NITROGEN

20.1 Choose correct statements and correct the incorrect statements.
A. Nitrogen is a second period and V-A group element in the periodic table.
B. There are 7 protons and 7 neutrons in the nucleus of nitrogen atom and around the nucleus there are 7 electrons.
C. Superior oxide of nitrogen is N_2O_5.
D. Nitrogen has several allotropic forms.
E. The highest oxidation state of nitrogen is +5 and the lowest is -3.
F. Elemental nitrogen has simple N_2 form.

20.2 Choose correct statements and correct the incorrect statements.
A. In the molecule of nitrogen there is a triple non polar covalent bond.
B. Nitrogen molecules are unstable and easily undergo chemical reactions.
C. Nitrogen is dissolved easily in water.
D. Nitrogen is obtained from air in liquefied form.
E. Nitrogen is a colorless and odorless gas.
F. Nitrogen is 21% and 78% oxygen by volume in air.
G. Nitrogen is used in the synthesis of ammonia and to cool down the various objects to low temperatures.

20.3 Write down the compounds of nitrogen;
A. in everyday life.
B. in chemistry lectures.

20.4 Determine the oxidation states of nitrogen in the following compounds:
NH_3, N_2, N_2O, NO, N_2O_3, N_2O_5, HNO_3.
In which nitrogen is reductant and in which it is oxidant.

20.5 Explain the types of bonds and their formation in the following compounds: N_2, O_2, and F_2. Based on the bounding explain how activity of nonmetals change from nitrogen to fluorine.

20.6 Compare;
A. nitrogen with phosphorus
B. nitrogen with oxygen
With respect to;
1. place in periodic table.
2. atomic structure.
3. nonmetallic properties.

20.7 Arrange the elements N, O, P, F, H, C, Cl, and S in order of increasing electro negativities.

20.8 Determine the types of chemical bonds, make a schema of formation of bonds for NH_3, H_2O, and HF. How does polarity of bond change from NH_3 to HF?

20.9 Write down the reaction equations of nitrogen with;
A. H_2; B. O_2; C. Li; D. Ca; E. K; F. Al
In the reactions with metals, nitrogen takes minimum oxidation state. Show the condition of reactions, oxidant and reductant.

20.10 Burning of magnesium in air forms two compounds. What are these compounds? Write down the reactions?

20.11 Explain how nitrogen is obtained in industry?

20.12 In laboratory nitrogen can be obtained from air. For this, air passes through a copper tube with hot chips. How do you think that reaction take place?

20.13 By means of which reaction can nitrogen be purified?
A. with oxygen
B. with chlorine
C. with hydrogen sulfide

20.14 Calculate the mass of magnesium necessary which reacted with 33.6 L of nitrogen at STP. Calculate the mass of magnesium nitride obtained.

20.15 Calculate the volume of hydrogen and nitrogen gases necessary to obtain 20 m^3 of ammonia with 40% theoretical yield.

20.16 By the reaction of 10 m^3 of nitrogen with excess hydrogen 8 m^3 ammonia is obtained. Calculate the volume of excess ammonia obtained theoretically possible.

20.17 Calculate the density of nitrogen and ammonia relatively to:
A. hydrogen B. air C. oxygen
Explain how to keep the mouth of tubes, up or down, when these gases are collected.

20.18 Calculate:
A. mass of nitrogen with:
1. 5.6 L;
2. 112 mL;
3. 2.24 m^3 volumes at STP;

B. volume of nitrogen at STP with:
1. 56 g;
2. 84 kg;
3. 28 t masses.

AMMONIA, SALTS OF AMMONIA

21.1 Write down the reaction equations to obtain ammonia with:
A. a synthesis reaction;
B. a double displacement reaction;
Give the conditions of the reaction.

21.2 Can we collect ammonia through the water displacement method? Why? Give the reaction equation and explain.

21.3 Five glass cylinders are filled with following gases:

1. nitrogen
2.chlorine
3.oxygen
4.ammonia
5. sulfur dioxide.
Propose an identification method of these substances.

21.4 Write reaction equations of ammonia with water and following acids:
A. hydrochloric acid
B. hydrogen bromide
C. hydrogen bromide
D. nitric acid
E. sulfuric acid

21.5 Give the formulas of following ammonium salts:
A. chloride
B. nitrate
C. sulfide
D. bromide
E. carbonate
F. hydrogen sulfate
G. dihydrogen phosphate
H. sulfate
I. hydrogen phosphate

Write reaction equations to obtain these salts with combination reactions.

21.6 Complete the reaction equations to obtain ammonia:
A. $N_2 + H_2$ (temp.) $\rightarrow$
B. $(NH_4)_2SO_4 + KOH$ (temp.) $\rightarrow$
C. $NH_4NO_3 + NaOH$ (temp.) $\rightarrow$
D. $NH_4Cl + NaOH$ (temp.) $\rightarrow$
E. $NH_4Cl + Ca(OH)_2$ (temp.) $\rightarrow$
F. $NH_4Br + Ba(OH)_2$ (temp.) $\rightarrow$
Which of these reactions can be used to produce ammonia in industry and in laboratory?

21.7 Ammonia burns with oxygen and form nitrogen and water. Ammonia is oxidized with oxygen in presence of the catalyst (alloy of platinum and rhodium); forming nitrogen monoxide and water. Write down the reaction equations described and balance them by oxidation number method.

21.8 Complete following the reactions, write if possible the ionic equations for the reactions.
A. $NH_4Cl + KOH$ (temp.) $\rightarrow$
B. $NH_4Cl + AgNO_3 \rightarrow$
C. NH_4Cl (temp.) $\rightarrow$
D. $(NH_4)_2S + NaOH$ (temp.) $\rightarrow$
E. $(NH_4)_2S + HCl \rightarrow$
F. $(NH_4)_2S + CuSO_4 \rightarrow$
G. $(NH_4)_2S$ (temp.) $\rightarrow$
H. $(NH_4)_2SO_4 + Ca(SO_4)_2 \rightarrow$
I. $(NH_4)_2SO_4 + BaCl_2 \rightarrow$
K. $(NH_4)_2SO_4$ + (temp.) $\rightarrow$
L. $(NH_4)_2CO_3 + HNO_3 \rightarrow$
M. $(NH_4)_2CO_3 + Ca(OH)_2$ (temp.)$\rightarrow$
N. $(NH_4)_2CO_3 + CH_3COOH \rightarrow$
O. NH_4HCO_3 (temp.) $\rightarrow$

In which of these reactions ammonium salts show common properties of salts? Which reactions can be named qualitative?

21.9 Complete the reaction equations, write ionic equations for the reactions which take place in solution:

I
A. $NH_3 + H_2O \rightarrow$
B. $NH_3 + HI \rightarrow$
C. $NH_3 + Mg \rightarrow$
D. $NH_3 + H_2SO_4 \rightarrow$
E. $NH_3 + MgO \rightarrow$

II
A. $(NH_4)_2SO_4 + HCl \rightarrow$
B. $(NH_4)_2CO_3 + H_2SO_4 \rightarrow$
C. $NH_4Cl + Zn(NO_3)_2 \rightarrow$
D. $NH_4NO_3 + KOH$ (temp.) $\rightarrow$
E. $NH_4Cl + CO_2 \rightarrow$

III
A. $NH_4OH + HCl \rightarrow$
B. $NH_4OH + H_2SO_4 \rightarrow$
C. $NH_4OH + HNO_3 \rightarrow$
D. $NH_4OH + Ca(OH)_2 \rightarrow$
E. $NH_4OH + CO_2 \rightarrow$

21.10 Perform the transformations below:
A. $N_2 \rightarrow NH_3 \rightarrow NH_4Cl \rightarrow NH_3$
$(NH_4)_2SO_4$
NH_4HSO_4
B. $NH_3 \rightarrow NH_4Cl \rightarrow NH_4NO_3 \rightarrow NH_4OH \rightarrow NH_3$

C. $(NH_4)_2CO_3 \rightarrow NH_3 \rightarrow (NH_4)_2SO_4$
NH_4Cl

D) $N_2 \rightarrow NH_3 \rightarrow NH_4NO_3$
$NH_4HS \rightarrow NH_4SO_4 \rightarrow NH_4OH$
NH_3

21.11 Write the reaction equations to obtain ammonium sulfate from nitrogen, oxygen, hydrogen, sulfur, water.

21.12 Characterize
A. ammonium chloride,
B. ammonium sulfide,
C. ammonium carbonate,
D. ammonium sulfate
with respect to;
1. composition

2. specific chemical properties
3. preparation methods
4. common salt's properties

21.13 Calculate the volume at STP of ammonia with a mass of:
A. 34 g B. 85 g C. 17 kg

21.14 Calculate the mass of ammonia with a volume of at STP:
A. 1.12 L B. 89.6 L C. 2.24 m^3

21.15 Calculate the mass percentage of ammonia in a solution that is obtained through dissolution of 700 L of ammonia in 1 L of water.

21.16 It was mixed:
A. 5.1 g of ammonia with 14.6 g of hydrogen chloride;
B. 11.2 L of ammonia with 22.4 L of hydrogen chloride.
Calculate the masses of salts obtained. Which gas remains in excess? Calculate its mass, and volume.

21.17 Calculate the volume of ammonia at STP and mass of 40% nitric acid solution necessary to obtain:
A. 5 mol ammonium nitrate; B. 160 g ammonium nitrate; C. 16 kg ammonium nitrate.
D. 50 kg of ammonium saltpeter with 97.6% ammonia nitrate by mass.

21.18 Calculate the mass of 80% sulfuric acid solution by mass that is necessary to absorb 86.6 L ammonia at STP. What is the mass of ammonium sulfate?

21.19 Calculate the volume and mass of ammonia which can be obtaining by reaction of :
A. 3 mol calcium hydroxide and 4 mol ammonium chloride;
B. 7.4 g of calcium hydroxide and 21.4 g of ammonium chloride;
C. Excess calcium hydroxide and 214 g of ammonium chloride, if yield is 90 %.

21.20 10% aqueous ammonia solution by mass is called "ammonia solution". Calculate:
A. the mass of ammonia and water;
B. the volume of ammonia and water necessary to prepare 200 mL solution with a density of 0.96 g/mL.

21.21 Standard of ammonia content in water is 5 mg/L. Calculate the mass of ammonia in such a solution with a density of 1 kg/L.

21.22 Find volume of ammonia at STP which is formed from decomposition of 107 kg ammonium chloride:
$NH_4Cl \rightarrow NH_3\uparrow + HCl\uparrow$

21.23 Ammonium chloride is an effective salt which is used to eliminate edema in heart. It is readily absorbed by digestive tract and converted into urea and hydrochloric acid by liver.
$2NH_4Cl + H_2CO_3 \rightarrow CO(NH_2)_2 + 2H_2O + 2HCl$

Calculate the volume of 2.5 % ammonium chloride solution by mass which is necessary for human stomach, if daily dose is 10 g (same density with water). Calculate the mass of ammonium chloride obtained. Calculate the mass of ammonium chloride necessary to prepare such a solution with 3 kg mass.

21.24 Calculate the mass of 98.5 % ammonium nitrate which can be obtained by acid – base reaction of ammonia with 3.5 t of 63% nitric acid solution by mass.

OXIDES OF NITROGEN, ACIDS OF NITROGEN, NITRATES, NITROGEN CYCLE IN NATURE

22.1 Write the formula of oxides of nitrogen with following oxidation states:
+1, +2, +3, +4, +5

22.2 Which of the nitrogen oxides represent acidic properties? Characterize it with chemical properties.

22.3 Choose the statements that refer to nitrogen monoxide or nitrogen dioxide:
A. colorless gas;
B. reddish-brown gas;
C. 1.6 times heavier than air;
D. slightly heavier than air;
E. is obtained in air through thunderstorms;
F. is obtained by getting in contact with oxygen of another nitric oxide;
G. is poisonous, it irritates the mucous;
H. it oxidizes easily with oxygen from air;
I. It forms nitric acid by reaction with water.

22.4 Write the reaction equations:
A. $N_2O_5 + H_2O \rightarrow$
B. $N_2O_5 + CaO \rightarrow$
C. $NH_3 + O_2$ [Pt] $\rightarrow NO + ?$
D. $NO_2 + O_2 + H_2O \rightarrow$
E. $N_2O_5 + NaOH \rightarrow$
F. $N_2 + O_2$ [elect.] $\rightarrow$
G. $NO + O_2 \rightarrow$

22.5 Perform the following transformation:
$N_2 \rightarrow NH_3 \rightarrow NO \rightarrow NO_2 \rightarrow HNO_3$

22.6 Explain, why rain water contains trace amount of nitric acid during the storm. Support your idea with reactions.

22.7 Complete the following reactions in molecular form. Write the reaction equations in ionic form. What common or specific properties does nitric acid demonstrate in each one of these reactions?
I
A. $HNO_3 + MgO \rightarrow$
B. $HNO_3 + Al_2O_3 \rightarrow$
C. $HNO_3 + Na_2O \rightarrow$
D. $HNO_3 + CuO \rightarrow$

E. $HNO_3 + Fe_2O_3 \rightarrow$
F. $HNO_3 + FeO \rightarrow$

II

A. $HNO_3 + KOH \rightarrow$
B. $HNO_3 + Ca(OH)_2 \rightarrow$
C. $HNO_3 + Al(OH)_3 \rightarrow$
D. $HNO_3 + Cu(OH)_2 \rightarrow$
E. $HNO_3 + Fe(OH)_3 \rightarrow$
F. $HNO_3 + NH_4OH \rightarrow$

III

A. $HNO_3 + Na_2CO_3 \rightarrow$
B. $HNO_3 + K_2S \rightarrow$
C. $HNO_3 + Na_2SiO_3 \rightarrow$
D. $HNO_3 + CaCO_3 \rightarrow$
E. $HNO_3 + Na_2SO_3 \rightarrow$
F. $HNO_3 + CH_3COONa \rightarrow$

22.8 Choose the substances that can react with dilute nitric acid. Write the reaction equations in molecular and ionic form.
$Cu(OH)_2$, H_2PO_4, $Fe(OH)_3$, $BaCO_3$, $BaCl_2$, CO_2, MgO, SO_3, Al_2O_3.

22.9 Write the reaction equations for the preparation of nitrates of: ammonium, sodium, calcium, copper, potassium, iron (III), aluminum, magnesium, by two methods.

22.10 Perform the following transformations. Write the reaction equations in ionic form, if it is possible.
A. $HNO_3 \rightarrow Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 \rightarrow Zn(NO_3)_2 \rightarrow Mg(NO_3)_2$

B. $N_2O_5 \rightarrow KNO_3 \rightarrow HNO_3 \rightarrow Ca(NO_3)_2 \rightarrow NaNO_3$
C. $N_2O_5 \rightarrow HNO_3 \rightarrow Pb(NO_3)_2 \rightarrow KNO_3 \rightarrow KNO_2$
D. $NH_3 \rightarrow NO \rightarrow NO_2 \rightarrow HNO_3 \rightarrow NO_2$, $HNO_3 \rightarrow N_2O_5$

22.11 The nitric acid interacts with many nonmetals and almost all metals (except Au and Pt) according to following this equation scheme:

$$Me + HNO_3 \rightarrow Me(NO_3) + H_2O + X$$

where X=NO_2, NO, N_2O, N_2 , NH_4NO_3 , depending on acid concentration and metal activity. Balance the following equations by oxidation number method.
A. $Cu + HNO_3(conc.)\ (temp.) \rightarrow Cu(NO_3)_2 + H_2O + NO_2\uparrow$
B. $Cu + HNO_3(conc.)\ (temp.) \rightarrow Cu(NO_3)_2 + H_2O + NO\uparrow$
C. $Zn + HNO_3(conc.)\ (temp.) \rightarrow Zn(NO_3)_2 + H_2O + NO\uparrow$
D. $Zn + HNO_3(conc.)\ (temp.) \rightarrow Zn(NO_3)_2 + H_2O + N_2\uparrow$
E. $C + HNO_3(conc.)\ (temp.) \rightarrow CO_2\uparrow + H_2O + NO_2\uparrow$
F. $S + HNO_3(conc.)\ (temp.) \rightarrow SO_2\uparrow + H_2O + NO_2\uparrow$
G. $P + HNO_3(conc.)\ (temp.) \rightarrow H_3PO_4 + H_2O + NO_2\uparrow$

22.12 Characterize the chemical properties of nitrates by using bond structure in:
A. $Cu(NO_3)_2$ B. $Pb(NO_3)_2$ C. $Al(NO_3)_3$
D. $Ca(NO_3)_2$ E. KNO_3 F. $AgNO_3$

22.13 There are sodium chloride, sodium sulfate, sodium nitrate and ammonium chloride in four tubes. Give an identification method for each substance.

22.14 Prepare ammonium nitrate using nitrogen, hydrogen, oxygen and water. Write all the reaction equations.

22.15 Choose the corresponding areas of application from column B for the substances from column A:

A	B
A. Ammonia	1.to obtain mineral fertilizers.
	2. to obtain the nitric acid in industry.
B. Nitric acid	3. to obtain the nitric acid in laboratory.
	4. in medicines.
C. Nitrates	5. to obtain the drugs.
	6. to obtain the explosive substances.
D. Ammonium salt	7. to obtain the dyes.

22.16 27 kg nitrogen monoxide was obtained by catalytic oxidation of 17 kg of ammonia. Calculate the percent yield of the reaction.

22.17 The chemical analysis of nitrogen oxides showed that:
A. the first oxide with 45 g mass contains 21 g of nitrogen;
B. the second oxide with 23 g mass contains 7 g of nitrogen;
C. the third oxide with 135 g mass contains 35 g of nitrogen.
Find the formulae of nitrogen oxides.

22.18 A 500 g of 20 % nitric acid solution reacts with 300 g of water. Find the mass percentage of nitric acid in obtained solution.

22.19 200 g of 60 % nitric acid solution was mixed with 200 g of 10 % nitric acid solution. Find:
A. the mass percentage of dissolved substance in obtained solution;
B. the amount of nitric acid in obtained solution.

22.20 Find the mass of nitric acid which can be obtained by the reaction of sulfuric acid with 179 kg saltpeter, containing 95% sodium nitrate.

22.22 The nitric acid was obtained by interaction of strong sulfuric acid with 170 g of sodium nitrate. Find:
A. mass of nitric acid, if the theoretical yield of the reaction is 90 %;
B. the mass of 63 % nitric acid solution, if the theoretical yield of the reaction is 90 %;
C. The percent yield of nitric acid, if its mass is 113.4 g

22.23 It is given :
$NH_3 \rightarrow NO \rightarrow NO_2 \rightarrow HNO_3$,

1 mol 1 mol 1 mol 1 mol
find the mass of 63% nitric acid solution, which can be obtained from 20 kmol ammonia if percent yield of reaction is 80%.

22.24 Determine what color of litmus paper is obtained in a solution prepared by mixing:
A. 126 nitric acid solution with 56 g potassium hydroxide solution;
B. 126 g of 5% nitric acid solution with112 g of potassium hydroxide solution;
Find the mass of obtained salts in each of the reactions.

22.25 Find the mass percent of potassium nitrate in 200 g solution, if it releases 2.24 L of oxygen at STP by the evaporation of solution and the calcinations of dry residue.

22.26 Find the mass of sodium nitrate, if 33.6 L of oxygen at STP is obtained by its thermal decomposition.

22.27 To prepare a canned tomatoes 0.2% potassium nitrate solution by mass is used. Calculate the mass of potassium nitrate used to prepare 10 kg solution.

22.28 25 tons of $CaCO_3$ are treated with nitric acid for the preparation of calcium saltpeter. The percent yield of the reaction is 85%. Find the mass of obtained saltpeter.

22.29 Radicicole bacteria decompose 400 kg of nitrogen within 1 year on an area of 1 hectare. Calculate the mass of ammonium nitrate be introduced so that the content of nitrogen in the soil is equal to 400 kg, if the mass of nitrogen in saltpeter is 35%.

22.30 An average yield of wheat in 1 hectare field causes 75 kg nitrogen loss. How many kg of saltpeter substitutes this amount of nitrogen, if you know that almost 20% of the nitrogen in the soil supply to be back in the natural process?