CSIR UGC – NET JRF: December 2019

Chemical Science

❖ Question Paper

Section-A

Q.1 A, B, C and D are four consecutive points on a circle such that chords AB =BC=CD=10.0 cm and DA = 20.0 cm. The radius of the circle (in cm) is

(a) 10.0 (b) $10\sqrt{2}$ (c) $10\sqrt{3}$ (d) 20.0

Q.2 The length of a rod is measured repeatedly by two persons. Person A reports the length to be 1002 ± 1 cm while person B reports the length to be 1001 ± 2 cm. It is known from a more reliable method that the length is 1000.1 ± 0.5 cm. which one of the following statements is correct?

(a) Measurement made by B are less accurate, but more precise, compared to those by A.

(b) Measurement made by A are less accurate, but more precise, compared to those by B.

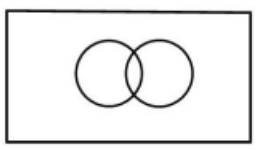
(c) Measurement made by B are more accurate and more precise, compared to those by A.

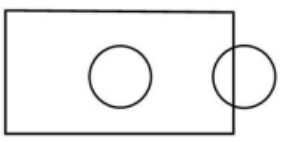
(d) Measurement made by A are more accurate and more precise, compared to those by B.

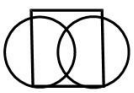
Q.3 The graph below shows the rainfall and temperature at a place over one week. Which day of the week would feel the most humid?

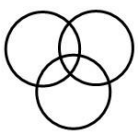
(a) Monday (b) Wednesday (c) Thursday (d) Saturday

Q.4 Which among the following diagrams can represent the relationships between houses, offices and buildings?

(a) 

(b) 

(c) 

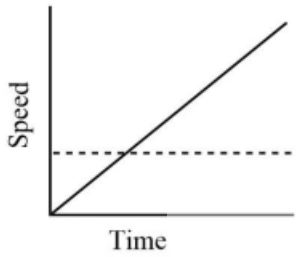
(d) 

Q.5 Consider a location on earth where the sun is overhead at noon. Compared to its shadow at 10.00 AM, the shadow of a tower at 4.00 PM would be

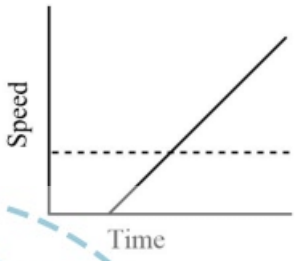
(a) twice longer (b) three times longer (c) four times longer (d) eight times longer

Q.6 A girl is running at constant speed to catch a bus which is stationary. Before she reaches the bus leaves and moves with a constant acceleration. Which one of these graphs describes the situation correctly?

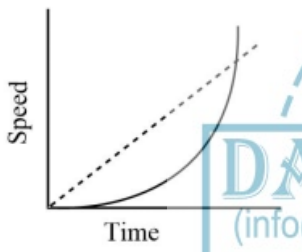
(a)



(b)



(c)



(d)

Q.7 In a population of 900, the number of married couples is as the number of singles. There are 100 twins of which 50 twins are singles. The population has 400 females in all. What is the number of married persons?

(a) 325 (b) 600 (c) 250 (d) 300

Q.8 A tells B, "I could be visiting you on any day in the next two months and you must give me gold coins of as much total weight in grams as the number of days that would elapse form today". If gold coins are available in integer gram weights, what is the least number of coins with which B can meet A's demand on any day?

(a) 31 (b) 7 (c) 6 (d) 13

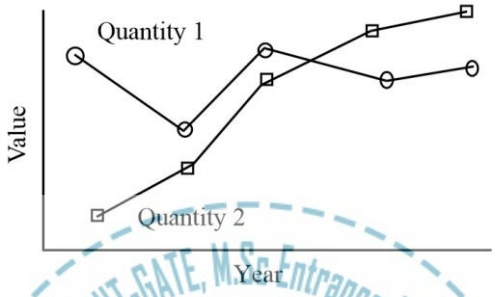
Q.9 There are nine identical balls, one of which is heavier than the other eight. What is the least number of weighings, using a two-pan balance, needed for definitely identify the heavier ball?

(a) One (b) Two (c) Three (d) Four

Q.10 Seven chairs numbered 1 to 7 are placed around table. Starting from chair number 5, a person keeps going around the table anticlockwise. After crossing 41 chairs, the person will reach the chair number

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

Q.11 The trends of two quantities over five years are shown in the graph. Which of the following are valid inferences?



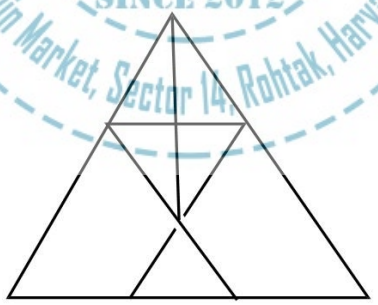
A. The mean value of the quantities are nearly equal

B. The variation of the quantities are nearly equal

C. Quantity 1 varies less over the given period as compared to Quantity 2

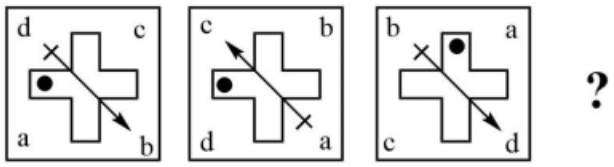
(a) Only A is true (b) Only B is true (c) A and C are true (d) A and B are true

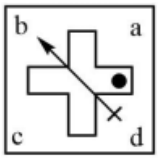
Q.12 The number of triangles in the figure is

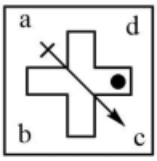


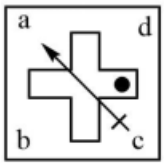
(a) 9 (b) 10 (c) 11 (d) 12

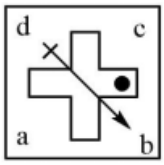
Q.13 Find out the next figure in the following sequence?



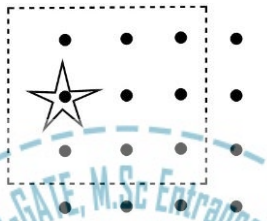
(a) 

(b) 

(c) 

(d) 

Q.14 A move of a coin is defined as crossing any number of points in a straight line on the 4×4 grid (horizontally, vertically or diagonally). What is the least number of moves in which a coin, starting from the indicated position, can cover all nine points within the marked square?



(a) Four (b) Five (c) Six (d) Seven

Q.15 The difference, the sum and the product of two integers are in the proportion 1: 3: 10. The two integers are:

(a) 3, 9 (b) 2, 5 (c) 5, 10 (d) 3, 10

Q.16 A partially filled hour glass has water failing from the upper bowl to the lower bowl. Which of the following statements is correct?

(a) The level of water rises in the lower bowl at the same rate as the fall in the upper bowl

(b) The level of water rises in the lower bowl at the half rate as the fall in the upper bowl

(c) The rate of increase in the volume of water in the lower bowl is the same as the rate of decrease in the upper bowl

(d) The area of top of the water column is the same in both bowls at all times.

Q.17 The difference between the squares of two consecutive integers is 408235. The sum of the numbers is

(a) 16324 (b) 27061 (c) 180325 (d) 408235

Q.18 In a certain cipher language 'BIKE' is coded 'YFHB' and 'CAR' is coded as 'ZXO' than 'SCOOTER' can be coded as

(a) TAPPIYB (b) PYVVAHJ (c) PZLLQBO (d) JZKKMCO

Q.19 Examine the following statements:

(I). Fat cells normally produce hormone A in proportion to the amount of fat. Obese individuals, however, have lower than normal levels of hormone A.

(II) Hormone A reduces food intake

Which among the following is a valid inference based on the above statements?

(a) Impaired production of hormone A cause obesity

(b) Impaired action of hormone A cause obesity

(c) Obesity results into low levels of hormone A

(d) Excess food intake causes depletion of hormone A

Q.20 A dirt is randomly thrown at a circular board on which two concentric rings of radii R and 2R having the same width (width much less than R) are marked. The probability of the dart hitting the smaller ring is

(a) Twice the probability that it hits the larger ring

(b) Half of the probability that it hits the larger ring

(c) Four time the probability that it hits the larger ring

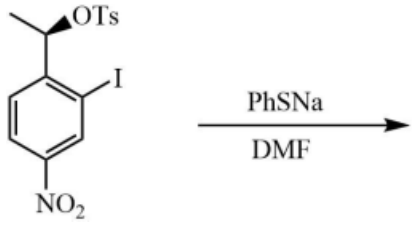
(d) One-fourth the probability that it hits the larger ring

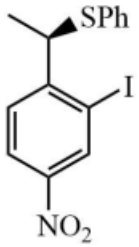
Section-B

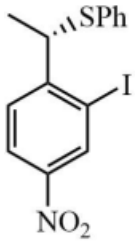
Q.21 Molar composition of a mixture of P and Q at equilibrium is 3:1 (P:Q). A small disturbance in composition results in change of chemical potential of P by 10 J mol^{-1}. The chemical potential of Q will change (in J mol^{-1}) by

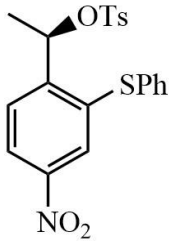
(a) 30 (b) 3.3 (c) –30 (d) –3.3

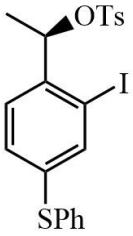
Q.22 The major product formed in the following reaction is



(a) 

(b) 

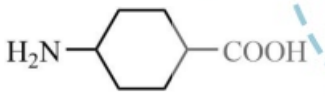
(c) 

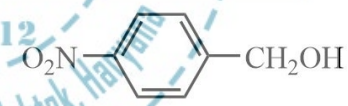
(d) 

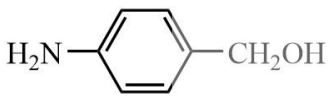
Q.23 In common Glass electrode, alkaline error caused at pH > 10 is least for

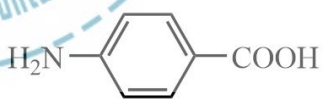
(a) 0.01 M NaCl (b) 1.0 M NaCl (c) 1.0 LiCl (d) 1.0 KCl

Q.24 The major product formed in the following reaction is

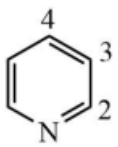
(a) 

(b) 

(c) 

(d) 

Q.25 The correct match of ^{13}C NMR chemical shift values (δ ppm) for pyridine is



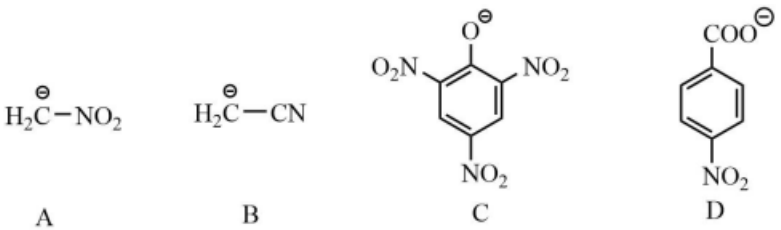
(a) C2: 136; C3: 124; C4: 150 (b) C2: 124; C3: 150; C4: 136

(c) C2: 150; C3: 124; C4: 136 (d) C2: 150; C3: 136; C4: 124

Q.26 A liquid of density 1.1 g cm^{-3} climbs to a height of 5.0 cm when a capillary with internal radius of 0.2 mm is dipped into it. The surface tension (in Nm^{-1}) of the liquid is closed to

(a) 0.05 (b) 0.108 (c) 0.018 (d) 0.005

Q.27 The correct order of basicity of the following anions is



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

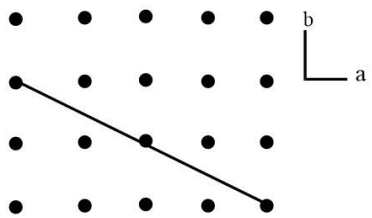
Q.28 Consider a two-level system in which the excited state, separated from the ground state by energy ε, is doubly degenerate. The fraction of the molecules in the excited state, as $T \to \infty$, is

(a) 1/3 (b) 1/2 (c) 2/3 (d) 1

Q.29 The value of a physical variable was found to be 196, 198,194, 199 and 198 in a set of five independent measurements. The average value and the standard deviation would be closest, respectively, to

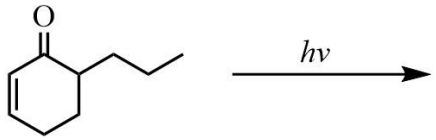
(a) 198 and 2 (b) 197 and 4 (c) 197 and 2 (d) 198 and 4

Q.30 The Miller index for the plane as shown in the figure and parallel to the c-axis, is

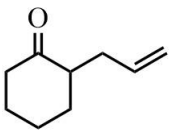


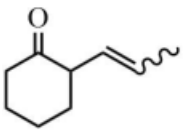
(a) 110 (b) 120 (c) 210 (d) 220

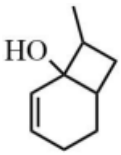
Q. 31 The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

Q.32 If the rate constant for a base catalysed ester hydrolysis reaction is 0.20 L mol^{-1} s^{-1}, half-life (in second) of the ester (Given $[ester]_o = [base]_o = 0.05$ mol L^{-1}) would be closest to

(a) 40 (b) 100 (c) 140 (d) 200

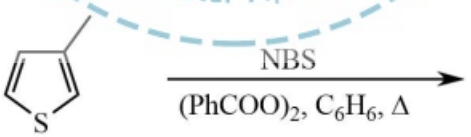
Q.33 Consider four species A, B, C and D.

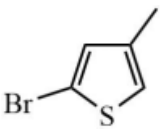
Oxidation of A with C in an acidic medium gives D. A, B, C and D are, respectively,

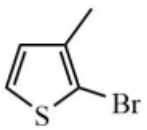
(a) $S_4O_6^{2-}$, I_2, KIO_3 and SO_4^{2-} (b) $S_4O_6^{2-}$, KIO_3, I_2 and SO_4^{2-}

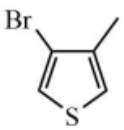
(c) $S_2O_3^{2-}$, KIO_3, I_2 and $S_4O_6^{2-}$ (d) $S_2O_3^{2-}$, KIO_3, I_2, and SO_4^{2-}

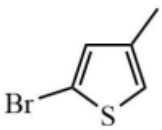
Q. 34 The major product formed in the following reaction is



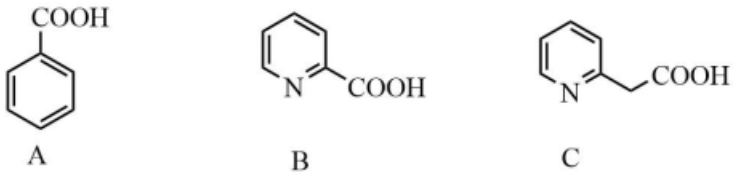
(a) 

(b) 

(c) 

(d) 

Q.35 The correct order for the rate of thermal decarboxylation of the following compound is



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

Q.36 Correct order of molar extinction coefficient values of the visible absorption bands for the following species is

(a) $[Cr(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+} >$ Chlorophyll $> [NiCl_4]^{2-}$

(b) Chlorophyll $> [NiCl_4]^{2-} > [Cr(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+}$

(c) $[NiCl_4]^{2-} >$ Chlorophyll $> [Cr(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+}$

(d) Chlorophyll $> [Cr(H_2O)_6]^{2+} > [NiCl_4]^{2-} > [Mn(H_2O)_6]^{2+}$

Q.37 The common hapticity observed for coordination of C_{60} to a metal center is

(a) 2 (b) 4 (c) 5 (d) 6

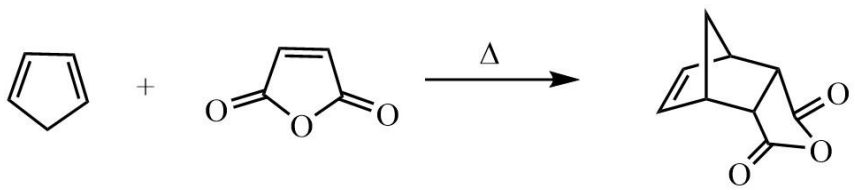
Q.38 The cell potential (in V) of a Ag/AgCl/KCl electrode connected to the standard hydrogen electrode at 298 K is closed to (Given $E^0_{(AgCl/AgCl^-)} = 0.222$ V and assume that the activity of KCl is 0.01)

(a) 0.197 (b) 0.297 (c) 0.340 (d) 0.440

Q.39 The titration of 4.4 g of a polymer having carboxylic acid end group requires 11 mL of 0.02M NaOH. The average molar mass (in kg mol^{-1}) of the polymer is

(a) 40 (b) 20 (c) 15 (d) 10

Q.40 True statement for the following transformation is



(a) ΔH^0 and ΔS^0 are positive

(b) ΔH^0 and ΔS^0 are negative

(c) ΔH^0 is positive and ΔS^0 is negative

(d) ΔH^0 is negative and ΔS^0 is positive

Q.41 Choose the correct statements for oxyhaemoglobin and cytochrome P_{450}(resting state) from the following:

A. Both contain dianion of protoporphyrin-IX

B. They have same fifth-ligand to metal centre from the protein backbone

C. They contain single active site

D. They contain metal ion in +3 oxidation state

Answer is

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

Q.42 The magnitude of bond angle in gaseous NF_3, SbF_3 and $SbCl_3$ follow the order

(a) $NF_3 > SbF_3 > SbCl_3$

(b) $SbCl_3 > SbF_3 > NF_3$

(c) $SbF_3 > SbCl_3 > NF_3$

(d) $NF_3 > SbCl_3 > SbF_3$

Q.43 Identify from following, the products of K-electron capture by the nucleus:

A. neutron B. neutrino C. positron

Answer is:

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

Q.44 Pair of lanthanide ions which show significant deviation between the experimental and calculated magnetic moments, considering contribution from the ground state only (given $\mu_{eff} = g[J(J+1)]^{1/2}$, is

(a) $Gd^{3+}$and Lu^{3+} (b) $Sm^{3+}$and Tb^{3+} (c) $Eu^{3+}$and Tb^{3+} (d) $Sm^{3+}$and Eu^{3+}

Q.45 The frequency of O–H stretch occurs at ~3600 cm^{-1}. The O–D stretch frequency (in cm^{-1}) would be close to

(a) 3000 (b) 2600 (c) 1800 (d) 900

Q.46 In IR spectrum, recorded neat, a compound shows a strong and broad band at 3300 cm^{-1}. The band has become sharp and shifts to 3600 cm^{-1} when the spectrum is recorded in CCl_4 at high dilution. This proves that the compound has

(a) OH group, which is involved in intramolecular H-bonding

(b) OH group, which is involved in intermolecular H-bonding

(c) a terminal alkyne group

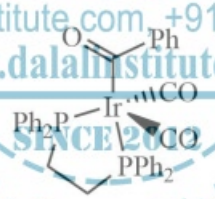
(d) OH group, present in severely sterically hindered environment

Q.47 The pair of light source and atomizer resulting highest sensitivity to atomic absorption spectrometric measurement is:

(a) Hg lamp; nitric oxide flame (b) Hg lamp; graphite furnace

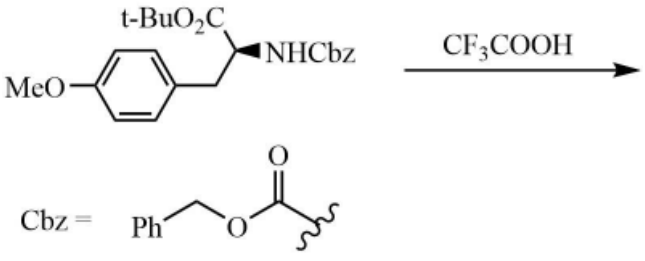
(c) Hollow cathode lamp; graphite furnace (d) Hollow cathode lamp; acetylene-nitric oxide flame

Q.48 For the complex shown below in non-fluxional state, the expected $^{31}P\{H\}$ NMR resonances is/are[^{31}P, $I = ½$]

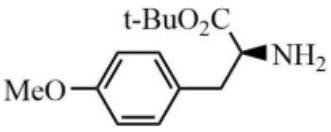


(a) one singlet (b) one doublet (c) two singlets (d) two doublets

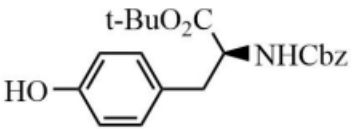
Q.49 The major product formed in the following reaction is

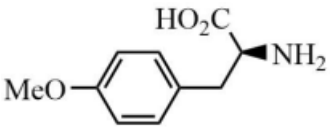


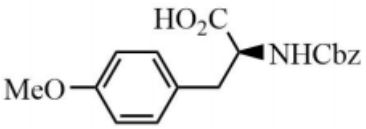
(a)



(b)



(c) 

(d) 

Q.50 A cube does not have the symmetry element

(a) C_2 (b) C_3 (c) C_4 (d) C_6

Q.51 Consider the entropy changes in a system undergoing transformation, as depicted in the diagram, below

The correct statement among the following is

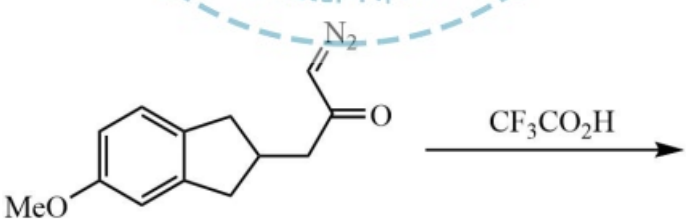
(a) $\Delta S_1 = \Delta S_2$ and $\Delta S \neq \Delta S_1 + \Delta S_2$ (b) $\Delta S_1 > \Delta S_2$ and $\Delta S \neq \Delta S_1 + \Delta S_2$

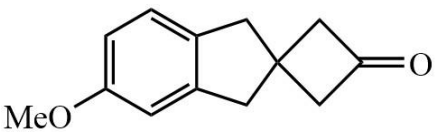
(c) $\Delta S_1 = \Delta S_2$ and $\Delta S = \Delta S_1 + \Delta S_2$ (d) $\Delta S_1 > \Delta S_2$ and $\Delta S = \Delta S_1 + \Delta S_2$

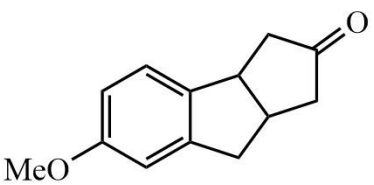
Q.52 The most stable vanadium species in aqueous medium is

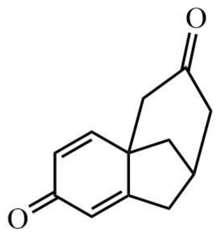
(a) $[V(H_2O)_5(OH)]^{2+}$ (b) $[VO(H_2O)_5]^{2+}$ (c) $[VO(H_2O)_5]^{+}$ (d) $[V(H_2O)_4(OH)_2]^{2+}$

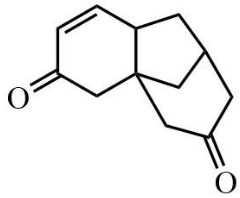
Q.53 The major product formed in the following reaction is



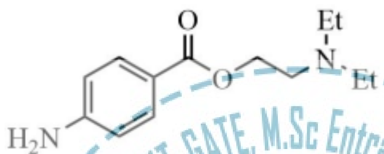
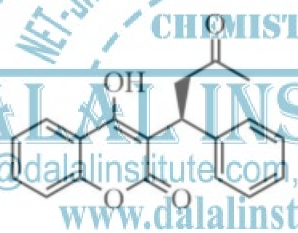
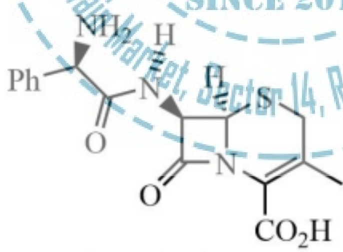
(a) 

(b) 

(c) 

(d) 

Q.54 The correct match for the drug molecules in the column A with their medical use in column B is

	Column A		Column B
P	 Procaine	I	Anaesthetic
Q	 Warfarin	II	Anticoagulant
R	 Cephalexin	III	Antibiotic

(a) P-I; Q-II; R-III (b) P-II; Q-I; R-III (c) P-III; Q-I; R-II (d) P-I; Q-III; R-II

Q.55 The hydrogen atomic orbital given by $Nr^2e^{-r/3a_0}(3cos^2\theta - 1)$ represents

(a) 2p orbital (b) 3p orbital (c) 3d orbital (d) 4d orbital

Q.56 The ion having the highest bond order is

(a) NO^+ (b) O_2^+ (c) N_2^+ (d) C_2^+

Q.57 For an octahedral Cu^{2+} complex depicting axial EPR spectrum ($g_{\parallel} > g_{\perp}$), the geometry of Cu^{2+} and the orbital containing the unpaired electron are, respectively

(a) Tetragonally elongated, $d_{x^2-y^2}$ (b) Tetragonally compressed, d_{z^2}

(c) Tetragonally elongated, d_{z^2} (d) Tetragonally compressed, $d_{x^2-y^2}$

Q.58 E_{1cb} mechanism is follow in the reaction of

(a) 2-bromopentane with t-BuOK to give pent-2-ene

(b) nitromethane with benzaldehyde in the presence of KOH to give β-nitrostyrene

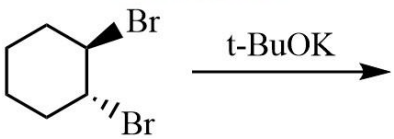
(c) Bromobenzene with $NaNH_2$ to give aniline

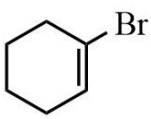
(d) *p*-chloronitrobenzene with NaOMe to give *p*-nitroanisole

Q.59 The expected number of V_{CO} bands in the IR spectra of *fac*-$[Mo(PPh_3)_3(CO)_3]$ and *trans*-$[Mo(PPh_3)_2(CO)_4]$ are, respectively

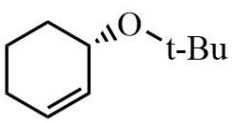
(a) one and one (b) two and two (c) two and one (d) three and one

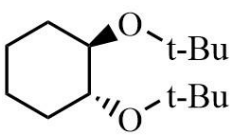
Q.60 The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

Section-C

Q.61 $FeCr_2O_4$ and $NiGa_2O_4$ have normal and inverse spinel structures, respectively. The correct statement is

(a) Fe(II) and Ni(II) occupy octahedral sites

(b) Fe(II) and Ni(II) occupy tetrahedral and octahedral sites, respectively

(c) Cr(III) and Ga(III) occupy octahedral sites

(d) Cr(III) and Ga(III) occupy tetrahedral and octahedral sites, respectively

Q.62 Match the items in Column X with those of Column Y.

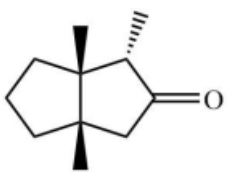
	Column X (species)		Column Y (structure/properties)
A	NaH	I	Polymeric chain
B	BeH_2	II	interstitial hydride
C	$HfH_{2.10}$	III	tricapped trigonal prismatic
D	$[TcH_9]^{2-}$	IV	Saline hydride

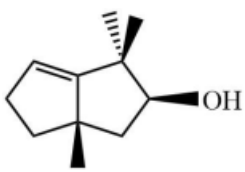
The correct match is

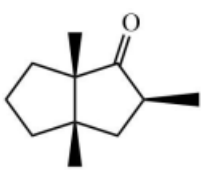
(a) A-IV; B-II; C-III; D-I (b) A-I; B-IV; C-II; D-III

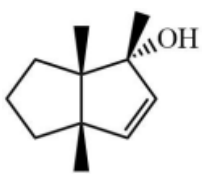
(c) A-IV; B-I; C-II; D-III (d) A-IV; B-I; C-III; D-II

Q.63 The major product formed in the following reaction is

(a) 

(b) 

(c) 

(d) 

Q.64 Match the items in column I with those of column II

	Column X		Column Y
A	Conductometric titration	I	Voltage

B	Amperometric titration	II	Resistance
C	pH metric titration	III	ΔI
D	Differential pulse polarography	IV	I_d

Correct match is

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

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

Q.65 Consider the following statements:

(A) The highest oxidation state of Group 8 elements is more readily shown in their oxides than in fluorides.

(B) Fe can exist in –2 formal oxidation state also.

(C) Mn, Tc and Re easily form M(II) compounds.

The correct statements is/are

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

Q.66 In the electronic spectrum of $[IrBr_6]^{2-}$, the number of charge transfer bands and their origin are, respectively

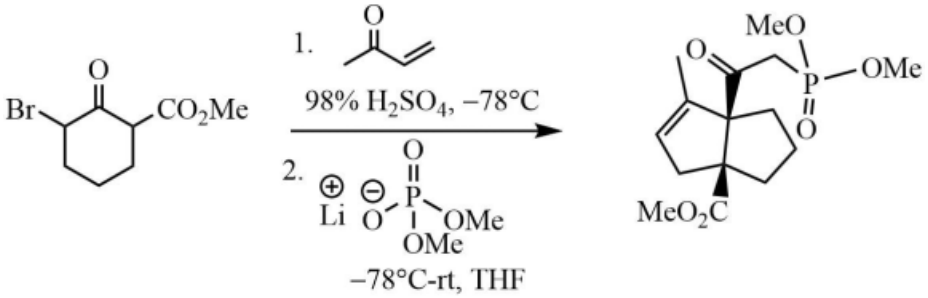
(a) Two, ligand → metal ($\sigma \rightarrow t_{2g}$ and $\sigma \rightarrow a_{1g}^{*}$) (b) one, ligand → metal ($\sigma \rightarrow e_g$)

(c) Two, ligand → metal ($\sigma \rightarrow t_{2g}$ and $\sigma \rightarrow e_g$) (d) one, ligand → metal ($\sigma \rightarrow t_{2g}$)

Q.67 The degeneracy of the state having energy $\frac{27h^2}{8ml^2}$ for a particle in a 3-D cubic box of length L is

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

Q.68 The correct order of the reactions involved in the following transformation is



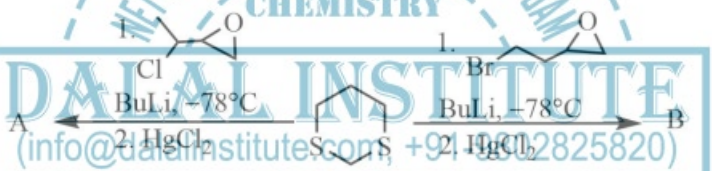
(a) Michael addition, Quasi-Favorskii rearrangement, Aldol condensation

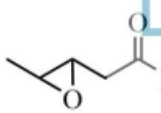
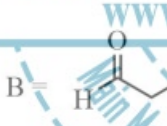
(b) Quasi-Favorskii rearrangement, Michael addition, Aldol condensation

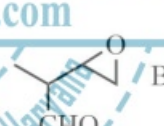
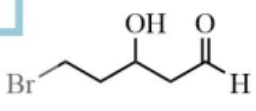
(c) Michael addition, Aldol condensation, Quasi-Favorskii rearrangement

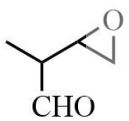
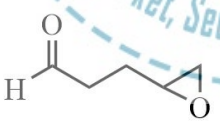
(d) Aldol condensation, Quasi-Favorskii rearrangement, Michael addition

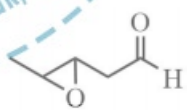
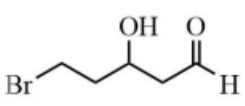
Q.69 The Major products A and B formed in the following reactions are



(a) A =  B = 

(b) A =  B = 

(c) A =  B = 

(d) A =  B = 

Q.70 Among $SO_2(OH)F$, CH_3COOH, LiF and H_2O, the compounds which behaves as a base in

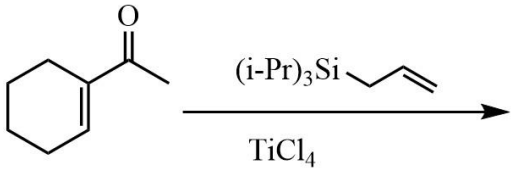
(a) CH_3COOH and LiF

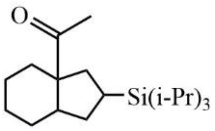
(b) LiF only

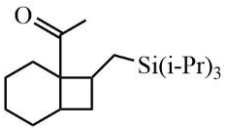
(c) $SO_2(OH)F$, LiF and H_2O

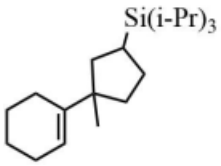
(d) CH_3COOH, LiF and H_2O

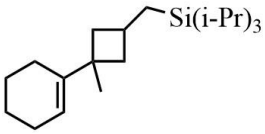
Q.71 The major product formed in the following reaction



(a) 

(b) 

(c) 

(d) 

Q.72 X-rays of 173 pm wavelength are reflected by the (111) plane of a cubic primitive crystal at $\theta = 30°$. The unit cell length (in pm) is closest to

(a) 173 (b) 300 (c) 346 (d) 600

Q.73 The reducible representation, Γ, in the table is equal to the following superposition of the irreducible representations of C_{2v} point group.

C_{2v}	E	C_2	σ_v	σ'_v
A_1	1	1	1	1
A_2	1	1	–1	–1
B_1	1	–1	1	–1
B_2	1	–1	–1	1

Γ	8	–2	–6	4

(a) $A_1+2A_2+5B_1$ (b) $A_1+2A_2+5B_2$ (c) $5A_1+A_2+2B_1$ (d) $A_1+5A_2+2B_2$

Q.74 In Mossbauer spectrum of a sample containing iron recorded in the presence of a static magnetic field, the number of possible allowed transition(s) is

(a) 2 (b) 4 (c) 6 (d) 8

Q.75 The correct order of metal-carbon distance is

(a) $Fe(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2 > Ni(\eta^5\text{-}Cp)_2$

(b) $Fe(\eta^5\text{-}Cp)_2 > Ni(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2$

(c) $Ni(\eta^5\text{-}Cp)_2 > Fe(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2$

(d) $Ni(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2 > Fe(\eta^5\text{-}Cp)_2$

Q.76 ($C_P - C_v$) for a non-ideal gas differs from ($C_P - C_v$) for a perfect gas by the expression

(a) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial U}{\partial T}\right)_S$ (b) $\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial U}{\partial V}\right)_T$ (c) $-\frac{1}{T}\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial U}{\partial V}\right)_T$ (d) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial U}{\partial T}\right)_P$

Q.77 The spatial part of the dominant resonance structure of the LiH molecule is (only valance part of the wave function is shown).

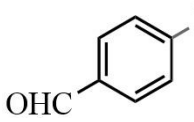
(a) $2s_{Li}(r_1)\, 2s_{Li}(r_2)$

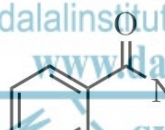
(b) $2s_{Li}(r_1)\, 1s_H(r_2) + 2s_{Li}(r_2)\, 1s_H(r_1)$

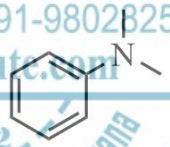
(c) $2s_{Li}(r_1)\, 1s_H(r_2) - 2s_{Li}(r_2)\, 1s_H(r_1)$

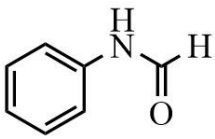
(d) $1s_H(r_1)\, 1s_H(r_2)$

Q.78 The compound that shows peaks in the EI mass spectrum at m/z 121, 105, 77, 44 is

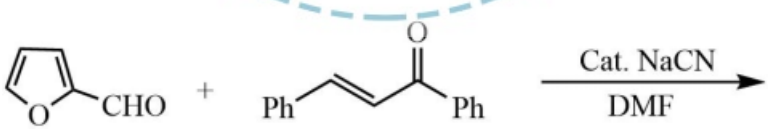
(a) 

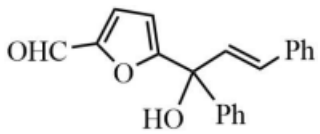
(b) 

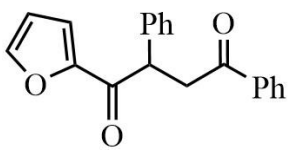
(c) 

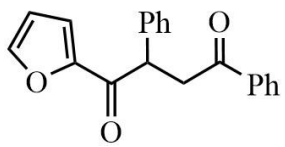
(d) 

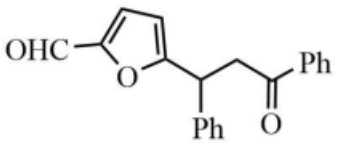
Q.79 The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

Q.80 Consider the gas phase reaction $2A(g) + 3B(g) \rightleftharpoons 2C(g)$ at a given temperature. When 2.0 moles of A(g) are reacted with 2.0 moles of B(g), 0.8 moles of C(g) are formed at equilibrium at a total pressure of 2.0 bar. The value of the equilibrium constant, K_P of this reaction at given temperature is closed to

(a) 0.3 (b) 0.9 (c) 2.4 (d) 19.1

Q.81 The oxidation of NO to NO_2 occurs *via* the mechanism given below.

$$2NO \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} N_2O_2$$

$$N_2O_2 + O_2 \xrightarrow{k_2} 2NO_2$$

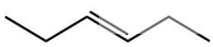
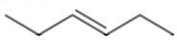
$\frac{d[NO_2]}{dt}$ in the presence of large excess of O_2 can be written as

(a) $2k_1(NO)^2$ (b) $2k_1k_2(NO)^2(O_2)$ (c) $k_1/k_2(NO)^2$ (d) $2k_2(NO)^2$

Q.82 The electrolyte solution that has the smallest Debye-length at 298 K is

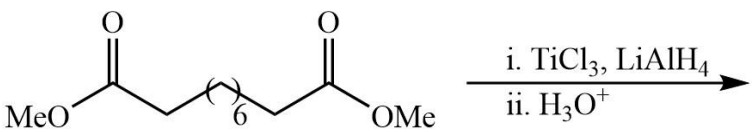
(a) 0.01 M NaCl (b) 0.01 M Na_2SO_4 (c) 0.01 $CuCl_2$ (d) 0.01 M $LaCl_3$

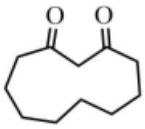
Q.83 The major product A and the by product B formed in the following reaction are

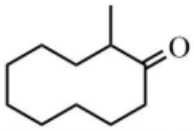
(a) A =  B = CO_2,S=P(OMe)$_3$ (b) A =  B = S=C=O,S=P(OMe)$_3$

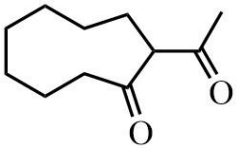
(c) A =  B = CO_2,S=P(OMe)$_3$ (d) A =  B = S=C=O,S=P(OMe)$_3$

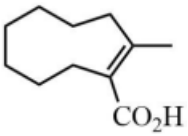
Q.84 The major product formed in the following reaction



(a) 

(b) 

(c) 

(d) 

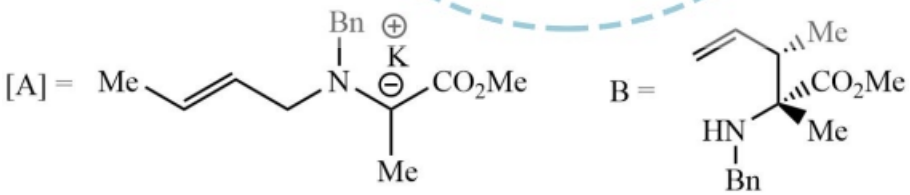
Q.85 In the pure rotational microwave spectrum of a XY molecule, the adjacent lines are separated by 4 cm^{-1}. If the molecules irradiated by a radiation of 30,000 cm^{-1}, the first Stokes line (in cm^{-1}) appears at

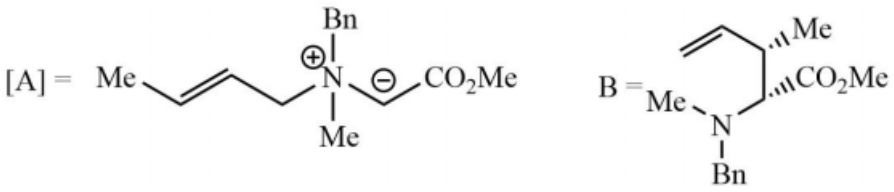
(a) 29988 (b) 30012 (c) 30004 (d) 29996

Q.86 The intermediate A and the major product B formed in the following reaction are

(a) 

(b) 

(c) 

(d) 

Q.87 In linear variation method using two orthogonal basis functions, the two roots obtained are ϵ_0 and ϵ_1 ($\epsilon_0 < \epsilon_1$). The correct relation of those with exact ground and first excited state energies, E_0 and E_1, respectively, is

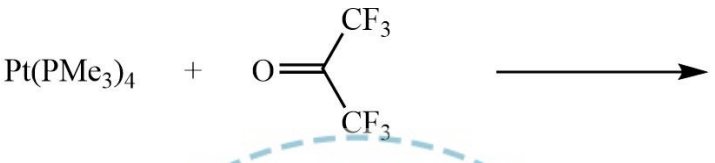
(a) $\epsilon_0 \geq E_0$ and $\epsilon_1 < E_1$

(b) $\epsilon_0 < E_1$ and $\epsilon_1 \geq E_0$

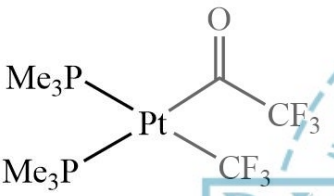
(c) $\epsilon_0 < E_0$ and $\epsilon_1 < E_1$

(d) $\epsilon_0 \geq E_0$ and $\epsilon_1 \geq E_1$

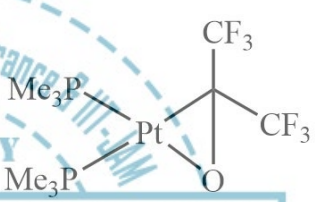
Q.88 The major product formed in the following reaction



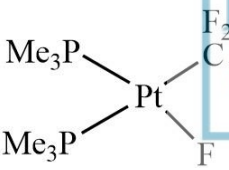
(a)



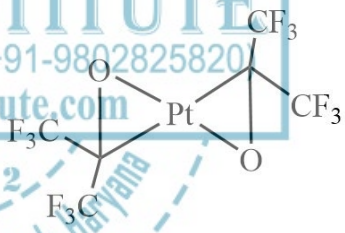
(b)



(c)



(d)



Q.89 Choose the equilibrium from the following that are not favoured to go to right:

(A) $As_2S_5 + 5HgO \rightleftharpoons As_2O_5 + 5HgS$

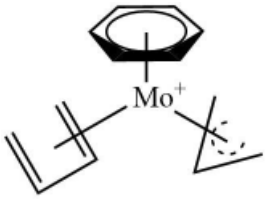
(B) $La_2(CO_3)_3 + Bi_2S_3 \rightleftharpoons Bi_2(CO_3)_3 + La_2S_3$

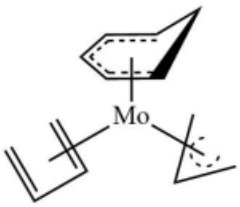
(C) $CdSO_4 + CaS \rightleftharpoons CdS + CaSO_4$

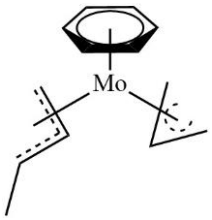
(D) $BeF_2 + HgI_2 \rightleftharpoons BeI_2 + HgF_2$

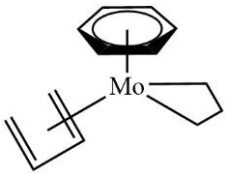
(a) A and B (b) A and C (c) B and C (d) B and D

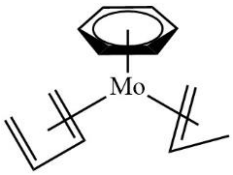
Q.90 The main product of nucleophillic attack of H^- on the complex ion given below is



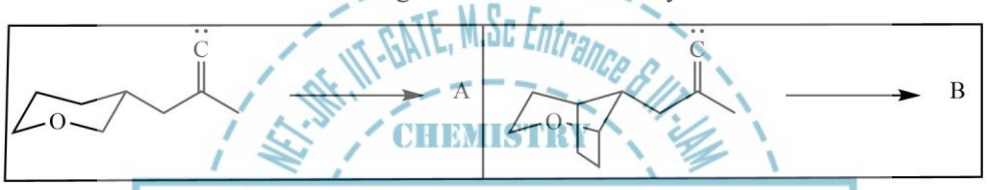
(a) 

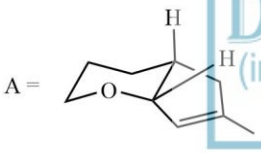
(b) 

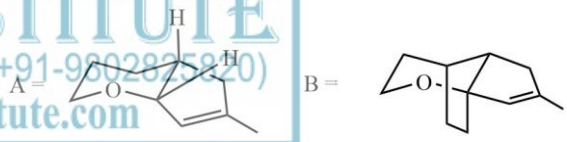
(c) 

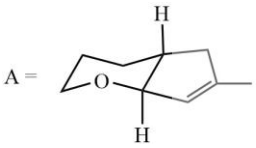
(d) 

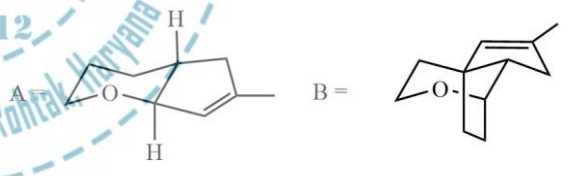
Q.91 Products A and B formed in the following transformation of alkylidene carbenes are



(a) 

(b) 

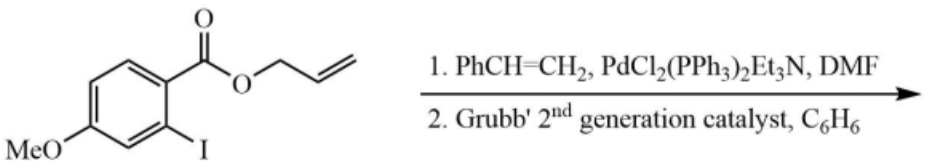
(c) 

(d) 

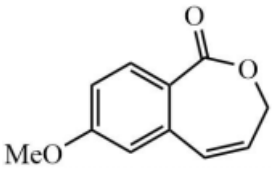
Q.92 The molar residual entropy (in J K^{-1}) of solid OCS would be closest to

(a) 0 (b) 2.9 (c) 5.8 (d) 8.7

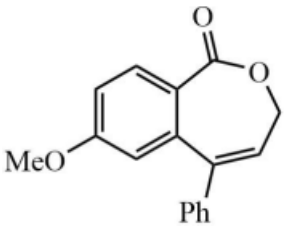
Q.93 The major product formed in the following reaction



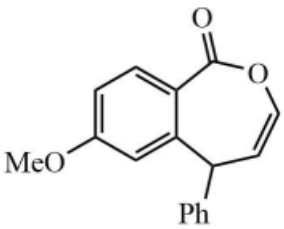
(a)



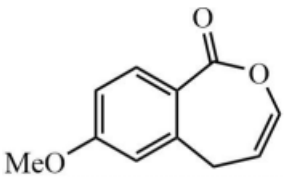
(b)



(c)



(d)

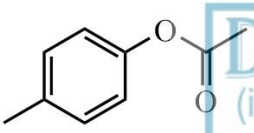


Q.94 The structure of the compound, which displays the following spectral data is IR = 1690, 1100 cm^{-1}

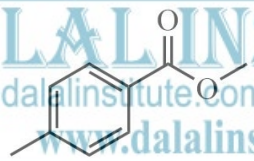
^{1}H NMR: δ 2.8 (s, 3H), 3.8 (s, 3H), 6.9 (d, J = 8Hz, 2H), 7.8 (d, J = 8Hz, 2H)

^{13}C NMR: δ 197, 165, 130, 129, 114, 56, 26

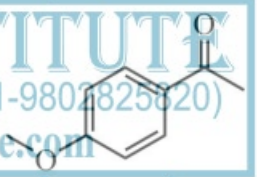
(a)



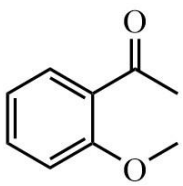
(b)



(c)



(d)



Q.95 The function, which is not an eigenfunction of the indicated operator, is

	Operator	Function
(a)	$\frac{d^2}{dx^2} - x^2$	$e^{-x^2/2}$
(b)	$\frac{d^2}{dx^2} + x^2$	$e^{-x^2/2}$
(c)	$\frac{d^2}{dx^2}$	$cos\frac{\pi x}{4}$
(d)	$\frac{d^2}{dx^2}$	e^{4ix}

Q.96 The order of a surface catalysed unimolecular reaction, at very low and very high pressures of the reactant, would be, respectively

(a) 0, 0 (b) 1, 0 (c) 0, 1 (d) 1, 1

Q.97 In spectrofluorimetric determination in solution

A. absorbance of analyte solution is kept near to 0.05

B. oxygen is eradicated from solution

C. pH of solution is controlled

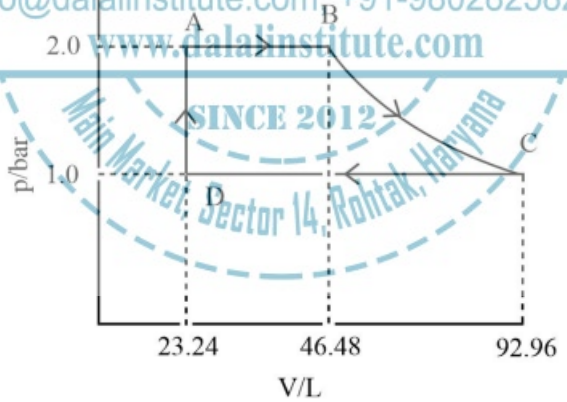
D. wavelength of incident light is always above 400 nm

Correct from the above is

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

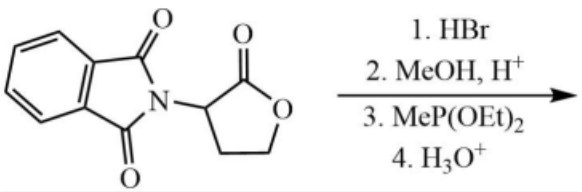
Q.98 1.0 mol of a perfect monoatomic gas is put through the cycle shown in the figure. The total work (in J) sone during the cycle is

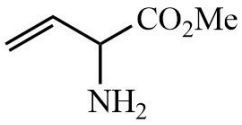
(use 1L-bar = 100 J, R = 8.314 J K^{-1} mol^{-1} = 0.083 L-bar K^{-1} mol^{-1}, ln 2 = 0.7)

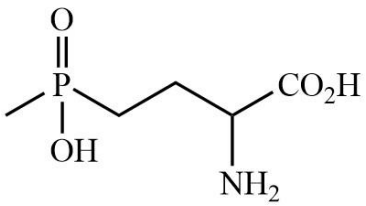


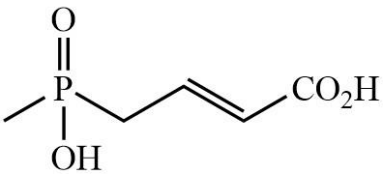
(a) 930 (b) – 4183 (c) 8831 (d) –5113

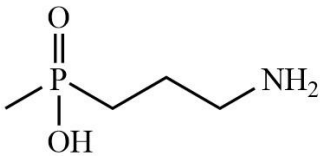
Q.99 The major product formed in the following reaction



(a) 

(b) 

(c) 

(d) 

Q.100 The Huckel molecular orbital of benzene that is degenerate with the molecular orbital $\frac{1}{2}(\chi_2 + \chi_3 - \chi_5 - \chi_6)$, is

(a) $\frac{1}{\sqrt{12}}(2\chi_1 + \chi_2 - \chi_3 - 2\chi_4 - \chi_5 + \chi_6)$ (b) $\frac{1}{2}(\chi_2 - \chi_3 + \chi_5 - \chi_6)$

(c) $\frac{1}{\sqrt{12}}(2\chi_1 - \chi_2 - \chi_3 + 2\chi_4 - \chi_5 - \chi_6)$ (d) $\frac{1}{\sqrt{6}}(\chi_1 - \chi_2 + \chi_3 - \chi_4 + \chi_5 - \chi_6)$

Q.101 The rate-determining step in the catalytic synthesis of acetic acid by Monsanto process is

(a) oxidative addition of CH_3I to $[RhI_2(CO)_2]^-$ (b) migration of CH_3 group to CO of $[RhI_3(CO)_2(CH_3)]^-$

(c) loss of CH_3COI from $[RhI_3(CO)_2(COCH_3)]^-$ (d) coordination of CO to $[RhI_3CO(COCH_3)]^-$

Q.102 The species for which the shapes (geometry) can be predicted by VSEPR theory is/are

(A) $[PtCl_4]^{2-}$ (B) $[TeCl_6]^{2-}$ (C) PF_3 and SF_6

Answer is

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

Q.103 In trans 1,2-dichloroethylene, the IR inactive mode is

(a) C – Cl symmetric stretch (b) C – Cl asymmetric stretch

(c) C – H asymmetric stretch (d) In phase out of plane C – Cl bend

Q.104 The correct statement about base hydrolysis of $[Co(py)_4(Cl)_2]^+$ (py = pyridine) is

(a) Rate expression is, Rate = $k[Co(py)_4Cl_2]^+[OH^-]$

(b) Reaction does not depend on hydroxide ion concentration

(c) Reaction proceeds through $S_{N1}CB$ mechanism

(d) Intermediate involves in this reaction is $[Co(py)_4Cl_2(OH)]$

Q.105 Match Column I, II and III

Column I(metal)		Column II(enzyme)		Column III (end product)	
A	Ni	I	carbonic anhydrase	X	uric acid
B	Zn	II	Xanthine oxidase	Y	methane
C	Mo	III	Coenzyme F_{430}	Z	Carbonic acid

The correct match is

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

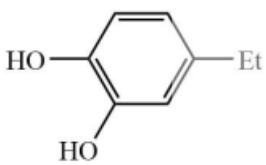
(b) A-III-Y; B-II-X; C-I-Z

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

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

Q.106 The major product formed in the following reaction

(a)



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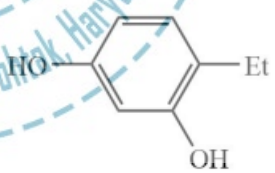

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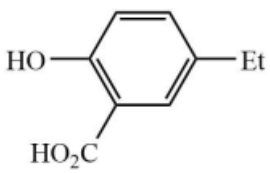

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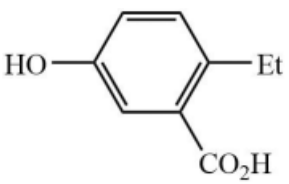
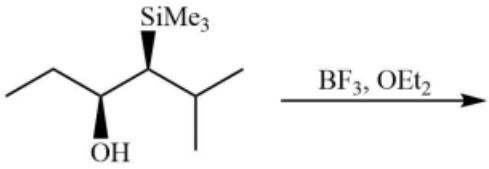


Q.107 The reaction that gives (E)-2-methylhex-3-ene as the major product is

(a)



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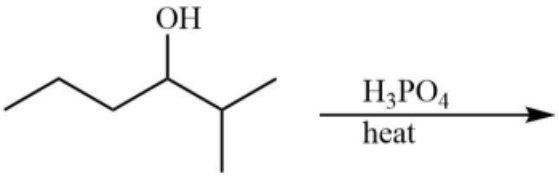

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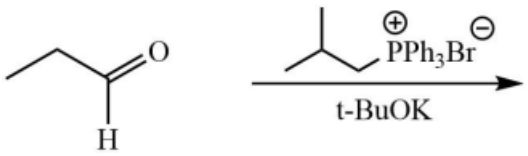
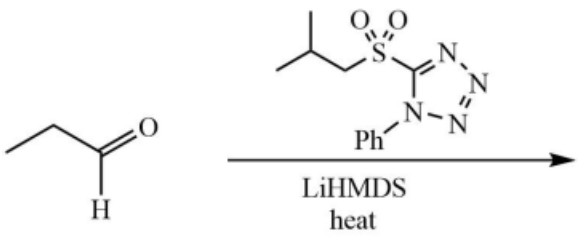
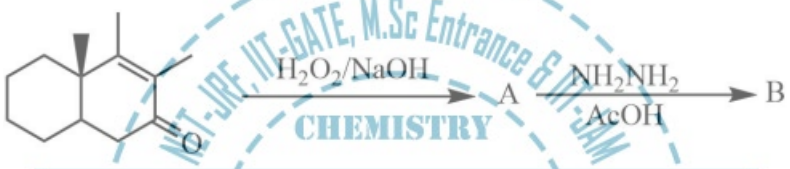


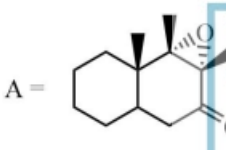
(d)



Q.108 The major products A and B formed in the following reaction sequence are



(a)



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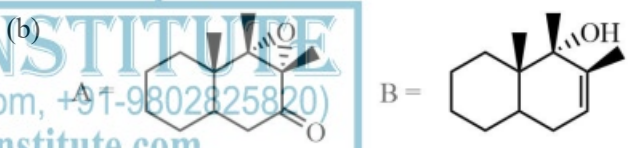

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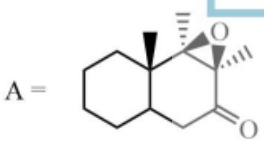

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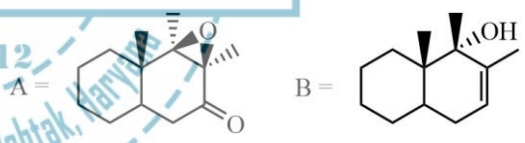


Q.109 The rate constant of a second order reaction 2A → Z is k_2. If the initial concentration of the reactant is a_0 and the concentration of the product at time t is x, then a linear function of t with the slope k_2a_0 is

(a) $\ln\left(\frac{x}{a_0-x}\right)$ (b) $\frac{x}{a_0(a_0-x)}$ (c) $\frac{x}{a_0-x}$ (d) $\ln\left(\frac{x}{a_0(a_0-x)}\right)$

Q.110 The correct match of spin-only magnetic moment for the complexes *cis*-$[Fe(phen)_2(NCS\text{-}N)_2]$ (A) and $[Fe(phen)_3Cl_2]$ (B) at 300 K is (phen = 1,10-phenanthroline)

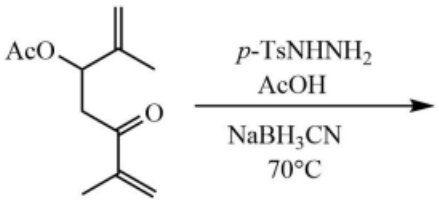
(a) 4.89 BM for both A and B

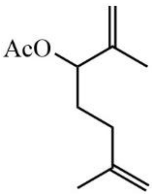
(b) 0 BM for both A and B

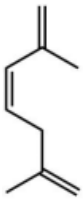
(c) 4.89 BM for A and 0 BM for B

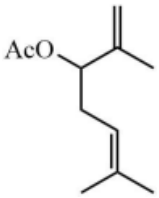
(d) 0BM for A and 4.89 BM for B

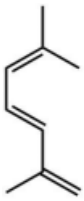
Q.111 The major product formed in the following reaction is



(a) 

(b) 

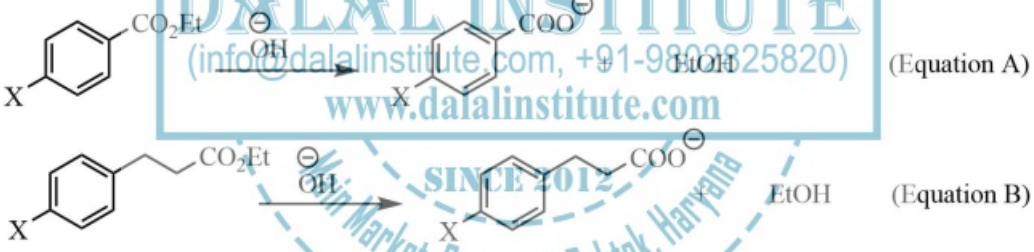
(c) 

(d) 

Q.112 In a polymer of N monomer units, the root mean square separation between the two ends is proportional to

(a) $N^{1/2}$ (b) N (c) $N^{3/2}$ (d) N^2

Q.113 Ture statement regarding Hammett reaction constant (ρ) for the following transformations given in equations A and B is



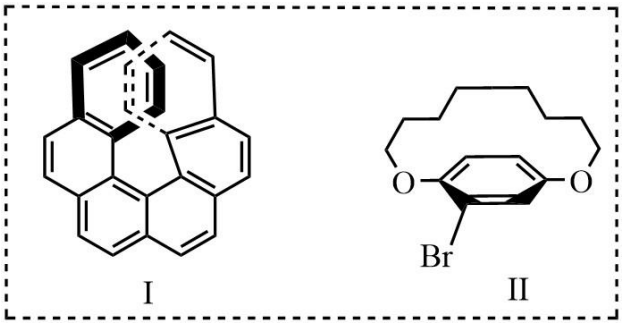
(a) ρ for A and B is same and positive (b) ρ for A and B is same and negative

(c) ρ for A is larger value than for B (d) ρ for A is negative and for B is positive

Q.114 The cluster types of $[Fe_5(CO)_{14}N]^-$ and $[Co_6(CO)_{13}N]^-$ are, respectively,

(a) *nido-*, *nido-* (b) *nido-*, *closo-* (c) *closo-*, *nido-* (d) *closo-*, *closo-*

Q.115 The correct absolute configuration of the following compounds is

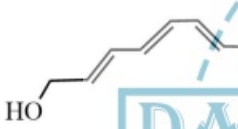


(a) I: M; II: R (b) I: M; II: S (c) I: P; II: R (d) I: P; II: S

Q.116 The intermediate A and the major product B formed in the following reaction are

(a)

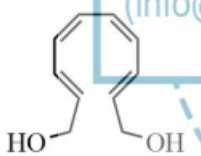
[A] =



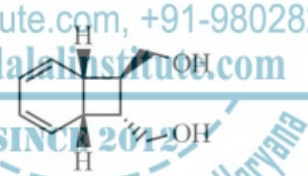
B =

(b)

[A] =

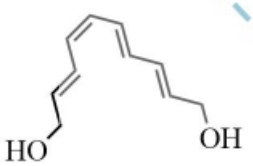


B =

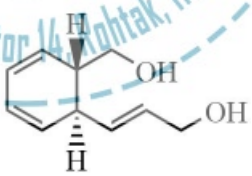


(c)

[A] =



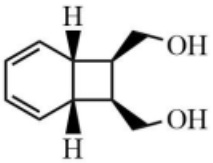
B =



(d)

[A] =

B =



Q.117 The correct statements for dithionite and dithionate anions from the following are

(A) both have S–S bond

(B) both are dianionic

(C) oxidation state of sulphur is +3 and +5, respectively

(D) sulphur in dithionate has lone pair of electrons

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

Q.118 Complexes which has/have unpaired electron(s) that is equal to that of iron center in oxymyglobin is/are

A. $[Fe(ox)_3]^{3-}$ B. $[Fe(CN)_6]^{3-}$ C. $[NiCl_4]^{2-}$ D. $[Cu(NH_3)_4]^{2+}$

(Given: ox = oxalate)

Correct answer is

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

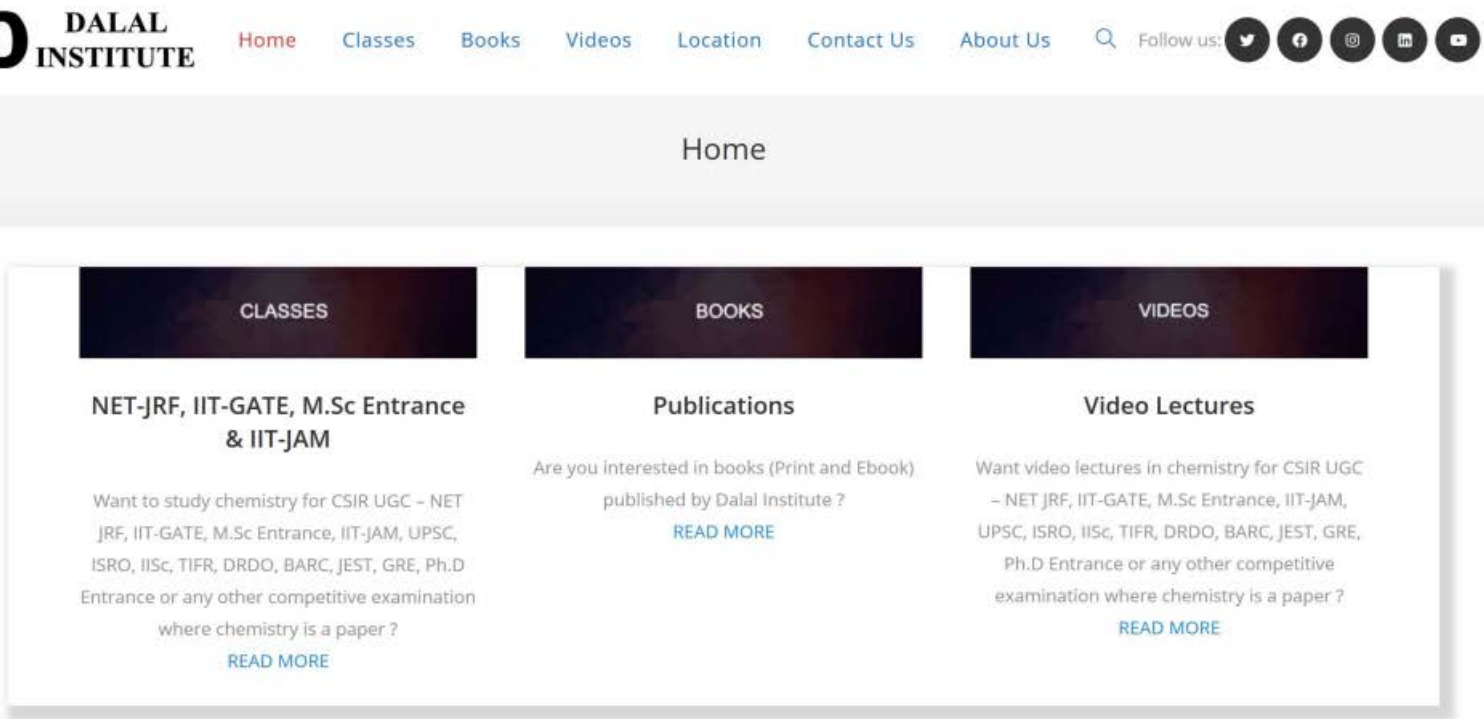
Q.119 For the electrochemical cell Ag|AgCl|MCl(0.01M)|MCl(0.02M)|AgCl|Ag, the junction potential is highest when M^+ is

(a) H^+ (b) Li^+ (c) Na^+ (d) K^+

Q.120 For the reaction $K + Br_2 \rightarrow KBr + Br$, which follows the harpoon mechanism, the reactive cross section is closest to

(Use $\frac{e^2}{4\pi\varepsilon_0} = 2.3 \times 10^{-27}$ J m, Ionisation energy of K = 422.5 kJ mol^{-1}, electron affinity of Br_2 = 250 kJ mol^{-1} and $N_A = 6 \times 10^{23}$ mol^{-1})

(a) 50×10^{-18} m^2 (b) 2×10^{-18} m^2 (c) 64×10^{-18} m^2 (d) 16×10^{-18} m^2



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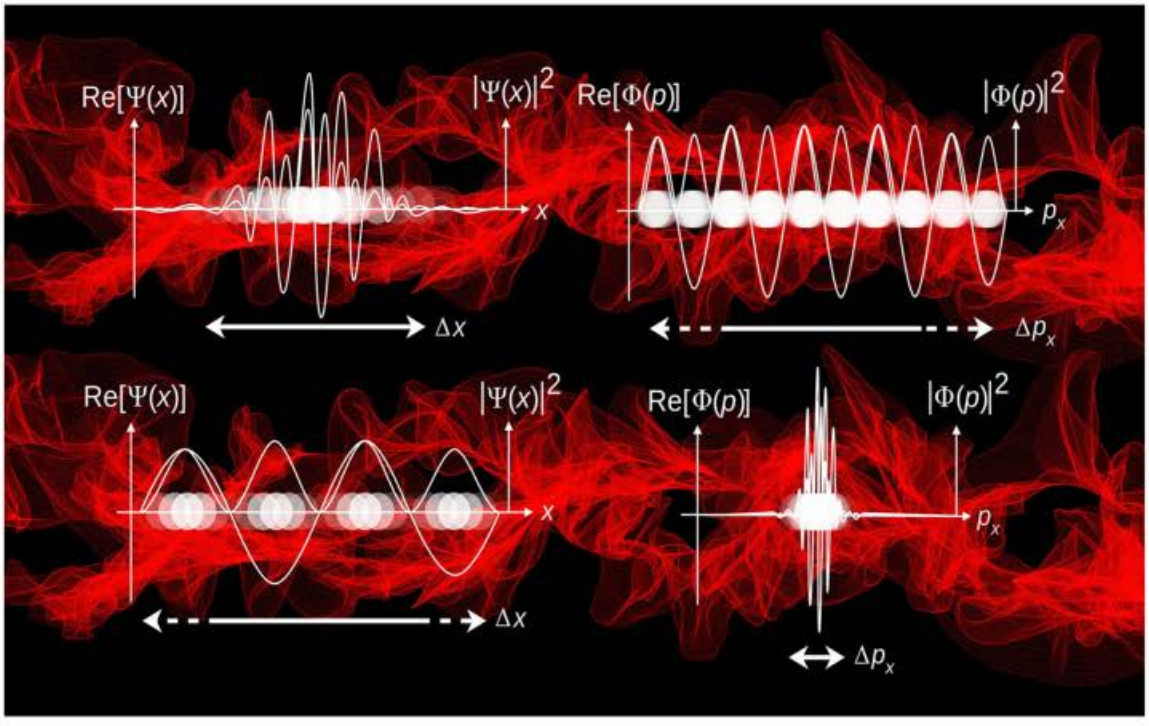

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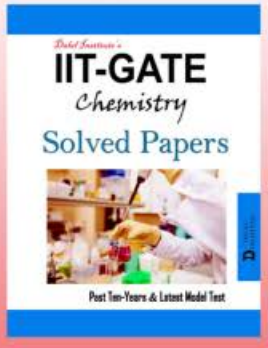

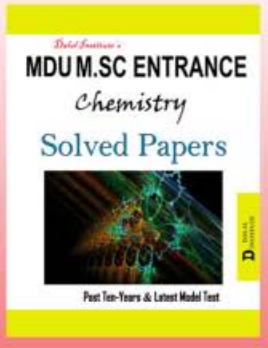

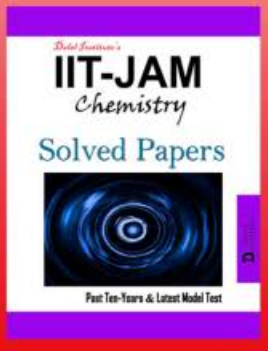

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