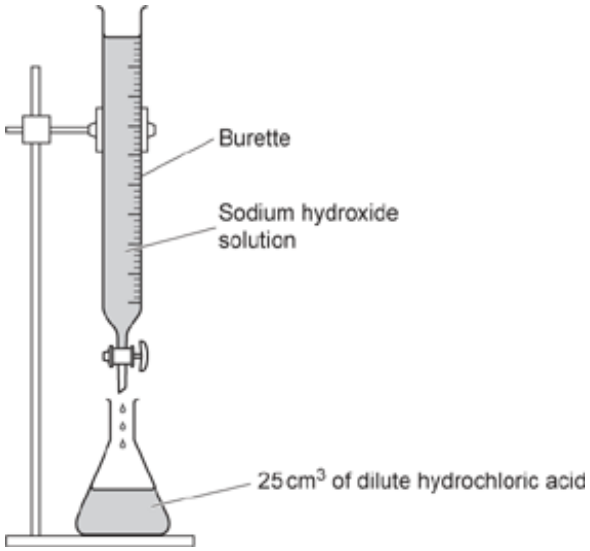
1(a). A student investigates the neutralisation reaction between sodium hydroxide solution and dilute hydrochloric acid.

They do a titration experiment.

The diagram shows the apparatus they use.



Describe how the student uses the apparatus to do the titration.

Include the name of a suitable indicator and state the colour change that would be seen.

[5]

(b). The student repeats the titration four times.

They work out the average volume of sodium hydroxide from their concordant results.

i. What is meant by **concordant** results?

[1]

ii. In the titration the student:

- uses 25 cm^3 of 0.12 mol / dm^3 dilute hydrochloric acid in the conical flask
- adds 0.4 mol / dm^3 sodium hydroxide solution from the burette.

The equation for the reaction is shown.

$HCl + NaOH \rightarrow NaCl + H_2O$

Calculate the average volume of sodium hydroxide used **in cm^3.**

Average volume of sodium hydroxide = ... cm^3 **[4]**

2. Copper is extracted by heating copper oxide with carbon.

$2CuO + C \rightarrow 2Cu + CO_2$

i. Explain why this is an example of a **redox** reaction.

[2]

ii. Calculate the mass of copper that can be made from 15 tonnes of copper oxide.

$2CuO + C \rightarrow 2Cu + CO_2$

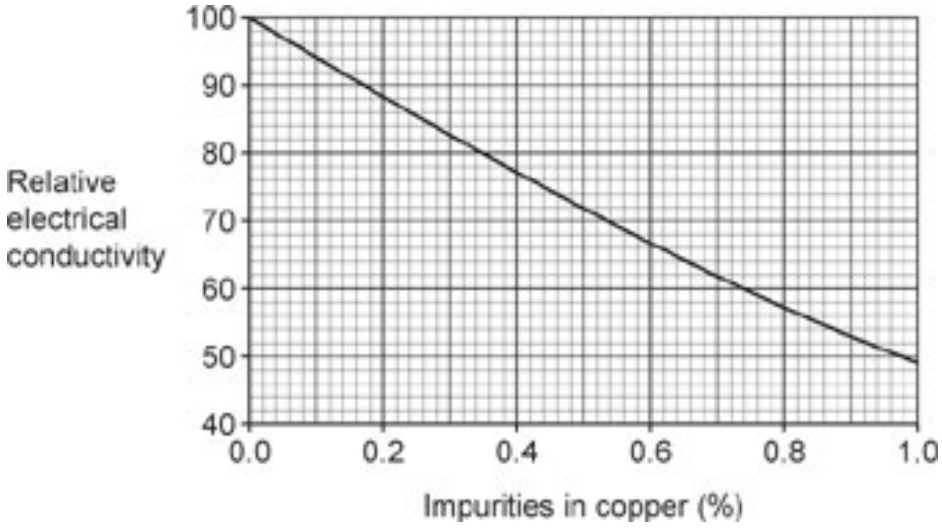
Give your answer to **2** significant figures.

Relative atomic mass (A_r): Cu = 63.5
Relative molecular mass (M_r): CuO = 79.5

Mass of copper = ...tonnes **[3]**

iii. Copper is used in electrical wires.

The graph shows how impurities in copper affect the relative electrical conductivity of copper.



Copper extracted from copper oxide is about 99% pure.

Explain why copper extracted from copper oxide is purified to almost 100% pure using electrolysis.

Use data from the graph in your answer.

[2]

3. How is the mass of a solute, in g, related to the concentration of the solution, in g / dm^3, and the volume of the solution, in dm^3?

A mass = concentration × volume

B $\text{mass} = \frac{\text{concentration} \times \text{volume}}{1000}$

C $\text{mass} = \frac{\text{concentration}}{\text{volume}}$

D $\text{mass} = \frac{\text{volume}}{\text{concentration}}$

Your answer ☐ **[1]**

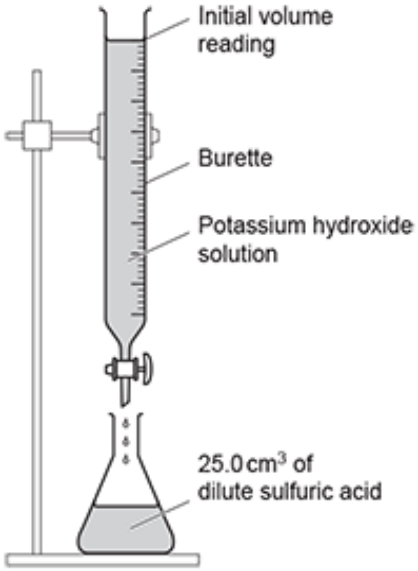
4. What is the volume of 0.6 moles of nitrogen gas, N_2, at room temperature and pressure?

A 14.4 dm^3
B 16.8 dm^3
C 40.0 dm^3
D 46.7 dm^3

Your answer ☐ **[1]**

5(a). A student plans a titration experiment.

The diagram shows some of the apparatus they use.



At the end of the titration, the student reads the final volume reading from the top of the meniscus instead of from the bottom of the meniscus.

How does the measured volume of potassium hydroxide compare to the actual volume?

Tick (✓) **one** box.

The measured volume will be greater than the actual volume. ☐
The measured volume will be smaller than the actual volume. ☐
The measured volume will be the same as the actual volume. ☐

[1]

(b). The student uses a potassium hydroxide solution with a concentration of 0.100 mol / dm^3 to neutralise the 25.0 cm^3 of dilute sulfuric acid.

The table shows the student's results.

Titration number	**1**	**2**	**3**	**4**
Final burette reading (cm^3)	24.1	26.6	26.0	26.8
Initial burette reading (cm^3)	0.0	1.5	2.1	2.8
Titre (volume of potassium hydroxide solution used) (cm^3)	24.1	25.1	23.9	24.0

i. Calculate the average titre using the student's concordant results.

Average titre = ... cm^3 **[1]**

ii. This is the equation for the reaction in this experiment.

$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

Calculate the concentration of sulfuric acid in **g / dm^3** .

Relative atomic mass (A_r): H = 1.0 O = 16.0 S = 32.0

Concentration of sulfuric acid = ... g / dm^3 **[5]**

6. A factory makes some methanol.

They predict they will make 60 tonnes of methanol. The reaction has a percentage yield of 78%.

Calculate the mass of methanol they actually make.

Mass of methanol = ... tonnes **[3]**

7. 0.1 g of magnesium reacts with hydrochloric acid to make 0.008 g of hydrogen gas.

Calculate the volume occupied by 0.008 g of hydrogen gas in **cm^3** .

Relative atomic mass (A_r): H = 1.0

Volume of hydrogen gas = ... cm^3 **[4]**

END OF QUESTION PAPER