P BLOCK ELEMENTS – GROUP 17

TUTORIAL

1. "Halogens exist in nature as diatomic molecules. F_2 and Cl_2 exist as gases, where as Br_2 exists as a liquid and I_2 exists as a solid."

    i. Giving reasons, explain the statement given above.

    ii.

    a) Sketch the variation of boiling points of halogens.

    b) Indicate the species with boiling points above 0 °C.

    c) Explain the reason for the variation observed in (a) above.

2.

    i.

    a) Write the electronegativities of the halogens in the ascending order.

    b) Using your answer to part (a) above, deduce the order of the reactivity of the halogens, by giving relevant reasons.

    c) Hence, comment on the feasibility of the reaction between $F_2(g)$ and KI(s).

    ii.

    a) Giving reasons, explain why halogens act as oxidizing agents.

    b) Write the variation of the oxidizing property of Halogens when going down the group.

    c) Give reasons for the variation mentioned in (b) above.

3.

    i. "A F atom always forms just one bond, whereas Cl, Br, and I atoms could form multiple bonds."

    Using the electron configurations and orbital diagrams of the atoms mentioned, explain the above statement.

ii. Write two uses of each of the following.
   a) Cl_2
   b) Br_2
   c) I_2

4. Answer the questions given below.
   i. Write the balanced chemical reaction for the partial dissolution of Cl_2 in water.

   ii. Write the balanced chemical reaction for the dissolved Cl_2 with excess water.

   iii. What is the type of reaction that undergoes in (ii) above?

   iv. Out of the two products formed in (ii) above, which is the more unstable species?

   v. What happens to the species mentioned in (iv) above when exposed to sunlight? Explain using a balanced chemical equation.

   vi. What happens to flower petals when exposed to the reactive species in (v) above?

   vii. Write the balanced chemical equation for the reaction between Cl_2 and a coloured species **X**.

   viii. Will the addition of conc. H_2SO_4 to the colourless species formed in (vii) above bring its colour back?

   ix. Complete the following table about the bleaching properties of the following.

Bleaching Agent	**Is the bleaching property due to the oxidation or the reduction of the bleaching agent?**	**Is the bleaching activity temporary or permanent?**
H_2O_2		
SO_2		
Cl_2		

5. $Cl_2(g)$ reacts with cold dilute NaOH to give aqueous salts **A**, **B** and water *(Reaction 01)*. $Cl_2(g)$ also reacts with hot conc. NaOH to give aqueous salts **B**, **D** and water *(Reaction 02)*. **A** and **D** are sodium salts of two oxoacids of chlorine.

   i. Identify the compounds **A, B** and **D**.

   ii. Write the balanced chemical equations for the reactions 01 and 02.

   iii. What is the type of reaction that takes place in reaction 01 and 02?

   iv. The solution obtained from the reaction 01 is commonly known as "Milton solution". Give one use of this solution.

   v. Are **A** and **D** oxidizing agents or reducing agents?

   vi. Draw the Lewis structures of **A** and **D**.

   vii. What are the oxidation numbers of Cl in the compounds in (f) above?

6. $Cl_2(g)$ reacts with excess $NH_3(g)$ to form gases **P** and **Q** *(Reaction 01)* . Gas **P** further reacts with NH_3 to give **R**, a white coloured gas (*Reaction 02*). When $NH_3(g)$ is reacted with excess $Cl_2(g)$ gas P and trichloramine are formed *(Reaction 03)*.

   When $Cl_2(g)$ reacts with gas **T** in the presence of water, aqueous form of gas **P** and aqueous compound **V** are formed *(Reaction 04)*. When a solution of $BaCl_2(aq)$ is added to a solution of **V**, a white coloured precipitate **W** which is insoluble in dil HNO_3 is formed along with NaCl *(Reaction 05).* Gas **T** has bleaching properties in the presence of moisture.

   i. Identify the compounds **P, Q, R, T, V** and **W**.

   ii. Write the balanced chemical equations for the reactions 01 - 05.

7.

   i. Write the acidity of Hydrogen halides in the ascending order.

   ii. What are the three factors that can be used to explain the above variation?

   iii. Sketch the variation of the boiling points of the above hydrogen halides.

8. A student transfers aqueous solutions of NaCl, NaBr and NaI in to three identical test tubes. However, he forgets to label them. The following procedure carried out to identify the solutions.
    - The test tubes were labelled as **A1, B1** and **C1**.
    - Dil. HNO_3 was added to all three test tubes they were shaken thoroughly.
    - Half of the volume of the solution in test tube **A1** was transferred to an empty, clean, dry test tube **A2**.
    - A similar procedure was carried out for **B1** and **C1** to obtain **B2** and **C2** respectively.

	Observations					
Test Tube	*Addition of $AgNO_3(aq)$* ***(Test 01)***	*Addition of conc $NH_3(aq)$ to one half of the solution after test 01*	*Addition of dil $NH_3(aq)$ to the other half of the solution after test 01*	*Addition of $Pb(NO_3)_2(aq)$* ***(Test 02)***	*Heating the solution from test 02* ***(Test 03)***	*Cooling the solution from test 03*
A1	Pale yellow ppt	Ppt dissolved	**P**	-	-	-
A2	-	-	-	Pale yellow ppt	Ppt dissolved	Needle like crystals
B1	Yellow ppt	Ppt did not dissolve	**Q**	-	-	-
B2	-	-	-	**R**	Ppt dissolved	Gold dust like crystals
C1	White ppt	Ppt dissolved	Ppt dissolved	-	-	-
C2	-	-	-	**S**	**T**	Needle like crystals

    i. Identify the solutions in the test tubes **A1, B1** and **C1**.

    ii. Fill in the blanks of the table with relevant observations for blanks **P – T**.

    iii. Write balanced chemical equations and relevant observations (if any) when the Cl_2 water test is carried out for the solutions in test tubes **A1, B1** and **C1.**

9. 1.7 g of KI(s) (in excess) was completely dissolved in 50 mL of distilled water in a 250 mL conical flask. Next, 10 mL of dil H_2SO_4 acid was added to it. After that, 2.00 mL of liquid bleach was pipetted into the above flask and the solution was mixed thoroughly by swirling. This solution was titrated against a 0.1 M $Na_2S_2O_3(aq)$ solution. When the colour of the solution became pale yellow, few drops of starch solution were added to the conical flask, and the titration was continued. The end point was found to be 25.00 mL.

Reactions taking place, (Note that the equations have not been balanced.)

$$OCl^-(aq) + I^-(aq) + H^+(aq) \longrightarrow Cl^-(aq) + I_3^-(aq) + H_2O(l)$$

$$S_2O_3^{2-}(aq) + I_3^-(aq) \longrightarrow S_4O_6^{2-}(aq) + I^-(aq)$$

Calculate the concentration of the active ingredient (i.e. $OCl^-(aq)$) in liquid bleach.