})$ and $\text{I}_2(\text{vap})$ are 0.055 and $0.031 \text{ cal g}^{-1}\text{K}^{-1}$ respectively, then enthalpy of sublimation of iodine at 250°C in cal g^{-1} is :

- (A) 2.85 (B) 22.8
(C) 11.4 (D) 5.7

79. Given



Oxidizing power of the species will increase in the order :

- (A) $\text{Co}^{3+} < \text{Ce}^{4+} < \text{Bi}^{3+} < \text{Pb}^{4+}$ (B) $\text{Co}^{3+} < \text{Pb}^{4+} < \text{Ce}^{4+} < \text{Bi}^{3+}$
(C) $\text{Ce}^{4+} < \text{Pb}^{4+} < \text{Bi}^{3+} < \text{Co}^{3+}$ (D) $\text{Bi}^{3+} < \text{Ce}^{4+} < \text{Pb}^{4+} < \text{Co}^{3+}$

80. Which of the following statements is not true about RNA?

- (A) It controls the synthesis of protein (B) It is present in the nucleus of the cell
(C) It usually does not replicate (D) It has always double stranded α -helix structure

81. The correct statement among the following is :

- (A) $(\text{SiH}_3)_3\text{N}$ is planar and more basic than $(\text{CH}_3)_3\text{N}$ (B) $(\text{SiH}_3)_3\text{N}$ is pyramidal and more basic than $(\text{CH}_3)_3\text{N}$
(C) $(\text{SiH}_3)_3\text{N}$ is pyramidal and less basic than $(\text{CH}_3)_3\text{N}$ (D) $(\text{SiH}_3)_3\text{N}$ is planar and less basic than $(\text{CH}_3)_3\text{N}$

82. In the following reaction; $x\text{A} \rightarrow y\text{B}$

$$\log_{10} \left[-\frac{d[\text{A}]}{dt} \right] = \log_{10} \left[\frac{d[\text{B}]}{dt} \right] + 0.3010$$

'A' and 'B' respectively can be :

- (A) n-Butane and Iso-butane (B) C_2H_4 and C_4H_8
(C) C_2H_4 and C_6H_6 (D) N_2O_4 and NO_2

83. An element has a face-centred cubic (fcc) structure with a cell edge of a . The distance between the centres of two nearest tetrahedral voids in the lattice is :

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

84. The metal that gives hydrogen gas upon treatment with both acid as well as base is :

- (A) mercury (B) zinc
(C) iron (D) magnesium

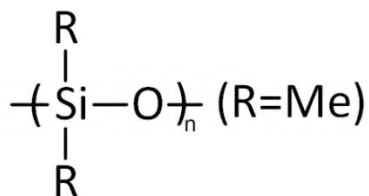
85. The idea of froth floatation method came from a person X and this method is related to the process Y of ores. X and Y, respectively, are :

- (A) washer woman and concentration
(B) fisher woman and concentration
(C) wisher man and reduction
(D) fisher man and reduction

86. The correct sequence of thermal stability of the following carbonates is :

- (A) $\text{BaCO}_3 < \text{SrCO}_3 < \text{CaCO}_3 < \text{MgCO}_3$
(B) $\text{MgCO}_3 < \text{CaCO}_3 < \text{SrCO}_3 < \text{BaCO}_3$
(C) $\text{BaCO}_3 < \text{CaCO}_3 < \text{SrCO}_3 < \text{MgCO}_3$
(D) $\text{MgCO}_3 < \text{SrCO}_3 < \text{CaCO}_3 < \text{BaCO}_3$

87. The basic structural unit of feldspar, zeolites, mica, and asbestos is :



- (A)
(B) $(\text{SiO}_4)^{4-}$
(C) $(\text{SiO}_3)^{2-}$
(D) SiO_2

88. The correct set of species responsible for the photochemical smog is :

- (A) NO , NO_2 , O_3 and hydrocarbons
(B) N_2 , NO_2 and hydrocarbons
(C) CO_2 , NO_2 , SO_2 and hydrocarbons
(D) N_2 , O_2 , O_3 and hydrocarbons

89. Peptization is a :

- (A) process of converting soluble particles to form colloidal solution
(B) process of converting precipitate into colloidal solution
(C) process of bringing colloidal molecule into solution
(D) process of converting a colloidal solution into precipitate

90. Which of the following is a thermosetting polymer?

- (A) Buna-N
(B) PVC
(C) Nylon6
(D) Bakelite

- End of Question Paper -