CHEM-C1230 Principles of Physical Chemistry 2021
Exercise session 1 – 24.9.21

Pearson Exercise 1 (Intro to Pearson)

Pearson Exercise 2 (Intro to Thermodynamics)

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Current locations of exercise session

- You can choose what works for you:
- In-person class (room KE2, CHEM building, max. 40 people) – hosted by prof. Kari
- Online class (Zoom) – hosted by Han

Exercises & incoming deadlines

- Exercise 1: “Introduction to MasteringChemistry for Physical Chemistry”
  - Deadline Mon 27.9 11:59 PM
- Exercise 2: “Thermodynamics 1.1.”
  - Deadline Thu 30.9 11:59 PM
- You will not be penalized for using hints. There are a lot of detailed hints on Pearson.

Exercise 1: Intro to Pearson

- Please check “How to login to the Pearson system” on MyCourses if needed.
- Do Exercise 1: Introduction to MasteringChemistry for Physical Chemistry
  - Deadline 27.9 11:59 PM
- The purpose of this exercise is just to familiarize you with Pearson, which you will be using for the rest of the course.
- Issue with Pearson? Please ask me on Zoom or Slack channel #general

Exercise 2 - Thermodynamics 1.1.

Air is a mixture of several gases. The 10 most abundant of these gases in *dry* air are listed here along with their mole fractions and molar masses.

Component	Mole fraction	Molar mass (g/mol)
Nitrogen	0.78084	28.013
Oxygen	0.20948	31.998
Argon	0.00934	39.948
Carbon dioxide	0.000375	44.0099
Neon	0.00001818	20.183
Helium	0.00000524	4.003
Methane	0.000002	16.043
Krypton	0.00000114	83.80
Hydrogen	0.0000005	2.0159
Nitrous oxide	0.0000005	44.0128

- **Question 1 - Part A.**
- Assuming ideal gas behavior, what mass of carbon dioxide is present in 1.00 m3 of dry air at a temperature of 11∘C and a pressure of 733 torr?
- Calculate the number of moles of air in 1 cubic meter:

$$ideal\ gas\ equation\ PV = nRT \ \rightarrow \ n_{air} = \frac{PV}{RT}$$

- Find the number of moles and mass of CO2:
- $n_{CO2} = 0.000375 \times n_{air}$
- $m_{CO2} = M_{CO2} \times n_{CO2}$

- **Question 1 - Part B.**
- mass percentage of oxygen in dry air:

$$\frac{0.20948\ mol\ oxygen\ \times M_{O2}}{1\ mol\ air\ \times M_{air}} \times 100$$

$(M_{air} = 28.97\ g/mol)$

Exercise 2 - Thermodynamics 1.1.

- **Question 2.** A tank is filled with an ideal gas at 400 K and pressure of 1.00 atm
- Part A. The tank is heated until the pressure of the gas in the tank doubles. What is the temperature of the gas?
- Since the number of moles and volume of the gas are constant, ideal-gas equation. nR/V constant
- P1/T1 = P2/T2 → Find T2

- Part B. A bit similar to part A. Check the hints on Pearson if needed.

Exercise 2 - Thermodynamics 1.1.

- **Question 3.** Dalton's law: $P_{\text{total}} = P_1 + P_2 + P_3 + \ldots$
- Part A. Three gases (8.00 g of methane, CH4, 18.0 g of ethane, C2H6, and an unknown amount of propane, C3H8) were added to the same 10.0-L container. At 23.0∘C, the total pressure in the container is 4.50 atm. Calculate the partial pressure of each gas in the container.
  - Find n_{CH4}, then find P_{CH4} by the ideal gas law
  - Find n_{C2H6} then find P_{C2H6} by the ideal gas law
  - Then find partial pressure of propane using Dalton's law.

- Part B. Check the hints on Pearson if needed.

Exercise 2 - Thermodynamics 1.1.

- **Question 4.**

The mass of a He atom is less than that of an Ar atom. Does that mean that because of its larger mass, Ar exerts a higher pressure on the container walls than He at the same molar density, volume, and temperature?

What's the relationship between pressure and momentum, momentum and mv_x^2 (mass & speed)?

$$P = \frac{F}{A} = \frac{ma_i}{A} = \frac{m}{A}\left(\frac{d\mathrm{v}_i}{dt}\right) = \frac{1}{A}\left(\frac{dm\mathrm{v}_i}{dt}\right) = \frac{1}{A}\left(\frac{dp_i}{dt}\right)$$

$$P = \frac{F}{A} = \rho_N m v_x^2$$

(ρN is the gas number density)

From this equation of translational energy, conclude if momentum depends on mass, speed, or temperature:

$$\frac{m\left\langle \mathrm{v}_x^2 \right\rangle}{2} = \frac{k_B T}{2}$$

(Proof of this equation in chapter 14. k_B is the Boltzmann constant)

→ Does the mass or speed difference between He and Ar atoms affect the pressure, if T is the same?

Exercise 2 - Thermodynamics 1.1.

- **Question 5.**
- From least diathermal to most diathermal
- → least heat transfer to most heat transfer

Exercise 2 - Thermodynamics 1.1.

- **Question 6.**
- Check the hints on Pearson if needed.

- **Question 7.**
- Part A. the van der Waals equation

$$P = \frac{nRT}{V - nb} - \frac{n^2 a}{V^2}$$

- n = 1
- Part B. Compare P ideal and P real