

## NON METAL CHLORINE

15.1. Determine the positions in the periodic table and the atomic structure of the following elements:

- A. Chlorine                      B. Sulfur                      C. Oxygen  
D. Nitrogen                      E. Phosphorus  
F. Carbon                      G. Silicon

Give a conclusion about the place in the periodic table and electron configuration of non metal elements

15.2. Compare:

A. chlorine with bromine

B. sulfur with chlorine

according to:

1. position in the periodic table.
2. atomic structure.
3. non metallic properties.

15.3. Write down the simple formulas of non-metallic substances, explain the physical properties.

15.4. Which of the simple substances are dangerous and toxic, but still indispensable to produce important chemicals?

15.5. Choose the pairs that the element manifests:

1. strong oxidizing properties:

- A. S and Cl  
B. S and O  
C. F and Cl  
D. N and O

2. strong reducing properties:

- A. C and N    B. I and Br    C. Cl and S    D. Cl and Br

15.6. Explain how the non metallic properties increase or decrease in the following lists:

- A. C, N, O, F  
B. F, Cl, Br, I  
C. Si, P, S, Cl  
D. O, S, Se, I

15.7. Write down the formulas of oxides and of volatile hydrogen compounds for elements having these atomic numbers in the order of: 6, 7, 14, 15, 16, and 17.

15.8. Write down the equations of reactions of chlorine, bromine, oxygen, sulfate, nitrogen, phosphorous, carbon with:

- A. lithium                      B. magnesium                      C. aluminum.

15.9. Write down the reactions in which the following are obtained:

- A. hydrogen compounds of nonmetals obtained from chlorine, bromine, oxygen, sulfur, nitrogen, and carbon.  
B. oxides of phosphorous (V), sulfur (IV), carbon (IV) obtained from burning of simple substances.

15.10. Explain the type of chemical bonds; make a scheme of bond formation for the following:

- A.  $\text{Cl}_2$ , HCl, NaCl

B.  $\text{F}_2$ , HF, NaF

C.  $\text{Br}_2$ , HBr, NaBr

15.11. Put the substances in order of increasing oxidation number of chlorine:

HClO, HCl,  $\text{Cl}_2$ ,  $\text{NaClO}_4$ ,  $\text{KClO}_3$

which oxidation number makes chlorine only an oxidant, and which only a reductant.

15.12. Explain why chlorine is found in nature only in the form of chlorides. Name the following minerals, NaCl, KCl-NaCl, KCl-Mg $\text{Cl}_2 \cdot 6\text{H}_2\text{O}$ .

15.13. Write down the reactions of chlorine with barium, sodium, iron, copper, phosphorous, and water. What is the function (oxidant or reductant) of chlorine in these reactions?

15.14. Explain which processes take place during the dissolution of chlorine in water. Why is chlorine a good bleacher and disinfectant in moist environment?

15.15. Calculate the relative density of chlorine and hydrogen chloride accordingly:

- A. hydrogen                      B. air

How will the gas collecting tube be kept up or down? Why?

15.16. Complete the following reactions.

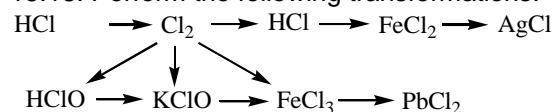
- A.  $\text{Cl}_2 + \text{Zn} \rightarrow$   
B.  $\text{Cl}_2 + \text{O}_2 \rightarrow$   
C.  $\text{Cl}_2 + \text{H}_2 \rightarrow$   
D.  $\text{Cl}_2 + \text{He} \rightarrow$   
E.  $\text{Cl}_2 + \text{Al} \rightarrow$   
F.  $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow$

Which role does chlorine play in these reactions (oxidant or reductant)?

15.17. Balance the following reactions according to oxidation number method:

- A.  $\text{MnO}_2 + \text{HCl}(\text{conc}) (\text{temp.}) \rightarrow \text{MnCl}_2 + \text{Cl}_2\uparrow + \text{H}_2\text{O}$   
B.  $\text{Cl}_2 + \text{H}_2\text{O} \leftrightarrow \text{HCl} + \text{HClO}$   
C.  $\text{Cl}_2 + \text{KOH} \rightarrow \text{KCl} + \text{KClO} + \text{H}_2\text{O}$   
D.  $\text{Cl}_2 + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + \text{Ca}(\text{OH})_2 + \text{H}_2\text{O}$   
E.  $\text{Cl}_2 + \text{KOH} (\text{temp.}) \rightarrow \text{KCl} + \text{KClO}_3 + \text{H}_2\text{O}$   
F.  $\text{KMnO}_4 + \text{HCl}(\text{conc}) \rightarrow \text{Cl}_2\uparrow + \text{MnCl}_2 + \text{KCl} + \text{H}_2\text{O}$   
G.  $\text{Cl}_2 + \text{KI} \rightarrow \text{I}_2 + \text{KCl}$   
H.  $\text{Cl}_2 + \text{NaBr} \rightarrow \text{Br}_2 + \text{NaCl}$

15.18. Perform the following transformations:



15.19. Choose the correct answers:

- A. Chlorine is found only in pure state in nature.  
B. Chlorine is used to obtain hydrogen chloride  
C. The word "chlorine" means "yellowish-green"

D. Solution of chlorine in water kills bacteria, is applied in bleaching of tissues and paper, for disinfection.  
E. Chlorine is chemically inactive.

15.20. Calculate the volume of chlorine necessary to react with hydrogen:

- A. having 5 mol.
- B. with a volume of 44.8 L at STP.
- C. with volume of 10 L.

15.21. Calculate the volume of hydrogen and chlorine necessary to obtain hydrogen chloride with:

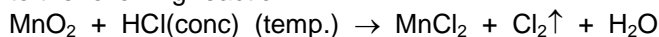
- A. a 0.4 mol.
- B. a volume of 224 L at STP.
- C. a volume of 10 L.

15.22. Mixture of 5 L of hydrogen and 8 L of chlorine exploded. Calculate which gases and how much volumes will remain after the reaction.

15.23. Calculate the volume of chlorine with a mass of:

- A. 7.1 g
- B. 142 g
- C. 35.5 g
- D. 71 g

15.24. In laboratories, chlorine can be obtained according to the following reaction:



Calculate the volume of chlorine that can be obtained from the reaction of:

- A. 8.7 g of  $\text{MnO}_2$  with a solution that contains 7.3 g of hydrochloric acid.
- B. 17.4 g of  $\text{MnO}_2$  with a 365 g of 30% hydrochloric acid solution.
- C. 0.87 g of  $\text{MnO}_2$  with a 4.29 mL of 36% hydrochloric acid solution (density=1.183g/ml).

15.25. Calculate the mass of iron necessary to react with 6.72 L chlorine gas at STP. What is the mass of the obtained salt? Calculate the mass percent of salt in the solution if the slag obtained was dissolved in 100 mL of water.

15.26. 8 L of hydrogen chloride at STP was obtained from the explosion of a mixture of hydrogen and chlorine. Remained gas was used to completely reduce 8 g of copper (II) oxide. Calculate the volume of the initial mixture.

15.27. Calculate the mass of iodine that can be obtained from the following reaction:

If chlorine was used with:

- A. 2 moles.
- B. a volume of 56 L at STP.
- C. a mass of 355 g.

15.28. Density of hydroiodic acid in sea water relative to potassium iodide is 6.5 mg per L of water. Calculate the volume of sea water from which iodine with a mass of 1 kg was obtained.

15.29. Fluorite can be taken by human organism directly

with food and water. In some regions, the concentration of fluoride salts relative to sodium fluoride is 2 mg per L of water. Considering the fact that an ordinary human consumes on average 2 L of water per 24 hours, calculate the mass of fluorine consumed daily.

15.30. Average concentration of bromine in sea water relatively to sodium bromide is 0.01%. Considering that density of sea water is equal to  $1 \text{ g/cm}^3$ , calculate the mass and quantity of bromine that can be obtained from sea water having a volume of  $1 \text{ m}^3$ .

## HYDROCHLORIC ACID, CHLORIDES

16.1. What are the characters of the hydrogen chloride solution? How can it be understood? How is this solution called?

16.2. Explain why the hydrogen chloride is stored in steel bottles under pressure. Can hydrochloric acid be kept in steel bottles as well? Why?

16.3. Glass bottles are filled with:

- A. chlorine
- B. air
- C. hydrogen chloride

Propose a method that would help us to recognize the gases inside without using any chemical reactions.

16.4. Write down the reactions by which hydrogen chloride can be obtained, as a result of the reaction of:

- A. hydrogen with chlorine
  - B. sodium chloride with concentrated sulfuric acid
  - C. potassium chloride with concentrated sulfuric acid
  - D. magnesium chloride with concentrated sulfuric acid
- Which of these reactions are industrial, and which are used in laboratories. Under what circumstances do these reactions take place?

16.5. Complete the reaction; write down them in the ionic form:

- A.  $\text{HCl} + ? \rightarrow \text{MnCl}_2 + \text{Cl}_2\uparrow + ?$
- B.  $\text{HCl} + ? \rightarrow \text{AgCl}\downarrow + ?$
- C.  $\text{Fe}(\text{OH})_3 + ? \rightarrow \text{FeCl}_3 + ?$
- D.  $? + ? \rightarrow \text{FeCl}_2 + \text{H}_2\text{O}$
- E.  $\text{HCl} + \text{Na}_2\text{CO}_3 \rightarrow ? + ? + ?\uparrow$
- F.  $\text{CuO} + \text{HCl} \rightarrow ? + ?$

16.6. Write down the reactions of hydrochloric acid in both molecular and ionic form with:

- A. iron
- B. magnesium oxide
- C. potassium hydroxide
- D. potassium carbonate
- E. aluminum
- F. iron (III) oxide
- G. iron (II) hydroxide
- H. lead (II) nitrate

16.7. Complete the following possible reactions in ionic form,

- A.  $\text{HCl} + \text{Zn} \rightarrow$
- B.  $\text{HCl} + \text{Ag} \rightarrow$
- C.  $\text{HCl} + \text{CuO} \rightarrow$
- D.  $\text{HCl} + \text{FeO} \rightarrow$
- E.  $\text{HCl} + \text{NaOH} \rightarrow$
- F.  $\text{HCl} + \text{H}_2\text{SO}_3 \rightarrow$
- G.  $\text{HCl} + \text{Zn} \rightarrow$
- H.  $\text{HCl} + \text{Al} \rightarrow$
- I.  $\text{HCl} + \text{Fe}_2\text{O}_3 \rightarrow$
- K.  $\text{HCl} + \text{K}_2\text{O} \rightarrow$
- L.  $\text{HCl} + \text{Mg}(\text{OH})_2 \rightarrow$
- M.  $\text{HCl} + \text{Al}(\text{OH})_3 \rightarrow$
- N.  $\text{HCl} + \text{Cu} \rightarrow$
- O.  $\text{HCl} + \text{Mg} \rightarrow$
- P.  $\text{HCl} + \text{SO}_2 \rightarrow$
- R.  $\text{HCl} + \text{CO}_2 \rightarrow$
- S.  $\text{HCl} + \text{Fe}(\text{OH})_3 \rightarrow$
- T.  $\text{HCl} + \text{HBr} \rightarrow$

16.8. Choose the substances that react with hydrochloric acid:

$\text{AgNO}_3$ ,  $\text{CuSO}_4$ ,  $\text{Pb}(\text{NO}_3)_2$ ,  $\text{Na}_2\text{SiO}_3$ ,  $\text{NaNO}_3$ ,  $\text{CaCO}_3$ ,  $\text{FeS}$ ,  $\text{K}_3\text{PO}_4$ .

Give reasons by writing the reactions in both molecular and ionic form.

16.9. Complete the following transformations,

- A.  $\text{NaCl} \rightarrow \text{HCl} \rightarrow \text{NaCl} \rightarrow \text{PbCl}_2$
- B.  $\text{Cl}_2 \rightarrow \text{HCl} \rightarrow \text{ZnCl}_2 \rightarrow \text{AgCl}$
- C.  $\text{Cl}_2 \rightarrow \text{CuCl}_2 \rightarrow \text{Cu}(\text{NO}_3)_2$
- D.  $\text{CuCl}_2 \rightarrow \text{FeCl}_2 \rightarrow \text{ZnCl}_2 \rightarrow \text{MgCl}_2 \rightarrow \text{AgCl}$
- E.  $\text{KCl} \rightarrow \text{X} \rightarrow \text{CaCl}_2 \rightarrow \text{KCl}$

16.10. Propose:

- A. Two methods of obtaining of copper (II) chloride,  $\text{CuCl}_2$
- B. Three methods of obtaining of zinc chloride,  $\text{ZnCl}_2$ .

16.11. Characterize the chemical properties of hydrochloric acid salts by using:

- A. copper (II) chloride
- B. zinc chloride
- C. aluminum chloride

16.12. How can the presence of following ions be understood?

$\text{H}^+$  and  $\text{Cl}^-$  in a hydrochloric acid solution.  
 $\text{Na}^+$  and  $\text{Cl}^-$  in a table salt solution.

16.13. There are three unlabeled tubes contain solutions of:

- A. hydrochloric acid
- B. sodium chloride
- C. sodium hydroxide

Propose a method to recognize each substance.

16.14. Match the substances from A with their application B:

A

- A. chlorine
- B. hydrochloric acid
- C. sodium chloride

B

- 1. Preparation of chlorinated lime
- 3. Cleaning of iron's surface from rust
- 4. Bleaching
- 5. Obtaining of plastic material
- 6. Obtaining of iodine and bromine
- 7. Obtaining of rubber
- 8. Preservatives
- 9. Obtaining of insecticides
- 10. In medicine
- 11. In food.

16.15. Calculate the mass of HCl in a solution obtained by dissolving 44.8 L HCl at STP in 127 mL water.

16.16. Calculate the volume of hydrogen chloride, if it forms 73 g of 20% hydrochloric acid solution by mass when dissolved in water.

16.17. Calculate the mass of a substance in a solution obtained by dissolving 4.48 L hydrogen chloride at STP in a 74 g of 5% hydrochloric acid solution by mass.

16.18. Calculate the mass of hydrogen chloride in a solution obtained by dissolving a product which is obtained by the following reactions in 262.8 mL water:

- A. 1 g hydrogen and 28.4 g chlorine.
- B. 11.2 L hydrogen with 8.96 L chlorine at STP.

16.19. Calculate the masses of salts:

- A. sodium chloride
  - B. magnesium chloride
  - C. aluminum chloride
- necessary to obtain 6 mol hydrogen chloride which is obtained from the reaction of sulfuric acid, if salts are obtained in reaction medium. Which salt will be needed most?

16.20. Calculate the volume of gas obtained through the reaction of:

- A. 11.2 g iron and excess hydrochloric acid.
- B. 5.6 g iron and a 36.5 g of 10% hydrochloric acid solution by mass.
- C. 16.8 g iron and a 66.36 mL of 20% hydrochloric acid solution (density=1.1g/mL).
- D. 10 g potassium carbonate and a solution that contains 8.25 g of hydrogen chloride.
- E. 50 g limestone containing 20% impurities and a 219 g of 10% hydrochloric acid solution by mass.

16.21. Calculate the mass of 10%hydrochloric acid solution necessary to neutralize a solution that contains:

- A. 0.1 mol barium hydroxide.

- B. 34.2 g barium hydroxide.  
C. 171 g 20% barium hydroxide solution by mass.

16.22. Hydrogen chloride, which is obtained from the reaction of 234 g sodium chloride with concentrated sulfuric acid, was absorbed by water so that a 500 g of 25% hydrochloric acid solution by mass was obtained. Calculate the percent yield of mass of hydrogen chloride relative to the theoretical yield.

16.23. A 224 mL of hydrogen chloride at STP reacted with 65 mL of silver nitrate solution (density=1.05g/ml). The obtained precipitate was filtrated. Determine the mass of precipitate and masses of the substances that hadn't been filtrated.

16.24. Hydrogen chloride, which is obtained from reaction of excess concentrated sulfuric acid with 11.7 g of sodium chloride, was treated with a 40 g of 10% sodium hydroxide solution. Determine the color of litmus paper when it is dipped into resulting solution.

16.25. A 39 g copper-zinc alloy substitutes with 6.72 L of hydrochloric acid gas at STP. Calculate the mass of copper in the alloy.

16.26. A 8.3% dilute hydrochloric acid solution by mass is used in cases of deficiency of acid in gastric juice. The biggest doze needed for an adult is 2 mL (density=1.04g/mL), and for 24 h is 6 mL solution. Calculate the mass of acid used by a human during 24 h.

16.27. A 0.9% sodium chloride solution is called "Isotonic solution" in medicine. When it is introduced into the organism, it exerts the same pressure on the vein vessels as blood plasma does. Calculate the mass of sodium chloride necessary to prepare 10 kg such a solution.

16.28. A blood substitute is prepared from a base of pill that contains 1.5 g sodium chloride, 0.02 g potassium chloride, and 0.01 g calcium chloride, and that is subsequently dissolved in 100 mL water. Calculate the percent of mass of each salt in the obtained solution.

16.29. A hypertonic solution (2% sodium chloride by mass) is used to wash the stomach in cases of intoxication with silver nitrate, because the products of the reaction are not toxic. Write down the equation of the respective reaction. Calculate the mass of solution that can be prepared from 1 kg dry salt.