CAIE IGCSE Chemistry

12.1 Experimental design

Notes

Name appropriate apparatus for the measurement of time, temperature, mass and volume

Measuring time

Stopwatches- The time taken for a reaction to occur can be measured or controlled by a stopwatch. The user can set a certain fixed time in experiments where time intervals are a controlled variable, e.g. 30s. This apparatus is more accurate than use of a analogue clock as most have a more precise measurement, e.g. to the nearest millisecond

Measuring temperature

Thermometer- Temperature can be measured using a thermometer, liquid-in-glass thermometers are commonly used in school laboratories due to their ease of use and low expense. They usually have an uncertainty of ±0.5°C.

Measuring mass

Measuring balance- The mass of an object or a substance can be measured using a digital balance, commonly giving readings to 2 decimal places. Before every use, the balance should be tared (set to zero) and once the object is placed on the centre of the balance, it should be given time for the reading to settle on a stable measurement before it is recorded

Measuring volume of liquids

Burettes- The volume of a liquid is measured using a burette, commonly used in titrations. 0.00cm^3 is at the top of the burette column so when a measurement is taken, the scale is read from top to bottom.

Volumetric pipettes- A specific, fixed volume of a liquid can be measured using a volumetric pipette. A pipette filler is used to draw the liquid into the volumetric pipette. Commonly used in titrations, 10cm^3 and 25cm^3 can be measured and delivered using the volumetric pipette that has this volume marked.

Measuring cylinder- An approximate volume of a liquid can be measured using a measuring cylinder. They are less accurate than volumetric pipettes, but measuring cylinders come in a range of sizes (from 10cm^3 to 1L) and are simpler and quicker to use.

Measuring volume of gases

Gas syringe- Gas syringes can be used to collect gas produced from a chemical reaction, measuring volumes of gas or for delivering a gas to a closed system.

Suggest advantages and disadvantages of experimental methods and apparatus

Advantages and disadvantages of apparatus

Apparatus	Advantages	Disadvantages
Stopwatch	Can measure time intervals to a high level of precision as some can measure to a hundredth of a second	Accuracy of stopwatch reading depends on the reaction time of the user so human error is introduced
Thermometer	Ease of use and cheap to acquire	Liquid-in-glass thermometers (commonly used in school labs) have limited temperature ranges, lower precision compared to digital temperature probes and parallax error can occur
Measuring Balance	Speed of readings to a high level of accuracy, e.g. to micrograms	Sensitive to environmental factors such as air currents and fluctuations in temperature in the lab
Burette	Wide range of burettes so can measure accurate volumes and a range	Meniscus reading errors can occur if user does not view the measurement at eye level
Volumetric pipettes	Can accurately measure a specified volume consistently	Limited to measuring only one fixed volume, e.g. 25cm^3 volumetric pipettes
Gas syringe	Can measure volumes of gas to a high level of accuracy	Gases in the closed system can become sensitive to environmental factors such as temperature or pressure changes

Experimental methods

To comment on the advantages and disadvantages of an experimental method, you must access and comment on the following questions:

- The advantages and disadvantages of the apparatus used, e.g. '*a measuring cylinder has a less accuracy than a volumetric pipette*'
- How many repeats have been done? Were the answers similar or different? The closer the repeat readings are, the more precise the result.
- Were there any controlled variables to ensure that the independent variable is the only factor causing a change? For example, if temperature is the independent variable, examples of controlled variables can include volumes and concentrations of any solution, pressure or pH of a solution.