Starters for 10 – Transition skills

0.3.1 Laboratory equipment

Practical work is a key aspect in the work of a chemist.

To help you plan effective practical work it is important that you are familiar with the common laboratory equipment available to you.

1. For each of the pieces of glassware shown in the images below, state their name and give a possible volume(s).

   a.   Name:

   ....

   Possible volume(s):

   ....

   b.   Name:

   ....

   Possible volume(s):

   ....

   c.   Name:

   ....

   Possible volume(s):

   ....

   d.   Name:

   ....

   Possible volume(s):

   ....

   e.   Name:

   ....

   Possible volume(s):

   ....

   f.   Name:

   ....

   Possible volume(s):

   ....

   (6 marks)

2. Name the common laboratory equipment in the images below.   (4 marks)

   a.

   ....

   b.

   ....

   c.

   ....

   d.
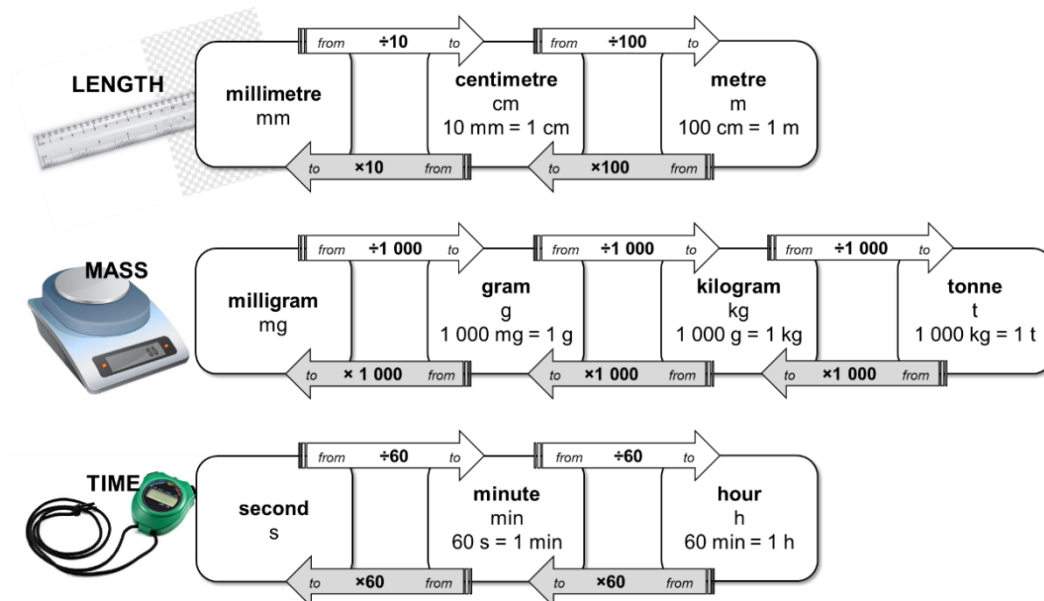
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0.2.6 Unit conversions 1 – Length, mass and time

Mo's teacher has drawn a diagram on the board to help him with converting quantities from one unit into another.

For example, to convert a length in millimetres into units of centimetres, divide by 10, eg 10 mm = 1 cm.

Use the diagram to help with the following unit conversions.   (10 marks)

1. A block of iron has a length of 1.2 cm. Calculate its length in millimetres.

2. The width of the classroom is 7200 cm. Calculate its length in metres.

3. A reaction reaches completion after 4½ minutes. Convert this time into seconds.

4. The stop clock reads 2 min 34 s. Convert this time into seconds.

5. A method states that a reaction needs to be heated under reflux for 145 min. Calculate this time in hours and minutes.

6. A factory produces 15 500 kg of ammonia a day. Calculate the mass of ammonia in tonnes.

7. A paper reports that 0.0265 kg of copper oxide was added to an excess of sulfuric acid. Convert this mass of copper oxide into grams.

8. A packet of aspirin tablets states that each tablet contains 75 mg of aspirin. Calculate the minimum number of tablets that contain a total of 1 g of aspirin.

9. A student measures a reaction rate to be 0.5 g/s. Convert the rate into units of g/min.

10. A factory reports that it produces fertiliser at a rate of 10.44 kg/h. Calculate the rate in units of g/s.

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0.2.7 Unit conversions 2 – Volume

The SI unit for volume is **metre cubed, m^3**. However as volumes in chemistry are often smaller than 1 m^3, fractions of this unit are used as an alternative.

centimetre cubed, cm^3	decimetre cubed, dm^3
centi- *prefix* one hundredth	**deci-** *prefix* one tenth
1 cm = $\frac{1}{100}$ m so,	1 dm = $\frac{1}{10}$ m so,
1 cm^3 = $\left(\frac{1}{100}\right)^3$ m^3 = $\left(\frac{1}{1\,000\,000}\right)$ m^3	1 dm^3 = $\left(\frac{1}{10}\right)^3$ m^3 = $\left(\frac{1}{1\,000}\right)$ m^3

1. Complete the table by choosing the approximate volume from the options in bold for each of the everyday items (images not drawn to scale). (1 mark)

1 cm^3　　　　　　　**1 dm^3**　　　　　　　**1 m^3**

	drinks bottle	sugar cube	washing machine
Approx. volume			

2. Complete the following sentences; (1 mark)
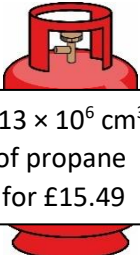
To convert a volume in **cm^3** into a volume in **dm^3**, divide by.............................

To convert a volume in **cm^3** into a volume in **m^3**, divide by...............................

3. a. A balloon of helium has a volume of 1600 cm^3. What is its volume in units of dm^3?

　　b. The technician has prepared 550 cm^3 of HCl(aq). What is its volume in units of m^3?

　　c. An experimental method requires 1.35 dm^3 of NaOH(aq). What volume is this in cm^3?

　　d. A swimming pool has a volume of 375 m^3. What volume is this in cm^3?

　　e. A 12 g cylinder of CO_2 contains 6.54 dm^3 of gas. What volume of gas is this in units of m^3?

(5 marks)

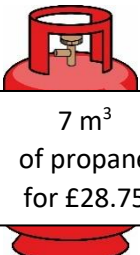4. Which cylinder of propane gas is the best value for money? (3 marks)

a.

2.13×10^6 cm^3
of propane
for £15.49

b.

2700 dm^3
of propane
for £21.25

c.

7 m^3
of propane
for £28.75

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0.2.8 Moles and mass

One mole of a substance is equal to **6.02 × 10²³ atoms**, **ions** or **particles** of that substance. This number is called the **Avogadro constant**.

The value of the Avogadro constant was chosen so that the relative formula mass of a substance weighed out in grams is known to contain exactly 6.02 × 10²³ particles. We call this mass its **molar mass**.

We can use the equation below when calculating an amount in moles:

$$\text{amount of substance (mol)} = \frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$$

How is a mole similar to a dozen?

Stating the amount of substance in moles is just the same as describing a quantity of eggs in dozens. You could say you had 24 or 2 dozen eggs.

Use the equation above to help you answer the following questions.

1. Calculate the amount of substance, in moles, in: (3 marks)
   a. 32 g of methane, CH_4 (molar mass, 16.0 g mol⁻¹)
   b. 175 g of calcium carbonate, $CaCO_3$
   c. 200 mg of aspirin, $C_9H_8O_4$

2. Calculate the mass in grams of: (3 marks)
   a. 20 moles of glucose molecules (molar mass, 180 g mol⁻¹)
   b. 5.00 × 10⁻³ moles of copper ions, Cu^{2+}
   c. 42.0 moles of hydrated copper sulfate, $CuSO_4 \cdot 5H_2O$

3. a. 3.09 g of a transition metal carbonate was known to contain 0.0250 mol.
      i. Determine the molar mass of the transition metal carbonate. (1 mark)
      ii. Choose the most likely identity for the transition metal carbonate from the list below:

      $CoCO_3$ **$CuCO_3$**   **$ZnCO_3$** (1 mark)

   b. 4.26 g of a sample of chromium carbonate was known to contain 0.015 mol.
      Which of the following is the correct formula for the chromium carbonate? (2 marks)

      $CrCO_3$ **$Cr_2(CO_3)_3$**   **$Cr(CO_3)_3$**

   BONUS QUESTION

   If you had 1 mole of pennies which you could share with every person on earth how much could you give each person? Approximate world population = 7 500 000 000.

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0.2.9 Moles and concentration

To calculate the concentration of a solution we use the equation:

$$\text{concentration (mol dm}^{-3}) = \frac{\text{amount of substance (mol)}}{\text{volume (dm}^3)}$$

Use the equation to help you complete each of the statements in the questions below.

1. a. 1.5 mol of NaCl dissolved in 0.25 dm³ of water produces a solution with a concentration

    of .... mol dm⁻³.   (1 mark)

    b. 250 cm³ of a solution of HCl(aq) with a concentration of 0.0150 mol dm⁻³ contains

    ....moles.   (1 mark)

    c. A solution with a concentration of 0.85 mol dm⁻³ that contains 0.125 mol has a volume

    of ....dm³.   (1 mark)

2. In this question you will need to convert between an amount in moles and a mass as well as using the equation above.

    Space for working is given beneath each question.

    a. 5.0 g of NaHCO₃ dissolved in 100 cm³ of water produces a solution with a concentration

    of ....mol dm⁻³.   (2 marks)

    b. 25.0 cm³ of a solution of NaOH(aq) with a concentration of 3.8 mol dm⁻³ contains

    .... g of NaOH.   (2 marks)

c. The volume of a solution of cobalt(II) chloride, $CoCl_2$, with a concentration of 1.3 mol dm^{-3}

that contains 2.5 g of $CoCl_2$ is ....cm^3.   (3 marks)