

Name:

Date:21.03.2022

Matriculation no.:

Exam for General Chemistry

For calculations, both the numerical value and the unit of the result must be correct. **Do not use a pencil for writing!** Each task counts 10 points.

Constants and conversion factors:

$$N_A = 6.022 \cdot 10^{23} \text{ mol}^{-1}$$

$$c = 3.000 \cdot 10^8 \text{ m s}^{-1}$$

$$m_e = 9.109 \cdot 10^{-31} \text{ kg}$$

Zero point of the Celsius scale: 273.15 K

$$1 \text{ bar} = 10^5 \text{ Pa} = 10^5 \text{ N m}^{-2} = 0.987 \text{ atm}$$

$$1 \text{ C} = 1 \text{ A s}$$

$$h = 6.626 \cdot 10^{-34} \text{ J s}$$

$$e = 1.602 \cdot 10^{-19} \text{ C}$$

$$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$F = 96485 \text{ C mol}^{-1}$$

$$1 \text{ J} = 1 \text{ W s} = 1 \text{ V A s} = 1 \text{ N m} = 1 \text{ kg m}^2 \text{ s}^{-2}$$

1) Complete the following table:

Element	Na <sup>+</sup>			B	
Charge of nucleus $Z$ , e		15	17		
Mass of nucleus $MZ$ , Da	23	31	35	12	
Number of protons $N_p$					33
Number of neutrons $N_n$					41
Number of electrons $N_e$		15	18		33

2) 10 g glucose ( $C_6H_{12}O_6$ ) are burned completely with the stoichiometric amount of oxygen. What will be the pressure at 150 °C in a combustion vessel with a volume of 10 dm<sup>3</sup>?

3) Draw the structural formula of acetone ( $\text{CH}_3\text{COCH}_3$ ), including all lone pairs of electrons and formal charges. What are the bond angles? Where are single, double,  $\sigma$ , and  $\pi$  bonds? Indicate the state of hybridization of the individual atoms, dipole moment of acetone and its direction (if present).

4) Calculate the mass fraction of water in oxalic acid dihydrate ( $\text{C}_2\text{O}_4\text{H}_2 \cdot 2 \text{H}_2\text{O}$ ).

$M(\text{C}) = 12 \text{ g/mol}$ ;  $M(\text{O}) = 16 \text{ g/mol}$ ;  $M(\text{H}) = 1 \text{ g/mol}$

5) How many molecules are in 1 mg of ethane ( $C_2H_6$ )?

$M(C) = 12 \text{ g/mol}$ ;  $M(H) = 1 \text{ g/mol}$

6) Benzene has a boiling point of  $80^{\circ}\text{C}$ . Calculate the vapour pressure of a solution of benzene at  $80^{\circ}\text{C}$  containing 5g Anthracene in 100g Benzene.

$M(\text{Benzene}) = 78 \text{ g/mol}$ ,  $M(\text{Anthracene}) = 178 \text{ g/mol}$

7) A saturated solution of  $\text{BaF}_2$  has a concentration of  $9 \cdot 10^{-3} \text{ mol/l}$ . Calculate the solubility product.

8) Calculate the reaction enthalpy of  $6 \text{ C (Graphite)} + 3 \text{ H}_2 \rightarrow \text{C}_6\text{H}_6$  from the given combustion enthalpies:

Carbon (Graphite)  $-393,5 \text{ kJ/mol}$  ; Hydrogen  $-285,8 \text{ kJ/mol}$ ; Benzene  $-3267,4 \text{ kJ/mol}$



9) 5.25 g of a gas occupy a volume of 4 dm<sup>3</sup> at 20 °C and 1 bar. Calculate the molar mass of the gas.

10) The half-life period (half-life time) of a reaction of first order is 5s. Calculate the rate constant  $k$  of the reaction.