Chemistry Revision-2025

Model paper- 02

Time: 60 minutes

01) a) i) Arrange the following species in the increasing order of the property within brackets.

a) NO^+, NO_3^-, NO_2^- (N – O bond length) ……

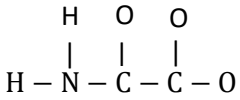
b) NH_2^-, NH_3, NH_4^+ (Electronegativity) …….....

c) $Na_2CO_3, MgCO_3, PbCO_3$ (Thermal stability) …….

d) H_2O, H_3O^+, OF_2, BF_3 (Bond angle) ……

e) MgO, CaO, Na_2O (Covalent property) ……

b) Skeleton of the $H_2NCOCO_2^-$ ion is given below.



i) Draw the most acceptable Lewis structure for the above ion.

ii) Draw 3 resonance structures other than the answer in ii).

iii) Complete the table given below using the structure drawn in i) above.

	Around N	N bonded to C	Around C bound by two O
Electron pair geometry			
Shape			
Hybridization			
Bond angle			

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iv) Name the atomic/hybrid orbitals participating in forming the following σ bonds.

i) N – C N =…….. C =……..
ii) C – C C =…….. C =……..
iii) C – O C =…….. O =……..

c) State whether the following statements are true or false and give reasons for your answer.

1) Electronegativity of N atom is $NO_3^- > NO_2^+$.

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2) Boiling points and melting points of CCl_4 is higher than that of CH_3F .

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2. Acidic, aqueous nitride solutions are reacted with H_2O_2 to form nitrates. Peroxonitrous acid (HOONO) is formed as an intermediate. Answer the following questions regarding peroxonitrous ion $[OONO]^-$. The skeleton is given below. O-O-N-O

i. Draw the most acceptable Lewis structure for the ion.

ii. Draw resonance structures for the ion above and comment on relative stabilities.

iii. Use the VSEPR theory to deduce the structure around the following atoms

1. N

2. O atom bound to both N and O

iv. Complete the electron pair geometry, hybridisation of the atoms in the following table

	N	**O attached to both N and O**
Electron pair geometry		
Hybridisation		

v. Draw the structure of the anion showing the rough bond angle.

2. A) Arrange the property denoted by brackets in the increasing order. No explanation required.

(i) C-O bond distance in CO, CO_2 and CO_3^{2-}

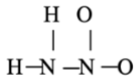
(ii) Electronegativity of N in NO_2^+, NO_3^-, NH_3

(iii) Thermal decomposition temperature of $BeSO_4$, $MgSO_4$, $CaSO_4$

(iv) Boiling point of Ne, Ar, Kr

(v) Atomic radius of S, F, Si and Cl

B) Nitroamide (H_2NNO_2) is a weak acid. In the presence of a base this dissociates to N_2O and H_2O. Answer the following questions based on nitroamide. The skeletal structure is given below.



(i) Draw the most stable Lewis structure of the above.

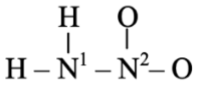
(ii) Draw the resonance structures of the above and comment on their stabilities providing reasons.

(iii) Indicate (i) electron pair geometry, (ii) shape around the atoms (iii) hybridisation of the atom of the central atoms in the following table.

	N attached to 2 H atoms	**N attached to 2 O atoms**
i. Electron pair geometry		
ii. Shape around the atom		
iii. Hybridisation of the atom		

(iv) Is this molecule polar or non-polar?

(v) Identify the orbitals or hybrid orbitals responsible for the following bond formation. N atoms are indicated as 1 and 2 below.



(i) N^1 and N^2_____

(ii) N^1 and H_____

C. Xe, CH_3Cl, HF

(1) Which compound of the above contain the following interactions?

a. Dipole-dipole interactions _____

b. H-bonds _____

c. London dispersion forces _____

Essay Questions

1.

2.83 g of a sample of haematite iron ore [iron (III) oxide, Fe_2O_3] were dissolved in concentrated hydrochloric acid and the solution diluted to 250 cm^3. 25.0 cm^3 of this solution was reduced with tin(II) chloride (oxidised to Sn^{4+} in the process) to form a solution of iron(II) ions. This solution of iron(II) ions required 26.4 cm^3 of a 0.02 mol dm^{-3} potassium dichromate (VI) solution for complete oxidation back to iron(III) ions.

(a) Write the half reactions.

(i) the reduction of iron(III) ions by tin(II) ions

(ii) the oxidation of iron(II) ions by the dichromate(VI) ion. Then write the full reaction.

(b) Calculate the percentage of iron(III) oxide in the ore.

(c) Suggest why potassium manganate(VII) cannot be used for this titration?

(d) Is potassium dichromate (VI) a primery standard ? Explain your answer.

2. a) Consider the molecules CF_4 (g), CCl_4 (g) and CBr_4 (g).

Calculate

i) the C-F bond energy in CF_4 (g). ΔH_f° for CF_4 (g) = -933 kJ mol^{-1}

ii) the C-Cl bond energy in CCl_4 (g). ΔH_f° for CCl_4 (g) = - 96 kJ mol^{-1}

iii) the C-Br bond energy in CBr_4 (g). ΔH_f° for CBr_4 (g) = + 79 kJmol^{-1}

ΔH_s° for C(graphite) = +700 kJ mol^{-1}, ΔH_f° of F(g), Cl(g), Br(g) are +80 kJ mol^{-1}, +130 kJ mol^{-1}, and +110 kJ mol^{-1} respectively.

b. For hexafluoroethane, $F_3C\text{-}CF_3$, ΔH_f° = - 1343 kJ mol^{-1}. Using the C-F bond energy calculated in a), calculate the energy of the C-C bond in F_3C - CF_3.

c. Consider the following reaction: $CCl_4\,(g) + F_2\,(g) \rightarrow CF_2Cl_2\,(g) + Cl_2\,(g)$

i) Use the bond energy data from a) estimate ΔH_r° for this reaction.

ii) Use the ΔH data from i) to calculate the ΔH_f° for CF_2Cl_2 (g).

3. a. Derive PV = nRT using gas laws.

b. A vessel of volume V contains 0.28 g of nitrogen under 1.5×10^4 Nm^{-2} at 27 ℃. This vessel was connected to another vessel to volume V which has been completely evacuated. Thereafter, the two vessels were heated to 227 ^{0}C, and a gas $\mathbf{X_2}$ was introduced into the system until the pressure was 4.0×10^4 Nm^{-2} at the same temperature. The mass of $\mathbf{X_2}$ required for this purpose was 1.14 g. If nitrogen and $\mathbf{X_2}$ behave as ideal gases under these conditions, calculate the relative molecular mass of **X**. (N=14)

c. Later the temperature was brought to 727 ℃ and the nitrogen and $\mathbf{X_2}$ reacted completely to form NX_3 (g). If there is no thermal expansion in the container calculate the final pressure inside the container and calculate the partial pressures of all the content present inside.

4. **A, B, C** and **D** are elements which belong to the second or third periods and their hydrides are **E, F , G** and **H** respectively. All the elements which belong to the group of **A** form ionic hydrides while in the group of **B**, only **B** *does not* form an ionic hydride. When the product obtained by the reaction of **A** and $\mathbf{N_2}$, is reacted with colourless, odourless, non-toxic liquid state **H, G** is formed. **G** has a characteristic smell and basic on moistened litmus paper. Salt of **A** gives a red colour in flame test.

(i) Identify the components from **A** to **H**

(ii) Write the balanced equation of the reaction between **A** and $\mathbf{N_2}$ and the reaction between **E** and **H**.

(iii) Give a test to identify **G** and write its observation.