

CSIR UGC – NET JRF: June 2018

Chemical Science

❖ Question Paper

Section-A

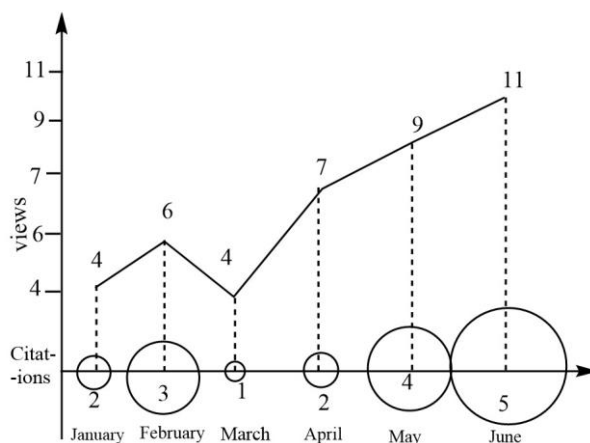
Q.1 The area of the triangle formed by joining the points (2017, 2017), (2027, 2027) and (2037, 2017) is

- (a) 2017 (b) 100 (c) $100\sqrt{10}$ (d) $100\sqrt{20}$

Q.2 A stick of length L is broken into two pieces at random. What is the average length of the smaller piece?

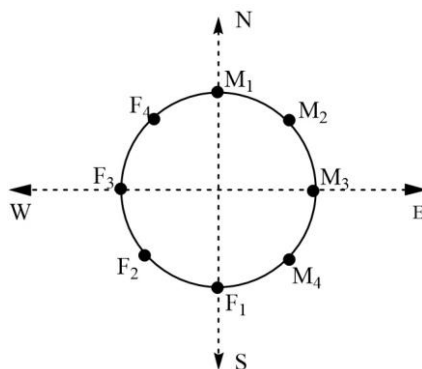
- (a) L/6 (b) L/4 (c) L/3 (d) L/2

Q.3 Number of times a research paper is viewed and cited is shown in the plot. In which month the percentage increase in citation more than the double of the percentage increase in view?



- (a) February (b) April (c) May (d) June

Q.4 Four males M_1, M_2, M_3, M_4 and four females F_1, F_2, F_3 and F_4 are spotting around a round table facing away from the table as shown in the figure below. If each one moves three positions to his/her right and one position to the left, then in which direction does F_4 face?



- (a) East (b) North-East (c) North-West (d) North

Q.5 In the diagram, what is the ratio of the total shaded area (of the circle and semi-circle) to the total area of the square and the rectangle?

- (a) $\frac{5}{6}\pi$ (b) $\frac{6}{5}\pi$ (c) $\frac{5}{12}\pi$ (d) $\frac{\pi}{4}$

Q.6 Which of the following options is the best choice for the missing number?

0.1, 0.25, 0.3, 0.2, 0.5, 0.6, 0.3,, 0.9, 0.4, 1.0, 1.2

- (a) 1.05 (b) 0.85 (c) 0.75 (d) 0.65

Q.7 Fourteen of the students in a class are girls. Eight students in a class wear blue shirts. Two are neither girls nor wear blue shirts. Five students who wear blue shirts are girls. How many students are there in a class?

- (a) 19 (b) 29 (c) 17 (d) 24

Q.8 Prof. Murthy likes to let her students choose who their partners will be; however, no pair of students may work together for more than seven class periods in a row. Alice and Bob have work together for seven class periods in a row. Calvin and Denny have work together for three class periods in a row. Calvin does not want work with Alice. Who should be assigned for the work with Bob?

- (a) Calvin (b) Alice (c) Denny (d) None

Q.9 Three semi-circles are drawn inside a big circle as shown in the figure. If the radius of the two identical smaller semi-circles is $1/4^{\text{th}}$ of that of the big circle is twice that of the small semi-circle, what proportion of the big circle's area is shaded?



- (a) 11/12 (b) 12/16 (c) 13/16 (d) 13/14

Q.10 A ball is dropped from a height of 100m. The ball after each bounce rises vertically by half its previous height (This means at the first bounce it rises by 50 m, by 25 m at the second bounce and so on). What is the vertical distance travelled by the ball between first and the fifth bounces?

- (a) $\frac{355}{2}m$ (b) $\frac{365}{2}m$ (c) $\frac{375}{2}m$ (d) $\frac{385}{2}m$

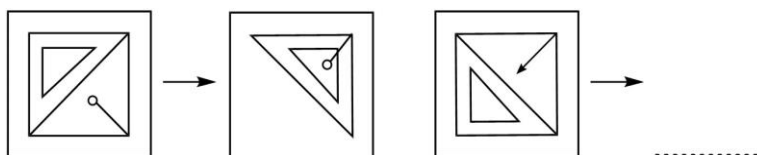
Q.11 Consider a number 54 expressed in a base different from ten. What is the base of this number system if its equivalent value in the decimal system is 49?

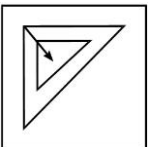
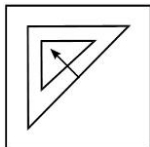
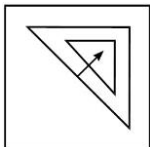
- (a) 1 (b) 3 (c) 4 (d) 9

Q.12 A fuel station sold diesel costing Rs. 15000 to 150 persons on a day. If the lower limit of sale to a person is Rs.50, what is the maximum amount in rupees for which one person could have purchased diesel on that day?

- (a) 7450 (b) 7500 (c) 7550 (d) 7600

Q.13 which of the position is appropriate for the blank space?



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

Q.14 If Sangeeta's daughter is my daughter's mother, then how I related to Sangeeta?

- (a) Son is the only possibility (b) Son-in-Law is the only possibility
(c) Daughter is the only possibility (d) Son-in-Law or Daughter

Q.15 In a group of 44 players, 26 play hockey, 24 play football and 24 play cricket. Eight of them play both hockey and football, 12 play both football and cricket, and 5 play all the three games. How many play both hockey and Cricket?

- (a) 10 (b) 15 (c) None (d) 7

Q.16 It is given that

(a) $a^* = a$ if $a > 0$

$= 0$ if $a \leq 0$, for any real number a

Suppose two real numbers x and y , $(xy)^* = (x)^*(y)^*$. Then which of the following is necessarily true?

- (a) $x > 0$ and $y > 0$ (b) $\{x < 0 \text{ and } y < 0\}$ or $\{x > 0 \text{ and } y > 0\}$
(c) $\{x \leq 0 \text{ and } y \leq 0\}$ or $\{x \geq 0 \text{ and } y \geq 0\}$ (d) $\{x \geq 0\}$ or $\{y \geq 0\}$ or $\{x \geq 0 \text{ and } y \geq 0\}$

Q.17 A long-distance runner finds a water station after completing $\frac{1}{7}$ th of the total distance. After covering another $\frac{1}{6}$ th of the total distance he get medical-aid. Another runner joins him 4 km after the medical-aid station. The second runner stops 4 km before the completion of run, covering $\frac{1}{2}$ of the total distance. What is the total distance?

- (a) 21 km (b) 30 km (c) 42 km (d) 50 km

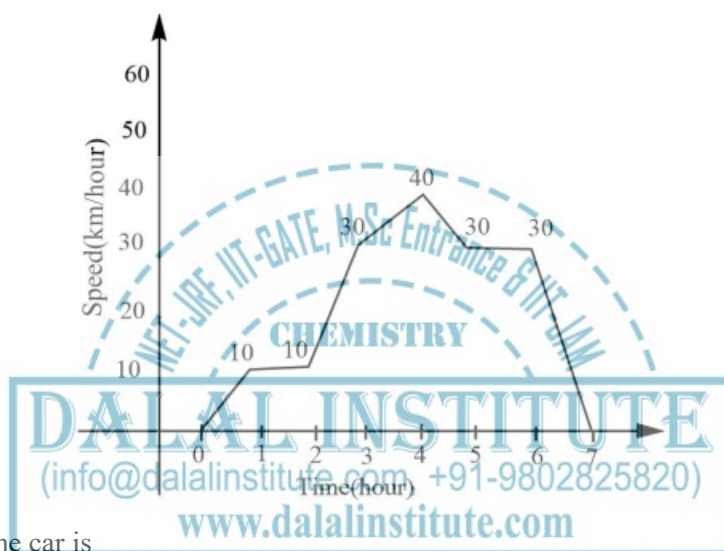
Q.18 A and B move clock-wise around a circle, starting from a common point O. A takes 9 minute to complete a round but restart after a delay of 1 minute. B takes 13 minutes to complete the round but restart after a delay of 2 minutes. How many minutes after they began would they meet again at O?

- (a) 30 (b) 29 (c) 31 (d) 28

Q.19 Two students are solving the same problem independently. If the probability that the first one solves the problem is $\frac{3}{5}$ and the probability that second solves the problem is $\frac{4}{5}$, what is the probability that atleast one of them solves the problem?

- (a) $\frac{17}{25}$ (b) $\frac{19}{25}$ (c) $\frac{21}{25}$ (d) $\frac{23}{25}$

Q.20 Movement of a car with respect to time is given below:



The average speed of the car is

- (a) 30.42 (b) 20.43 (c) 10.43 (d) 21.43

Section-B

Q.21 The correct order of C–O bond length is

- (a) $\text{H}_3\text{B}\cdot\text{CO} > [\text{Mn}(\text{CO})_6]^+ > [\text{Cr}(\text{CO})_6] > [\text{V}(\text{CO})_6]^-$
 (b) $[\text{V}(\text{CO})_6]^- > [\text{Cr}(\text{CO})_6] > [\text{Mn}(\text{CO})_6]^+ > \text{H}_3\text{B}\cdot\text{CO}$
 (c) $[\text{Mn}(\text{CO})_6]^+ > [\text{Cr}(\text{CO})_6] > [\text{V}(\text{CO})_6]^- > \text{H}_3\text{B}\cdot\text{CO}$
 (d) $[\text{Cr}(\text{CO})_6] > [\text{V}(\text{CO})_6]^- > \text{H}_3\text{B}\cdot\text{CO} > [\text{Mn}(\text{CO})_6]^+$

Q.22 The structure of CaB_6 is close to that of

- (a) cesium chloride (b) nickel arsenide (c) rock salt (d) zinc blende

Q.23 Trivalent lanthanide ion having isotropic magnetic susceptibility is

- (a) Eu^{3+} (b) Gd^{3+} (c) Yb^{3+} (d) Lu^{3+}

Q.24 Using a double beam UV-visible spectrophotometer, Beer's law fails for $\text{K}_2\text{Cr}_2\text{O}_7$ solution when

- (a) Intensity of light source is changed
 (b) Detector is not a photomultiplier tube
 (c) Cuvette of 2 cm size is used
 (d) pH is not kept same in all measurements

Q.25 Dinuclear anion $[\text{I}_2(\text{OH})_2\text{O}_8]^{4-}$ has two bridging oxo groups. The geometry around each iodine is

- (a) octahedral (b) monocapped octahedral (c) Square pyramidal (d) Pentagonal bipyramidal

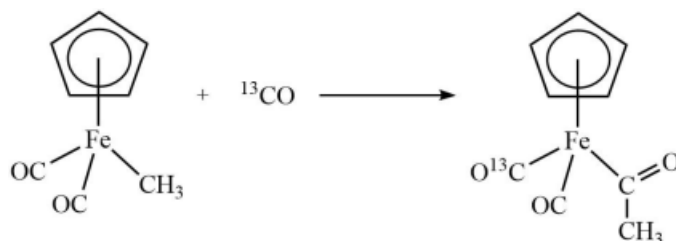
Q.26 For electronic spectra of $\text{K}_2\text{Cr}_2\text{O}_7$ (A) and K_2MoO_4 (B) the correct combination is

- (a) transition is d-d and λ_{max} for A < B (b) transition is LMCT and λ_{max} for A < B
 (c) transition is LMCT and λ_{max} for A > B (d) transition is MLCT and λ_{max} for A > B

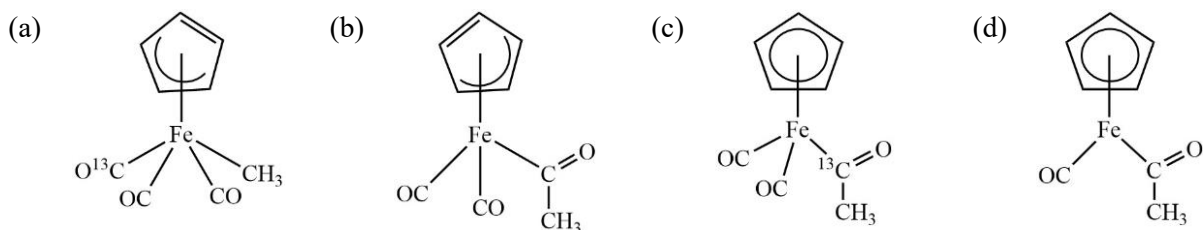
Q.27 High spin complex of a 3d metal ion M has a magnetic moment of 2.9 B.M. in octahedral coordination environment and 4.1 B.M. in tetrahedral environment. The M ion is

- (a) Co^{III} (b) Ni^{II} (c) Cu^{II} (d) Co^{II}

Q.28 For the following reaction



The structure of the intermediate is



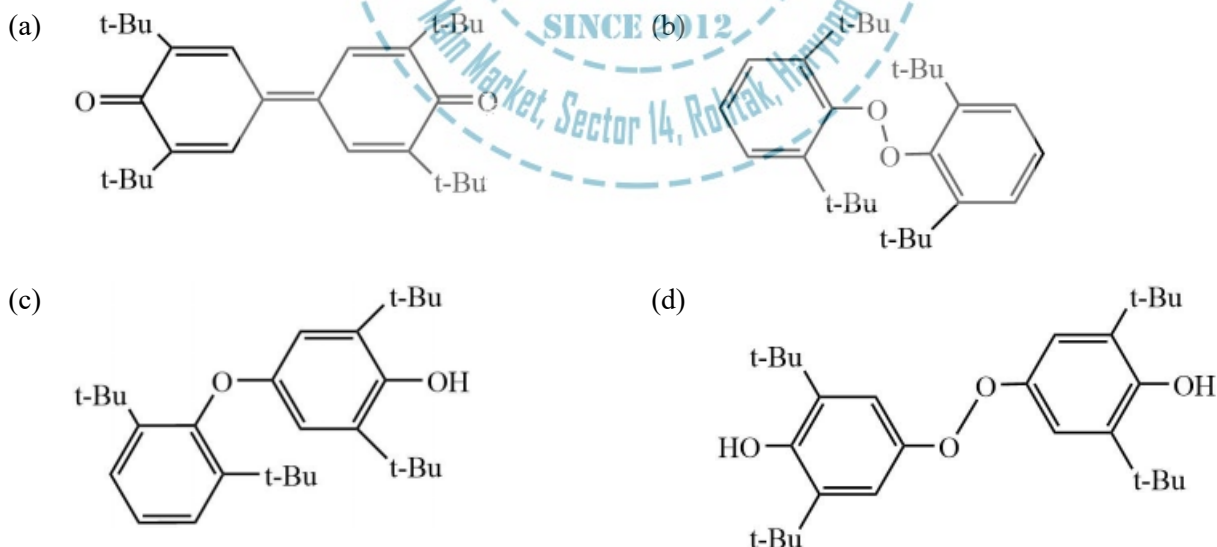
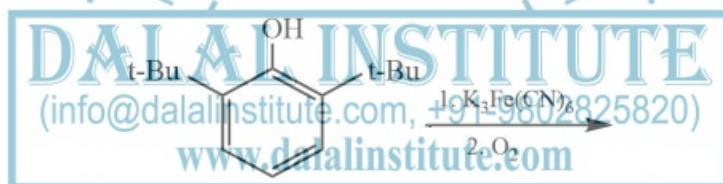
Q.29 The total degeneracy of the ground state term of Co^{II} (high spin) in octahedral geometry is

- (a) 18 (b) 12 (c) 28 (d) 9

Q.30 Among the elements Zn, Ga, Ge and As, the one with the lowest ionisation energy is

- (a) As (b) Zn (c) Ga (d) Ge

Q.31 The major product formed in the following reaction is



Q.32 Mass spectrum of a compound shows an $[M+2]$ ion peak that is about 4% of M^+ . This indicates that the compound has one

- (a) Fluorine (b) sulfur (c) bromine (d) Chlorine

Q.33 For the catalytic activity of Cu and Zn containing enzyme, *superoxide dismutase*, what is/are the correct statement(s)?

- (A) Cu and Zn both are essential
 (B) only Cu is essential
 (C) Zn is essential and Cu may be replaced by any other divalent metal atom
 (D) Zn may be replaced by any other divalent metal atom
- (a) (A) only (b) (C) only (c) (D) only (d) (B) and (D) only

Q.34 Consider the nature of solvents in column I and the corresponding λ_{\max} for I_2 in various solvents given in column II. (for I_2 vapour λ_{\max} is 520 nm). Match column I with column II

| Column I | | Column II (λ_{\max} , nm) | |
|----------|----------------------|------------------------------------|-----|
| (A) | non-donor | (i) | 520 |
| (B) | weak donor | (ii) | 500 |
| (C) | strong donor | (iii) | 450 |
| (D) | π electron donor | (iv) | 360 |

The correct match is

- (a) (A) – (i); (B) – (ii); (C) – (iii); (D) – (iv) (b) (A) – (iii); (B) – (iv); (C) – (ii); (D) – (i)
 (c) (A) – (i); (B) – (iii); (C) – (iv); (D) – (ii) (d) (A) – (iv); (B) – (iii); (C) – (ii); (D) – (i)

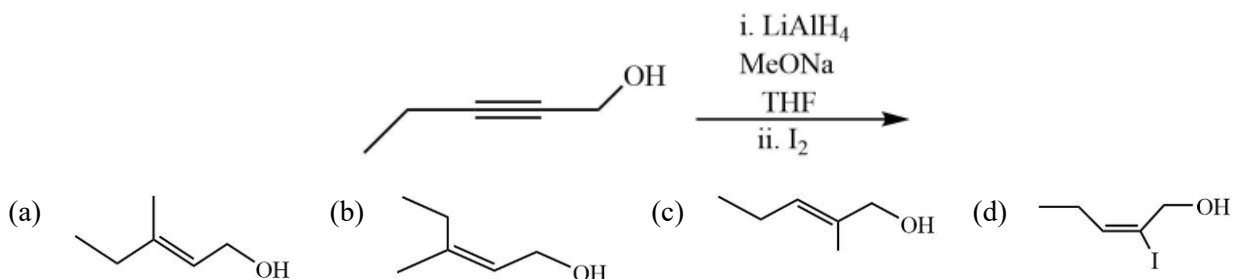
Q.35 Removal of an electron from NO molecule results in

- A. an increase in the $\nu(\text{NO})$ in IR spectrum
 B. an EPR active species
 C. electrons in HOMOs being closer to the oxygen than to nitrogen 2p orbitals
 D. electrons in HOMOs being closer to the nitrogen than to oxygen 2p orbitals

The correct answer is

- (a) A only (b) A and C only (c) B and D (d) A, B and C

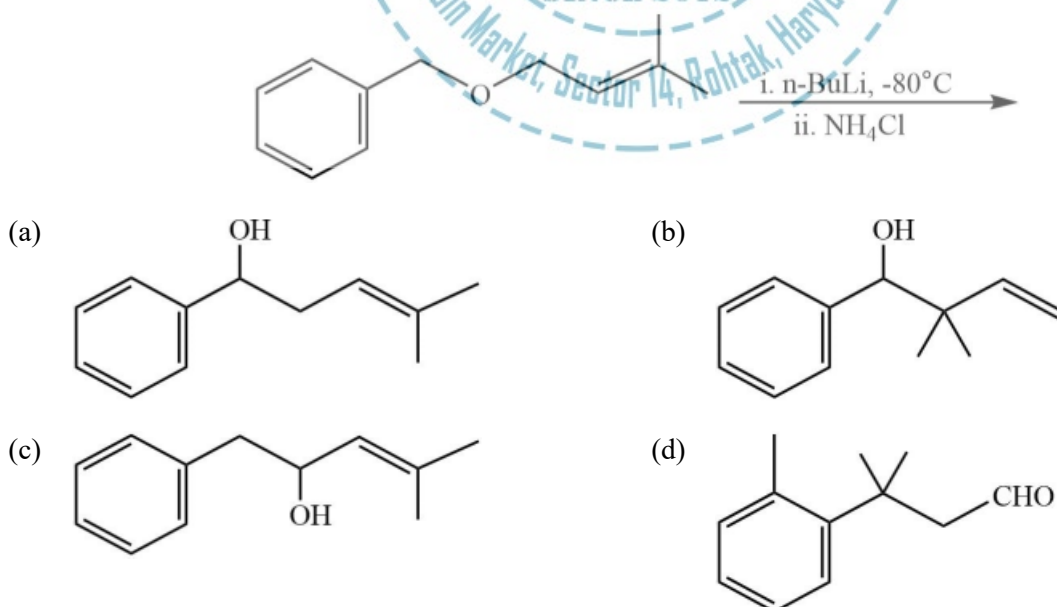
Q.36 The major product formed in the following reaction is



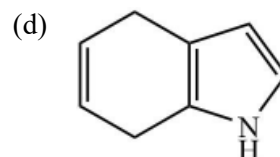
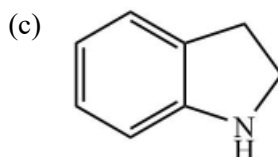
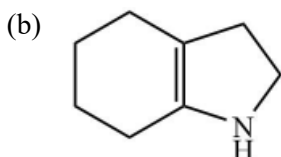
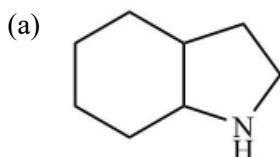
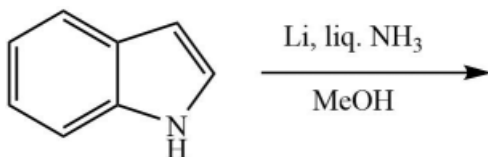
Q.37 The major product formed in the following reaction is



Q.38 The major product formed in the following reaction is



Q.39 The major product formed in the following reaction is



Q.40 For the following compounds, the correct order of reactivity towards nucleophilic acyl substitution is

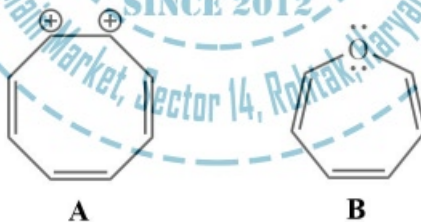
(a) acetyl chloride < methyl acetate < acetic anhydride < acetamide

(b) acetamide < methyl acetate < acetic anhydride < acetyl chloride

(c) acetamide < acetic anhydride < acetyl chloride < methyl acetate

(d) methyl acetate < acetamide < acetic anhydride < acetyl chloride

Q.41 The correct statement about following species is



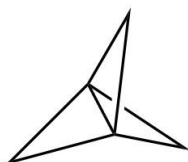
(a) Both A and B are aromatic

(b) A is aromatic and B is antiaromatic

(c) A is non-aromatic and B is antiaromatic

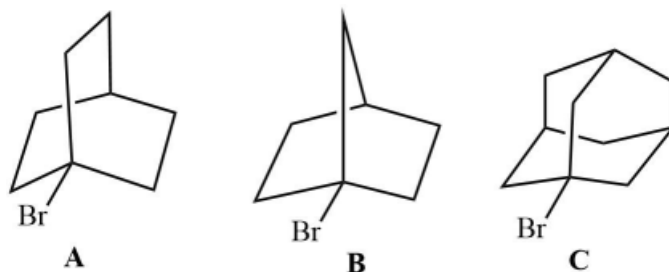
(d) A is aromatic and B is homoaromatic

Q.42 IUPAC nomenclature of following propellane is



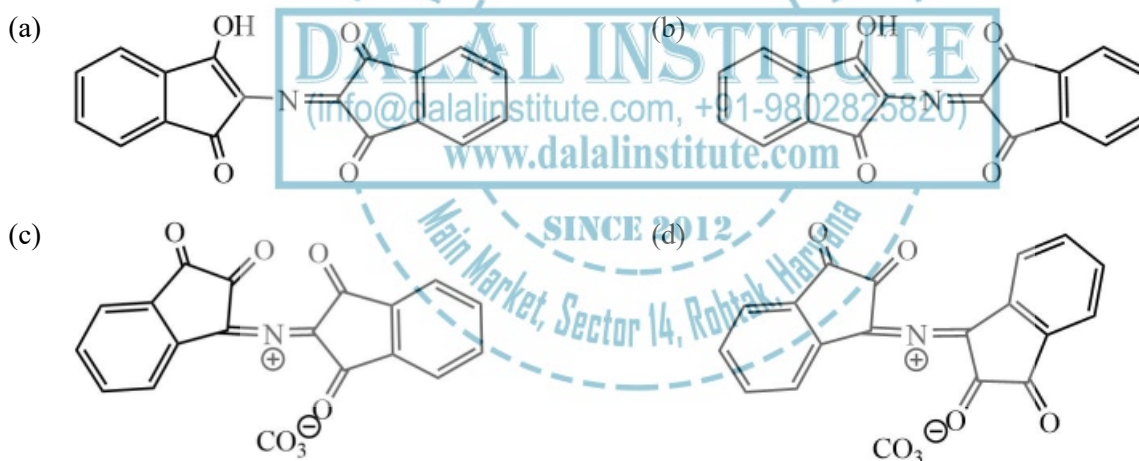
- (a) tricyclo[1.1.1.0^{2,4}] pentane (b) tricyclo[1.1.1.0^{1,3}] pentane
 (c) tricyclo[1.1.1^{1,3}.0^{1,5}] pentane (d) tricyclo[1.1.1.0^{1,3}] pentane

Q.43 The correct order of rate of solvolysis in 80% ethanol at 25°C is



- (a) B > C > A (b) A > B > C (c) C > B > A (d) C > A > B

Q.44 The structure of the product formed during the reaction of amino acid with ninhydrin is



Q.45 Number of signals observed in the ¹³C NMR spectrum of the following compound is

- (a) 4 (b) 5 (c) 6 (d) 8

Q.46 A Gaussian distribution has the functional form $f(x) = \frac{2}{\sqrt{2a^2\pi}} e^{-(x-b)^2/2a^2}$. The variance of such distribution is

- (a) A (b) a² (c) b (d) b²

Q.47 The term symbol for the ground state of B_2 is

- (a) $^1\Sigma_g^+$ (b) $^1\Sigma_g^-$ (c) $^3\Sigma_g^-$ (d) $^3\Sigma_g^+$

Q.48 Elementary steps of a reaction are as follows

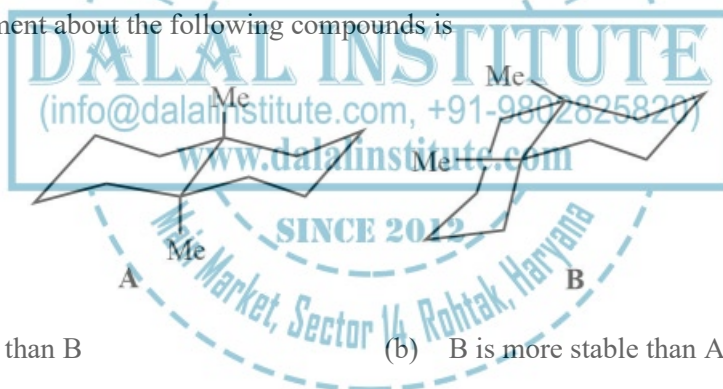
If steady state approximation is applicable to C, the rate of a product formation in the reaction is

- (a) Proportional to $[A][B]$ (b) Proportional to $[A]^2[B]^2$
 (c) Proportional to $[A]^{1/2}[B]^{1/2}$ (d) Independent of $[A][B]$

Q.49 In the pure Raman rotational spectrum of $^{16}O_2$, whose electronic ground state is $^3\Sigma_g^-$, transition to/from

- (a) even J levels are missing (b) odd J levels are missing
 (c) all J levels appear (d) none of the J levels appear

Q.50 The correct statement about the following compounds is



- (a) A is more stable than B (b) B is more stable than A
 (c) A and B are equally stable (d) A and B both are locked conformations

Q.51 The commutator of \hat{x} with the Hamiltonian \hat{H} , $[\hat{x}, \hat{H}]$, is

- (a) 0 (b) $i\hbar$ (c) $-\frac{\hbar^2}{2m}\hat{p}_x$ (d) $\frac{i\hbar}{m}\hat{p}_x$

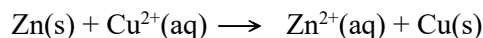
Q.52 The lowest energy state of a $1s^2 2s^1$ electronic configuration, according to Hund's rule, is

- (a) 3S_0 (b) 1S_0 (c) 3S_1 (d) 1S_1

Q.53 If the unit of the rate constant of a reaction is $L^3\text{mol}^{-3}\text{s}^{-1}$, the order of the reaction is

- (a) 1 (b) 2 (c) 3 (d) 4

Q.54 The standard cell potential for the reaction



is +1.10V. The Gibbs free energy change during the reaction is

($F = 96500 \text{ coulomb mol}^{-1}$)

- (a) $-21.2 \text{ kJ mol}^{-1}$ (b) $+212 \text{ kJ mol}^{-1}$ (c) -212 kJ mol^{-1} (d) -212 J mol^{-1}

Q.55 The change in entropy for a reversible adiabatic process is

- (a) maximum (b) minimum (c) Zero (d) Positive

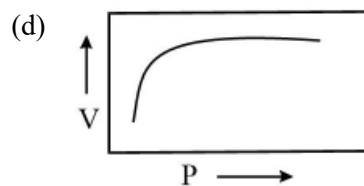
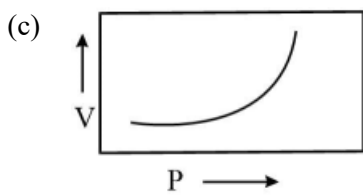
Q.56 Correct match for the coenzymes in Column A and with their function in Column B is

| | Column A | | Column B |
|---|----------|------|---------------------|
| P | NADH | i. | Oxidation |
| Q | FAD | ii. | Acyl group transfer |
| R | CoASH | iii. | Reduction |

- (a) P-i; Q-ii; R-iii (b) P- iii; Q- i; R- ii (c) P-iii; Q-ii; R-i (d) P-ii; Q-i; R-iii

Q.57 The graph that represents the Langmuir Adsorption Isotherm is





Q.58 Origin of the colligative properties of a dilute solution is

- (a) volatility of solute molecule (b) interaction of solute-solvent molecules
(c) zero enthalpy of mixing (d) entropy of mixing

Q.59 If all the lattice points of an FCC structure are occupied by uniform hard spheres that touch each other, the fraction of volume occupied is

- (a) $\frac{\pi\sqrt{2}}{6}$ (b) $\frac{\pi\sqrt{3}}{6}$ (c) $\frac{\pi}{6}$ (d) $\frac{2\pi}{6}$

Q.60 A 5 g/L polymer solution is prepared with a polymer whose mass is 25 kg. The osmotic pressure (in atm) of this solution at 25°C is

(Consider $RT \approx 2500 \text{ J mol}^{-1}$)

- (a) 0.002 (b) 0.05 (c) 0.005 (d) 0.008

Q.61 Which of the following are not *closo* cluster?

[$\{\text{Co}(\eta^5\text{-C}_5\text{H}_5)\}_2(\text{C}_2\text{B}_6\text{H}_8)$] (A), [$\text{B}_4\text{C}_2\text{H}_8$] (B), [$\text{B}_{10}\text{H}_8\{\text{Au}(\text{PPh}_3)\}$] (C), [$\text{C}_2\text{B}_8\text{H}_{10}$] (D)

The correct answer is

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

Q.62 The correct increasing order of C–C bond length in the following molecules [A–D]

[$\text{PtCl}_3(\text{C}_2\text{H}_4)$] (A), [$\text{Pt}(\text{PPh}_3)_2(\text{C}_2\text{H}_4)$] (B), [$\text{Pt}(\text{PPh}_3)_2\{\text{C}_2(\text{CN})_4\}$] (C), is

- (a) (C) < (A) < (B) (b) (A) < (B) < (C) (c) (B) < (C) < (A) (d) (C) < (B) < (A)

Q.63 Consider the following statements for the oxygenation of hemocyanine:

- (A) oxidation state of both copper atoms changes by two
 (B) it becomes intense blue from colourless
 (C) dioxygen is reduced to O_2^{2-}
 (D) the $\mu-\eta^2:\eta^2$ bond forms between each oxygen and copper atoms.

The correct statements are:

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

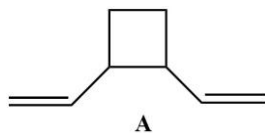
Q.64 The transformation are given in column I and reagent in column II. Match the items of column I with those of column II

| | Column I | | Column II |
|-----|--------------------------------------|-------|-----------------------------|
| (A) | $[MnO_4^-] \rightarrow [MnO_4]^{2-}$ | (i) | H_2SO_4 |
| (B) | $Me_3CH \rightarrow [Me_3C]^+$ | (ii) | Na in liquid NH_3 |
| (C) | $Ag + Au \rightarrow Ag[AuF_4]$ | (iii) | $[H_2SO_3F]^+$ (super acid) |
| (D) | $H_3PO_4 \rightarrow [P(OH)_4]^+$ | (iv) | Liquid BrF_3 |

The correct match is

- (a) (A)-(i); (B)-(ii); (C)-(iii); (D)-(iv) (b) (A)-(ii); (B)-(iii); (C)-(iv); (D)-(i)
 (c) (A)-(iii); (B)-(i); (C)-(ii); (D)-(iv) (d) (A)-(iii); (B)-(i); (C)-(iv); (D)-(ii)

Q.65 One of the products formed in the bis(η^3 -allyl) nickel complex catalysed cyclodimerization of butadiene in the presence of PR_3 is compound A given below, Identify its precursor.



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

Q.66 Height equivalent to theoretical plate (HETP) in gas-liquid chromatography depends significantly on which of the following?

- (A) Temperature of gas
- (B) Velocity of carrier gas
- (C) Packing of column
- (D) Column material

Correct answer is

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

Q.67 Identify the correct statements about the electronegativity of groups given below:

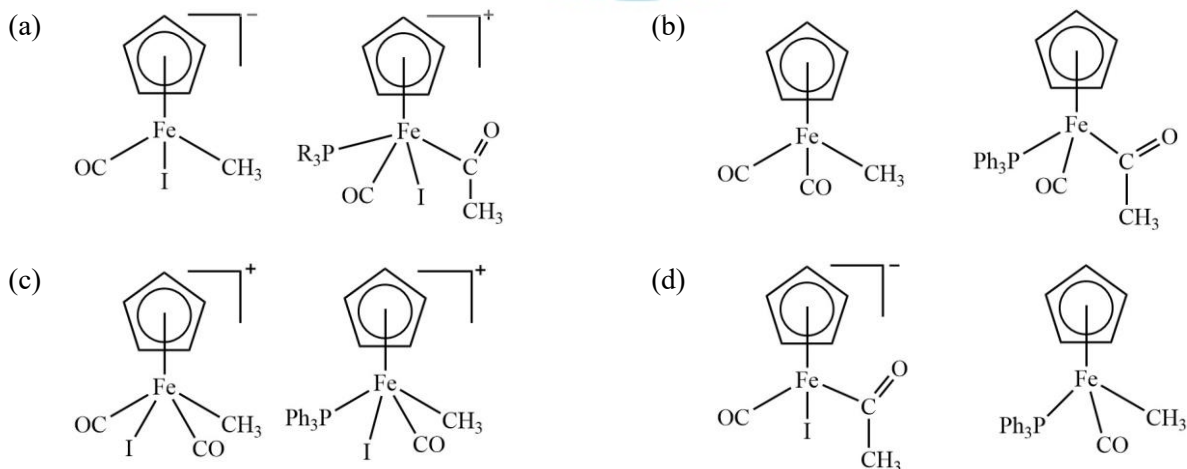
- (A) CF_3 group has greater value than that of NF_2
- (B) NH_2 group has greater value than that of NF_2
- (C) OH group has greater value than that of NF_2
- (D) CH_3 and C_2H_5 groups have almost similar values

Correct answer is

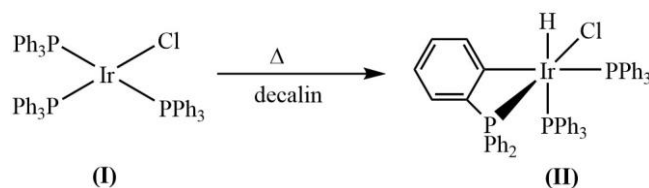
- (a) A, B and D (b) B and C (c) B, C and D (d) B and D

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Q.68 The reaction of $[\eta^5\text{-C}_5\text{H}_5]\text{Fe}(\text{CO})$ with CH_3I gives compound A. The ^1H NMR spectrum of A shows two singlets in an integrated intensity ratio of 3:5. Compound A upon reaction with PPh_3 gives compound B. The ^1H NMR spectrum of B shows 3 signals in an integrated intensity ratio of 3:5:15. Compounds A and B respectively, are



Q.69 For the following reactions, correct statement(s) is/are



(A) Oxidation state of iridium increases from I to III

(B) It is β -hydride elimination reaction

(C) (I) and (II) both are diamagnetic

(D) It is migratory insertion reaction

The correct answer is

- (a) (A) only (b) (A) and (C) (c) (C) and (D) (d) (B), (C) and (D)

Q.70 Identify the pair of molecules which are isoelectronic and isostructural from the following:

[Pd(PPh₃)₄] (A), [V(CO)₆] (B), [Cr(CO)₆] (C), [Rh(PPh₃)₃Cl] (D), [[η^5 -C₅H₅]Ni(NO)] (E), Ni(CO)₄ (F)

- (a) B and C (b) A and F (c) A and D (d) C and E

Q.71 The structures of [Re₂Cl₈]²⁻ (A) and [Os₂Cl₈]²⁻ (B) are made up of two MCl₄ units. For these structures, which statement is correct?

- (a) (A) and (B) both have MCl₄ units eclipsed. (b) (A) and (B) both have MCl₄ units staggered.
 (c) (A) has both MCl₄ unit staggered and (B) has both units eclipsed. (d) (A) has both MCl₄ unit eclipsed and (B) has both units staggered.

Q.72 In fission of ²³⁵U atom the energy released is 200 MeV. In one day fission of 1 kg ²³⁵U will give power (in MW) approximately

- (a) 550 (b) 650 (c) 950 (d) 1250

Q.73 Choose the correct set of statements for *cis*-platin.

(A) It can be prepared from K₂[PtCl₄].

(B) It can be prepared from [Pt(NH₃)₄]Cl₂.

(C) In its preparation, the observed *trans* effect for Cl^- is greater than that of NH_3 .

(D) In blood it stays in equilibrium with *cis*- $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{H}_2\text{O})]^+$.

(E) In DNA strand, it binds to two adjacent cytosine bases.

The correct set is

- (a) A, C and D (b) A, C, D and E (c) B, C and D (d) B, C, D and D

Q.74 Match fluorescence colours given in column A with lanthanide ions given in column B

| Column A | | Column B | |
|----------|-------|----------|---------|
| (i) | Pink | (a) | Sm(III) |
| (ii) | Red | (b) | Tb(III) |
| (iii) | Green | (c) | Eu(III) |
| (iv) | Blue | (d) | Tm(III) |

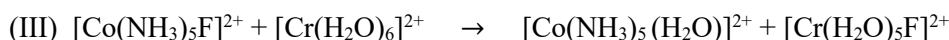
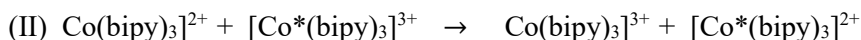
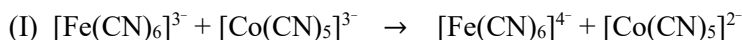
Correct match is

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

Q.75 A binary fluoride (Z) of xenon combines with two moles of NaF to give a product which on heating to 100°C affords compound A. The alkaline solution of A gives perxenate salt. Z and A are, respectively,

- (a) XeF_2 and XeF_4 (b) XeF_4 and XeF_6 (c) XeF_6 and XeF_4 (d) XeF_6 and XeF_6

Q.76 Consider the statements A-D regarding equations I-III



- (A) Marcus equation is applicable to I and II.
 (B) Marcus equation is applicable to II only.
 (C) Equation I and II involve inner sphere electron transfer.
 (D) Equation I and III involve inner sphere electron transfer.

The correct statements are:

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

Q.77 Consider the following statements:

- (A) Cr^{2+} is easier to oxidise than V^{2+} in the gas phase
(B) Cr^{2+} is more powerful reducing agent than V^{2+} .
(C) The rate of water exchange for $\text{Cr}^{2+}(\text{aq})$ is much faster than for $\text{V}^{2+}(\text{aq})$.

The correct statements are

- (a) A, B and C (b) A and B (c) D only (d) B, C and D

Q.78 Consider the following statements:

I: AsCl_5 is thermally less stable than PCl_5 .

II: Size of As is more than that of P.

Choose correct answer from the following

- (a) Statements I and II are true and II is the correct explanation of I.
(b) Statements I and II are true and II is not the correct explanation of I.
(c) Statement I is true and statement II is false.
(d) Both the statements I and II are false.

Q.80 For the Wacker process, pick the correct statements from the following:

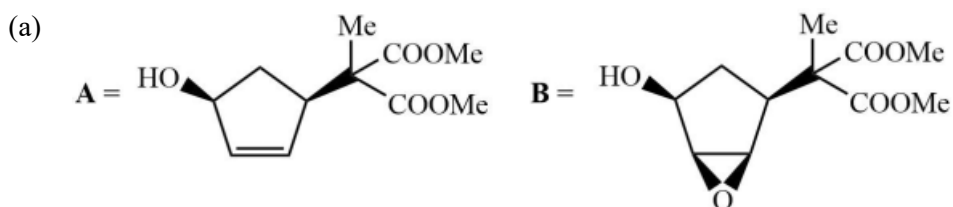
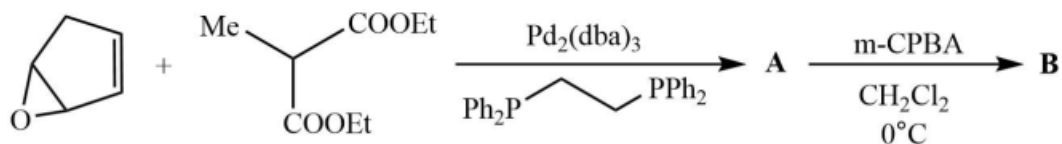
- (A) $\text{Pd}(\text{II})$ is reduced to $\text{Pd}(0)$ by $\text{Cu}(\text{I})$
(B) $\text{Pd}(0)$ is oxidised to $\text{Pd}(\text{II})$ by $\text{Cu}(\text{I})$
(C) $\text{Cu}(\text{II})$ promotes the reductive elimination

Correct answer is

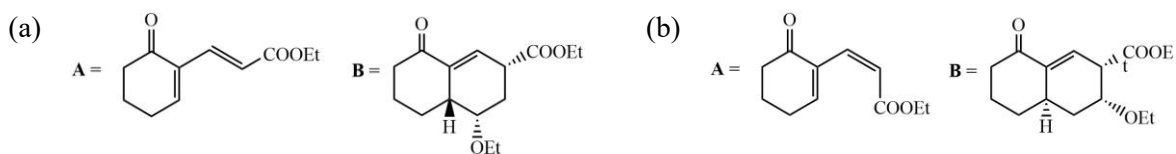
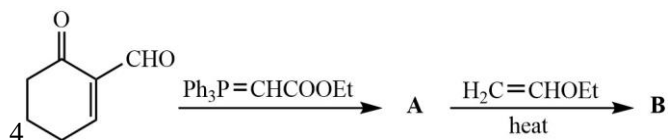
- (a) A and C (b) B and C (c) A and B (d) B only

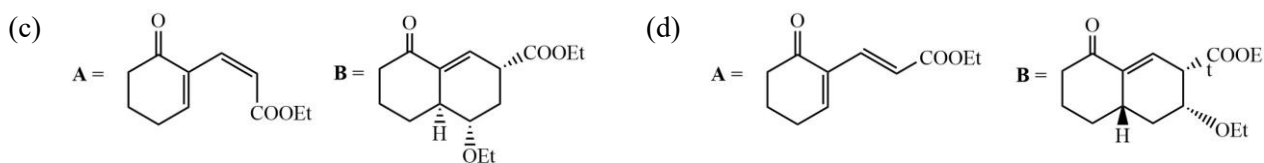
Q.81 Structure of the intermediate A and the final product B in the following reaction sequence are

(dba = dibenzylidene acetone)

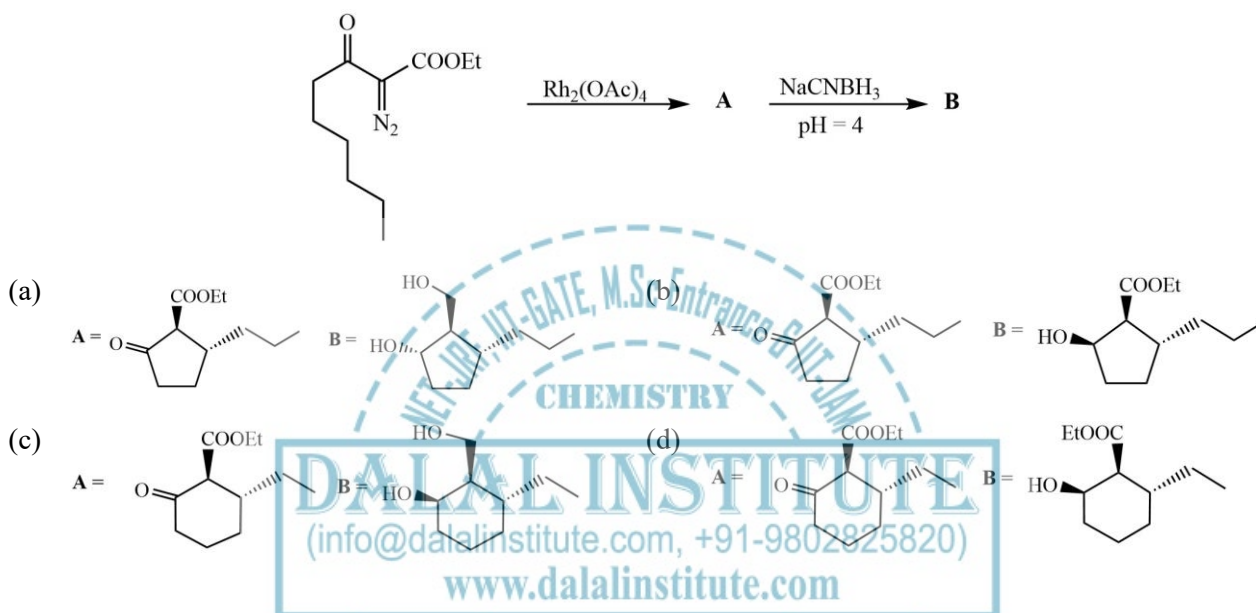


Q.82 The major product A and B formed in the following reaction sequence are

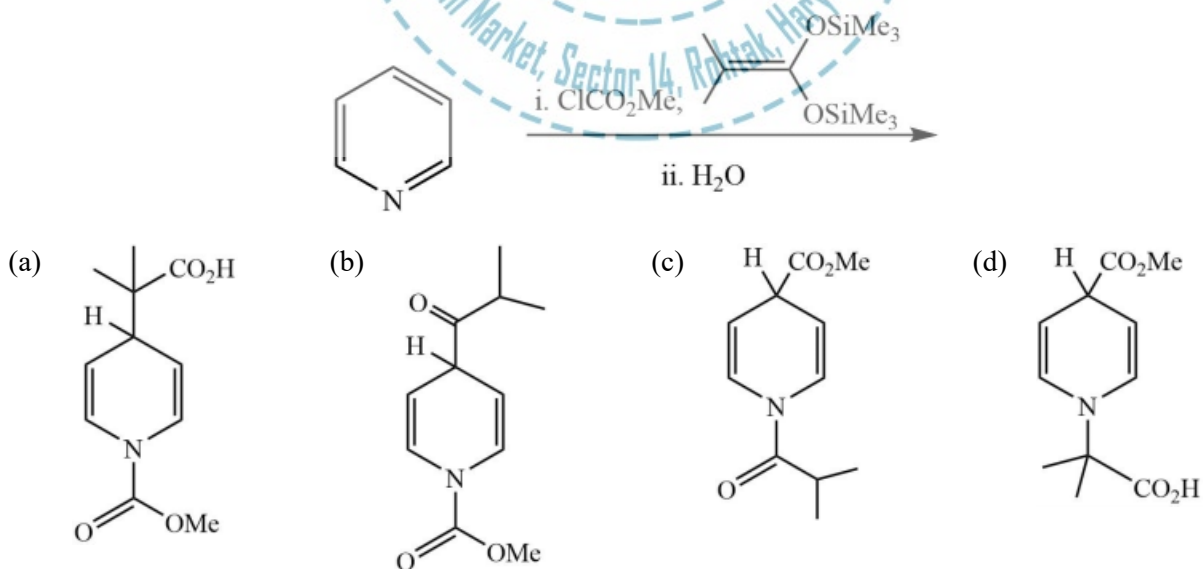




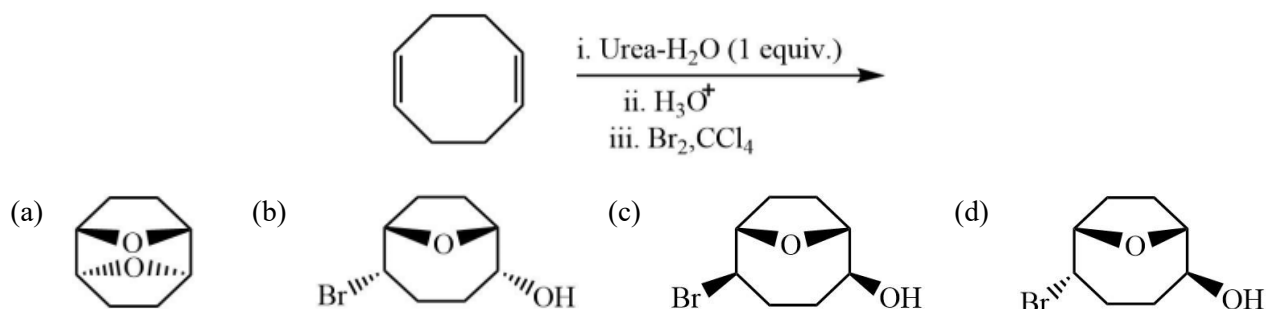
Q.83 The major product A and B formed in the following reaction sequence are



Q.84 The major product in the following reaction is



Q.85 The major product in the following oxidation reaction is



Q.86 The major allylic alcohol A and the ester B formed in the following reaction sequence are

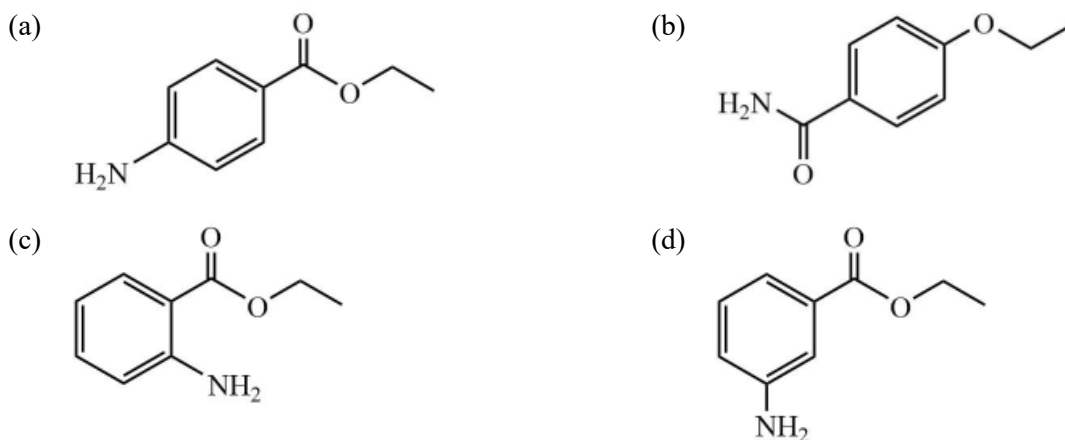


Q.87 A compound shows following spectral data:

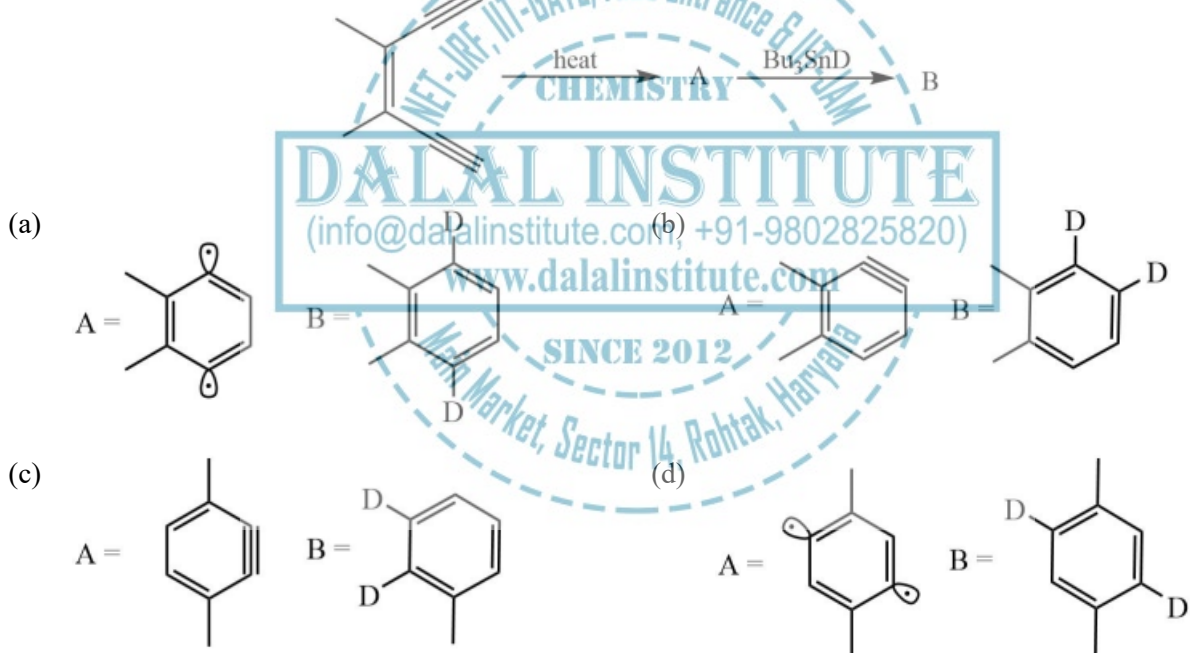
$^1\text{H NMR}$: δ 7.9 (d, $J = 8$ Hz, 2H), 6.6 (d, $J = 8$ Hz, 2H), 4.3 (q, $J = 6$ Hz, 2H), 4.0 (br s, 2H, D_2O exchangeable), 1.4 (t, $J = 6$ Hz, 3H)

Mass: m/z 165, 137, 120, 92

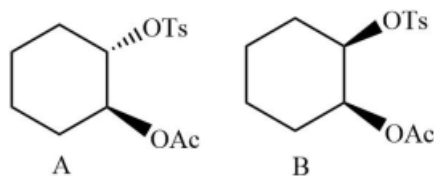
The correct structure of the compound is



Q.88 The structure of the intermediate A and the major product B formed in the following reaction are

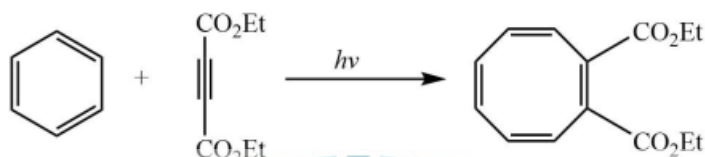


Q.89 The correct statement about solvolysis using NaOAc/AcOH of following compounds is



- (a) A react faster than B to give *trans*-1,2-diacetoxycyclohexane
 (b) B react faster than A to give *trans*-1,2-diacetoxycyclohexane
 (c) A react faster than B to give *cis*-1,2-diacetoxycyclohexane
 (d) B react faster than A to give *trans*-1,2-diacetoxycyclohexane

Q.90 Mechanism of the following transformation involves



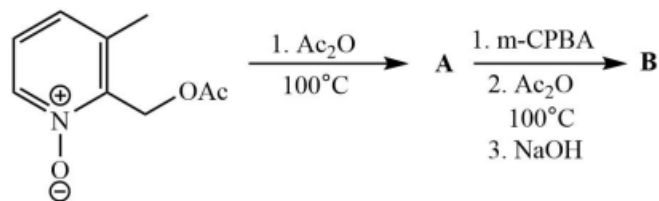
- (a) A [2+2] cycloaddition followed by 'con' rotatory electrocyclic ring opening
 (b) A [4+2] cycloaddition followed by 'con' rotatory electrocyclic ring opening
 (c) A [4+2] cycloaddition followed by cope rearrangement
 (d) A [2+2] cycloaddition followed by 'dis' rotatory electrocyclic ring opening

Q.91 The major products in the following photochemical reaction are



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

Q.92 The major product A and B formed in the following reaction sequence are



- (a) A = B =
- (b) A = B =
- (c) A = B =
- (d) A = B =

Q.93 For the following thermal [2+2] cycloaddition reaction, the correct statement about Transition State(TS) and preference for *endo* product formation is

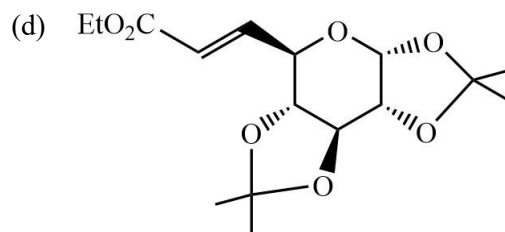
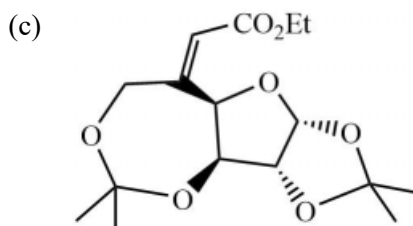


- (a) TS: $\pi_{2s} + \pi_{2s}$; Me > i-Pr > t-Bu (b) TS: $\pi_{2s} + \pi_{2a}$; t-Bu > i-Pr > Me
- (c) TS: $\pi_{2s} + \pi_{2a}$; Me > i-Pr > t-Bu (d) TS: $\pi_{2s} + \pi_{2s}$; t-Bu > i-Pr > Me

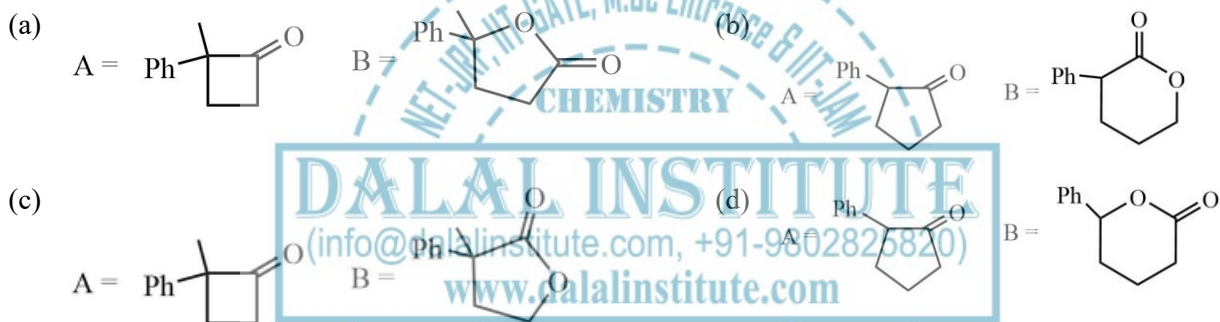
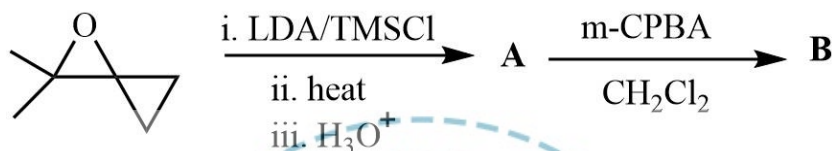
Q.94 Reaction of D-glucose with following reagents produces

Reagents: 1. Acetone, H^+ ; 2. PDC; 3. $((\text{EtO})_2\text{P}(\text{O})\text{CH}_2\text{CO}_2\text{Et}, \text{NaH}$

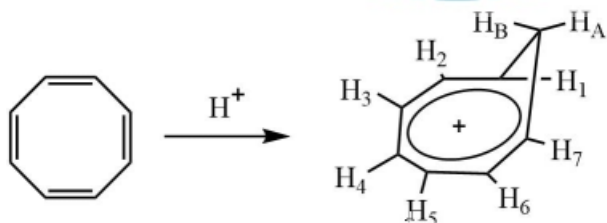
- (a)
- (b)



Q.95 The major product A and B formed in the following reaction sequence are



Q.96 The correct match of proton in Column A with the $^1\text{H NMR}$ chemical shifts in Column B for the product of the following reaction is

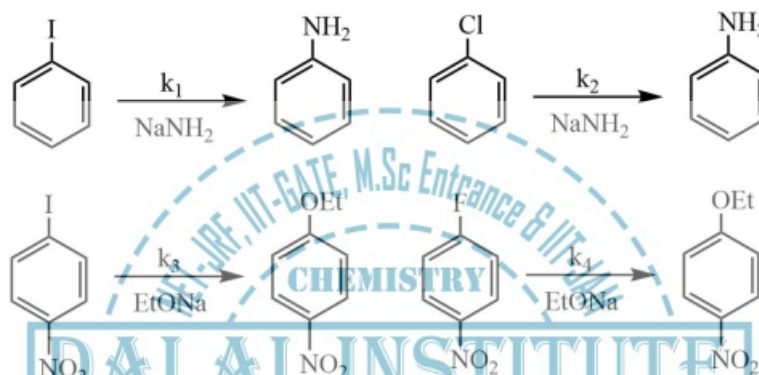


| Column A | | Column B (δ ppm) | |
|----------|---------------------|--------------------------|------|
| P | H_A | i | -0.3 |
| Q | H_B | ii | 5.1 |

| | | | |
|---|----------------------|-----|-----|
| R | H _{1&7} | iii | 6.4 |
| S | H ₂₋₆ | iv | 8.5 |

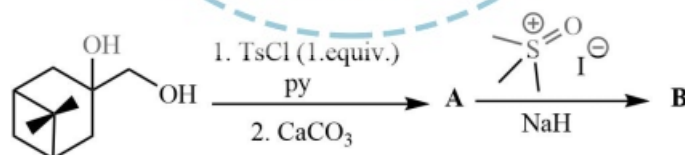
- (a) P-ii; Q-i; R-iii; S-iv (b) P-i; Q-ii; R-iv; S-iii (c) P-iv; Q-i; R-iii; S-ii (d) P-ii; Q-vi; R-i; S-iii

Q.97 The correct order of rates for the following reactions is



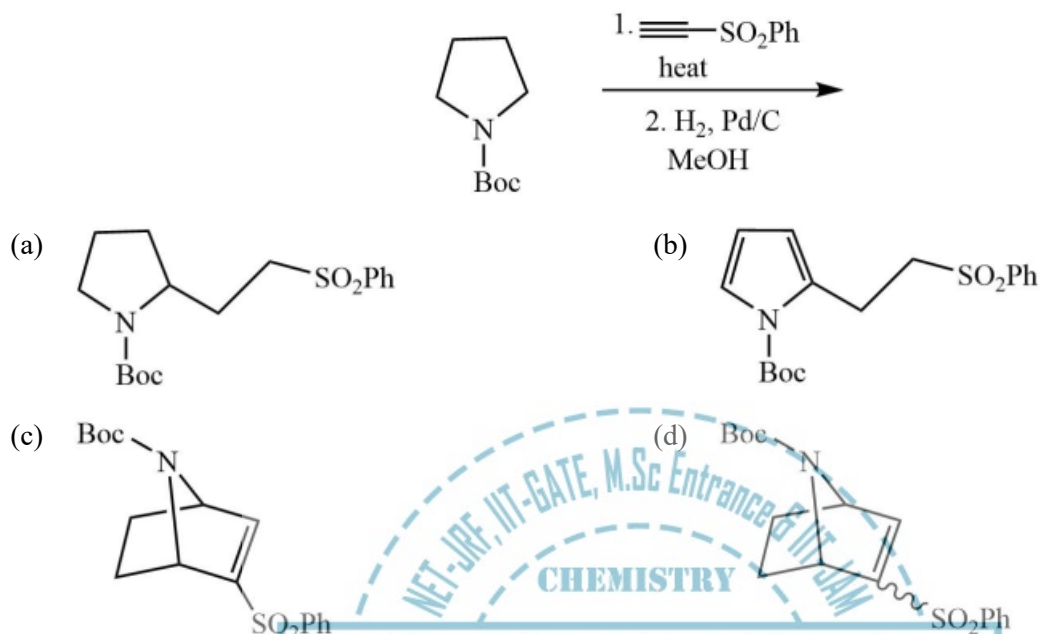
- (a) $k_1 > k_2$ and $k_3 > k_4$ (b) $k_1 > k_2$ and $k_4 > k_3$
 (c) $k_2 > k_1$ and $k_3 > k_4$ (d) $k_2 > k_1$ and $k_4 > k_3$

Q.98 The major product A and B formed in the following reaction sequence are



- (a) A = bicyclo[2.2.1]heptan-2-one, B = bicyclo[2.2.1]heptane-2,3-epoxide
 (b) A = bicyclo[2.2.1]heptane-2,3-epoxide, B = bicyclo[2.2.1]heptane-2,3-diol
 (c) A = bicyclo[2.2.1]heptane-2,3-epoxide, B = bicyclo[2.2.1]heptane-2-one
 (d) A = bicyclo[2.2.1]heptan-2-one, B = bicyclo[2.2.1]heptane-2,3-diol

Q.99 The major heterocyclic compound formed in the following reaction is



Q.100 Irradiation of either *cis*- or *trans*-stilbene at 313 nm result in the formation of a mixture of 93% *cis* and 7% *trans* olefin because

- (a) *trans*-stilbene is more stable than *cis*-stilbene
- (b) the extinction coefficient of *trans*-stilbene is greater than *cis*-stilbene at exciting wavelength
- (c) the transition state structures of *cis*- and *trans*-stilbene are different
- (d) the triplet excited states of *cis*- and *trans*-stilbene are at different energy levels

Q.101 Which of the following statements on ground state perturbation theory, involving the zeroth order energy $E_0^{(0)}$, first order energy correction $E_0^{(1)}$ and second order energy correction $E_0^{(2)}$, is false?

- (a) $E_0^{(1)}$ is the average value of perturbation operator with respect to the ground state of the zeroth order Hamiltonian.
- (b) $E_0^{(1)}$ is necessarily negative.
- (c) $E_0^{(2)}$ is necessarily negative.

(d) $E_0^{(0)} + E_0^{(1)}$ is an upper bound to the exact ground state energy.

Q.102 A particle is in a state $\varphi = \psi_1 + 3\psi_2$, where ψ_1 and ψ_2 are eigenfunctions of the Hamiltonian of the particle with eigenvalues E_1 and E_2 , respectively. The average energy of the particle in the state φ is

- (a) $(E_1 + 9E_2)/10$ (b) $(E_1 + 3E_2)$ (c) $(E_1 + 9E_2)/4$ (d) $(E_1 + 3E_2)/10$

Q.103 Consider a model system of five non-interacting fermions in a single 3-dimensional harmonic oscillator. The Hamiltonian of a single particle is

$$\hat{H} = \frac{1}{2m} (\hat{p}_x^2 + \hat{p}_y^2 + \hat{p}_z^2) + \frac{1}{2} m\omega^2 (x^2 + y^2 + z^2)$$

Where m is the mass of the particle, ω is the angular frequency, \hat{p}_x , \hat{p}_y and \hat{p}_z are the momentum operators. The ground state energy of the system of 5 non-interacting fermions is

- (a) $\frac{21}{2} \hbar\omega$ (b) $\frac{15}{2} \hbar\omega$ (c) $\frac{5}{2} \hbar\omega$ (d) $\frac{25}{2} \hbar\omega$

Q.104 Two opposite sides (in the y -direction) of a square box of side L are slightly stretched. Consider the following four statements:

- A. The point group changes from D_{4h} to D_{2h}
 B. The (1,2) and (2,1) energy levels remain doubly degenerate.
 C. Both the energy levels are lowered and the energy of the (1,2) levels are higher than that of the (2,1) level.
 D. Both the energy levels are lowered and the energy of the (1,2) levels are lower than that of the (2,1) level.

The two correct statements are:

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

Q.105 Which of these is not suitable unnormalized wave function for the excited $1s^1 2s^1$ electron configuration of the helium atom?

- (a) $[1s(1)2s(2) - 2s(1)1s(2)][\beta(1)\beta(2)]$
 (b) $[1s(1)2s(2) + 2s(1)1s(2)][\alpha(1)\beta(2) - \beta(1)\alpha(2)]$
 (c) $[1s(1)2s(2) - 2s(1)1s(2)][\alpha(1)\beta(2) + \beta(1)\alpha(2)]$

(d) $[1s(1)2s(2)-2s(1)1s(2)][\alpha(1)\beta(2)]$

Q.106 The number of lines in EPR spectrum of CD_3 ($I_D = 1$) is

- (a) 3 (b) 5 (c) 7 (d) 9

Q.107 The volume (cm^3) of CO absorbed on charcoal (273 K) at two different pressures is given below

| | | |
|-------------|----|----|
| P(kPa) | 40 | 80 |
| V(cm^3) | 25 | 40 |

Assuming Langmuir isotherm, the maximum possible volume (cm^3) CO that can be absorbed is

- (a) 50 (b) 100 (c) 150 (d) 200

Q.108 Translational partition function of a D_2 molecule confined in a 100 cm^3 vessel at 25°C is

($h = 6.626 \times 10^{-34}\text{ J.s}$, $k = 1.381 \times 10^{-23}\text{ JK}^{-1}$)

- (a) 3.8×10^{22} (b) 5.8×10^{24} (c) 7.8×10^{26} (d) 9.8×10^{28}

Q.109 For an enzyme-substrate reaction,

the slope and intercept of the plot between $\frac{1}{r}$ and $\frac{1}{[S]}$ are 10^{-2} s and $10^2\text{ M}^{-1}\text{ s}$, respectively. If $E_0 = 10^{-6}\text{ M}$ and $\frac{k_{-1}}{k_2} = 1000$, the value of k_1 will be close to (in units of $\text{M}^{-1}\text{ s}^{-1}$). [r is the rate of the reaction and E_0 is the initial concentration of the enzyme]

- (a) 1×10^{11} (b) 1×10^4 (c) 1×10^8 (d) 1×10^6

Q.110 Difference between activation energies of the reverse and forward steps of a reversible reaction is $9.212RT$. If the pre-exponential factor of the forward reaction is double that of the reverse reaction is double that of the reverse reaction at the same temperature, the equilibrium constant for the reaction at that temperature will be

($\ln 10 = 2.303$)

- (a) 1×10^4 (b) 2×10^4 (c) 1×10^{-4} (d) 2×10^{-4}

Q.111 One of the correct normalized sp^2 hybrid orbitals is

- (a) $\frac{1}{3}\varphi_{2s} + \frac{1}{3}\varphi_{2p_x} + \frac{1}{3}\varphi_{2p_y}$ (b) $\frac{1}{2}\varphi_{2s} + \frac{\sqrt{3}}{\sqrt{8}}\varphi_{2p_x} + \frac{\sqrt{3}}{\sqrt{8}}\varphi_{2p_y}$
 (c) $\frac{1}{\sqrt{3}}\varphi_{2s} + \frac{\sqrt{2}}{\sqrt{3}}\varphi_{2p_x}$ (d) $\frac{1}{3}\varphi_{2s} + \frac{2}{3}\varphi_{2p_x}$

Q.112 The transition moment integral for a rotational transition between $J = 1; M_J = 0$ and $J = 2; M_J = 0$ states for a diatomic molecule along the z-axis is proportional to

- (a) $\int_0^\pi \cos^2 \theta (3\cos^2 \theta - 1) d\theta$ (b) $\int_0^\pi \cos^2 \theta (3\cos^2 \theta - 1) \sin \theta d\theta$
 (c) $\int_0^\pi \cos \theta (3\cos^2 \theta - 1) \sin \theta d\theta$ (d) $\int_0^\pi \cos \theta (3\cos^2 \theta - 1) \sin^2 \theta d\theta$

Q.113 Assuming harmonic approximation, the energy change for reaction $HCl + D_2 \rightarrow DCl + HD$ in cm^{-1} is (the vibrational frequency data in cm^{-1} is given in the table below),

| HCl | D_2 | DCl | HD |
|------|-------|------|------|
| 2885 | 2990 | 1990 | 3627 |

- (a) -258 (b) 258 (c) -129 (d) 129

Q.114 The allowed transition in fluorine molecule is

- (a) $\Sigma_g^+ \rightarrow \Sigma_g^+$ (b) $\Sigma_g^+ \rightarrow \Sigma_g^-$ (c) $\Sigma_g^+ \rightarrow \Pi_u$ (d) $\Sigma_g^+ \rightarrow \Delta_u$

Q.115 A symmetric top molecule, among the following is

- (a) Ethylene (b) allene (c) butatriene (d) hexatriene

Q.116 a solution of Fe^{2+} is titrated potentiometrically using Ce^{3+} solution at 25°C . The EMF (in V) of the redox system thus formed when, (i) 50% of Fe^{3+} and (ii) 80% of Fe^{3+} are titrated, would respectively be

(Given $E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^0 = 0.77\text{V}$, $\log_{10} 2 = 0.3010$)

- (a) 0.734 and 0.77 (b) 0.77 and 0.385 (c) 0.77 and 0.734 (d) 0.385 and 0.367

Q.117 The (002) plane of an elemental FCC crystal diffracts X-rays ($\lambda = 0.154$ nm) at Bragg angle 90° . The density of the crystal is 4×10^4 kg m $^{-3}$. The atomic weight of elemental solid is

- (a) 22 (b) 44 (c) 88 (d) 66

Q.118 The standard cell potential of cell, Pt | H $_2$ (g) | HBr(aq) | AgBr(s), was measured over a range of temperatures, and the data was fitted as

$$E^0(\text{Volt}) = 0.01 - 1 \times 10^4(T - 298) - 2 \times 10^{-6}(T - 298)^2$$

The standard reaction entropy (JK $^{-1}$ mol $^{-1}$) and enthalpy (kJmol $^{-1}$) at 298 K are

- (a) -9.65 and -3.84 (b) -3.84 and -9.65 (c) -18.3 and -7.68 (d) -7.68 and -18.3

Q.119 In the phase diagram of water, the solid-liquid boundary has a negative slope. The reason for this unusual behaviour can be traced to decrease in

- (a) Density of the system on melting (b) Volume of the system on melting
(c) Entropy of the system on melting (d) Enthalpy of the system on melting

Q.120 At 300 K, the thermal expansion coefficient and the isothermal compressibility of liquid water are 2×10^{-4} K $^{-1}$ and 5×10^{-5} bar $^{-1}$, respectively. $(\partial U / \partial V)_T$ (in k bar) for water at 320 K and 1 bar will be

- (a) 2.4 (b) 1.2 (c) 0.6 (d) 12.0

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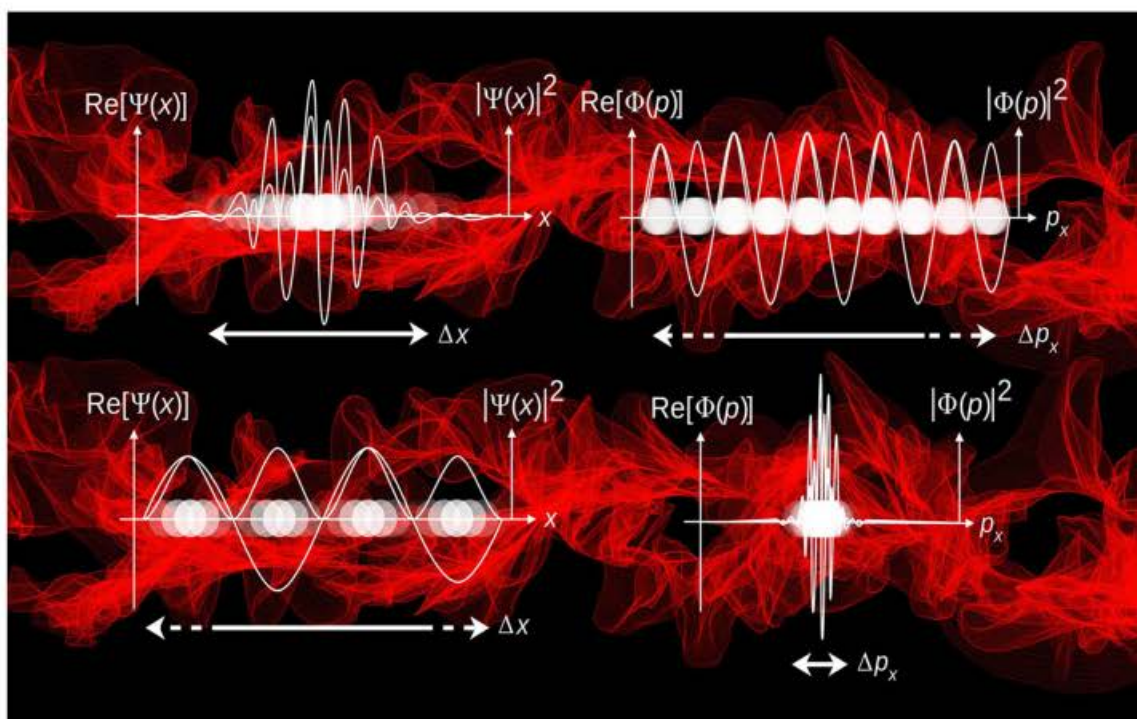
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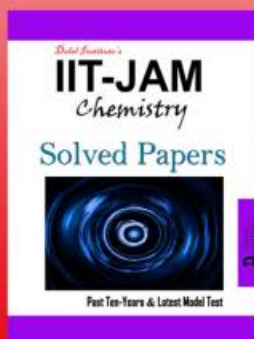
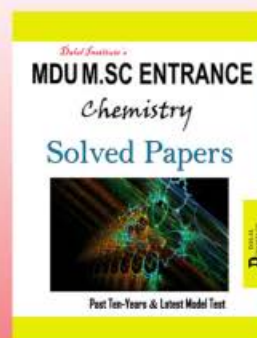
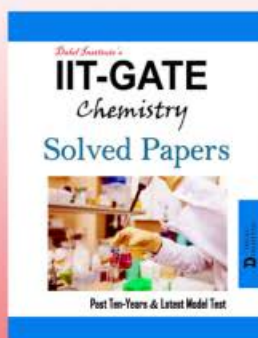
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