1. Calculate the change in the internal energy of helium (monoatomic ideal gas) at isobaric expansion from 5 to 10 liters at a pressure of 196 kPa.

2. 1 mol of xenon at 25 °C and 202.6 kPa expands adiabatically: a) reversibly to 101.3 kPa, b) against a pressure of 101.3 kPa. What will be the final temperature in each case?

3. 1 mol of water vapor was reversibly and isothermally condensed into a liquid at 100 ° C. Calculate work, heat, change in internal energy and enthalpy in this process. The specific heat of vaporization of water at 100 ° C is 2260 J / g.

4. Determine the amount of heat required to heat 5 g of nitrogen from 15 to 25 ° C, if the volume of gas does not change.

5. Gas, expanding from 10 to 16 liters at a constant pressure of 101.3 kPa, absorbs 126 J of heat. Determine the change in the internal energy of the gas.

6. Determine the change in internal energy, the amount of heat, and the work performed during the reversible isothermal expansion of nitrogen from 0.5 to 4 m3 (initial conditions: temperature 26.8 ° C, pressure 93.2 kPa).

7. Calculate the change in enthalpy of oxygen (ideal gas) at isobaric expansion from 80 to 200 liters at normal atmospheric pressure.

8. What amount of heat is needed to raise the temperature of 16 g of oxygen from 300 to 500 K at a pressure of 101.3 kPa? How will the internal energy change?

9. A kettle containing 1 kg of boiling water is heated to complete evaporation at normal pressure. Determine A, Q, ΔU, ΔH for this process. The molar heat of vaporization of water is 40.6 kJ / mol.

10. Determine the final temperature and work required to adiabatically compress nitrogen from 10 L to 1 L if the initial temperature and pressure are 26.8 ° C and 101.3 kPa, respectively.

**The first law of thermodynamics**

1. Calculate the change in the internal energy of 20⋅10-3 kg of ethyl alcohol due to evaporation at a normal boiling point, if its specific heat of vaporization at this temperature is 837,38⋅103 J / kg, and the specific volume of vapor is equal to 607⋅10-3 m3 / kg. The amount of liquid is not taken into account.

2. Calculate the change in internal energy upon evaporation of 90 g of water at normal boiling point, if the heat of vaporization is 40714.2 J / mol, the specific volume of vapor is 1.699 L / g. The amount of water in the liquid state is not taken into account.

3. Assuming that the vapor obeys the law of ideal gases, calculate the change in internal energy when 50 g of toluene is evaporated at 300 C. The specific heat of vaporization of toluene is 347.8 J / g. The amount of toluene in the liquid state should not be taken into account.

4. How will the internal energy of 200 g of benzene change when it evaporates at 200 C, if its molar heat of vaporization is 30.92 kJ / mol. Benzene vapors obey the law of ideal gases, the volume in the liquid state should not be taken into account.

5. Calculate the change in internal energy upon evaporation of 1 kg of water at a normal boiling point, if its specific heat of vaporization is 2258,7⋅103 J / kg. Steam is an ideal gas, do not take into account the volume of liquid water.

**Thermochemistry**

1. Calculate the difference for the following processes at a pressure of 1,0133⋅105 Pa.

H2+O2=H2O ( 298 К)

СH3COOC2H5+ H2O=СH3COOH+ C2H5OH (298 К)

N2+H2=NH3 (673 К)

C+2H2=CH4 (1073 К)

2. If the heat of combustion of substances:

Substance....... CH≡CH CO H2O (liquid) CH2=CHCOOH (liquid)

, kJ/mol -1299,63 -283,18 0 -1368,03

Calculate the thermal effect of the reaction CH≡CH+CO+H2O(liq)=CH2=CHCOOH(liq) (standard pressure and temperature 298 K). What is the magnitude of the thermal effect of this reaction at V = const?

3. If the heat of formation of substances:

Substance..............................CH≡CH CO H2O (liq) CH2=CHCOOH (liq)

, kJ/mol -1299,63 -283,18 0 -1368,03

Calculate the thermal effect of the reaction CH≡CH+CO+H2O(liq)=CH2=CHCOOH(liq) (standard pressure and temperature 298 K). What is the magnitude of the thermal effect of this reaction at V = const?

4. Calculate the difference between the heat effects of the reaction СH3CНO(g) + H2= C2H5OH (liquid) at constant pressure and constant volume (J) at 298 K. What is the meaning of this difference when the temperature rises to 400 K and the alcohol turns into gas?

5. The reaction Мg(ОН)2=МgО+ H2O(g) in the presence of 400 K and 101.3 kPa in an open vessel absorbs 89.03 kJ of heat. What is the thermal effect if the reaction is carried out at this temperature, but in a closed vessel?

6. The standard enthalpy of the reaction СаСО3=СаО+ CO2 in an open container at 1000 K is 169.0 kJ / mol. What is the magnitude of the heat effect if the reaction is carried out at this temperature, but in a closed vessel?

7. At 298 K, 1 mol of naphthalene releases 5,152.96 kJ of heat when burned in a calorimetric bomb to separate water and carbon dioxide. What is the magnitude of the thermal effect of this process at constant pressure, if the water vapor generated during combustion: a) condenses; b) does not condense?

8. The heat of vaporization of methanol at 298 K is 37.5 kJ / mol. Calculate the heat of vaporization of methanol at 320 K. Obtain the necessary data from the handbook (Appendix I).

9. Calculate the heat of formation of aluminum bromide from common substances at 450 K. Obtain the necessary data from the handbook (Appendix I).

1. 10. Calculate the heat of formation of methane from simple substances at a temperature of 298 K, standard pressure and V = const, if: (H2O(liq)) kJ/mol,СО2  kJ/mol; The heat of combustion of СН4  kJ/mol.

11. At 298 K and standard pressure, the heat of formation of Fe2O3 from simple substances is -821.32 kJ / mol, and for Al2O3 —1675.60 kJ / mol. Calculate the thermal effect of the reduction of 1 mole of Fe2O3 with metallic aluminum.

12. Calculate the heat effect of the following reaction at 298 K and standard pressure:

CaC2(solid) +2H2O(liq)=Ca(OH)2(solid) + C2H2 Obtain the necessary data from the reference book (Appendix I).

Calculate the heat effects of the following reactions at 13.298 K and standard pressure:

(COOH)2(s)=HCOOH(liq)+CO2 (1)

C2H5OH(liq)+O2=CH3COOH(liq)+H2O(liq) (2)

2CH3Cl(g)+Mg(s)=C2H6(g)+MgCl2 (3)

3C2H2(g)=C6H6(liq) (4)

CH4+4SO2Cl2(liq)=CCl4(liq)+4SO2+4HCl (5)

Obtain the necessary data from the reference book