



## Exercises:

### Exercise 1:

Calculate the perfect gas constant  $R$  in  $\text{J Kg}^{-1}\text{K}$

-1 for one mole of the following

gases;  $\text{H}_2$ ,  $\text{O}_2$ ,  $\text{N}_2$  and  $\text{CO}_2$  under standard conditions of temperature and pressure.

conditions.

Data:  $M(\text{H}) = 1\text{g mol}^{-1}$ ,  $M(\text{O}) = 16\text{g mol}^{-1}$ ,  $M(\text{N}) = 14\text{g mol}^{-1}$  and  $M(\text{C}) = 12\text{g mol}^{-1}$

### Exercise 2:

From the equation of state for a perfect gas:

$$P V = n R T$$

Where  $R$  is the perfect gas constant ( $8.314\text{ J mol}^{-1}\text{K}^{-1}$ ), and  $n$  is the number of moles of the gas.

1-Demonstrate that this equation can be written as  $P = \rho \cdot R \cdot T / M$ , where  $\rho$  is the density of the gas, and  $M$  is the molar mass ( $\text{Kg/mol}$ ).

2- Rewrite the equation of state for a perfect gas, introducing the number of gas molecules

as well as the expression of the constant  $k = R / N_A$  called Boltzmann's constant, where  $N_A$  is the Avogadro number.

**Exercise 3:** The pressure of a perfect gas is equal to 2 atm.

pressure in; Bar, Pascal, mmHg, torrs and  $\text{N/m}^2$ .

**Exercise 4:** Calculate the volume occupied by 3.6 g of oxygen at  $27^\circ\text{C}$  and a pressure of 2 atm?

Data:  $M(\text{O}) = 16\text{g mol}^{-1}$  and  $R = 0.0821\text{ atm mol}^{-1}\text{K}^{-1}$

### Exercise 5:

A quantity of 10 g of  $\text{CO}_2$  occupies a volume of 5 liters at a pressure of 740 torr. Determine the gas temperature.

**Exercise 6:**

What will become of the temperature (in  $^{\circ}\text{C}$ ) of a sample of methane ( $\text{CH}_4$ ), if a volume of 1 liter at 735 torr and  $25^{\circ}\text{C}$  is compressed to 809 torr and then occupies a volume of 0.9 liters.

**Exercise 7:**

A car tire is inflated to  $27^{\circ}\text{C}$  at 2 bars. After the car has been driven, the tire pressure is 2.2 bar. Assuming the volume of the tire to be constant, and

considering the air in the tire as a perfect gas, calculate the temperature inside the tire.

**Exercise 8:**

A mass of oxygen occupies a volume of 3litres at a pressure of 2 atm. Determine the volume occupied by the same mass of gas at normal pressure, with temperature remains constant.

**Exercise 9:**

One mole of a perfect gas occupies a volume of  $200\text{ cm}^3$  at  $100^{\circ}\text{C}$ . Assuming the pressure of the gas is constant, calculate its volume at  $25^{\circ}\text{C}$ .

**Exercise 10:**

A gas mixture containing 0.15 g hydrogen ( $\text{H}_2$ ) g, 0.7 g nitrogen ( $\text{N}_2$ )g and 0.34 g ammonia ( $\text{NH}_4$ )g at a total pressure of 1 atm and a temperature of  $25^{\circ}\text{C}$ .

Calculate:

- 1- The mole fraction of each gas.
- 2- The partial pressure of each gas.
- 3- The volume occupied by each gas and the total volume of the mixture.

**Exercise 11:**

Consider two rigid-walled containers, one containing hydrogen and the other methane, the other methane, we have

	P (atm)	T (K)	V (L)
$H_2$	5	250	10
$CH_4$	40	300	40

- 1- Calculate the masses of hydrogen and methane contained in each vessel.
- 2- Heat the two containers to a temperature of 350K. Calculate the pressure of  $H_2$  and  $CH_4$ .
- 3- Using a tap, connect the two containers.
  - a- What happens?
  - b- Calculate the partial pressures of each gas and deduce the total pressure.

**Exercise 12:**

Mix a volume  $V_1 = 3$  liters of carbon dioxide ( $CO_2$ ) at a pressure  $P_1 = 4$  atm with a volume  $V_2 = 1$  liter of oxygen ( $O_2$ ) at a pressure  $P_2 = 6$  atm. The temperature of each gas has the same value  $T = 300$  K.

- 1- Calculate the number of moles of each gas.
- 2- Calculate the total pressure P of the mixture. Check Dalton's law.
- 3- Calculate the density of the mixture in  $Kg /m^3$  and in  $g/ l$