Questions on ppm 2

1. The European Unit limit for copper in drinking water is 2.0 ppm. A student analyses 10.0 cm^3 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^3 of water is 10.0 g — Assuming density of water is 1 g cm^{-3}

1.5 μg of Cu is 1.5×10^{-6} g — Convert to same units

Concentration of copper in ppm = $\frac{1.5 \times 10^{-6}}{10.0} \times 10^6 = 0.15$ 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^{-3}.

Number of moles of copper in 10.0 cm^3 of water is $1.5 \times 10^{-6} / 63.55 = 2.4 \times 10^{-8}$ mol

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

Alternatively

0.15 ppm is $0.15/10^6 \times 1000 = 1.5 \times 10^{-4}$ g of copper in 1 dm^3 of water. — Mass of 1 dm^3 of water

Moles of copper in 1 dm^3 of water is $1.5 \times 10^{-4} / 63.55 = 2.4 \times 10^{-6}$ mol

Therefore concentration is 2.4×10^{-6} mol dm^{-3}

2. The EU limit for chromium in drinking water is 50 μg dm^{-3}.

(a) Calculate the maximum allowed concentration in ppm.

To convert μg to g multiply by 10^{-6}: 50 μg is 5.0×10^{-5} g

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

(b) The concentration of chromium in a sample of water is 7.70×10^{-7} mol dm^{-3}. Determine whether this sample exceeds the legal limit.

Mass of chromium in 1 dm^3 is $7.70 \times 10^{-7} \times 52.00 = 4.00 \times 10^{-5}$ g

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

This does not exceed the legal limit.

Questions on ppm 2

3. The concentration of dissolved oxygen (O_2) in a sample of river water is 10.0 ppm. Calculate the number of oxygen molecules in 200 cm^3 of the river water.

Avogadro's constant is 6.02×10^{23} mol^{-1}

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

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

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^3) of CO_2 present in a room with dimensions 4m x 4m x 3m.

Volume of room = 4 x 4 x 3 = 48 m^3

Volume of CO_2 = $\frac{400}{10^6} \times 48 = 0.0192$ m^3

There are 10^6 cm^3 in 1 m^3. To convert m^3 to cm^3 multiply by 10^6

Volume of CO_2 in cm^3 = $0.0192 \times 10^6 = 19\,200$ cm^3

(b) 1.00 g of ethanol (C_2H_5OH) is burnt in the room. Assuming complete combustion of the ethanol, calculate by how much (in ppm) the concentration of CO_2 in the room will increase. Assume that the temperature in the room remains stable at 20°C and the pressure is 100 kPa.

Not STP, therefore use PV=nRT

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

1.00 g of ethanol is 1.00/46.08 = 0.0217 mol

If pressure is in kPa, the volume will come out in dm^3

P = 100 kPa
V = V
n = 0.0217
R = 8.31 J K^{-1} mol^{-1}
T = 20 + 273 = 293 K

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

There are 1000 cm^3 in 1 dm^3.
To convert dm^3 to cm^3 multiply by 1000

Volume of CO_2 = $0.528 \times 1000 = 528$ cm^3

The volume of CO_2 in the room increases by 528 cm^3

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

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

Alternatively

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