IIT-GATE: Model Test

Chemistry

❖ Question Paper

Section-A

Q.1 - Q.25 carry one mark each.

Q.1 In the reactions (A) and (B),

$$nH_2O + Cl^- \rightarrow [Cl(H_2O)_6]^- \quad \ldots\ldots\ldots(A)$$

$$6H_2O + Mg^{2+} \rightarrow [Mg(H_2O)_6]^{2+} \quad \ldots\ldots\ldots(B)$$

water behaves as

(a) An acid in both (A) and (B)

(b) An acid in (A) and a base in (B)

(c) A base in (A) an acid in (B)

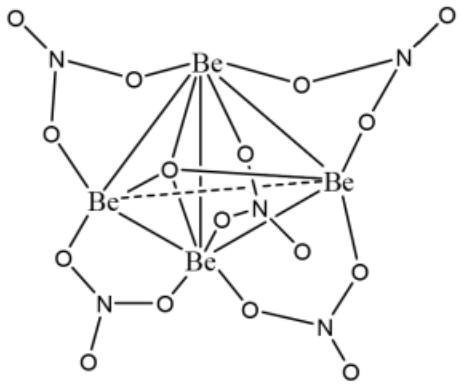
(d) A base in both (A) and (B)

Q.2 The size of the d orbitals in Si, P, S and Cl follows the order.

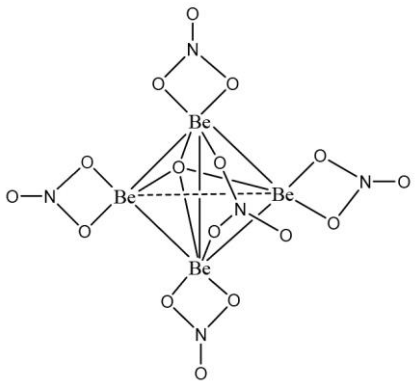
(a) Cl > S > P > Si (b) Cl > P > S > Si (c) P > S > Si > Cl (d) Si > P > S > Cl

Q.3 The correct structure of basic beryllium nitrate is:

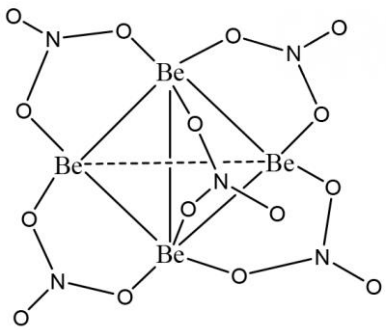
(a)



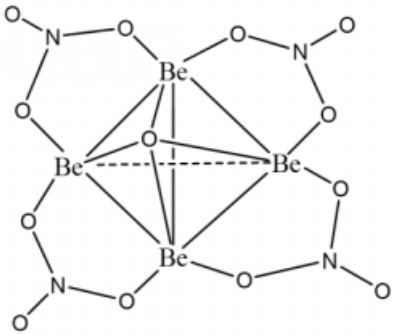
(b)



(c)



(d)



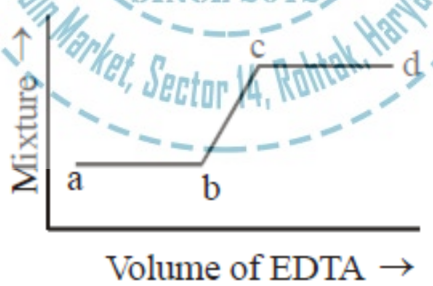
Q.4 The total number of lone pairs of electrons in I_3^- is:

(a) Zero (b) Three (c) Six (d) Nine

Q.5 If Mossbauer spectrum of $Fe(CO)_5$ is recorded in the presence of a magnetic field, the original spectrum with two lines changes into the one with

(a) 3 lines (b) 4 lines (c) 5 lines (d) 6 lines

Q.6 The spectrophotometric response for the titration of a mixture of Fe^{3+} and Cu^{2+} ions against EDTA is given below.



The correct statement is:

(a) Volume ab = $[Fe^{3+}]$ and volume cd = $[Cu^{2+}]$

(b) Volume ab = $[Cu^{2+}]$ and volume cd = $[Fe^{3+}]$

(c) Volume ab = $[Fe^{3+}]$ and volume cd = excess EDTA

(d) Volume ab = $[Cu2^{2+}]$ and volume cd = excess EDTA

Q.7 In 'carbon-dating' application of radioisotopes, ^{14}C emits

(a) β – particle (b) α – particle (c) γ – particle (d) Positron

Q.8 The actual base pairs present in the double helical structure of DNA containing adenine (A), thymine (T), cytosine (C) and guanine (G), are

(a) AG and CT (b) AC and GT (c) AG and AC (d) AT and GC

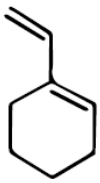
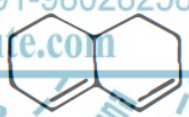
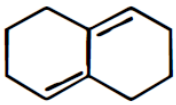
Q.9 The oxidation state of iron in met-hemoglobin is

(a) 3 (b) 2 (c) 4 (d) 0

Q.10 The reaction of $Ni(CO)_4$ with the ligand L ($L = PMe_3$ or $P(OMe)_3$)L yields $Ni(CO)_3L$. The reaction is

(a) Associative (b) Dissociative (c) Interchange (I_a) (d) Interchange (I_d)

Q.11 The diene which undergoes Diels–Alder reaction with maleic anhydride is

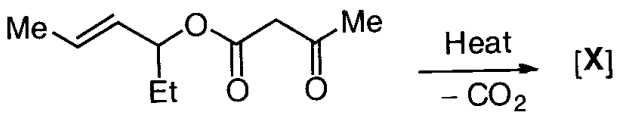
(a)  (b)  (c)  (d) 

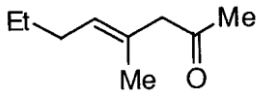
Q.12 The sequence of an mRNA molecule produced from a DNA template strand with the composition 5'–AGCTACACT–3' is

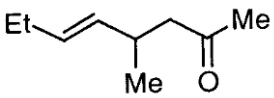
(a) 5'–AGUGUAGCU–3' (b) 5'–UCGAUGUGA–3'

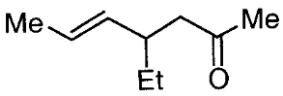
(c) 5'–AGTGTAGCT–3' (d) 5'–TCGATGTGA–3'

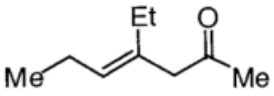
Q.13 In the following reaction



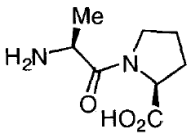
(a) 

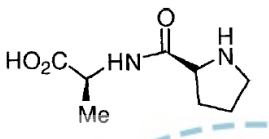
(b) 

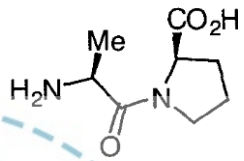
(c) 

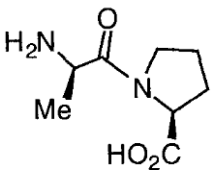
(d) 

Q.14 The structure of the dipeptide Ala–Pro derived from the natural amino acids is

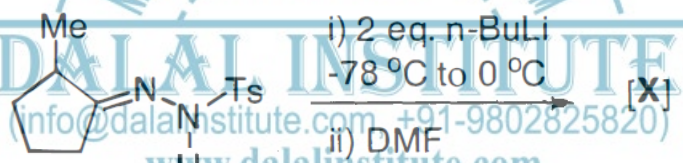
(a) 

(b) 

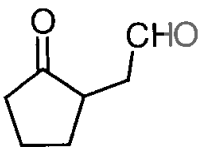
(c) 

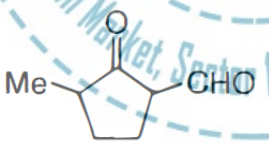
(d) 

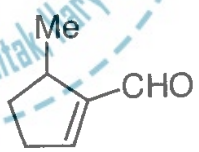
Q.15 In the following reaction

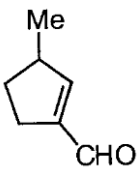


the major product [X] is

(a) 

(b) 

(c) 

(d) 

Q.16 In a polarographic measurement, (aqueous KCl solution used as supporting electrolyte) an applied potential more than +0.4 V, results mainly in the formation of

(a) Hg^{I} (b) Hg^{II} (c) Cl_2 (d) O_2

Q.17 The correct order of the isomeric shift in Mossbauer spectra (^{57}Fe source) of iron compounds is

(a) Fe(II) > Fe(III) > Fe(IV) (b) Fe(III) > Fe(II) > Fe(IV)

(c) Fe(IV) > Fe(III) > Fe(II) (d) Fe(IV) > Fe(II) > Fe(III)

Q.18 The hapticities 'x' and 'y' of the arene moieties in the diamagnetic complex $[(\eta^x\text{- } C_6H_6)Ru(\eta^y \text{ - } C_6H_6)]$ respectively are

(a) 6 and 6 (b) 4 and 4 (c) 4 and 6 (d) 6 and 2

Q.19 The rate of the reaction $Ni(CO)_4 + PPh_3 \xrightarrow{h\nu} [Ni(CO)_3(PPh_3)] + CO$ depends on

(a) Concentration of both the reactants (b) Concentration of $Ni(CO)_4$ only

(c) Concentration of PPh_3 only (d) The steric bulk of PPh_3

Q.20 The product of the reaction of propene, CO and H_2 in the presence of $Co_2(CO)_8$ as a catalyst is

(a) Butanoic acid (b) Butanal (c) 2-butanone (d) Methylpropanoate

Q.21 The S and L values for ^{15}N atom respectively, are

(a) ½ and 1 (b) ½ and 0 (c) 1 and 0 (d) 3/2 and 0

Q.22 The point group symmetries for trans-$[Cr(en)_2F_2]^+$ and $[TiCl_6]^{3-}$, respectively, are

(a) D_{2d} and D_{3d} (b) D_{3d} and D_{4d} (c) D_{4h} and D_{3h} (d) D_{3h} and D_{4h}

Q.23 $Co_4(CO)_{12}$ adopts the

(a) *Closo*-structure (b) *Nido*-structure (c) *Arachano*-structure (d) *Hypho*-structure

Q.24 Reductive elimination step in hydrogenation of alkenes by Wilkinson catalyst results in (neglecting solvent in coordination sphere of Rh)

(a) T-shaped $[Rh(PPh_3)_2Cl]$ (b) Trigonal-planar $[Rh(PPh_3)_2Cl]^{2+}$

(c) T-shaped $[Rh(H)(PPh_3)Cl]^+$ (d) Trigonal-planar $[Rh(H)(PPh_3)_2]$

Q.25 In the following reaction $[PtC1_4]^{2-} + NO_2^- \rightarrow A \xrightarrow{NH_3} B$, compound B is

(a) trans-$[PtCl_2(NO_2)(NH_3)]^-$ (b) cis-$[PtCl_2(NO_2)(NH_3)]^-$

(c) trans- $[PtCl_2(NH_3)_2]$ (d) cis-$[PtCl_2(NO_2)_2]^{2-}$

Q.26 - Q.55 carry two marks each.

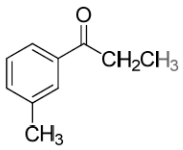
Q.26 On reacting 1.55 g of a diol with an excess of methylmagnesium iodide, 1.12 L (corrected to STP) of methane gas is liberated. The molecular mass (g mol^{-1}) of the diol is _____.

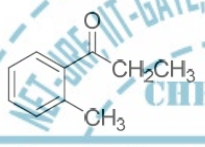
Q.27 The structure of the compound having the following characteristic spectral data, is

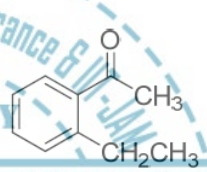
IR: 1690 cm^{-1};

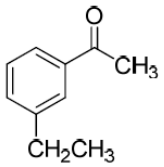
^{1}H-NMR: 1.30 (3H, t, J = 7.2 Hz); 2.41 (2H, q, J = 7.2 Hz); 2.32 (3H, s); 7.44 (1H, t, J = 7.0 Hz); 7.57 (1H, dt, J = 7.0, 3.0 Hz); 7.77 (1H, t, J = 3.0 Hz); 7.90 (1H, dt, J = 7.0, 3.0 Hz);

EI Mass: m/z 119 (100%); 57 (80%)

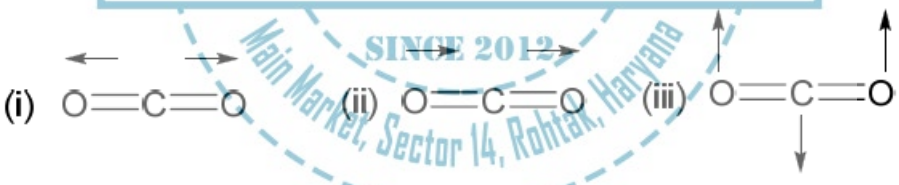
(a) 

(b) 

(c) 

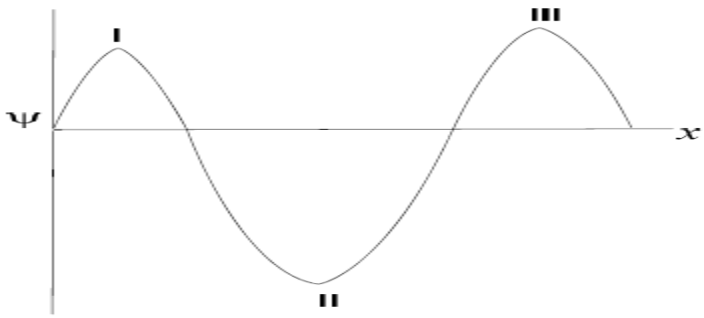
(d) 

Q.28 Of the vibrational modes given below, the IR active mode(s) is(are)



(a) (ii) only (b) (iii) only (c) (i) and (ii) (d) (ii) and (iii)

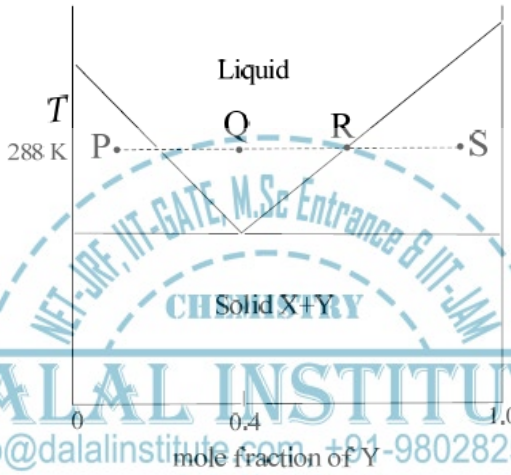
Q.29 A system is described by the following real wavefunction.



The probability (P) of finding the particle in a region dx around points I, II, and III in the figure obeys the trend

(a) P(I) > P(II) > P(III) (b) P(II) > P(III) > P(I) (c) P(II) > P(I) > P(III) (d) P(III) > P(I) > P(II)

Q.30 The temperature-composition (T-x) phase diagram of the two-component system made of X and Y is given below. At a temperature of 288 K and starting at the point P, Y is added until the composition reaches S. Which of the following statements is NOT TRUE?



(a) At P, the solid and liquid are present in almost equal proportions.

(b) At Q, the system is all liquid.

(c) At S, the system has more solid than liquid.

(d) At R, the liquid is pure X.

Q.31 The rotational partition function of a diatomic molecule with energy levels corresponding to J = 0 and 1, is (where,ε is a constant)

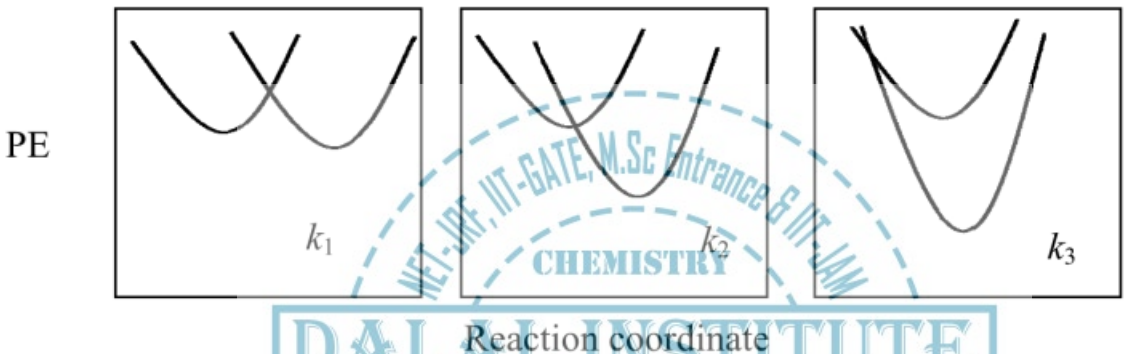
(a) $1 + e^{-2\varepsilon}$ (b) $1 + 3e^{-2\varepsilon}$ (c) $1 + e^{-3\varepsilon}$ (d) $1 + 3e^{-3\varepsilon}$

Q.32 The internal energy of an ideal gas follows the equation U = 3.5 PV + k, where k is a constant. The gas expands from an initial volume of 0.25 m^3 to a final volume of 0.86 m^3. If the initial pressure is 5 N m^{-2}, the change in internal energy (in Joules) is (given $PV^{1.3}$ =constant) _____.

Q.33 The solubility product of AgBr(s) is 5×10^{-13} at 298 K. If the standard reduction potential of the half-cell, $E^0_{Ag|AgBr(s)|Br^-}$ is 0.07 V, the standard reduction potential, $E^0_{Ag^+|Ag}$ (in volts) is _____.

Q.34 One mole of a substance is heated from 300 K to 400 K at constant pressure. The Cp of the substance is given by, Cp (J $K^{-1}mol^{-1}$) = 5 + 0.1 T. The change in entropy, in J $K^{-1}mol^{-1}$, of the substance is _____

Q.35 The potential energy (PE) versus reaction coordinate diagrams for electron transfer reactions with rate constants k_1, k_2 and k_3, are given below. The increasing order of the rate constants is



(a) $k_2 < k_3 < k_1$ (b) $k_2 < k_1 < k_3$ (c) $k_3 < k_2 < k_1$ (d) $k_3 < k_1 < k_2$

Q.36 The distance between two successive (110) planes in a simple cubic lattice with lattice parameter 'a' is

(a) $\sqrt{2}a$ (b) $\sqrt{3}a$ (c) $2\sqrt{2}a$ (d) $\frac{a}{\sqrt{2}}$

Q.37 The percent transmittance of 8×10^{-5} M solution of $KMnO_4$ is 39.8 when measured at 510 nm in a cell of path length of 1 cm. The absorbance and the molar extinction coefficient (in M^{-1} cm^{-1}) of this solution are, respectively,

(a) 0.30 and 4500 (b) 0.35 and 4800 (c) 0.4 and 5000 (d) 0.48 and 5200

Q.38 The value of 'g' and the number of signals observed for the reference standard, diphenylpicrylhydrazyl (DPPH), in the solid state ESR spectrum are, respectively,

(a) 2.0036 and 1 (b) 2.0036 and 3 (c) 2.2416 and 1 (d) 2.2416 and 3

Q.39 Ammonolysis of S_2Cl_2 in an inert solvent gives

(a) S_2N_2 (b) $S_2N_2Cl_2$ (c) $S_2N_2H_4$ (d) S_4N_4

Q.40 The complexes $K_2[NiF_6]$ and $K_3[CoF_6]$ are

(a) Both paramagnetic.

(b) Both diamagnetic.

(c) Paramagnetic and diamagnetic, respectively.

(d) Diamagnetic and paramagnetic, respectively.

Q.41 The most polar compound among the following is:

(a) SF_4 (b) BF_3 (c) XeF_4 (d) SO_3

Q.42 The pair of gaseous molecules/ions having tetrahedral structure is

(a) $SnCl_4$, PH_4^+ (b) $SnCl_4$, XeF_4 (c) ICl_4^-, PH_4^+ (d) $SnCl_4$, ICl_4^-

Q.43 Consider the following:

Volumetric method for Ag(I)	Indicator used
(a). Fajan method	Chromate
(b). Mohr's method	Fluorescein
(c). Vohlard method	ferric salt

The method and indicator matches correctly in

(a) (a) and (b) only (b) (b) and (c) only (c) (c) only (d) (b)only

Q.44 An unknown lead solution has diffusion current of 1.0 μA. To a 10 ml of this solution 0.5 ml of 0.04 M lead solution is added. The diffusion current of the spiked solution is 1.50 μA. The concentration of the unknown lead solution is

(a) 0.0020 M (b) 0.0050 M (c) 0.0035 M (d) 0.0010 M

Q.45 The ^{32}Pradio isotope, used in leukemia therapy, has $t_{1/2}$ = 14.26 days. What % of ^{32}P remains after 35 days?

(a) 30% (b) 8% (c) 81.7% (d) 18.3%

Q.46 On a 30 cm column, the t_R of A and B respectively are16.40 and 17.63 minutes. The t_0 of the column is 1.30 minutes. The peak width at base lines for A and B are 1.11 and 1.21 minutes respectively. The column resolution R_S is

(a) 1.06 (b) 1.23 (c) 2.12 (d) 2.23

Q.47 Which one of the following pairs of electronic configurations of high-spin transition metal ions (3d) in an octahedral field undergoes a substantial John-Teller distortion:

(a) d^3, d^9 (b) d^4, d^9 (c) d^5, d^9 (d) d^6, d^9

Q.48 Which one of the following pairs consists of a good oxidizing and a good reducing agent respectively:

(a) Ce(IV), Ln(III) (b) Ln(III), Eu(II) (c) Ce(IV), Eu(II) (d) Ln(III), Ce(III)

Q.49 Which one of the pairs of following statements about reduction of $[CoCl(NH_3)_5]^{2+}$ By Cr(II) is correct:

(A). Reactant $[CoCl(NH_3)_5]^{2+}$ has non-labile coordination sphere

(B). Reaction proceeds by outer-sphere mechanism

(C). Reactant $[CoCl(NH_3)_5]^{2+}$has labile coordination sphere

(D). Reaction proceeds by inner-sphere mechanism

(a) (A) and (B) (b) (A) and (D) (c) (C) and (B) (d) (C) and (D)

Q.50 Hemocyanin contains

(a) A dinuclear copper core and binds dioxygen in the cuprous state.

(b) A dinuclear copper core and binds dioxygen in the cupric state.

(c) A mononuclear copper core and binds dioxygen in the cuprous state.

(d) A mononuclear copper core and binds dioxygen in the cupric state.

Q.51 For the reaction $A_2 \rightleftharpoons 2A$ in a closed container, the relation between the degree of dissociation (α) and the equilibrium constant K_p at a fixed temperature is given by

(a) $. \alpha = \left[\frac{K_p}{K_p+4p}\right]$ (b) $. \alpha = \left[\frac{K_p}{K_p+4p}\right]^{1/2}$ (c) $\alpha = \left[\frac{K_p+4p}{K_p}\right]$ (d) $\alpha = \left[\frac{K_p+4p}{K_p}\right]^{1/2}$

Q.52 The fugacity of a gas depends on pressure and the compressibility factor ($Z = p\bar{V}/RT$) through the relation ($\bar{V}$ is the molar volume)

For most gases at temperature T and up to moderate pressure, this equation shows that

(a) $f < p$, if $T \rightarrow 0$ (b) $f < p$, if $T \rightarrow \infty$ (c) $f > p$, if $T \rightarrow 0$ (d) $f = p$, if $T \rightarrow 0$

Q.53 The internal pressure $(\partial U/\partial V)_T$ of a real gas is related to the compressibility factor $Z = p\bar{V}/RT$ by [$\bar{V}$ is the molar volume]

(a) $(\partial U/\partial V)_T = RT(\partial Z/\partial V)_T$ (b) $(\partial U/\partial V)_T = RT/(\bar{V}Z)$

(c) $(\partial U/\partial V)_T = (RT^2/\bar{V})(\partial Z/\partial V)_V$ (d) $(\partial U/\partial V)_T = (\bar{V}/RT^2)(\partial Z/\partial T)_V$

Q.54 Suppose, the ground stationary state of a harmonic oscillator with force constant 'k' is given by

$$\Psi_0 = \exp[-Ax^2]$$

Then A should depend on k as

(a) $A \propto k^{-1/2}$ (b) $A \propto k$ (c) $A \propto k^{1/2}$ (d) $A \propto k^{1/3}$

Q.55 Combining two real wave functions ϕ_1 and ϕ_2, the following functions are constructed:

$$A = \phi_1 + \phi_2, B = \phi_1 + i\phi_2, C = \phi_1 - i\phi_2, D = i(\phi_1 + \phi_2)$$

The correct statement will then be

(a) A and B represent the same state (b) A and C represent the same state

(c) A and D represents the same state (d) B and D represent the same state

Section-B

Q.56 - Q.60 carry one mark each.

Q.56 A physiological disorder X always leads to the disorder Y. However, disorder Y may occur by itself. A population shows 4% incidence of disorder Y. Which of the following inferences is valid?

(a) 4% of the population suffers from both X and Y.

(b) Less than 4% of the population suffers from X.

(c) At least 4% of the population suffers from X.

(d) There is no incidence of X in the given population.

Q.57 Exposing an organism to a certain chemical can change nucleotide bases in a gene, causing mutation. In one such mutated organism if a protein had only 70% of the primary amino acid sequence, which of the following is likely?

(a) Mutation broke the protein.

(b) The organism could not make amino acids.

(c) Mutation created a terminator codon.

(d) The gene was not transcribed.

Q.58 There are k baskets and n balls. The balls are put into the baskets randomly. If k < n,

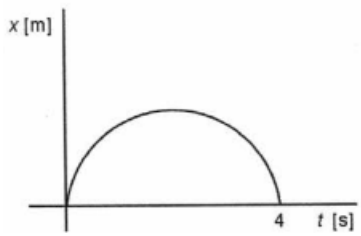
(a) There is no empty basket.

(b) There are exactly (n – k) baskets with at least one ball.

(c) There is at least one basket with two or more balls.

(d) There are (n – k) baskets with exactly two balls.

Q.59 An ant is crawling along the x-axis such that the graph of its position on the x-axis versus time is a semi-circle (see figure). The total distance covered in the 4 s is



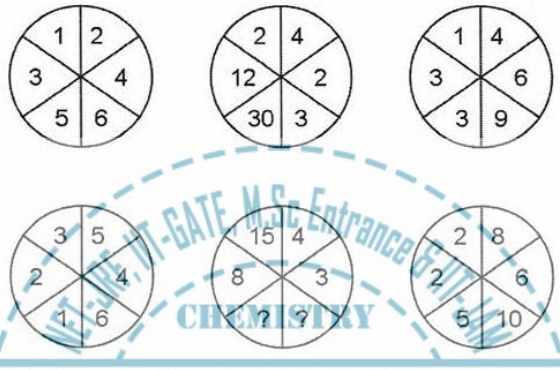
(a) 4 m (b) 2 m (c) 2πm (d) 4πm

Q.60 In a bag containing only blue, red and green marbles, all but 15 are blue, all but 13 are red and all but 12 are green. How many are red?

(a) 13 (b) 7 (c) 25 (d) 20

Q.61 - Q.65 carry two marks each.

Q.61 Find the missing numbers in the bottom middle circle. (Clue: left halves of the central circles relate to the left circles and the right halves to the right circles)



(a) 10, 20 (b) 15, 15 (c) 21, 2 (d) 6, 2

Q.62 A jar containing an iron block B was floating on water in a bigger container. The block was taken out and put into water. As a result, the level of water in the container will

(a) Rise (b) Fall

(c) Remain the same (d) Rise of fall depending on the mass of the block

Q.63 A room has a west facing window with glass panes. Which of the following is the most effective way to prevent the room from getting hot in summer?

(a) Cover the inside of the glass pane by a black paper.

(b) Cover the outside of the glass pane by an aluminum foil.

(c) Cover the outside of the glass pane by a white thermocol sheet.

(d) Cover the inside of the glass pane by a white thermocol sheet.

Q.64 A person chewing a bubble gum did not experience ear pain in a jet plane while landing whereas another person not chewing a gum had ear pain. The reason could be

(a) Chewing gum is a pain killer.

(b) Chewing equilibrates pressure on both sides of the ear drum.

(c) Chewing gum closes the ear drum.

(d) Chewing distracts the person.

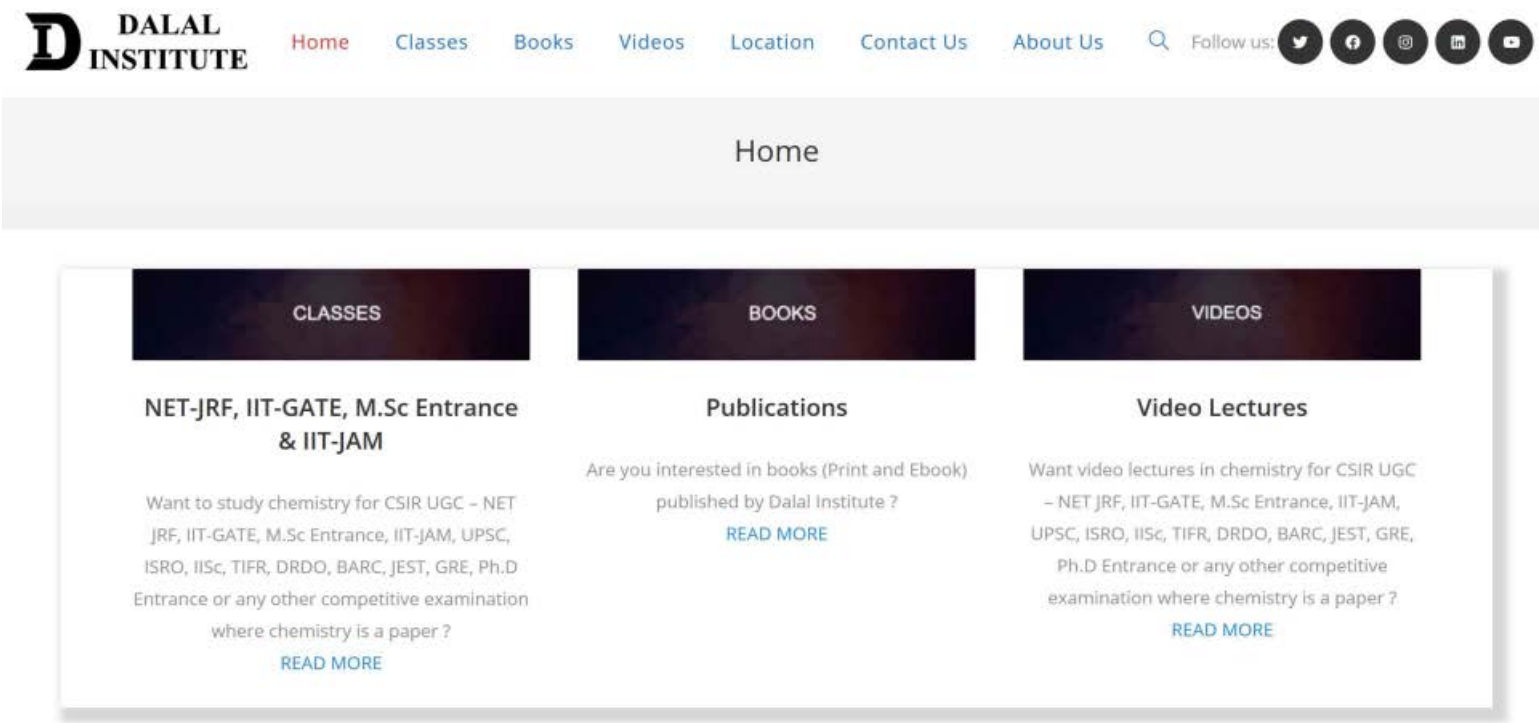
Q.65 The reason why a lunar eclipse does not occur at every full moon is:

(a) The position of the sun is not favorable at all full moons.

(b) The orbital planes of the moon and that of the earth are inclined to each other by a small angle.

(c) The shape of earth is not a perfect sphere.

(d) The moon reflects only from one hemisphere



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