Final Answer Keys IOQC 2020-21 Part I (NSEC) held on 6.2.2021

Question No	Set 31	Set 32	Set 33	Set 34
1	a	a	b	a
2	c	c	a	a
3	b	d	a	c
4	d	b	b	c
5	c	b	a	b
6	b	a	c	c
7	b	a	d	a
8	d	b	c	c
9	b	a	c	a
10	b	c	a	d
11	a	c	c	a
12	a	b	a	b
13	b	b	b	a
14	a	d	b	c
15	c	b	a	b
16	a	c	c	d
17	c	d	b	d
18	a	a	d	b
19	d	c	d	d
20	c	a	b	d
21	d	d	d	b
22	b	a	d	b
23	d	d	b	b
24	a	b	a	a
25	b,c	b,c	c,d	c,d
26	b,d	a,d	a,b,c,d	a,d
27	a,d	b,d	b,d	a,d
28	a,b,d	c,d	c,d	b,c
29	c,d	a,b,c,d	a,d	c,d
30	a,d	a,d	b,c	a,b,d
31	a,b,c,d	a,b,d	a,d	a,b,c,d
32	c,d	c,d	a,b,d	b,d

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN CHEMISTRY 2015 -16

Date of Examination: 22nd November, 2015

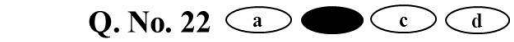
Time: 1230 to 1430 Hrs

Q. Paper Code: C 230

Write the question paper code mentioned above on YOUR answer sheet (in the space provided), otherwise your answer sheet will NOT be assessed.Note that the same Q. P. Code appears on each page of the question paper.

Instructions to Candidates –

1. Use of mobile phones, smartphones, ipads during examination is **STRICTLY PROHIBITED**.
2. In addition to this question paper, you are given answer sheet along with Candidate's copy.
3. On the answer sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/carelessly filled information may disqualify your candidature.
4. On the answer sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Question paper has 80 multiple choice questions. Each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.



6. A correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer.
7. Any rough work should be done only in the space provided.
8. Periodic Table is provided at the end of the question paper.
9. Use of **non-programmable** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting your answer paper, take away the Candidate's copy for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the answer sheet.

Answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED.

Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE ANSWER SHEET.

Instructions to Candidates (continued)–

Read the following instructions after submitting the answer sheet.

12. **Comments regarding this question paper, if any, may be sent by email only to iaptpune@gmail.com till 24th November, 2015.**
13. **The answers/solutions to this question paper will be available on our website – www.iapt.org.in by 2nd December, 2015.**
14. **CERTIFICATES and AWARDS –**

    Following certificates are awarded by the IAPT to students successful in NSEs

    (i)Certificates to "Centre Top 10%" students

    (ii)Merit Certificates to "Statewise Top 1%" students

    (iii)Merit Certificates and a book prize to "National Top 1%" students
15. Result sheets and the "Centre Top 10%" certificates will be dispatched to the Prof-in-charge of the centre by January, 2016.
16. List of students (with centre number and roll number only) having score above MAS will be displayed on our website (**www.iapt.org.in**) by **22nd December, 2015.** See the **Eligibility Clause** in the Student's brochure on our website.
17. Students eligible for the INO Examination on the basis of selection criteria mentioned in Student's brochure will be informed accordingly.
18. Gold medals will be awarded to TOP 35 students in the entire process.

NATIONAL STANDARD EXAMINATION IN CHEMISTRY 2015

(1) A bottle of H_3PO_4 solution contains 70% (w/w) acid. If the density of the solution is 1.54 g cm^{-3}, the volume of the H_3PO_4 solution required to prepare 1 L of I N solution is

(A) 90 mL (B) 45 mL

(C) 30 mL (D) 23 mL

(2) Wood or cattle dung ash is used for cleaning cooking utensils in many parts of India. The statement that is **not true** for this ash is:

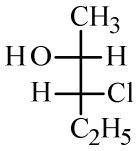
(A) it largely consists of metal oxides and silicates because non-metals are removed as gaseous compounds during burning of the wood/dung cakes.

(B) when added to water, it forms alkaline solution with pH~8 and above, which helps to remove oily substances from the utensils.

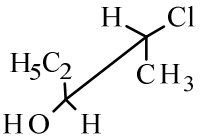
(C) several chemical components of ash remain undissolved as solids in water and these solids help in cleaning by providing scrubbing action.

(D) if left moist for a few hours in air, it slowly turns acidic because of oxidative decomposition

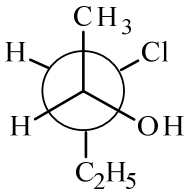
(3) The two projection formulae that represent a pair of enantiomers are



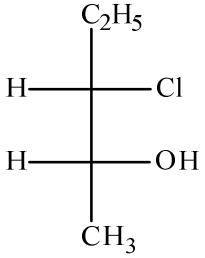
I



II



III



IV

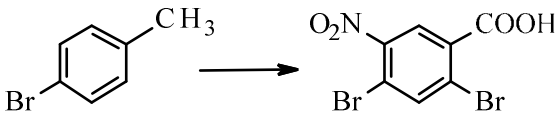
(A) I and II (B) III and IV

(C) I and III (D) II and IV

(4) When 1 L of 0.1 M sulphuric acid solution is allowed to react with 1 L of 0.1 M sodium hydroxide solution, the amount of sodium sulphate (anhydrous) that can be obtained from the solution formed and the concentration of H^+ in the solution respectively are

(A) 3.55 g, 0.1 M
(B) 7.10 g, 0.025 M
(C) 3.55 g, 0.025 M
(D) 7.10 g, 0.05 M

(5) The best sequence of reactions for the following conversion is



(A) (i) 1 mol $Br_2/FeBr_3$ (ii) $KMnO_4$, heat (iii) $HNO_3 + H_2SO_4$

(B) (i) $HNO_3 + H_2SO_4$ (ii) 1 mol $Br_2/FeBr_3$ (iii) $KMnO_4$, heat

(C) (i) $KMnO_4$, heat (ii) $HNO_3 + H_2SO_4$ (iii) 1 mol $Br_2/FeBr_3$

(D) (i) 1 mole $Br_2/FeBr_3$ (ii) $HNO_3 + H_2SO_4$ (iii) $KMnO_4$, heat

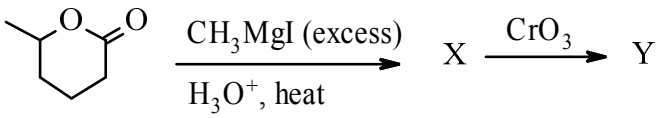
(6) If λ_0 and λ are the threshold wavelength and the wavelength of the incident light, respectively on a metal surface, the velocity of the photoelectron ejected from the metal surface is (m_e = mass of electron, h = Planck's constant, c = speed of light)

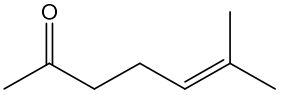
(A) $\sqrt{\frac{2h(\lambda_0-\lambda)}{m_e}}$
(B) $\sqrt{\frac{2hc(\lambda_0-\lambda)}{m_e}}$
(C) $\sqrt{\frac{2hc}{m_e}\left(\frac{\lambda_0-\lambda}{\lambda\lambda_0}\right)}$
(D) $\sqrt{\frac{2h}{m_e}\left(\frac{1}{\lambda_0}-\frac{1}{\lambda}\right)}$

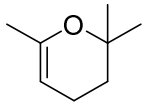
(7) A current of 5.0 A flows for 4.0 h through an electrolytic cell containing a molten salt of metal **M**. This results in deposition of 0.25 mol of the metal **M** at the cathode. The oxidation state of **M** in the molten salt is (1 Faraday = 96485 C mol^{-1})

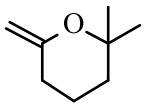
(A) +1
(B) +2
(C) +3
(D) +4

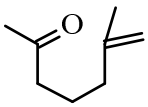
(8) The major product (Y) of the following reaction is -



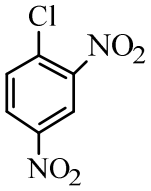
(A) 

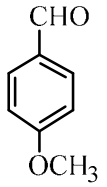
(B) 

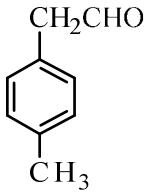
(C) 

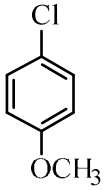
(D) 

(9) The compound that will **NOT** react with hot concentrated aqueous alkali at atmospheric pressure is

(A) 

(B) 

(C) 

(D) 

(10) The nature of $CsAuCl_3$ is (this compound contains Au in two oxidation states and there is no Au-Au bond)

(A) diamagnetic
(B) paramagnetic
(C) ferromagnetic
(D) antiferromagnetic

(11) The standard electrode potentials, E^0 of Fe^{3+}/Fe^{2+} and Fe^{2+}/Fe at 300 K are +0.77 V and –0.44 V, respectively. The E^0 of Fe^{3+}/Fe at the same temperature is

(A) 1.21 V
(B) 0.33 V
(C) –0.036 V
(D) 0.036 V

(12) The **incorrect** statement for lanthanides among the following statements is

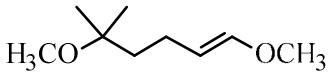
(A) 4f and 5d orbitals are so close in energy that it is very difficult to locate the exact position of electrons in lanthanides

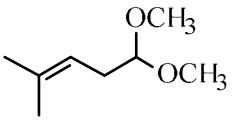
(B) most common stable oxidation state is +3

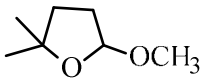
(C) tripositive lanthanide ions have characteristic color depending on nature of group with which they combine to form compounds

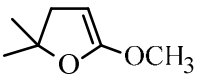
(D) some lanthanide ions absorb either in infrared or ultraviolet region of electromagnetic spectrum

(13) 4-Hydroxy-4-methylpentanal on heating with excess of methanol in the presence of an acid catalyst followed by dehydration of the product gives

(A) 

(B) 

(C) 

(D) 

(14) Ice crystallizes in a hexagonal lattice. At a certain low temperature, the lattice constants are a = 4.53 Å and c = 7.41 Å. The number of H_2O molecules contained in a unit cell (d ≈ 0.92 g cm^{-3} at the given temperature) is

(A) 4 (B) 8

(C) 12 (D) 24

(15) In the redox reaction

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

20 mL of 0.1 M $KMnO_4$ react quantitatively with

(A) 20 mL of 0.1 M oxalate (B) 40 mL of 0.1 M oxalate

(C) 50 mL of 0.25 M oxalate (D) 50 mL of 0.1 M oxalate

(16) The vapor pressure of benzene is 53.3 kPa at 60.6 °C, but it fall to 51.5 kPa when 19 g of a nonvolatile organic compound is dissolved in 500 g benzene. The molar mass of the nonvolatile compound is

(A) 82 (B) 85

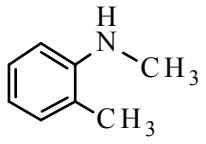
(C) 88 (D) 92

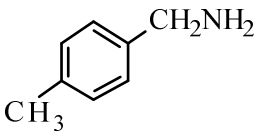
(17) Sodium metal dissolves in liquid ammonia and forms a deep blue solution. The color is due to absorption of light by

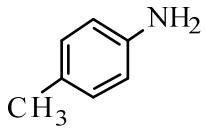
(A) sodium ions (B) ammoniated electrons

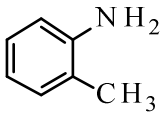
(C) free electrons (D) ammoniated sodium ions

(18) An organic base (X) reacts with nitrous acid at 0^{o}C to give a clear solution. Heating the solution with KCN and cuprous cyanide followed by continued heating with conc. HCl gives a crystalline solid. Heating this solid with alkaline potassium permanganate gives a compound which dehydrates on heating to a crystalline solid. 'X' is -

(A) 

(B) 

(C) 

(D) 

(19) The de Broglie wavelength of an object of mass 33 g moving with a velocity of 200 m s^{-1} is of the order of

(A) 10^{-31} m (B) 10^{-34} m

(C) 10^{-37} m (D) 10^{-41} m

(20) A person having osteoporosis is suffering from lead poisoning. Ethylene diamine tetra acetic acid (EDTA) is administered for this condition. The best form of EDTA to be used for such administration is -

(A) EDTA (B) tetrasodium salt

(C) disodium salt (D) calcium dihydrogen salt

(21) A water sample from a municipal water supply was found to have a pH = 7.0. On evaporating 2 L of this water, 2.016 g of white solid was left behind in the evaporation vessel, i.e., the total dissolved solid (TDS) content of this water was 1008 mg L^{-1}. However, addition of soap to a bucket of this water did not produce any visible scum. Based on these findings, one can conclude that

(A) there are no Ca^{2+} or Mg^{2+} ion in the water

(B) there are no CO_3^{2-} or HCO_3^- ion in the water

(C) concentration of any ion in the water is lower than 0.038 M

(D) water may be containing Na^+ ions in concentration > 0.04 M

(22) The best reaction sequence to convert 2-methyl-1-bromopropane into 4-methyl-2-bromopentane is

(A) (i) Mg in ether (ii) acetaldehyde (iii) H^+, H_2O iv) Δ v) HBr, H_2O_2

(B) (i) NaC≡CH in ether (ii) H_2, Lindlar catalyst (iii) HBr, no peroxide

(C) (i) alcoholic KOH (ii) CH_3COOOH (iii) H_2/Pt (iv) HBr, heat

(D) (i) NaC≡CH in ether (ii) H_3O^+ + $HgSO_4$ (iii) HBr, heat

(23) Metallic copper dissolves in

(A) dilute HCl (B) concentrated HCl

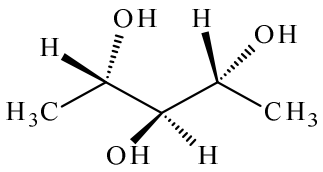
(C) aqueous KCN (D) pure ammonia

(24) A 50 mL solution of pH = 1 is mixed with a 50 mL solution of pH = 2. The pH of the mixture is

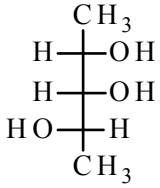
(A) 0.86 (B) 1.26

(C) 1.76 (D) 2.26

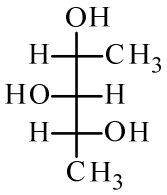
(25) The Fischer projection formula that represents the following compound is



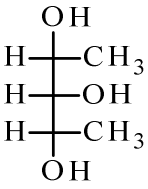
(A)



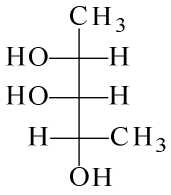
(B)



(C)



(D)



(26) Four statements for the following reaction are given below

$[CoCl_2(NH_3)_4]^+ + Cl^- \rightarrow [CoCl_3(NH_3)_3] + NH_3$

(I) only one isomer is produced if the reactant complex ion is a trans isomer

(II) three isomers are produced if the reactant complex ion is a cis isomer

(III) two isomers are produced if the reactant complex ion is a trans isomer

(IV) two isomers are produced if the reactant complex ion is cis isomer

The correct statements are

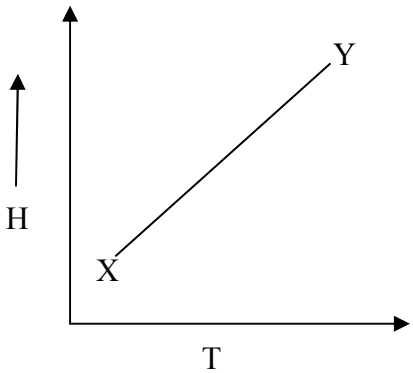
(A) I and II

(B) III and IV

(C) I and IV

(D) II and III

(27) The process in which an ideal gas undergoes change from X to Y as shown in the following diagram is



(A) isothermal compression
(B) adiabatic compression
(C) isothermal expansion
(D) adiabatic expansion

(28) With respect to halogens, four statements are given below

(I) The bond dissociation energies for halogens are in the order: $I_2 < F_2 < Br_2 < Cl_2$

(II) The only oxidation state is -1

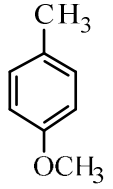
(III) The amount of energy required for the excitation of electrons to first excited state decreases progressively as we move from F to I

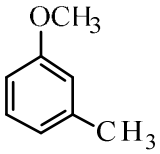
(IV) They form HX_2^- species in their aqueous solutions (X = halogen)

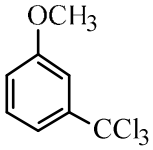
The correct statements are

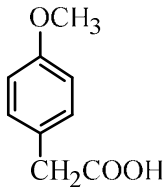
(A) I, II, IV
(B) I, III, IV
(C) II, III, IV
(D) I, III

(29) The order of reactivity of the following compounds in electrophilic monochlorination at the most favorable position is

(I) 

(II) 

(III) 

(IV) 

(A) I < II < IV < III
(B) III < IV < I < II
(C) IV < III < II < I
(D) III < II < IV < I

(30) The limiting molar conductivities of KCl, KNO_3 and $AgNO_3$ are 149.9, 145.0 and 133.4 S cm^2 mol^{-1}, respectively, at 25°C. The limiting molar conductivity of AgCl at the same temperature in S cm^2 mol^{-1} is

(A) 128.5
(B) 138.3
(C) 161.5
(D) 283.3

(31) Imagine that in any atom about 50% of the space is occupied by the atomic nucleus. If a silver foil is bombarded with α-particles, majority of the α-particles would

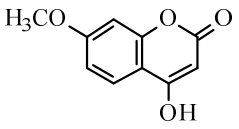
(A) be scattered

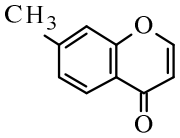
(B) be absorbed by the nuclei

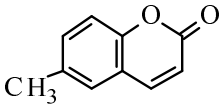
(C) pass through the foil undeflected

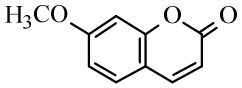
(D) get converted into photons

(32) An organic compound ("X") is a disubstituted benzene containing 77.8% carbon and 7.5% hydrogen. Heating an alkaline solution of "X" with chloroform gives a steam volatile compound "Y". Heating "Y" with acetic anhydride and sodium acetate gives a sweet smelling crystalline solid "Z". "Z" is

(A) 

(B) 

(C) 

(D) 

(33) The emf of a cell corresponding to the following reaction is 0.199 V at 298 K.

$Zn\ (s) + 2\ H^+\ (aq) \rightarrow Zn^{2+}\ (0.1\ M) + H_2\ (g)$ $\qquad (E^{O}_{Zn\,/\,Zn^{+2}} = 0.76V)$

The approximate pH of the solution at the electrode where hydrogen is being produced is (p_{H2} = 1 atm)

(A) 8 (B) 9

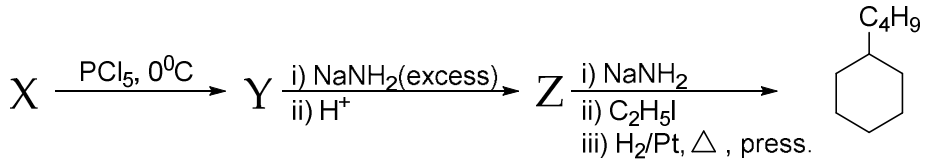
(C) 10 (D) 11

(34) The vapor pressure of two pure isomeric liquids **X** and **Y** are 200 torr and 100 torr respectively at a given temperature. Assuming a solution of these components to obey Raoult's law, the mole fraction of component **X** in vapor phase in equilibrium with the solution containing equal amounts of **X** and **Y,** at the same temperature**,** is

(A) 0.33 (B) 0.50

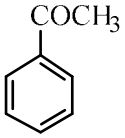
(C) 0.66 (D) 0.80

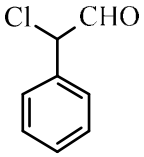
(35) n-Butylcyclohexane is formed through the following sequence of reactions.

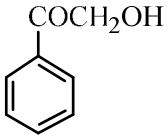


In the above scheme of reactions, "X" is -

(A) 

(B) 

(C) 

(D) 

(36) In a first order reaction, 75% of the reactant disappears in 1.386 h, the rate constant of the reaction is close to

(A) $7.2 \times 10^{-3}\ s^{-1}$ (B) $3.6 \times 10^{-3}\ s^{-1}$

(C) $1.8 \times 10^{-3}\ s^{-1}$ (D) $2.8 \times 10^{-4}\ s^{-1}$

(37) Four statements for Cr and Mn are given below.

(I) Cr^{2+} and Mn^{3+} have the same electronic configuration.

(II) Cr^{2+} is a reducing agent while Mn^{3+} is an oxidizing agent.

(III) Cr^{2+} is an oxidizing agent while Mn^{3+} is a reducing agent.

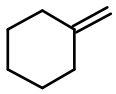
(IV) both Cr and Mn are oxidizing agents.

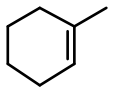
The correct statements are

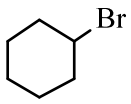
(A) I, III, IV (B) I, II

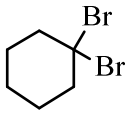
(C) I, II, IV (D) I, IV

(38) Four processes are indicated below:

(I)  (i) HBr/no peroxide (ii) alcoholic KOH, $\triangle$

(II)  (i) HI (ii) aqueous NaOH, $\triangle$

(III)  (i) Mg, ether (ii) CH_2O (iii) H^+, H_2O

(IV)  (i) aq KOH (ii) CH_3MgBr, ether (iii) H_3O^+

The processes that **do not** produce 1-methylcyclohexanol are

(A) II, IV (B) I, II

(C) III, IV (D) I, III

(39) The reaction that is **least feasible** is

(A) $Li_2CO_3 \rightarrow Li_2O + CO_2$

(B) $4Li + O_2 \rightarrow 2Li_2O$

(C) $6Li + N_2 \rightarrow 2Li_3N$

(D) $2C_6H_5C{\equiv}CH + 2Li \rightarrow 2C_6H_5C{\equiv}CLi + H_2$

(40) Glucose when dissolved in water leads to cooling of the solution. Suppose you take 250 mL water at room temperature in an open container (such as a bowl) made of thermally insulated material and dissolve a spoonful of glucose in it. If you are able to accurately measure the heat absorbed by this solution in reaching back to room temperature (assuming negligible changes in the composition and the amount of solution during this process), you will be measuring

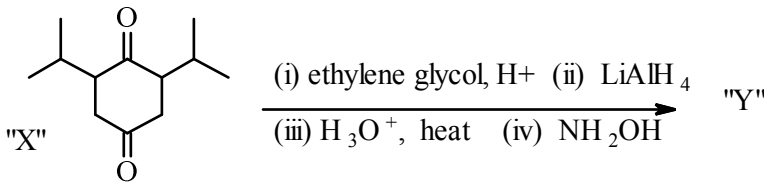
(A) the enthalpy of dissolution of the glucose in water

(B) the Gibbs free energy of dissolution of the glucose in water

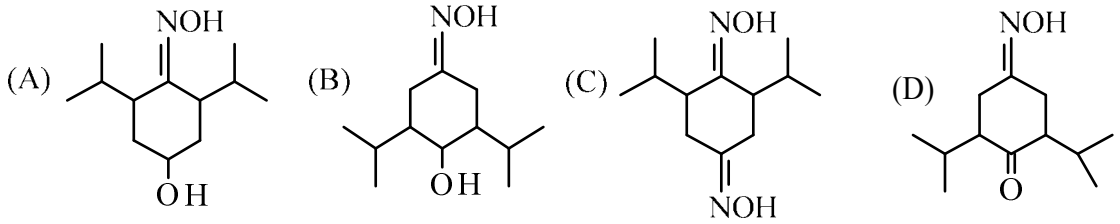
(C) the work done by the atmosphere on the system during the dissolution process

(D) the heat capacity of the solution

(41) Compound "X" undergoes the following sequence of reactions to form "Y".



Compound "Y" is -



(42) The complex that shows optical activity is

(A) *trans*-$[CoCl_2(en)_2]^+$ (B) *cis*-$[CoCl_2(en)_2]^+$

(C) *trans*-$[PtCl_2(NH_3)_2]$ (D) $[CoCl_2(NH_3)_2(en)]^+$

(43) 100 mL of 0.3 M acetic acid is shaken with 0.8 g wood charcoal. The final concentration of acetic acid in the solution after adsorption is 0.125 M. The mass of acetic acid adsorbed per gram of charcoal is

(A) 1.05 g (B) 0.0131 g

(C) 1.31 g (D) 0.131 g

(44) The reaction that **does not** produce nitrogen is

(A) heating $(NH_4)_2Cr_2O_7$ (B) NH_3 + excess of Cl_2

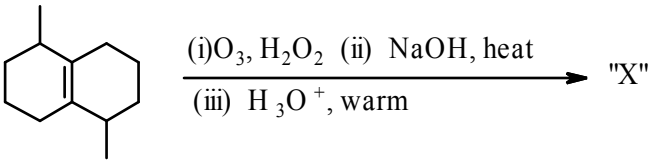
(C) heating of NaN_3 (D) heating of NH_4NO_3

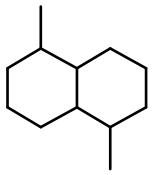
(45) The species having **highest** bond energy is

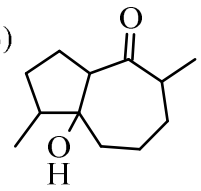
(A) O_2 (B) O_2^+

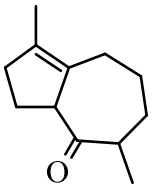
(C) O_2^- (D) O_2^{2-}

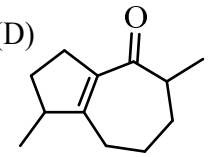
(46) The product ("X") of the following sequence of reactions is



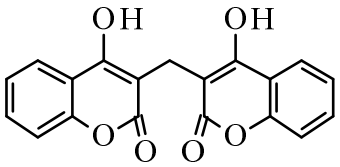
(A) 

(B) 

(C) 

(D) 

(47) Dicoumarol (X) is an anticoagulant. The number of possible monochloro substituted isomeric derivatives and the volume of hydrogen liberated at STP by the reaction of 0.5 mol of dicoumarol with sodium are respectively



(X)

(A) 5, 22.4 dm^3

(B) 5, 11.2 dm^3

(C) 6, 11.2 dm^3

(D) 4, 22.4 dm^3

(48) The structure of a molecule of $N(SiMe_3)_3$ is

(A) Pyramidal with angle close to 110^o

(B) T-shaped with angle 90^o

(C) Bent T-shaped with angle close to 89^o

(D) Trigonal planar with bond angle close to 120^o

(49) For an electron whose *x*-positional uncertainty is 1.0×10^{-10} m, the uncertainty in the *x*-component of the velocity in m s^{-1} will be of the order of

(A) 10^6

(B) 10^9

(C) 10^{12}

(D) 10^{15}

(50) The order of pπ-dπ interaction in the compounds containing bond between Si/P/S/Cl and oxygen is in the order

(A) P > Si > Cl > S

(B) Si < P < S < Cl

(C) S < Cl < P < Si

(D) Si > P > S > Cl

(51) The solubility products (K_{sp}) of three salts MX, MY_2 and MZ_3 are 1×10^{-8}, 4×10^{-9} and 27×10^{-8}, respectively. The correct order for solubilities of these salts is

(A) $MX > MY_2 > MZ_3$

(B) $MZ_3 > MY_2 > MX$

(C) $MZ_3 > MX > MY_2$

(D) $MY_2 > MX > MZ_3$

(52) Three isomeric compounds **M**, **N**, and **P** ($C_5H_{10}O$) give the following tests:

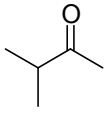
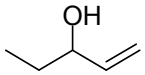
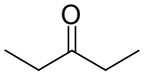
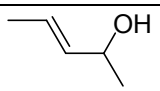
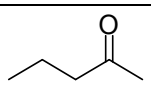
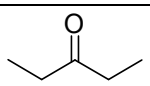
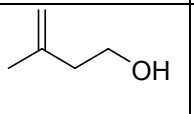
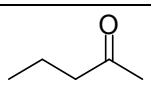
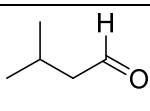
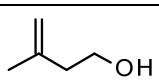
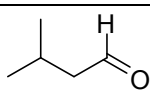
(i) **M** and **P** react with sodium bisulfite to form an adduct

(ii) **N** consumes 1 mol of bromine and also gives turbidity with conc. HCl/anhydrous $ZnCl_2$ after prolong heating

(iii) **M** reacts with excess of iodine in alkaline solution to give yellow crystalline compound with a characteristic smell.

(iv) p-Rosaniline treated with sulphur dioxide develops pink colour on shaking with **P**

The structures of M, N, and P, respectively are

	M	N	P
(A)			
(B)			
(C)			
(D)			

(53) The unbalanced equation for the reaction of P_4S_3 with nitrate in aqueous acidic medium is given below.

$P_4S_3 + NO_3^- \rightarrow H_3PO_4 + SO_4^{2-} + NO$

The number of mol of water required per mol of P_4S_3 is

(A) 18 (B) 8/3

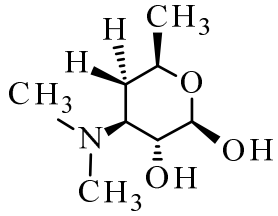
(C) 8 (D) 28

(54) Certain combinations of cations and anions lead to the formation of colored salts in solid state even though each of these ions with other counter ions may produce colorless salts. This phenomenon is due to temporary charge transfer between the two ions. Out of the following, the salt that can exhibit this behavior is

(A) $SnCl_2$ (B) $SnCl_4$

(C) $SnBr_2$ (D) SnI_4

(55) Desosamine has the following structure



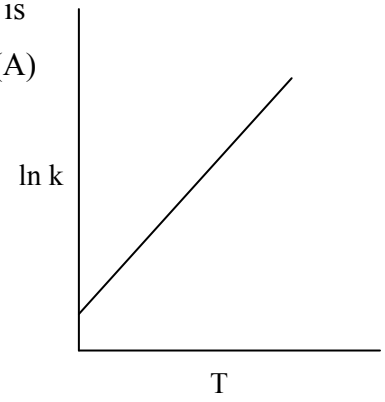
The number of functional groups which react with hydroiodic acid, the number of chiral centres, and the number of stereoisomers possible respectively are

(A) 4, 5, 8 (B) 3, 4, 16

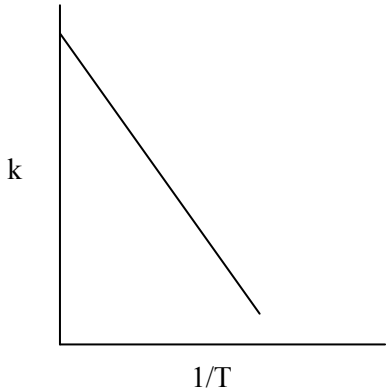
(C) 3, 4, 8 (D) 4, 4, 16

(56) If *k* is the rate constant of the reaction and *T* is the absolute temperature, the correct plot is

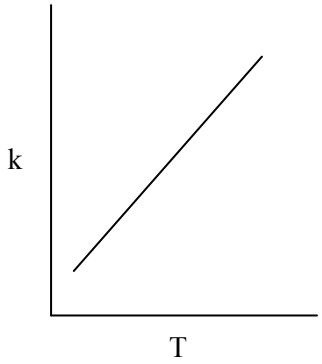
(A)



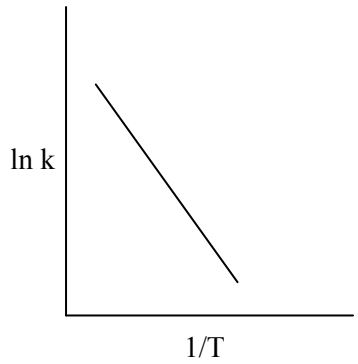
(B)



(C)



(D)



(57) 1,3-pentadiene and 1,4-pentadiene are compared with respect to their intrinsic stability and reaction with HI. The correct statement is

(A) 1,3-pentadiene is more stable and more reactive than 1,4-pentadiene

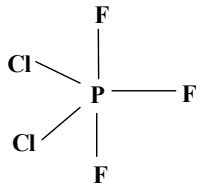
(B) 1,3-pentadiene is less stable and less reactive than 1,4-pentadiene

(C) 1,3-pentadiene is more stable but less reactive than 1,4-pentadiene

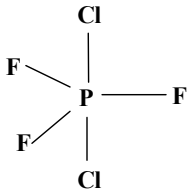
(D) 1,3-pentadiene is less stable but more reactive than 1,4-pentadiene

(58) From the given structures, the correct structure(s) of PF_3Cl_2 is/are

(I)



(II)



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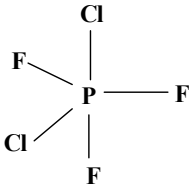


(A) only I

(B) only II

(C) only III

(D) I, II and III

(59) The ratio of the masses of methane and ethane in a gas mixture is 4:5. The ratio of number of their molecules in the mixture is

(A) 4:5

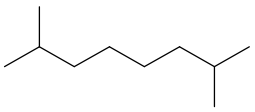
(B) 3:2

(C) 2:3

(D) 5:4

(60) The hydrocarbon that **cannot be** prepared effectively by Wurtz reaction is

(A)



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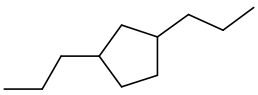

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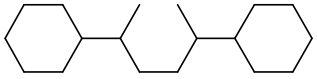
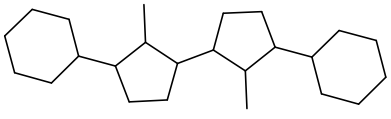


(D)



(61) Glacial acetic acid dissolves in

(I) liquid H_2S, as H_2S is a polar covalent compound

(II) liquid NH_3, as it can form hydrogen bond

(III) liquid $HClO_4$, as it can protonate acetic acid

The correct option is

(A) only I

(B) only II

(C) only III

(D) I, II and III

(62) The energy of an electron in the first Bohr orbit is −13.6 eV. The energy of Be^{3+} in the first excited state is

(A) – 30.6 eV

(B) – 40.8 eV

(C) – 54.4 eV

(D) + 40.8 eV

(63) Many protein-based biomaterials, such as waste hair and feathers, can absorb heavy metal ions from wastewater. It has been observed that metal uptake by these materials increases in alkaline condition. The enhanced uptake in alkaline conditions is due to

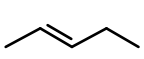
(A) generation of many ligand sites in the protein molecules due to removal of H^+

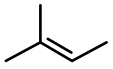
(B) availability of a high concentration of OH^- ions as ligands

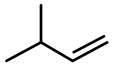
(C) increased cross-linkages in the protein chains by formation of amide bonds

(D) increase in solubility of the proteins

(64) Compound "X" reacts with diborane followed by alkaline hydrogen peroxide to form compound "Y". "Y" on reaction with a mixture of sodium bromide in sulphuric acid followed by bromobenzene and sodium in ether gives n-pentylbenzene. Compound "X" is

(A) 

(B) 

(C) 

(D) 

(65) When any solution passes through a cation exchange resin that is in acidic form, H^+ ion of the resin is replaced by cations of the solution. A solution containing 0.319 g of an

isomer with molecular formula $CrCl_3.6H_2O$ is passed through a cation exchange resin in acidic form. The eluted solution requires 19 cm^3 of 0.125 N NaOH. The isomer is

(A) triaquatrichloro chromium(III) chloride trihydrate

(B) hexaaqua chromium(III) chloride

(C) pentaaquamonochloro chromium(III) chloride monohydrate

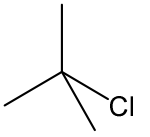
(D) tetraaquadichloro chromium(III) chloride dihydrate

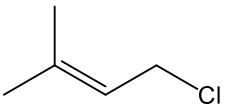
(66) In an experiment, it was found that for a gas at constant temperature, PV = C. The value of C depends on

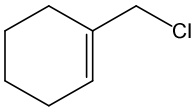
(A) atmospheric pressure (B) quantity of gas

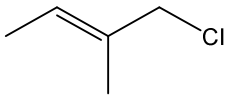
(C) molecular weight of gas (D) volume of chamber

(67) The compound that undergoes solvolysis in aq. ethanol most easily is

(A) 

(B) 

(C) 

(D) 

(68) Silver nitrate solution when added to a colorless aqueous solution **E** forms a white precipitate which dissolves in excess of **E**. If the white precipitate is heated with water, it turns black and the supernatant solution gives a white precipitate with acidified barium nitrate solution. Therefore, **E** is

(A) Na_2S (B) $Na_2S_2O_3$

(C) Na_2SO_3 (D) Na_2SO_4

(69) The metal **M** crystallizes in a body centered lattice with cell edge 400 pm. The atomic radius of **M** is

(A) 200 pm (B) 100 pm

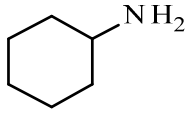
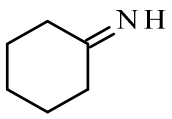
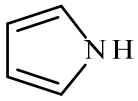
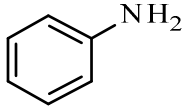
(C) 173 pm (D) 141 pm

(70) The reaction that **does not** proceed in forward direction is

(A) $BeF_2 + HgI_2 \rightarrow BeI_2 + HgF_2$ (B) $LiI + CsF \rightarrow LiF + CsI$

(C) $CuI_2 + 2CuF \rightarrow CuF_2 + 2CuI$ (D) $CaS + H_2O \rightarrow CaO + H_2S$

(71) The order of basicity of the following compounds is

(I)  (II)  (III)  (IV) 

(A) I > II > IV > III (B) IV > II > I > II

(C) III > II > I > IV (D) I > II > III > IV

(72) The appropriate sequence of reactions for obtaining 2-phenylbutanoic acid from benzene is

(A) (i) 1-chlorobutane/$AlCl_3$ (ii) limited Cl_2, light (iii) aq NaCN (iv) H^+, H_2O, heat

(B) (i) 2-chlorobutane/$AlCl_3$ (ii) $K_2Cr_2O_7/H_2SO_4$

(C) (i) propanoyl chloride/$AlCl_3$ (ii) Zn-Hg/HCl (iii) limited Cl_2, light (iv) aq. NaCN (v) H^+, H_2O, heat

(D) (i) butanoyl chloride/$AlCl_3$ (ii) $NaBH_4$ (iii) CuCN (iv) H^+, H_2O, heat

(73) The quantity that **does not** change for a sample of a gas in a sealed rigid container when it is cooled from 120^oC to 90^oC at constant volume is

(A) average energy of the molecule (B) pressure of the gas

(C) density of the gas (D) average speed of the molecules

(74) An ideal gas taken in an insulated chamber is released into interstellar space. The statement that is nearly true for this process is

(A) $Q = 0, W \neq 0$ (B) $W = 0, Q \neq 0$

(C) $\Delta U = 0, Q \neq 0$ (D) $Q = W = \Delta U = 0$

(75) 4-amino-3-methylbutanoic acid is treated with thionyl chloride followed by ammonia to obtain compound "X". "X" on reaction with bromine in an alkaline medium gave

compound "Y". For estimation, "Y" was titrated with perchloric acid. The volume of 0.1 M perchloric acid needed to react with 0.22 g of "Y" is

(A) 50 mL (B) 80 mL

(C) 120 mL (D) 200 mL

(76) For $[FeF_6]^{3-}$ and $[CoF_6]^{3-}$, the statement that is correct is

(A) both are colored

(B) both are colorless

(C) $[FeF_6]^{3-}$ is colored and $[CoF_6]^{3-}$ is colorless

(D) $[FeF_6]^{3-}$ is colorless and $[CoF_6]^{3-}$ is colored

(77) Cotton fibers consist of cellulose polymers with neighboring polymers chains held together by hydrogen bonds between –OH groups in the glucose units. Due to these hydrogen bonds

(A) cotton is insoluble in water

(B) cotton can easily absorb ghee and oils and therefore are used to make wicks in traditional lamps

(C) it is easier to iron cotton clothes when they are slightly wet or by applying steam to the clothes

(D) cotton clothes have a high wear and tear than other fibers

(78) For the following reaction, formation of the product is favored by

$A_2(g) + 4B_2(g) \ll 2AB_4(g), \ \Delta H < 0$

(A) low temperature and high pressure (B) high temperature and low pressure

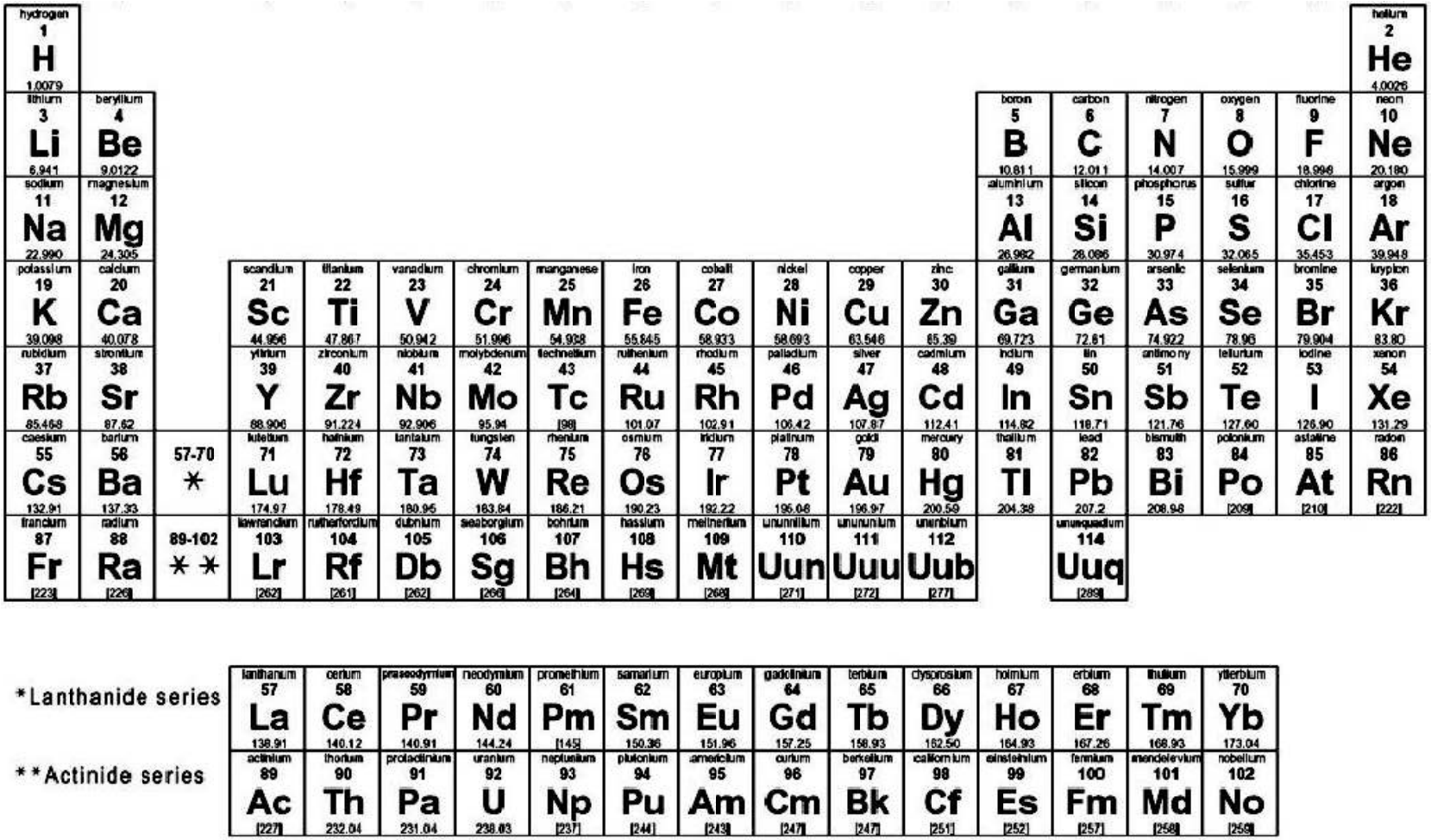
(C) low temperature and low pressure (D) high temperature and high pressure

(79) Imagine a hypothetical situation in which capacity of any molecular orbital is 3 instead of 2 and the combination rules for the formation of molecular orbitals remain the same. The number of delocalized pi-electrons stipulated by the modified Huckel's rule of aromaticity is (n= integer, including zero)

(A) (3n+2)
(B) (4n+3)
(C) (2n+3)
(D) (6n+3)

(80) One mole crystal of a metal halide of the type MX with molecular weight 119 g having face centered cubic structure with unit cell length 6.58 Å was recrystallized. The density of the recrystallized crystal was found to be 2.44 g cm^{-3}. The type of defect introduced during the recrystalization is

(A) additional M^+ and X^- ions at interstitial sites
(B) Schottky defect
(C) F-centre
(D) Frenkel defect


hydrogen 1 H 1.0079
helium 2 He 4.0026
lithium 3 Li 6.941
beryllium 4 Be 9.0122
boron 5 B 10.811
carbon 6 C 12.011
nitrogen 7 N 14.007
oxygen 8 O 15.999
fluorine 9 F 18.998
neon 10 Ne 20.180
sodium 11 Na 22.990
magnesium 12 Mg 24.305
aluminium 13 Al 26.982
silicon 14 Si 28.086
phosphorus 15 P 30.974
sulfur 16 S 32.065
chlorine 17 Cl 35.453
argon 18 Ar 39.948
potassium 19 K 39.098
calcium 20 Ca 40.078
scandium 21 Sc 44.956
titanium 22 Ti 47.867
vanadium 23 V 50.942
chromium 24 Cr 51.996
manganese 25 Mn 54.938
iron 26 Fe 55.845
cobalt 27 Co 58.933
nickel 28 Ni 58.693
copper 29 Cu 63.546
zinc 30 Zn 65.39
gallium 31 Ga 69.723
germanium 32 Ge 72.61
arsenic 33 As 74.922
selenium 34 Se 78.96
bromine 35 Br 79.904
krypton 36 Kr 83.80
rubidium 37 Rb 85.468
strontium 38 Sr 87.62
yttrium 39 Y 88.906
zirconium 40 Zr 91.224
niobium 41 Nb 92.906
molybdenum 42 Mo 95.94
technetium 43 Tc [98]
ruthenium 44 Ru 101.07
rhodium 45 Rh 102.91
palladium 46 Pd 106.42
silver 47 Ag 107.87
cadmium 48 Cd 112.41
indium 49 In 114.82
tin 50 Sn 118.71
antimony 51 Sb 121.76
tellurium 52 Te 127.60
iodine 53 I 126.90
xenon 54 Xe 131.29
caesium 55 Cs 132.91
barium 56 Ba 137.33
57-70 *
lutetium 71 Lu 174.97
hafnium 72 Hf 178.49
tantalum 73 Ta 180.95
tungsten 74 W 183.84
rhenium 75 Re 186.21
osmium 76 Os 190.23
iridium 77 Ir 192.22
platinum 78 Pt 195.08
gold 79 Au 196.97
mercury 80 Hg 200.59
thallium 81 Tl 204.38
lead 82 Pb 207.2
bismuth 83 Bi 208.98
polonium 84 Po [209]
astatine 85 At [210]
radon 86 Rn [222]
francium 87 Fr [223]
radium 88 Ra [226]
89-102 * *
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rutherfordium 104 Rf [261]
dubnium 105 Db [262]
seaborgium 106 Sg [266]
bohrium 107 Bh [264]
hassium 108 Hs [269]
meitnerium 109 Mt [268]
ununnilium 110 Uun [271]
unununium 111 Uuu [272]
ununbium 112 Uub [277]
ununquadium 114 Uuq [289]
*Lanthanide series
lanthanum 57 La 138.91
cerium 58 Ce 140.12
praseodymium 59 Pr 140.91
neodymium 60 Nd 144.24
promethium 61 Pm [145]
samarium 62 Sm 150.36
europium 63 Eu 151.96
gadolinium 64 Gd 157.25
terbium 65 Tb 158.93
dysprosium 66 Dy 162.50
holmium 67 Ho 164.93
erbium 68 Er 167.26
thulium 69 Tm 168.93
ytterbium 70 Yb 173.04
**Actinide series
actinium 89 Ac [227]
thorium 90 Th 232.04
protactinium 91 Pa 231.04
uranium 92 U 238.03
neptunium 93 Np [237]
plutonium 94 Pu [244]
americium 95 Am [243]
curium 96 Cm [247]
berkelium 97 Bk [247]
californium 98 Cf [251]
einsteinium 99 Es [252]
fermium 100 Fm [257]
mendelevium 101 Md [258]
nobelium 102 No [259]

C 230

NSEC - 2015									
C230			C281			C252			C243	
Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key
1	C		1	C		1	C		1	C
2	D		2	D		2	D		2	D
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4	D		4	D		4	D		4	D
5	A		5	A		5	A		5	A
6	C		6	C		6	C		6	C
7	C		7	C		7	C		7	C
8	A		8	D		8	B		8	B
9	D		9	C		9	D		9	B
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12	C		12	C		12	A		12	D
13	B		13	B		13	A		13	C
14	C		14	B		14	B		14	B
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21	C		21	C		21	B		21	B

NSEC - 2015									
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Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key
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26	C		26	D		26	B		26	C
27	B		27	D		27	D		27	B
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41	B		41	B		41	C		41	A
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NSEC - 2015									
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Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key
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47	B		47	B		47	D		47	A
48	D		48	A		48	D		48	C
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61	D		61	B		61	D		61	C
62	C		62	B		62	A		62	B
63	A		63	D		63	D		63	D

NSEC - 2015

C230			C281			C252			C243	
Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key		Q.No.	Answer key
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69	C		69	D		69	D		69	B
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76	D		76	D		76	D		76	D
77	C		77	C		77	C		77	C
78	A		78	A		78	A		78	A
79	D		79	D		79	D		79	D
80	B		80	B		80	B		80	B

All quires regarding the answer keys should be sent only to iaptpune@gmail.com with in December 2nd 2015

Thanks for the suggestions to the answer keys. The expert committee has gone through all the suggestions and recommended the corrections to answer keys for NSEC- 2017. No more queries and suggestions will be accepted. The list of students above MAS will be announced on December 22nd, 2017.

Qp Code 321		Qp Code 322		Qp Code 323		Qp Code 324	
Question No.	**Answer**	**Question No.**	**Answer**	**Question No.**	**Answer**	**Question No.**	**Answer**
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5	C	5	C	5	D	5	C
6	C	6	A	6	Deleted	6	C
7	C	7	D	7	C	7	B
8	B	8	Deleted	8	C	8	C
9	C	9	A	9	D	9	Deleted
10	C	10	C	10	D	10	C
11	A	11	B	11	D	11	C
12	D	12	D	12	C	12	deleted
13	Deleted	13	A	13	B	13	D
14	A	14	D	14	C	14	A
15	C	15	A	15	Deleted	15	C
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23	C	23	C	23	C	23	Deleted
24	D	24	B	24	D	24	A
25	D	25	C	25	B	25	C
26	D	26	Deleted	26	C	26	C
27	C	27	C	27	Deleted	27	D
28	B	28	B	28	Deleted	28	Deleted
29	C	29	B	29	A	29	D
30	Deleted	30	B	30	A	30	C
31	C	31	C	31	C	31	A
32	B	32	B	32	B	32	D
33	B	33	D	33	D	33	C

34	B		34	A		34	Deleted		34	C
35	B		35	C		35	B		35	A
36	D		36	D		36	C		36	Deleted
37	A		37	B		37	B		37	A
38	C		38	C		38	C		38	B
39	D		39	Deleted		39	C		39	B
40	B		40	Deleted		40	C		40	C
41	C		41	A		41	B		41	A
42	Deleted		42	A		42	A		42	D
43	Deleted		43	C		43	deleted		43	A
44	A		44	B		44	C		44	B
45	A		45	D		45	C		45	D
46	C		46	Deleted		46	C		46	Deleted
47	B		47	D		47	B		47	C
48	D		48	C		48	C		48	C
49	Deleted		49	C		49	Deleted		49	D
50	B		50	C		50	C		50	D
51	C		51	C		51	C		51	D
52	B		52	C		52	deleted		52	C
53	C		53	B		53	D		53	B
54	C		54	A		54	A		54	C
55	C		55	deleted		55	C		55	Deleted
56	B		56	C		56	C		56	C
57	A		57	C		57	C		57	B
58	**deleted**		58	C		58	B		58	B
59	C		59	B		59	C		59	B
60	C		60	C		60	C		60	B
61	C		61	Deleted		61	A		61	D
62	B		62	C		62	D		62	A
63	C		63	C		63	Deleted		63	C
64	Deleted		64	D		64	A		64	D
65	C		65	Deleted		65	C		65	B
66	C		66	D		66	C		66	C
67	D		67	C		67	D		67	Deleted
68	Deleted		68	A		68	Deleted		68	Deleted
69	D		69	A		69	D		69	A
70	C		70	B		70	C		70	A
71	A		71	B		71	A		71	C
72	D		72	C		72	D		72	B
73	C		73	Deleted		73	C		73	D
74	C		74	A		74	C		74	Deleted
75	A		75	Deleted		75	A		75	B
76	B		76	deleted		76	Deleted		76	C
77	B		77	D		77	A		77	B
78	C		78	A		78	B		78	C
79	Deleted		79	C		79	B		79	C
80	A		80	C		80	C		80	C

NSEC 2018 Answer keys

Qp Code C321		Qp Code C322		Qp Code C323		Qp Code C324	
Question No.	**Answer Keys**	**Question No.**	**Answer Keys**	**Question No.**	**Answer Keys**	**Question No.**	**Answer Keys**
1	C	1	A or C	1	C	1	A
2	C	2	B	2	B	2	B
3	D	3	A	3	C	3	D
4	A or C	4	D	4	C	4	C
5	A	5	C	5	C	5	D
6	D	6	D	6	D	6	B
7	D	7	D	7	C	7	C
8	C	8	A	8	C	8	B
9	C	9	C	9	A	9	B
10	**deleted**	10	B	10	A	10	D
11	C	11	A	11	D	11	A
12	B	12	C	12	C	12	B
13	A	13	D	13	C	13	C
14	B	**14**	**deleted**	14	D	14	A or C
15	C	15	C	15	D	15	C
16	**deleted**	16	C or D	16	D	16	C
17	D	17	C	17	B	17	D
18	B	18	D	18	A	18	C
19	C	19	B	19	B	19	D
20	A	20	D	20	D	20	B
21	D	21	D	21	C	**21**	**deleted**
22	A	22	B	22	C or D	22	D
23	C	23	A	23	B	23	C
24	D	24	D	**24**	**deleted**	24	C or D
25	B	25	C	25	B	25	C
26	B	**26**	**deleted**	26	D	26	C
27	C	27	D	27	B	27	A
28	A	28	C	28	C	28	A
29	**deleted**	29	B	29	D	29	C
30	D	30	B	30	B	**30**	**deleted**
31	C	31	D	31	D	31	B
32	A	32	A	32	B	32	B
33	D	33	C	33	D	33	D
34	D	34	B	34	D	34	A
35	B	35	A	35	C	35	C

36	C		**36**	**deleted**		36	D		36	C
37	C		37	C		37	A		37	D
38	C		38	B		38	B		38	C
39	B		39	D		39	C		39	C
40	A		40	B		40	B		40	D
41	D		41	C		41	D		41	D
42	C		42	D		42	C		42	C
43	D		43	C		**43**	**deleted**		43	C
44	A		44	C		44	D		44	C
45	D		45	A		45	D		45	B
46	B		46	A		46	D		46	D
47	D		47	B		47	A		47	D
48	A		48	C		48	C		48	C
49	C		49	C		49	B		49	B
50	C or D		50	C		50	C		50	A
51	D		51	A		51	A or C		51	D
52	A		52	D		52	C		52	B
53	C		53	C		53	C		53	D
54	B		54	B		54	C		54	B
55	B		55	A		55	C		55	D
56	C		56	C		56	C		56	A
57	D		57	C		57	B		57	C
58	C		58	B		58	B		58	C
59	C		59	C		59	C		59	A
60	B		60	C		60	C		60	C
61	B		61	D		61	B		61	B
62	D		62	C		62	B		62	D
63	C		63	C		63	C		63	D
64	B		64	D		64	C		64	C
65	C		65	B		65	A		65	C
66	D		66	D		66	C		66	B
67	C		67	C		67	**deleted**		67	A
68	C		68	D		68	C		68	**deleted**
69	**deleted**		69	C		69	D		69	**deleted**
70	C		70	C		70	A		70	C
71	C		71	C		71	A		71	C
72	B		72	C		72	D		72	C
73	C		**73**	**deleted**		73	C		73	A
74	C		74	C		**74**	**deleted**		74	A
75	A		75	B		75	C		75	C
76	C		76	D		76	A		76	B
77	D		77	A		77	D		77	C
78	D		78	D		78	A		78	D
79	C		79	B		79	C		79	D
80	B		80	C		80	A		80	C

Time: 2:30 PM to 3:45 PM

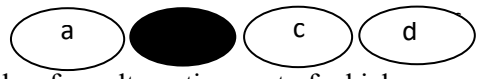
Question Paper Code: 31

Roll No. of Student's													

Write the question paper code mentioned above on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the question paper.

Instructions to Candidates:

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY **PROHIBITED.**
2. In addition to this question paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
4. On the OMR Answer Sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **14-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in Indian Olympiad Qualifier in Chemistry 2021-22 (Part I).
6. Question paper has two parts. In part A-1(Q. No.1 to 24) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as below.

Q.No.12 

In part A-2 (Q. No. 25 to 32) each question has four alternatives out of which any number of alternative(s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q.No.30 

7. For **Part A-1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A-2,** you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
8. Rough work should be done in the space provided. There are **10** printed pages in this paper
9. Use of **non- programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting answer paper, take away the question paper & Candidate's copy of OMR for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR answer sheet.

OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Instructions to Candidates (Continued) :

You may read the following instructions after submitting the answer sheet.

12. **Comments/Inquiries/Grievances regarding this question paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in on the specified format till January 29, 2022.**
13. **The answers/solutions to this question paper will be available on the website: www.iapt.org.in by January 27, 2022.**

14. **CERTIFICATES and AWARDS:**

Following certificates are awarded by IAPT/ACT to students, successful in the Indian Olympiad Qualifier in Chemistry 2021-22 (Part I)

(i) "CENTRE TOP 10 %" To be downloaded from iapt.org.in after 15.03.22
(ii) "STATE TOP 1 %" Will be dispatched to the examinee
(iii) "NATIONAL TOP 1 %" Will be dispatched to the examinee
(iv) "GOLD MEDAL & MERIT CERTIFICATE" to all students who attend OCSC – 2022 at HBCSE Mumbai

Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having score above MAS will be displayed on the website: **www.iapt.org.in** by **February 06, 2022 See the Minimum Admissible Score Clause** on the Student's brochure on the web.

16. List of students eligible for evaluation of IOQC 2021-22 (Part II) shall be displayed on www.iapt.org.in by February 10, 2022.

Useful constants

Charge of electron, $e = 1.602 \times 10^{-19} C$

Mass of electron, $m_e = 9.1 \times 10^{-31} kg$

Planck's constant, $h = 6.626 \times 10^{-34} J\,s$

Speed of light, $c = 3.0 \times 10^{8} ms^{-1}$

Avogadro constant, $N_A = 6.022 \times 10^{23} mol^{-1}$

Molar gas constant, $R = 0.082 L\,atm\,mol^{-1} K^{-1}$

$= 8.314 J\,mol^{-1}\,K^{-1}$

CHEMISTRY 2021-22 (Part I) (NSEC 2021 – 22)

Time: 75 Minutes **Max. Marks: 120**

Attempt All Thirty Two Questions

A – 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION

1. The correct order of CFSE of the following complex ions is
$[Zn(NH_3)_4]^{2+}$, $[Co(NH_3)_6]^{2+}$, $[Co(NH_3)_6]^{3+}$, $[Ir(NH_3)_6]^{3+}$

(a) $[Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$
(b) $[Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+} > [Co(NH_3)_6]^{3+} > [Ir(NH_3)_6]^{3+}$
(c) $[Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+}$
(d) $[Co(NH_3)_6]^{3+} > [Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$

2. Solvents are classified as polar and nonpolar based on their dipole moments.
Given below are some solvents.
(p)1,2-dibromobenzene (q) diisopropylether (r) trans-1,2-dichloroethene
(s) 1,2-dichloroethane (t) N-ethyl-N-methylpropan-1-amine
The set in which all solvents are polar is
(a) p, s, t (b) p, q, r (c) r, s, t (d) q, r, t

3. Which of the following statement/s is/are correct?

I. Half-life is 50 % of the total time taken for the completion of a reaction
II. Collision frequency (Z), which is the number of collisions per second per unit volume, is same as the rate constant of the reaction
III. A change in the activation energy of a reaction at a particular temperature will result in a proportional change in the rate and rate constant of the reaction at the same temperature
IV. All first order reactions are not unimolecular
V. For a zero order reaction, slope of a plot of $t_{1/2}$ Vs. initial concentration will be zero

(a) I, IV (b) II only (c) IV only (d) II, III,V

4. The orange colour of $K_2Cr_2O_7$ and yellow colour of K_2CrO_4 are, respectively, due to
(a) charge transfer transitions and d-d transitions
(b) d-d transitions and charge transfer transitions
(c) charge transfer transitions in both
(d) d-d transitions in both

5. One mole of neon (atomic mass = 20 g mol^{-1}) and one mole of argon (atomic mass = 40 g mol^{-1}) are stored in two separate containers I and II, at temperature T and 2T respectively. If both the gases are assumed to behave ideally

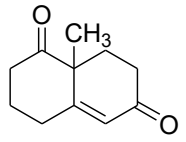
(a) K.E. and average velocity of the gas molecules will be the same in both I and II

(b) K.E. and average velocity of the gas molecules in II will be twice that of the gas molecules in I

(c) K.E. of the gas molecules in II will be twice that in I and average velocity of the gas molecules in both I and II will be the same

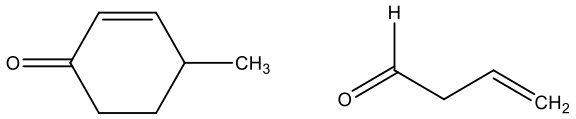
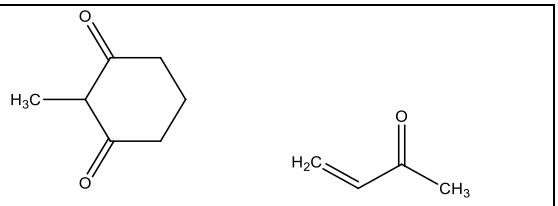
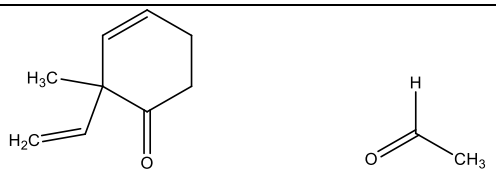
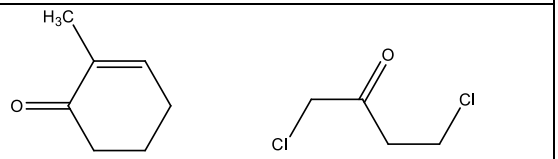
(d) Both K.E. and average velocity of the gas molecules in I will be twice that of the gas molecules in II

6. An aldehyde/ketone in the presence of a base forms a carbanion at the α-position which can react with a carbonyl group in an Aldol type of reaction. It can also react with an olefinic double bond which is activated by groups like CO, CN, NO_2 attached to the double bond. The latter reaction is an addition reaction across the double bond. Wieland-Miescher ketone is an important synthetic intermediate used to synthesize many compounds

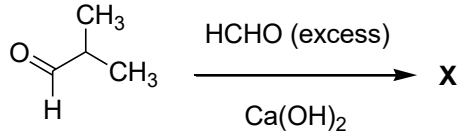


Wieland-Miescher Ketone

The pair of starting materials suitable for preparation of Wieland-Miescher ketone through a base catalysed reaction is

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

7. '**X**' in the following reaction is



2-methylpropanal

(a) 2,2-Dimethyl-1,3-propanediol

(b) 2-Methylpropan-1-ol

(c) iso-butyric acid

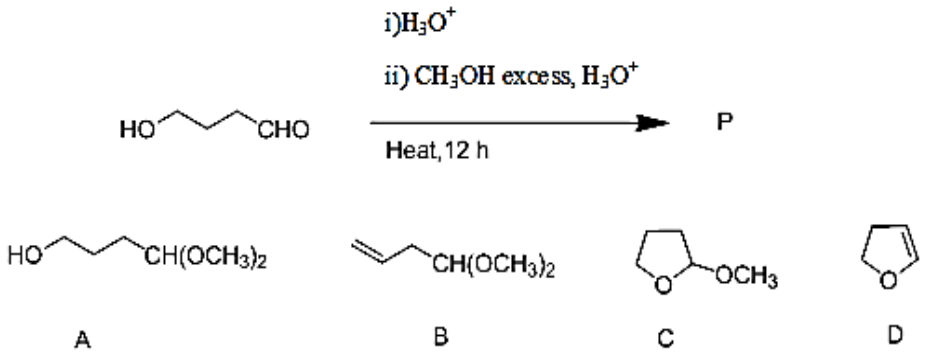
(d) 3-Hydroxy-2,2-dimethylpropanal

8. When 0.805 g of the potassium salt $(CH_2)_n(COOK)_2$ of a dibasic organic acid was reduced, 0.323 g of potassium was obtained. Molar mass of the acid is
(a) 194 (b) 116 (c) 118 (d) 156

9. Among (i) HCl, (ii) HOClO, (iii) $HOClO_2$ and (iv) $HOClO_3$, which cannot undergo a disproportionation reaction?
(a) Only (i) (b) (ii) and (iii) (c) (i) and (iv) (d) (ii), (iii) and (iv)

10. The electronic transition in He^+ ion that will occur at the same wavelength as that of the n = 2 to n = 1 transition in H atom is
(a) n = 2 to n = 1 (b) n = 3 to n = 1 (c) n = 3 to n = 2 (d) n = 4 to n = 2

11. '**P**' in the following reaction is



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

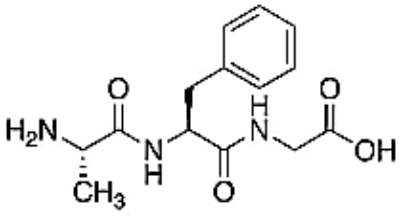
12. The number of stereoisomers is maximum for (ox = $C_2O_4^{2-}$)
(a) $[Co(ox)_3]^{3-}$ (b) $[Co(ox)_2ClBr]^{3-}$ (c) $[Co(ox)Cl_2Br_2]^{3-}$ (d) $[CoCl_3Br_3]^{3-}$

13. Maximum number of electrons with m_s = ½ which can be accommodated in subshells having total three nodes is
(a) 10 (b) 16 (c) 20 (d) 32

14. The Hinsberg test of the compound **X** produces a solid compound **Y** that is insoluble in 10 % aq. NaOH. **Y** dissolves in 10 % aq. sulphuric acid. The compound **X** is
(a) $NH_2CH_2CH_2CH_2N(CH_3)_2$ (b) $(CH_3)_2NCH_2CH_2NHCH_3$
(c) $NH_2CH_2C(CH_3)_2CH_2NH_2$ (d) $(CH_3)_2NCH_2N(CH_3)_2$

15. An ionic species, M^{3+}, is isoelectronic with $CuCl_2$ and has (Z+2) neutrons. The molar mass of M^{3+} is
(a) 128 (b) 62 (c) 68 (d) 134

16. In compound **X,** the number of chiral centres and the number of peptide linkages are, respectively



X

(a) 2,3 (b) 3,2 (c) 2,2 (d) 3,3

17. Which of the following reactions is *NOT* an example of Lewis acid-Lewis base reaction?

(a) $Zn + I_3^- \rightarrow Zn^{2+} + 3I^-$ (b) $I_2 + I_3^- \rightarrow I_5^-$

(c) $CoCl_3 + Cl^- \rightarrow CoCl_4^-$ (d) $SO_3 + H_2O \rightarrow H^+ + HSO_4^-$

18. A student intended to prepare 1000 mL of a 10 ppm solution of K^+ from KCl. He made appropriate calculations, weighed the salt accordingly and prepared the solution. However, after making the solution, he realized that the salt he used was KNO_3 and not KCl. The concentration of K^+ (ppm) in this prepared solution is

(a) 7.37 (b) 10.00 (c) 13.55 (d) 3.86

19. Oxide A is soluble in NaOH, oxide B in HCl and oxide C in both. The correct set of A, B and C is

	A	B	C
(a)	CO_2	SO_2	PbO_2
(b)	CO_2	Na_2O	ZnO
(c)	SO_2	ZnO	SnO_2
(d)	SO_2	BaO	Na_2O

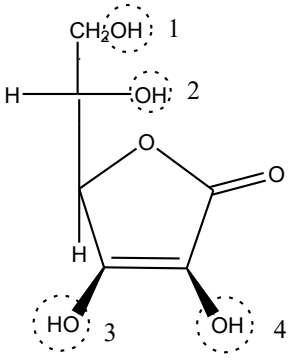
20. Ascorbic acid (Vitamin C), a naturally occurring water soluble vitamin and abundantly found in lemon, shows antioxidant properties. In ascorbic acid, the OH with the lowest pKa is

(a) 1

(b) 2

(c) 3

(d) 4



Ascorbic Acid

21. Compound **'X'** ($C_7H_{12}O_2$) gives - i) a positive silver mirror test and ii) a yellow precipitate on treatment with I_2/NaOH. The compound **'X'** is

(a) 2-hydroxy-3,3-dimethylcyclopentanone (b) 2,5-heptanedione

(c) 2,2-dimethyl-3-oxopentanal (d) 2,2-dimethyl-4-oxopentanal

22. If the ratio of the concentrations of the oxidized and reduced forms of a species in an electrochemical reaction can be given as [Ox]/[Red] = 1.0×10^{-3}, the correct expression among the following at 25°C is

(a) $E = E^o + \frac{1}{3}(0.0592/n)$ (b) $E - E^o = 3 \times (0.0592/ n)$

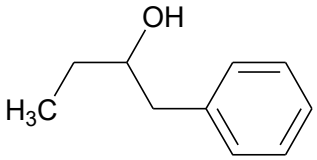
(c) $E = E^o - \frac{1}{3}(0.0592/n)$ (d) $E - E^o = (0.0592/n)^{1/3}$

23. Among the following numbers, the one in which all the zeros are significant is

(a) 0.0004 (b) 0.0400 (c) 40.000 (d) 0.0040

24. Among the following sets of compounds, the one in which a reaction between them followed by hydrolysis that *does not* lead to the formation of 1-phenyl-2- butanol is

(a) phenylacetaldehyde and ethylmagnesium bromide
(b) butanal and phenylmagnesium bromide
(c) propanal and benzylmagnesium bromide
(d) 1-phenyl-2-butanone and $NaBH_4$



1-phenyl-2-butanol

A-2

ANY NUMBER OF OPTIONS 4, 3, 2 or 1 MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL CORRECT OPTIONS ARE BUBBLED, AND NO WRONG OPTION

25. At room temperature**,** NaCl(s) and KCl(s) were taken in equal masses and dissolved in equal volumes of water in two separate closed containers I and II respectively.
Of the following, correct option/s is/are

(a) To compare molarities in (I) and (II), masses of both the solutions need to be known

(b) Molalities cannot be compared without measuring the mass of water added in each case

(c) If (I) and (II) are completely transferred into another container (III), [Cl^-] in (III) will be sum of that in (I) and (II)

(d) Information given is sufficient to compare the vapour pressures in (I) and (II)

26. In a pair of isomers of molecular formula C_5H_8, both the compounds undergo catalytic hydrogenation to form compounds of molecular formula C_5H_{10}. On ozonolysis followed by oxidative workup (H_2O_2), one of the isomers gives a diacid ($C_5H_8O_4$) while the other isomer gives a ketoacid ($C_5H_8O_3$). The pair/s which give/s above set of reactions is/are

(a) 3-ethylcyclopropene and 1-pentyne

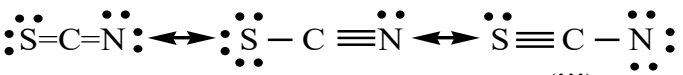
(b) cyclopentene and 1-methylcyclobutene

(c) 1-methylcyclobutene and 3-methylcyclobutene

(d) 1,2-dimethylcyclopropene and 3-methylcyclobutene

27. The resonance structures of SCN^- are given below along with the S-C and C-N bond lengths

	S-C (in pm)	C-N (in pm)
SCN^-	165	117
Single bond	181	147
Double bond	155	128
Triple bond	-----	116



(i) (ii) (iii)

Among the following, the *incorrect* statement/s is/ are

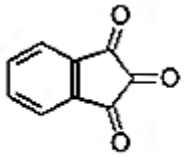
(a) The contribution from resonance structures (i) and (ii) is more important than that from structure (iii)

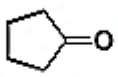
(b) The formal charge on S in structure (iii) is zero

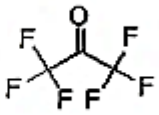
(c) The degree of contribution of these structures is in the order: i > ii > iii

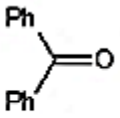
(d) The formal charge on N in structure (ii) is zero

28. The compound/s which form/s stable hydrate/s is/are


(a)

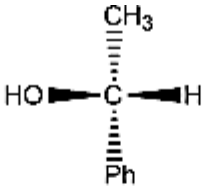

(b)

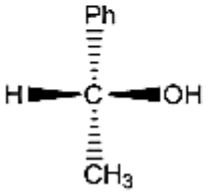

(c)

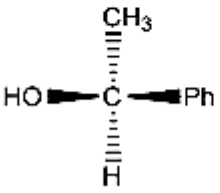

(d)

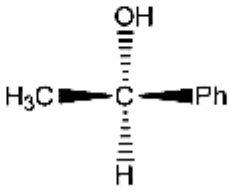
(a) a (b) b (c) c (d) d

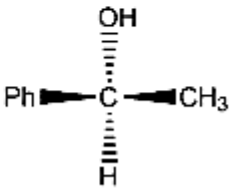
29. The formula/e which also represent/s a compound with formula **X** is/are


X


a


b


c

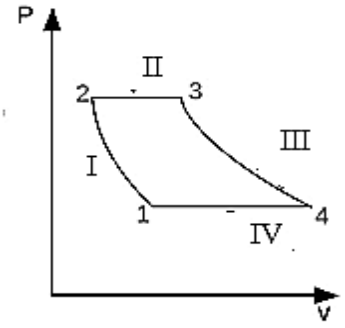

d

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

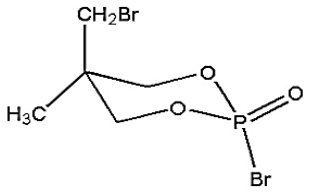
30. Following is the *P* vs *V* plot of a cyclic process 1 →2, 2 →3, 3 →4, 4 →1, denoted as I, II, III and IV respectively for a system of one mole of an ideal gas.

Assume that there is heat exchange between the system and surroundings only in II and IV.
Which of the following is/are correct?

(a) In II and IV ΔS is zero
(b) In I and III, ΔS is zero
(c) I and III are isothermal and reversible
(d) In II and IV, change in internal energy of the gas (ΔU) is zero



31. For the given compound, % s character of phosphorous hybrid orbitals which contribute to various bonds are given in the table below.

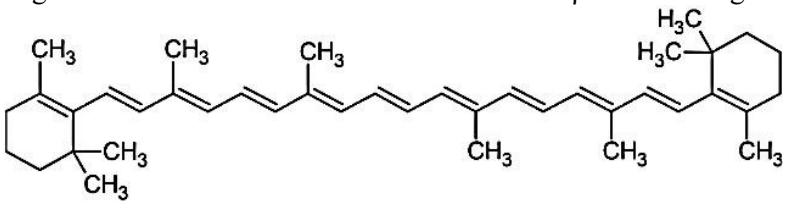


Bond	% s character
P=O	40
P-Br	< 20
P-O	20

This difference in % 's' character of various phosphorous bonds could be due to

(a) The large size of bromine atom
(b) The large electronegativity difference between P and O
(c) Increased overlap of σ-orbitals of terminal P-O bond
(d) Stronger covalent character of P-O in cyclic oxygen atoms

32. β-carotene and related compounds are plant pigments that give red, orange and yellow vegetables their vibrant colour. The structure of β-carotene is given below.



It is approved as a food additive in many countries. The correct statement/s that describe/s β-carotene is/are

(a) It is a strong oxidizing agent
(b) It reacts with singlet oxygen, an excited form of O_2, to produce an epoxide
(c) It absorbs red/yellow light of electromagnetic spectrum
(d) It comes in the oil phase when carrots are cooked in oil and water in a curry

IUPAC Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen 1.008 [1.0078, 1.0082]			Key: atomic number / Symbol / name / conventional atomic weight / standard atomic weight														2 He helium 4.0026
3 Li lithium 6.94 [6.938, 6.997]	4 Be beryllium 9.0122											5 B boron 10.81 [10.806, 10.821]	6 C carbon 12.011 [12.009, 12.012]	7 N nitrogen 14.007 [14.006, 14.008]	8 O oxygen 15.999 [15.999, 16.000]	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305 [24.304, 24.307]											13 Al aluminium 26.982	14 Si silicon 28.085 [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur 32.06 [32.059, 32.076]	17 Cl chlorine 35.45 [35.446, 35.457]	18 Ar argon 39.95 [39.792, 39.963]
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 [79.901, 79.907]	36 Kr krypton 83.798(2)
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 1 December 2018.

United Nations Educational, Scientific and Cultural Organization

2019 IYPT International Year of the Periodic Table of Chemical Elements

IUPAC

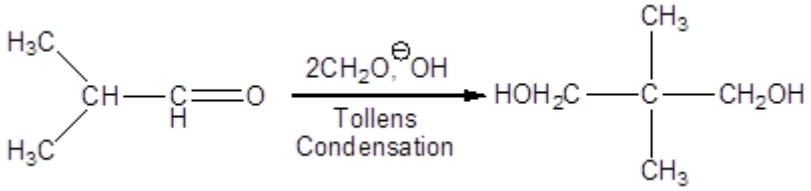
ROUGH WORK

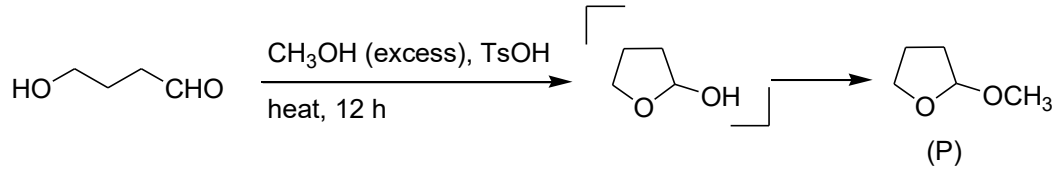
INDIAN OYMPIAD QUALIFIER IN CHEMISTRY 2021-22 (PART- I)

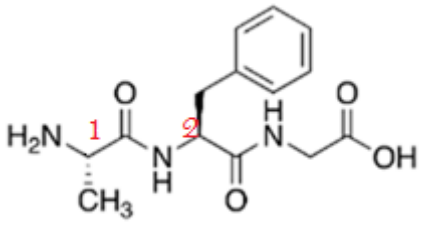
IOQC 2021-22 PART I (NSEC) Held on March 20, 2022

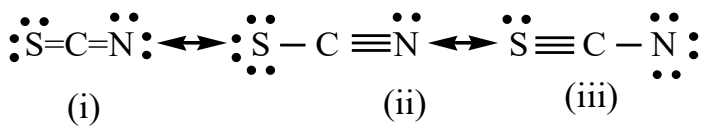
FINAL ANSWER KEY FOR IOQC 2021-22 PART 1

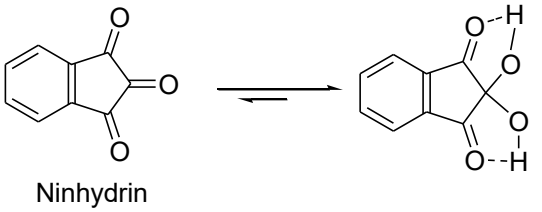
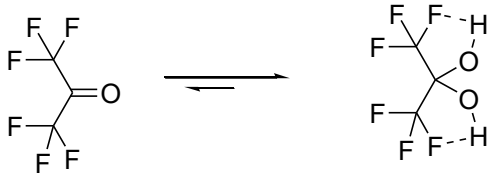
QUESTION	PAPER CODE 31	PAPER CODE 32	PAPER CODE 33	PAPER CODE 34
1	a	c	c	c
2	a	a	c	b
3	c	a	d	a
4	c	b or c	c	c
5	c	c	c	c
6	b	d	b	d
7	a	b	b	c
8	c	c	d	c
9	c	b	c	b
10	d	a	a	b
11	c	a	a	d
12	c	c	b or c	c
13	b	c	c	a
14	b	c	d	a
15	d	b	b	b or c
16	c	a	c	c
17	a	c	b	d
18	a	c	a	b
19	b or c	d	a	c
20	c	c	c	b
21	d	c	c	a
22	b	b	c	a
23	c	b	b	c
24	b	d	a	c
25	d	a, c	a, c	b, c
26	b, c	b, d	a, c	b or b, c
27	b or b, c	d	b	a, c
28	a, c	b, c	a, c	a, c
29	a, c	b or b, c	b, d	b
30	b	a, c	d	a, c
31	a, c	a, c	b, c	b, d
32	b, d	b	b or b, c	d

	IOQC 2021-22 Part-I (NSEC 2021-22)
	SOLUTION PAPER CODE - 31
	SECTION A-1
1	The magnitude of CFSE depends upon- (1) Geometry of the complex (Octahedral complexes have higher CFSE than Tetrahedral complexes), (2) Oxidation state of metal (higher the oxidation state, larger the CFSE), (3) Size of metal (5d metal have higher CFSE than 4d which have larger CFSE than 3d metals) and (4) Nature of ligand (stronger the ligand, larger is the CFSE). On the basis of 1, 2 and 3 factors. **Correct Option (a)**
2.	The set of which contains all polar solvents is (p)1,2-dibromobenzene (s) 1,2-dichloroethane (t) N-ethyl-N-methylpropan-1-amine **Correct Option: (a)**
3.	First order reaction need not be unimolecular. Order is experimentally determined and it is not related with molecularity. **Correct option: (c)**
4.	Colour is due to charge transfer transitions in both the cases. In both compounds, the oxidation state of Cr is +6 i.e., d^0 configuration. Hence d-d transition is not possible. **Correct option: (c)**
5.	K.E. $= \frac{3}{2} kT,$ hence K.E (Ne) $= \frac{3}{2} kT$ *and* for K.E. (Ar) $= \frac{3}{2} k(2T) = 3kT$ Thus K.E. will be twice in II (Ar) than in I (Ne). $\nu_{av.} = \sqrt{\frac{8RT}{\pi M}}$, for ν_{av} (Ne) $= \sqrt{\frac{8RT}{\pi 20}}$ for ν_{av} (Ar) $= \sqrt{\frac{8R(2T)}{\pi 40}} = \sqrt{\frac{8RT}{\pi 20}}$ $V_{av\ (Ne)} = V_{av\ (Ar)}$ Average velocity for both I and II will be same. **Correct option: (c)**
6.	The anion obtained from 2-methylcyclohexane-1,3-dione will undergo Michael type addition reaction with 3-buten-2-one. The Michael addition product will undergo intramolecular aldol condensation reaction to yield the Wieland-Miescher ketone. **Correct option: (b)**
7.	2-methylpropanal will undergo cross-aldol condensation followed by cross- cannizaro reaction. **Correct Option (a)** 
8.	1 mole of K salt of dibasic acid = 2 moles of K 0.805 g of salt = 0.323 g of K

	X g of salt = 39 x 2=78g of K hence X = 194 Mol wt of salt of acid =194 hence Mol wt acid = 194-78+2 =**118 g/mol** **Correct Option (c)**
9.	Disproportionation reactions are those redox reactions in which an element undergoes both oxidation and reduction. Any element in its highest or lowest oxidation state cannot show disproportionation reactions. In HCl and $HOClO_3$ the Cl atoms are in lowest oxidation state (-1) and highest oxidation state (+7) respectively. Hence (i) and (iv) cannot show disproportionation reactions. While Cl atom in HOClO (ii) and $HOClO_3$ (iii) have intermediate oxidation states of +3 and +5 respectively, hence can show disproportionation reactions. **Correct option (c)**
10.	$\frac{1}{\lambda} = R_H Z^2 [\frac{1}{n1^2} - \frac{1}{n2^2}]$ substituting Z =2 for He^+ and n = 4 and n = 2 we get: $\lambda = \frac{4}{3\,RH}$ $\frac{1}{\lambda} = R_H Z^2 [\frac{1}{n1^2} - \frac{1}{n2^2}]$ substituting Z =1 for H and n = 2 and n = 1 we get: $\lambda = \frac{4}{3\,RH}$ λ is same for Hydrogen n = 2 to n = 1and for He^+ n = 4 to n = 2. **Correct option: (d)**
11.	Intramolecular cyclisation will lead to the formation of a hemi acetal. This product will be converted to acetal, C on treatment with excess Methanol in presence of TsOH. **Correct option : (c)**  (P)
12.	The option (a) has 2 optical stereoisomers- d and l. Option (b) has 2 geometrical isomers- cis and trans. The cis isomer exists in d and l forms while trans is optically inactive, hence a total of 3 stereoisomers. Option (c) has 3 geometrical isomers-one cis and two trans. The cis isomer exists in d and l forms while both the trans isomers are optically inactive, hence a total of 4 *stereoisomers.* Option (d) has 2 geometrical isomers- facial and meridional, hence a total of 2 stereoisomers **Correct option : (c)**
13.	\When total nodes are 3, then the subshells will be 4s (Radial node = 3 + Angular node = 0), 4p (RN = 2 + AN = 1), 4d (RN = 1 + AN = 2) and 4f (RN = 0 + AN = 3). There will be 2 for 4s, 6 for 4p, 10 for 4d and 14 for 4f electrons i.e. 32 electrons. Half of it, that is 16 electrons will have m_s = ½. RN = n-l-1, AN = l. (n = principal quantum no, l = azimuthal quantum no.) **Correct option : (b)**
14	Since the compound 'X' responds to Hinsberg test to produce a solid compound, Y. 'Y' is insoluble in 10% aq. NaOH. However, the compound gets dissolved in 10% aq. sulfuric acid. Considering all such conditions, b is the best option. **Correct option : (b)**
15	M^{3+} has same no. of electrons to that of $CuCl_2$= (29+34) = 63 So, atomic no. (Z) of M^{3+} = (63+3) = 66 = (no. of protons (P) in M^{3+})

	No. of neutrons(N) in M^{3+} = (Z+2) = (66+2) = 68 Therefore, ionic mass of M^{3+}= (P+N) = (66+68) = 134 **Correct option : (d)**
16.	 There are two chiral centers marked red in the structure and two peptide linkages represented by two -CO-NH- hence **Correct option: (c)**
17	Reaction (a) is simply a redox reaction. Since no transaction of lone pair is involved, it is not Lewis acid-Lewis base type reaction. **Correct option: (a)**
18.	19.1025 mg KCl is required to be dissolved in 1000 ml of water to get10 ppm K^+ solution. Now when 19.1025 mg happens to be KNO_3 salt instead of KCl then the concentration K^+ ions in the solution will be =19.1025x39/101= 7.37 mg/1000 ml =7.37 ppm. **Correct Option (a)**
19	The set of oxide in which A is soluble in NaOH , B in HCl and C in both are b or c. **Correct Option (b) or (c)**
20	H of -OH marked '3' is more acidic because its conjugate base formed will be more resonance stabilized. Since it is more acidic hence it will have lower Pka. **Correct Option: (c)**
21	The molecule must have –CHO as well as CH_3–CO both present in its structure to give Silver mirror test and yellow precipitate with I_2/NaOH. Hence (d) 2,2-dimethyl-4-oxopentanal is the best option. **Correct option: (d)**
22	$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Oxi]}{[Red]}$ $E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log 1 \times 10^{-3}$ $E_{cell} - E^0_{cell} = - \frac{0.0592}{n} (-3)$ $E_{cell} - E^0_{cell} = 3. \frac{0.0592}{n}$ **Correct Option (b)**

23	Among the following numbers, the one in which all the zeros are significant is (a) 0.0004 (b) 0.0400 (c) 40.000 (d) 0.0040 **Correct Option (c)**
24	butanal and phenylmagnesium bromide followed by hydrolysis gives 1-phenyl-2-butanol. **Correct Option (b)**
	SECTION A-2
25	(a)To compare molarities in (I) and (II),we need to know the masses of both the solutions --- this statement is incorrect, because information given at the beginning of the question is good enough to know the molarities (b)Molalities cannot be compared without measuring the mass of water added in each case -----it is incorrect statement as volume of water added was same in both the cases. (c)If (I) and (II) are completely poured into another container (III), $[Cl^-]$ in (III) will be sum of that in (I) and (II) -----this is an incorrect statement, because volume of [Cl -] solution formed by mixing (I) and (II) will be different. (d)Information given is sufficient to compare the vapour pressure in (I) and (II)---------- **is correct**, as lowering of vapour pressure is directly proportional to mole fraction of the solute. **Correct option (d)**
26.	The pairs which give above set of reactions are (b) cyclopentene and 1-methylcyclobutene (c) 1-methylcyclobutene and 3-methylcyclobutene **Correct options: b, c**
27.	 (i) (ii) (iii) Statement (b) In structure (iii), the charge on S is +1 and statement (c) -- The degree of contribution of these structures is in the order: i > ii > iii are wrong statements. **Correct options: b or b, c**
28	Ninhydrin (a) and 1,1,1,3,3,3-hexafluoropropan-2-one (c) will form stable hydrates due

	to their capability to take part in intramolecular Hydrogen bonding. **Correct option: Answer: a, c**  Ninhydrin 
29	The molecule 'X' is of *R*- configuration. This matches with both a and c. **Correct options: a, c**
30	(a) In II and IV ΔS is zero ----- incorrect, because temperature of the system increases and hence the entropy. (b) For I and III, ΔS is zero ---- correct, as they are isentropic processes (c) I and III are isothermal and reversible ------- incorrect, as the process is adiabatic and reversible (d) In II and IV, change in internal energy of the gas (ΔU) is zero – incorrect, as II and IV are isobaric, change in internal energy of the gas (ΔU) will not be zero. **Correct option: b**
31	The difference in % 's' character of various phosphorous bonds could be due to- The larger size of bromine atom and increased overlap of σ-orbitals of terminal P-O bond. **Correct options: a, c**
32	The correct statement(s) are (b) It reacts with singlet oxygen, an excited form of O_2, to produce an epoxide and (d) It comes in the oil phase when carrots are cooked in oil and water in a curry **Correct options: b, d**

Indian Olympiad Qualifier in Chemistry (IOQC) 2021-2022

conducted jointly by

Homi Bhabha Centre for Science Education (HBCSE-TIFR)

and

Association of Chemistry Teachers (ACT)

Part II: Indian National Chemistry Olympiad (INChO)

Homi Bhabha Centre for Science Education (HBCSE-TIFR)

Total 89 marks Time- 2 hours

Roll No. | | | | | – | | | | | – | | | | | | |

- Write your Roll No. at the space provided above.
- This question booklet consists of 12 printed sheets including periodic table. Check that the booklet has all the pages. If not, report to the invigilator immediately.
- You must show the main steps in the calculations and state the necessary assumptions wherever applicable.
- Answers written in pencil will be penalized.
- Use of non-programmable scientific calculator is allowed.
- A copy of the Periodic Table of the Elements is provided at the end.
- Do not leave the examination room until you are directed to do so.
- The answer sheet must be returned to the invigilator. You can carry this question paper with you.

Fundamental Constants

Avogadro number $N_A = 6.022 \times 10^{23}$ mol^{-1} 1 atm = 101325 Pa

Molar gas constant $R = 8.314$ J K^{-1} mol^{-1} Density of water = 1000 kg m^{-3}

$= 0.08205$ L atm K^{-1} mol^{-1}

$pH = -\log [H^+]$ $pK_a = -\log K_a$

Enthalpy of combustion of ethanol = - 1371 kJ mol^{-1}

Saturation vapour pressure of ethanol at 298 K = 0.08 atm

For air, $\gamma = C_p/C_v = 1.4$

Problem 1 20 marks

A journey into epoxy resins

Epoxy resins are a versatile group of chemicals used in many industrial applications, particularly due to their strong adhesive qualities, and stability under conditions such as high temperature, high humidity, and corrosive environments.

Several resin based materials are in use, whose molecular level structure can be represented as shown in figure 1. It has high molar mass molecules (shown by bold lines) which may be monomeric, polymeric, or mixed condensation products of two or more compounds. The molecules are held together with various crosslinking chains (shown by grey solid lines) and/or non-bonding interactions such as charged interaction, van-der Waals forces (shown by dashed lines). Depending on the packing of resin molecules, there may be pore spaces between the molecules. Further there may be additional molecules or ions which may be trapped in this structure during the material production process.

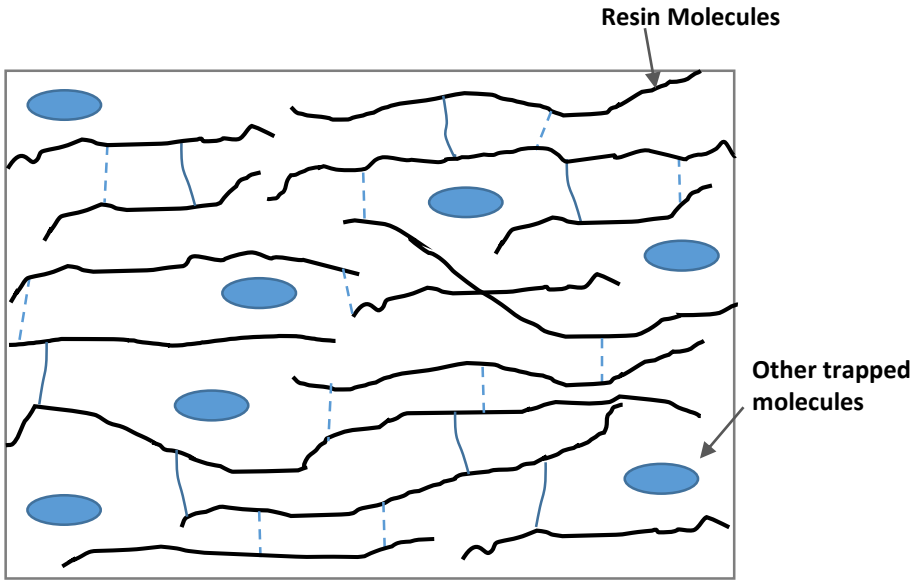


Figure 1: Model of a resin material

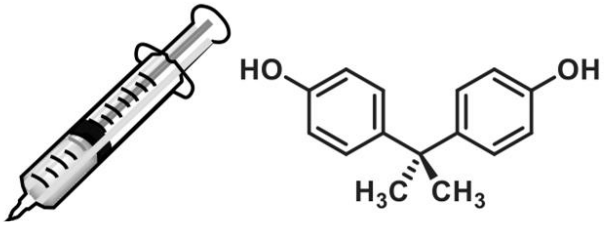
Properties of resinous materials depend on the nature of interactions between resin molecules (cross-links and non-bonding interactions), and their interactions with the trapped molecules. Sometimes interactions among the trapped molecules also may significantly affect the material properties.

One commonly known example of a commercial epoxy resin is supplied in a syringe/ tube containing a plunger and two compartments as shown in the figure 2. When the liquids present in these syringes are mixed, they condense together to produce resin.

Often, one syringe compartment contains epichlorohydrin (2 molar equivalent) and the other compartment is filled with Bisphenol A (1 molar equivalent) and NaOH (less than 2 molar equivalent).

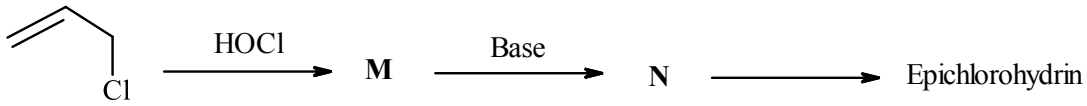
Figure 2: Commercial tube of an epoxy resin

Epichlorohydrin



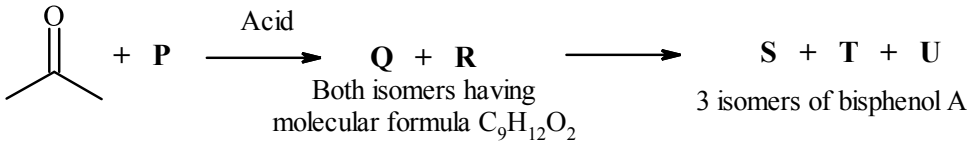
Bisphenol A

1.1. Epichlorohydrin is synthesized using a reaction of allyl chloride and hypochlorous acid as shown below. Draw the structures of **M** and **N** in the synthetic pathway.



1.2. Bisphenol A is often produced as a mixture of its isomers **S**, **T** and **U** via a reaction between acetone and compound **P** in presence of a mineral acid.

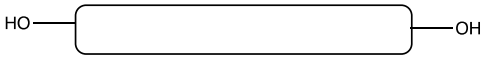
i) Draw the structures of **P** to **U** in reaction sequence shown below.



In this process, one of the isomers precipitates out easily as crystals, while the other two remain in solution and are separated by other means. This isomer also is found to have the highest melting point, indicating very strong intermolecular bonding, and is the only isomer having no optical activity.

ii) Identify this isomer (**S**, **T** or **U**).

In the following questions, if you are drawing a polymer, draw all end groups to receive full credit. For easier notation, phenyl groups can be represented as "Ph' and bisphenol A core unit ***if unchanged*** *in the reaction can be represented as following:*



When the two liquids in the two tubes (shown in Figure 2) are mixed, they react at a rate dependent on the concentration of epichlorohydrin and bisphenol A but not on the concentration of NaOH. Different molecules are obtained depending on the stoichiometric ratios of epichlorohydrin and bisphenol A.

1.3. **i)** Draw the structure of the predominant product **V** obtained when 2 equivalents of epichlorohydrin is treated with 1 equivalent of bisphenol A?

ii) Draw the structure of the product **W** obtained when bisphenol A is reacted with less than 2 equivalents of epichlorohydrin.

iii) Identify what kind of interactions are possible between two molecules of **W**.

a) ionic bonds

b) van der Waals bonding

c) H- bonds

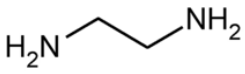
d) dipole-Dipole interactions

iv) To find the mechanism of the reaction in **1.3** i) and ii), one can do the isotopic labelling of one of the carbons wherein a particular carbon is replaced with a ^{13}C (e.g. $^{13}CH_3CH_2Cl$ or $CH_3{}^{13}CH_2Cl$ for chloroethane). In the above reaction, draw structures of all the ^{13}C-labelled molecules that would be suitable for investigating the reaction mechanism. Position of labelled carbon in a molecule can be identified spectroscopically.

Mechanical properties of resin material such as tensile strength depend significantly on the strength of bonds and their density within the material. Flexibility depends on ease with which resin and trapped molecules may slide over each other or change their molecular conformations without changing the structure and intermolecular bonds within the material.

v) What is the by-product formed in reaction described in **1.3 i)** and **ii)**? If not removed, is it likely to increase or decrease tensile strength of the resin matrix?

Epoxy resins are sometimes treated with co-reactants such as amines, acids, alcohols, thiols, etc., to modify its structural properties. Ethylene diamine is one such co-reactant.



Ethylene diamine

1.4. Draw the structure of the product formed in the following reactions carried out in polar aprotic solvent.

i) V is reacted with excess ethylene diamine (> 4 equivalents) at high dilution (1 g in 1000 mL).

ii) Excess of **V** (> 4 equivalents) is reacted with ethylene diamine at low dilution (1 g in 25 mL). This results in a chemical structure with charged groups.

iii) Treatment described in **1.4 ii)** makes the resin (mark X for the correct option(s)).

a) more flexible
b) more electrically conducting
c) gain in tensile strength

1.5. Epoxy resins act as adhesives for which of the following surfaces (mark X for all the correct ones).

i) surfaces made out of polyethylene, polystyrene.

ii) surfaces that have thiol (–SH) groups.

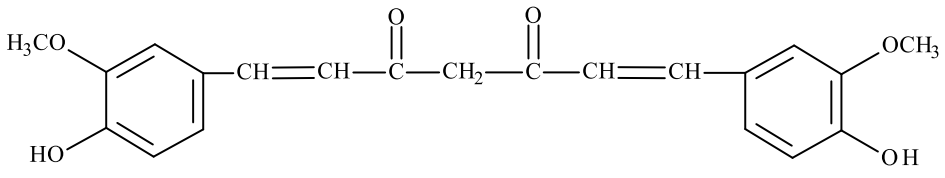
iii) cellulose surface on wood.

iv) polyester fabric.

Problem 2 — 19 marks

An edible compound and a colouring agent

A compound **Z** found in several natural edible plants has been an exciting area for researchers for centuries. It was first isolated from a plant in 1815 in Germany. A hundred years later, it was synthesized in laboratory and was identified to have the following structure.



Z

But it took a few more decades to understand its 3-D structural form existing in solutions and solids. In 1953, a scientist Srinivas in Chennai tried extracting **Z** again from the same plant source using benzene as a solvent. To check if the extract contained only **Z** or also other components, he added it into a chromatography column.

A chromatography column is a cylindrical tube filled with a stationary phase of a solid such as powdered silica. The mixture to be separated is added from the top followed by a solvent, which acts as the mobile phase. As the mobile phase flows down the silica in the tube, it carries components of mixture with it. Due to different affinities of components with stationary and mobile phases, these get separated into bands.

Using benzene as a mobile phase, Srinivas found 6 bands separating out as shown in Figure 1, of which three bands **1**, **2** and **4** were significant. One of these three bands was of **Z**, while the two other bands were of compounds **Y** and **X** with molar masses, 338 and 308, respectively, and similar molecular framework as **Z**.

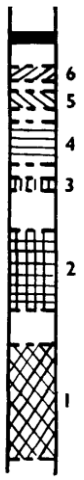


Figure 1: Chromatogram of benzene extract on silica

On reaction with acidic $FeCl_3$(aq), all three compounds gave very dark red colours, which according to Srinivas were more intense than what should be obtained due to phenolic groups in the structure shown above. He predicted that there should be other group(s) within molecules of **X**, **Y**, and **Z** which also bonds with Fe^{3+} ions. Several geometrical isomers are possible for **X, Y** and **Z**. Srinivas predicted that only one isomer is predominantly observed experimentally each for **Z**, **Y**, and **X** (which is also stabilized by several inter-atomic interactions in the molecules). All of his above predictions were found true by later experiments.

2.1 Based on Srinivas' inferences, draw the most stable geometrical isomer of **Z, Y and X**. Each structure should indicate all possible inter atomic interactions, if any.

2.2 Identify which of the bands **1**, **2** and **4** are **X**, **Y**, and **Z**.

2.3 Solubility of **Z** in aqueous solutions increases with pH, accompanied by change in its colour. Draw the form in which **Z** would exist in strongly alkaline solutions (pH ~ 14).

*In this problem, if structure is asked for ionic **compounds**, both ions should be shown.*

Until 20th century, boron was not known to be a part of plant tissues because analytical methods to determine it below milligram levels were not available. In the beginning of 20th century, reaction of boric acid with **Z** producing coloured compounds paved way for detailed analysis of boron in plant samples.

One of the challenges in using boric acid-**Z** reaction for quantitative analysis was reducing the time required for reaction to complete. Certain experiments indicated that initial addition of oxalic acid to the mixture of boric acid and **Z** finished the colour development in shorter time (in less than one hour). Mechanistic investigations showed that boric acid reacted with sufficient oxalic acid to produce a species **P**, which had much higher pKa than oxalic acid. **P** on reaction with **Z** gave visible colour due to formation of **Q** in solutions even with low boron concentrations of ~1 μM.

2.4 Draw the structures of **P** and **Q**.

While **Z** was synthesized in laboratory in 1910's, but the yield was low due to formation of many side products. A modified and efficient synthesis method was developed in 1960 by Pabon and his team in the Netherlands. In this method, 0.2 mole of acetylacetone (pentan-2,4-dione) was stirred with 10 g (excess) of boric anhydride (B_2O_3), and a thick paste was formed containing a new ionic compound **R**. **R** was mixed with butylamine and this mixture further reacted with compound **S** (used as a flavouring agent in food) in the presence of N,N-dimethylformamide (a polar, aprotic solvent) and trimethyl borate (a dehydrating agent) to form another ionic

compound **T**, which had much higher molar mass than **Q**. Acidic hydrolysis of **T** in dilute HCl yielded compound '**Z**' and an inorganic acid.

2.5. Draw the structures of **R**, **S**, and **T**.

2.6. What are the other by-products obtained in this reaction?

Boric anhydride was added to suppress formation of some unwanted compounds.

2.7. Draw structure of two of the side products which would have formed if boric anhydride was not used in the above reaction (which was observed in the synthesis in 1910's).

Problem 3 — 31 marks

Chemical Oxygen Generation and Oxygen safety

Producing gaseous O_2 from a material through chemical reactions is called chemical oxygen generation. Such materials, known as chemical oxygen generators (COGs), are useful for O_2 storage and delivery at places where pressurized oxygen cylinders/tanks can pose risks. This problem looks at COGs such as chlorates, peroxides, and superoxides which are used for obtaining breathable O_2 under special needs.

Oxygen Candles

Oxygen candles containing chlorate salts are used to produce oxygen gas in an emergency in aircrafts, space stations, etc. An oxygen candle, typically, contains $NaClO_3$, BaO_2, and iron powder. An ignition causes oxidation of iron powder generating heat. At a high temperature (~ 500°C), $NaClO_3$ decomposes spontaneously producing breathable oxygen.

In aircrafts, it is instructed to pull down the mask oxygen first before wearing it in emergency. That pulling releases the firing pin and causes the ignition. Once the reaction starts, it continues exothermically.

3.1 The reaction producing breathable oxygen must also produce non-toxic by-products. Identify the missing product(s) in the given equation and balance the equation.

$$NaClO_3 \rightarrow \_\_\_\_\_ + O_2\uparrow$$

Often, chlorate decomposition is associated with a side reaction, which produces a toxic gas **A**. Separation of **A** from the gas mixture is a must. One of the roles of BaO_2 in oxygen candle is to remove **A**. Successful reaction between BaO_2 and gaseous **A** results in a barium salt **B**, and another gas, **C**.

3.2 Identify **A**, **B** and **C**, and balance the chemical equation below.

$$BaO_2 + \mathbf{A} \rightarrow \mathbf{B} + \mathbf{C}$$

Superoxides

Metal superoxides (containing O_2^- ions) are used as effective COGs in mining industry to tackle breathing problem. An aqueous yellow solution of a metal superoxide, **D**, produces oxygen gas (33.8% of its mass) and compound **E**, as shown in the following scheme. Interestingly, the exhaled CO_2 from breathing can be consumed by **E** producing **F**, without hampering the O_2 generation process.

3.3. Identify **D**, **E**, and **F**. Shows steps and calculations wherever required.

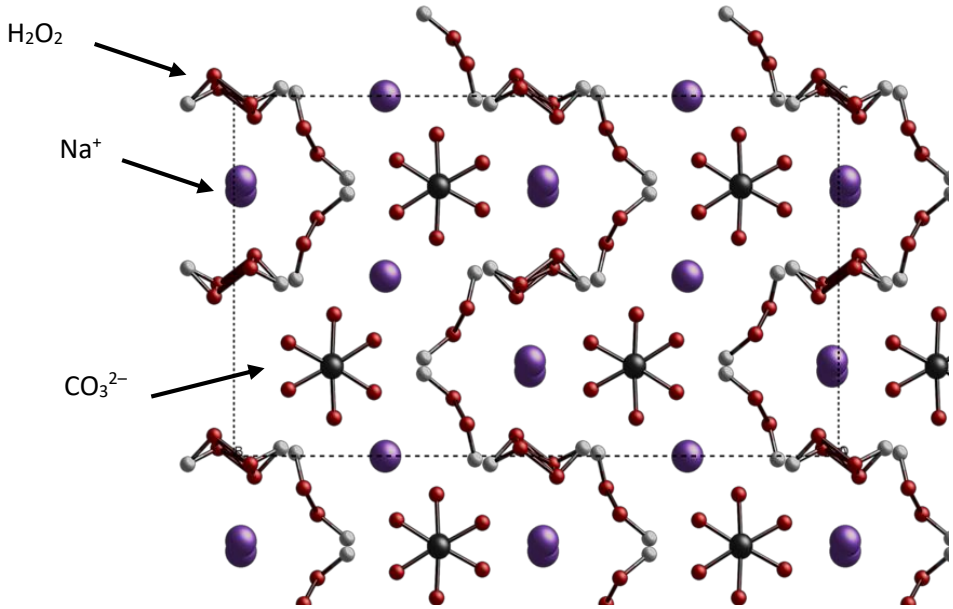
$$\mathbf{D} \xrightarrow[\text{Medium}]{\text{Aqueous}} \mathbf{E} + O_2\uparrow \xrightarrow{CO_2} \mathbf{F}$$

Peroxides:

H_2O_2 is a very good COGs, but its storage and transport are difficult due to its unstable nature. A solid adduct of H_2O_2 with sodium carbonate: Sodium percarbonate with formula $\mathbf{x}Na_2CO_3 \bullet \mathbf{y}H_2O_2$ (**x** and **y** are the respective stoichiometries), releases H_2O_2 in presence of water.

$$x Na_2CO_3.yH_2O_2 \xrightarrow{water} x Na_2CO_3 + y H_2O_2$$

The unit cell of crystal structure of this adduct is given below. In this arrangement, each carbonate oxygen makes one H-bond with one –OH of neighboring peroxide. (Note: two CO_3^{2-} units stacked on each other are rotated with respect of each other, which in 2-Dimentional view give a false impression of a hexagonal species)



3.4. Find **x** and **y**. Show calculation/steps required to arrive at the answer.

Another such solid peroxide material is **G**•H_2O_2. Upon exposing to water it produces 17% of its mass of O_2.

3.5. Find the molecular weight of **G**. Show steps of calculation.

In a research lab of a cosmetic company, one new intern was instructed to prepare this adduct. When he was carrying the white solid **G** to his bench, it was accidentally spilled into a hot sodium hydroxide solution. Immediately, gas bubbles started coming out of the solution. A moist red litmus paper held over the evolving bubbles turned blue. To confirm what gas might be evolving, he took a sky blue coloured salt, **H**, and dissolved it in water. A filter paper wet with this sky blue solution held above the evolving bubbles turned deep blue.

3.6. Identify **G** and **H**. Write chemical equations for the reactions responsible for the colour change of filter paper wet with **H** from sky blue to deep blue.

Risk associated with the use of O_2:

Oxygen gas is not flammable by itself but it supports combustion. Alcohols are volatile and flammable in air—in presence of 21% (v/v) O_2, these can catch fire at room temperature if there is a spark, flame or heat source in vicinity. At higher O_2 concentrations, a substance may catch fire even at lower temperatures. Therefore, in spaces (particularly closed rooms) with higher concentrations of oxygen (~23%), risks of fire outbreaks are much higher. Intensive Care Units (ICUs) in hospitals are spaces where both of the above risks need to be carefully managed.

Consider an ICU room of size 12 m × 7 m× 2.6 m with 12 beds. On a day, the ICU had 11 patients on ventilator support. Unfortunately, nobody noticed that the exhaust of the ICU was damaged; due to which the room air was getting replaced only over a period of 6 hours (instead of 30 minutes). Leaks from ventilator tubes had increased oxygen concentration in the room air to 23.4% (mole fraction).

Additionally, a sanitizer containing 70% w/v ethanol was being used in the ICU. Per day, typically 60 mL of sanitizer was used per patient, and 200 mL sanitizer was used four times for sanitizing the floor after mopping, all of which eventually evaporated and become a part of the room air.

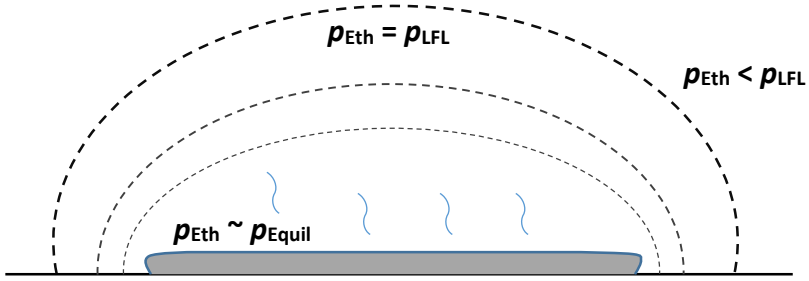
Assume for ambient air in ICU-

i) all component gases to be ideal.
ii) density = 1225 g m^{-3} , specific heat ~ 1.01 J g^{-1} K^{-1}
iii) average temperature = 298 K.
iv) specific heat per unit mass of the gases considered in this problem is same as that of air.

3.7 If the ethanol vapour in the room at any given time undergoes combustion instantaneously, determine the maximum rise in the room air temperature. [Hint: Ethanol concentration in room air at any time would be about 6/24 of the total ethanol evaporated in room in the whole day.]

However, at low vapour concentrations of ethanol in room air discussed above, it will not catch fire. At a temperature of 25 °C, lower flammability limit (LFL) of ethanol is 3.0%. [LFL: minimum concentration in v/v at which the vapour can catch fire in ambient air].

Accidently, 500 mL of sanitizer from a bottle spilled on the floor. During evaporation, the partial pressure of ethanol close to the liquid surface is close to its equilibrium vapour pressure and decreases with distance from the surface (as shown below). In 15 min, the vapour spreads, and a zone of volume 1.5 m^3 has ethanol concentration above its LFL.



3.8 Determine the average mole fraction of oxygen in this zone of 1.5 m^3, assuming: i) average ethanol vapour concentration in this zone is mean of the minimum and maximum values in the zone; and ii) average pressure in this space remains 1 atm, and other gases in air (oxygen, nitrogen) as a homogenous mixture which diffuse out of this zone uniformly as ethanol vapour keeps adding.

In this zone if there is an electrical spark in any electronic equipment, the ethanol can catch fire and get burned within fraction of a second.

3.9 Assume that this zone acts as an adiabatic closed system which expands to twice its volume within 0.5 s of burning. For this system, estimate the following quantities at the end of 0.5 sec. [Note that the pressure increases because of heat released as well as increase in number of molecules in the zone.]

i) average temperature of the gaseous mixture
ii) average mole fraction of oxygen left in this zone (which may support burning of other materials in this zone, and sustain fire)

3.10 In the room, increased oxygen level increased fire risk because it (Write True/False as applicable):

i) increases rate of combustion reaction.
ii) increases peak temperature of air (as cooling due to diffusion or air circulation is slower).
iii) increases heat released per unit mass of ethanol.
iv) increases peak pressure in air mixture during combustion (making it more explosive).
v) allows for longer combustion if fuel is available.

3.11 Better air circulation in closed rooms helps in reducing fire hazards by preventing (Mark X against the correct option(s))

i) fuel vapour buildup in any space.
ii) oxygen level from dropping below a certain level.
iii) oxygen level from increasing above a certain level.
iv) fast temperature rise in any small air space.

Problem 4 19 marks

Polyoxometallates

One of the interesting aspect of chemistry is reactions among colorless substances to produce colored substances. One such reaction is when colorless substances, namely, phosphate salts, molybdate salts, mineral acids and reducing agents (such as ascorbic acid) are mixed in appropriate proportion, it produces a deep blue substance known as molybdenum blue (MB). This reaction is known since 18th century and has been used in estimation of phosphates in water samples. However, its molecular level understanding was developed in 21st century.

This problem explores two aspects of MB reaction: the chemical structure of the coloured species, and some reactions which can interfere with this reaction in natural water samples.

Part A- Structure

The coloured specie in the above MB reaction is a unique polymeric cluster of molybdenum oxides, whose properties are explored here.

Oxides of Group VI transition metals in highest oxidation state (general formula MO_3, where M = Cr/Mo/W) are known to be acidic, and dissolve in strong aqueous alkalis to form $[MO_4]^{2-}$ ions.

4.1 The $[MO_4]^{2-}$ ions of Mo and W are not reduced easily but that of Cr is easily reduced. The likely reason(s) for the above is/are (Mark **X** against the correct option(s))-

i) Due to higher electronegativity, oxygen can oxidize the metals to the highest oxidation state

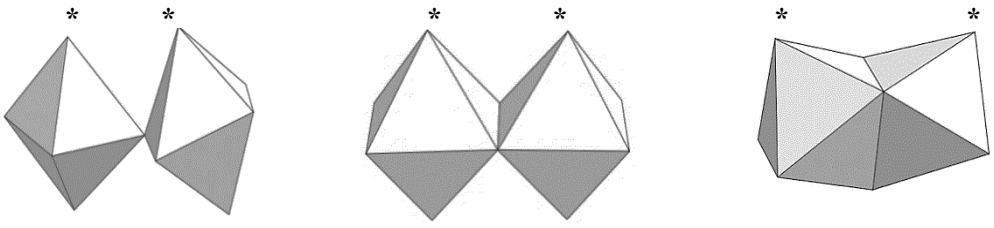
ii) Higher oxidation states of members down in the group in transition series are more stable.

iii) Mo and W show the effect of lanthanide contraction.

iv) Effect of nuclear charge on d orbitals decreases down the group making them more available for bonding.

Under acidic conditions, $[MO_4]^{2-}$ ions get protonated, which, depending on pH, may then polymerize or precipitate back as MO_3. The CrO_4^{2-} units rarely polymerise beyond dichromate. However, protonation of $[MoO_4]^{2-}$ results in expansion of coordination sphere to octahedral units such as $[MoO_3(OH_2)_3]$ which often polymerize to form clusters.

Two octahedral units can combine in three different ways are shown below, where O is at each vertex and metal ion is at the center of each octahedron.



Corner shared Edge shared Face shared

4.2 Assuming that the metal - oxygen bond lengths are equal for all these three polyhedra, the true statement(s) from the following is/are – (Mark X against the correct option(s))

i) The effective negative charge around each molybdenum ion in edge sharing polyhedra will be less than that in corner sharing polyhedral.
ii) The distance between two molybdenum ions in edge sharing polyhedra will be less than that in corner sharing polyhedral.
iii) The O atoms at the apex positions (*) in face sharing polyhedra are at a maximum distance from each other leading to most stable structure.
iv) Corner sharing polyhedra will lead to more stable structure than an edge sharing polyhedral.

Under mild acidic conditions (pH = 5-6), molybdate ions readily condense to give heptamolybdate ion containing seven octahedron units, where each octahedron shares 3 edges with its neighbours.

4.3 Write the balanced chemical equation for this transformation.

$7[MoO_4]^{2-}$ + ____$H^+ \rightarrow$ _____ + _____

In presence of PO_4^{3-} (and under acidic conditions), molybdates can produce clusters with general formula $[PMo_qO_r]^{n-}$. The structure of first such cluster (of **Z**, shown in Fig. 1) was discovered by James Keggin using X-ray crystallography, and hence these are called Keggin structures.

4.4 Let us try to build the Keggin structure **Z (**$[PMo_{12}O_r]^{n-}$**)**, stepwise by building its sub-units (whose charges are not explicitly shown) in following questions.

i) Consider three octahedra condensing to form a polyhedra $[Mo_3O_x]$, where each MoO_6 unit shares an edge each with the other two units. Determine x in the given formula.
ii) Consider four of $[Mo_3O_x]$ joined to each other through corner shared oxygen atoms forming a new condensed polyhedron $[Mo_{12}O_y]$. Determine y in the given formula.

In structure **Z** (shown below), $[Mo_{12}O_y]$ framework has been formed around a phosphate unit, where P is bonded to four O atoms, one each from the $[Mo_3O_x]$ sub-units.

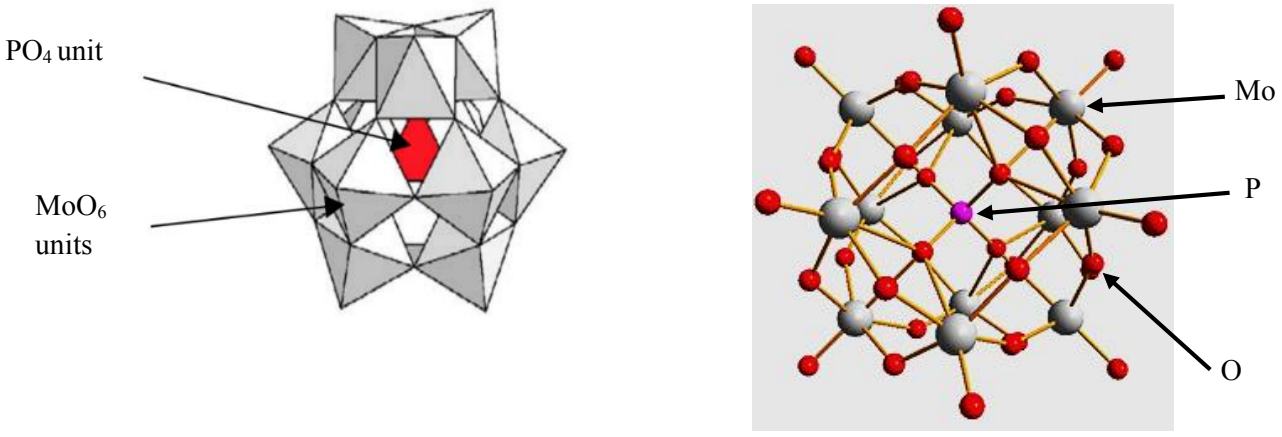


Figure 1*: Keggin structure of **Z** in a) polyhedral notation b) ball and stick notation*

Z contains four types of oxygen atoms and the description for the same is as follows-

O_a - refers to the oxygen at shared edge of two MoO_6 octahedra (bridging neighbouring Mo within $[Mo_3O_x]$ units)

O_b - refers to the oxygen at shared corner of two MoO_6 octahedra (of different $[Mo_3O_x]$ units)

O_p - refers to the oxygen shared between MoO_6 octahedra and the PO_4 unit

O_t - refers to the oxygen at terminal position (unshared with other octahedra)

iii) Determine the number of O_a, O_b and O_p atoms in the above structure.

4.5 The species **Z** shown above is pale yellow in color (all Mo retaining +6 oxidation state). Complete the chemical equation leading to the formation of **Z**.

$PO_4^{3-} + 12]MoO_4]^{2-} + \_\_\_H^+ \rightarrow \_\_\_\_\_ + \_\_\_\_\_$

Addition of a reducing agent in reaction mixture described in **4.5**, leads to 4e- reduction of **Z** producing a deep blue coloured species, $\mathbf{Z_{red}}$. The reduction is facilitated by protonation of some of the oxygen atoms in **Z**. The electrons involved in reduction are not added to any particular Mo atoms but are delocalized across multiple Mo atoms. The colour of $\mathbf{Z_{red}}$ originates because of electron transfers between a Mo(V) and its neighboring Mo(VI) ions and not due to d-d transitions in Mo.

4.6 Among the 4 types of oxygen, protonation of one type is favorable, which also can allow fast electron transfer between neighboring Mo ions; thus facilitating reduction of **Z**. This oxygen type is (Mark X against the correct option)

i) O_a **ii)** O_b **iii)** O_t **iv)** O_c

Part B - Phosphate determination

Typical phosphate level in polluted waters is ~ 0.1 – 1 mM. In MB test, water sample is mixed with reagents (Na_2MoO_4, acid and reductant) and the colour intensity of the blue species $\mathbf{Z_{red}}$ formed is measured (which is proportional to the amount of phosphate present).

4.7 For estimation of phosphate in a 100 mL polluted water sample, the appropriate amount of 10 mM Na_2MoO_4 solution which should be added is:

i) 10 mL **ii)** 100 mL **iii)** 200 mL **iv)** 25 mL **v)** 75 mL

Natural water samples sometimes have species such as silicates, fluorides and organic acids like oxalic acid which may react with some of the reagents used in MB test, and hence interfere in phosphate estimation in different ways.

Silicates ($Si(OH)_4$) present in water can react with molybdates at neutral or alkaline conditions to produce colored Keggin ions **R** (similar to **Z**). Thus, silicate can cause error in phosphate determination if molybdate salt is added before addition of acid.

4.8. Write balanced chemical equation for the formation of **R** from silicates under the above condition.

Flouride (F^-) if also present can react with silicates under acidic condition.

4.9 Write the possible balanced reaction(s) between silicates and fluorides that can take place in water sample when acid is added.

However, F^- itself interferes in MB test by binding to Mo(VI). H_3BO_3 is effective in preventing F^- interference in MB test.

4.10 Write the balanced equation for reaction that occurs between F^- and H_3BO_3 under acidic conditions.

Oxalic acid interferes in phosphate determination by reacting with molybdates but formic acid does not.

4.11 Draw the structure of species formed by the reaction between oxalic acid and molybdate.

4.12 Using excess Na_2MoO_4 in MB test under acidic condition can minimize the errors induced by (Mark **X** against the correct options(s)):

i) silicates **ii)** fluorides **iii)** oxalate

Set 1 (IQOC2021S1)

Q	Ans	Solution
1	a	$B_2H_6.2NH_3$ is formed by the unsymmetrical cleavage of diborane molecule. Both the cation and anion are tetrahedral in shape and hence 'B' will be sp^3 hybridised
2	c	(i) P_4+ Cl_2 (g)Q(*l*) – PCl_3(liquid) and PCl_5 (solid). Hence Q(*l*) is PCl_3 (ii) Q(l) + O_2(g) R (*l*) – PCl_3 + O_2 $POCl_3$ (liquid) + H_2O PCl_5 + O_2 P_2O_5 (solid). Hence R(*l*) is $POCl_3$ (iii) P_4 + O_2 (323 K) S (s); P_4 + $5O_2$ P_4O_{10}. Only this product can be formed at 323 K. Hence S(s) is P_4O_{10} (iv) S(s) + H_2O(*l*) T(aq); P_4O_{10} + $6H_2O$ $4H_3PO_4$. Hence T(aq) is H_3PO_4
3	b	$Fe(CO)_5$ has trigonal bipyramidal geometry. For TBP geometry, corresponding hybridisation in this case is dsp^3. The participating 'd' orbital in this type of hybridisation leading to a TDP geometry is dz^2
4	d	Based on the properties of 'p' block elements
5	c	Arrhenius equation and concept of catalysis
6	b	Intramolecular aldol condensation followed by haloform reaction and filtration
7	b	Based on Lewis dot structures- six structures (maximum) possible for the sulphate ion
8	d	No of mmoles of H_2SO_4 = 517.3 ; No of mmol of OH^- = 1034.6; If 'y' is the weight of Na in the mixture, 32000 = 23y + (1034.6 –y) 39 ; y = 521.8 ; Hence weight of Na = (521.8 x23)/ 1000 = 12g
9	b	Let masses of H_2O and H_2 be 1 and 1.5 g K_c = $(1.5/2)^4$/ $(1/18)^4$ = 3.32 x10^4
10	b	Both the molecules contain a chiral center. In presence of a base, 2-methylcyclopentanone will undergo racemization via the formation of an achiral enolate intermediate. Hence optical rotation disappears. With NH_2NH_2 / KOH at high temperature , the carbonyl group gets reduced. The final product does not have a chiral center. Hence no optical rotation is observed.
11	a	The linear oligomer synthesized by linking *ten* glycine molecules is 10 x [$C_2H_5O_2N$] – 9x[H_2O]= $C_{20}H_{32}O_{11}N_{10}$
12	a	The complex $[NiCl_2Br_2]^{2-}$ is tetrahedral, paramagnetic with two unpaired electrons and cannot show geometrical and optical isomerism. The complex $[PtCl_2Br_2]^{2-}$ is square planar, diamagnetic and can show cis-trans isomerism.
13	b	Colour of the gas evolved is reddish brown and the aqueous solution is

		basic And the solid is less soluble Hence $LiNO_3$ is the correct choice
14	a	Le Chatelier principle
15	c	4 $AgNO_3$ + 2 H_2O + H_3PO_2 → HNO_3 + H_3PO_4 Answers obtained from the stoichiometric equation given above(6.8 x1x 108)/ 4 x170 = 4.32g Ag; 6.8 x1 /4 x170 = 0.01 moles of H_3PO_2
16	a	Can be arrived at from the structure
17	c	XeO_3 – polar; $XeOF_4$ – polar; XeF_2- non polar; XeF_4 – non polar; XeO_4 – non polar
18	b	1 dm^3 = 1000 mL. Hence the answer
19	d	Alkylation, followed by formation of RMgBr Replacement of RMgBr by H gives the product
20	c	Based on Nernst equation Positive value of E (electrode potential) is obtained only in option c
21	d	Compound (i), an aromatic amide, when heated with NaOH liberates NH_3 which turns moist turmeric paper brown. Compound (ii) has $RCOCH_3$ functionality and forms iodoform (yellow precipitate) when treated with NaOH and I_2. Compound (iii), a secondary amine, forms a yellow oil when treated with $NaNO_2$, HCl at 0 ^oC. Compound (iv) with phenolic- OH gives colouration with $FeCl_3$
22	b	$N_1V_1=N_2V_2$; $NaHC_2O_4$ solution = 0.1 M $C_2O_4^{2-}$ is oxidized to CO_2 by $KMnO_4$. M $C_2O_4^{2-}$ = 0.2 N $HC_2O_4^-$ 10 x 0.2 = 10 x N^1 (MnO_4^-) N^1=0.2 MnO_4^- is reduced to Mn^{2+} . Hence, M(MnO_4^-) x 5 = N' Hence Molarity of MnO_4^- = 0.04 M
23	d	Brevicomin is a cyclic ketal. This molecule can be synthesized from the open chain ketodiol, 6,7-dihydroxynonan-2-one
24	a	Reduction of –CN, followed by successive methylation and Hoffman elimination
25	b, c	Intermolecular forces and size of the molecule
26	b,d	Concept of molarity, pH and Henderson equation Only in options b and d, pH is 4.0- 5.0
27	a, d	Second IE of He is same as the first IE of He^+ (H like atom) For a H like atom, En = - z^2 x 13.61/n^2. Here z = 2 and n = 1 Dependence of IE on atomic radius and electronic configuration
28	a,b, d	Product 'a' due to anti addition of Br_2 on any one of the two olefinic units

		(formation of a cyclic bromonium ion) Both 'b' and 'd' will be formed due to resonance stabilized allylic carbocation formation. Product 'c' cannot be formed because addition leading to its formation is not possible
29	c,d	Electronic configuration and MO theory. S_2 has two unpaired electrons In both N_2^+ and N_2^- , there is one unpaired electron on one of the N atoms.
30	a,d	Water is a weaker acid than nitromethane (data given). After the nucleophilic attack of the carbanion obtained from nitromethane to the carbonyl functionality of 2-methyl cyclohexanone, a diastereomeric mixture will be obtained.
31	a,b,c,d	All answers can be derived as correct from the structures given
32	c,d	Since the kinetic curves for both samples are different in zones 1 and 2, the virus must be reacting with different entities in these two zones From the plots it can be seen that almost 95 % inactivation happens within 10h

INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY - 2022

Date of Examination: November 27, 2022
Time: 11:30 AM to 1:30 PM

Question Paper Code: 31

Student's Roll No:										

Write the question paper code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the question paper.

Instructions to Candidates:

1. Use of mobile phone, smart watch, and ipad during examination is STRICTLY PROHIBITED.
2. In addition to this question paper, you are given OMR Answer Sheet along with Candidate's copy.
3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.

   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
4. On the OMR Answer Sheet, use only **BLUE** or **BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **Ten-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in NSEC - 2022.
6. Question paper has two parts. In part A1 (Q. No.1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

   Q.No. 12 (a) (●) (c) (d)

   In part A2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative (s) (1, 2, 3, or 4) may be correct. You have to choose all correct alternative(s) and fill the appropriate bubble(s), as shown

   Q.No. 52 (a) (●) (c) (●)
7. For **Part A1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A2**, you get 6 marks if all the correct alternatives are marked. No negative marks in this part.
8. Rough work may be done in the space provided. There are 16 printed pages in this paper
9. Use of **non - programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting answer paper, take away the question paper & Candidate's copy OMR sheet for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR answer sheet.

OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Instructions to Candidates (Continued) :

You may read the following instructions after submitting the answer sheet.

12. Comments/Inquiries/Grievances regarding this question paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in **on the specified format till December 3, 2022**

13. The answers/solutions to this question paper will be available on the website:

www.iapt.org.in **by December 2, 2022.**

14. CERTIFICATES and AWARDS:

Following certificates shall be awarded by IAPT/ACT to the students, successful in the NATIONAL STANDARD EXAMINATION IN CHEMISTRY – 2022

(i) CENTRE TOP 10 % To be downloaded from iapt.org.in after 15.01.23

(ii) STATE TOP 1 % Will be dispatched to the examinee

(iii) NATIONAL TOP 1 % Will be dispatched to the examinee

(iv) GOLD MEDAL & MERIT CERTIFICATE to all students who attend OCSC – 2023 at HBCSE Mumbai

Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having score above MAS will be displayed on the website: www.iapt.org.in by **December 25, 2022. See the Minimum Admissible Score** clause on the Student's brochure on the web.

16. List of students eligible to appear for Indian National Chemistry Olympiad (INChO – 2023) shall be displayed on www.iapt.org.in by December 30, 2022.

Constants you may need….

Charge of electron,	$e = 1.602 \times 10^{-19} C$	Speed of light,	$c = 3.0 \times 10^{8}\ ms^{-1}$
Mass of electron,	$m_e = 9.1 \times 10^{-31} kg$	Avogadro constant,	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Planck's constant,	$h = 6.63\ 10^{-34}\ Js$	Faraday	$F = 96500\ C\ mol^{-1}$
		Molar gas constant,	$R = 0.082\ L\ atm\ mol^{-1}\ K^{-1}$ $= 8.314\ J\ mol^{-1}\ K^{-1}$

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN CHEMISTRY
(NSEC - 2022)

Time: 120 minute **Max. Marks: 216**

Attempt All Sixty Questions

A - 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.

1. The results obtained by four students, each performing a set of four titrations with the same solution under identical conditions, are given below. If the expected titre value is 20.0 mL, the set of data (mL) with good accuracy and poor precision is
   (a) 19.9, 20.0, 20.1, 19.9 (b) 18.1, 18.2, 18.0, 18.1
   (c) 17.9, 18.1, 21.5, 21.0 (d) 20.0, 19.8, 19.4, 20.2

2. The statement that is NOT correct about atomic spectra is
   (a) Electric discharges through gases produce line spectra
   (b) Each element in the gaseous state has a unique line spectrum
   (c) The number of lines in the spectrum is same as the number of electrons in the atom
   (d) Atoms can emit photons with wavelengths lower than that of visible light

3. A closed 2.0 L container initially holds 3.0 mol of O_2 (g) and 2.0 mol of N_2(g) at room temperature, T. If the pressure remains constant when 1.0 mol of O_2 (g) is added, the final temperature of the system is- (Assume ideal gas behaviour throughout)
   (a) (3/5) T (b) (5/6) T (c) 2T (d) (6/5) T

4. The equilibrium constant (K_c) for trimerization of phenyl acetylene to triphenyl benzene is 3.0 at 310 K. If at equilibrium, 0.9 mol dm^{-3} of triphenyl benzene is present, concentration of phenyl acetylene at equilibrium is:
   (a) 1/3 mol dm^{-3} (b) 3.0 mol dm^{-3} (c) 1.732 mol dm^{-3} (d) 0.67 mol dm^{-3}

5. At 298 K, the standard free energies of formation of *cis*- and *trans*-1,2-dichloroethene are 41.549 kJ and 33.235 kJ respectively. The most appropriate mol ratio of *trans*- and *cis*- isomers at equilibrium at 298 K is
   (a) 10:3 (b) 3:10 (c) 28:1 (d) 1:28

6. The pH of the solution produced by complete consumption of 10 mL of 0.4 M NaOH to 'x' mL of 0.5M CH_3COOH was found to be 4.57. The value of 'x' (mL) is (Given-K_a of $CH_3COOH = 1.8 \times 10^{-5}$).
   (a) 12.0 (b) 10.4 (c) 19.8 (d) 6.5

7. The correct order of concentrations of the ions/molecules present in 1.0 L of 1.0 M H_2SO_4 (aq) solution is
   (a) $OH^- < SO_4^{2-} < HSO_4^- < H_3O^+ < H_2O$ (b) $OH^- < HSO_4^- < SO_4^{2-} < H_3O^+ < H_2O$
   (c) $H_2O < HSO_4^- < OH^- < SO_4^{2-} < H_3O^+$ (d) $H_2O < OH^- < SO_4^{2-} < HSO_4^- < H_3O^+$

8. The pOH of the solution obtained by mixing 30 mL of a strong monobasic acid of pH 3.0 and 70 mL of a strong monoacidic base of pH 12.0 at 298 K is
(a) 3.17 (b) 2.17 (c) 5.17 (d) 0.17

9. If refractive index, density, pressure, volume, heat capacity and surface tension are represented respectively as η, ρ, P, V, Q and γ, the set that contains only intensive properties is
(a) η, ρ, γ, Q (b) ρ, P, Q, γ (c) V, Q, η, ρ (d) η, ρ, P, γ

10. Heat of reaction and heat of formation will be the same in
I. $1/2\,N_2(g) + O_2(g) \rightarrow NO_2(g)$
II. $Xe(g) + 2F_2(g) \rightarrow XeF_4(g)$
III. $N_2(g) + O_3(g) \rightarrow N_2O_3(g)$
IV. $C(\text{diamond}) + O_2(g) \rightarrow CO_2(g)$
(a) Only I (b) Only I and II (c) Only I, II and III (d) Only II, III and IV

11. From the following data
$2CH_6N_2(\ell) + 5O_2(g) \rightarrow 2N_2(g) + 2CO_2(g) + 6H_2O(g)\ (\Delta H_r^0 = -2606\ kJ)$ and
$H_2O(\ell) \rightarrow H_2O(g)\ (\Delta H_v^0 = 44\ kJ\ mol^{-1})$
Heat of combustion of CH_6N_2 at 298K can be calculated as
(a) $-1567\ kJ\ mol^{-1}$ (b) $-1435\ kJ\ mol^{-1}$ (c) $-1171\ kJ\ mol^{-1}$ (d) $-2342\ kJ\ mol^{-1}$

12. When 100 g each of the salts NaCl, $MgSO_4$, $Ca(NO_3)_2$, K_2CO_3, were dissolved separately in 1.0 kg of water, the solution with the highest boiling point will be of
(a) $Ca(NO_3)_2$ (b) $MgSO_4$ (c) NaCl (d) K_2CO_3

13. When the pH of the system is increased by 2.0 units, maximum decrease in half cell potential for the reaction will be observed in
(a) $V^{2+}(aq) \rightarrow V^{3+}(aq) + e^-$ (b) $VO_3^- + 2H^+ \rightarrow VO_2^+ + H_2O$
(c) $VO^{2+} + 2H^+ + e^- \rightarrow V^{3+} + H_2O$ (d) $VO^{2+} + H_2O \rightarrow VO_2^+ + 2H^+ + e^-$

14. The reaction that takes place during charging of the lead storage cell is given below
$2\,PbSO_4(s) + 2\,H_2O(\ell) \rightarrow Pb(s) + PbO(s) + 2\,H_2SO_4(aq)$
If a current of 10.0 A is passed for 1.50 h for charging, the amount of $PbSO_4$ reacted is
(a) 25.0 g (b) 56.0 g (c) 120.5 g (d) 170.0 g

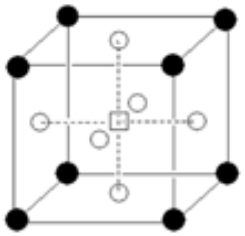
15. A sample of water from a water tank has a resistance of 100 Ω at 298 K, when placed in a conductivity cell of cell constant 0.2 m^{-1}. On dissolving 58.5 g of NaCl in the water tank, a sample of this solution gave a resistance of 40 Ω . The molar conductivity of NaCl at this concentration is 10 $\Omega^{-1} m^2 mol^{-1}$. The volume of water in the water tank is
(a) 3.33×10^6 L (b) 3333.3 L (c) 363.5 L (d) 4.2×10^5 L

16. Initial concentrations of the reactants and the corresponding half-lives for the reaction $P + Q \rightarrow R$ are given below. The rate law for the reaction is

Entry	$[P_0]$ (mol dm^{-3} x 10^{-6})	$[Q_0]$ (mol dm^{-3} x 10^{-6})	$t_{1/2}$ (s)
1	500	10	30
2	500	20	60
3	10	500	60
4	20	500	60

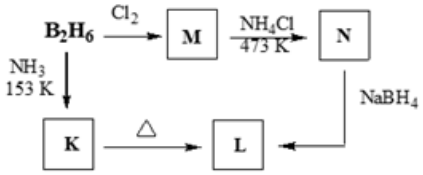
(a) $dR/dt = k[P]$ (b) $dR/dt = k[P]/[Q]$ (c) $dR/dt = k[Q]$ (d) $-d[P]/dt = k[P]/[Q]$

17. The unit cell structure of a mineral perovskite crystallizes in cubic unit cell wherein calcium (filled circles) and oxide (hollow circles) constitute a cubic close packing (ccp) arrangement and titanium ion (hollow square) occupies an interstitial hole as shown below. (Charges are omitted for simplicity). The empirical formula of this compound is



(a) Ca_2TiO_3 (b) Ca_4TiO_6
(c) $CaTiO_3$ (d) Ca_8TiO_6

18. Study the sequence of reactions of diborane (B_2H_6) given below and identify the products K, L, M and N. (The shown reagents are taken in excess).



(a) **K** = BNH_6; **L** = (BN)x; **M** = B_2H_5Cl; **N** = $B_3N_3H_3Cl_3$
(b) **K** = $[B_2H_6.2NH_3]$; **L** = $B_3N_3H_6$; **M** = B_2H_5Cl; **N** = $B_3N_3Cl_6$
(c) **K** = BNH_6; **L** = (BN)x; **M** = BCl_3; **N** = $B_3N_3Cl_6$
(d) **K** = $[B_2H_6.2NH_3]$; **L** = $B_3N_3H_6$; **M** = BCl_3; **N** = $B_3N_3H_3Cl_3$

19. During extraction of gold, the gold ore is treated with aqueous KCN solution as shown by the equations (not balanced) below to get compound X which is further reduced by Zn to obtain compound Y and metallic gold. Identify X and Y.

Gold ore + $CN^- + H_2O + O_2 \rightarrow [X] + OH^-$ ..... (i)

$[X] + Zn \rightarrow [Y] + Au$ ..... (ii)

(a) X = $[Au(CN)_2]^-$, Y = $[Zn(CN)_2]^{2-}$ (b) X = $[Au(CN)_2]^-$, Y = $[Zn(CN)_4]^{2-}$
(c) X = $[Au(CN)_4]^{3-}$, Y = $[Zn(CN)_4]^{2-}$ (d) X = $[Au(CN)_2]^-$, Y = $[Zn(CN)_4]^{4-}$

20. The correct IUPAC name for the complex $[Au(en)_2(H_2O)_2]$ $[Au(ox)_3]$ is (en=ethylenediamine and ox=oxalate)
(a) Bisaquobisethylenediaminegold (III) trioxalatoaurate (III)
(b) Diaquobisethylenediamineaurate (III) trisoxalatogold (III)
(c) Bisaquodiethylenediamineaurate (III) trisoxalatogold (III)
(d) Diaquobisethylenediaminegold (III) trioxalatoaurate (III)

21. Addition of dil. HCl to an aqueous solution of a mixture of two inorganic salts yielded white precipitate **E** and filtrate **F**. Precipitate **E** dissolved in hot water. **F** in alkaline alizarin gives a positive red lake test. The cations present in the precipitate **E** and solution **F** respectively are
(a) $Ag^{+}; Fe^{3+}$ (b) $Hg^{2+}; Ba^{2+}$ (c) $Pb^{2+}; Al^{3+}$ (d) $Pb^{2+}; Zn^{2+}$

22. Br_2 disproportionates to Br^{-} and BrO_3^{-} in a hot alkaline solution as
$3Br_2 + 6\,OH^{-} \rightarrow 5Br^{-} + BrO_3^{-} + 3H_2O$
The equivalent weight of Br_2 is: (M = molar mass of Br_2)
(a) M/5 (b) M/6 (c) 3M/5 (d) 5M/3

23. The number of all the possible geometrical isomers for trigonal bipyramidal $OsO_2F_3^{+}$ cation is:
(a) 2 (b) 3 (c) 1 (d) 4

24. The correct order for the wavelength of absorption in the following complex ions is
(a) $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$
(b) $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$
(c) $[Ni(H_2O_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
(d) $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

25. Mixing of an aqueous salt solution containing nitrate ion with ferrous ion followed by gentle addition of conc. sulphuric acid from the sides of the test tube, results in brown coloration at the interface is due to
(a) interaction of ferrous ion with nitric oxide
(b) interaction between the resulting nascent oxygen, ferrous ion and nitrate ion
(c) formation of ferrous ion and nitrogen dioxide
(d) complex formation between ferrous ion and nitrate ion

26. Aqueous solutions of hydrogen sulphide and sulphur dioxide when mixed together gives
(a) bisulphite ion and water (b) hydrogen and sulphurous acid
(c) sulphur and water (d) hydrogen peroxide and sulphur

27. The ion with least coagulation value for arsenous sulphide sol is
(a) SO_4^{2-} (b) PO_4^{3-} (c) Al^{3+} (d) Ba^{2+}

28. The correct order of catenation property among the following is
(a) Pb > Si > Ge > Sn (b) Pb > Sn > Ge > Si
(c) Si > Sn > Ge > Pb (d) Si > Ge > Sn > Pb

29. An agriculturist wants to use different concentrations of phosphorus as a fertilizer using P_4O_{10}. The correct expression to calculate P from P_4O_{10} is
(a) $P_4O_{10} \times 2.29$ (b) $P \times 0.44$ (c) $P \times 2.29$ (d) $P_4O_{10} \times 0.44$

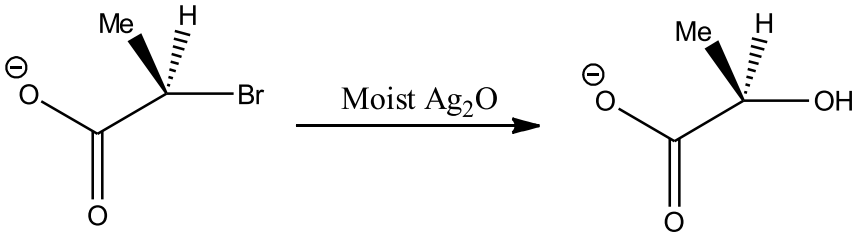
30. Given below are some names of the compounds.
(p) Acetals; (q) silicones; (r) ferrocene; (s) glyoxal, (t) ethyl acetate, (u) gammaxene
The set which is **NOT** having a double bond between an element and O(E=O where E is any element in the periodic table) as a functional group is
(a) p, s, u, t (b) p, q, r, s (c) q, r, s, t (d) p, q, r, u

31. Hybridization of S in CH_3SH molecule is
(a) dsp^3 (b) sp^2 (c) sp^3 (d) sp^3d

32. Using different reaction conditions nickel reacts with (p) Cl^-, (q) CN^-, (r) CO and (s) small amount of Al. Choose **incorrect** statement.
(a) (p), (q), and (r) respectively can result in tetrahedral, octahedral and square planar geometries around nickel
(b) Ligand (p) and (q) leads to homoleptic complex formation wherein final electronic configuration shows maximum multiplicity in case of (p)
(c) Ligand (r) reacts only in reducing medium to form organometallic compound
(d) In case of (s) formation of spongy product with large surface drive reduction reaction of C=C compounds

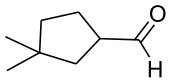
33. Optically pure 2-butanol has a specific rotation of +13.52 degrees. A synthesized and purified sample of 2-butanol has the observed specific rotation of +6.76 degrees. The correct statement based on this observation is
(a) the sample is completely racemized (b) 25% of the sample is racemic
(c) 50% of the sample is racemic (d) 6.76% of the sample is racemic

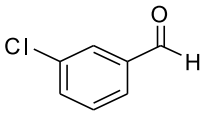
34. Certain organic reactions proceed through formation of intermediates which are highly strained and reactive. Given the following reaction, the correct statement about the mechanism of the reaction is

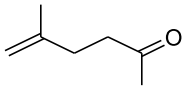


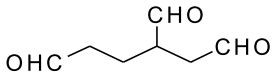
(a) Intramolecular S_N2 attack by $-COO^-$ to form an intermediate followed by the attack by HO^- via S_N2 pathway on the intermediate
(b) Intramolecular S_N2 attack by $-COO^-$ to form an intermediate followed by the attack by HO^- via S_N1 pathway on the intermediate
(c) HO^- attacks via S_N1 pathway on the reactant
(d) HO^- attacks via S_N2 pathway on the reactant

35. Which of the following compound is **NOT** named correctly according to the IUPAC nomenclature?

(a)  3,3 - Dimenthyl cyclopentanecar baldehyde

(b)  3 - Chlorobenzaldehyde

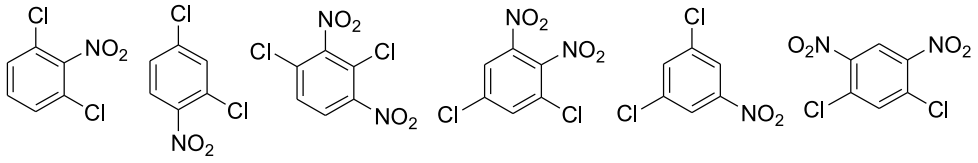
(c)  2 - Methy1-1-penten-4-one

(d)  Butane - 1,2,4-tricarbaldehyde

36. Which of the following compounds contains the maximum number of sp^2 hybridized carbon atoms?

(a) 1, 4-Cyclohexadiene
(b) 2, 5-dimethyl -2, 3, 4-hexatriene
(c) Benzaldehyde
(d) 1, 1-diallyl -3, 3-divinylcyclopentane

37. The number of products from the following, which cannot be formed on nitration of 1, 3-dichlorobenzene with a mixture of concentrated nitric acid and sulfuric acid is

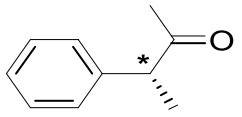


(i) (ii) (iii) (iv) (v) (vi)

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

38. Optically pure 3-Phenyl-2-butanone (X) with the following structure is treated with methyl magnesium iodide in anhydrous ether. The product formed after acidic hydrolysis is

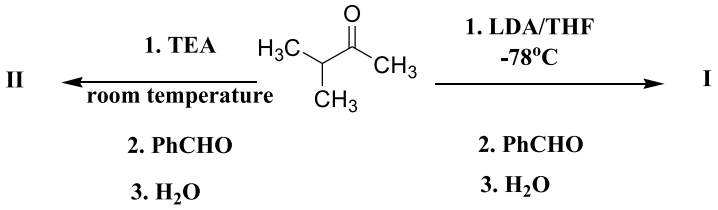
(a) diastereomeric mixture of alcohols
(b) optically pure alcohol
(c) racemic mixture of alcohols
(d) optically inactive alcohol



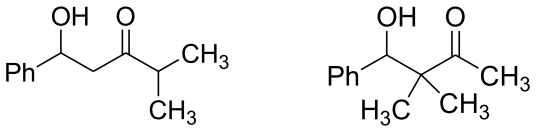
[X]

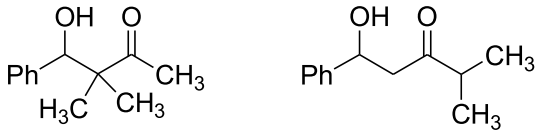
3-phenyl-2-butanone

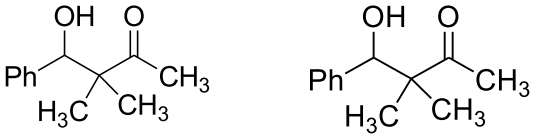
39. Aldehydes react with carbonyl compounds in the presence of bases by a mechanism similar to aldol condensation. Given below is the reaction of benzaldehyde with 3-methyl-2-butanone in the presence of lithium diisopropylamide (LDA), a strong bulky base and triethyl amine (TEA), a weak base. The correct structures of the major products, **I** and **II** formed in the following reactions are respectively

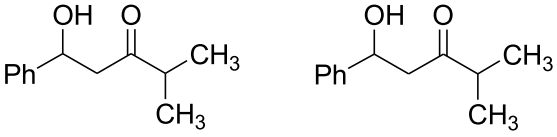


I **II**

(a) 

(b) 

(c) 

(d) 

40. The correct order of the given reagents to convert benzene to m-Chlorobromobenzene is

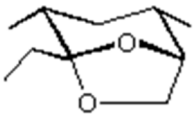
(1) sulfuric acid (conc.) and heat	(2) Cl_2 + $FeCl_3$ and heat	(3) $NaNO_2$ + H_3O^+ 0 °C	(4) H_2 Pt catalyst	(5) Mg in ether
(6) PBr_3	(7) H_3PO_2 (aqueous)	(8) HNO_3 (conc.) + H_2SO_4 (conc.) and heat	(9) Cu_2Br_2 + HBr	(10) $(CH_3CO)_2O$ + pyridine

(a) 1, 2, 5, 7 and 6 (b) 2, 8, 4, 3 and 9 (c) 8, 4, 10, 2, 3 and 9 (d) 8, 2, 4, 3 and 9

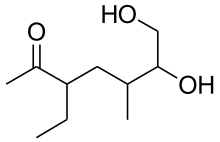
41. A chiral hydrocarbon (Molecular Formula C_6H_{12}) undergoes catalytic hydrogenation to yield an achiral product (Molecular Formula C_6H_{14}). The chiral hydrocarbon is

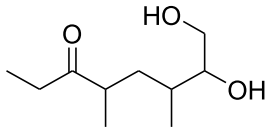
(a) *cis*-2-hexene
(b) 3-methyl-2-pentene
(c) 4-methyl-2-pentene
(d) 3-methyl-1-pentene

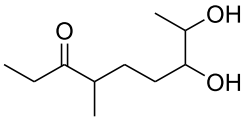
42. The structure of multistriatin, a pheromone of the elm bark beetle, is shown beside. The open chain ketodiol that on dehydrative cyclization gives multistriatin, bicyclic ketal (ignore stereo chemical aspects) is

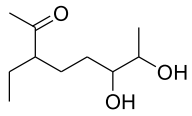


multistriatin

(a) 

(b) 

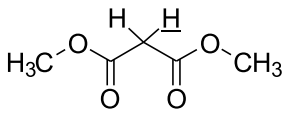
(c) 

(d) 

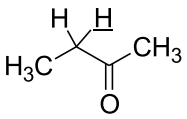
43. A monobasic acid (0.100 g) on complete combustion gave 0.252 g of CO_2 and 0.044 g of H_2O. For complete neutralization of 0.122 g of the acid, 10.0 mLof 0.1M NaOH solution was required. Molecular formula of the acid is

(a) $C_7H_6O_2$ (b) $C_6H_7O_2$ (c) $C_7H_7O_2$ (d) $C_6H_6O_2$

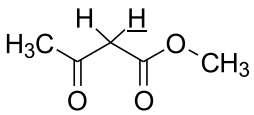
44. Acidity of acidic compounds depend on the stability of their conjugate bases. The correct order of acidity of the underlined H in the following compounds is
(Note: Assume that all the compounds exist in the keto form)



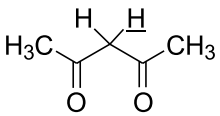
(i)



(ii)



(iii)

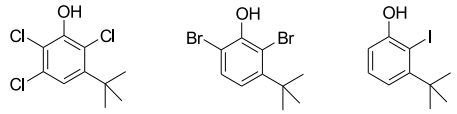


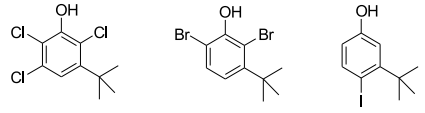
(iv)

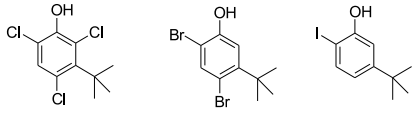
(a) (ii) > (iii) > (iv) > (i)
(b) (iv) > (iii) > (i) > (ii)
(c) (iii) > (ii) > (iv) > (i)
(d) (i) > (iii) > (iv) > (ii)

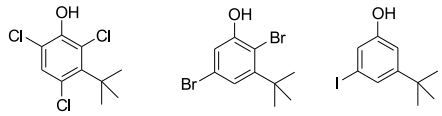
45. Reaction of *para*-Chloroaniline with acetic anhydride in pyridine gave a crude mixture of 94% of *para*-chloroacetanilide and 6% unreacted amine.
From the following, the best treatment suitable for purification of *para*-chloroacetanilide is
(a) treating the reaction mixture with methyl iodide
(b) washing an ether solution of the crude product with concentrated brine (aq. NaCl)
(c) washing an ether solution of the crude product with 5% cold aqueous sulfuric acid
(d) washing an ether solution of the crude product with 5% aqueous sodium carbonate

46. 3-tert-butylphenol when reacted separately with excess chlorine, bromine and iodine gave trichloro, di-bromo and mono-iodo derivatives of 3-tert-butylphenol respectively. The correct structures of the respective halogen derivatives are

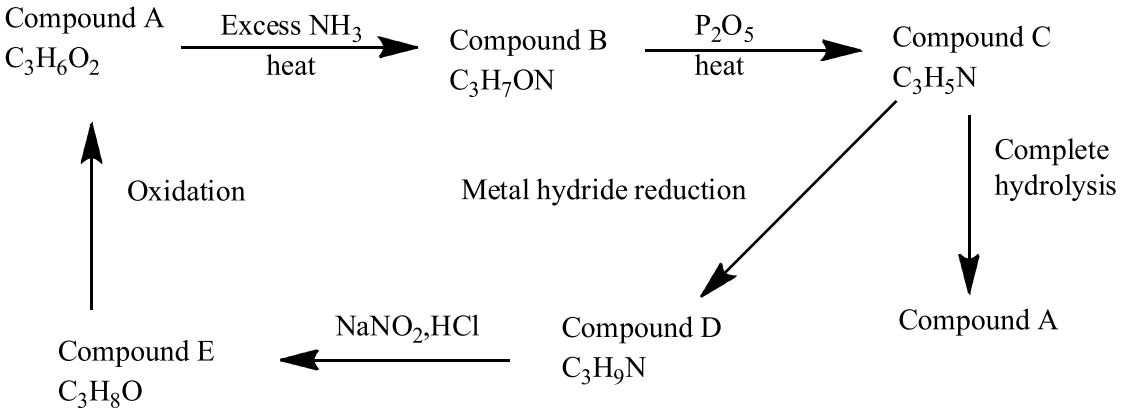
(a) 

(b) 

(c) 

(d) 

47. Consider the following sequence of reactions:
The functional groups undergoing change in the conversion of A to E respectively are



(a) -COOH, -NC, -$CONH_2$, -NH_2, -CH_2OH
(b) -COOH, -CN, -$CONH_2$, -NH_2, -CH_2OH
(c) -COOH, -$CONH_2$, -CN, -CH_2NH_2, -CH_2OH
(d) -$CONH_2$, -COOR, -NC, -NHR, >CHOH

48. The correct sequence of reagents which would convert p-Nitrotoluene to p-Iodobenzoic acid is

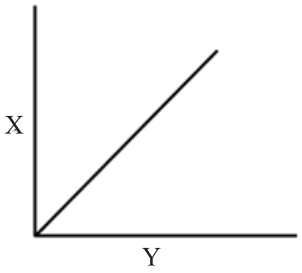
(a) (i) Br_2 + $FeBr_2$, (ii) Mg in ether, then CO_2, (iii) 3 H_2 and Pt or Ni catalyst, (iv) HNO_2, 0ºC, (v) KI solution
(b) (i) Br_2 in CCl_4 and heat, (ii) NaI in acetone, (iii) 3 H_2 and Pt or Ni catalyst, (iv) HNO_2, 0 ºC, (v) H_3PO_2
(c) (i) 3 H_2 and Pt or Ni catalyst, (ii) HNO_2, 0 ºC, (iii) Cu_2Br_2 + HBr, (iv) $KMnO_4$ and heat, (v) KI solution
(d) (i) $KMnO_4$ and heat, (ii) 3 H_2 and Pt or Ni catalyst, (iii) HNO_2, 0 ºC, (iv) KI solution

A – 2

ANY NUMBER OF OPTIONS 4, 3, 2 or 1 MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED.

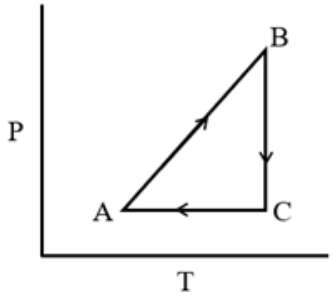
49. Following is a qualitative plot that can represent kinetic data obtained with a reactant R where $[R]_0$ and [R] represent the concentrations of R, at t = 0 and t = t respectively. 'Y' and 'X' are suitable parameters on the x- and y- axes.



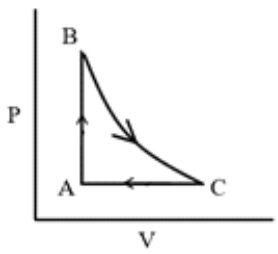
The correct representation of the curve is

	X	Y	order	X	Y	order
(a)	$[R]_0$ - [R]	time	Zero	Rate	time	First
(b)	$[R]_0$ - [R]	time	Zero	Initial rate	$[R]_0$	First
(c)	Rate	[R]	Zero	$t_{1/2}$	[R]	First
(d)	$t_{1/2}$	[R]0	Zero	ln $\{[R]_0/[R]\}$	t	First

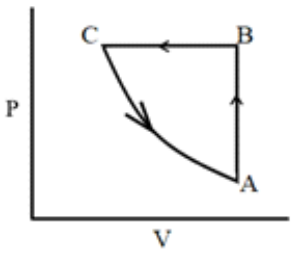
50. A given amount of an ideal gas undergoes the cyclic process ABCA as given below.



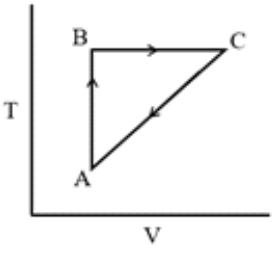
The equivalent representation/s of the same process is/are



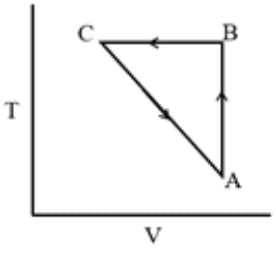
(a)



(b)



(c)



(d)

51. The correct statements among the following is /are

(a) When equal volumes of a solution containing Sr^{2+} (0.01M) and another containing F^- (0.001M) are mixed at 25ºC, SrF_2 will be precipitated (K_{sp} of $SrF_2 = 8.0 \times 10^{-10}$ at 25ºC)

(b) When equal volumes of a solution containing Ba^{2+} (1.0×10^{-4} M) and another containing F^- (1.0×10^{-2}M) are mixed at 25ºC, BaF_2 will be precipitated (K_{sp} of $BaF_2 = 1.0 \times 10^{-6}$ at 25ºC)

(c) The solubility product (K_{sp}) and the molar solubility (s) of $La(IO_3)_3$ are related as $K_{sp} = 27s^4$

(d) The solubility product and the molar solubility of $Ca_3(PO_4)_2$ are related as $27s^4$

52. For the phenomenon of adsorption, the correct statement/s among the following is /are

(a) According to Freundlich model, mass of N_2 gas adsorbed per g of silica surface will increase with temperature of adsorption

(b) If S is the surface area of an adsorbent, and 'A', 'm' and 'M' are the cross-sectional area, mass adsorbed and molar mass of the adsorbate respectively, then $S = \left(\frac{m}{M}\right) A N_A$ (N_A-Avogadro's number)

(c) The number of gas molecules physisorbed on unit mass of an adsorbent will be the same for two different gases at the same temperature.

(d) Adsorption of H_2 on Ni surface with $E_a = 96$ kJ mol^{-1} can be termed as chemisorption

53. When excess $KMnO_4$ is added to concentrated H_2SO_4, an oily green colored covalent compound **Y** is formed. Which of the following statements is/ are true for the above reaction.

(a) Compound **Y** is formed by a dehydration reaction

(b) In compound **Y** Mn is octahedrally surrounded by oxygen atoms

(c) **Y** is the highest oxide of Manganese

(d) Compound **Y** has Mn-O-Mn bridge

54. Read carefully all the three statements on defects in solids:

(i) In Frenkel defect, interstitial Ag^+ site is surrounded tetrahedrally by four Cl^- ions and four Ag^+ ions, where interstitial Ag^+ and Cl^- interaction is covalent

(ii) Addition of small amount of $SrCl_2$ in NaCl yields solid solution with a formula of $Na_{1-2x}Sr_xV_{Nax}Cl$, where V = valency

(iii) In general, Schottky defect increases the density of the substance

Choose the correct alternative(s).

(a) Statement (i) is correct

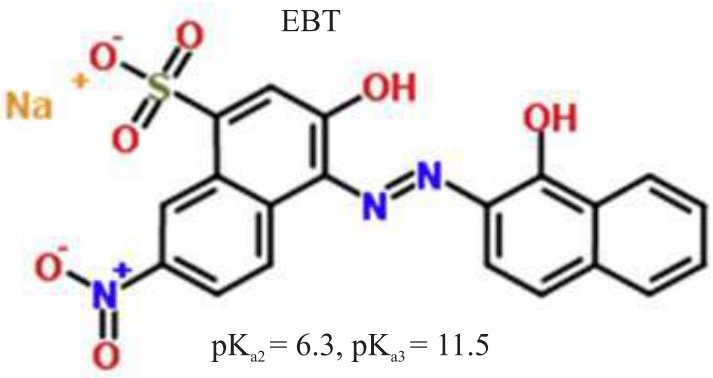
(b) Statements (ii) and (iii) are correct

(c) Statements (i) and (ii) are correct

(d) Statements (i) and (iii) are correct

55. Eriochrome black T (EBT) is an indicator in titrimetric estimation of calcium at pH 10.0 giving pink colour to the solution. It has structure as shown below. Considering that the pH of solution is 10.0, which statement(s) describe(s) the complexation of EBT with Ca(II) correctly

EBT



$pK_{a2} = 6.3$, $pK_{a3} = 11.5$

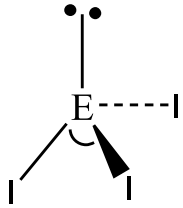
(a) On dissociation of EBT, Ca(II) binds at SO_3^- to form 1:2 complex

(b) Both sulphonate and nitro groups are involved in 1:1 complexation with Ca(II)

(c) EBT acts as a bidentate ligand to form a dianionic species, with deprotonation of one – OH, where Ca(II) binds to azide nitrogen and phenolic oxygen *trans* to $-NO_2$ group in 1:2 ratio

(d) There is a mixture of complexes of Ca(II) with EBT acting as a bidentate and tridentate ligand

56. The correct statement(s) regarding three EI_3 molecules (where E=P, As or Sb) is/are:



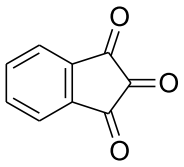
(a) These compounds are formed by mutual sharing of electrons and hence considered as covalent compounds

(b) PI_3 is most susceptible towards hydrolysis in water to give phosphorous acid

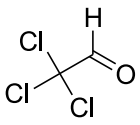
(c) SbI_3 has highest boiling point amongst all

(d) In AsI_3, there is least repulsion between bond pair and lone pair and thus has the largest I-E-I angle

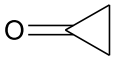
57. Aldehydes and ketones can react with water in the presence of an acid or base to yield an equilibrium mixture of the aldehyde/ketone and the corresponding hydrates (geminal diol). Among the following, the aldehyde/ketones which will have a greater percentage of the hydrate at equilibrium are



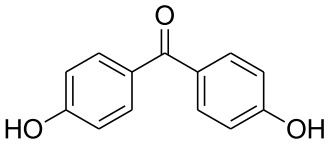
(a)



(b)

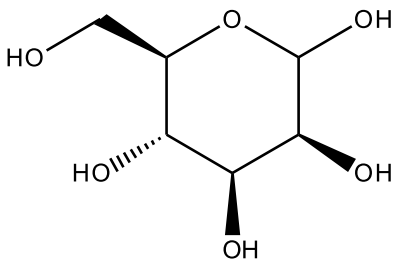


(c)



(d)

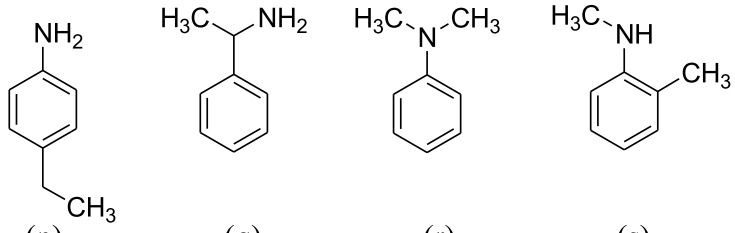
58. The correct statement/s about the pyranose form of a sugar (X) given below is/are:



(X)

(a) It exists in two anomeric pyranose forms
(b) It reacts with Tollens' reagent to give a silver mirror
(c) The penta-O-methyl derrvative of (X) is non reducing.
(d) It resists reduction with aqueous sodium borohydride

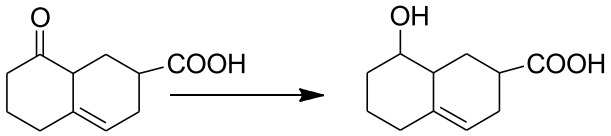
59. Given below are isomeric amines. The **incorrect** statement/s about them from the following is/are



(p) (q) (r) (s)

(a) (p) and (q) both will give unstable products respectively with $NaNO_2$ in HCl at 268 K
(b) Reaction of all amines with HCl is exothermic
(c) Reaction of benzene sulphonyl chloride with (s) gives a solid product that is soluble in NaOH
(d) (q) has the highest basicity among these

60. Which one/s of the reduction techniques mentioned below is/are **NOT** suitable for the following chemical transformation



(a) $NaBH_4$ based reduction
(b) $LiAlH_4$ based reduction
(c) DIBAL-H based reduction
(d) B_2H_6 based reduction

IUPAC Periodic Table of the Elements

1																	18
1 H hydrogen 1.008 [1.0078, 1.0082]	2		Key: atomic number **Symbol** name conventional atomic weight standard atomic weight									13	14	15	16	17	2 He helium 4.0026
3 Li lithium 6.94 [6.938, 6.997]	4 Be beryllium 9.0122											5 B boron 10.81 [10.806, 10.821]	6 C carbon 12.011 [12.009, 12.012]	7 N nitrogen 14.007 [14.006, 14.008]	8 O oxygen 15.999 [15.999, 16.000]	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305 [24.304, 24.307]	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 26.982	14 Si silicon 28.085 [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur 32.06 [32.059, 32.076]	17 Cl chlorine 35.45 [35.446, 35.457]	18 Ar argon 39.95 [39.792, 39.963]
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 [79.901, 79.907]	36 Kr krypton 83.798(2)
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 1 December 2018.

United Nations Educational, Scientific and Cultural Organization

2019 IYPT International Year of the Periodic Table of Chemical Elements

IUPAC

Rough Work

ASSOCIATION OF CHEMISTRY TEACHERS
National Standard Examination in Chemistry – 2023
Date of Examination: November 26, 2023
Time: 11:30 AM to 1:30 PM
Question Paper Code: 31

Student's Roll No:										

Write the Question Paper Code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the Question Paper.

Instructions to Candidates:

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY PROHIBITED.
2. In addition to this Question Paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
4. On the OMR Answer Sheet, use only **BLUE** or **BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **Ten-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in National Standard Examination in Chemistry – 2023.
   Question paper has two parts. In part A1 (Q. No.1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q.No.12 (a) (●) (c) (d)

In part A2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative(s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q.No.52 (a) (●) (c) (●)

7. For **Part A1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A2,** you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
8. Rough work may be done in the space provided. There are **14** printed pages in this paper
9. Use of **Non-programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting Answer Paper, take away the Question Paper & Candidate's copy of OMR sheet for your future reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR Answer Sheet.

OMR Answer Sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Instructions to Candidates (Continued) :
You may read the following instructions after submitting the Answer Sheet.

12. **Comments/Inquiries/Grievances regarding this Question Paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in on the specified format till Dec 3, 2023.**

13. **The answers/solutions to this Question Paper will be available on the website: www.iapt.org.in by Dec 2, 2023.** The score card may be downloaded after Dec 24, 2023

14. **CERTIFICATES and AWARDS:**
Following certificates are awarded by IAPT/ACT to students, successful in the National Standard Examination in Chemistry – 2023

(i) "CENTRE TOP 10 %" To be downloaded from iapt.org.in after 30.01.24
(ii) "STATE TOP 1 %" Will be dispatched to the examinee
(iii) "NATIONAL TOP 1 %" Will be dispatched to the examinee
(iv) "GOLD MEDAL & MERIT CERTIFICATE" to all students who attend OCSC – 2024 at HBCSE Mumbai

Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having score above **Minimum Admissible Score (MAS)** will be displayed on the website: **www.iapt.org.in** by **Dec 25, 2023. See the MAS clause** on the student's brochure on the web.

16. List of students eligible to appear for Indian National Chemistry Olympiad (INChO – 2024) shall be displayed on **www.iapt.org.in** by Dec 30, 2023.

Useful constants

Charge of electron, $e = 1.602 \times 10^{-19} C$
Mass of electron, $m_e = 9.1 \times 10^{-31} kg$
Planck's constant, $h = 6.63 \times 10^{-34} J\,s$
Speed of light, $c = 3.0 \times 10^{8} ms^{-1}$
Avogadro constant, $N_A = 6.022 \times 10^{23} mol^{-1}$
Faraday constant $F = 96500\ C\,mol^{-1}$
Molar gas constant, $R = 0.082\, L\,atm\,mol^{-1}K^{-1}$
$= 8.314\, J\,mol^{-1}\,K^{-1}$

ASSOCIATION OF CHEMISTRY TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY

(NSEC - 2023)

Time: 120 minute **Max. Marks: 216**

Attempt All Sixty Questions

A – 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.

1. The ligand with which the homoleptic octahedral complex of Co^{3+} will be most stable is:
   (a) Ethylenediamine tetra acetate ion
   (b) Dien (N-(2-aminoethyl)-1,2-ethanediamine)
   (c) Ethane-1,2-diamine
   (d) Ammonia

2. Which of the following properties may have positive values of ΔH?
   (i) Lattice enthalpy (ii) Hydration enthalpy
   (iii) Electron gain enthalpy for noble gases (iv) Ionisation enthalpy

   (a) (i) and (ii) (b) (iii) and (iv) (c) Only (iv) (d) (ii), (iii) and (iv)

3. The correct IUPAC name of potassium permanganate is:
   (a) potassium tetraoxomanganate(VI) (b) potassium tetraoxidopermanganate(VII)
   (c) potassium tetraoxidomanganese(VII) (d) potassium tetraoxidomanganate(VII)

4. Which of the following statements is true with respect to sodium salts of oxoanions of phosphorus NaH_2PO_2 and Na_2HPO_3
   (a) NaH_2PO_2 is reducing and Na_2HPO_3 is oxidizing
   (b) NaH_2PO_2 is more reducing than Na_2HPO_3
   (c) NaH_2PO_2 is more oxidizing than Na_2HPO_3
   (d) NaH_2PO_2 is oxidizing and Na_2HPO_3 is reducing

5. The fluoride/s of xenon, XeF_n (n = 2 or 4 or 6), which on complete hydrolysis gives back xenon as one of the products, is/are_____.
   I. XeF_2 II. XeF_4 III. XeF_6

   (a) II only (b) I and II (c) III only (d) I, II and III

6. If an element after oganesson (Og, atomic number 118 and electronic configuration [Rn] $5f^{14}$ $6d^{10}$ $7s^2$ $7p^6$) was discovered, in which of the following orbital, will the 119^{th} electron be accommodated?
   (a) 7d (b) 6f (c) 8s (d) 5g

7. The number of 'two-center-two electron' and 'three-center-two electron' bonds in $[Al(BH_4)_3]$ are respectively
   (a) twelve and zero (b) twelve and three (c) six and six (d) nine and three

8. Identify the correct matching of the following oxides in column **M** with their property in column **N**:

M	N
(i) Aluminium trioxide	(p) Acidic oxide
(ii) Calcium oxide	(q) Basic oxide
(iii) Arsenic pentoxide	(r) Amphoteric oxide

(a) (i)-(p), (ii)-(q), (iii)-(r) (b) (i)-(q), (ii)-(r), (iii)-(p)
(c) (i)-(r), (ii)-(q), (iii)-(p) (d) (i)-(r), (ii)-(p), (iii)-(q)

9. In each of the following reactions, role of water is:
(i) $H_2O + HCl \rightarrow H_3O^+ + Cl^-$
(ii) $6H_2O + Mg^{2+} \rightarrow [Mg(H_2O)_6]^{2+}$
(iii) $2H_2O + 2F_2 \rightarrow 4\ HF + O_2$

(a) (i) oxidant; (ii) reductant; (iii) base (b) (i) reductant; (ii) oxidant; (iii) base
(c) (i) base; (ii) base; (iii) reductant (d) (i) acid; (ii) base; (iii) reductant

10. The correct order of the following oxidizing agents in basic aqueous medium is:
CrO_4^{2-}/ Cr^{3+} $E^0 = -0.11$ V
FeO_4^{2-}/ Fe^{3+} $E^0 = +0.72$ V
MnO_4^{2-}/ Mn^{3+} $E^0 = +0.46$ V

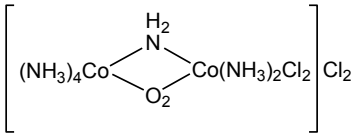
(a) $[CrO_4]^{2-} > [FeO_4]^{2-} > [MnO_4]^{2-}$ (b) $[FeO_4]^{2-} > [MnO_4]^{2-} > [CrO_4]^{2-}$
(c) $[CrO_4]^{2-} > [MnO_4]^{2-} > [FeO_4]^{2-}$ (d) $[MnO_4]^{2-} > [FeO_4]^{2-} > [CrO_4]^{2-}$

11. The correct order of ionic radii of Rb^+, Br^-, Sr^{2+} and Se^{2-} is
(a) $Rb^+ < Br^- < Sr^{2+} < Se^{2-}$ (b) $Sr^{2+} < Rb^+ < Br^- < Se^{2-}$
(c) $Se^{2-} < Br^- < Sr^{2+} < Rb^+$ (d) $Se^{2-} < Sr^{2+} < Rb^+ < Br^-$

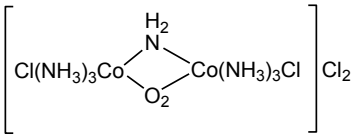
12. Consider the following statements:
(i) Calcination is carried out in absence of air below the melting point of the ore
(ii) Roasting and calcination are carried out in presence of flux
(iii) Calcination is carried out in limited supply of air above the melting point of the ore
(iv) Roasting is carried out in air below the melting point of ore
The correct set of statements is

(a) (i) and (iv) (b) (ii) and (iii) (c) (i), (iii) and (iv) (d) (iii) and (iv)

13. The cobalt complexes (I) and (II) given below are examples of



(I)



(II)

(a) linkage isomers (b) coordination isomers
(c) ligand isomers (d) coordination position isomers

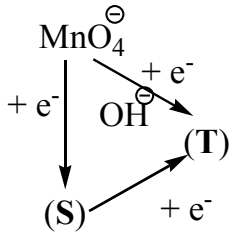
14. The magnetic moment (in units of BM) of copper in $[Cu(H_2O)_4]^{2+}$ and $[Cu(NH_3)_4]^{2+}$ respectively is:
(a) 1.73 and 0 (b) 1.73 and 1.73 (c) 2.83 and 2.83 (d) 0 and 2.83

15. In qualitative inorganic analysis of a water-soluble salt mixture (salt AB + salt XY) both the cations were identified as sulphides. In the tests for anions sodium carbonate extract when treated with $AgNO_3$ gave yellowish precipitate soluble with difficulty in NH_4OH while the other anion can be confirmed with brown ring test. (Given K_{sp} for AS = 1×10^{-44} and XS = 1.4×10^{-24}).
Identify the INCORRECT statement about the analysis.
(a) H_2S can be used under appropriate conditions of pH to separate and identify the cations.
(b) Cation A will be precipitated under acidic condition as the concentration of sulphides ions required is low.
(c) The anions are NO_3^- and Cl^-.
(d) Cation X will be precipitated as sulphides under alkaline condition, as the concentration of sulphides ions required is very high.

16. The correct statement about the solubilities of Group 2 hydroxides is:
(a) The solubilities increase because lattice energy increases as we go down Group 2
(b) The solubilities increase because lattice energy decreases as we go down Group 2
(c) The solubilities decrease because atomic size increases as we go down Group 2
(d) The solubilities decrease because lattice energy decreases as we go down Group 2

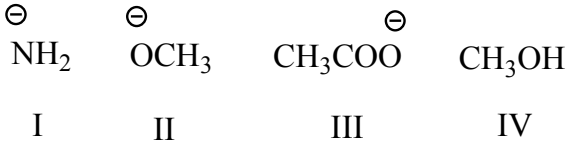
17. A solution of $CuSO_4.5H_2O$ in methanol has $[Cu^{2+}]$ = 1.00 mg per 1000 g of methanol. The molarity of Cu^{2+} in this solution is $Y \times 10^{-5}$ mol L^{-1}.Y is :
(Given- density of methanol = 0.792 g mL^{-1})
(a) 1.57 (b) 5.04 (c) 1.25 (d) 3.99

18. Following is the reaction flow chart for manganese oxidocomplexes under different alkaline pH conditions. Compounds (**S**) and (**T**) respectively are:



(a) S=$MnO(OH)_2$; T=$Mn(OH)_2$ (b) S=MnO_2; T=MnO(OH)
(c) S= MnO_4^{2-}; T=MnO(OH) (d) S= MnO_4^{2-}; T=MnO_2

19. The correct order of relative strength for the following nucleophilic species is:



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

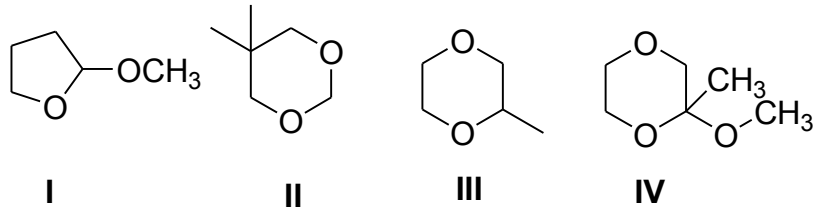
20. The product obtained on reaction of optically pure 1-bromo-1-phenyl ethane with CH_3OH, is:
(a) phenyl ethene.
(b) 1-methoxy-1-phenyl ethane with inverted configuration only.
(c) 1-methoxy-1-phenyl ethane with retention of configuration.
(d) a racemic mixture of 1-methoxy-1-phenyl ethane.

21. An alkane [X] contains five 1º, two 2º, one 3º and one 4º carbon atoms. The IUPAC name of [X] is:
    (a) 2,4,4-trimethylhexane (b) 3,5-dimethylheptane
    (c) 2,4-dimethylheptane (d) 4,4-dimethylheptane

22. The number of isomeric alkenes with molecular formula C_5H_{10} is (taking stereoisomers into account):
    (a) 4 (b) 5 (c) 6 (d) 7

23. At 0º C, 1 equivalent bromine is added to 2,4-hexadiene to produce 4,5-dibromo-2-hexene and its isomer 'X'. 'X' is:
    (a) 5,5-dibromo-2-hexene (b) 2,5-dibromo-3-hexene
    (c) 2,2-dibromo-3-hexene (d) 2,3-dibromo-4-hexene

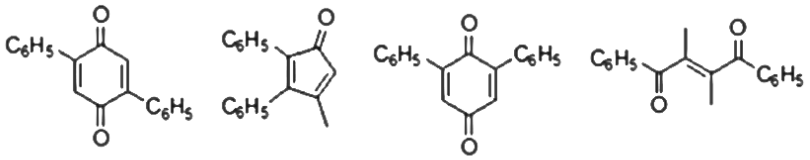
24. Which of the following is/are example/s of an acetal?



I II III IV

    (a) I and II (b) III and IV (c) Only IV (d) I, II and III

25. The compound which can be produced by double aldol condensation of 1-phenyl-1,2-propanedione:



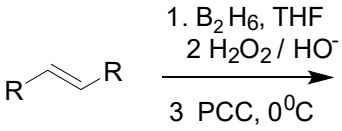
P Q R S

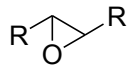
    (a) P (b) Q (c) R (d) S

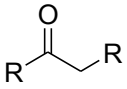
26. 2,2-Dimethyl-1,3-propanediol is formed by heating 2-methylpropanal with an excess of formaldehyde and $Ca(OH)_2$. The sequence of reactions taking place in this synthesis is:
    (a) dehydrogenation to 2-methyl-2-propenal followed by addition of formaldehyde.
    (b) dehydrogenation to penta-2,3-diene followed by addition of formaldehyde.
    (c) a crossed aldol reaction followed by a crossed Cannizzaro reaction.
    (d) a crossed Cannizzaro reaction followed by a crossed aldol reaction.

27. Number of different types of dipeptides produced using a mixture of glycine and L-valine, and number of optically active dipeptides formed in this mixture will be:
    (a) Four dipeptides, all optically active (b) Two dipeptides, all optically active
    (c) Four dipeptides, three optically active (d) Two dipeptides, none optically active

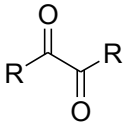
28. Predict the major product in the following reaction.
PCC is pyridinium chlorochromate



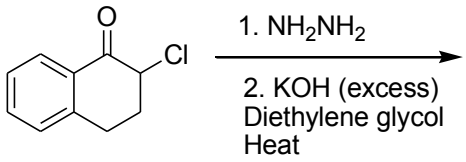
(a) 

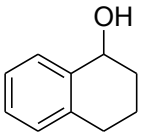
(b) 

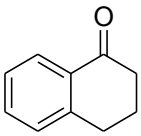
(c) 

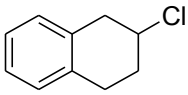
(d) 

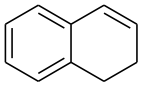
29. Find out the product in the following reaction.



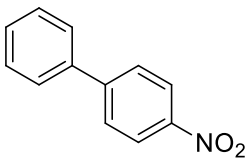
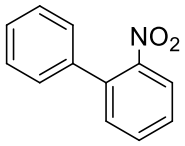
(a) 

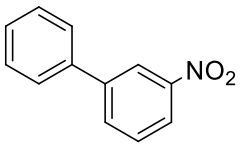
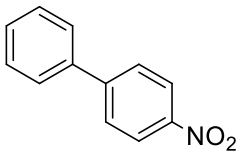
(b) 

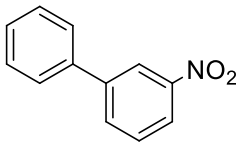
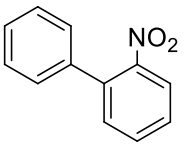
(c) 

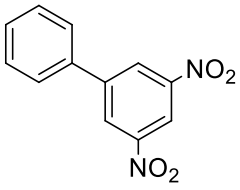
(d) 

30. The product/s obtained on reaction of biphenyl (Ph-Ph) with nitrating mixture (HNO_3 + H_2SO_4) is/are:

(a)  and 

(b)  and 

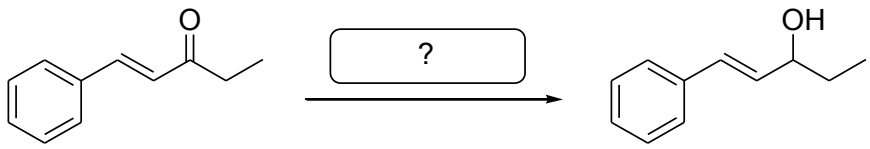
(c)  and 

(d) 

31. Chlorination of propane gives four dichloro products. One of them is optically active. The number of trichloro products possible from the optically active dichloro product is (excluding stereoisomers):

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

32. The suitable reagent for the following transformation is:



(a) Na / liq. NH_3 (b) H_2, Pd/C
(c) $LiAlH_4$ (d) Zn-Hg, HCl, heat

33. Column **A** represents a set of functional groups and Column **B** their respective electronic effects. The correct match is:

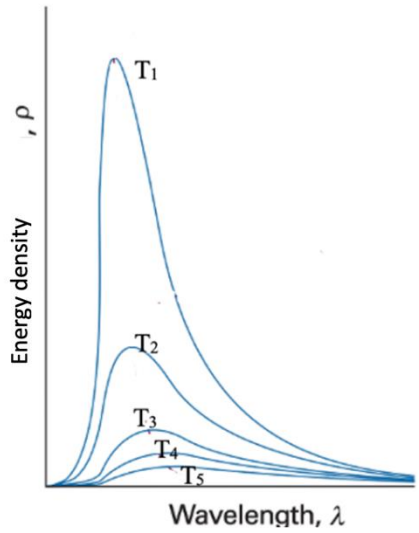
Column **A**		Column **B**
(a) $-NH_2$, -COCl, $-SO_3H$, -COOH	;	*m*-directing, EWG, activating, *o/p*-directing
(b) -X, $-NHCOCH_3$, -CHO, $-CH_3$	;	*o/p* directing, EDG, *m*-directing, activating
(c) -COCl, $-COCH_3$, $-NH_2$, -CN	;	EDG, EWG, deactivating, *m*-directing
(d) $-SO_3H$, $-NH_2$, $-OCH_3$, $-CONH_2$	;	activating, deactivating, EWG, EWG

[EDG: Electron donating group and EWG: Electron withdrawing group]

34. The correct order of reactivity of -CHO, -COR, -COOR, $-CONR_2$ groups toward MeMgI in ether is:

(a) $-CONR_2$ > -COOR > -COR > -CHO (b) -CHO > -COR > -COOR > $-CONR_2$
(c) $-CONR_2$ > -CHO > -COR > -COOR (d) -CHO > $-CONR_2$ > -COOR > -COR

35. The plots of energy density (energy per unit area) vs wavelength for blackbody radiation at various temperatures is given below.
The correct option among the following is:



(i) $T_1 > T_2 > T_3 > T_4 > T_5$
(ii) As temperature increases, the wavelength at which the intensity is maximum shifts towards the higher energy regions of the electromagnetic spectrum.
(iii) Radiations of all wave lengths are emitted, absorbed, reflected, and refracted by the black body.
(iv) The total energy density increases as the temperature is decreased.

(a) (i) and (ii) (b) (ii) and (iii) (c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

36. A student adds 'x' g of iron (Fe) powder to dil. HCl and measures the work done by the reaction between HCl and the added Fe to be 1000 J. If the experiment was conducted at a constant pressure of 1 atm at 27°C, mass of Fe powder added is:
(a) 22.4 g (b) 2.24 g (c) 11.2 g (d) 1.12 g

37. Antacids are medicines that temporarily neutralize the acid in the stomach and prevent heartburns. The volume of an antacid syrup containing 2.9 g of $Mg(OH)_2$ per 100 mL to be given to a patient whose stomach contains 2 L of gastric juice with HCl concentration of $6.0 \times 10^{-3} M$ is :
(Molar mass of $Mg(OH)_2$ = $58.0\ g\ mol^{-1}$)
(a) 4.0 mL (b) 7.8 mL (c) 12.0 mL (d) 120 mL

38. A half-cell reaction represented by (i) as given below

$$Fe(OH)_2(s) + 2e^- \longrightarrow Fe(s) + 2OH^-(aq) \qquad E^\ominus = -0.9\,V \quad \text{(i)}$$

takes place in two different electrochemical cells, I and II, in which the other half cell reactions are (ii) and (iii) respectively:

$$Al^{3+}(aq) + 3e^- \longrightarrow Al(s) \qquad E^\ominus = -1.7\,V \quad \text{(ii)}$$
$$AgBr(s) + e^- \longrightarrow Ag(s) + Br^-(aq) \qquad E^\ominus = -0.07\,V \quad \text{(iii)}$$

The correct option that represents the redox reactions in cells I and II is:

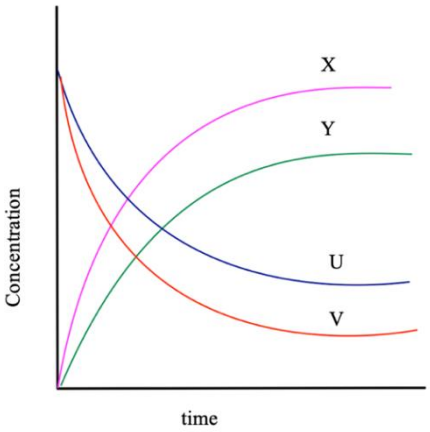
(a) Fe is oxidised in cell I; Fe is oxidised in cell II
(b) Fe is oxidised in cell I; Fe is reduced in cell II
(c) Fe is reduced in cell I; Fe is reduced in cell II
(d) Fe is reduced in cell I; Fe is oxidised in cell II

39. The following are the concentration vs time plots of the reactants and products represented by the reaction

$$L(g) + 2\,M(g) \longrightarrow N(g) + 3\,O(g)$$

The curves that represent M(g) and N(g) qualitatively are respectively

(a) X, Y
(b) Y, U
(c) V, Y
(d) U, X

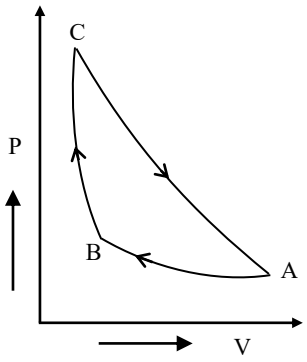


40. The current produced due to photoelectric effect
(a) increases with the increase of frequency of the incident radiation.
(b) increases with the increase in intensity of the incident radiation.
(c) decreases with time of irradiation.
(d) is independent of the intensity of incident radiation.

41. The property of radiation that is not different at various regions of the electromagnetic spectrum is:
(a) energy (b) frequency (c) velocity (d) wavelength

42. Among the following, the correct statements about the compressibility factor (Z) of real gases are:
(i) If Z < 1, intermolecular repulsive forces are more dominant.
(ii) If Z < 1, intermolecular attractive forces are more dominant.
(iii) If Z > 1, intermolecular repulsive forces are more dominant.
(iv) If Z >1, intermolecular attractive forces are more dominant.
(a) (i) and (iv) (b) (i) and (iii) (c) (ii) and (iv) (d) (ii) and (iii)

43. The figure represents the processes AB, BC and CA undertaken by a certain mass of an ideal gas. Along the path AB, the gas is isothermally compressed with release of 800 J heat to the surroundings. It is then compressed adiabatically along the path BC and the work done is 500 J. The gas then returns to the state A along path CA and absorbs 100 J heat from the surroundings. The work done by the gas along the path CA is:



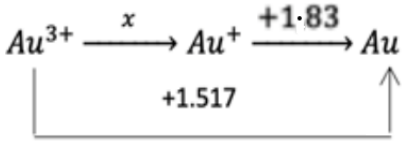
(a) – 300 J (b) – 900 J
(c) – 600 J (d) – 400 J

44. Two flasks I and II of equal volume are evacuated and connected by a tube of negligible volume fitted with a stopcock. They are then placed in two different constant temperature baths of 250 K and 750 K respectively. 20 moles of an ideal gas are introduced into the system of these flasks through the stopcock. When the system reaches equilibrium, the ratio of the moles of the gas in flasks I and II is:
(a) 1 : 1 (b) 2 : 1 (c) 3 : 1 (d) 4 : 1

45. When a certain amount of a univalent salt AB (molar mass = 54 $g\,mol^{-1}$) was dissolved in 0.1 dm^3 of water, the relative lowering of the vapour pressure was found to be 3.55%. The molality of the resulting solution is:
(Assume complete dissociation of the salt under given condition. Density of water = 1 $g\,cm^{-3}$)
(a) 0.5 m (b) 1.0 m (c) 2.0 m (d) 4.0 m

46. The rate constant values for the decay of radioisotopes X and Y, used in radio-medicine are 0.05 h^{-1} and 0.025 h^{-1} respectively. In a hospital, at a time 't_0' the activity of a sample of X was found to be twice that of Y. The activities of the two radioisotopes will be approximately equal when the time elapsed is:
(a) twice the half-life of Y (b) twice the half-life of X
(c) equal to the half-life of X (d) equal to ½ the half-life of Y

47. Latimer diagrams are the compact representations of electrochemical equilibria in substances of multiple oxidation states. The value of the potential, x, in the Latimer diagram of gold (at pH = 1.0) is:



(a) 2.72 V (b) 3.18 V (c) -3.18 V (d) 1.36 V

48. Electrolysis of aqueous $CuSO_4$ (0.1 M) was carried out in two cells I and II. In I, the electrodes are of Cu and in II they were of Pt. As the electrolysis proceeds pH of the electrolyte solution will:
(a) decrease in II and remain the same in I (b) remain the same in both I and II
(c) increase in both I and II (d) increase in I and decrease in II

A – 2

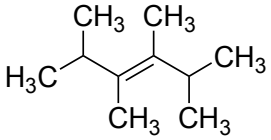
ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT

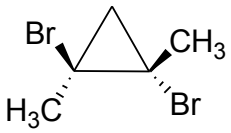
MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.

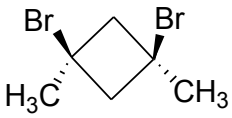
49. Choose the correct statement(s) regarding zeolites:
    (a) Silicon atoms are replaced by aluminium atoms in the zeolites.
    (b) The pores and cavities of the zeolites as well as size and shape of reactant decides the reactions taking place in the zeolites.
    (c) The cracking of hydrocarbons and isomerisation reactions are catalyzed by zeolites in the petrochemical industries.
    (d) Zeolites act as molecular sieves and can separate the molecules of different sizes.

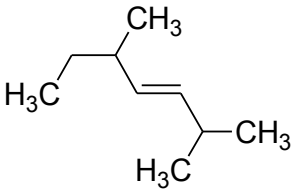
50. Crystalline iron(III) nitrate nonahydrate, $Fe(NO_3)_3.9H_2O$, has a very pale violet colour. When added to water, the crystals dissolve to form a brown solution. Treatment of this brown solution with concentrated nitric acid yields a very pale violet solution while treatment with HCl yields a yellow solution.
    Identify the correct statements regarding the above observations.
    (a) The brown colour is due to $[Fe(OH)(H_2O)_5]^{2+}$, $[Fe(OH)_2(H_2O)_4]^{+}$
    (b) Violet colour is due to $[Fe(H_2O)_6]^{3+}$ and yellow colour due to $[FeCl_4]^{-}$
    (c) Addition of HNO_3 shifts the equilibrium $[Fe(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Fe(OH)(H_2O)_5]^{2+} + H_3O^{+}$ to left giving pale violet colour
    (d) Addition of HNO_3 shifts the equilibrium $[Fe(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Fe(OH)(H_2O)_5]^{2+} + H_3O^{+}$ to right giving violet colour

51. The optically active compounds from the following are:

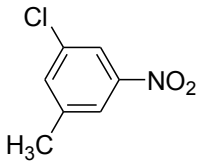
(a) 

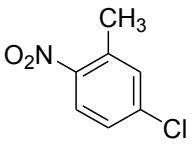
(b) 

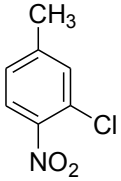
(c) 

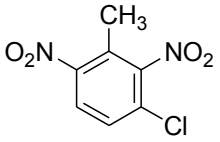
(d) 

52. 3-chlorotoluene is reacted with a mixture of conc. H_2SO_4 and HNO_3. The product/s formed is/are:

(a) 

(b) 

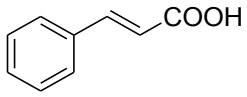
(c) 

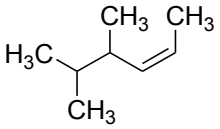
(d) 

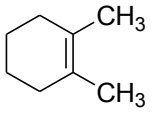
53. 2,4,6-trinitrophenol is more acidic than phenol. Identify the correct statement(s)
    (a) pK_a for 2,4,6-trinitrophenol is less than that of phenol.
    (b) phenol is stabilized by intramolecular π hydrogen bonding.
    (c) The conjugate base of 2,4,6-trinitrophenol delocalizes the negative charge on the oxygen atom to a very large extent.
    (d) The conjugate base of phenol delocalizes the negative charge to a greater extent than the conjugate base of 2,4,6-trinitrophenol.

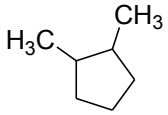
54. The correct statements for 1,3-butadiene from following are:
    (a) Molar addition of Br_2 yields only 1,4-dibromo-2-butene as the major product when the reaction is performed for longer time period
    (b) Molar addition of Br_2 yields only 1,2-dibromo-2-butene for longer time period
    (c) $C_1 – C_2$ and $C_3 – C_4$ bonds are slightly longer than a C=C bond
    (d) $C_2 – C_3$ single bond is slightly shorter than a C – C bond

55. Which of the following representations will exhibit *cis-trans* isomerism?

(a) 

(b) 

(c) 

(d) 

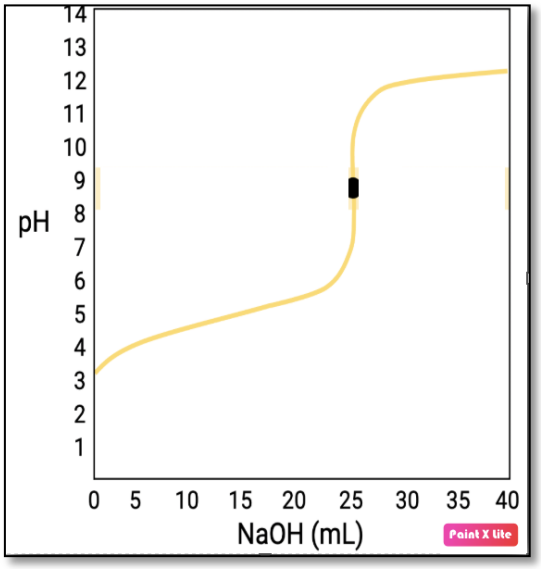
56. For an elementary dimerization reaction of the type $2R \rightarrow R_2$, the value of the steric factor was found to be 2.5. This indicates that
    (a) the experimentally obtained rate is 2.5 times faster than the theoretical rate.
    (b) ratio of the number of collisions calculated from collision theory and that actually take place is 1: 2.5.
    (c) the activation energy of the reaction is the same for both the experimental and calculated values.
    (d) the molecules of reactant R may be of some complex structure.

57. The correct statement/s among the following is/are:
    (a) The charge on the diffused layer of AgI colloidal solution by the addition of few drops of dilute aqueous solution of KI to an aqueous solution of $AgNO_3$ is negative.
    (b) The charge on the diffused layer of AgI colloidal solution by the addition of few drops of dilute aqueous solution of $AgNO_3$ to an aqueous solution of KI is positive.
    (c) When the ionic strength of a colloidal solution is increased, thickness of the double layer is increased, and the colloid gets precipitated.
    (d) When the ionic strength of a colloidal solution is increased, thickness of the double layer is decreased, and the colloid gets precipitated.

58. In reverse osmosis the flow of solvent across semi permeable membrane occurs
    (a) when hydrostatic pressure is greater than osmotic pressure
    (b) when hydrostatic pressure is lower than osmotic pressure
    (c) from higher concentrated solution to lower concentrated solution
    (d) from lower concentrated solution to higher concentrated solution

59. Given below is the plot of pH vs volume of NaOH added in an acid-base titration. The correct statement/s among the following is/are:

(a) Before the equivalence point, a series of buffer solutions determine the pH.
(b) The graph represents the titration of a strong acid with NaOH.
(c) At the equivalence point, hydrolysis of the anion of the acid determines the pH.
(d) After the equivalence point acid/salt buffer solution determines the pH.



60. The correct statement/s among the following is/are:
(a) The probability density (ψ^2) for a hydrogen atom is zero at r = 0.
(b) In an atom, orbitals with the same quantum number have different energies.
(c) The energy of a given orbital with same principal quantum number decreases as the atomic number 'Z', increases.
(d) For a given atomic number, the configuration having the maximum number of parallel spins is of the lowest energy than any other arrangement arising from the same configuration.

PERIODIC TABLE OF ELEMENT

1 **H** Hydrogen 1																	2 **He** Helium 4
2 **Li** Lithium 3	3 **Be** Beryllium 9											5 **B** Boron 11	6 **C** Carbon 12	7 **N** Nitrogen 14	8 **O** Oxygen 16	9 **F** Fluorine 19	10 **Ne** Neon 20
11 **Na** Sodium 23	12 **Mg** Magnesium 24											13 **Al** Aluminum 27	14 **Si** Silicon 28	15 **P** Phosphorus 31	16 **S** Sulfur 32	17 **Cl** Chlorine 35.5	18 **H** Argon 40
19 **K** Potassium 39	20 **Ca** Calcium 40	21 **Sc** Scandium 45	22 **Ti** Titanium 48	23 **V** Vanadium 51	24 **Cr** Chromium 52	25 **Mn** Manganese 55	26 **Fe** Iron 56	27 **Co** Cobalt 59	28 **Ni** Nickel 59	29 **Cu** Copper 64	30 **Zn** Zinc 65	31 **Ga** Gallium 70	32 **Ge** Germanium 73	33 **As** Arsenic 75	34 **Se** Selenium 79	35 **Br** Bromine 80	36 **Kr** Krypton 84
37 **Rb** Rubidium 86	38 **Sr** Strontium 88	39 **Y** Yttrium 89	40 **Zr** Zirconium 91	41 **Nb** Niobium 93	42 **Nb** Niobium 96	43 **Tc** Technetium 98	44 **Ru** Ruthenium 101	45 **Rh** Rhodium 103	46 **Pd** Palladium 106	47 **Ag** Silver 108	48 **Cd** Cadmium 112	48 **In** Indium 115	50 **Sn** Tin 119	51 **Sb** Antimony 122	52 **Te** Tellurium 128	53 **I** Iodine 127	54 **Xe** Xenon 131
55 **Cs** Cesium 133	56 **Ba** Barium 137	57 **La** Lanthanum 139	72 **Hf** Hafnium 179	73 **Ta** Tantalum 181	74 **W** Tungsten 184	75 **Re** Rhenium 186	76 **Os** Osmium 190	77 **Ir** Iridium 192	78 **Pt** Platinum 195	79 **Au** Gold 197	80 **Hg** Mercury 201	81 **Ti** Thallium 204	82 **Pb** Lead 207	83 **Bi** Bismuth 209	84 **Po** Polonium 210	85 **At** Astatine 210	86 **Rn** Radon 222
87 **Fr** Francium 223	88 **Ra** Radium 226	89 **Ac** Actinium 227	104 **Unq** Unnilquadium 257	105 **Unp** Unnilpentium 260	106 **Unh** Unnilhexium 263	107 **Uns** Unnilseptium 262	108 **Uno** Unniloctium 265	109 **Une** Unnilennium 266									

58 **Ce** Cerium 140	59 **Pr** Praseodymium 141	60 **Nd** Neodymin 144	61 **Pm** Promethium 147	62 **Sm** Samarium 150	63 **Eu** Europium 152	64 **Gd** Gadolinium 157	65 **Tb** Terbium 159	66 **Dy** Dysprosium 136	67 **Ho** Holmium 165	68 **Er** Erbium 167	69 **Tm** Thulium 169	70 **Yb** Yuterbium 173	71 **Lu** Lutertium 175
90 **Th** Thorium 232	91 **Pa** Proactinum 231	92 **U** Uranium 238	93 **Np** Neptunium 237	94 **Pu** Plutonium 244	95 **Am** Americium 243	96 **Cm** Curium 247	97 **Bk** Berkerium 247	98 **Cf** Californium 249	99 **Es** Einsteinium 254	100 **Fm** Fermium 253	101 **Md** Mendelevevium 256	102 **No** Nobelium 254	103 **Lr** Lawrensium 257

2 **He** Helium 4	← Proton number ← Symbol ← Name of element ← Relative atomic mass		

ASSOCIATION OF CHEMISTRY TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY

NSEC - 2023

FINAL ANSWER KEY NSEC - 2023

QUESTION	PAPER CODE 31	PAPER CODE 32	PAPER CODE 33	PAPER CODE 34
1	a	d	c	a
2	b	c	b	c
3	d	c	c	b
4	b	b	d	a
5	b	b	d	a
6	c	a	d	c
7	c	d	a	b
8	c	a	c	d
9	c	b	b	a
10	b	d	a	c
11	b	b	a	c
12	a	b	c	b
13	d	c	c	b
14	b	c	b	a
15	c	c	d	a
16	b	c	a	c
17	c	b	c	d
18	d	b	c	c
19	d	a	b	b
20	d	d	b	c
21	a	b	a	a
22	c	c	a	b
23	b	b	c	d
24	a	c	d	b
25	a	d	c	b
26	c	d	b	c
27	c	d	c	c
28	b	a	a	c
29	d	c	b	c
30	a	b	d	b

QUESTION	PAPER CODE 31	PAPER CODE 32	PAPER CODE 33	PAPER CODE 34
31	c	a	b	b
32	c	a	b	a
33	b	c	c	d
34	b	c	c	b
35	a	b	c	c
36	a	d	c	b
37	c	a	b	c
38	d	c	b	d
39	c	c	a	d
40	b	b	d	d
41	c	b	b	d
42	d	a	d	c
43	c	a	c	c
44	c	c	c	c
45	b	d	b	b
46	b	c	b	b
47	d	b	d	d
48	a	c	a	a
49	a, b, c, d	a, c	a, b, c, d	a, c
50	a, b, c	a, c, d	a, b, c	a, c, d
51	b, d	a, b, d	b, d	a, b, d
52	b, c, d	c, d	b, c, d	c, d
53	a, c	a, b, d	a, c	a, b, d
54	a, c, d	a, c	a, c, d	a, c
55	a, b, d	a, b, c, d	a, b, d	a, b, c, d
56	c, d	a, b, c	c, d	a, b, c
57	a, b, d	b, d	a, b, d	b, d
58	a, c	b, c, d	a, c	b, c, d
59	a, c	a, c	a, c	a, c
60	c, d	c, d	c, d	c, d

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN CHEMISTRY
(NSEC 2019-20)

Answer Keys NSEC -2019; held on November 24, 2019									
	Code 31	Code 32	Code 33	Code 34		Code 31	Code 32	Code 33	Code 34
Q. No.	keys	keys	keys	keys	Q. No.	keys	keys	keys	keys
1	C	D	B	C	41	B	C	C	D
2	A	B	C	A	42	C	A	A	A
3	D	C	B	C	43	B	A	Removed	D
4	D	D	C	A	44	B	B	A	D
5	A	D	B	B	45	D	D	D	B
6	A	B	D	D	46	C	C	B	D
7	D	D	B	B	47	Removed	B	A	C
8	B	A	C	C	48	B	C	D	A
9	D	A	D	C	49	D	A	A	D
10	A	D	Removed	A	50	C	A	A	A
11	C	A	A	D	51	C	C	D	D
12	A	D	B	A	52	A	C	D	B
13	D	B	C	A	53	A	D	C	B
14	A	D	A	C	54	C	B	B	C
15	C	D	C	B	55	B	C	C	B
16	B	C	B	C	56	C	C	A	D
17	C	D	C	B	57	B	A	C	A
18	B	D	B	C	58	C	C	A	C
19	B	A	C	A	59	D	A	B	D
20	D	Removed	A	A	60	A	B	B	Removed
21	C	B	D	D	61	D	B	C	B
22	A	C	D	A	62	D	D	D	D
23	A	B	C	C	63	B	C	C	C
24	B	C	D	D	64	D	D	C	D
25	D	B	C	B	65	B	B	A	B
26	C	D	D	A	66	D	C	A	B
27	B	C	B	D	67	C	A	B	C
28	C	Removed	D	A	68	A	B	D	Removed
29	A	B	A	A	69	B	A	B	C
30	C	C	D	C	70	A	A	C	B
31	D	C	D	D	71	D	D	A	D
32	A	A	A	C	72	D	A	A	C
33	B	A	C	D	73	C	A	C	C
34	C	C	A	A	74	D	D	D	B
35	C	B	D	B	75	A	A	C	B
36	A	C	B	A	76	D	A	C	A
37	C	B	D	B	77	B	D	B	C
38	A	C	D	C	78	C	C	A	A
39	B	B	B	B	79	A	B	B	A
40	A	A	A	D	80	Removed	D	A	C

IOQC - 31

Time: 2:30 PM to 3:30 PM

Question Paper Code: 31

Student's Roll No:														

Write the question paper code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the question paper.

Instructions to Candidates:

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY **PROHIBITED**
2. In addition to this question paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
4. On the OMR Answer Sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **fourteen-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in Indian Olympiad Qualifier in Chemistry 2020 – 21 (Part I).
6. Question paper has two parts. In part A1 (Q. No.1 to 24) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q.No.12 

In part A2 (Q. No. 25 to 32) each question has four alternatives out of which any number of alternative(s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q.No.30 

7. For **Part A1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer.
   In **Part A2,** you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
8. Rough work should be done only in the space provided. There are **12** printed pages in this paper.
9. Use of **non - programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting answer paper, take away the question paper & candidate's copy of OMR for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR answer sheet.

OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Instructions to Candidates (Continued) :

You may read the following instructions after submitting the answer sheet.

12. **Comments/Inquiries/Grievances regarding this question paper, if any, can be shared on the Inquiry/Grievance column on www.iaptexam.in on the specified format till February 12, 2021.**

13. **The answers/solutions to this question paper will be available on the website: www.iapt.org.in by February 13, 2021.**

14. **CERTIFICATES and AWARDS:**
Following certificates are awarded by IAPT / ACT to students, successful in the Indian Olympiad Qualifier in Chemistry 2020 – 21 (Part I).
(i) "CENTRE TOP 10 %"
(ii) "STATE TOP 1 %"
(iii) "NATIONAL TOP 1 %"
(iv) "GOLD MEDAL & MERIT CERTIFICATE" to all students who attend OCSC – 2021 at HBCSE Mumbai.

15. All these certificates (except gold medal) will be downloadable from IAPT website: www.iapt.org.in after March 15, 2021.

16. List of students (with centre number and roll number only) having score above MAS will be displayed on the website: www.iapt.org.in by **Feb 25, 2021. See the Minimum Admissible Score Clause** on the Student's brochure on the web.

17. List of students eligible for evaluation of IOQC 2020-21 (Part II) shall be displayed on www.iapt.org.in by March 1, 2021.

Useful constants

Charge of electron, $e = 1.602 \times 10^{-19} C$

Mass of electron, $m_e = 9.1 \times 10^{-31} kg$

Planck's constant, $h = 6.626 \times 10^{-34} J\,s$

Speed of light, $c = 3.0 \times 10^{8} ms^{-1}$

Avogadro constant, $N_A = 6.022 \times 10^{23} mol^{-1}$

Molar gas constant, $R = 0.082\, L\, atm\, mol^{-1} K^{-1}$

$= 8.314\, J\, mol^{-1}\, K^{-1}$

Question Paper Code: 31

Time : 60 Minutes **Max. Marks: 120**

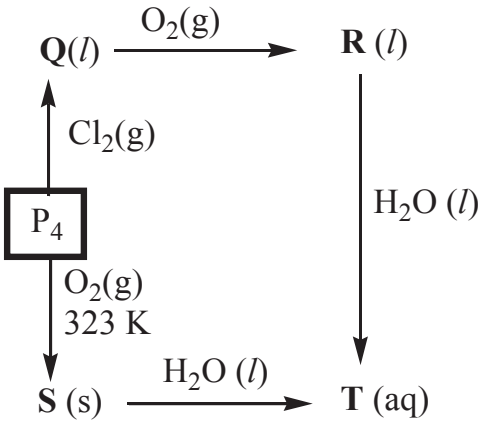
Attempt All The Thirty two Questions

A – 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION

1. Reaction of ammonia with diborane gives an ionic product ($B_2H_6.2NH_3$).
The hybridization of boron in the cation and anion of this product are respectively
(a) sp^3 in both (b) sp^3 and sp^2 (c) sp^2 and sp^3 (d) sp^2 in both

2. A sequence of reactions of phosphorous (P_4) is given below
The correct set of products (Q, R, S and T) among the following is



(a) $Q = PCl_3$; $R = POCl_3$; $S = P_2O_3$; $T = H_3PO_3$
(b) $Q = PCl_5$; $R = P_2O_5$; $S = P_4O_6$; $T = H_3PO_3$
(c) $Q = PCl_3$; $R = POCl_3$; $S = P_4O_{10}$; $T = H_3PO_4$
(d) $Q = PCl_5$; $R = P_4O_{10}$; $S = P_4O_{10}$; $T = H_3PO_4$

3. In the gaseous state of $Fe(CO)_5$, the 'd' orbital that would participate in hybridization is
(a) $d_{x^2-y^2}$ (b) d_{z^2}
(c) d_{xz} (d) any one of the 'd' orbitals

4. Among the following, the *correct* statement/s about 'p' block elements is/are
I. The valence shell electronic configuration of all of them is $ns^2\ np^{1-6}$
II. Only in p block, metals, nonmetals and metalloids are present
III. Halogens have the lowest negative electron gain enthalpy in the respective periods
IV. Noble gases have no tendency to accept an electron and hence they have large negative values of electron gain enthalpy
(a) I, IV (b) II, III (c) IV only (d) II only

5. A chemical reaction is carried out at two different temperatures T_1 and T_2 ($T_2 > T_1$) and also with and without a catalyst.

The statement that is correct among the following is

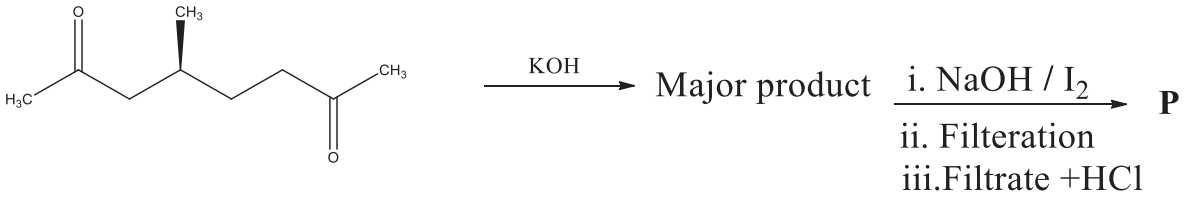
(a) Lowering in the activation energy of the reaction due to catalyst would be higher at T_2 than at T_1

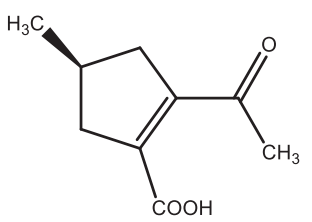
(b) Lowering in the activation energy of the reaction due to catalyst would be higher at T_1 than at T_2

(c) The factor by which the rate of the reaction is increased by the catalyst would be lower at T_2 than at T_1

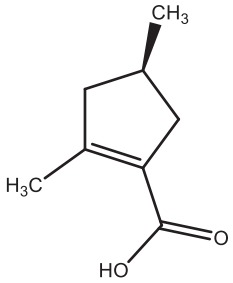
(d) The factor by which the rate of the reaction is increased by the catalyst would be higher at T_2 than at T_1

6. The product **'P'** in the following sequence of reactions is

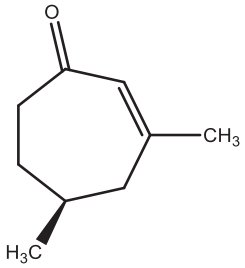




(A)



(B)



(C)

CHI_3

(D)

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

7. Among the following, maximum number of resonance structures is possible for

(a) PO_4^{-3} (b) SO_4^{-2} (c) CO_3^{-2} (d) MnO_4^-

8. A mixture of sodium (Na) and potassium (K) metals weighing 32 g was reacted with water and the solution obtained could be neutralized with 517.3 mL of 1.0 M H_2SO_4 (aq).

The mass of sodium that was present in the mixture is

(a) 20 g (b) 16 g (c) 10 g (d) 12 g

9.The mass ratio of steam and hydrogen is found to be 1:1.5 at equilibrium in the following reaction

$3Fe\ (s) + 4H_2O\ (g) \rightleftharpoons Fe_3O_4(s) + 4H_2\ (g)$

The value of the equilibrium constant **(K_c)** of the above reaction is

(a) 3.0×10^{-5} (b) 3.3×10^{4} (c) 3.3×10^{6} (d) 1.3×10^{3}

10. Two students did a set of experiments on ketones **'X'** and **'Y'** independently and obtained the following results.

Reaction /Experiment	**X**	**Y**
Optical rotation	Yes	Yes
Optical rotation after treatment with a base	Zero	Yes
NH_2NH_2, KOH, Heat	Formation of an optically inactive hydrocarbon C_6H_{12}	Formation of an optically inactive hydrocarbon C_6H_{12}

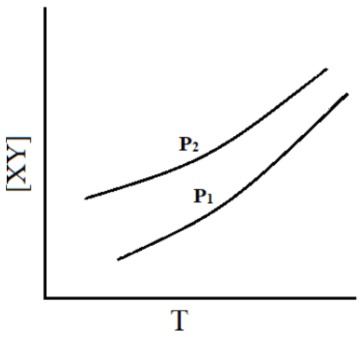
The ketones **'X'** and **'Y'** are respectively
(a) 2-ethylcyclobutanone and 3-ethylcyclobutanone
(b) 2-methylcyclopentanone and 3-methylcyclopentanone
(c) 3-methylcyclopentanone and 2-methylcyclopentanone
(d) 3-methyl-4-penten-2-one and 4-methyl-1-penten-3-one

11. Glycine ($C_2H_5O_2N$) is the simplest of amino acids. Molecular formula of the linear oligomer synthesized by linking *ten* glycine molecules together via a condensation reaction would be
(a) $C_{20}H_{32}O_{11}N_{10}$ (b) $C_{20}H_{68}O_{29}N_{10}$ (c) $C_{20}H_{40}O_{10}N_{10}$ (d) $C_{20}H_{50}O_{20}N_{10}$

12. If Ni^{2+} is replaced by Pt^{2+} in the complex ion $[NiCl_2Br_2]^{2-}$, which of the following would change?
I. Magnetic moment II. Geometry
III. Geometrical isomerism IV. Optical isomerism
(a) I, II, III (b) II, III (c) I, II (d) II, III, IV

13. An inorganic compound **'X'** of an alkali metal on heating gives a reddish-brown gas **'Y'** and a binary solid **'Z'**. This solid is less soluble in water and its solution is basic. **'X'** does not give a positive silver nitrate test. **'X'** can be identified as
(a) KIO_3 (b) $LiNO_3$ (c) $NaNO_3$ (d) KNO_2

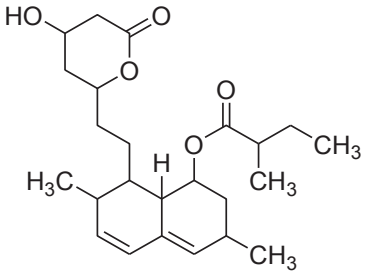
14. The qualitative plots given represent the yield of the product, [XY], at equilibrium in the reaction $X(g) + Y(g) \rightleftharpoons XY(g)$, as a function of temperature, at total pressures P_1 and P_2. The reaction is



(a) endothermic and $P_1 < P_2$ (b) endothermic and $P_2 < P_1$
(c) exothermic and $P_1 > P_2$ (d) exothermic and $P_2 > P_1$

15. When 6.8 g of $AgNO_3$ completely reacts with H_3PO_2, metallic silver produced (g) and H_3PO_2 consumed (mole) are respectively
(a) 4.32 and 0.1 (b) 1.08 and 0.01
(c) 4.32 and 0.01 (d) 2.16 and 0.01

16. Lovastatin, a drug used to reduce the risk of cardio vascular diseases has the following structure



Lovastatin

The number of stereogenic centers present in lovastatin is

(a) 8 (b) 3 (c) 4 (d) 6

17. Among the following sets, the one in which all the molecules are non polar is

(a) XeF_4, XeO_3, XeO_4 (b) XeF_2, XeO_4, $XeOF_4$

(c) XeF_2, XeF_4, XeO_4 (d) XeF_2, XeO_3, $XeOF_4$

18. Gas phase reactions (i) and (ii) are of first and second order respectively

$2N_2O_5 \rightarrow 4NO_2 + O_2$ ..... (i)

$2NO + O_2 \rightarrow 2NO_2$..... (ii)

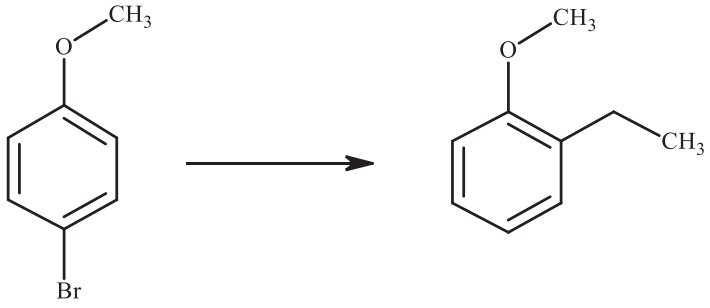
Under certain conditions, the rate constants (k_1, k_2) of (i) and (ii) respectively, have the same numerical value, when the concentrations of the reactants are expressed in mol/dm^3.

If the concentrations are expressed in mol/mL, the correct relationship between k_1 and k_2 is

(a) $k_2 \times 10^{-3} = k_1$ (b) $k_2 \times 10^3 = k_1$

(c) $k_1 = k_2$ (d) $k_1 \times 10^6 = k_2$

19. The correct sequence of reactions to get **'Q'** as the *only* product from **'P'** is



P **Q**

(a) (i) H_2 & Pt catalyst (ii) C_2H_5Cl & $AlCl_3$

(b) (i) Mg in ether (ii) aqueous alcohol (iii) C_2H_5Cl & $AlCl_3$

(c) (i) Mg in ether (ii) C_2H_5Cl & $AlCl_3$

(d) (i) C_2H_5Cl & $AlCl_3$ (ii) Mg in ether (iii) aqueous alcohol

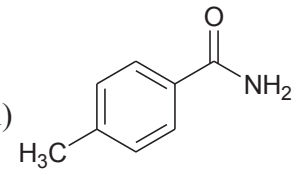
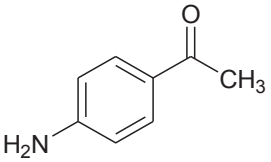
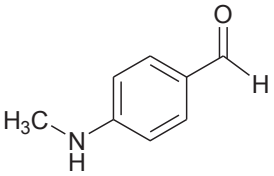
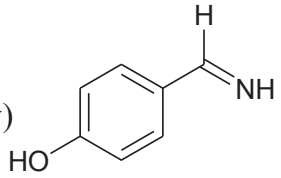
20. The Galvanic cell can be represented as Zn / Zn^{2+} (0.1M) // Cu^{2+} (0.1M)/Cu. Among the following, the cell that can produce an EMF more than that of the Galvanic cell is

(E^0 of Zn^{2+}/Zn and Cu^{2+}/Cu are -0.763V and 0.337V respectively)

(a) Zn / Zn^{2+} (0.1M) // Cu^{2+} (0.01M)/Cu (b) Zn / Zn^{2+} (1M) // Cu^{2+} (0.01M)/Cu

(c) Zn / Zn^{2+} (0.01M) // Cu^{2+} (1M)/Cu (d) Zn / Zn^{2+} (0.01M) // Cu^{2+} (0.01M)/Cu

21. The correct match of the molecules in column I and reactions in column II is

Column I	Column II
i) 	(L) Coloration with $FeCl_3$
ii) 	(M) Effervescence with $NaHCO_3$
iii) 	(N) Yellow precipitate with NaOH and I_2
iv) 	(O) Yellow oil with $NaNO_2$, HCl at 0 ^oC
	(P) Heating with NaOH gives out a gas that turns moist turmeric paper brown

(a) i)-N ii)-L iii)-O iv)-M

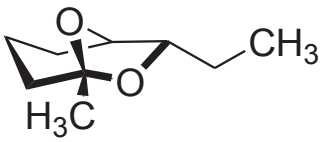
(b) i)-O ii)-N iii)-L iv)- P

(c) i)-P ii)-O iii)-L iv)-M

(d) i)-P ii)-N iii)-O iv)-L

22. While doing titration, a student recorded a burette reading of 10.0 mL for the neutralization of 10.0 mL $NaHC_2O_4$ (aq) with 0.1 M NaOH (aq). In a separate experiment, 10.0 mL of this $NaHC_2O_4$ (aq) solution could be completely oxidized by 10.0 mL of $KMnO_4$ in an acidic medium.
What would be the molarity of $KMnO_4$ used by this student?
(a) 0.02 M (b) 0.04 M (c) 0.1 M (d) 0.2 M

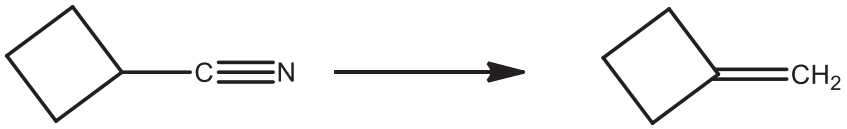
23. Pheromones are chemicals that animals produce for social response. The structure of brevicomin, a pheromone, is shown below. The open chain ketodiol that would form brevicomin is



Brevicomin

(a) 7,8-dihydroxynonan-3-one (b) 6,7-dihydroxynonan-3-one
(c) 7,8-dihydroxynonan-2-one (d) 6,7-dihydroxynonan-2-one

24. The best reagents and conditions to accomplish the following conversion is



(a) (i) $LiAlH_4$ in ether, (ii) 3 moles of CH_3I followed by heating with AgOH
(b) (i) $LiAlH_4$ in ether; (ii) P_2O_5 and heat
(c) (i) 20 % H_2SO_4 & heat, (ii) P_2O_5 and heat
(d) H_2 and Lindlar catalyst

A2

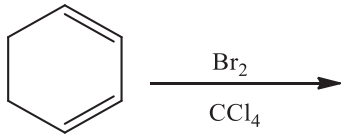
ANY NUMBER OF OPTIONS, 4, 3, 2 or 1 MAY BE CORRECT
MARKS WILL BE AWARDED ONLY IF ALL CORRECT OPTIONS ARE BUBBLED AND NO WRONG OPTION

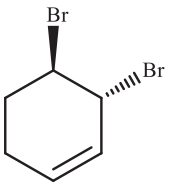
25. The correct statement/s among the following is/are
(a) Intermolecular forces in n-heptane are stronger than those in 2-methylheptane
(b) Boiling point of 2,2-dimethylpentane is higher than that of 2, 2-dimethylbutane
(c) Both hydrogen bonding and van der Waals forces exist between molecules of 2-methylbutan-2-ol
(d) In 2,2-dimethylbutane, 1°, 2° and 3° types of carbon atoms are present

26. Which of the following aqueous solution/s will have a pH value between 4.0 and 5.0 at 25 ºC?
(a) 0.01 M solution of benzoic acid ($K_a = 6.6 \times 10^{-5}$ at 25 ºC)
(b) 0.02 mol benzoic acid and 0.05 mol sodium benzoate dissolved in appropriate amount of water to make a solution of 1L
(c) A mixture of 999 mL water and 1mL 0.2 M HCl
(d) 499 mL of 0.01M NaOH and 501 mL of 0.01 M HCl mixed together

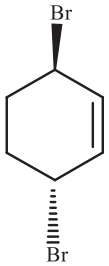
27. The energy required to remove an electron from a gaseous species 'X' to form 'X^+' is known as first ionization energy (IE) of X. The energy required to remove an electron from a gaseous species 'X^+' to form 'X^{++}' is called the second IE of X. Similarly, the energy required to remove an electron from a gaseous species X^- to form X is called the IE of X^-.
Identify the correct statement/s from the following
(a) The second IE of the He atom is *four times* that of the (first) IE of the H atom.
(b) The first IEs of F, Ne and Na atoms follow the order IE(Na) < IE(Ne) < IE(F)
(c) The second IE of the H^- ion is much less than the (first) IE of the H atom.
(d) The IEs of Li, Na and K atoms follow the order IE(K) < IE(Na) < IE (Li)

28. The product/s formed in the following reaction is/are

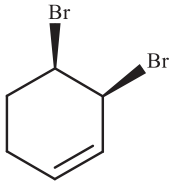




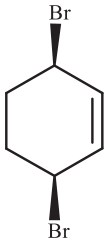
(A)



(B)



(C)



(D)

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

29. Which of the following option/s is /are correct?

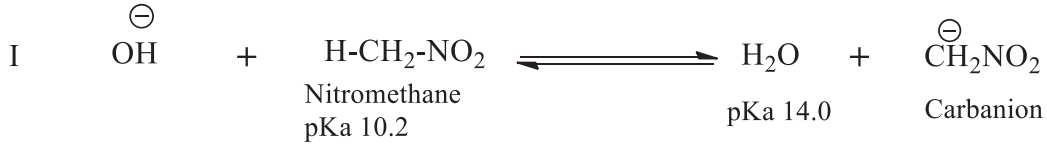
(a) C_2 is paramagnetic

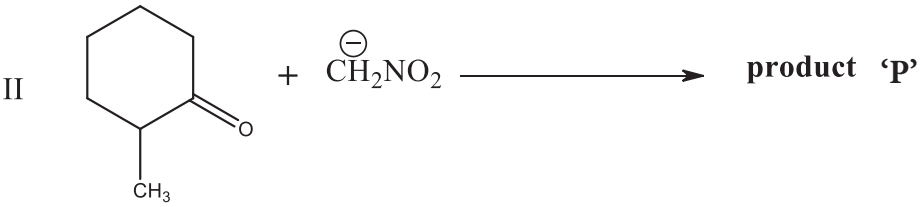
(b) He_2^+ has the same energy as that of two isolated He atoms

(c) S_2 is paramagnetic and S_2^{2-} is diamagnetic

(d) N_2^+ and N_2^- have the same bond order

30. Nitromethane undergoes an aldol type reaction with a racemic mixture of 2-methylcyclohexanone in presence of aqueous NaOH in two steps (I, II) to give the product '**P**'. The statement/s *NOT* correct among the following is/are





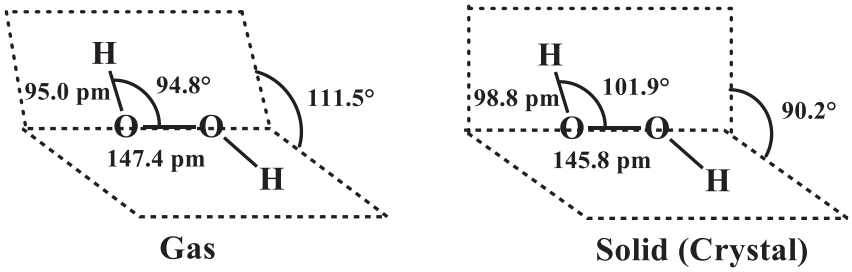
(a) The equilibrium in step I will be more towards the right as water is a stronger acid than nitromethane

(b) The carbanion formed in reaction I can be stabilized due to resonance

(c) The product formed will be a mixture of four stereoisomers in the form of two pairs of enantiomers

(d) The mixture of products formed can be readily dehydrated to give a single product

31. The structures of hydrogen peroxide (H_2O_2) in the solid and gaseous states are given below. H_2O_2 (l) is slightly more viscous than H_2O (l). The correct option/s among the following is/are



(a) Both O atoms are near enough to cause repulsion between the electron lone pairs thus making the O-O bond susceptible for cleavage

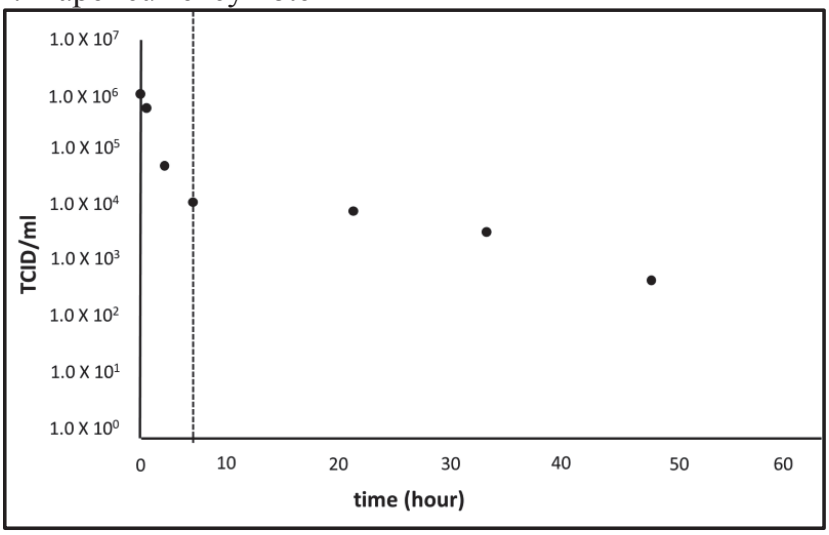
(b) The strong intermolecular H-bonding along with restricted rotation present in the liquid state of H_2O_2 make it more viscous than H_2O (l)

(c) The molecule gets twisted to minimize the repulsion between the lone pair and bond pair of electrons

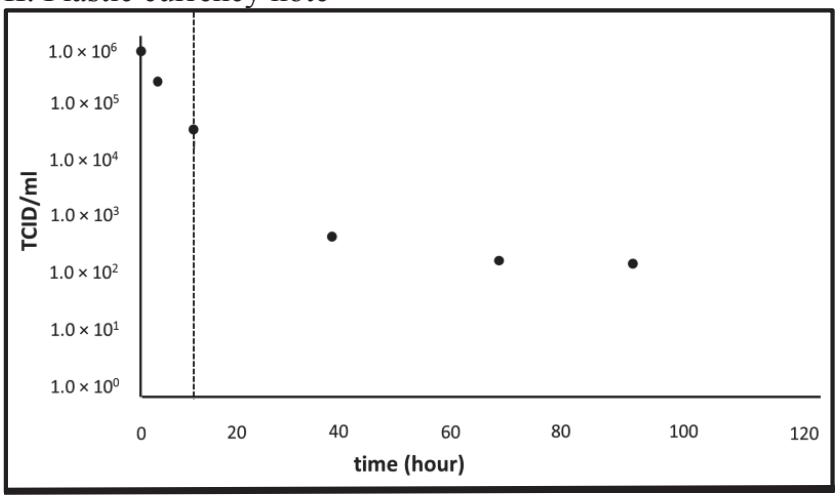
(d) The difference in the dihedral angles in the solid and gaseous states is a consequence of hydrogen bonding between the molecules

32. Viruses are nonliving complex chemical entities. They undergo inactivation and hence lose the ability to infect a host, with time. Concentration (expressed as 'median tissue culture infectious dose', TCID/ml, a unit used in expressing virus concentrations) vs. time plots of a corona virus on the surfaces of a paper currency note and a plastic currency note are shown below. Both these plots have two separate regions (shown by vertical lines in the plots), indicating two time zones.

I. Paper currency note



II. Plastic currency note



The correct option/s among the following is/are

(a) Inactivation of the virus follows zero order kinetics in 1st zone and first order kinetics in 2nd zone
(b) The rate of inactivation is independent of the surface material
(c) The virus reacts with different chemical entities/substances in 1st zone and 2nd zone
(d) On both the surfaces, at least 95 % of the virus is inactivated within 10 h

IUPAC Periodic Table of the Elements

1																	18
1 **H** hydrogen 1.008 [1.0078, 1.0082]	2		Key:									13	14	15	16	17	2 **He** helium 4.0026
3 **Li** lithium 6.94 [6.938, 6.997]	4 **Be** beryllium 9.0122		atomic number **Symbol** **name** conventional atomic weight standard atomic weight									5 **B** boron 10.81 [10.806, 10.821]	6 **C** carbon 12.011 [12.009, 12.012]	7 **N** nitrogen 14.007 [14.006, 14.008]	8 **O** oxygen 15.999 [15.999, 16.000]	9 **F** fluorine 18.998	10 **Ne** neon 20.180
11 **Na** sodium 22.990	12 **Mg** magnesium 24.305 [24.304, 24.307]	3	4	5	6	7	8	9	10	11	12	13 **Al** aluminium 26.982	14 **Si** silicon 28.085 [28.084, 28.086]	15 **P** phosphorus 30.974	16 **S** sulfur 32.06 [32.059, 32.076]	17 **Cl** chlorine 35.45 [35.446, 35.457]	18 **Ar** argon 39.95 [39.792, 39.963]
19 **K** potassium 39.098	20 **Ca** calcium 40.078(4)	21 **Sc** scandium 44.956	22 **Ti** titanium 47.867	23 **V** vanadium 50.942	24 **Cr** chromium 51.996	25 **Mn** manganese 54.938	26 **Fe** iron 55.845(2)	27 **Co** cobalt 58.933	28 **Ni** nickel 58.693	29 **Cu** copper 63.546(3)	30 **Zn** zinc 65.38(2)	31 **Ga** gallium 69.723	32 **Ge** germanium 72.630(8)	33 **As** arsenic 74.922	34 **Se** selenium 78.971(8)	35 **Br** bromine 79.904 [79.901, 79.907]	36 **Kr** krypton 83.798(2)
37 **Rb** rubidium 85.468	38 **Sr** strontium 87.62	39 **Y** yttrium 88.906	40 **Zr** zirconium 91.224(2)	41 **Nb** niobium 92.906	42 **Mo** molybdenum 95.95	43 **Tc** technetium	44 **Ru** ruthenium 101.07(2)	45 **Rh** rhodium 102.91	46 **Pd** palladium 106.42	47 **Ag** silver 107.87	48 **Cd** cadmium 112.41	49 **In** indium 114.82	50 **Sn** tin 118.71	51 **Sb** antimony 121.76	52 **Te** tellurium 127.60(3)	53 **I** iodine 126.90	54 **Xe** xenon 131.29
55 **Cs** caesium 132.91	56 **Ba** barium 137.33	57-71 lanthanoids	72 **Hf** hafnium 178.49(2)	73 **Ta** tantalum 180.95	74 **W** tungsten 183.84	75 **Re** rhenium 186.21	76 **Os** osmium 190.23(3)	77 **Ir** iridium 192.22	78 **Pt** platinum 195.08	79 **Au** gold 196.97	80 **Hg** mercury 200.59	81 **Tl** thallium 204.38 [204.38, 204.39]	82 **Pb** lead 207.2	83 **Bi** bismuth 208.98	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89-103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **Nh** nihonium	114 **Fl** flerovium	115 **Mc** moscovium	116 **Lv** livermorium	117 **Ts** tennessine	118 **Og** oganesson

57 **La** lanthanum 138.91	58 **Ce** cerium 140.12	59 **Pr** praseodymium 140.91	60 **Nd** neodymium 144.24	61 **Pm** promethium	62 **Sm** samarium 150.36(2)	63 **Eu** europium 151.96	64 **Gd** gadolinium 157.25(3)	65 **Tb** terbium 158.93	66 **Dy** dysprosium 162.50	67 **Ho** holmium 164.93	68 **Er** erbium 167.26	69 **Tm** thulium 168.93	70 **Yb** ytterbium 173.05	71 **Lu** lutetium 174.97
89 **Ac** actinium	90 **Th** thorium 232.04	91 **Pa** protactinium 231.04	92 **U** uranium 238.03	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 1 December 2018.

United Nations Educational, Scientific and Cultural Organization

2019 IYPT International Year of the Periodic Table of Chemical Elements

100 IUPAC

NATIONAL STANDARD EXAMINATION IN CHEMISTRY

NSEC - 2022

FINAL ANSWER KEY NSEC - 2022

QUESTION	PAPER CODE 31	PAPER CODE 32	PAPER CODE 33	PAPER CODE 34
1	d	a	c	c
2	c	c	d	c
3	b	d	c	d
4	d	b	b	d
5	c	d	d	c
6	c	d	c	b
7	a	c	b	d
8	b	b	d	c
9	d	d	c	c
10	b	c	c	a
11	b	c	a	b
12	c	a	b	d
13	c	b	d	b
14	d	d	b	b
15	a	b	b	c
16	a	b	c	c
17	c	c	c	d
18	d	c	d	a
19	b	d	a	a
20	d	a	a	c
21	c	c	c	d
22	c	c	d	b
23	b	b	b	d
24	a	a	d	c
25	a	a	c	c
26	c	c	c	b
27	c	c	b	a
28	d	d	a	a
29	d	d	a	c
30	d	d	c	c

QUESTION	PAPER CODE 31	PAPER CODE 32	PAPER CODE 33	PAPER CODE 34
31	c	c	c	d
32	a	a	d	d
33	c	c	d	d
34	a	a	d	c
35	c	c	c	a
36	d	d	a	c
37	c	c	c	a
38	b	b	a	c
39	a	a	a	d
40	d	d	d	c
41	d	d	d	b
42	b	b	b	a
43	a	a	a	d
44	b	b	b	d
45	c	c	c	b
46	c	c	c	a
47	c	c	c	b
48	d	d	d	c
49	b, d	a, c	c, d	a, b, c
50	a, c	b, d	a	a, c
51	a, c	a, c, d	a, b, c	b, c, d
52	b, d	a, c	b, d	b, d
53	a, c, d	b, d	a, c	a, c
54	a, c	a, c	a, c	a, c
55	c, d	c, d	b, d	b, d
56	a	a	a, c, d	a, c, d
57	a, b, c	a, b, c	a, c	a, c
58	a, b, c	a, b, c	a, b, c	c, d
59	a, c	a, c	a, c	a
60	b, c, d	b, c, d	b, c, d	a, b, c

C321

INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY 2018 -19

Date of Examination: 25TH November, 2018

Time: 1100 to 1300 Hrs

Q. Paper Code: C321

Write the question paper code mentioned above on YOUR answer sheet (in the space provided), otherwise your answer sheet will NOT be assessed. Note that the same Q. P. Code appears on each page of the question paper.

Instructions to Candidates –

1. Use of mobile phones, smartphones, ipads during examination is **STRICTLY PROHIBITED**.
2. In addition to this question paper, you are given answer sheet along with Candidate's copy.
3. On the answer sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/carelessly filled information may disqualify your candidature.
4. On the answer sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. The email ID and date of birth entered in the answer sheet will be your login credentials for accessing performance report. Please take care while entering.
6. Question paper has 80 multiple choice questions. Each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

7. A correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer.
8. Any rough work should be done only in the space provided.
9. Use of **non-programmable** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting your answer paper, take away the Candidate's copy for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the answer sheet.

Answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED.

Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE ANSWER SHEET.

Instructions to Candidates (continued) –

Read the following instructions after submitting the answer sheet.

12. **Comments regarding this question paper, if any, can be shared only on Google forms,** https://goo.gl/forms/Lxb1l8Bqov3Cl9FQ2 **till 27th November, 2018.**
13. **The answers/solutions to this question paper will be available on our website – www.iapt.org.in by 2nd December, 2018.**
14. **CERTIFICATES and AWARDS –**
    Following certificates are awarded by the IAPT to students successful in NSEs

    (i) "Centre Top 10%" that will be sent to NSE centre by post.

    (ii) "Statewise Top 1%" that can be downloaded after Feb -15th, 2019 from iapt.org.in

    (iii) "National Top 1%". Certificates can be downloaded after Feb -15th, 2019 from iapt.org.in

15. Result sheets can be downloaded from our website in the month of February. The "Centre Top 10%" certificates will be dispatched to the Prof-in-charge of the centre by February, 2019.
16. List of students (with centre number and roll number only) having score above MAS will be displayed on our website (www.iapt.org.in) by **22nd December, 2018.** See the **Eligibility Clause** in the Student's brochure on our website.
17. Students eligible for the INO Examination on the basis of selection criteria mentioned in Student's brochure will be informed accordingly.
18. Students qualified for OCSC (Chemistry) – 2019 will be awarded gold medals.

Useful Constants:

Charge of electron, $e = 1.602 \times 10^{-19}$ C

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg

Planck's constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light, $c = 3.0 \times 10^{8}$ m s^{-1}

Avogadro constant, $N_A = 6.022 \times 10^{23}$ mol^{-1}

Molar gas constant, $R = 0.082$ L atm mol^{-1} K^{-1}

$= 8.314$ J mol^{-1} K^{-1}

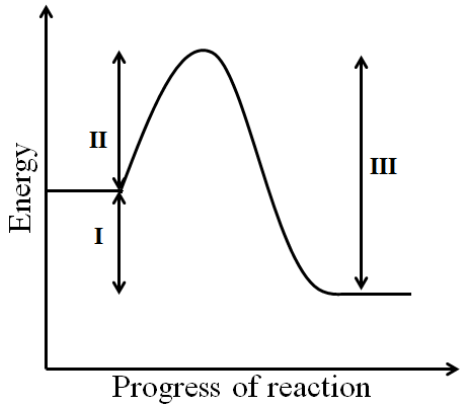
INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY 2018-19

Total Time: 120 minutes **Marks: 240**

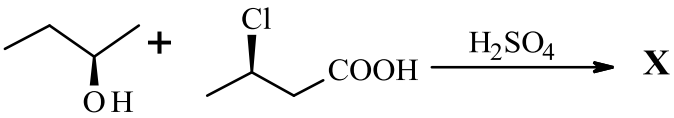
Only one out of four options is correct

(1) Which of the energy values marked as I,II and III in the following diagram, will change by the addition of a suitable catalyst?



(A) II only (B) I and II (C) II and III (D) III only

(2) The product '**X**' in the following reaction is



(A) a racemic mixture of ester (B) an optically inactive ester

(C) an optically active ester (D) a meso ester

(3) At 298 K, change in internal energy for the complete combustion of fullerene, C_{60}(s), an allotrope of carbon, and the enthalpy of formation of CO_2 (g) are -25970 kJ mol^{-1} and -393 kJ mol^{-1} respectively. The enthalpy of formation of C_{60} (s) at 298 K is

(A) – 2390 kJ (B) 4.95 x10^4 kJ (C) 2.60 x10^4 kJ (D) 2390 kJ

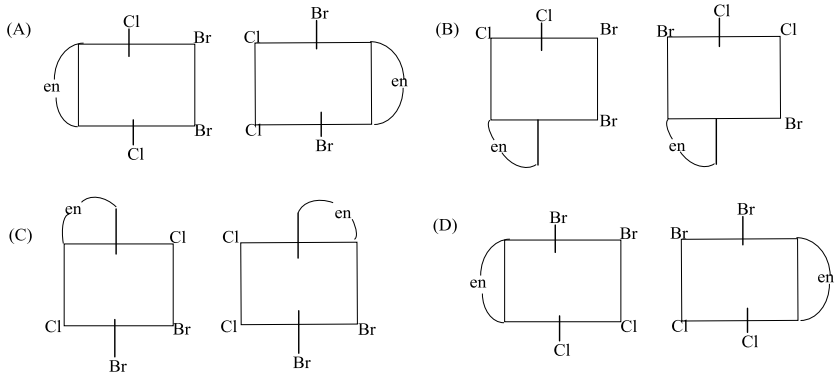
(4) Which of the following is *not* paramagnetic?

(A) S^{2-} (B) N^{2-} (C) O^{2-} (D) NO

(5) Solubility product of AgCl is 1.8×10^{-10}. The minimum volume (in L) of water required to dissolve 1 mg of AgCl is close to

(A) 0.5 (B) 7.5 (C) 50 (D) 0.75

(6) The complex $[M(en)(Br)_2(Cl)_2]$ has two optical isomers. Their configurations can be represented as



(7) A sample of water from a river was analyzed for the presence of metal ions and the observations were recorded as given below

Reagent added	Observation
dil. HCl	No change
aq. Na_2CO_3	White precipitate
aq. Na_2SO_4	No change

The water sample is likely to contain

(A) Ba^{2+} (B) Cu^{2+} (C) Li^{+} (D) Mg^{2+}

(8) The lattice enthalpy and enthalpy of solution in water for solid NaCl are 753 kJ mol^{-1} and 5 kJ mol^{-1} respectively(Fig above). If the solution enthalpies of Na^{+} and Cl^{-} are in the ratio 6:5, the enthalpy of hydration of Na^{+} ion is

(A) 408 kJ mol^{-1} (B) -412 kJ mol^{-1} (C) –408 kJ mol^{-1} (D) – 412 kJ mol^{-1}

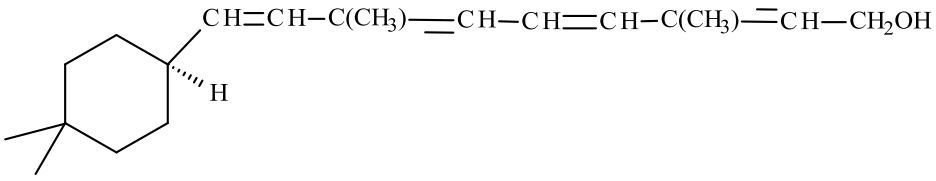
(9) The gaseous product obtained on reaction of BF_3 with LiH is

(A) HF (B) H_2 (C) B_2H_6 (D) F_2

(10) The equilibrium constant K for the reversible reaction A=B is 2 x10^3 at 350K. The rate constants of the forward reaction in the presence and absence of a suitable catalyst at the same temperature are 5x10^4 s^{-1} and 4x10^{-6} s^{-1} respectively. The rate constant of the reverse reaction in the absence of the catalyst is

(A) 2 x 10^{-3} s^{-1} (B) 2.5 x 10^{-1} s^{-1} (C) 1.6 x10^{-7} s^{-1} (D) 1.25 x10^{-2} s^{-1}

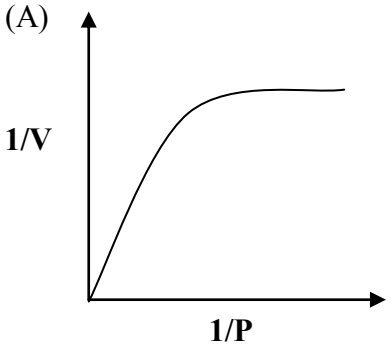
(11) The number of stereoisomers possible for the following compound



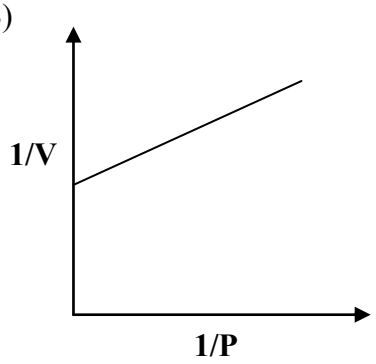
(A) 4 (B) 2 (C) 16 (D) 32

(12) An adsorption isotherm equation proposed by Langmuir is of the form $V = \frac{V_0 bP}{(1+bP)}$ where V is the volume of gas adsorbed at pressure P. For a given adsorbate/adsorbent system, V_0 and b are constants. The dependence of V on P can be depicted as

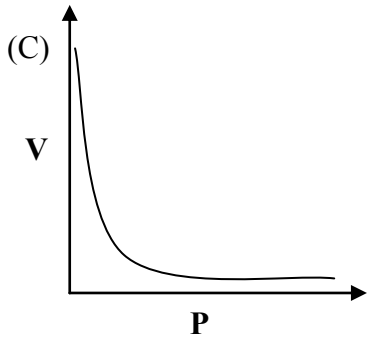
(A)



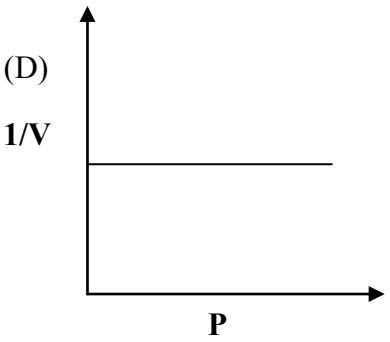
(B)



(C)



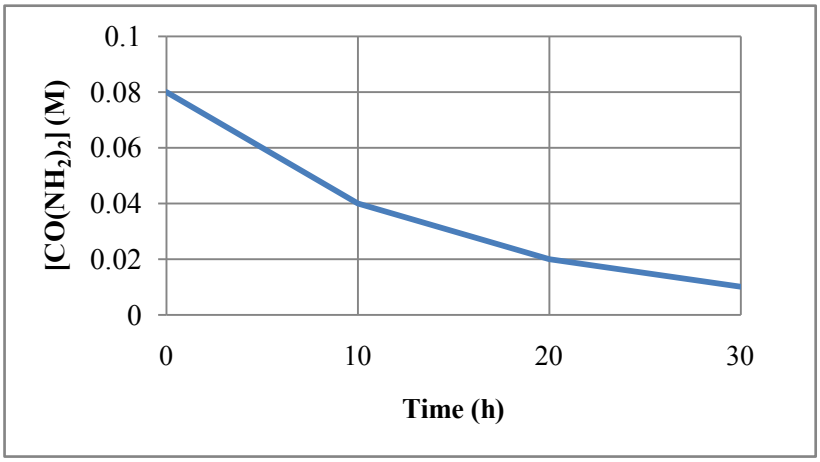
(D)



(13) For the reaction $4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g)$, $\Delta H_{reaction} = -112$ kJ. If the N_2O_5 is assumed to be formed in the reaction as a solid, $\Delta H_{reaction}$ will be ($\Delta H_{sublimation}$ of N_2O_5 is 54 kJ mol^{-1})

(A) – 220 kJ (B) – 4 kJ (C) – 166 kJ (D) –332 kJ

(14) Urea, $CO(NH_2)_2$, decomposes at 90°C as $CO(NH_2)_2$ (aq) $\rightarrow NH_4^+$ (aq) + OCN^- (aq)
Experimental data obtained for the reaction is given in the following plot



From the graph it can be inferred that

(A) Average rate of the reaction is the same for successive time intervals of 10 h

(B) unit of rate constant of the reaction is h^{-1}

(C) rate constant of the reaction is the lowest at 30 h

(D) the reaction is of zero order

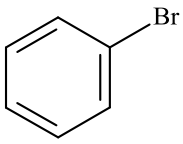
(15) If for an aqueous solution of a weak acid, $pH = pK_a + 2$ at 25°C, the approximate fraction of the acid in the dissociated form is

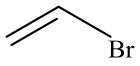
(A) 1.1% (B) 0.99 % (C) 99.0 % (D) 9.9%

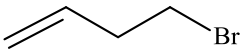
(16) 2.0 L of N_2 gas kept at 25° C and 5 atm pressure were expanded isothermally against a constant pressure of 1 atm until the pressure of the gas reaches 1 atm. Assuming ideal behaviour, reversible work of expansion in this process (in J) is close to

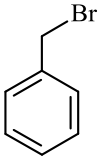
(A) 810 J (B) –194 kJ (C) – 810 kJ (D) 3390 kJ

(17) The compound which would undergo a reaction with ammonia by S_N1 mechanism is

(A) 

(B) 

(C) 

(D) 

(18) The daily energy requirement of a teenager is 7800 kJ. As calculated from the data given in the table below, the amount of glucose he has to consume (g) per day assuming that the entire energy he requires comes from the combustion of glucose is

Molecule	ΔH_f (kJ mol^{-1})
$C_6H_{12}O_6$	-1273
CO_2 (g)	-394
H_2O	-286

(A) 262 (B) 500 (C) 131 (D) 250

(19) The pressure inside two gas cylinders of volume 25 m^3 and 50 m^3 are 10 kPa and 20 kPa respectively. The cylinders are kept at the same temperature and sepearted by a valve. What is the pressure in the combined system when the valve is opened?

(A) 30 kPa (B) 15 kPa (C) 16.7 kPa (D) 2.5 kPa

(20) Aluminium and copper are extracted from their oxide and sulphide ores respectively. Which of the following is correct?

I. Copper is extracted by the auto reduction of copper oxide by copper sulphide

II. Aluminium cannot be obtained by chemical reduction due to its strong affinity for oxygen

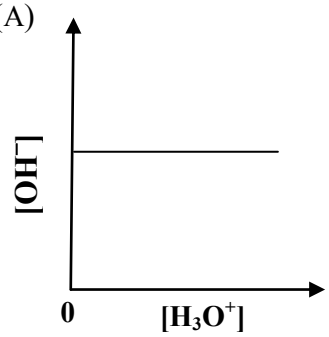
III. In electrometallurgy of Al, graphite is used as cathode to avoid reoxidation of Al into Al_2O_3 by preventing formation of O_2.

IV. Sulphide ores of copper are difficult to be reduced than the oxide ores

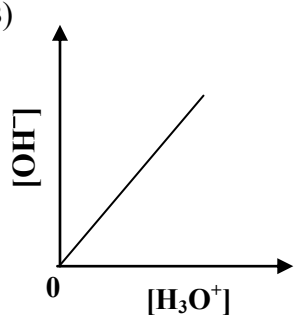
(A) I, II, IV (B) II and III (C) II and III (D) II and IV

(21) Which of the following graphs describes the relationship between $[H_3O^+]$ and $[OH^-]$ in an aqueous solution at a constant temperature?

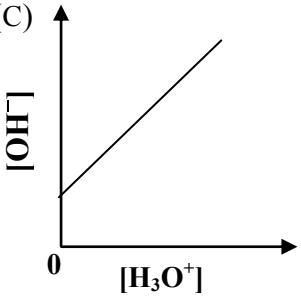
(A)



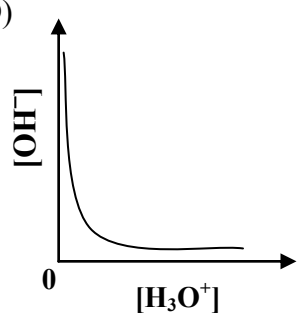
(B)



(C)



(D)



(22) From the given standard electrode potentials

$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$ $E^0 = 0.15$ V

$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$ $E^0 = 1.07$ V

The approximate free energy change for the process

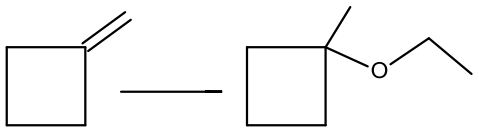
$2Br^-(aq) + Sn^{4+}(aq) \rightarrow Br_2(l) + Sn^{2+}(aq)$ is

(A) 177.6 kJ (B) 355 kJ (C) –177.6 kJ (D) –355 kJ

(23) Number of moles of $KClO_3$ that have to be heated to produce 1.0 L of O_2 (g) at STP can be expressed as

(A) 1/3 (1/22.4) (B) ½ (1/22.4) (C) 2/3 (1/22.4) (D) 3/2 (22.4)

(24) The sequence of reagents required for the following conversion is



(A) (i) B_2H_6/H_2O_2 /OH^- (ii) Na (iii) C_2H_5I (B) (i) HCl (ii) C_2H_5ONa

(C) (i) H_3O^+ (ii) Na (iii) C_2H_5OH (D) (i) H_3O^+ (ii) Na (iii) C_2H_5Cl

(25) Among the following, number of oxygen atoms present is the *maximum* in

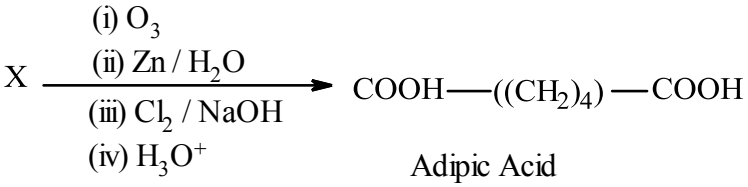
(A) 1.0 g of O_2 molecules (B) 4.0 g of O atoms

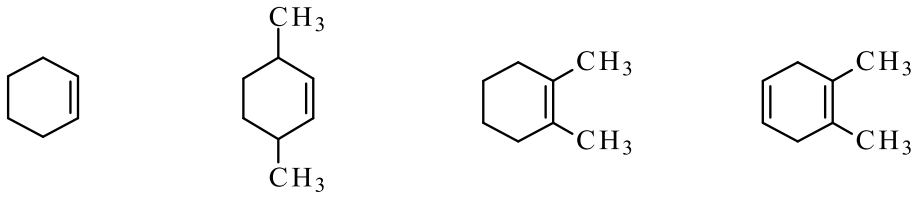
(C) 1.0 g of O_3 (D) 1.7g of H_2O

(26) Which of the following elements will exhibit photoelectric effect with light of the longest wavelength?

(A) K (B) Rb (C) Mg (D) Ca

(27) Compound '**X**' in the following reaction is





(A) (B) (C) (D)

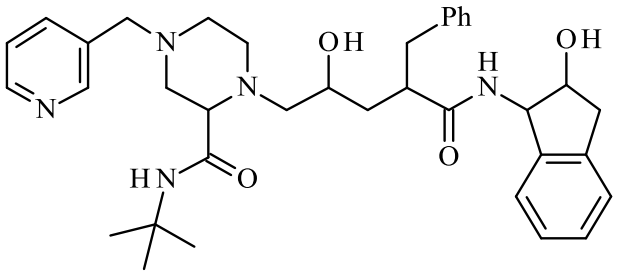
(28) The standard molar entropies of H_2 (g), N_2 (g) and NH_3 (g) are 130, 190 and 193 J mol^{-1} K^{-1} respectively. For the reaction ½ N_2 (g) + 3/2H_2 (g) ⇌ NH_3 (g) ($\Delta H_{reaction}$ = –45 kJ) to be in equilibrium, the temperature must be equal to

(A) 464 K (B) 928 K (C) 737 K (D) 354 K

(29) Density of CO_2 gas at 0 °C and 2.00 atm pressure can be expressed as

(A) 2 g m^{-3} (B) 4 g m^{-3} (C) 4 × 10^3 kg m^{-3} (D) 8 g L^{-1}

(30) The maximum number of moles of CH_3I consumed by one mole of crixivan, a drug used against AIDS is



Crixivan

(A) 2 (B) 3 (C) 5 (D) 7

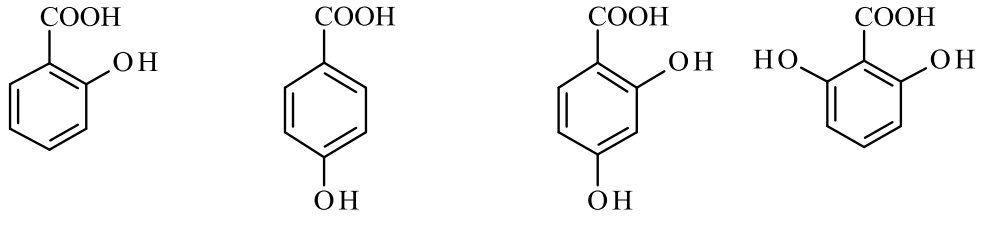
(31) Concentration of K^+ ions inside a biological cell was found to be 25 times higher than that outside. The magnitude of the potential difference between the two sides of the cell is close to (2.303 RT/F can be taken as 59 mV; difference in concentrations of other ions can be taken as negligible.)

(A) 4.2 mV (B) 195 mV (C) 82 mV (D) -82 mV

(32) The standard redox potential for the reaction $2H_2O \rightarrow O_2 + 4H^+ + 4\ e^-$ is –1.23V. If the same reaction is carried out at 25^{0}C and at pH =7, the potential will be

(A) –0.82 V (B) –3.28 V (C) 0.82 V (D) –1.18 V

(33) The order of pK_a values of the following acids is



I II III IV

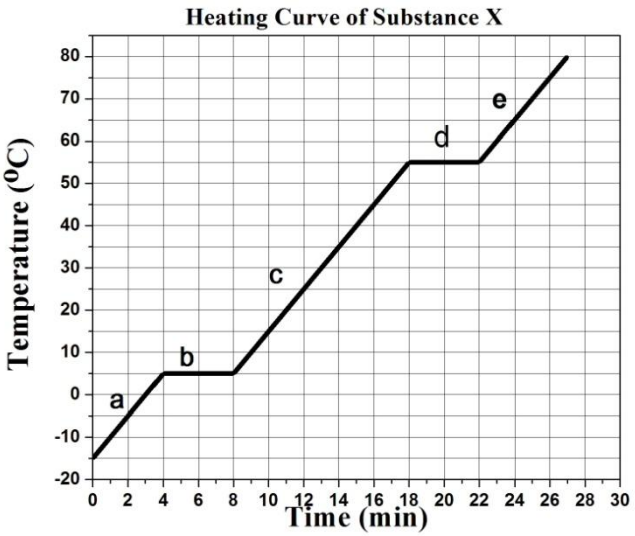
(A) IV > I > III > II (B) III > IV > I > II

(C) II > I > III > IV (D) II > III > I > IV

(34) If the radius of the hydrogen atom is 53 pm, the radius of the He^+ ion is close to

(A) 75 pm (B) 38 pm (C) 106 pm (D) 27 pm

(35) A substance **X** was heated at constant pressure and the temperature observed at various times of heating was plotted as given below



Which of the following is/are correct?

I. Melting point of **X** is -5°C

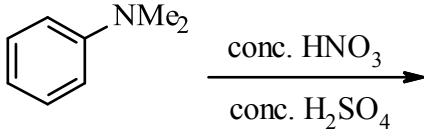
II. Solid and liquid forms of **X** coexist in the region b

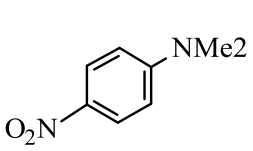
III. Boiling point of **X** is 55°C

IV. Solid and liquid forms of **X** coexist in the region d

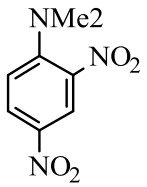
(A) I and IV (B) II and III (C) III only (D) I , II and III

(36) The *major* product of the following reaction is

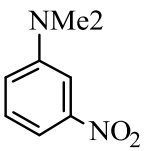




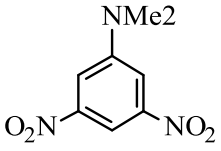
(A)



(B)



(C)



(D)

(37) In which of the following, all the bond lengths are *not* the same?

I. IF_4^+ II. BF_4^- III. SF_4 IV. $TeCl_4$

(A) I, II , IV (B) II, III, IV (C) I, III, IV (D) I, II, III

(38) Among the following, the reaction/s that can be classified as oxidation- reduction is /are

I. $Cr_2O_7^{2-}(aq) + 2\,OH^-(aq) \rightarrow 2\,CrO_4^{2-} + H_2O(l)$

II. $SiCl_4(l) + 2Mg(s) \rightarrow 2MgCl_2(l) + Si(s)$

III. $6Cl_2(l) + 12KOH(l) \rightarrow 2KClO_3(s) + 10\,KCl + 6H_2O(l)$

IV. $2\,H_2O_2 \rightarrow 2H_2O(l) + O_2(g)$

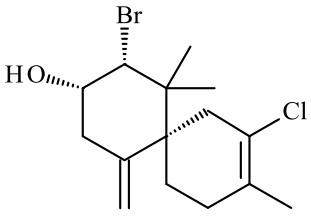
(A) I and IV (B) I, II and III (C) II, III and IV (D) IV only

(39) Among the following pairs, the one in which both the compounds as pure liquids can show significant auto ionization is

(A) H_2O and H_2S (B) BrF_3 and ICl_3

(C) PF_5 and PCl_5 (D) HF and HCl

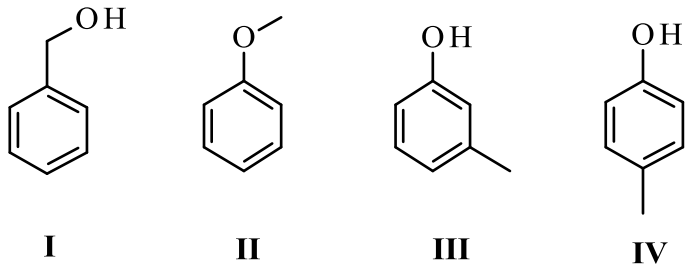
(40) The number of quaternary and chiral carbon atoms present in elatol, isolated from an algae are respectively



Elatol

(A) 2, 3 (B) 4, 2 (C) 3, 2 (D) 1, 3

(41) Compounds **X** (pK_a ~ 15) and **Y** (pK_a ~ 10), both produce H_2 on treatment with sodium metal and both yield a mixture of isomers on mononitration. **X** and **Y** respectively are



I **II** **III** **IV**

(A) IV, I (B) III, II (C) III, I (D) I, III

(42) A crystal of KCl containing a small amount of $CaCl_2$ will have

(A) vacant Cl^- sites

(B) vacant K^+ sites and a higher density as compared to pure KCl

(C) vacant K^+ sites and a lower density as compared to pure KCl

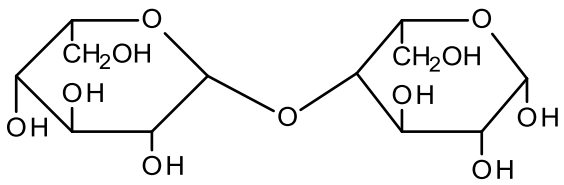
(D) K^+ ions in the interstitial sites

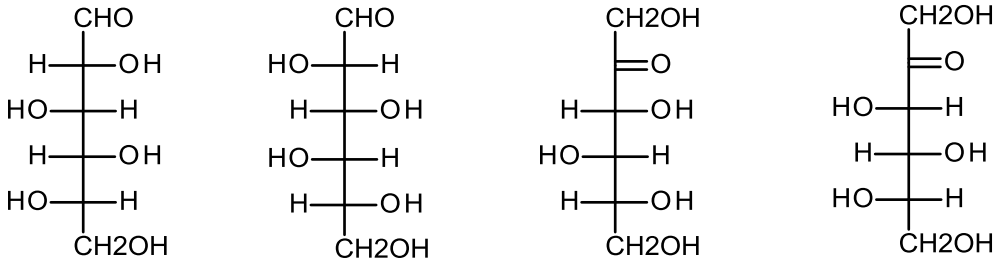
(43) In the following reaction, the values of **a**, **b** and **c**, respectively are

a $F_2(g)$ + **b** $OH^-(aq)$ → **c** $F^-(aq)$ + **d** $OF_2(g)$ + **e** $H_2O(l)$

(A) 3, 2, 4 (B) 3, 4, 2 (C) 2, 2, 4 (D) 2, 2, 2

(44) The monosaccharide present in the following disaccharide is





(A) (B) (C) (D)

(45) The IUPAC name of the complex $[Pt(en)(NH_3)(Cl)_2(ONO)][Ag(CN)_2]$is

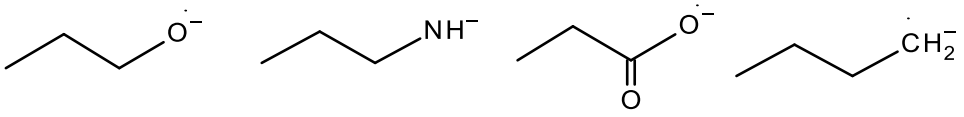
(A) monoamminedichlorido(ethane-1,2-diammine)nitritoplatinum(IV) dicyanoargentate(I)

(B) monoaminebischlorido(ethane-1,2-diamine)nitroplatinate(IV) dicyanosilver(I)

(C) monoaminebischlorido(ethane-1,2-diammine)nitritoplatinate(IV) dicyanoargentate(I)

(D) monoamminedichlorido(ethane-1,2-diamine)nitritoplatinum(IV) dicyanoargentate(I)

(46) The correct order of basicity of the following species is



I II III IV

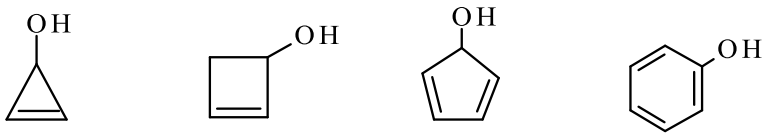
(A) III < IV < II < I (B) III < I < II < IV

(C) III < II < I < IV (D) IV < I < II < III

(47) Which among the following is nonlinear?

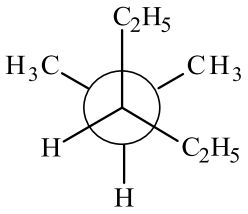
(A) N_3^- (B) ClF_2^- (C) Br_3^- (D) $BrCl_2^+$

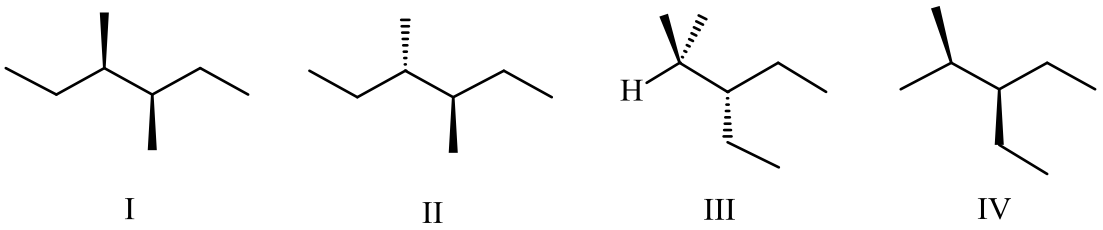
(48) The compound most likely to lose water on protonation is



(A) (B) (C) (D)

(49) The Newman projection shown is the same as





I II III IV

(A) I and IV (B) II and III (C) III and IV (D) I and II

(50) Which one of the following is *not* used as a monomer for the synthesis of a high molecular weight silicone polymer?

(A) $MeSiCl_3$ (B) Me_2SiCl_2 (C) Me_3SiCl (D) $PbSiCl_3$

(51) In $YBa_2Cu_3O_{7-x}$, a superconducting oxide that got George Bednorz and Karl Muller the Nobel prize in 1986, Cu can exist in both +2 and +3 oxidation states and their proportion depends on the value of 'x'. In $YBa_2Cu_3O_{7-0.5}$.

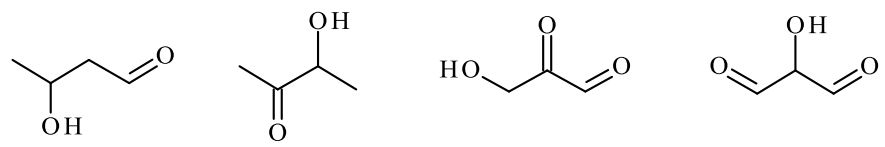
(A) 0.5 moles of Cu are in +3 oxidation state

(B) 5% of Cu is in +3 oxidation state

(C) All the Cu is in +3 oxidation state

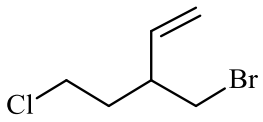
(D) All Cu is in +2 oxidation state

(52) Compound '**Y**' (molar mass = 88.12 g mol^{-1}) containing 54.52 % carbon, 9.17 % hydrogen and 36.31% oxygen gives a reddish-brown precipitate in Fehling's test. '**Y**' is



(A) (B) (C) (D)

(53) The IUPAC name of the following compound is



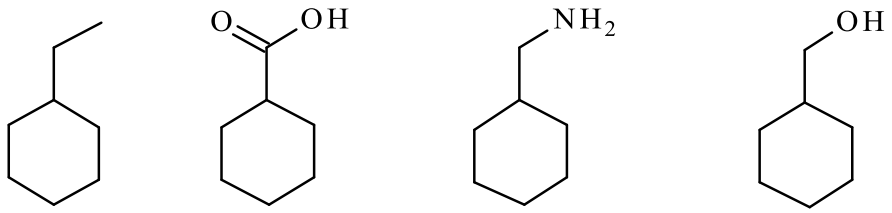
(A) 1-Bromo-4-chloro-3-ethenylbutane

(B) 4-Bromo-1-chloro-3-ethenylbutane

(C) 3-(Bromomethyl)-5-chloropent-1-ene

(D) 3-(Bromomethyl)-1-chloropent-4-ene

(54) The correct order of boiling points of the following compounds is



I **II** **III** **IV**

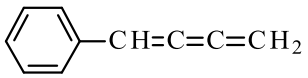
(A) III < IV < II < I (B) I < III < IV < II

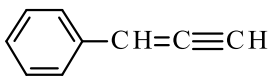
(C) I < II < III < IV (D) IV < III < I < II

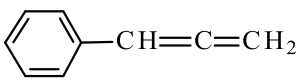
(55) Which of the following is a strong oxidising agent?

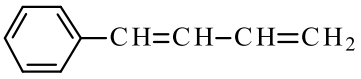
(A) $AlCl_3$ (B) $TlCl_3$ (C) NF_3 (D) PCl_3

(56) The molecule in which all atoms are *not* coplanar is

(A) 

(B) 

(C) 

(D) 

(57) The most stable radical among the following is

(A) (B) (C) (D)

(58) During World War II, soldiers posted at high altitudes experienced crumbling of the tin buttons of their uniforms into a grey powder. This can be attributed to

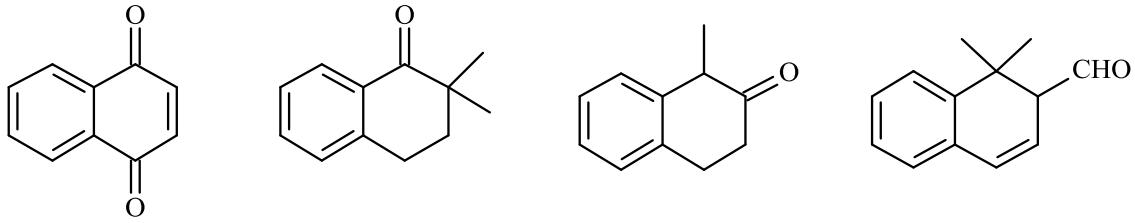
(A) oxidation of tin

(B) interaction with nitrogen in the air at low pressure

(C) change in the crystal structure of tin

(D) reaction of tin with water vapour in the air

(59) The molecules that can exhibit tautomerism are



I **II** **III** **IV**

(A) I, IV (B) II, III (C) III, IV (D) I, II

(60) A scientist attempts to replace a few carbon atoms in 1.0 g of diamond with boron atoms or nitrogen atoms in separate experiments. Which of the following is correct?

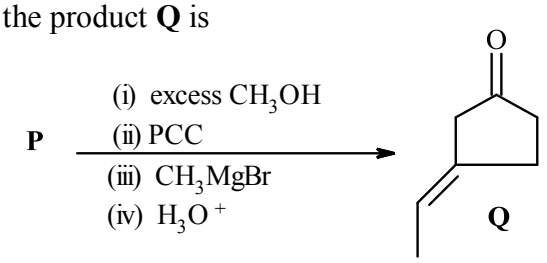
(A) The resulting material with B doping will be an n-type semiconductor

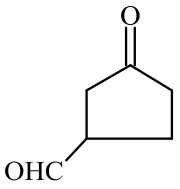
(B) The resulting material with B doping will be a p-type semiconductor

(C) B doping is NOT possible as B cannot form multiple bonds

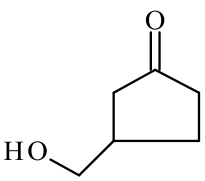
(D) The resulting material with N doping will be a p-type semiconductor

(61) Compound '**P**' that undergoes the sequence of reactions given below to give the product **Q** is

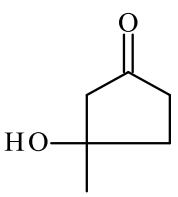




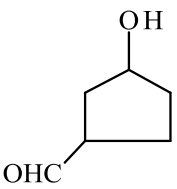
(A)



(B)

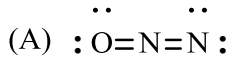


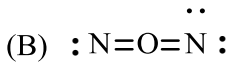
(C)

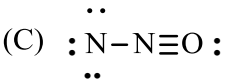


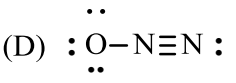
(D)

(62) The most stable Lewis structure of N_2O is

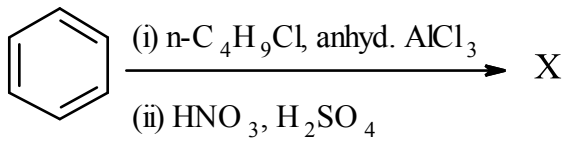
(A) 

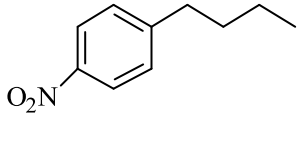
(B) 

(C) 

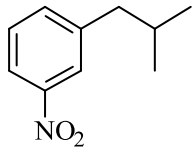
(D) 

(63) The *major* product '**X**' formed in the following reaction is

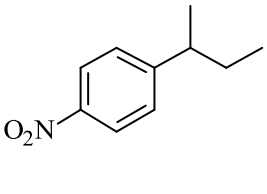




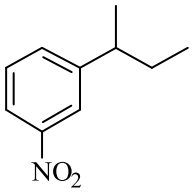
(A)



(B)



(C)



(D)

(64) Which of the following accounts best for the fact that F^- is smaller than O^{2-}?

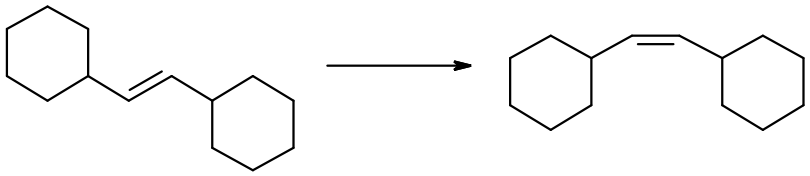
(A) F^- has a larger nuclear mass than O^{2-}

(B) F^- has a larger nuclear charge than O^{2-}

(C) F^- is more polarizable than O^{2-}

(D) F is more electronegative than O

(65) The correct sequence of reagents from those listed below for the following conversion is



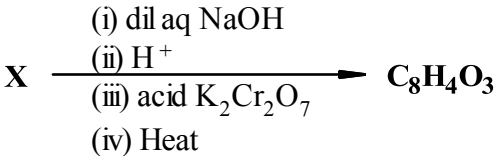
I. $NaNH_2$ II. Br_2 III. H_2 /Pd-C, quinoline IV. H_3O^+

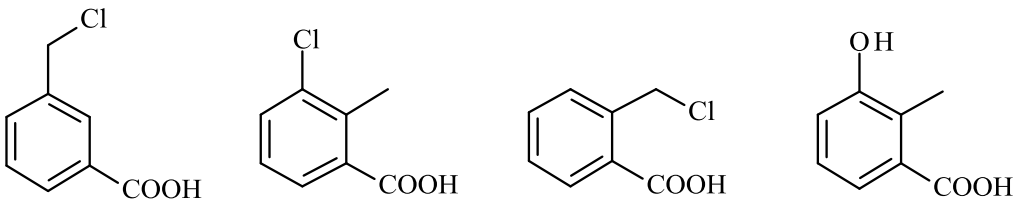
(A) IV – I – III (B) III – IV – I (C) II – I – III (D) I – II – III

(66) An orbital among the following that has two radial nodes and two angular nodes is

(A) 3d (B) 4p (C) 4f (D) 5d

(67) The compound '**X**' undergoing the following reaction is





(A) (B) (C) (D)

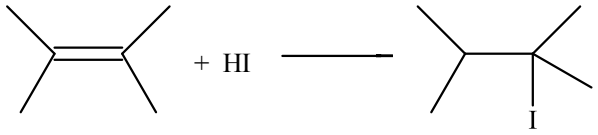
(68) A dilute solution of an alkali metal in liquid ammonia is

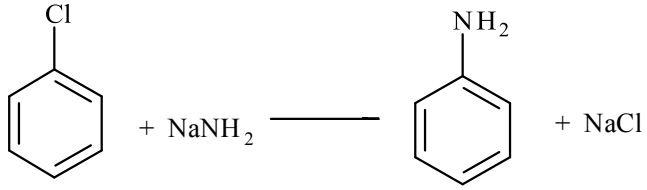
I. blue in colour II. conducts electricity

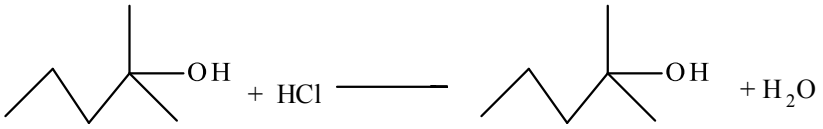
III. paramagnetic IV. an oxidising agent

(A) I and III (B) II and IV (C) I,II and III (D) I and III

(69) The reactions from those given below that involve a carbocation intermediate are

(i) 

(ii) 

(iii) 

(A) i, ii and iii (B) i and ii (C) i and iii (D) ii and iii

(70) The C-O bond length is the *shortest* in

(A) $[Cr(CO)_6]$ (B) $[Mo(CO)_6]$ (C) $[Mn(CO)_6]^+$ (D)$[V(CO)_6]^-$

(71) The rate of the reaction between two reactants X and Y can be expressed as $R = k [X]^2 [Y]$. In an experiment, the initial rate of the reaction was found to be R_1 when the initial concentrations of X and Y are $[X_0]$ and $[Y_0]$. Another experiment was performed in which $[X_0]$ was taken as ½ $[X_0]$. What should be $[Y_0]$ in this experiment to get the initial rate as $0.5R_1$?

(A) 4 $[Y_0]$ (B) ½ $[Y_0]$ (C) 2 $[Y_0]$ (D) $[Y_0]$

(72) Among the following, the compound that has the highest dipole moment is

(A) CH_3COOCH_3 (B) CH_3CONH_2

(C) $CH_3COC_2H_5$ (D) CH_3COCl

(73) A common method to clean acid spills is to use Na_2CO_3 (Molar mass 106 g). If 50.0 mL of 0.75 M HCl is spilt on a wooden surface, the amount of Na_2CO_3 required is

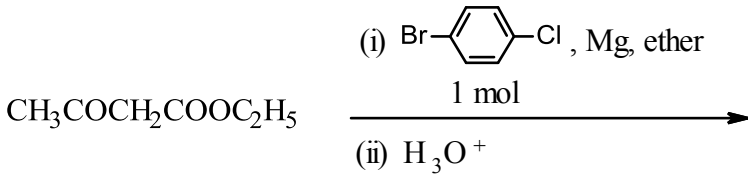
(A) 3.75 g (B) 7.5 g (C) 2.0 g (D) 4.0 g

(74) The spin-only magnetic moments of $[Fe(NH_3)_6]^{3+}$ and $[FeF_6]^{3-}$ (in units of BM) respectively are

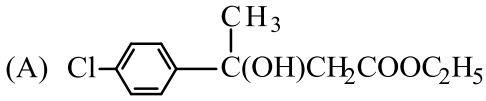
(A) 1.73 and 1.73 (B) 5.92 and 1.73

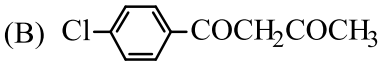
(C) 1.73 and 5.92 (D) 5.92 and 5.92

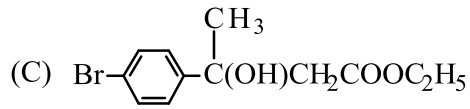
(75) The *major* product of the following reaction is

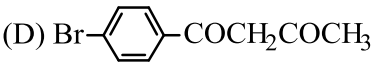


$CH_3COCH_2COOC_2H_5$

(A) 

(B) 

(C) 

(D) 

(76) The standard electrode potential (E^0) of the Daniel cell is 1.1 V and the overall cell reaction can be represented as $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$.

Under which of the following conditions will the cell potential be higher than 1.1V?

(A) 1.0M Zn^{2+}, 1.0M Cu^{2+} (B) 1.2 M Zn^{2+}, 1.2 M Cu^{2+}

(C) 0.1 M Zn^{2+}, 1.0M Cu^{2+} (D) 1.0 M Zn^{2+}, 0.01M Cu^{2+}

(77) Penicillamine is used in the treatment of arthritis. One molecule of penicillamine contains a single sulphur atom and the weight percentage of sulphur in penicillamine is 21.49%. Molecular weight of penicillamine in g mol^{-1} is

(A) 85.40 (B) 68.76 (C) 125.2 (D) 149.2

(78) An ion exchange resin, RH_2, can replace Ca^{2+} in hard water as

$RH_2 + Ca^{2+} \rightarrow RCa^{2+} + 2\ H^+$

When a 1.0 L hard water sample was passed through the resin, all H^+ ions were replaced by Ca^{2+} ions and the pH of eluted water was found to be 2.0. The hardness of water (as ppm of Ca^{2+}) in the sample of water treated is

(A) 50 (B) 100 (C) 125 (D) 200

(79) The analysis of three different binary oxides of bromine (Br) and oxygen (O) gives the following results:

Compound	Mass of O combined with 1.0 g of Br
X	0.101 g
Y	0.303 g
Z	0.503 g

Which of the following statements is *not* correct?

I Compound **Y** is Br_2O_3 II Compound **Z** is Br_2O_5

III Compound **Z** is Br_2O_7 IV Compound **Y** is Br_2O_5

(A) I and III (B) II and IV (C) III and IV (D) I and II

(80) Which of the following statement/s is/are correct?

I. Number of significant figures in 2345.100 is three

II. 0.00787 rounded to two significant figures is written as 0.787×10^{-2}

III. 340 rounded to two significant figures is written as 0.34×10^3

IV. The number of significant figures in 0.020 is two

(A) II and III (B) III and IV (C) I, II and IV (D) III only

INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY 2017 -18

Date of Examination: 26TH November, 2017

Time: 1100 to 1300 Hrs

Q. Paper Code: C321

Write the question paper code mentioned above on YOUR answer sheet (in the space provided), otherwise your answer sheet will NOT be assessed. Note that the same Q. P. Code appears on each page of the question paper.

Instructions to Candidates –

1. Use of mobile phones, smartphones, ipads during examination is **STRICTLY PROHIBITED**.
2. In addition to this question paper, you are given answer sheet along with Candidate's copy.
3. On the answer sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/carelessly filled information may disqualify your candidature.
4. On the answer sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. The email ID and date of birth entered in the answer sheet will be your login credentials for accessing performance report. Please take care while entering.
6. Question paper has 80 multiple choice questions. Each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

7. A correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer.
8. Any rough work should be done only in the space provided.
9. Use of **non-programmable** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting your answer paper, take away the Candidate's copy for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the answer sheet.

Answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED.

Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE ANSWER SHEET.

Instructions to Candidates (continued) –

Read the following instructions after submitting the answer sheet.

12. **Comments regarding this question paper, if any, can be shared only on Google forms,** https://goo.gl/forms/Lxb1l8Bqov3Cl9FQ2 **till 28th November, 2017.**
13. **The answers/solutions to this question paper will be available on our website – www.iapt.org.in by 2nd December, 2017.**
14. **CERTIFICATES and AWARDS –**
    Following certificates are awarded by the IAPT to students successful in NSEs

    (i)Certificates to "Centre Top 10%" students

    (ii)Merit Certificates to "Statewise Top 1%" students

    (iii)Merit Certificates and a book prize to "National Top 1%" students

15. Result sheets can be downloaded from our website in the month of February. The "Centre Top 10%" certificates will be dispatched to the Prof-in-charge of the centre by February, 2018.
16. List of students (with centre number and roll number only) having score above MAS will be displayed on our website (www.iapt.org.in) by **22nd December, 2017.** See the **Eligibility Clause** in the Student's brochure on our website.
17. Students eligible for the INO Examination on the basis of selection criteria mentioned in Student's brochure will be informed accordingly.

Useful Constants:

Charge of electron, $e = 1.602 \times 10^{-19}$ C

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg

Planck's constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light, $c = 3.0 \times 10^{8}$ m s^{-1}

Avogadro constant, $N_A = 6.022 \times 10^{23}$ mol^{-1}

Molar gas constant, $R = 0.082$ L atm mol^{-1} K^{-1}

$= 8.314$ J mol^{-1} K^{-1}

Indian Association of Physics Teachers

NATIONAL STANDARD EXAMINATION IN CHEMISTRY 2017-2018

Total time: 120 minutes **Marks: 240**

Only one out of four options is correct

1) At constant T and P, 5.0L of SO_2 are reacted with 3.0L of O_2 according to the following equation $2SO_2\ (g) + O_2\ (g) \rightarrow 2SO_3\ (g)$

The volume of the reaction mixture at the completion of the reaction is

(A) 0.5L (B) 8.0L (C) 5.5L (D) 5L

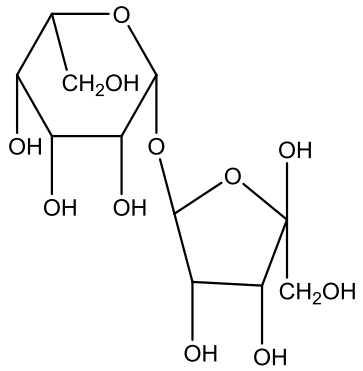
2) The following disaccharide is made up of

(A) D-aldose and D-ketose

(B) L-aldose and L-ketose

(C) D-aldose and L-ketose

(D) L-aldose and D-ketose



3) One mole of 4-nitrocatechol (4-nitro-1,2-dihydroxybenzene) on treatment with an excess of NaH followed by one mole of methyl iodide gives –

(A) 4-nitro-1,2-dimethoxybenzene

(B) 4-nitro-5-methyl-1,2-dimethoxybenzene

(C) 2-methoxy-5-nitrophenol

(D) 2-methoxy-4-nitrophenol

4) The colour changes of an indicator HIn in acid base titrations is given below

$$\underset{\text{Colour X}}{HIn\ (aq)} \rightleftharpoons \underset{\text{Colour Y}}{H^+\ (aq) + In^-\ (aq)}$$

Which of the following statements is correct?

(A) In a strong alkaline solution colour Y will be observed

(B) In a strongly acidic solution colour Y will be observed

(C) Concentration of In^- is higher than that of HIn at the equivalence point

(D) In a strong alkaline solution colour X is observed

5) The table below gives the results of three titrations carried out with 0.200 M HCl to determine the molarity of a given NaOH solution using phenolphthalein as indicator. NaOH was taken in the burette and HCl was taken in a conical flask for the titrations.

Titration No	$V_{HCl\ (mL)}$	$V_{NaOH\ (mL)}$	$M_{NaOH\ moldm^{-3}}$
I	21.4	19.3	0.222
II	18.6	16.8	0.221
III	22.2	21.1	0.210

The actual molarity of the prepared NaOH solution was 0.220 $moldm^{-3}$.

Which among the following could be the reason for the wrong value obtained in titration III?

(A) Number of drops of phenolphthalein added to the titration flask was more in this titration

(B) The concentration of HCl was wrongly used as 0.250 M for the calculation of M_{NaOH}

(C) A few drops of NaOH solution were spilled outside the titration flask during titration

((D) A few drops of the neutralized solution from titration II were left behind in the flask

6) The solution with pH value close to 1 is

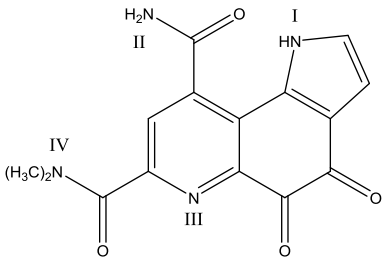
(A)10 mL of 0.1 M HCl + 90 mL of 0.1 M NaOH

(B) 55 mL of 0.1 M HCl + 45 mL of 0.1 M NaOH

(C) 75 mL of 0.2 M HCl + 25 mL of 0.2 M NaOH

(D) 75 mL of 0.2 M HCl + 25 mL of 0.1 M NaOH

7) The most basic nitrogen in the following compound is



(A) I (B) II

(C) III (D) IV

8) For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, the rate expression is $-d[NH_3]/dt = k[H_2][N_2]$

The correct statement is

I. The reaction is not elementary II. The reaction is of second order

III. $-d[H_2]/dt = -d[NH_3]/dt$

(A) II only (B) I and II (C) II and III (D) I , II and III

9) Which of the following is correct?

A liquid with

(A) low vapour pressure will have a low surface tension and high boiling point

(B) high vapour pressure will have high intermolecular forces and high boiling point

(C) low vapour pressure will have high surface tension and high boiling point

(D) low vapour pressure will have low surface tension and low boiling point

10) At 25^0C, nitrogen exists as N_2 and phosphorous exists as P_4 because

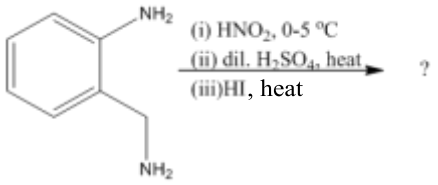
(A) N_2 has valence electrons only in bonding and nonbonding orbitals, while P has valence electrons in both bonding and antibonding orbitals

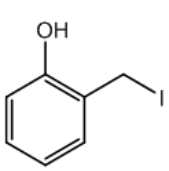
(B) higher electronegativity of N favours formation of multiple bonds

(C) bigger size of P does not favour multiple bonds

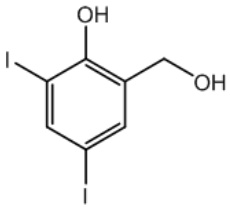
(D) P has preference to adapt structures with small bond angles

11) The product of the following reaction is

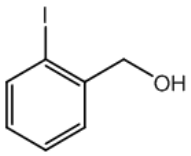




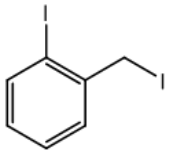
(A)



(B)



(C)



(D)

12) Three samples of 100 g of water (samples I, II and III), initially kept at 1 atm pressure and 298 K were given the following treatments.

Sample I was heated to 320 K and cooled to 298 K

Sample II was heated to 300 K, cooled to 273K and heated to 298 K

Sample III was heated to 373K and cooled to 298 K

At the end of these processes, the internal energy of

(A) III is the highest

(B) II is the highest

(C) I and III are the same; II is lower than that of I and III

(D) I, II and III are the same

13) For the reaction

$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$

the rate expression was found to be $-d[BrO_3^-]/dt = k[Br^-][H^+]^2[BrO_3^-]$

Which of the following statement/s is /are correct?

I. Doubling the initial concentration of all the reactants will increase the reaction rate by a factor of 8

II. Unit of rate constant of the reaction in a buffer solution is min^{-1}

III. Doubling the concentration of all the reactants at the same time will increase the reaction rate by a factor of 16

IV. rate of conversion of BrO_3^- and rate of formation of Br^- are the same

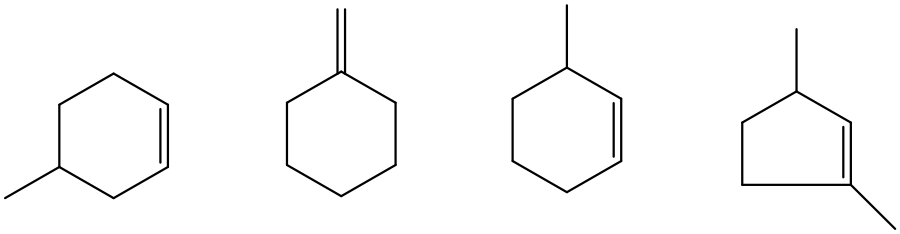
(A) I and II (B) II and III (C) II and IV (D) III only

14) In the Lewis structure of ozone (O_3), the formal charge on the central oxygen atom is

(A) +1 (B) -1 (C) 0 (D) -2

15) Which of the following on treatment with hot concentrated acidified $KMnO_4$ will give

2-methylhexane-1,6-dioic acid as the only organic product?



(A) (B) (C) (D)

16) For the following spontaneous process

$H_2O_{(l)} \rightarrow H_2O_{(s)}$ at 268 K , which of the following is true?

(A) $\Delta S_{sys} < 0$ (B) $\Delta S_{sys} > 0$ (C) $\Delta S_{surr} < 0$ (D) $\Delta S_{sys} = -\Delta S_{surr}$

17) Lithium oxide (Li_2O; molar mass =30 g mol^{-1}) is used in space shuttles to remove water vapour according to the following reaction

$Li_2O_{(s)} + H_2O(g) \rightarrow 2LiOH_{(s)}$

If 60 kg of water and 45 kg of Li_2O are present in a shuttle

I. water will be removed completely

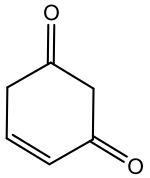
II. Li_2O will be the limiting reagent

III. 100 kg of Li_2O will be required to completely remove the water present

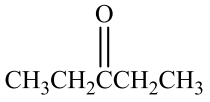
IV. 27 kg of water will remain in the shuttle at the end of the reaction

(A) II only (B) II and IV (C) III and IV (D) II, III

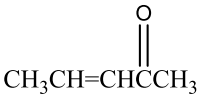
18) The order of enol content in the following molecules is



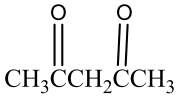
(a)



(b)



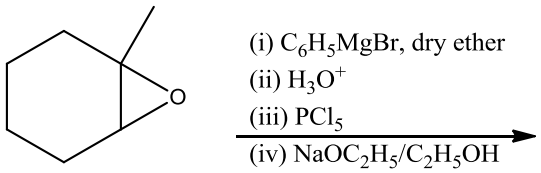
(c)

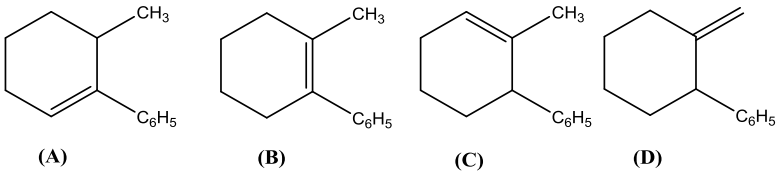


(d)

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

19) The product of the following reaction is





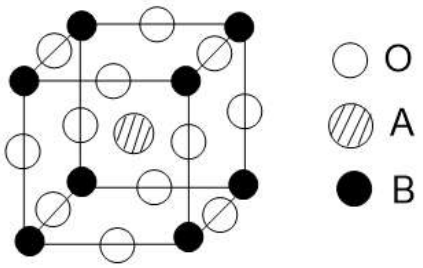
20) At constant volume, 6.0 mol of H_2 gas at 0^0 C and 100 kPa was heated to 250 kPa. The molar heat of H_2 at constant pressure (C_P) = 28.9 J mol^{-1}.(assume that the heat capacity values do not change with temperature).The final temperature of the H_2 gas and the change in entropy of the process are

(A) 273^0 C and 113 kJ mol^{-1} K^{-1} (B) 410^0 C and 158.8 J mol^{-1} K^{-1}

(C) 682.5^0 C and 113 J mol^{-1} K^{-1} (D) 682.5 K and 113 J mol^{-1} K^{-1}

21) The cubic unit cell of an oxide of metals A and B is as given below, in which oxygen,

A and B are represented by open circles, crossed circles and dark circles respectively.



The formula of the oxide can be deduced as

(A) AB_8O_{12} (B) ABO (C) ABO_6 (D) ABO_3

22) When a medal is electroplated with silver (Ag)

(A) the medal is the anode

(B) Ag metal is the cathode

(C) the solution contains Ag^+ ions

(D) the reaction at the anode is $Ag^+ + e^- \rightarrow Ag$

23) The energy of an electron in Bohr's orbit of hydrogen atom is – 13.6 eV. The total electronic energy of a 'hypothetical' He atom in which there are no electron – electron repulsions is

(A) 27.2 eV (B) -27. 2 eV (C) -108.8 eV (D) 108.8 eV

24) Iodine is a solid and sublimes at ordinary temperatures. This is because of

(A) weak I-I bonds

(B) strong I-I bonds

(C) lone pair - bond pair repulsions

(D) weak van der Waals forces between I_2 molecules

25) The equilibrium constants of the following isomerisation reaction at 400 K and 298 K are 2.07 and 3.42 respectively.

cis-butene $\underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}}$ trans-butene

Which of the following is/are correct?

I. The reaction is exothermic

II. The reaction is endothermic

III. At 400 K 50% of cis-butene and 50% of trans-butene are present at equilibrium

IV. Both at 298 K and 400 K, $k_1 = k_{-1}$

(A) I and IV (B) II and IV (C) I and III (D) I only

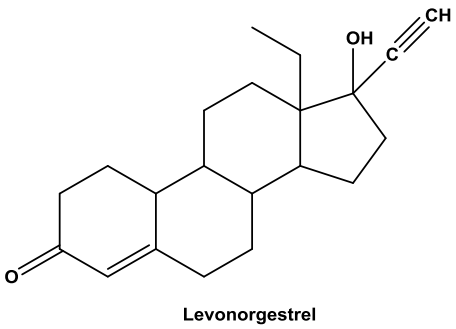
26) Which of the following *will not* give a straight line plot for an ideal gas?

(A) V vs T (B) T vs P (C) V vs 1/P (D) V vs 1/T

27) Levonorgestrel is a commonly used contraceptive. The number of chiral centers present in this molecule is

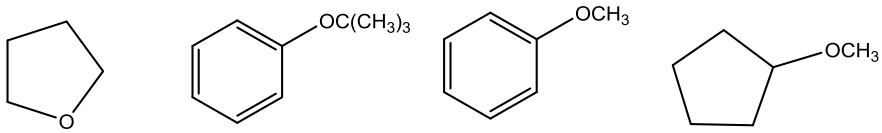
(A) 4 (B) 5

(C) 6 (D) 7



Levonorgestrel

28) Which of the following ethers *cannot* be prepared by Williamson Synthesis?



(A) (B) (C) (D)

29) IUPAC name of the complex ion $[CrCl_2(ox)_2]^{3-}$ is

(A) dichlorodioxalatochromium (III)

(B) dioxalatodichrlorochromate(III)

(C) dichlorodioxalatochromate (III)

(D) bisoxalaeodichlorochromate(III)

30) Sodium azide (NaN_3) is used in the airbag of cars. This is a safety device which inflates on an impact according to the reaction $2NaN_3 \rightarrow 2Na + 3N_2$

An air bag of a particular car can be filled with 44.8L of gas at STP. The mass (g) of NaN_3 required to fill this airbag completely at 298K and 1 atm. pressure is

(A) 87 (B) 130 (C) 84 (D) 100

31) Which of the following mixtures of water and H_2SO_4 would have mass percentage of H_2SO_4 close to 30?

(A) 30 g H_2SO_4 + 100 g H_2O

(B) 1 mol of H_2SO_4 + 2 mol of H_2O

(C) 1mol of H_2SO_4 + 200 g of H_2O

(D) 0.30 mol H_2SO_4 + 0.70 mol H_2O

32) In chlorides, the common oxidation states of aluminium and thallium are +3 and +1 respectively because

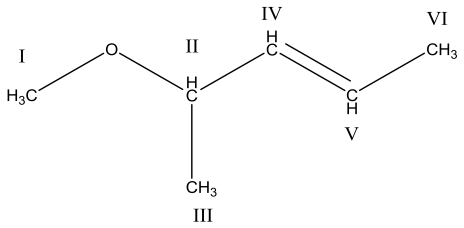
(A) Tl-Cl bond is ionic and Al-Cl bond is covalent

(B) 6s electrons of Tl are bound more strongly than the 3s electrons of Al

(C) Tl-Cl bond is stronger than Al-Cl bond

(D) 3s electrons of Al are bound strongly than the 6s electrons of Tl

33) In the given compound the order of ease with which hydrogen atom can be abstracted from carbons I to VI is



(A) II > VI > IV = V > I > III (B) II > I > VI > III > IV =V

(C) II > I > III > VI > IV =V (D) VI > II > I > III > IV =V

Use the table given below to answer questions 34 and 35

Reaction	E_0/V
$Ag \rightarrow Ag^+ + e^-$	-0.80
$Cr^{3+} + 3e^- \rightarrow 3\ Cr$	-0.74
$Zn^{2+} + 2e^- \rightarrow Zn$	-0.76
$I_2(s) + 2e^- \rightarrow 2\ I^-$	0.54
$Co^{2+} + 2e^- \rightarrow Co$	-0.28
$Ni^{2+} + 2e^- \rightarrow Ni$	-0.26

34) The best reducing agent among the following is

(A) Ag^{+} (B) Zn^{2+} (C) Cr^{3+} (D) I^{-}

35) E^{0} of the given cell is

$$Ni \mid (Ni^{+2},\ 1.0\ M) \parallel (Co^{+2},\ 1.0\ M) \mid Co$$

(A) +0.02 V (B) -0.02 V (C) -0.54 V (D) +0.54 V

36) Which of the following is *not* a pair of a Lewis acid and a Lewis base?

(A) H^{+}, $(C_2H_5)_2O$

(B) H_2O, $AlCl_3$

(C) Fe^{3+}, CO

(D) SiF_4, BF_3

37) The type/s of isomerism that $Co(NH_3)_4Br_2Cl$ can exhibit is/are

(A) geometric and ionisation

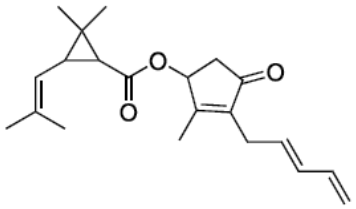
(B) ionisation

(C) Optical and ionisation

(D) Optical, ionisation and geometric

38) Pyrethrins are produced in chrysanthemum flowers and used as insecticides.

Structure of pyrethrin I is given below.



Pyrethrin I (molar mass = 328.0g/mol)

The volume of 0.05 mol dm^{-3} bromine water that would react with 500 mg sample of Pyrethrin I is

(A) 12.2 cm^3 (B) 122 dm^3 (C) 122 cm^3 (D) 1.31×10^3 cm^3

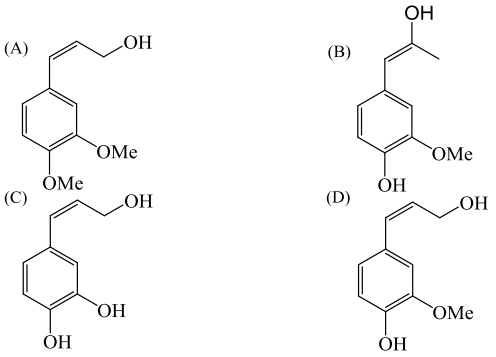
39) Coniferyl alcohol is isolated from pine trees. The following observations were made about this alcohol .

I. It forms methylated product with MeI in presence of a base

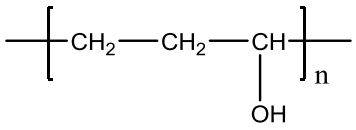
II. One equivalent of coniferyl alcohol reacts with two equivalents of benzoyl chloride

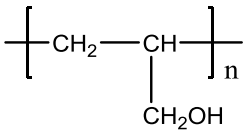
III. Upon ozonolysis , coniferyl alcohol gives a product 'Y' (M.F $C_2H_4O_2$)

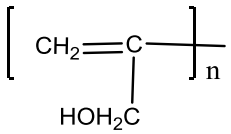
The structure of coniferyl alcohol would be

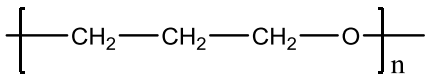


40) Which of the following represents a polymer of prop-2-en-1-ol?

(A) 

(B) 

(C) 

(D) 

41) A 500 mL glass flask is filled at 298 K and 1 atm. pressure with three diatomic gases X, Y and Z. The initial volume ratio of the gases before mixing was 5:3:1. The density of the heaviest gas in the mixture is not more than 25 times that of the lightest gas. When the mixture was heated, vigorous reactions take place between X and Y and X and Z in which all the three gases were completely used up.

The gases X, Y, Z respectively are

(A) H_2, O_2, N_2 (B) H_2, O_2, Cl_2 (C) H_2, F_2, O_2 (D) O_2, H_2, F_2

42) The reaction X +Y → Z is first order with respect to X and second order with respect to Y. The initial rate of formation of Z = R mol^{-} $dm^{3}sec^{-1}$ when $[X]_0$ and $[Y]_0$ are 0.40 mol dm^{-3} and 0. mol dm^{-3} respectively. If $[X]_0$ is halved and $[Y]_0$ is doubled, the value of the initial rate would become

(A) 4R (B) R/4 (C) R (D) 2R

43) Which one of the following statements *is not* correct about glucose ?

(molar mass of glucose =180 g mol^{-1})

(A) An aqueous 0.25 M solution of glucose is prepared by dissolving 45 g of glucose in water to give 1000 cm^3 of solution

(B) 1.00 mmol glucose has a mass of 180 mg

(C) 90.0 g glucose contain $1.8x10^{22}$ atoms of carbon

(D) 100 cm^3 of a 0.10 M solution contains 18 g of glucose

44) The van der Waals equation for one mole of a real gas can be written as $(P + a/V^2)(V - b) = RT$. For the gases H_2, NH_3, and CH_4, the value of 'a'(bar L^{-2} mol^{-2}) are

0.2453, 4.170 and 2.253 respectively.

Which of the following can be inferred from the 'a' values?

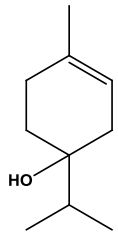
(A) NH_3 can be most easily liquefied

(B) H_2 can be most easily liquified

(C) value of 'a' for CH_4 is less than that of NH_3 because it has the lower molar mass

(D) intermolecular forces are the strongest in hydrogen

45) Terpinen-4-ol is an active ingredient in tea tree oil has the following structure



The correct observations for terpinen-4-ol is/are

I. It rotates the plane of plane polarized light

II. It reacts with Baeyers's reagent to form form a triol

III. On reaction with NaBr and H_2SO_4, it gives form a diobromo compound

IV. On ozonolysis it gives a compound with molecular formula $C_{10}H_{18}O_3$

(A) I, II, III and IV (B) I, III and IV (C) II and III (D) III and IV

46) The correct order of the ability of the leaving groups is

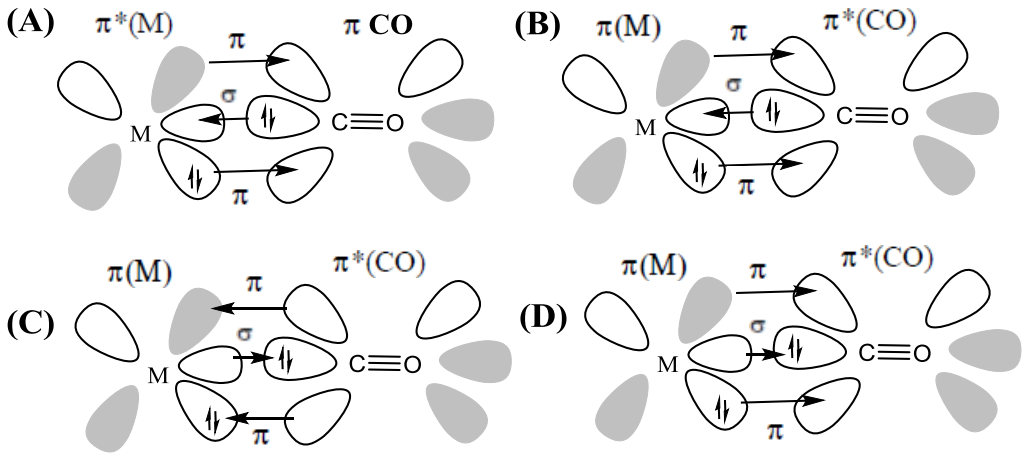
(A) $OCOC_2H_5 > OC_2H_5 > OSO_2Et > OSO_2CF_3$

(B) $OC_2H_5 > OCOC_2H_5 > OSO_2CF_3 > OSO_2Me$

(C) $OSO_2CF_3 > OSO_2Me > OCOC_2H_5 > OC_2H_5$

(D) $OCOC_2H_5$ > OSO_3CF_3 > OC_2H_5 > OSO_2Me

47) Metal 'M' forms a carbonyl compound in which it is present in its lower valance state. Which of the following bonding is possible in this metal carbonyl ?



48) Acetic acid (CH_3COOH) is partially dimerised to $(CH_3COOH)_2$ in the vapour phase. At a total pressure of 0.200 atm, acetic acid is 92.0% dimerized at 298 K. The value of equilibrium constant of dimerisation under these conditions is

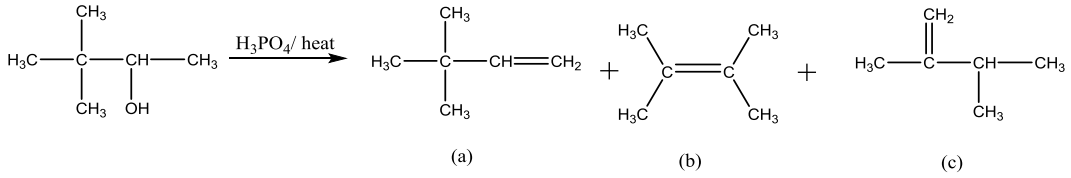
(A) 57.5 (B) 9.7 (C) 97 (D) 194

49) Silanes are silicon hydrides of general formula Si_nH_{2n+2} and have several applications. From the data given below, the bond dissociation enthalpy of Si-Si bond can be deduced as

ΔH of the reaction $2Si\ (s) + 3H_2\ (g) \rightarrow Si_2H_6\ (g)$ is 80.3kJ mol^{-1}
Bond dissociation enthalpy for H–H = 436 kJ/mol
Bond dissociation enthalpy for Si–H = 304 kJ/mol
Δf_H [Si(g)] = 450 kJ/mol

(A) – 304 kJ mol^{-1} (B) 384.3 kJ mol^{-1} (C) 304 kJ mol^{-1} (D) -384.3 kJ mol^{-1}

50) In the following reaction, three products a, b, c are obtained.



The approximates experimental yields of the three compounds were 64%, 33% and 3%. Which of the following is the correct with respect to yield and the corresponding product?

(A) (a)-33%; (b)-64%; (c)-3% (B) (a)-3%; (b)-64%; (c)-33%

(C) (a)-3%; (b)-33%; (c)-64 % (D) (a)-64%; (b)-3%; (c)-33%

51) Which of the following represents the correct order of dipole moment?

(A) $NH_3 > NF_3 > H_2O$ (B) $NH_3 > H_2O > NF_3$

(C) $H_2O > NH_3 > NF_3$ (D) $H_2O > NF_3 > NH_3$

52) The best reaction sequence for the synthesis of 2-pentanone would be -

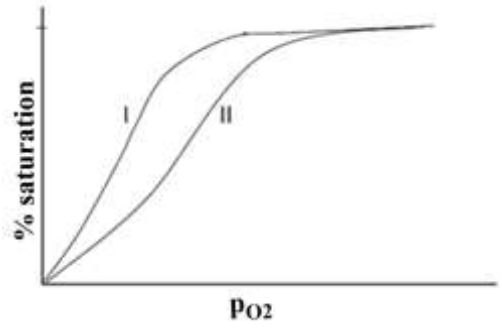
(A) $CH_3CH_2CH_2CHO \xrightarrow{CH_3MgI/\ ether} X \xrightarrow{H^+,\ H_2O}$

(B) $CH_3CH_2CH_2CN \xrightarrow{CH_3MgI/\ ether} X \xrightarrow{H^+,\ H_2O}$

(C) $CH_3CH_2CH_2CHO \xrightarrow{CH_3MgI/\ ether} X \xrightarrow{H^+,\ H_2O}$

(D) $CH_3CH_2CH_2MgI + CH_2O \xrightarrow{Ether} X \xrightarrow{H^+,\ H_2O}$

53) Haemoglobin is a Fe containing protein responsible for oxygen transport in the blood.. The curves given below indicate the percentage saturation of haemoglobin by O_2 as a function of partial pressure of O_2.



Which of the following statement/s is/are correct for the given curves?

I. In presence of CO_2, higher p_{O2} is needed for a given percentage saturation

II. In presence of CO_2, lower p_{O2} is needed for a given percentage saturation

III. The maximum percentage saturation is not affected by the presence of CO_2

IV. In the absence of CO_2, maximum saturation of haemoglobin occurs at lower p_{O2}

(A) I and IV (B) II and IV (C) I, III and IV (D) II and III

54) An appropriate reagent for the conversion of 1-propanol to 1-propanal is

(A) acidified potassium dichromate

(B) alkaline potassium permanganate

(C) pyridinium chlorochromate

(D) acidified CrO_3

55) A student performed an experiment to determine the molecular formula of a given sample of hydrated copper (II) sulphate by weighing the sample before and after heating. The formula obtained experimentally was $CuSO_4$ $5.5H_2O$ while the actual formula of the given sample is $CuSO_4$ $.5H_2O$. Which experimental error would account for the wrongly obtained result?

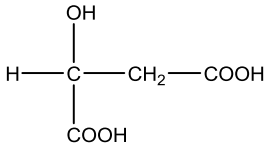
(A) During heating, some of the hydrated copper(II) sulphate was lost

(B) The hydrated sample was not heated long enough to remove all the water present

(C) Weight of the hydrated sample recorded was less than the actual weight taken

(D) The balance used in the study showed all weights consistently high by 0.10 g

56) Malic acid is a dicarboxylic acid present in apples and it has the following structure



Which of the following synthetic routes will give (±)malic acid?

(i) $H_2C{=}CH{-}COOH$ —(i) HBr, (ii) KOH (aq.), (iii) HCN/H_3O^+→

(ii) $H_2C(Br){-}CH_2{-}COOH$ —(i) KOH (aq.), (ii) PCC, (iii) HCN/H_3O^+→

(iii) $H_3C{-}CH_2{-}COOH$ —(i) Red P/I_2, (ii) NaOH (aq.), (iii) [O], (iv) HCN/H_3O^+→

(iv) $H_2C{=}CH{-}COOH$ —(i) B_2H_6/H_2O_2, (ii) [O], (iii) HCN/H_3O^+→

(A) i and ii (B) ii (C) ii and iii (D) i and iii

57) Which of the following cannot act as an oxidising agent?

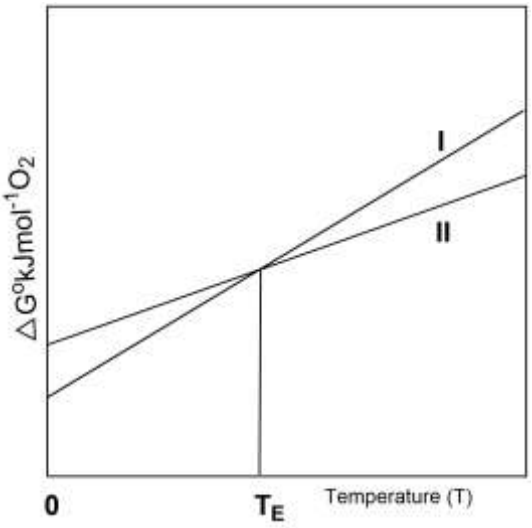
(A) S^{2-} B.Br_2 C. HSO_4^- D. SO_3^{-2}

58) Ellingham diagrams are plots of ΔG^0 vs temperature which have applications in metallurgy.

$2H_2 + O_2 = 2H_2O$ $\Delta G\ (J) = -247500 + 55.85\ T$ …….... (I)

$2CO + O_2 = 2CO_2$ $\Delta G\ (J) = -282400 + 86.81T$ …….……(II)

The Ellingham diagrams for the oxidation of H_2 (I) and CO (II) are given below. The two lines intersect (T_E) at 1125K.



Which of the following is correct?

I. $\Delta G°$ for reaction (i) is more negative at T < 1125K

II. ΔG° for the reduction of CO is more negative at T < 1125K

III. H_2 is a better reducing agent at T > 1125K

IV. H_2 is a better reducing agent at T < 1125K

(A) I and II (B) I and III (C) III only (D) I and IV

59) Hydrazine used in rocket fuels can be obtained by the reaction of ammonia and hydrogen peroxide according to the following equation

$2NH_3(g) + H_2O_2(l) \rightarrow N_2H_4(l) + 2H_2O(l)$ ($\Delta H^0_{reaction} = -241kJ/mol$)

If ΔH^0 (formation) of NH_3, H_2O_2 and H_2O are -46.1, - 187.8 and – 285.8kJ/mol respectively, ΔH^0 for the decomposition of hydrazine into N_2 and H_2 is

(A) 50.6 kJ/mol (B) 241kJ/mol (C) -50.6kJ/mol (D)120.5kJ/mol

60) Sn^{2+} compounds like SnO and $SnCl_2$ are well known reducing agents, while PbO_2 acts as an oxidizing agent. Which of the following statements support these reactivities?

I. SnO is more stable than SnO_2

II. Sn^{4+} is more stable than Sn^{2+}

III. Pb^{4+} is more stable than Pb^{2+}

IV. Pb^{2+} is more stable than Pb^{4+}

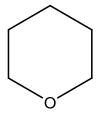
(A) I and III (B) I, III and IV

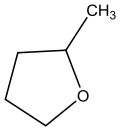
(C) II and IV (D) I, II and IV

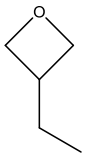
61) A fuel/oxidant system consisting of N,N-dimethylhydrazine $(CH_3)_2NNH_2$ and N_2O_4 (both liquids) is used in space vehicle propulsion. The liquid components are mixed stoichiometrically so that N_2, CO_2 and H_2O are the only products. If all gases are under the same reaction conditions, number of moles of gases produced from 1mole of $(CH_3)_2NNH_2$ is

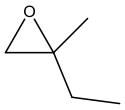
(A) 3 (B) 6 (C) 9 (D) 4.5

62) An ether (X) with molecular formula $C_5H_{10}O$ reacts with excess of hot aq. HI to give a product which on further reaction with hot NaOH in ethanol forms 1,3 pentadiene. Structure of X is

(A) 

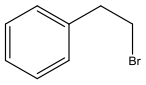
(B) 

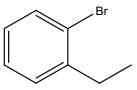
(C) 

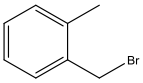
(D) 

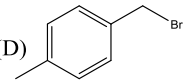
63) Compound 'Y' with molecular formula C_8H_9Br gives a precipitate on heating with alcoholic $AgNO_3$. Oxidation of 'Y' gives product 'Z' ($C_8H_6O_4$) which gives an anhydride upon heating.

Compound 'Y' is

(A) 

(B) 

(C) 

(D) 

64) The observed effective magnetic moment of two octahedral complexes, $K_4[Mn(CN)_6].3H_2O$ (X) and $K_4[Mn(SCN)_6]$ (Y) are 2.18 BM and 6.06 BM, respectively. Which of the following is correct?

I. X is a low spin complex with two unpaired electrons

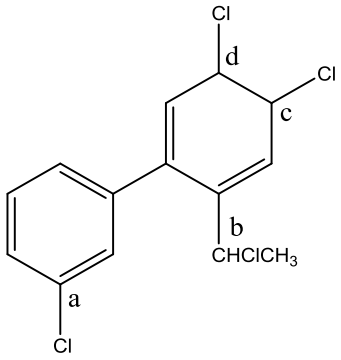
II. Y is a high spin complex with 5 unpaired electrons

III. X is a high spin complex with two unpaired electrons

IV. Y is a low spin complex with 5 unpaired electrons

(A) I and III (B) I, II (C) I , II and IV (D) I, II and III

65) The increasing reactivity of the sites (a-d) in the following compound in S_N1 reaction is



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

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

66) Which of the following has the shortest bond length?

(A) O_2 (B) O_2^- (C) O_2^+ (D) O_2^{2-}

67) Which of the following statement/s is/are correct about weak acids in aqueous solutions?

I. When pH = pKa of a monoprotic acid, 50% of the acid is ionised

II. If pH = pKa_2 of a diprotic acid, the average charge of all the ionised species is 0.5

III. When pH = pKa +1 , 10% of the acid is ionised

IV. When pH =7, 50% of a monobasic acid is ionised

(A) I and IV (B) I, II and IV (C) I, II and IV (D) I only

68) 'Iodine number' is the grams of iodine atoms (atomic mass = 127 g mol^{-1}) that can react completely with100 g of a vegetable oil. Iodine monochloride (ICl) is a reagent used to determine iodine number. In an experiment, 25.00 cm^3 of 0.100 mol dm^{-3} ICl was added to 127g of the oil. The unreacted ICl was found to be equivalent to 40.00 cm^3 of 0.10 mol dm^{-3} of $Na_2S_2O_3$.

The iodine number of the oil can be deduced as

(A) 127 (B) 100 (C) 200 (D) 50

69) When NiO is doped with a small quantity of Li_2O

(A) both cation and anion vacancies are generated

(B) Shottky defects are generated

(C) NiO becomes an n-type semiconductor

(D) NiO becomes a p-type semiconductor

70) When a sample of gas kept at 20 °C and 4.0 atm is heated to 40 °C at constant volume

(A) average speed of the gas molecules will decrease

(B) number of collisions between the gas molecules per second will remain the same.

(C) average kinetic energy of the gas will increase.

(D) pressure of the gas will become 8 atm.

71) Addition of bromine to *cis*-3-hexene gives

(A) racemic dibromide (B) a mixture of diastereomeric dibromides

(C) optically active dibromide (D) meso dibromide

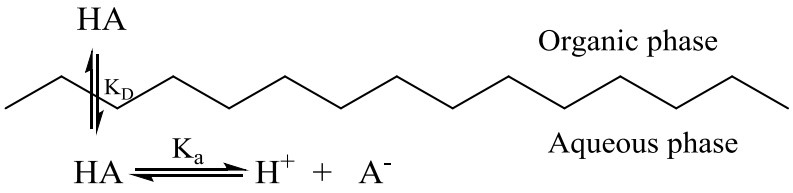
72) An organic compound "X" forms an orange–yellow precipitate with 2,4-DNP reagent. It does not react with aqueous $[Ag(NH_3)_2]NO_3$. X on reduction with $NaBH_4$ gives a secondary alcohol and on oxidation with nitric acid yields a dicarboxylic acid containing the same number of carbon atoms. On bromination, X gives a monobromo product. On the basis of these reactions, it can be concluded that X

I. contains aldehydic carbonyl group II. contains ketonic carbonyl group

III. contains ester carbonyl group IV. does not contain C=C bonds

(A) I only (B) III and IV (C) III only (D) II and IV

73) The undissociated form of a weak organic acid HA can be extracted from the aqueous phase into an organic phase using a water-immiscible organic solvent according to the following scheme



Which of the following is/are correct for this extraction?

I. $[HA]_{org}/[HA]_{aq}$ depends on the pH of the aqueous phase

II. HA can be efficiently extracted from basic aqueous solutions

III. $[HA]_{org}/[HA]_{aq}$ depends on the initial concentration of HA

IV. $[HA]_{org}/[HA]_{aq}+[A^-]$ depends on the pH of the aqueous phase

(A) II and IV (B) IV only (C) I only (D) III and IV

74) The correct order of reactivity in nucleophilic substitution reaction of the following compounds a, b, and c would be

$CH_3CH_2CONH_2$ (a) $CH_3CH_2COOCH_3$ (b) CH_3CH_2COCl (c)

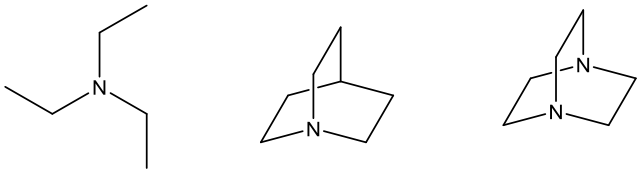
(A) a > c > b (B) a > b > c (C) c > b > a (D) c > a > b

75) The complex ion that does not have d electrons in the metal atom is

(A) $[MnO_4]^-$ (B) $[Co(NH_3)_6]^{3+}$

(C) $[Fe(CN)_6]^{3-}$ (D) $Cr(H_2O)_6]^{3+}$

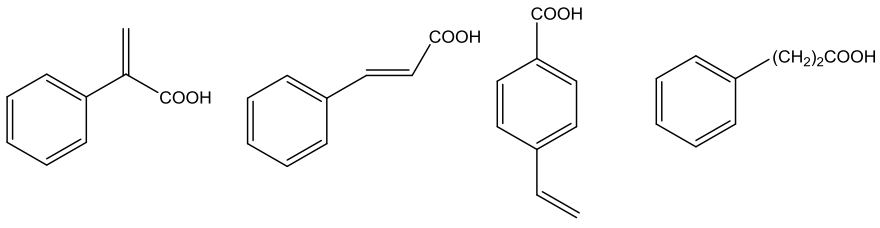
76) The order in which the compounds a, b and c react with CH_3I would be



(a) (b) (c)

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

77) An organic compound 'P' with molecular formula $C_9H_8O_2$ on oxidation gives benzoic acid as one of the products. The possible structure/s of 'P' is/are



(I) (II) (III) (IV)

(A) I and III (B) II and IV (C) I and II (D) II only

78) The energy of an electron in the ground state of H atom is -13.6eV.
The negative sign indicates that
(A) electrons are negatively charged

(B) H atom is more stable than a free electron

(C) energy of the electron in the H atom is lower than that of a free electron

(D) work must be done to make a H atom from a free electron and proton

79) Radius of Ar atom is 145pm. The percentage volume occupied by an Ar atom at STP is

(A) 0.03 (B) 3.0 (C) 0.30 (D) 0.06

80) The reduction of O_2 to H_2O in acidic solution has a standard reduction potential of 1.23 V. If the pH of the acid solution is increased by one unit, half cell potential will

$$O_2\,(g) + 4\,H^+(aq) + 4e^- \rightarrow 2H_2O\,(l)$$

(A) decrease by 59 mV

(B) increase by 59 mV

(C) decrease by 236 mV

(D) increase by 236 mV

Rough Sheet

Answer keys for NSEC- 2017. Please send your suggestions to the answer keys by filling the Google forms using the link given below. The last date for suggestions will be December 4th 2017. The corrections to final answer keys if any will be displayed on December 10th 2017. Google forms **link:** **https://goo.gl/forms/Lxb1l8Bqov3Cl9FQ2**

Qp Code 321		Qp Code 322		Qp Code 323		Qp Code 324	
Question No.	Answer Keys	Question No.	Answer Keys	Question No.	Answer Keys	Question No.	Answer Keys
1	C	1	C	1	A	1	B
2	D	2	C	2	D	2	A
3	C	3	B	3	A	3	B
4	A	4	C	4	B	4	C
5	C	5	C	5	D	5	C
6	C	6	A	6	Deleted	6	C
7	C	7	D	7	C	7	B
8	B	8	Deleted	8	C	8	C
9	C	9	A	9	D	9	Deleted
10	C	10	C	10	D	10	C
11	A	11	B	11	D	11	C
12	D	12	D	12	C	12	D
13	Deleted	13	A	13	B	13	C
14	A	14	D	14	B	14	A
15	C	15	A	15	Deleted	15	C
16	A	16	A	16	C	16	C
17	D	17	B	17	B	17	C
18	A	18	C	18	B	18	B
19	B	19	C	19	A	19	C
20	D	20	D	20	B	20	C
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22	C	22	D	22	A	22	D
23	C	23	C	23	B	23	Deleted
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25	D	25	B	25	B	25	C
26	D	26	Deleted	26	C	26	C
27	C	27	C	27	Deleted	27	D
28	B	28	B	28	Deleted	28	Deleted
29	B	29	B	29	A	29	C
30	Deleted	30	B	30	A	30	C
31	C	31	C	31	C	31	A
32	B	32	B	32	B	32	D
33	B	33	D	33	D	33	C
34	A	34	A	34	Deleted	34	C
35	B	35	B	35	B	35	A
36	D	36	D	36	C	36	Deleted
37	A	37	B	37	B	37	A

38	B	38	C	38	C	38	B
39	D	39	Deleted	39	C	39	C
40	B	40	Deleted	40	A	40	C
41	C	41	A	41	B	41	A
42	Deleted	42	A	42	A	42	D
43	Deleted	43	C	43	B	43	A
44	A	44	B	44	C	44	B
45	A	45	D	45	C	45	D
46	C	46	Deleted	46	C	46	Deleted
47	B	47	D	47	B	47	C
48	D	48	C	48	C	48	C
49	Deleted	49	C	49	Deleted	49	D
50	B	50	C	50	C	50	D
51	C	51	C	51	C	51	D
52	B	52	A	52	D	52	C
53	C	53	B	53	C	53	B
54	C	54	A	54	A	54	B
55	A	55	B	55	C	55	Deleted
56	B	56	C	56	C	56	C
57	A	57	C	57	C	57	B
58	B	58	C	58	B	58	B
59	C	59	B	59	C	59	A
60	C	60	C	60	C	60	B
61	C	61	Deleted	61	A	61	D
62	B	62	C	62	D	62	A
63	C	63	C	63	Deleted	63	B
64	Deleted	64	D	64	A	64	D
65	C	65	Deleted	65	C	65	B
66	C	66	C	66	C	66	C
67	D	67	C	67	D	67	Deleted
68	Deleted	68	A	68	Deleted	68	Deleted
69	C	69	A	69	C	69	A
70	C	70	B	70	C	70	A
71	A	71	C	71	A	71	C
72	D	72	C	72	D	72	B
73	C	73	Deleted	73	C	73	D
74	C	74	A	74	C	74	Deleted
75	A	75	Deleted	75	A	75	B
76	B	76	D	76	Deleted	76	C
77	C	77	C	77	A	77	B
78	C	78	A	78	B	78	C
79	Deleted	79	C	79	C	79	C
80	A	80	D	80	C	80	A