

# CSIR UGC – NET JRF: June 2017

## Chemical Science

### ❖ Question Paper

#### Section-A

Q.1 If the product of three consecutive positive integers is equal to their sum, then what would be the sum of their squares?

- (a) 9                                      (b) 14                                      (c) 16                                      (d) 24

Q.2 A tall metal cylinder is filled end-to-end with  $n$  snugly fitting spherical wax balls of diameter  $d$ . If the balls melt completely, the volume fraction occupied by the melted wax is?

- (a) Independent of both  $d$  and  $n$ .  
(b) Dependent on both  $d$  and  $n$ .  
(c) Independent of  $d$ , but dependent on  $n$ .  
(d) Dependent on  $d$ , but independent of  $n$ .

Q.3 Some fishermen caught some fish. No one caught more than 20 fish.  $a_1$  number of fishermen caught at least one fish among them,  $a_2$  number of fishermen caught at least two fish among them, and so on and  $a_{20}$  number of fishermen caught exactly 20 fish among them. How many fish were caught?

- (a)  $a_1 + a_2 + a_3 + \dots + a_{20}$                                       (b)  $a_1 + 2a_2 + 3a_3 + \dots + 20a_{20}$   
(c)  $20(a_1 + a_2 + a_3 + \dots + a_{20})$                                       (d)  $20(a_1 + 2a_2 + 3a_3 + \dots + 20a_{20})$

Q.4  $N$  is a two-digit number such that the product of its digits when added to their sum equals  $N$ . The unit digit of  $N$  would be?

- (a) 1                                      (b) 7                                      (c) 8                                      (d) 9

Q.5 If  $P + 1/Q = 1$  and  $Q + 1/R = 1$ , then what is  $PQR$ ?

- (a) -1                      (b) 2                      (c) -2                      (d) None

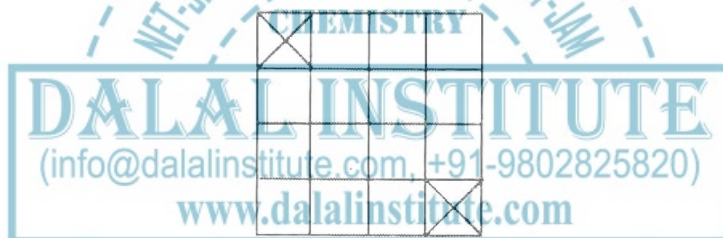
Q.6 What is the remainder when  $3^{256}$  is divided by 5?

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

Q.7 If equal weights of 22 carat gold (alloy of 22 parts gold and 2 parts copper by weight) and 24 carat gold (pure gold) are mixed to form an alloy, what will be the weight proportion of copper in the alloy?

- (a)  $\frac{1}{2}$                       (b)  $\frac{1}{8}$                       (c)  $\frac{1}{12}$                       (d)  $\frac{1}{24}$

Q.8 A  $4\text{ m} \times 4\text{ m}$  floor needs to be covered by tiles of size  $2\text{ m} \times 1\text{ m}$ . Two diagonally opposite corners of size  $1\text{ m} \times 1\text{ m}$  should be left uncovered. How many tiles are required to complete the job without breaking the tiles or overlapping them?



- (a) 6                      (b) 7                      (c) 8                      (d) Not possible

Q.9 If  $42 \rightarrow 26$ ,  $71 \rightarrow 78$ ,  $33 \rightarrow 16$ , then  $62 \rightarrow ?$

- (a) 68                      (b) 54                      (c) 38                      (d) 39

Q.10 A shopkeeper sells a file and a notebook for Rs 27 to the first customer, a notebook and a pen for Rs 31 to the second customer and a pen and file for Rs 29 to the third customer. The prices of the items are rounded in rupees. Which of the following inferences is correct?

- (a) The pen is the costliest of the three.  
(b) The file is the costliest of the three.  
(c) The notebook is the costliest of the three.  
(d) The shopkeeper sold the different items to different customers at different rates.

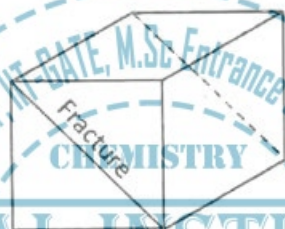
Q.11 If NET14 & NET15 are five-digit numbers such that their sum = 157229, then N + E + T would be?

- (a) 15                      (b) 21                      (c) 25                      (d) 72

Q.12 A cylindrical cake is to be cut into 16 equal pieces. What is the minimum number of cuts required to do so?

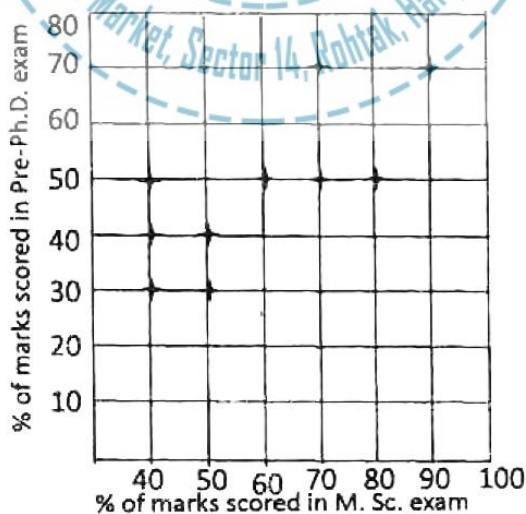
- (a) 9                      (b) 3                      (c) 8                      (d) 5

Q.13 The diagram shows a cubic block of marble ( $1 \times 1 \times 1 \text{ m}^3$ ) having a planar fracture. What is the maximum number of slabs sized  $20 \times 20 \times 5 \text{ cm}^3$  that can be cut from this block avoiding the fracture?



- (a) 200                      (b) 300                      (c) 400                      (d) 500

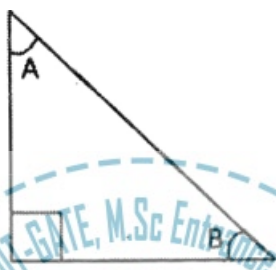
Q.14



Pre-Ph.D. exam score of 10 students are plotted against their M.Sc. marks. Which of the following is true?

- (a) Two students have scored better in Pre-Ph.D. than their M.Sc. exam.
- (b) All those students who scored 50% in Pre-Ph.D. scored more percentage of marks in their M.Sc. exam.
- (c) Two students scored the same percentage of marks in their Pre-Ph.D. and M.Sc. exams.
- (d) The student who scored maximum in M.Sc. is the only student to get maximum in Pre-Ph.D. exam.

Q.15 With reference to the right-angled triangle shown, what is the value of  $\sin(A)\cos(B) + \cos(A)\sin(B)$ ?



- (a)  $-1/2$                       (b) 1                      (c)  $1/2$                       (d)  $-1$

Q.16 Consider a square of side  $a$ . Fit the largest possible circle inside it and the largest possible square inside the circle. What is the side length of the innermost square?

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

Q.17 Walking from my home at a speed of 5 km/h I am 8 minutes late in reaching my office. If I walk at a speed of 8 km/h I reach 5 minutes late. How far is my office from the house?

- (a) 2 km                      (b)  $1/3$  km                      (c)  $2/3$  km                      (d)  $1/2$  km

Q.18 A, B & C are three distinct digits. If they are added as below:

	A	B	C
+	A	B	C
+	A	B	C
	C	C	C

Find out the values of A, B & C

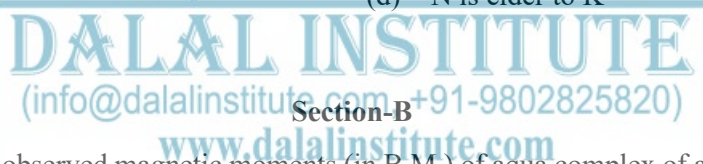
- (a)  $A = 3, B = 4, C = 5$  (b)  $A = 2, B = 3, C = 1$  (c)  $A = 5, B = 1, C = 3$  (d)  $A = 1, B = 8, C = 5$

Q.19 A tight fitting band is wrapped around the Equator. Another circular band whose length is 15 m more lies at a certain height over the first band. A group of human beings attempt to pass under the longer band. Can they walk under it? (Earth's circumference is roughly 40,000 km. The height of human beings is between 1 & 2 m)?

- (a) Yes (b) No  
(c) Can not be determined (d) Only those with height less than 1.7 m.

Q.20 L is the tallest and eldest of a group of five people K, L, M, N & P. M is elder to N and shorter than K. M & P are of the same age and P is taller than K. N & K are of same height & K is younger than P. which of the following interference is certain?

- (a) P is taller than M (b) N is the youngest  
(c) N is elder to P (d) N is elder to K



Q.21 The calculated and observed magnetic moments (in B.M.) of aqua complex of a lanthanide ion are 0 and  $\sim 3.5$ , respectively. The lanthanide ion is?

- (a)  $\text{Pm}^{3+}$  (b)  $\text{Pr}^{3+}$  (c)  $\text{Eu}^{3+}$  (d)  $\text{Sm}^{3+}$

Q.22 The compound that gives a basic solution in HF is?

- (a)  $\text{AsF}_5$  (b)  $\text{PF}_5$  (c)  $\text{BF}_3$  (d)  $\text{BrF}_3$

Q.23 Based on VSEPR theory, the predicted shapes of  $[\text{XeF}_5]^-$  and  $\text{BrF}_5$ , respectively, are?

- (a) Pentagonal planar and square pyramidal (b) Square pyramidal and trigonal bipyramidal  
(c) Trigonal bipyramidal and square pyramidal (d) Square pyramidal and pentagonal planar

Q.24 Both potassium and sulfuric acid form intercalation compounds with graphite. The graphite layers are

- (a) Reduced in both the cases.

- (b) Oxidized in both the cases.  
(c) Oxidized in the case of potassium and reduced in the case of sulphuric acid.  
(d) Reduced in the case of potassium and oxidized in the case of sulfuric acid.

Q.25 The resonance Raman stretching frequencies (in  $\text{cm}^{-1}$ ) of the bound  $\text{O}_2$  species in oxy-hemerythrin and oxy-haemoglobin, respectively, are

- (a)  $\sim 850$  and  $1100$       (b)  $\sim 750$  and  $850$       (c)  $\sim 850$  and  $850$       (d)  $\sim 1100$  and  $850$

Q.26 CdS, HgS and  $\text{BiI}_3$  are coloured due to?

- (a)  $L \rightarrow M$  charge transfer transitions.  
(b)  $d-d$  electronic transitions.  
(c)  $M \rightarrow L$  charge transfer transitions.  
(d) Combination of  $L \rightarrow M$  charge transfer and  $d-d$  electronic transitions.

Q.27 Which one of the following pairs has two magic numbers for closed nuclear shells?

- (a) 8, 10      (b) 10, 20      (c) 50, 82      (d) 82, 130

Q.28 Identify the correct statement(s) for phosphorimetric measurement from the following:

- A. It is done after a time delay when fluorescence, if present becomes negligible.  
B. Immobilization of analyte increases phosphorescence.  
C. Phosphorescence decreases in the presence of heavy atoms.

Answer(s) is/are?

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

Q.29 Choose the isoelectronic pair among the following:

(A)  $[\text{V}(\text{CO})_6]$ , (B)  $[\text{Cu}(\eta^5\text{-C}_5\text{H}_5)(\text{CO})]$ , (C)  $[\text{Co}(\text{CO})_4]^-$ , (D)  $[\text{IrCl}(\text{CO})(\text{PPh}_3)_2]$

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

Q.30 An organometallic fragment that is isolobal to  $\text{CH}_3^+$  is

- (a)  $[\text{Fe}(\text{CO})_5]$       (b)  $[\text{Mn}(\text{CO})_5]$       (c)  $[\text{Cr}(\text{CO})_5]$       (d)  $[\text{Ni}(\text{CO})_3]^+$

Q.31 In vitro reaction of an excess of  $\text{O}_2$  with free heme B in aqueous medium the end product is?

- (a) Hematin      (b)  $[\text{O}_2\text{-Fe(III)-protoporphyrin-IX}]$   
 (c) Heme B( $\text{O}_2$ )      (d) Oxo-ferrylprotoporphyrin-IX cation radical

Q.32 Consider the following sulphur donor atom bearing bidentate ligand where X and name of ligands are given in following columns:



X	Ligand name
A. $\text{NR}_2$	I. Dithiocarbonate
B. OR	II. Dithiocarbamate
C. $\text{O}^-$	III. Xanthate
D. SR	IV. Thioxanthate

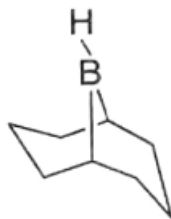
Correct match of entries given in two columns is?

- (a) A-II; B-III; C-I; D-IV      (b) A-III; B-II; C-IV; D-I  
 (c) A-I; B-II; C-III; D-IV      (d) A-IV; B-I C-II; D-III

Q.33 The relative rates of water exchange for the hydrated complexes of (a)  $\text{Ni}^{2+}$ , (b)  $\text{V}^{2+}$  and (c)  $\text{Cr}^{3+}$  ions follow the trend?

- (a) (a) > (b) > (c)      (b) (a) < (b) < (c)      (c) (a) > (b) < (c)      (d) (a) < (b) > (c)

Q.34 The IUPAC name of the following compound:



- (a) 9-borabicyclo[3.3.1]nonane                      (b) 1-borabicyclo[3.3.1]nonane  
 (c) 9-borabicyclo[3.3.0]octane                      (d) 1-borabicyclo[3.3.0]octane

Q.35 The correct match of natural products in Column I with their biosynthetic precursors in Column II is:

	Column I	Column II
A		(i) L-Allysine
B		(ii) L-Ornithine
		(iii) Farnesyl pyrophosphate
		(iv) Geranyl pyrophosphate

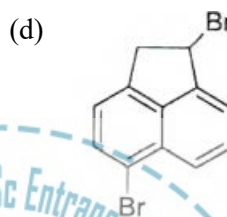
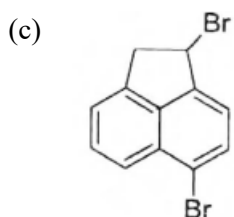
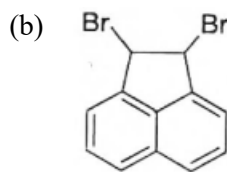
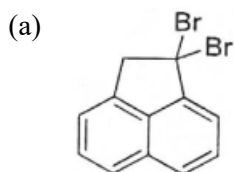
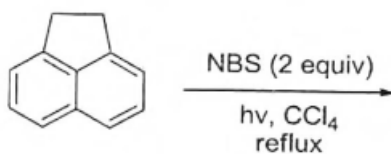
- (a) A: iv, B: i                      (b) A: iv, B: ii                      (c) A: iii, B: i                      (d) A: iii, B: ii

Q.36 The correct order of  $pK_a$  values for the following species is?

- (a)  $\text{PhNH}_3^+ < \text{i-Pr}_2\text{NH}_2^+ < \text{Ph}_2\text{NH}_2^+$                       (b)  $\text{Ph}_2\text{NH}_2^+ < \text{PhNH}_2^+ < \text{i-Pr}_2\text{NH}_2^+$   
 (c)  $\text{i-Pr}_2\text{NH}_2^+ < \text{Ph}_2\text{NH}_2^+ < \text{PhNH}_2^+$                       (d)  $\text{PhNH}_3^+ < \text{Ph}_2\text{NH}_2^+ < \text{i-Pr}_2\text{NH}_2^+$

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

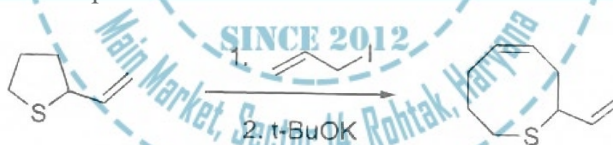




Q.38  $^{13}\text{C}$  NMR spectrum of  $\text{DMSO}-d_6$  gives a signal at  $\delta$  39.7 ppm as a?

- (a) Singlet (b) Triplet (c) Quintet (d) Septet

Q.39 Following reaction is an example of:

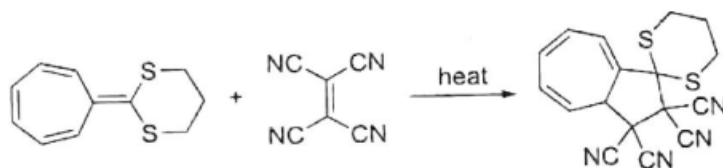


- (a) Ramberg-Bäcklund reaction (b) [2,3]-sigmatropic shift  
(c) [3,3]-sigmatropic shift (d) Pummerer rearrangement

Q.40 Among the following, the synthetic equivalent of acetyl anion is?

- (a) (b)  $\text{CH}_3\text{CN}$   
(c) (d)  $\text{CH}_3\text{CH}_2\text{NO}_2$

Q.41 Following reaction is an example of:



- (a) [3+2] cycloaddition  
 (b) [4+2] cycloaddition  
 (c) [6+2] cycloaddition  
 (d) [8+2] cycloaddition

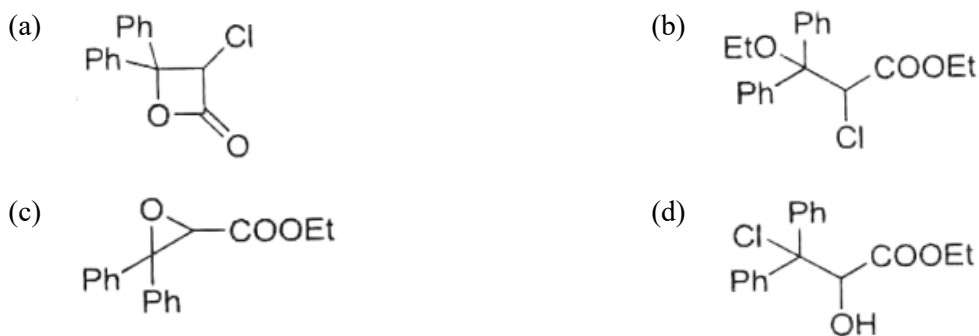
Q.42 Major product of the following reaction is:



Q.43 The most stable conformation of 2-fluoro-ethanol is?

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

Q.44 The major product formed in the sodium ethoxide mediated reaction between benzophenone and ethyl chloroacetate is?



Q.45 The major product formed in the following reaction is:



Q.46 Among the following, the natural product that is a steroid and contains an  $\alpha,\beta$ -unsaturated ketone is?

- (a) Estrone                      (b) Prostaglandin                      (c) Cortisone                      (d) Morphine

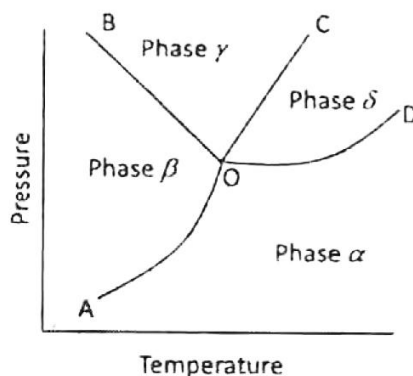
Q.47 Which of the functions below is a common eigen function of  $d/dx$  &  $d/dx^2$  operators?

- (a)  $\cos x$                       (b)  $Kx$                       (c)  $e^{ix}$                       (d)  $e - x^2$

Q.48 A phase transition process is always?

- (a) Isothermal -isoentropic                      (b) Isochoric -isothennal  
 (c) Isobaric -isochoric                      (d) Isothermal -isobaric

Q.49 A one-component system with the associated phase diagram (see the figure) is not possible because:



- (a) OB has a negative slope  
 (b) OC has a positive slope  
 (c) Both OB and OC are linear  
 (d) OB, OC and OD cannot all coexist, given OA

Q.50 Consider a particle in its ground state confined to a one-dimensional box in the interval (0, 8). The probability of finding it between  $4.0 - \delta/2$  and  $4.0 + \delta/2$  is close to ( $\delta$  is sufficiently small so that the wavefunction can be taken as a constant in this interval)

- (a)  $\delta/4$  (b)  $\delta/3$  (c)  $\delta/2$  (d)  $\delta$

Q.51 The  $\nu = 0$  to 1 vibration-rotation spectrum of a diatomic molecule exhibits transitions for  $R(0)$ ,  $R(1)$ ,  $P(1)$  and  $P(2)$  lines at 2242, 2254, 2216 and 2203  $\text{cm}^{-1}$ , respectively. From this data, we can conclude that the molecule?

- (a) Has rigid rotation and harmonic vibration  
 (b) Has anharmonic vibration  
 (c) Has rotational-vibrational interaction  
 (d) Is affected by nuclear spin-statistics

Q.52 Consider aqueous solutions of two compounds A and B of identical concentrations. The surface tension of the solution of A is smaller than that of pure water while for B it is greater than that of pure water under identical conditions. From this one infers that

- (a) Surface concentration of A is smaller than its bulk concentration.  
 (b) Surface concentration of B is larger than its bulk concentration.  
 (c) Surface concentration of A is larger than that of B.  
 (d) Surface concentration of A is smaller than that of B.

Q.53 For a monodisperse polymer, the number average molar mass ( $\bar{M}_n$ ) and weight average molar mass ( $\bar{M}_w$ ) are related according to?

- (a)  $(\bar{M}_w) < (\bar{M}_n)$       (b)  $(\bar{M}_w) = (\bar{M}_n)$       (c)  $(\bar{M}_w) > (\bar{M}_n)$       (d)  $(\bar{M}_w) < \log(\bar{M}_n)$

Q.54 An intense purple colour (Plasmon band) is exhibited by a colloid consisting of spherical?

- (a) Silver particles of 10 nm diameter      (b) Silicon particles of 5 nm diameter  
(c) Gold particles of 5 nm diameter      (d) Iron particles of 3 nm diameter

Q.55 The correct statement for any cyclic thermodynamic process is?

- (a)  $\oint dq = 0$       (b)  $\oint dw = 0$       (c)  $\oint dU = 0$       (d)  $\oint Vdq = 0$

Q.56 Metallic silver crystallizes in face centred cubic lattice structure with a unit cell of length 40 nm. The first order diffraction angle of X-ray beam from (2, 1, 0) plane of silver is  $30^\circ$ . The wavelength of X-ray used is close to?

- (a) 11 nm      (b) 18 nm      (c) 25 nm      (d) 32 nm

Q.57 If the pre-exponential factor in Arrhenius equation is  $1.6 \times 10^{12} \text{ s}^{-1}$ , the value of the rate constant at extremely high temperature will be close to?

- (a)  $1.6 \times 10^{12} \text{ s}^{-1}$       (b)  $4.2 \times 10^{12} \text{ s}^{-1}$       (c)  $2.4 \times 10^{12} \text{ s}^{-1}$       (d)  $1.2 \times 10^{12} \text{ s}^{-1}$

Q.58 In kinetic study of a chemical reaction, slopes are drawn at different times in the plot of concentration of reactants versus time. The magnitude of slopes with increase of time?

- (a) Remains unchanged      (b) Increases  
(c) Decreases      (d) Increase & decrease periodically

Q.59 The electrochemical cell potential ( $E$ ), after the reactants and products reach equilibrium, is ( $E^0$  is the standard cell potential and  $n$  is the number of electrons involved)

- (a)  $E = E^0 + nF/RT$       (b)  $E = E^0 - nF/RT$       (c)  $E = E^0$       (d)  $E = 0$

Q.60 For the electronic configuration  $ls^2 2s^2 2p^4$ , two of the possible term symbols are  $^1S$  and  $^3P$ . the remaining term is?

- (a)  $^1D$                       (b)  $^1F$                       (c)  $^3D$                       (d)  $^3F$

### Section-C

Q.61 Match items in column A with items in column B:

Column A	Column B
I: $\text{SbF}_5 + \text{BrF}_3 \rightarrow [\text{BrF}_2]^+ + [\text{SbF}_6]^-$	a) Lewis acid behaviour of $\text{BrF}_3$
II: $[\text{BrF}_2][\text{SbF}_6] + \text{Ag}[\text{BrF}_4] \rightarrow \text{Ag}[\text{SbF}_6] + 2\text{BrF}_3$	b) Lewis base behaviour of $\text{BrF}_3$
III: $\text{KF} + \text{BrF}_3 \rightarrow \text{K}^+ + [\text{BrF}_4]^-$	c) Self ionisation
IV: $2\text{BrF}_3 \rightarrow [\text{BrF}_2]^+ + [\text{BrF}_4]^-$	d) Neutralisation

The correct answer is?

- (a) I-(a); II-(b); III-(c); IV -(d)                      (b) I -(b); II-(d); III-(c); IV -(a)  
 (c) I-(c); II-(d); III-(b); IV -(a)                      (d) I-(b); II-(d); III -(a); IV -(c)

Q.62 Mossbauer spectrum of complex  $[\text{Fe}(\text{1, 10-phenanthroline})_2(\text{NCS})_2]$  shows two lines at 300 K, four lines at 186 K, and again two lines at 77 K. This can be attributed to:

- A. Change in the coordination mode of NCS.  
 B. Change in the spin-state of iron.  
 C. cis-trans isomerisation.  
 D. Change in metal-ligand bond distances. The correct statements are:

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

Q.63  $(\text{R}_3\text{Ge})_2$  on photolysis gives a radical which shows ESR spectrum. The ESR signals carrying the signature of  $^{73}\text{Ge}$  ( $I = 9/2$ ) are in terms of?

- (a) Nine lines                      (b) Ten lines                      (c) Two lines                      (d) One line

Q.64 Choose the correct statement for magnitude of threshold energy of an endoergic nuclear reaction between stationary nucleus and a moving projectile?

- (a) It is greater than  $|Q|$  of nuclear reaction. (b) It has to be more than kinetic energy of a projectile.
- (c) It is less than  $|Q|$  of nuclear reaction. (d) It has to be equal to kinetic energy of a projectile.

Q.65 Identify correct statements from the following:

- A. Area of differential thermal analysis peak is proportional to amount of sample.  
B. Area of differential thermogravimetric analysis curve is proportional to mass loss:  
C. Phase transition cannot be studied with differential scanning calorimetry.  
D. Simultaneous determination of two metal ions is possible with thermogravimetric analysis .

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

Q.66 Consider following statements for fission of  $^{235}\text{U}$  with thermal neutrons:

- A. The % of nuclei undergoing unsymmetrical fission is maximum.  
B. In each fission, one thermal neutron is produced.  
C. Magnitude of energy released per fission is of the order 200 MeV.

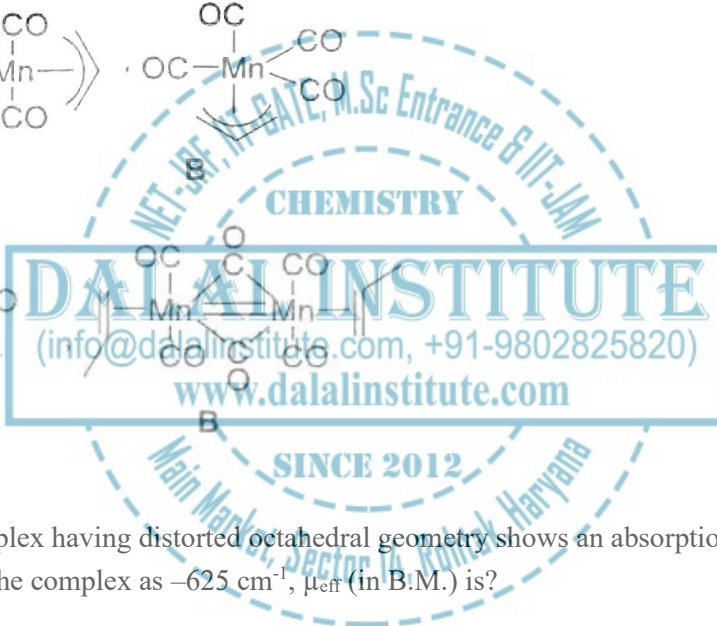
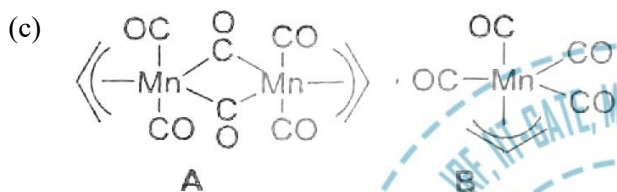
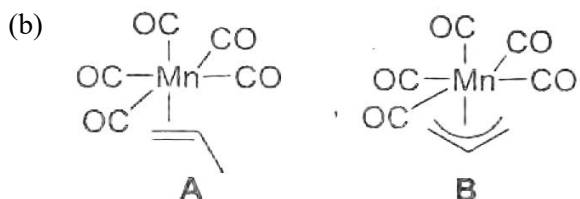
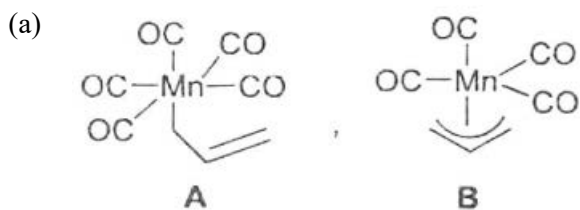
The correct statements is/are?

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

Q.67 Addition of two electrons to the bismuth cluster  $\text{Bi}_5^{3+}$  results in a change of structure type from?

- (a) Closo to Nido (b) Nido to archno  
(c) Closo to archno (d) Archno to hypo

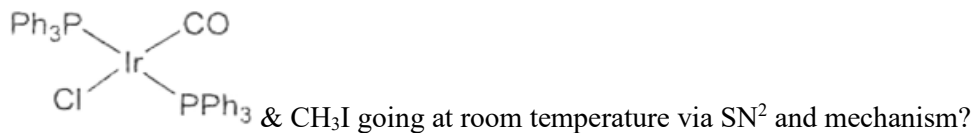
Q.68 Reaction of  $\text{Na}[\text{Mn}(\text{CO})_5]$  with  $\text{H}_2\text{C}=\text{CHCH}_2\text{Cl}$  gives A along  $\text{NaCl}$ . Photosynthesis of compound A results in compound B together with elimination of  $\text{CO}$ . The correct structural formulations of compounds A and B are respectively?



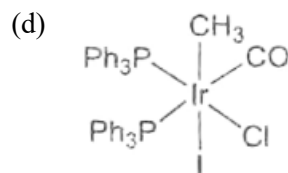
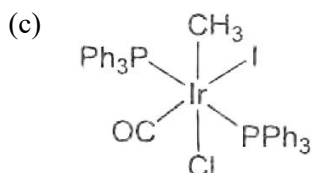
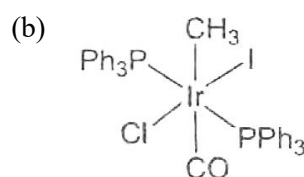
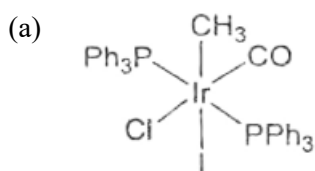
Q.69 A copper(II) complex having distorted octahedral geometry shows an absorption band at 625 nm. Given spin-orbit coupling of the complex as  $-625 \text{ cm}^{-1}$ ,  $\mu_{\text{eff}}$  (in B.M.) is?

- (a) 1.73                      (b) 1.81                      (c) 1.63                      (d) 1.93

Q.70 Identify the product in the reaction between:







Q.71 Addition of  $\text{NaBI}_4$  to  $[\eta^5\text{-Cp}]\text{Fe}(\eta^6\text{-C}_6\text{H}_6)$  will give?

- (a)  $[(\eta^5\text{-Cp})\text{Fe}(\text{H})_2]^-$  (b)  $[(\eta^5\text{-Cp})\text{Fe}(\text{H})(\eta^6\text{-C}_6\text{H}_6)]$   
 (c)  $[\eta^5\text{-Cp}]\text{Fe}(\eta^5\text{-C}_6\text{H}_7)$  (d)  $[(\eta^5\text{-Cp})\text{Fe}(\eta^5\text{-C}_6\text{H}_7)]$

Q.72 The  $\mu_{\text{eff}}$  of  $[\text{Fe}(\text{S}_2\text{CNET}_2)_3]$  changes with temperature with the involvement of two electronic states. The states are?

- (a) Low spin  $^2\text{T}_{2g}$  and high spin  $^6\text{A}_{1g}$  (b) Low spin  $^1\text{A}_{1g}$  and high spin  $^3\text{T}_{2g}$   
 (c) Low spin  $^2\text{E}_g$  and high spin  $^6\text{A}_{1g}$  (d) Low spin  $^2\text{T}_{2g}$  and high spin  $^4\text{T}_{1g}$

Q.73 Match the items in the three columns:

Complex (Column 1)	Color (Column 2)	Absorption max ( $\lambda_{\text{max}}$ , Column 3)
A. $[\text{Ni}(\text{H}_2\text{O})_6](\text{NO}_3)_2$	I. Blue	X. 675
B. $[\text{Ni}(\text{NH}_3)_6](\text{NO}_3)_2$	II. Green	Y. 565
C. $[\text{Ni}(\text{en})_3](\text{NO}_3)_2$	III. Violet	Z. 615

The correct answer is?

- (a) A-II-X; B-I-Z; C-III-Y (b) A-I-X; B-II-Y; C-III-Z  
 (c) A-III-Y; B-I-Z; C-II-X (d) A-I-X; B-II-Z; C-III-Y

Q.74 Mass fragment of  $[\text{IrCl}]^+$  in mass spectrometry shows three mass peaks at  $m/z = 226, 228,$  and  $230$ . Given that natural abundances of  $^{191}\text{Ir}$ ,  $^{193}\text{Ir}$ ,  $^{35}\text{Cl}$ , and  $^{37}\text{Cl}$  are 37%, 63%, 76%, and 24% respectively, the intensities of the mass peaks are in the order?

- (a) 49.5: 100: 26.6      (b) 100: 49.5: 26.6      (c) 26.6: 100:49.5      (d) 26.6: 49.5: 100

Q.75 The  $^{31}\text{P}\{^1\text{H}\}$  NMR spectrum of  $2,2,6,6\text{-N}_4\text{P}_4\text{Cl}_4(\text{NMe}_2)_4$  is expected to show?

- (a) Two triplets      (b) Two doublets  
(c) One doublet and one triplet      (d) One quartet and one doublet

Q.76 The number of bonding molecular orbitals and the number of available skeletal electrons in  $[\text{B}_6\text{H}_6]^{2-}$ , respectively, are?

- (a) 7 & 14      (b) 6 & 12      (c) 18 & 12      (d) 11 & 14

Q.77 The compound  $\text{N}_2\text{F}_2$  has two isomers. Choose the correct option from the following:

- (a) Both isomers possess  $\sigma_v$  plane.  
(b) Both isomers possess  $\sigma_h$  plane.  
(c) One isomer has a  $\sigma_h$  plane while the other has a  $\sigma_v$  plane.  
(d) None of them have a  $\sigma_h$  plane.

Q.78 Consider the following statements for metallo-thioneins:

- A. They contain about 30% cysteine residues.  
B. They prefer to bind soft metal ions such as  $\text{Cd}(\text{II})$ ,  $\text{Hg}(\text{II})$  and  $\text{Zn}(\text{II})$ .  
C. They are involved in electron transfer reactions.  
D. They are low molecular weight proteins. Correct statements are?

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

Q.79 Consider the following statements for deoxy hemerythrin and deoxy-hemocyanin:

- A. They are involved in  $\text{O}_2$  transport in biological systems.  
B. They contain two metal ions in their active site.

C. Active site metal centres are bridged by amino acid residues.

D. They prefer to bind only one O<sub>2</sub> per active site.

The correct statements are?

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

Q.80 Consider the following statements for octa-hedral complexes, (a) [CrF<sub>6</sub>]<sup>3-</sup>, (b) [Cr(ox)<sub>3</sub>]<sup>3-</sup> and (c) [Cr(en)<sub>3</sub>]<sup>3+</sup>:

A. Their *d-d* transitions are at 14900, 17500, and 21800 cm<sup>-1</sup>, respectively.

B. Their spin-only magnetic moments are same

C. Two of them have optical isomers

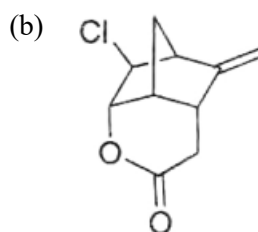
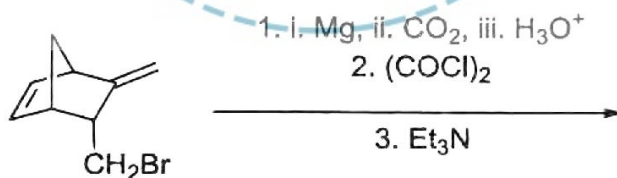
D. All of them show John-Teller distortion. The correct statements are?

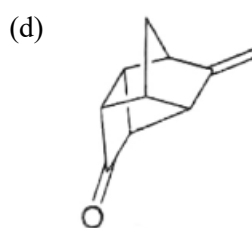
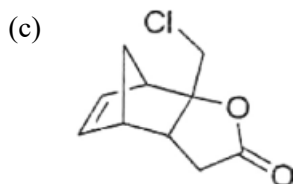
- (a) A, B, and C      (b) A, C and D      (c) B, C, and D      (d) B and D

Q.81 The specific rotation  $[\alpha]_D$  for (S)-(+)-2-butanol is 10° mL/g dm. The observed optical rotation ( $\alpha_{\text{obs}}$ ) of a sample composed of a mixture of (R)- and (S)-2-butanol is -0.45°. If the cell path length is 0.6 dm and the concentration of 2-butanol in the sample is 0.15 g/mL, the percentages of (R) and (S) enantiomers in the sample are?

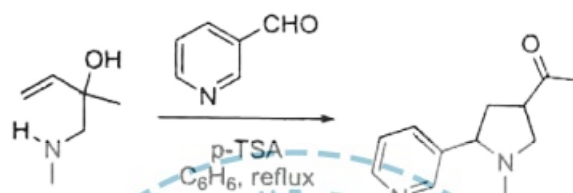
- (a) R = 25%, S = 75%    (b) R = 40%, S = 60%    (c) R = 60%, S = 40%    (d) R = 75%, S = 25%

Q.82 The major product formed in the following reaction is:



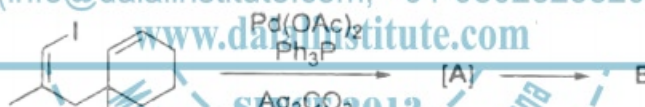




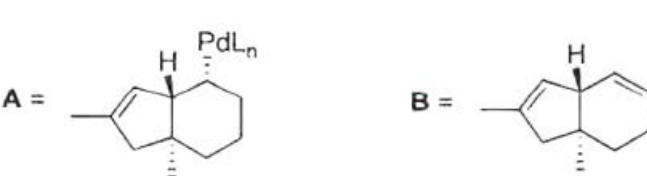
Q.83 Following reaction involves:

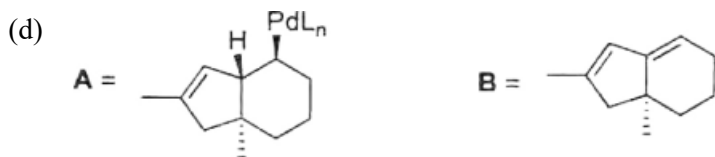


- (a) Claisen followed by Mannich reaction  
 (b) Aza-Cope followed by Mannich reaction  
 (c) Claisen followed by aza-aldol reaction  
 (d) Aza-Cope followed by aza-aldol reaction

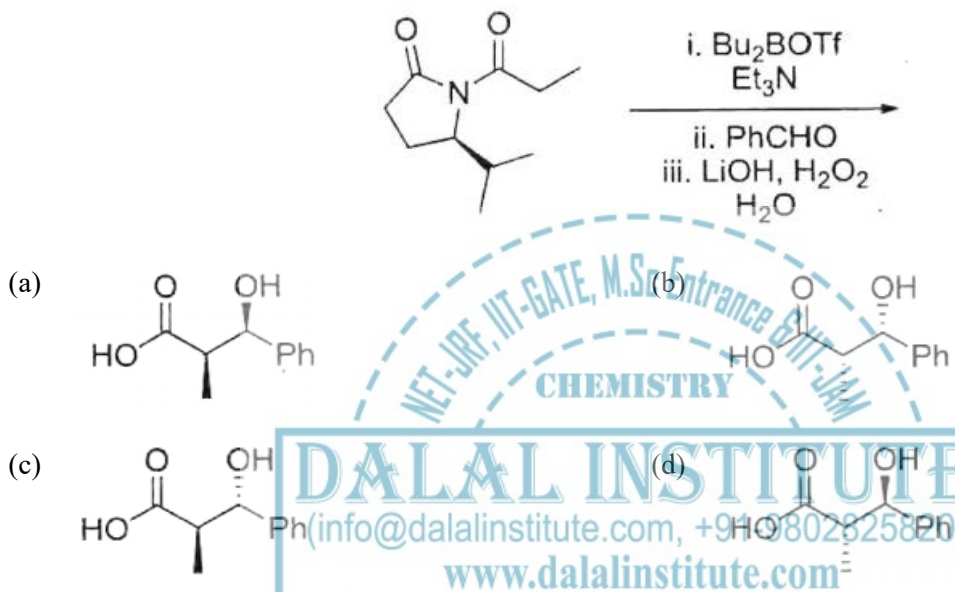
Q.84 The intermediate A and the major product B formed in the following reaction is:



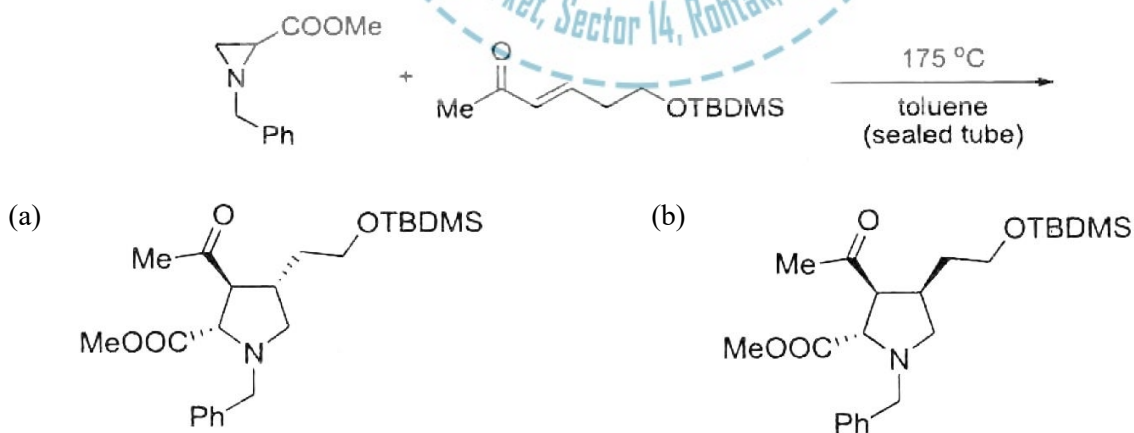
- (a) 
- (b) 
- (c) 

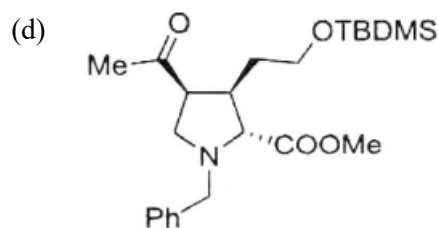
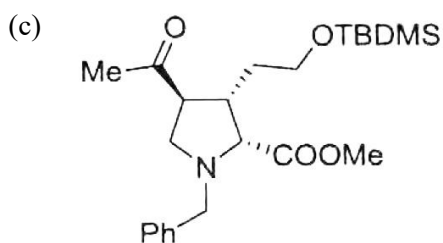


Q.85 The major product formed in the following reaction is:

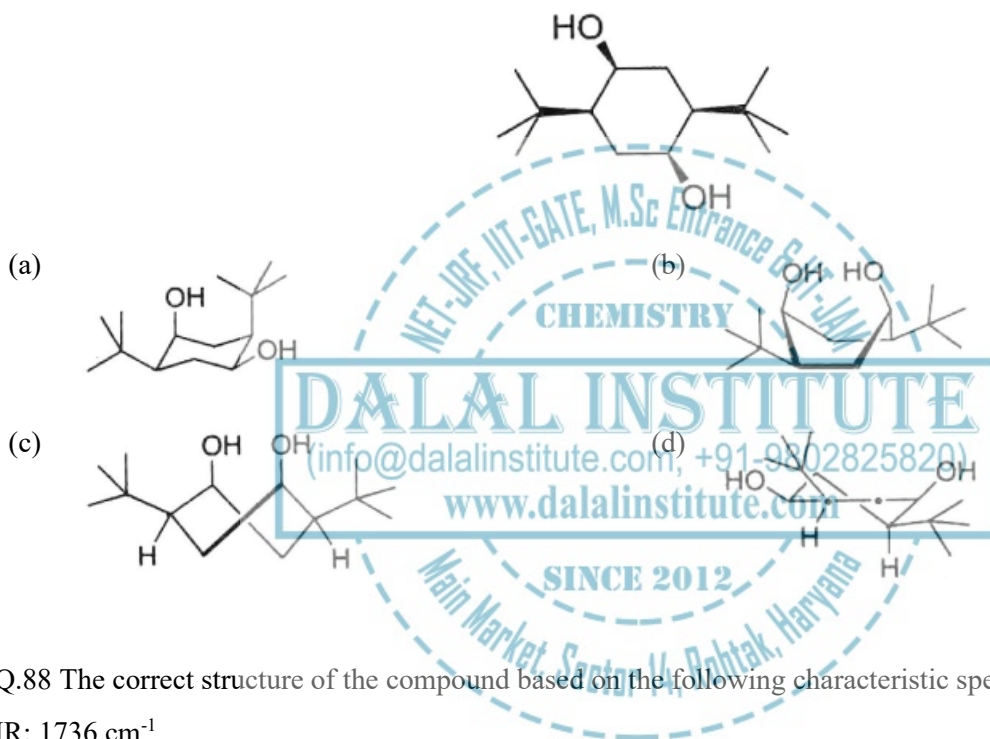


Q.86 The major product formed in the following reaction is:





Q.87 The most stable conformation for the following compound is:

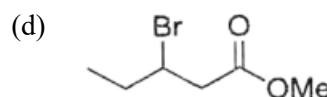
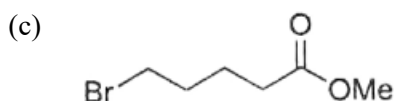
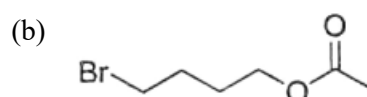
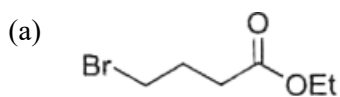


Q.88 The correct structure of the compound based on the following characteristic spectral data is

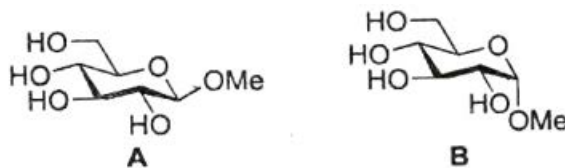
IR:  $1736\text{ cm}^{-1}$

$^1\text{H NMR}$ :  $\delta$  3.59 (s, 3H), 3.32 (t, 2H), 2.25 (t, 2H), 1.85-1.75 (m, 2H), 1.73-1.62 (m, 2H)

$^{13}\text{C NMR}$ :  $\delta$  174.0, 51.0, 32.9, 32.8, 31.0, 23.0



Q.89 The major product formed in the reaction of D-glucose with  $\text{ZnCl}_2$  in MeOH is a methyl glucopyranoside (A or B). The structure of this product and the molecular orbital interaction present between ring-oxygen and the anomeric C-O bond responsible for its stability, respectively, are



- (a) A and  $n \rightarrow \sigma^*$       (b) A and  $n \rightarrow \sigma$       (c) B and  $n \rightarrow \sigma^*$       (d) B and  $n \rightarrow \sigma$

Q.90 Among the following correct statement for nucleic acids is?

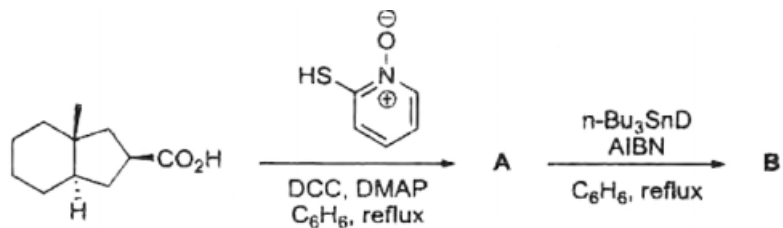
- (a) Uracil is present in DNA      (b) Uracil is present in RNA  
 (c) Phosphorylation in RNA is at 2' & 5' positions      (d) Normally three hydrogen bonds stabilize A-T base pair

Q.91 The major products A and B formed in the following reaction sequence are:



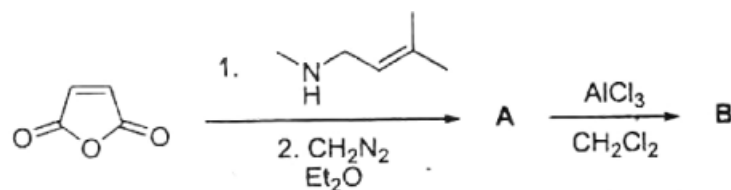
- (a)  $A = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-Br}$        $B = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-CO}_2\text{H}$   
 (b)  $A = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-Br}$        $B = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-CO}_2\text{H}$   
 (c)  $A = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-Br}$        $B = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-CO}_2\text{H}$   
 (d)  $A = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-Br}$        $B = \text{Ph-CH}_2\text{-CH}_2\text{-CH=CH-CO}_2\text{H}$

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



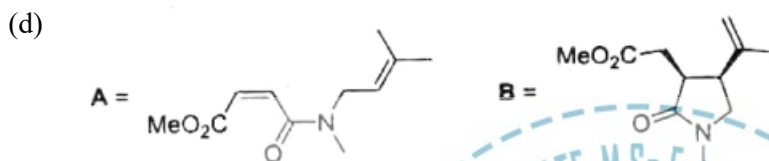
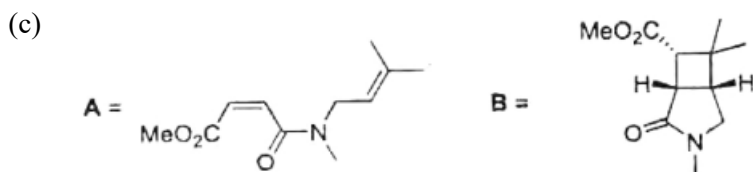
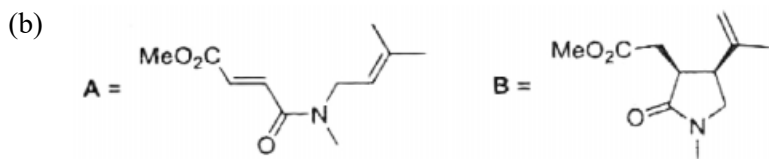
- (a)
- (b)
- (c)
- (d)

Q.93 The major products A and B formed in the following reaction sequence are:

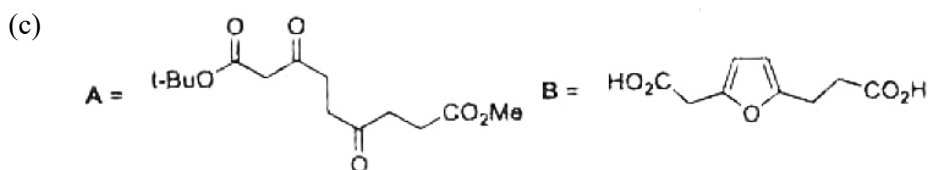
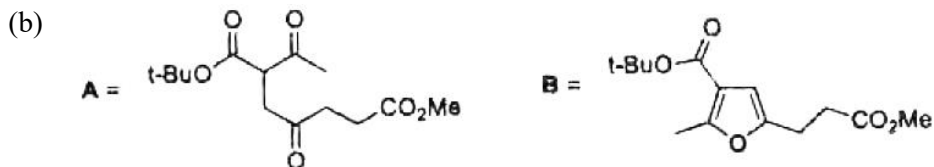
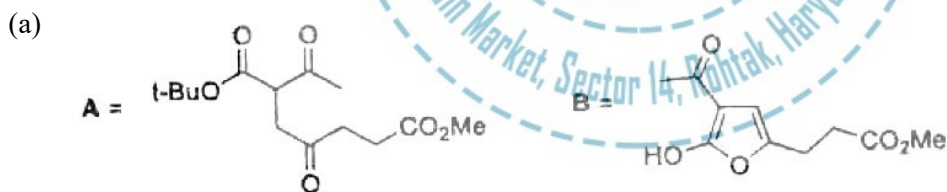


- (a)

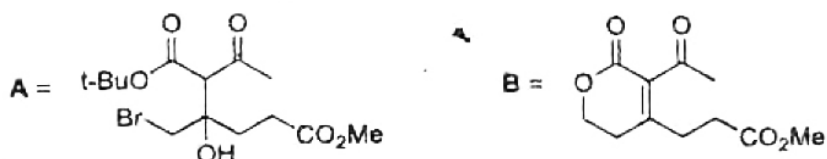




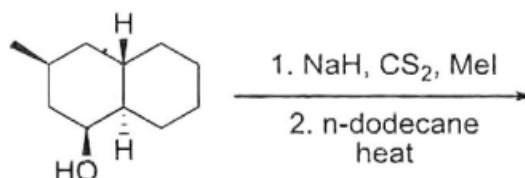
Q.94 The major products A and B formed in the following reaction sequence are:



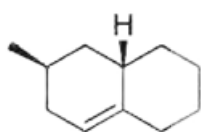
(d)



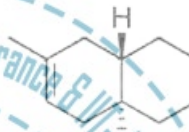
Q.95 The major product formed in the following reaction is:



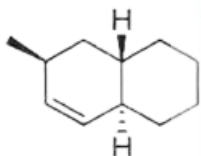
(a)



(b)



(c)



(d)



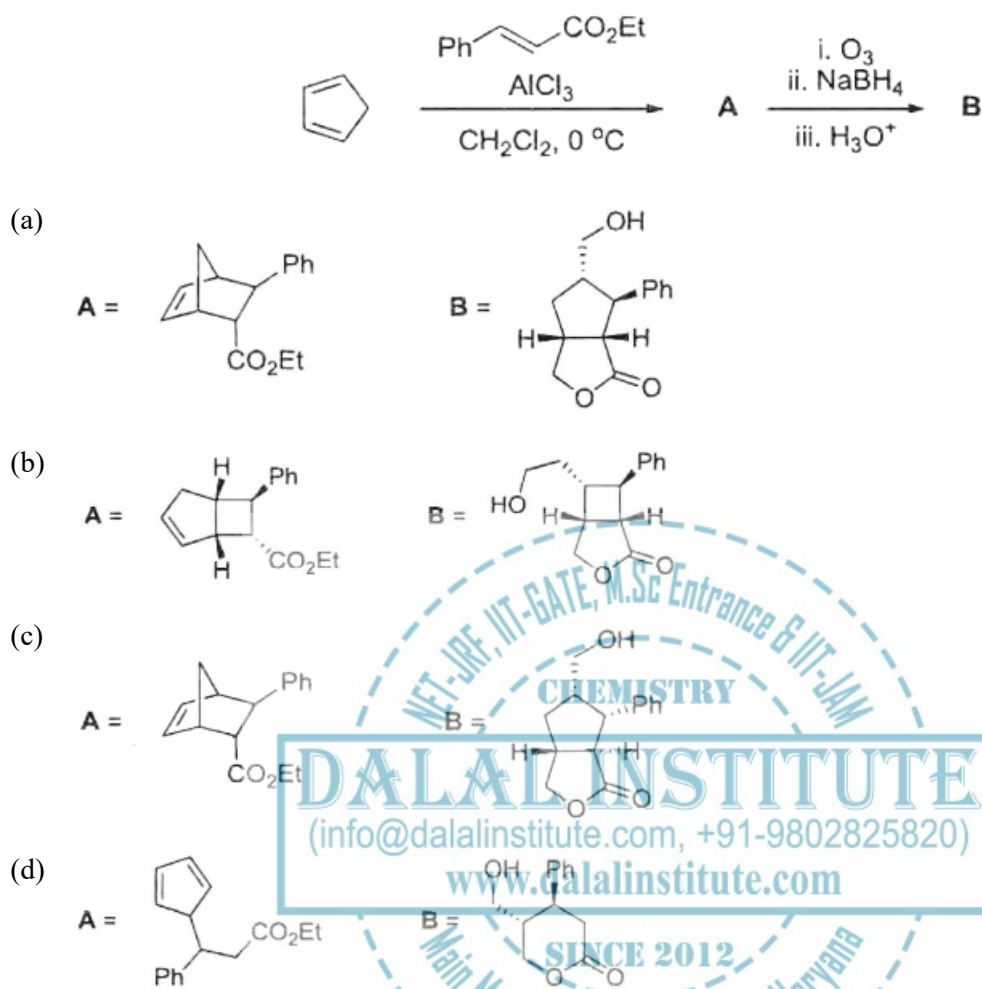
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 www.dalalinstitute.com

Q.96 The correct combination of reagents to effect the following reaction is:

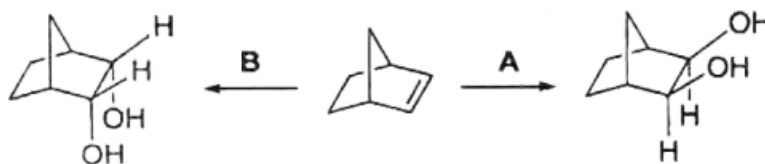
(a) a. POCl<sub>3</sub>, pyridine; b. AgOAc; c. LiAlH<sub>4</sub>(b) a. NaBH<sub>4</sub>; b. Ph<sub>3</sub>P, DEAD, PhCO<sub>2</sub>H(c) a. Ph<sub>3</sub>P, DEAD, PhCO<sub>2</sub>H; b. LiAlH<sub>4</sub>

(d) a. PCC; b. L-selectride

Q.97 The major products A and B formed in the following reaction sequence are:

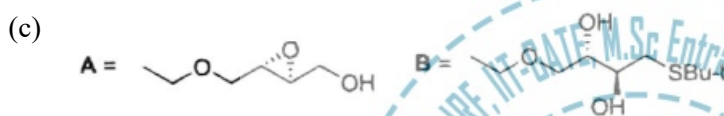
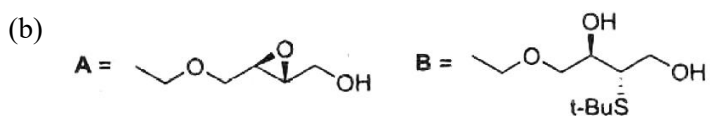
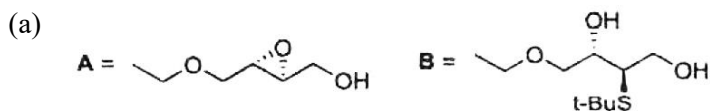
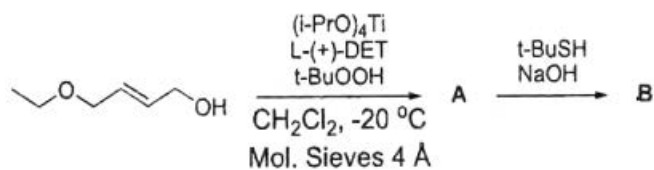


Q.98 The correct combination of reagents A and B to effect following transformations are:

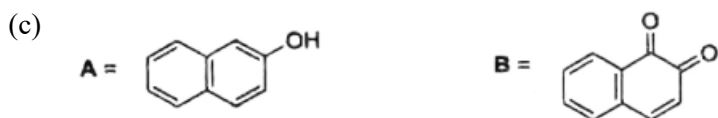
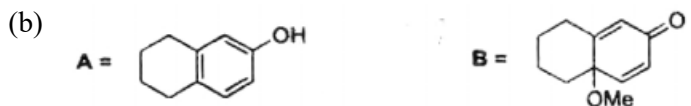
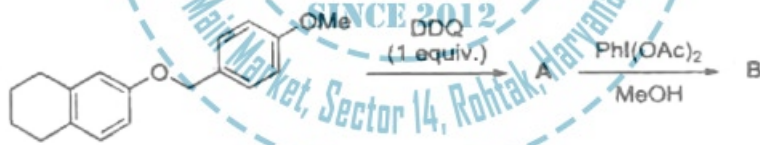


- (a) A = cat. OsO<sub>4</sub>, NMO; B = i. I<sub>2</sub>, PhCO<sub>2</sub>Ag, ii. aq. NaOH
- (b) A = alkaline KMnO<sub>4</sub>; B = i. I<sub>2</sub>, PhCO<sub>2</sub>Ag, H<sub>2</sub>O, ii. aq. NaOH
- (c) A = I<sub>2</sub>, PhCO<sub>2</sub>Ag, ii. aq. NaOH; B = cat. OsO<sub>4</sub>, TMEDA, NMO
- (d) A = i. m-CPBA, ii. aq. NaOH; B = alkaline KMnO<sub>4</sub>

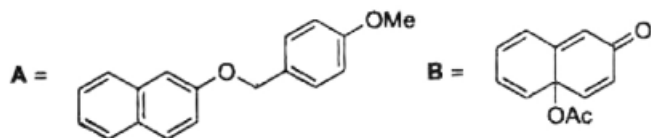
Q.99 The major products A and B formed in the following reaction sequence are:



Q.100 The major products A and B formed in the following reaction sequence are:



(d)



Q.101 For the reaction  $\text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + 1/2\text{O}_2(\text{g})$ , the equilibrium constant  $K_p$  depends on the degree of dissociation  $\alpha$  ( $\alpha \ll 1$ ) and total pressure  $P$  as?

- (a)  $K_p \propto \alpha^2 P$       (b)  $K_p \propto \alpha^{3/2} P^{1/2}$       (c)  $K_p \propto \alpha^{1/2} P^{3/2}$       (d)  $K_p \propto \alpha P^2$

Q.102 The minimum work required by an engine to transfer 5 J of heat from a reservoir at 100 K to one at 300 K is?

- (a) 5 J      (b) 10 J      (c) 15 J      (d) 20 J

Q.103 The correct relation involving symmetry operations?

- (a)  $S_4^2 = S_2$       (b)  $\sigma(xz)\sigma(yz) = C_2(x)$       (c)  $S_4^3 = C_4^3$       (d)  $S_6^3 = S_2$

Q.104 A polydisperse polymer sample has ten molecules of molar mass  $20,000 \text{ g mol}^{-1}$  and fifteen molecules of molar mass  $10,000 \text{ g mol}^{-1}$ . The number average molar mass of the sample is?

- (a) 13,000      (b) 14,000      (c) 15,000      (d) 16,000

Q.105 Consider a system of three particles which can occupy energy levels with energy  $0$ ,  $\epsilon$  and  $2\epsilon$ , such that the total energy  $E = 4\epsilon$ . Cases A, B and C correspond to spin  $1/2$  fermions, spin  $0$  bosons, and classically distinguishable particles, respectively. The correct ordering of entropy is?

- (a)  $S_A > S_B > S_C$       (b)  $S_B > S_A > S_C$       (c)  $S_C > S_B > S_A$       (d)  $S_C > S_A > S_B$

Q.106 The two limiting wavefunctions of the ground state of  $\text{H}_2^+$  molecular ion, as the internuclear separation  $R$  goes to (i)  $\infty$  (infinity) and (ii)  $0$  (zero) are ( $1s_a$ ,  $1s_b$  are  $1s$ -orbital wave functions of hydrogen atoms  $a$  and  $b$  in  $\text{H}_2^+$ , and  $1s_{\text{He}}$  is the wave function of the  $1s$  orbital of  $\text{He}^+$ )

- (a) (i)  $1s_a(r)$ ; (ii)  $1s_b(r)$       (b) (i)  $1s_b(r)$ ; (ii)  $1s_a(r)$   
 (c) (i)  $1s_a(r_1) 1s_b(r_2)$  (ii)  $1s_{\text{He}}(r_1) 1s_{\text{He}}(r_2)$       (d) (i)  $1s_a(r) + 1s_b(r)$ ; (ii)  $1s_{\text{He}}(r)$

Q.107 For a certain magnetic field strength, a free proton spin transition occurs at 700 MHz. Keeping the magnetic field strength constant, the  $^{14}\text{N}$  nucleus will resonate at?

( $g(\text{p}) \approx 5.6$  and  $g(^{14}\text{N}) \approx .0.4$ )

- (a) 700 MHz                      (b) 400 MHz                      (c) 200 MHz                      (d) 50 MHz

Q.108 The first electronic absorption band maximum of a polar and relatively rigid aromatic molecule appears at 310 nm but its fluorescence maximum in acetonitrile solution appears with a large Stokes shift at 450 nm. The most likely reason for the Stokes shift is?

- (a) Large change in molecular geometry in the excited state.  
 (b) Increase in dipole moment of the molecule in the excited state.  
 (c) Decrease in polarizability of the molecule in the excited state.  
 (d) Lowered interaction of the excited molecule with polar solvent.

Q.109 The un-normalized radial wave function of a certain hydrogen atom eigenstate is  $(6r - r^2) \exp(-r/3)$ . A possible angular part of the eigenstate is

- (a)  $5\cos^3\theta - 3\cos\theta$                       (b)  $3\cos^2\theta - 1$                       (c)  $\cos\theta$                       (d) 1

Q.110 Given a trial wave function  $\psi_t = C_1\phi_1 + C_2\phi_2$  & the Hamiltonian matrix elements,  $\int \phi_1^* H \phi_1 dv = 0$ ,  $\int \phi_1^* H \phi_2 dv = 2.5$ ,  $\int \phi_2^* H \phi_2 dv = 12.0$ , the variationally determined ground state energy is?

- (a) -0.52                      (b) -0.50                      (c) 12.50                      (d) 12.52

Q.111 For a point group, an incomplete character table is given below with one irreducible representation missing:

	E	$2C_3$	$3\sigma_v$
$A_1$	1	1	1
-	-	-	-
E	2	-1	0

The Mullikan symbol and characters of the missing representation are?

(a)	$A'_1$	1	-1	1
(c)	$A_2$	1	1	-1

(b)	$B_1$	1	-1	-1
(d)	$B_2$	1	-1	1

Q.112 Given below is a specific vibrational mode of  $\text{BCl}_3$  with  $\oplus$  and  $\ominus$  denoting movements of the respective atoms above and below the plane of the molecule respectively. The irreducible representation of the vibrational mode and its IR/ Raman activity are?

$D_{3h}$	E	$2C_3$	$3C_2$	$\sigma_h$	$2S_3$	$3\sigma_v$		
$A_1$	1	1	1	1	1	1		$x^2 + y^2 + z^2$
$A_2$	1	1	-1	1	1	-1	$R_z$	
$E'$	2	-1	0	2	-1	0	$(x, y)$	$(x^2 - y^2, xy)$
$A_1''$	1	1	1	-1	-1	-1		
$A_2''$	1	1	-1	-1	-1	1	$z$	
$E''$	2	-1	0	-2	1	0	$(R_x, R_z)$	$(xz, yz)$

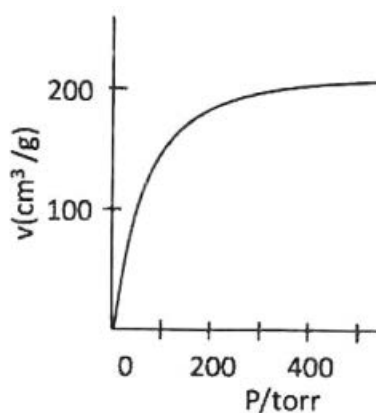


- (a)  $A_2'$ ; neither IR nor Raman active                      (b)  $E'$ ; both IR and Raman active  
 (c)  $A_1'$ ; Raman active    (d)  $A_2''$ ; IR active

Q.113 The first excited state ( $^2P_{1/2}$ ) of fluorine lies at an energy of  $400 \text{ cm}^{-1}$ , above the ground state ( $^2P_{3/2}$ ). The fraction of Fluorine atoms in the first excited state at  $k_B T = 420 \text{ cm}^{-1}$  is close to?

- (a)  $1/1 + e$                       (b)  $1/2 + e$                       (c)  $1/1 + 4e$                       (d)  $1/1 + 2e$

Q.114 The figure below depicts an adsorption isotherm of  $\text{O}_2$  on charcoal at 90 K:



At pressure 25 torr, only 10% of charcoal sites are occupied by  $O_2$ . Therefore, the ratio of adsorption to desorption rate constants (in  $\text{torr}^{-1}$ ) is close to?

- (a) 0.003                      (b) 0.004                      (c) 0.006                      (d) 0.015

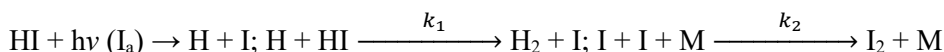
Q.115 Polonium is the only metal known to exist in a simple cubic lattice form. The density of polonium at  $0^\circ\text{C}$  is measured to be  $10.00 \text{ g/cm}^3$ . The atomic radius of polonium would then be (assume the mass of a polonium atom =  $2.7 \times 10^{-22} \text{ g}$ )

- (a) 1.1 Å                      (b) 1.9 Å                      (c) 1.5 Å                      (d) 2.3 Å

Q.116 The specific conductance of a solution is  $0.176 \Omega^{-1}\text{cm}^{-1}$ . If the cell constant is  $0.255 \text{ cm}^{-1}$ , the conductance  $\Omega^{-1}$  of that solution is?

- (a) 1.449                      (b) 0.690                      (c) 0.045                      (d) 0.431

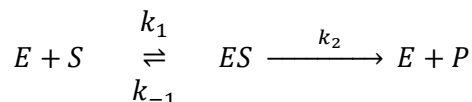
Q.117 Photochemical decomposition of HI takes place with the following mechanism:



Considering hydrogen (H) and iodine (I) atoms as intermediates, the rate of removal of HI is?

- (a)  $I_a/2$                       (b)  $I_a$                       (c)  $2I_a$                       (d)  $I_a^2$

Q.118 In an enzyme-catalysed reaction:





$k_2 = 3.42 \times 10^4 \text{ s}^{-1}$ . If  $[E_0] = 1 \times 10^{-2} \text{ mol dm}^{-3}$ , the magnitude of maximum velocity and tum over number using Michalis-Menten kinetics are?

- (a)  $3.42 \times 10^2 \text{ mol dm}^{-3}\text{s}^{-1}$ ;  $3.42 \times 10^4 \text{ s}^{-1}$       (b)  $3.42 \times 10^6 \text{ mol dm}^{-3}\text{s}^{-1}$ ;  $3.42 \times 10^4 \text{ s}^{-1}$   
(c)  $3.42 \times 10^4 \text{ mol dm}^{-3}\text{s}^{-1}$ ;  $3.42 \times 10^6 \text{ s}^{-1}$       (d)  $3.42 \times 10^4 \text{ mol dm}^{-3}\text{s}^{-1}$ ;  $3.42 \times 10^2 \text{ s}^{-1}$

Q.119 Arrhenius equation for two chemical reactions are:  $k_1 = A_1 e^{-E_1/RT}$ ,  $k_2 = A_2 e^{-E_2/RT}$ . If  $E_1 > E_2$ , then at given temperature T,

- (a)  $k_1/k_2 < A_1/A_2$       (b)  $k_2/k_1 < A_2/A_1$       (c)  $k_1 k_2 > A_1 A_2$       (d)  $k_1 + k_2 > A_1 + A_2$

Q.120 The fugacity of a real gas is less than the pressure (P) of an ideal gas at the same temperature (T) only when ( $T_b$  is the Boyle temperature of the real gas)?

- (a) High P,  $T < T_b$       (b) Low P,  $T < T_b$       (c) High P,  $T > T_b$       (d) Low P,  $T > T_b$



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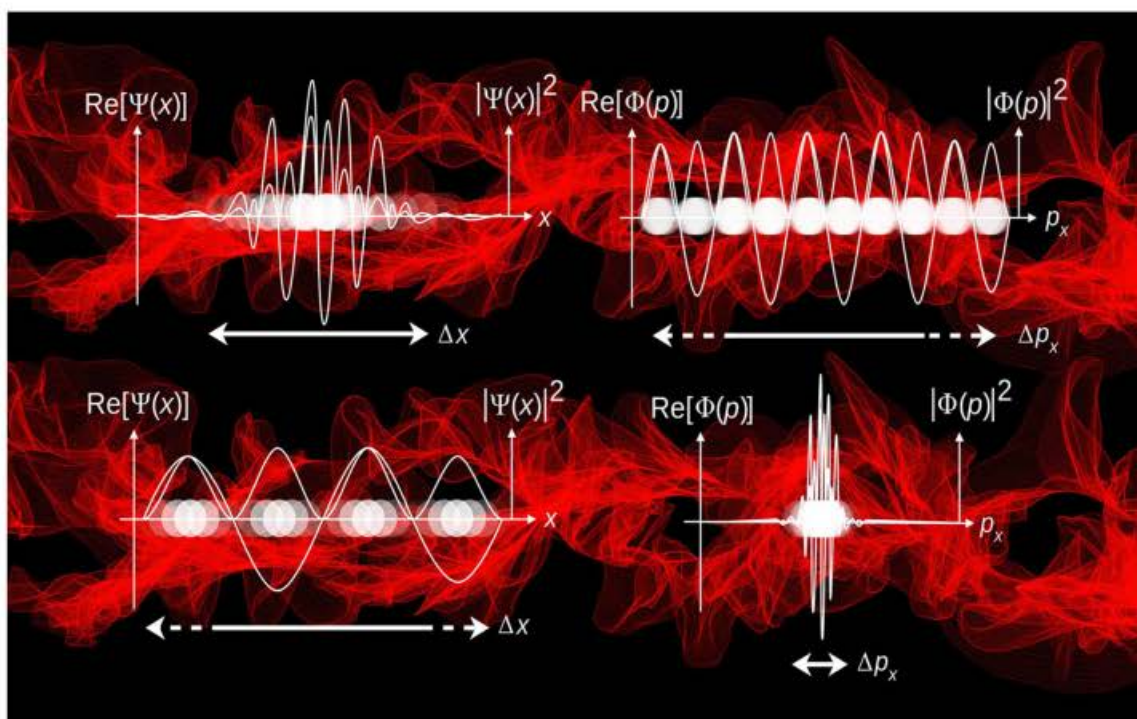
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# Table of Contents

<b>CSIR UGC – NET JRF: Model Test</b> .....	<b>7</b>
<b>Chemical Science</b> .....	<b>7</b>
❖ Question Paper.....	7
❖ Answer Key .....	35
❖ Solution.....	36
<b>CSIR UGC – NET JRF: June 2011</b> .....	<b>42</b>
<b>Chemical Science</b> .....	<b>42</b>
❖ Question Paper.....	42
❖ Answer Key .....	76
❖ Solution.....	77
<b>CSIR UGC – NET JRF: December 2011</b> .....	<b>82</b>
<b>Chemical Science</b> .....	<b>82</b>
❖ Question Paper.....	82
❖ Answer Key .....	116
❖ Solution.....	117
<b>CSIR UGC – NET JRF: June 2012</b> .....	<b>122</b>
<b>Chemical Science</b> .....	<b>122</b>
❖ Question Paper.....	122
❖ Answer Key .....	157
❖ Solution.....	158
<b>CSIR UGC – NET JRF: December 2012</b> .....	<b>163</b>
<b>Chemical Science</b> .....	<b>163</b>
❖ Question Paper.....	163
❖ Answer Key .....	198
❖ Solution.....	199
<b>CSIR UGC – NET JRF: June 2013</b> .....	<b>205</b>
<b>Chemical Science</b> .....	<b>205</b>
❖ Question Paper.....	205

❖ Answer Key .....	237
❖ Solution.....	238
<b>CSIR UGC – NET JRF: December 2013.....</b>	<b>243</b>
<b>Chemical Science .....</b>	<b>243</b>
❖ Question Paper.....	243
❖ Answer Key .....	274
❖ Solution.....	275
<b>CSIR UGC – NET JRF: June 2014.....</b>	<b>280</b>
<b>Chemical Science .....</b>	<b>280</b>
❖ Question Paper.....	280
❖ Answer Key .....	314
❖ Solution.....	315
<b>CSIR UGC – NET JRF: December 2014.....</b>	<b>320</b>
<b>Chemical Science .....</b>	<b>320</b>
❖ Question Paper.....	320
❖ Answer Key .....	357
❖ Solution.....	358
<b>CSIR UGC – NET JRF: June 2015.....</b>	<b>364</b>
<b>Chemical Science .....</b>	<b>364</b>
❖ Question Paper.....	364
❖ Answer Key .....	402
❖ Solution.....	403
<b>CSIR UGC – NET JRF: December 2015.....</b>	<b>409</b>
<b>Chemical Science .....</b>	<b>409</b>
❖ Question Paper.....	409
❖ Answer Key .....	442
❖ Solution.....	443
<b>CSIR UGC – NET JRF: June 2016.....</b>	<b>449</b>
<b>Chemical Science .....</b>	<b>449</b>

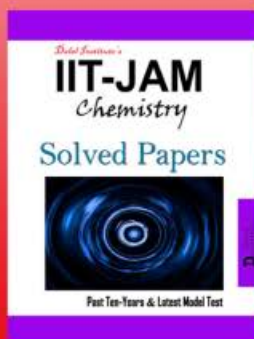
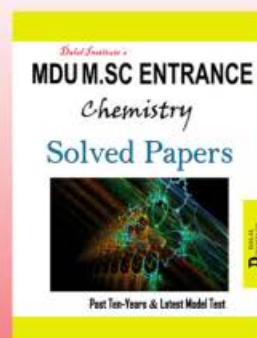
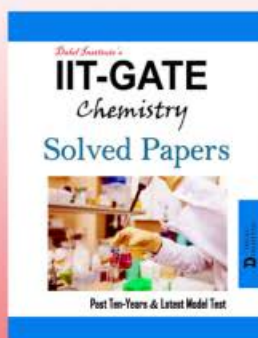
❖ Question Paper.....	449
❖ Answer Key .....	487
❖ Solution.....	488
<b>CSIR UGC – NET JRF: December 2016.....</b>	<b>494</b>
<b>Chemical Science .....</b>	<b>494</b>
❖ Question Paper.....	494
❖ Answer Key .....	531
❖ Solution.....	532
<b>CSIR UGC – NET JRF: June 2017.....</b>	<b>538</b>
<b>Chemical Science .....</b>	<b>538</b>
❖ Question Paper.....	538
❖ Answer Key .....	571
❖ Solution.....	572
<b>CSIR UGC – NET JRF: December 2017.....</b>	<b>577</b>
<b>Chemical Science .....</b>	<b>577</b>
❖ Question Paper.....	577
❖ Answer Key .....	609
❖ Solution.....	610
<b>CSIR UGC – NET JRF: June 2018.....</b>	<b>615</b>
<b>Chemical Science .....</b>	<b>615</b>
❖ Question Paper.....	615
❖ Answer key .....	647
❖ Solution.....	648
<b>CSIR UGC – NET JRF: December 2018.....</b>	<b>654</b>
<b>Chemical Science .....</b>	<b>654</b>
❖ Question Paper.....	654
❖ Answer Key .....	685
❖ Solution.....	686
<b>CSIR UGC – NET JRF: June 2019.....</b>	<b>691</b>

<b>Chemical Science .....</b>	<b>691</b>
❖ Question Paper.....	691
❖ Answer Key .....	724
❖ Solution.....	725
<b>CSIR UGC – NET JRF: December 2019.....</b>	<b>730</b>
<b>Chemical Science .....</b>	<b>730</b>
❖ Question Paper.....	730
❖ Answer Key .....	761
❖ Solution.....	762



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