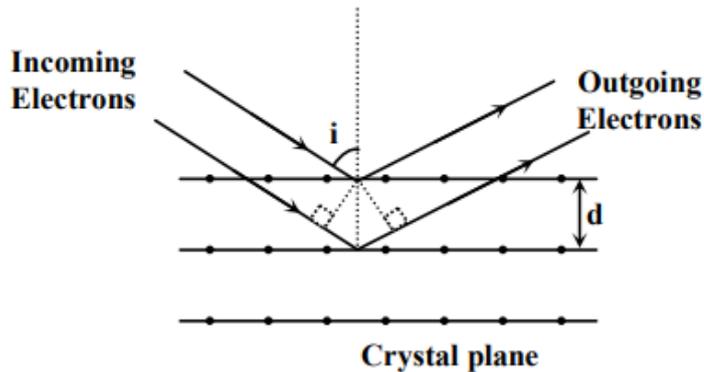


2008

PHYSICS

Directions Q. Nos. 1-3 are based on the following paragraph.

Wave property of electrons implies that they will show diffraction effects. Davisson and Germer demonstrated this by diffracting electrons from crystal is obtained by requiring that electron waves reflected from the planes of atoms in a crystal interfere constructively (see figure).

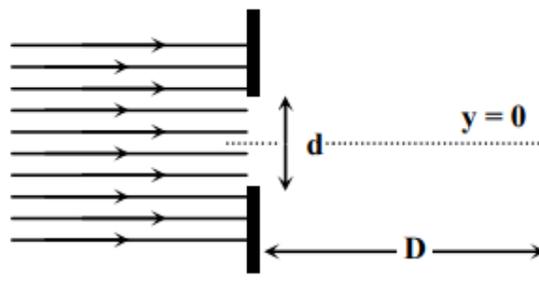


- Electrons accelerated by potential V are diffracted from a crystal. If $d = 1 \text{ \AA}$ and $i = 30^\circ$, V should be about ($h = 6.6 \times 10^{-34} \text{ J-s}$, $m_e = 9.1 \times 10^{-31} \text{ kg}$, $e = 1.6 \times 10^{-19} \text{ C}$)

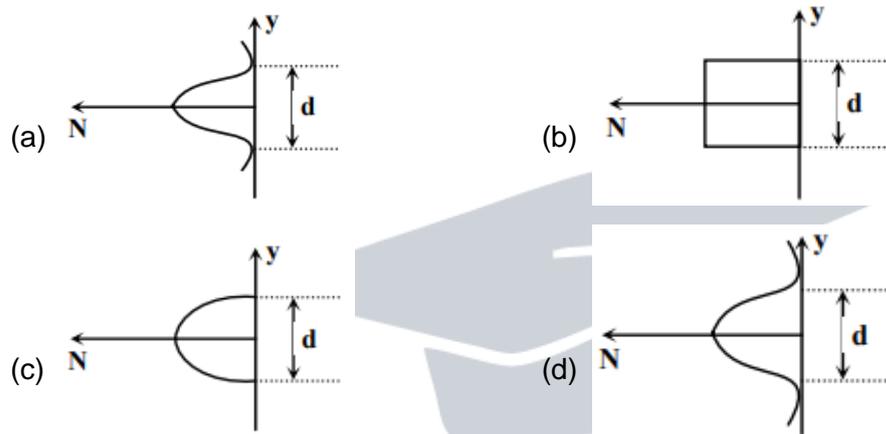
(a) 2000	(b) 50 V
(c) 500 V	(d) 1000 V
- If a strong diffraction peak is observed when electrons are incident at an angle i from the normal to the crystal planes with distance d between them (see figure), de-Broglie wavelength λ_{dB} of electrons can be calculated by the relationship (n is an integer)

(a) $d \sin i = n\lambda_{dB}$	(b) $2d \cos i = n\lambda_{dB}$
(c) $2d \sin i = n\lambda_{dB}$	(d) $d \cos i = n\lambda_{dB}$

3. In an experiment electrons are made to pass through a narrow slit of width d comparable to their de-Broglie wavelength. They are detected on a screen at a distance D from the slit (see figure).



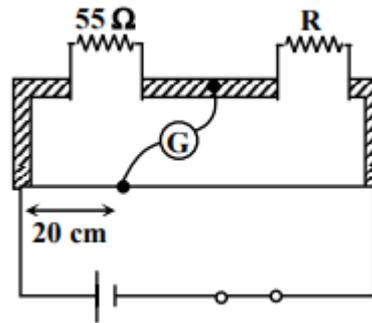
Which of the following graphs can be expected to represent the number of electrons N detected as a function of the detector position y ($y = 0$ corresponds to the middle of the slit)?



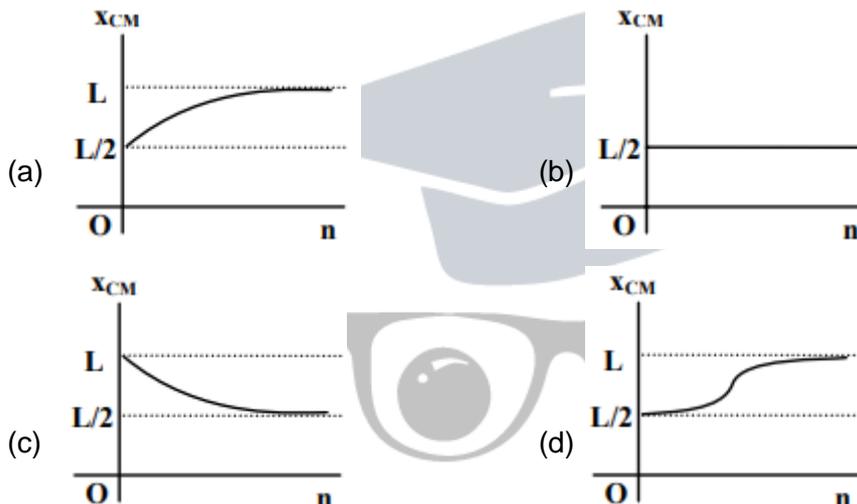
4. A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth is 11 kms^{-1} , the escape velocity from the surface of the planet would be
- (a) 1.1 kms^{-1} (b) 11 kms^{-1}
(c) 110 kms^{-1} (d) 0.11 kms^{-1}
5. A spherical solid ball of volume V is made of a material of density ρ_1 . It is falling through a liquid of density ρ_2 ($\rho_2 < \rho_1$). [Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed v , i.e., $F_{\text{viscous}} = -kv^2$ ($k > 0$)]. The terminal speed of the ball is

- (a) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$ (b) $Vg \rho_1/k$
(c) $\sqrt{\frac{Vg\rho_1}{k}}$ (d) $Vg(\rho_1 - \rho_2)/k$

6. Shown in the figure adjacent is a meter-bridge setup with null deflection in the galvanometer. The value of the unknown resistor R is



- (a) 13.75Ω (b) 220Ω
(c) 110Ω (d) 55Ω
7. A thin rod of length L is lying along the x -axis with its ends at $x = 0$ and $x = L$. Its linear density (mass/length) varies with x as $k(x/L)^n$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against n , which of the following graphs best approximates the dependence of x_{CM} on n ?



8. While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18 cm during winter. Repeating the same experiment during summer, she measures the column length to be x cm for the second resonance. Then,
- (a) $18 > x$ (b) $x > 54$
(c) $54 > x > 36$ (d) $36 > x > 18$
9. The dimensions of magnetic field in M , L , T and C (Coulomb) is given as
- (a) $[MLT^1C^{-1}]$ (b) $[MT^2C^{-2}]$
(c) $[MT^{-1}C^{-1}]$ (d) $[MT^{-2}C^{-1}]$
10. Consider a uniform square plate of side a and mass m . The moment of inertia of this plate about an axis perpendicular to its plane and passing through one of its corners is
- (a) $\frac{5}{6} ma^2$ (b) $\frac{1}{12} ma^2$
(c) $\frac{7}{12} ma^2$ (d) $\frac{2}{3} ma^2$

11. A body of mass $m = 3.513 \text{ kg}$ is moving along the x -axis with a speed of 5.00 ms^{-1} . The magnitude of its momentum is recorded as
- (a) 17.6 kg ms^{-1} (b) $17.565 \text{ kg ms}^{-1}$
(c) 17.56 kg ms^{-1} (d) 17.57 kg ms^{-1}
12. An athlete in the Olympic games covers a distance of 100 m in 10 s . His kinetic energy can be estimated to be in the range
- (a) $200 \text{ J} - 500 \text{ J}$ (b) $2 \times 10^5 \text{ J} - 3 \times 10^5 \text{ J}$
(c) $20,000 \text{ J} - 50,000 \text{ J}$ (d) $2,000 \text{ J} - 5,000 \text{ J}$
13. A parallel plate capacitor with air between the plates has a capacitance of 9 pF . The space between its plates is d . The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $K_1 = 3$ and thickness $\frac{d}{3}$ while the other one has dielectric constant $K_2 = 6$ and thickness $\frac{2d}{3}$. Capacitance of the capacitor is now
- (a) 1.8 pF (b) 45 pF
(c) 40.5 pF (d) 20.25 pF
14. The speed of sound in oxygen (O_2) at a certain temperature is 460 ms^{-1} . The speed of sound in helium (He) at the same temperature will be (assume both gases to be ideal)
- (a) 460 ms^{-1} (b) 500 ms^{-1}
(c) 650 ms^{-1} (d) 330 ms^{-1}

Directions Question Nos. 15 and 16 are Assertion-Reason type questions. Each of these question contain two statements

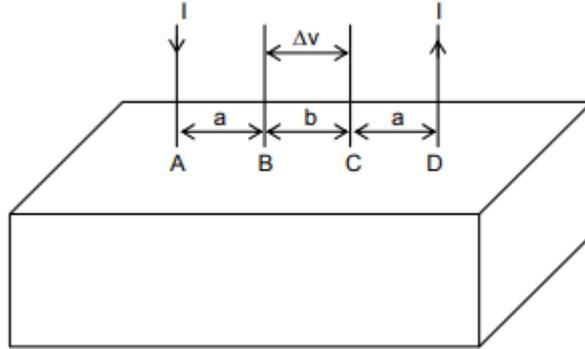
Statement I (Assertion) and **Statement II** (Reason). Each of these question also has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

- (a) Statement I is false, Statement II is true
(b) Statement I is true, Statement II is true; Statement II is the correct explanation of Statement I
(c) Statement I is true, Statement II is true; Statement II is not the correct explanation of Statement I
(d) Statement I is true, Statement II is false
15. This question contains Statement I and Statement II. Of the four choices given after the statements, choose the one that best describes the two statements.
- Statement I** Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.
- Statement II** For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z .



Directions Q. Nos. 19 and 20 are based on the following paragraph.

Consider a block of conducting material of resistivity ρ shown in the figure. Current I enters at A and leaves from D. We apply superposition principle to find voltage ΔV developed between B and C.



The calculation is done in the following steps

- (i) Take current I entering from A and assume it to spread over a hemispherical surface in the block.
- (ii) Calculate field $E(r)$ at distance r from A by using Ohm's law $E = \rho J$, where J is the current per unit area at r .
- (iii) From the r dependence of $E(r)$, obtain the potential $V(r)$ at r .
- (iv) Repeat steps (i), (ii) and (iii) for current I leaving D and superpose results for A and D.

19. ΔV measured between B and C is

(a) $\frac{\rho l}{\pi a} - \frac{\rho l}{\pi(a+b)}$

(b) $\frac{\rho l}{a} - \frac{\rho l}{(a+b)}$

(c) $\frac{\rho l}{2\pi a} - \frac{\rho l}{2\pi(a+b)}$

(d) $\frac{\rho l}{2\pi(a-b)}$

20. For current entering at A, the electric field at a distance r from A is

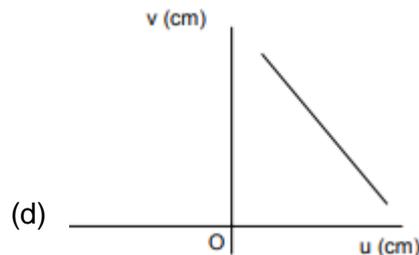
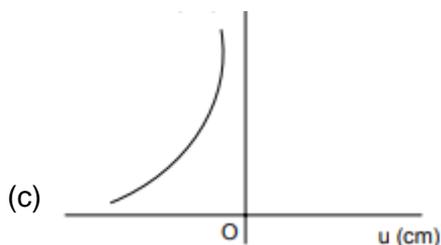
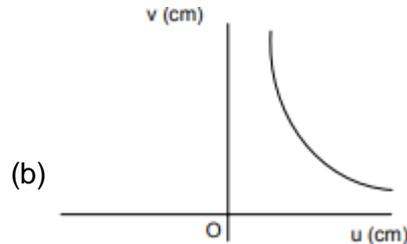
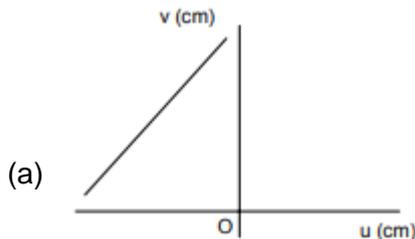
(a) $\rho l / 8\pi r^2$

(b) $\rho l / r^2$

(c) $\rho l / 2\pi r^2$

(d) $\rho l / 4\pi r^2$

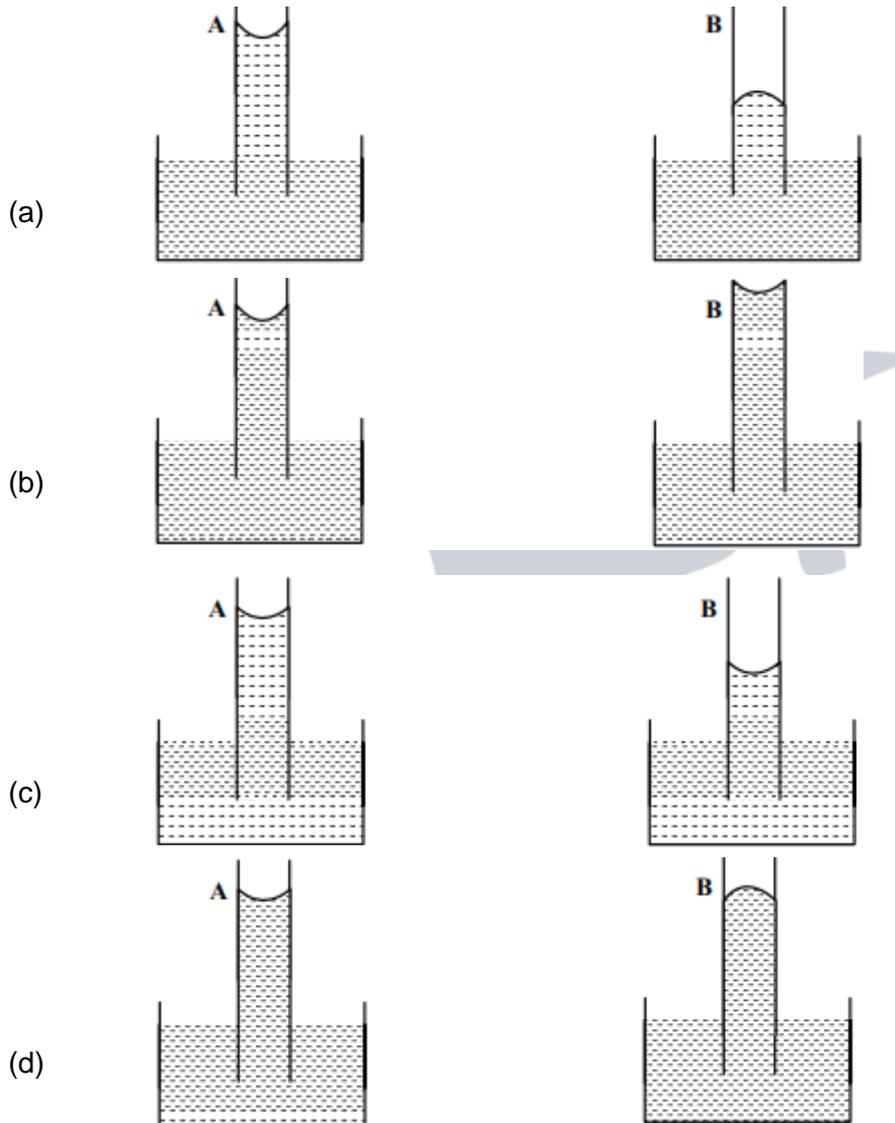
21. A student measures the focal length of a convex lens by putting an object pin at a distance u from the lens and measuring the distance v of the image pin. The graph between u and v plotted by the student should look like



22. A block of mass 0.50 kg is moving with a speed of 2.00 ms^{-1} on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is

- (a) 0.16 J (b) 1.00 J
(c) 0.67 J (d) 0.34 J

23. A capillary tube (A) is dipped in water. Another identical tube (B) is dipped in a soap-water solution. Which of the following shows the relative nature of the liquid columns in the two tubes?

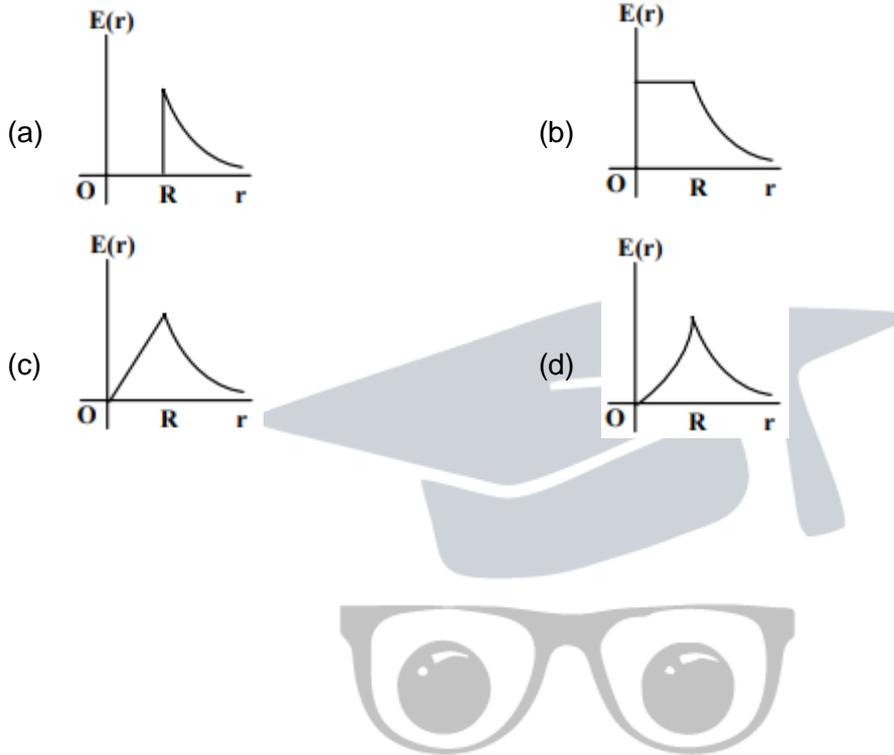


24. Suppose an electron is attracted towards the origin by a force $\frac{k}{r}$, where k is a constant and r is the distance of the electron from the origin. By applying Bohr model to this system, the radius of the n th orbital of the electron is found to be r_n and the kinetic energy of the electron to be T_n . Then, which of the following is true?

- (a) $T_n \propto 1/n^2$, $r_n \propto n^2$ (b) T_n independent of n , $r_n \propto n$
(c) $T_n \propto \frac{1}{n}$, $r_n \propto n$ (d) $T_n \propto \frac{1}{n}$, $r_n \propto n^2$

29. An experiment is performed to find the refractive index of glass using a travelling microscope. In this experiment distance are measured by
- (a) a vernier scale provided on the microscope
 - (b) a standard laboratory scale
 - (c) a meter scale provided on the microscope
 - (d) a screw gauge provided on the microscope

30. A thin spherical shell of radius R has charge Q spread uniformly over its surface. Which of the following graphs most closely represents the electric field $E(r)$ produced by the shell in the range $0 \leq r < \infty$, where r is the distance from the centre of the shell?



CHEMISTRY

31. The organic chloro compound, which shows complete stereo chemical inversion during a S_N2 reaction is
- (a) $(C_2H_5)_2CHCl$ (b) $(CH_3)_3CCl$
(c) $CH_3)_2CHCl$ (d) CH_3Cl
32. The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]NO_2$ (where (en) is ethylene diamine) are, respectively
- (a) 6 and 2 (b) 4 and 2
(c) 4 and 3 (d) 6 and 3
33. Identify the wrong statement in the following
- (a) Chlorofluorocarbons are responsible for ozone layer depletion
(b) Greenhouse effect is responsible for global warming
(c) Ozone layer does not permit infrared radiation from the sun to reach the earth
(d) Acid rain is mostly because of oxides of nitrogen and sulphur
34. Phenol, when it first reacts with concentrated sulphuric acid and then with concentrated nitric acid, gives
- (a) 2, 4, 6-trinitrobenzene (b) o-nitrophenol
(c) p-nitrophenol (d) nitrobenzene
35. Toluene is nitrated and the resulting product is reduced with tin and hydrochloric acid. The product so obtained is diazotised and then heated with cuprous bromide. The reaction mixture so formed contains
- (a) mixture of x- and p-bromotoluenes (b) mixture of o-and p-dibromobenzenes
(c) mixture of o-and p-bromoanilines (d) mixture of o-and m-bromotoluenes
36. In the following sequence of reactions, the alkene affords the compound 'B'
- $$CH_3CH=CHCH_3 \xrightarrow{O_3} A \xrightarrow[Zn]{H_2O} B.$$
- The compound B is
- (a) CH_3CH_2CHO (b) CH_3COCH_3
(c) $CH_3CH_2COCH_3$ (d) CH_3CHO
37. Larger number of oxidation states are exhibited by the actinoides than those by the lanthanoides, the main reason being
- (a) 4f orbitals more diffused than the 5f orbitals
(b) lesser energy difference between 5f and for than between 4f and 5d orbitals
(c) more energy difference between 5f and 6d than between 4f and 5d orbitals
(d) more reactive nature of the actinoids than the lanthanoids
38. In which of the following octahedral complexes of Co (at. No. 27), will the magnitude of Δ_0 be the highest?
- (a) $[Co(CN)_6]^{3-}$ (b) $[Co(C_2O_4)_3]^{3-}$
(c) $[Co(H_2O)_6]^{3+}$ (d) $[Co(NH_3)_6]^{3+}$



39. At 80° C, the vapour pressure of pure liquid 'A' is 520 mmHg and that of pure liquid 'B' is 1000 mmHg. If a mixture solution of 'A' and 'B' boils at 80° C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mmHg)

- (a) 52 mole per cent (b) 34 mole per cent
(c) 48 mole per cent (d) 50 mole per cent

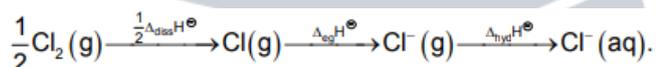
40. For a reaction $\frac{1}{2}A \rightarrow 2B$, rate of disappearance of 'A' is related to the rate of appearance of 'B' by the expression

- (a) $-\frac{d[A]}{dt} = \frac{1}{2} \frac{d[B]}{dt}$ (b) $-\frac{d[A]}{dt} = \frac{1}{4} \frac{d[B]}{dt}$
(c) $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$ (d) $-\frac{d[A]}{dt} = 4 \frac{d[B]}{dt}$

41. The equilibrium constants K_{p1} and K_{p2} for the reactions $X \rightleftharpoons 2Y$ and $Z \rightleftharpoons P + Q$, respectively are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal, then the ratio of total pressure at these equilibria is

- (a) 1 : 36 (b) 1 : 1
(c) 1 : 3 (d) 1 : 9

42. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below



The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$ (using the data,

$$\Delta_{diss}H^\ominus_{Cl_2} = 240 \text{ kJmol}^{-1}, \Delta_{eg}H^\ominus_{Cl} = -349 \text{ kJmol}^{-1}, \Delta_{hyd}H^\ominus_{Cl} = -381 \text{ kJmol}^{-1})$$

- (a) + 152 kJ mol⁻¹ (b) - 610 kJ mol⁻¹
(c) - 850 kJ mol⁻¹ (d) + 120 kJ mol⁻¹

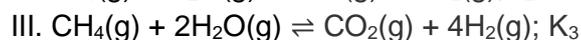
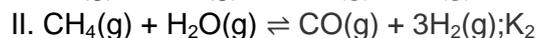
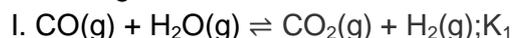
43. Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?

- (a) Metal sulphides are thermodynamically more stable than CS₂
(b) CO₂ is thermodynamically more stable than CS₂
(c) Metal sulphides are less stable than the corresponding oxides
(d) CO₂ is more volatile than CS₂

44. Bakelite is obtained from phenol by reacting with

- (a) (CH₂OH)₂ (b) CH₃CHO
(c) CH₃COCH₃ (d) HCHO

45. For the following three reactions I, II and III, equilibrium constants are given

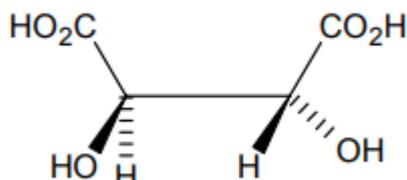


Which of the following relations is correct?

- (a) $K_1\sqrt{K_2} = K_3$ (b) $K_2K_3 = K_1$
(c) $K_3 = K_1K_2$ (d) $K_3K_2^3 = K_1^2$

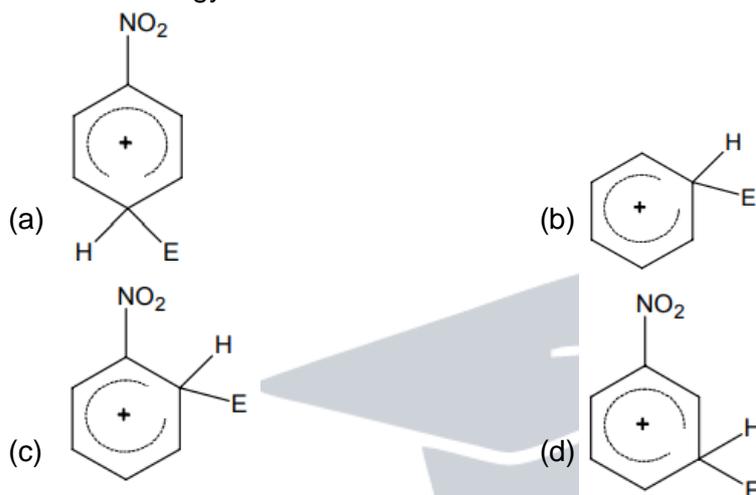


46. The absolute configuration of



- (a) S, S
(b) R, R
(c) R, S
(d) S, R

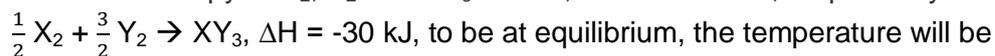
47. The electrophile, E^{\oplus} attacks the benzene ring to generate the intermediate σ -complex is of lowest energy?



48. α -D-(+)-glucose and β -D-(+)-glucose are

- (a) conformers
(b) epimers
(c) anomers
(d) enantiomers

49. Standard entropy of X_2 , Y_2 and XY_3 are 60, 40 and 50 JK^{-1} , respectively. For the reaction,



- (a) 1250 K
(b) 500 K
(c) 750 K
(d) 1000 K

50. Four species are listed below

- (i) HCO_3^- (ii) H_3O^+
(iii) HSO_4^- (iv) HSO_3F

Which one of the following is the correct sequence of their acid strength?

- (a) (iv) < (ii) < (iii) < (i)
(b) (ii) < (iii) < (i) < (iv)
(c) (i) < (iii) < (ii) < (iv)
(d) (iii) < (i) < (iv) < (ii)

51. Which one of the following constitutes a group of the isoelectronic species?

- (a) C^{2-} , O^{2-} , CO, NO
(b) NO^+ , C^{2-} , CN^- , N_2
(c) CN^- , N_2 , O^{2-} , CO^{2-}
(d) N_2 , O^{2-} , NO^+ , CO

52. Which one of the following pairs of species have the same bond order?
 (a) CN^- and NO^+ (b) CN^- and CN^+
 (c) O_2^- and CN^- (d) NO^+ and CN^+
53. The ionisation enthalpy of hydrogen atom is $1.312 \times 10^6 \text{ J mol}^{-1}$. The energy required to excite the electron in the atom from $n = 1$ to $n = 2$ is
 (a) $8.51 \times 10^5 \text{ J mol}^{-1}$ (b) $6.56 \times 10^5 \text{ J mol}^{-1}$
 (c) $7.56 \times 10^5 \text{ J mol}^{-1}$ (d) $9.84 \times 10^5 \text{ J mol}^{-1}$
54. Which one of the following is the correct statement?
 (a) Boric acid is a protonic acid
 (b) Beryllium exhibits coordination number of six
 (c) Chlorides of both beryllium and aluminium have bridged chloride structures in solid phase
 (d) $\text{B}_2\text{H}_6 \cdot 2\text{NH}_3$ is known as 'inorganic benzene'
55. Given, $E_{\text{Cr}^{3+}/\text{Cr}}^\circ = -0.72\text{V}$,
 $E_{\text{Fe}^{2+}/\text{Fe}}^\circ = -0.42\text{V}$
 The potential for the cell $\text{Cr}|\text{Cr}^{3+}(0.1\text{M})||\text{Fe}^{2+}(0.01\text{M})|\text{Fe}$ is
 (a) 0.26 V (b) 0.399 V
 (c) -0.339 V (d) -0.26 V
56. Amount of oxalic acid present in a solution can be determined by its titration with KMnO_4 solution in the presence of H_2SO_4 . The titration gives unsatisfactory result when carried out in the presence of HCl , because HCl
 (a) gets oxidised by oxalic acid to chlorine
 (b) furnishes H^+ ions in addition to those from oxalic acid
 (c) reduces permanganate to Mn^{2+}
 (d) oxidises oxalic acid to carbon dioxide and water
57. The vapour pressure of water at 20°C is 17.5 mm Hg. If 18 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is added to 178.2 g of water at 20°C , the vapour pressure of the resulting solution will be
 (a) 17.675 mm Hg (b) 15.750 mm Hg
 (c) 16.500 mm Hg (d) 17.325 mm Hg
58. Among the following substituted silanes the one which will give rise to crosslinked silicone polymer on hydrolysis is
 (a) R_4Si (b) RSiCl_3
 (c) R_2SiCl_2 (d) R_3SiCl
59. In context with the industrial preparation of hydrogen from water gas ($\text{CO} + \text{H}_2$), which of the following is the correct statement?
 (a) CO and H_2 are fractionally separated using differences in their densities
 (b) CO is removed by absorption in aqueous Cu_2Cl_2 solution
 (c) H_2 is removed through occlusion with Pd
 (d) CO is oxidised to CO_2 with steam in the presence of a catalyst followed by the absorption of CO_2 in alkali

60. In a compound atoms, of element Y from ccp lattice and those of element X occupy $2/3^{\text{rd}}$ of tetrahedral voids. The formula of the compound will be
- (a) X_4Y_3 (b) X_2Y_3
(c) X_2Y (d) X_3Y_4



68. The conjugate of a complex number is $\frac{1}{i-1}$. Then, that complex number is
- (a) $-\frac{1}{i-1}$ (b) $\frac{1}{i+1}$
(c) $-\frac{1}{i+1}$ (d) $\frac{1}{i-1}$
69. Let R be the real line. Consider the following subsets of the plane $R \times R$
 $S = \{(x, y) : y = x + 1 \text{ and } 0 < x < 2\}$
 $T = \{(x, y) : x - y \text{ is an integer}\}$. Which one of the following is true?
 (a) Neither S nor T is an equivalence relation on R
 (b) Both S and T are equivalence relations on R
 (c) S is an equivalence relation on R but T is not
 (d) T is an equivalence relation on R but S is not
70. The perpendicular bisector of the line segment joining P(1, 4) and Q(k, 3) has y-intercept - 4. Then, a possible value of k is
- (a) 1 (b) 2
(c) -2 (d) -4
71. The solution of the differential equation $\frac{dy}{dx} = \frac{x+y}{x}$ satisfying the condition $y(1) = 1$ is
- (a) $y = \log x + x$ (b) $y = x \log x + x^2$
(c) $y = xe^{(x-1)}$ (d) $y = x \log x + x$
72. The mean of the numbers a, b, 8, 5, 10 is 6 and the variance is 6.80. Then, which one of the following gives possible values of a and b?
- (a) a = 0, b = 7 (b) a = 5, b = 2
(c) a = 1, b = 6 (d) a = 3, b = 4
73. The vector $a = \alpha i + 2j + \beta k$ lies in the plane of the vectors $b = i + j$ and $c = j + k$ and bisects the angle between b and c. Then, which one of the following gives possible values of α and β ?
- (a) $\alpha = 2, \beta = 2$ (b) $\alpha = 1, \beta = 2$
(c) $\alpha = 2, \beta = 1$ (d) $\alpha = 1, \beta = 1$
74. The non-zero vectors a, b and c are related by $a = 8b$ and $c = -7b$. Then, the angle between a and c is
- (a) 0 (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{2}$ (d) π
75. The line passing through the points (5, 1a), and (3, b, 1) crosses the yz-plane at the point $(0, \frac{17}{2}, \frac{-13}{2})$. Then,
- (a) a = 2, b = 8 (b) a = 4, b = 6
(c) a = 6, b = 4 (d) a = 8, b = 2

76. If the straight lines $\frac{x-1}{k} = \frac{y-2}{2} = \frac{z-3}{3}$ and $\frac{x-2}{3} = \frac{y-3}{k} = \frac{z-1}{2}$ intersect at a point, then the integer k is equal to

- (a) -5 (b) 5
(c) 2 (d) -2

Directions Q. Nos. 87 to 91 are Assertion-Reason type questions. Each of these questions contains two statements

Statement I (Assertion) and

Statement II (Reason). Each of these question also has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

- (a) Statement I is false, Statement II is true
(b) Statement I is true, Statement II is true; Statement II is the correct explanation of Statement I
(c) Statement I is true, Statement II is true; Statement II is not the correct explanation of Statement I
(d) Statement I is true, Statement II is false

77. **Statement I** For every natural number $n \geq 2$, $\frac{1}{\sqrt{1}} + \frac{1}{\sqrt{2}} + \dots + \frac{1}{\sqrt{n}} > \sqrt{n}$.

Statement II For every natural number $n \geq 2$, $\sqrt{n(n+1)} < n+1$.

78. Let A be 2 x 2 matrix with real entries. Let I be the 2 x 2 identity matrix. Denote by tr(A), the sum of diagonal entries of A. Assume that $A^2 = I$.

Statement I If $A \neq I$ and $A \neq -I$, then $\det(A) = -1$.

Statement II If $A \neq I$ and $A \neq -I$, then $\text{tr}(A) \neq 0$.

79. **Statement I** $\sum_{r=0}^n (r+1)^n C_r = (n+2)2^{n-1}$.

Statement II $\sum_{r=0}^n (r+1)^n C_r x^r = (1+x)^n + nx(1+x)^{n-1}$.

80. Let p be the statement "x is an irrational number", q be the statement "y is a transcendental number" and r be the statement "x is a rational number, if y is a transcendental number".

Statement I r is equivalent to either q or p.

Statement II r is equivalent to $\sim (p \leftrightarrow \sim q)$.

81. In a shop, there are five types of ice-creams available. A child buys six ice-creams.

Statement I The number of different ways the child can buy the six ice-creams, is ${}^{10}C_5$.

Statement II The number of different ways the child can buy the six ice-creams is equal to the number of different ways of arranging 6 A's and 4 B's in a row.

82. Let $f(x) = \begin{cases} (x-1)\sin\left(\frac{1}{x-1}\right), & \text{if } x \neq 1 \\ 0, & \text{if } x = 1 \end{cases}$.

Then, which one of the following is true?

- (a) f is neither differentiable at $x = 0$ nor at $x = 1$
 (b) f is differentiable at $x = 0$ and at $x = 1$
 (c) f is differentiable at $x = 0$ but not at $x = 1$
 (d) f is differentiable at $x = 1$ but not at $x = 0$

83. The first two terms of a geometric progression add upon 12. The sum of the third and the fourth terms is 48. If the terms of the geometric progression are alternately positive and negative, then the first term is

- (a) -4 (b) -12
 (c) 12 (d) 4

84. Suppose the cubic $x^3 - px + q$ has three distinct real roots, where $p > 0$ and $q > 0$. Then, which one of the following holds?

- (a) The cubic has minima at $\sqrt{\frac{p}{3}}$ and maxima at $-\sqrt{\frac{p}{3}}$
 (b) The cubic has minima at $-\sqrt{\frac{p}{3}}$ and maxima at $\sqrt{\frac{p}{3}}$
 (c) The cubic has minima at both $\sqrt{\frac{p}{3}}$ and $-\sqrt{\frac{p}{3}}$
 (d) The cubic has maxima at both $\sqrt{\frac{p}{3}}$ and $-\sqrt{\frac{p}{3}}$

85. How many real solutions does the equation $x^7 + 14x^5 + 16x^3 + 30x - 560 = 0$ have?

- (a) 7 (b) 1
 (c) 3 (d) 5

86. The statement $p \rightarrow (q \rightarrow p)$ is equivalent to

- (a) $p \rightarrow (p \rightarrow q)$ (b) $p \rightarrow (p \vee q)$
 (c) $p \rightarrow (p \wedge q)$ (d) $p \rightarrow (p \leftrightarrow q)$

87. The value of $\cot(\operatorname{cosec}^{-1} 5/3 + \tan^{-1} 2/3)$ is

- (a) $\frac{6}{17}$ (b) $\frac{3}{17}$
 (c) $\frac{4}{17}$ (d) $\frac{5}{17}$

88. The differential equation of the family of circles with fixed radius 5 units and centre on the line $y = 2$ is

- (a) $(x-2)y^2 = 25 - (y-2)^2$
 (b) $(y-2)y^2 = 25 - (y-2)^2$
 (c) $(y-2)^2y^2 = 25 - (y-2)^2$
 (d) $(x-2)^2y^2 = 25 - (y-2)^2$



