



INSTITUTO SUPERIOR TÉCNICO

Química

Curso de Engenharia do Ambiente

1º Semestre de 2016-2017

Física e Química da Atmosfera

Teste de Química (29-10-2016, 9h)

Duração 1h 30 m

Read carefully all the questions before answering. Justify as much as possible all your answers.

I

Select the correct answer for the following questions:

1(0.75) – The initial atmosphere of the Earth (H_2 , He) was initially replaced by another that included:

- A – H_2O , CO_2 , O_2
- B – H_2O , CO_2 , SO_2
- C – H_2O , CO_2 , O_3

2 (0.75) – The present earth atmosphere is composed by

- A – 78% of N_2 , 21% of O_2 and 1% of Ar
- B – 78% of N_2 , 21% of O_2 and 1% of CO_2
- C – 70% of N_2 , 27% of O_2 and 3% of CO_2

3 (0.75) – In the Troposphere the temperature decreases with the altitude because

- A – the distance to the tropopause increases
- B – the distance to the soil increases
- C – photochemical reactions decrease in intensity

4 (0.75) – A high value of residence time for a compound in the atmosphere means that

- A – its concentration is very low
- B – it is formed by chemical processes in the atmosphere
- C – it is well mixed in the whole Earth atmosphere

5 (0.75) – Select a compound responsible for the increase in ozone concentration in the troposphere

- A – CO_2
- B – SO_2
- C - Hydrocarbon

6 (0.75) – Large concentrations of particulate matter in the atmosphere

- A – decrease the visibility
- B – accelerate the deposition processes
- C - contribute to better air quality

II

- a) (2) Describe the reactions involved in the natural formation and depletion of the stratospheric ozone layer (Chapman cycle) and relate them to the temperature variation in this region (the stratosphere) of the atmosphere.
- b) (2) The Chapman cycle described in the previous question results in a steady state concentration of stratospheric ozone. Explain why the presence of pollutants like CFCs in the stratosphere will result in a significant increase in ozone depletion.

III

a) (2) Describe the process known as Greenhouse Effect. Talk about the consequences of its total non-existence and how and why it changed in magnitude since pre-industrial times.

b) Methane and sulfur hexafluoride are two greenhouse gases.

GHG	Residence time
Carbon dioxide (CO ₂)	Variable (50-200 y)
Methane (CH ₄)	12 y
Sulfur hexafluoride (SF ₆)	3200 y

- 1) (1) Compare qualitatively the evolution of GWP₂₀ and GWP₁₀₀ of these two gases.
- 2) (0.5) Name two other gases or families of gases that present greenhouse effect.
- 3) (0.5) Do you include water among the greenhouse gases? Why?

IV

The annual global emission of methane is estimated to be 598 Tg y⁻¹.

a) (2) Calculate the atmospheric residence time of methane.

C(CH₄) = 1.7 ppmv (molar fraction of CH₄)
Mass of the atmosphere = 5 x 10¹⁸ Kg

$$T_g = 10^{-12} \text{ g}$$

b) (1.5) Pre industrial methane concentration (mole fraction) was 722 ppbv. What is the corresponding increase in mass of carbon in the atmosphere?

V

The average concentration of sulfur dioxide in Nikel Russia (nickel and palladium mining and smelting company) is 50 µg/m³.

a) (s) Calculate the molar fraction of SO₂ in ppb at 15°C and 1 atm?

$$R = .08206 \text{ l.atm/mol.K}$$

b) Calculate the pH of rain water in that same area?

$$K_H = 5.4 \text{ M.atm}^{-1} \quad K_{a1} = 1.7 \times 10^{-2} \quad K_{a2} = 6.4 \times 10^{-8}$$
$$C_g = K_H \cdot P_g$$