

## Questions on ppm 2

1. The European Unit limit for copper in drinking water is 2.0 ppm. A student analyses 10.0 cm<sup>3</sup> of water and finds that it contains 1.5 μg of copper.

- (a) Determine whether this sample of water exceeds the legal limit for copper.

10.0 cm<sup>3</sup> of water is 10.0 g

Assuming density of water is 1 g cm<sup>-3</sup>

1.5 μg of Cu is 1.5x10<sup>-6</sup> g

Convert to same units

$$\text{Concentration of copper in ppm} = \frac{1.5 \times 10^{-6}}{10.0} \times 10^6 = 0.15 \text{ ppm}$$

This is lower than 2.0 ppm, therefore the legal limit is not exceeded.

- (b) Calculate the concentration of the copper in mol dm<sup>-3</sup>.

Number of moles of copper in 10.0 cm<sup>3</sup> of water is 1.5x10<sup>-6</sup>/63.55 = 2.4x10<sup>-8</sup> mol

$$\text{Concentration (mol dm}^{-3}\text{)} = \frac{\text{number of moles}}{\text{Volume in dm}^3} = \frac{2.4 \times 10^{-8}}{(10.0/1000)} = 2.4 \times 10^{-6} \text{ mol dm}^{-3}$$

Alternatively

Mass of 1 dm<sup>3</sup> of water

0.15 ppm is 0.15/10<sup>6</sup> x 1000 = 1.5x10<sup>-4</sup> g of copper in 1 dm<sup>3</sup> of water.

Moles of copper in 1 dm<sup>3</sup> of water is 1.5x10<sup>-4</sup>/63.55 = 2.4x10<sup>-6</sup> mol

Therefore concentration is 2.4x10<sup>-6</sup> mol dm<sup>-3</sup>

2. The EU limit for chromium in drinking water is 50 μg dm<sup>-3</sup>.

- (a) Calculate the maximum allowed concentration in ppm.

To convert μg to g multiply by 10<sup>-6</sup>: 50 μg is 5.0x10<sup>-5</sup> g

$$\text{Concentration of chromium in ppm} = \frac{5.0 \times 10^{-5}}{1000} \times 10^6 = 0.05 \text{ ppm}$$

- (b) The concentration of chromium in a sample of water is 7.70x10<sup>-7</sup> mol dm<sup>-3</sup>. Determine whether this sample exceeds the legal limit.

Mass of chromium in 1 dm<sup>3</sup> is 7.70x10<sup>-7</sup> x 52.00 = 4.00x10<sup>-5</sup> g

$$\text{Concentration of chromium in ppm} = \frac{4.00 \times 10^{-5}}{1000} \times 10^6 = 0.04 \text{ ppm}$$

This does not exceed the legal limit.

## Questions on ppm 2

3. The concentration of dissolved oxygen (O<sub>2</sub>) in a sample of river water is 10.0 ppm. Calculate the number of oxygen molecules in 200 cm<sup>3</sup> of the river water.

*Avogadro's constant is  $6.02 \times 10^{23} \text{ mol}^{-1}$*

$$\text{Mass of oxygen} = \frac{10.0}{10^6} \times 200 = 2.00 \times 10^{-3} \text{ g}$$

$$\text{Moles of oxygen} = \frac{2.00 \times 10^{-3}}{32.00} = 6.25 \times 10^{-5} \text{ mol}$$

$$\text{Number of oxygen molecules} = 6.25 \times 10^{-5} \times 6.02 \times 10^{23} = 3.77 \times 10^{19}$$

4. The current level of carbon dioxide in the air is about 400 ppm.

- (a) Calculate the volume (in cm<sup>3</sup>) of CO<sub>2</sub> present in a room with dimensions 4m x 4m x 3m.

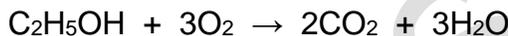
$$\text{Volume of room} = 4 \times 4 \times 3 = 48 \text{ m}^3$$

$$\text{Volume of CO}_2 = \frac{400}{10^6} \times 48 = 0.0192 \text{ m}^3$$

There are 10<sup>6</sup> cm<sup>3</sup> in 1 m<sup>3</sup>. To convert m<sup>3</sup> to cm<sup>3</sup> multiply by 10<sup>6</sup>

$$\text{Volume of CO}_2 \text{ in cm}^3 = 0.0192 \times 10^6 = 19\,200 \text{ cm}^3$$

- (b) 1.00 g of ethanol (C<sub>2</sub>H<sub>5</sub>OH) is burnt in the room. Assuming complete combustion of the ethanol, calculate by how much (in ppm) the concentration of CO<sub>2</sub> in the room will increase. Assume that the temperature in the room remains stable at 20°C and the pressure is 100 kPa.



$$1.00 \text{ g of ethanol is } 1.00/46.08 = 0.0217 \text{ mol}$$

Not STP, therefore use PV=nRT

$$P = 100 \text{ kPa}$$

$$V = V$$

$$n = 0.0217$$

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$T = 20 + 273 = 293 \text{ K}$$

If pressure is in kPa, the volume will come out in dm<sup>3</sup>

$$PV = nRT \quad V = \frac{0.0217 \times 8.31 \times 293}{100} = 0.528 \text{ dm}^3$$

There are 1000 cm<sup>3</sup> in 1 dm<sup>3</sup>. To convert dm<sup>3</sup> to cm<sup>3</sup> multiply by 1000

$$\text{Volume of CO}_2 = 0.528 \times 1000 = 528 \text{ cm}^3$$

The volume of CO<sub>2</sub> in the room increases by 528 cm<sup>3</sup>

The easiest way to find the increase in ppm is to use ratios:

$$\text{Increase in concentration in ppm} = \frac{528}{19200} \times 400 = 11 \text{ ppm}$$

Alternatively

$$\text{Increase is } \frac{528 \times 10^{-6}}{48} \times 10^6 = 11 \text{ ppm}$$