Volumes of gases

Worked solutions

GCSE science calculations

This topic online

1 **Higher tier**

A balloon is filled with 0.50 mol of carbon dioxide at room temperature and pressure.

Calculate the volume of the carbon dioxide in dm^3. (1 mark)

Volume = moles x 24

volume = 0.50 x 24

12 dm^3

2 **Higher tier**

A small oxygen cylinder used by a paramedic releases 2.5 mol of oxygen.

Calculate the volume of this oxygen at room temperature and pressure, in dm^3. (1 mark)

Volume = moles x 24

volume = 2.5 x 24

60 dm^3

3 **Higher tier**

In an electrolysis experiment, 0.040 mol of hydrogen gas is collected at room temperature and pressure.

Calculate the volume of hydrogen in dm^3. (1 mark)

Volume = moles x 24

volume = 0.040 x 24

0.96 dm^3

4 **Higher tier**

Ewan collects 0.00350 mol of a gas in a gas syringe at room temperature and pressure.

Calculate the volume of gas in the syringe in cm^3. (2 marks)

Volume = moles x 24

volume = 0.00350 x 24

volume = 0.084 dm^3

Change dm^3 to cm^3: multiply by 1000

volume = 0.084 x 1000

84 cm^3

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5 **Higher tier**

A fizzy drinks factory in Bristol measures 480 cm^3 of carbon dioxide escaping from a bottle at room temperature and pressure.

Calculate the number of moles of carbon dioxide. (2 marks)

Change cm^3 to dm^3: divide by 1000

$480\ cm^3 = 480 \div 1000 = 0.480\ dm^3$

Volume = moles x 24, so moles = volume ÷ 24

$moles = 0.480 \div 24$

0.020 mol

6 **Higher tier**

A block of dry ice contains 8.8 g of carbon dioxide, CO_2.

Relative atomic masses (A_r): C = 12, O = 16

Calculate the volume of the carbon dioxide gas when all of the dry ice has turned to gas at room temperature and pressure. (3 marks)

Relative formula mass of CO_2

$M_r = 12 + (2 \times 16) = 44$

Moles = mass ÷ M_r

$moles = 8.8 \div 44 = 0.20\ mol$

Volume = moles x 24

$volume = 0.20 \times 24$

4.8 dm^3

7 **Higher tier**

A food packaging line fills a crisp bag with 6.0 dm^3 of nitrogen at room temperature and pressure.

Calculate the number of moles of nitrogen in the bag. (2 marks)

Volume = moles x 24

$6.0 = moles \times 24$

Divide both sides by 24

$moles = 6.0 \div 24$

0.25 mol

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8 **Higher tier**

Fatima collects 1.8 dm^3 of oxygen, O_2, at room temperature and pressure.

Relative atomic mass (A_r): O = 16

Calculate the mass of oxygen she collects. (3 marks)

Volume = moles x 24, so moles = volume ÷ 24

moles = 1.8 ÷ 24 = 0.075 mol

Relative formula mass of O2

$M_r = 2 \times 16 = 32$

Moles = mass ÷ M_r, so mass = moles x M_r

mass = 0.075 x 32

2.4 g

9 **Higher tier**

A small piece of zinc reacts with acid and gives off 90 cm^3 of hydrogen at room temperature and pressure.

Calculate the number of moles of hydrogen. Give your answer in standard form. (3 marks)

Change cm^3 to dm^3: divide by 1000

90 cm^3 = 90 ÷ 1000 = 0.090 dm^3

Volume = moles x 24, so moles = volume ÷ 24

moles = 0.090 ÷ 24

moles = 0.00375 mol

3.75×10^{-3} mol

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10 **Higher tier**

A camping stove burns butane gas.

$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

All volumes are measured at room temperature and pressure, where water is a liquid.

a. Calculate the volume of oxygen needed to burn 40 cm^3 of butane completely.

b. Calculate the volume of gas produced when 40 cm^3 of butane burns completely. Show your working.

(3 marks)

a)

Gas volumes are in the same ratio as the moles in the equation

C4H10 : O2 = 2 : 13

volume O2 = 40 x 13 ÷ 2

volume O2 = 520 ÷ 2

260 cm^3

b)

C4H10 : CO2 = 2 : 8

volume CO2 = 40 x 8 ÷ 2

volume CO2 = 320 ÷ 2 = 160 cm^3

Water is a liquid, so do not count it as gas

160 cm^3

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11 **Higher tier**

Ms Kowalski adds a catalyst to 1.7 g of hydrogen peroxide, H_2O_2, dissolved in 50 cm^3 of water. All of the hydrogen peroxide decomposes.

$2H_2O_2 \rightarrow 2H_2O + O_2$

Relative atomic masses (A_r): H = 1, O = 16

Calculate the volume of oxygen produced at room temperature and pressure, in cm^3. Show your working.

(4 marks)

The 50 cm^3 of water is not needed

Relative formula mass of H_2O_2

$M_r = (2 \times 1) + (2 \times 16) = 34$

Moles = mass ÷ M_r

moles H_2O_2 = 1.7 ÷ 34 = 0.050 mol

2 H_2O_2 give 1 O_2, so halve

moles O_2 = 0.050 ÷ 2 = 0.025 mol

Volume = moles × 24

volume = 0.025 × 24 = 0.60 dm^3

Change dm^3 to cm^3: multiply by 1000

volume = 0.60 × 1000

600 cm^3

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12 **Higher tier**

Kwame heats some calcium carbonate in a crucible until it has all decomposed.

- Mass of the empty crucible = 32.40 g
- Mass of the crucible and calcium carbonate = 38.60 g

$CaCO_3 \rightarrow CaO + CO_2$

Relative atomic masses (A_r): C = 12, O = 16, Ca = 40

Calculate the volume of carbon dioxide given off at room temperature and pressure, in dm^3.
Give your answer to 2 significant figures. Show your working.

(5 marks)

Use only the mass of the solid, not the crucible

mass = 38.60 - 32.40 = 6.20 g

Relative formula mass of CaCO3

Mr = 40 + 12 + (3 x 16) = 100

Moles = mass ÷ Mr

moles CaCO3 = 6.20 ÷ 100 = 0.062 mol

1 CaCO3 gives 1 CO2

moles CO2 = 0.062 mol

Volume = moles x 24

volume = 0.062 x 24

volume = 1.488 dm^3

1.5 dm^3

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