Technocrat Notes Practical Skills/ How Science Works

How to plan an experiment?

1) Work out the aim of the experiment- what are you trying to find out?
2) Identify the independent, dependent and control variables
3) Decide what data to collect
4) Select appropriate equipment which will give you accurate results
5) Make a risk assessment and plan any safety precautions
6) Write a detailed method
7) Carry out tests and gather evidence to address the aim of the experiment

Variable

A variable is a quantity that has the potential to change, e.g. mass.

Independent Variable

The thing you change in the experiment

Dependent Variable

The thing you measure in the experiment

Continuous Data

Can have any value on a scale and always have a higher resolution. Opposite to Discrete.

Categoric Data

Values that can be sorted into categories.

Discrete Data

Data gathered via counting (e.g. number of bubbles released)

How to chose appropriate equipment (3)

1) Must be appropriate for task. For example, be able to measure a volume of gas without letting any escape.
2) Must be the right size. It must be able to collect all the gas produced in the experiment.
3) Must be the right level of sensitivity.

A method must include: (5)

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1) All substancs and quantities to b used.
2) How to control variables
3) The exact apparatus needed. A diagram can be used to show how to set the apparatus up.
4) Any safety precautions which need to be taken.
5) What data to collect and how to collect it

Define Repeatable

If the same person does the experiment again with the same equipment and methods, they will get the same/similar results

Define Reproducible

If someone else does the experiment again, or uses a different method or piece of equipment, the results will be the same/similar.

How do you weigh solids

Weight solids using a balance.
Make sure that:
- The container will not affect the weight measured. This can be achieved by setting the balance to zero with the container on it.
-Make sure all the solid is transferred between containers and try to minimize the times you have to transfer. This can be achieved by washing the remaining solid from old container into the new using the solvent if making up a standard solution, or reweighing the new container.

How to measure the volume of a liquid
(3 possible methods: Pipette, Burette and Volumetric Flask)

There are different possible methods for measuring liquids, but always make sure you measure from the bottom of the meniscus.
3 possible methods:
Pipettes are long, narrow tubes which are used to suck up an accurate volume of liquid and transfer to another container. Often calibrated for the fact the last drop of liquid remains in the pipette to reduce transfer errors. Best for small amounts. Only measure one amount (e.g. 10dm3)
Burettes measure from top to bottom. They have a tap which you can use to release liquid into another container. To use, you take an initial reading and a final reading. The difference is the amount of liquid used.
Volumetric flasks allow you to accurately measure a very specific amount of liquid. They come in various sizes and there is a line in the neck that marks out the volume they measure. They are used for accurate dilutions and standard solutions. To use, first measure out liquid/solid that's being diluted or dissolved. Rinse out the measuring vessel into the volumetric cylinder with a little solvent to make sure everything's transferred. Then fill the flask with solvent from the bottom to the neck. Then fill drop by drop till the bottom of the meniscus is level with the line.

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How to measure a gas

Measure with a gas syringe at room temperature and pressure. Make sure the syringe is sealed and the plunger moves smoothly.

How to measure temperature

Use a thermometer or a temperature probe.
Make sure the bulb is completely submerged in any mixture you're measuring.
Wait for the temperature to stabilize before the initial reading.
Read the temperature at eyelevel with the scale.

How to reduce the subjectivity of qualitative results (in regards to colour change and precipitation reaction)

If looking for colour change, put a white background behind your reaction container.
If looking for precipitate, mark an X on a piece of paper and place it under the reaction container.
Your solution is cloudy when you can no longer see the X.

Reflux reactions

Heating a reaction mixture in a flask fitted in a condenser so that any materials evaporate, condense at drip back into the mixture.

Distillation

Gently heating a mixture so that the compounds evaporate off in order of increasing boiling point and can be collected separately. This can be done during a reaction to collect a product as it forms or after it has finished to purify the mixture.

Removing water soluble impurities

Add water to an organic mixture in a separating funnel. Any water soluble impurities move out of the organic layer and dissolve into the aqueous layer. The layers have different densities so easy to separate.

Use line graphs when...

2 sets of continuous data

Use scatter plots when...

Showing how 2 sets of data are related

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Use a bar chart when...

One set of data is categoric

m^3 in dm^3

x 1000

dm^3 in cm^3

x 1000

Percentage error

(Uncertainty ÷ Reading) x 100

Systematic Error

The same every time you repeat the experiment. They may be because of the set up or equipment you used.

Random Error

They vary. These errors can occur from making a mistake when reading a measurement.

Valid result

Answer the original question. If the experiment had not controlled all the variables, the results would not be valid as you would not be testing the thing you wanted.

Accurate results

Those that are really close to the true answer

Precise results

Can be consistently reproduced in independent experiments. If they are reproducible they are more likely to be true. If the data is not precise, you cannot draw a valid conclusion. For experiments, the more repeats you do, the closer together the data you get, the more precise it it. Sometimes called reliable results, it is both repeatable and reproducible.

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What can repeating an experiment remove?

Random error but NOT systematic error. Results that are 'off' due to random error will be removed/minimised by finding the mean (low removing high), making results more precise. It wont remove systematic error so will not be more accurate.

Evaluation of experiments:

• Did data collected answer question?
•Were all variables controlled?
•Was the apparatus used on an appropriate scale?
•Could more sensitive equipment be used to reduce random errors and uncertainty?
•Was the experiment repeated, and were the results similar?