CHEMISTRY AS 90930

Carry out a practical chemistry investigation, with direction

The notes below refer to an Investigation into Rates of Reaction

- Read the instructions carefully! Don't heat the acid to different temperatures when the task asks you to investigate surface area! Don't dilute the solution when the task asks you to investigate different catalysts! Read the instructions carefully!
- Prepare your method step by step taking into account all of the variables – Independent (the one you change); dependent (the one that is affected by what you change, it is the thing measured and recorded i.e. the data you collect) ; controlled variables – the ones kept the same "to make it fair".
- Plan to do repeat trials – see later.
- Think about a results table. And the Units!!

Justifying choices made for accuracy

Examples

Use a 50 mL (e.g.) **measuring cylinder** to measure the volume (and not the markings on a beaker). And don't use a 100 mL cylinder to measure 10 mL – find something smaller – as this will be more accurate.

Use a **stop watch** to record the times (and not a clock on the wall) – as this way you can record the exact number of seconds.

If you use the same measuring cylinder for the same solution it does not need to be washed and dried. (But if you don't, washing might leave water in it which would dilute the subsequent solutions slightly so make sure you drain it well).

Using the same sized glassware will mean any solution left in the measuring cylinder could be assumed to be reasonably constant.

Have the same person judging the end point e.g. when the last little piece of Mg reacts and can't be seen any more. We all have different perception of the "end" – and slightly different eye sight - and need the results to be consistent.

Make sure your end point is clear – state it…… Time until…..

- no magnesium ribbon can be seen any more
- no more fizzing from the antacid tablet etc
- the school crest logo can no longer be seen under a flask
- 100 mL of gas has been collected in an upturned water filled measuring cylinder
- the solution turned from colourless to blue
- etc

Justifying choices made for reliability

Examples

Repeat and average to make the results more reliable; ideally three results at each dilution. This way any obvious outlier results can be seen and the experiment(s) repeated.

Range of **4** or more dilutions (to establish a trend).

<u>A range of temperatures</u> – will be limited by safety – e.g. not above 60^{o}C maybe for thiosulfate, and lower for acid. Your teacher will stop you if you have chosen something dangerous. But it is pointless to do 55, 50, 45 and 40^o C. You can also cool using an iced water bath. Try and spread the range (but not 0^{o}C for obvious reasons). During the experiment it may be necessary to rethink the range if a reaction is too fast to measure accurately or too slow, or doesn't finish (e.g. Mg and acid). But if the reaction is too slow, rethink the range.

<u>A range of concentrations</u> – guide line is probably half the possible range or over, e.g. 100 – 40 %. You might choose a wider range e.g. 100, 80, 60, 40, 20%. But if 20% is too slow, consider adding in a 70%, 50% or 30%. It doesn't matter if you end up plotting a graph with 100, 80, 70, 60, 40 % as long as axes are correct (evenly spaced numbers) – and you have explained why you made these choices. You don't really even need a graph if you can see a clear trend from an <u>ordered</u> table.

<u>Processing Data</u>

Don't forget you can't average minutes and seconds unless you first convert all times to seconds. 2 minutes 13 seconds = (2 x 60) + 13 = 133 s. Remember the unit for seconds is written as s not sec, or secs!!

<u>Validity and reliability</u>

The relationship between reliability and validity can be confusing because measurements can be reliable without being valid. However, they cannot be valid unless they are reliable.

Validity has no single agreed definition but can refer to the extent to which a conclusion or measurement is well-founded. Data will be valid if your procedure /experiment actually tests what you want it to. It will be valid if you have identified and controlled appropriate the variables. It will be valid if the data collected measures what was intended.

Reliable. Have you tested with repetition? Reliability is the degree that repetition will yield the same/similar results. Your experimental results might be considered reliable if your trial and repeats were all "quite close" or if you identified any really obvious outlier results and discarded them and repeated those experiments. If your averaged results follow a numerical trend or show a relationship when plotted you can probably say they appear to be reliable and valid.

<u>Conclusion</u>

- Must match the processed data. Sometimes the "trend" is not what you expected – but describe it anyway! You can't ignore data because it isn't what you expected. But you can identify that it wasn't what you expected, and perhaps suggest why!
- Must relate to the **aim** of the investigation; look back at the task sheet – use it to write the conclusion
- Must refer to the **rate** of reaction

  "As the temperature increases, **the rate of reaction** increases / reaction rate increases".

  "As the concentration decreases, **the rate of reaction** decreases" (or vice versa).

  "As the surface area increased, **the rate of reaction** increased"
- Must be justified. Justify the conclusion by using results e.g. … because the 20^{o}C solution took 500s whereas the 100^{o}C solution took 34 s" …. etc

Collision Theory for rates of reaction

You must be able to explain the effect of changing temperature, surface area or concentration on terms of **collisions between particles**, i.e. simple collision theory.

The collisions between reactants A and B are *per unit time*, not just "more collisions" or "less collisions". They are not quicker or slower collisions (particles don't have more or less average kinetic energy unless the temperature changes). They are not more or less energetic (unless the temperature changes). It is all about more frequent collisions or less frequent collisions – Or more or less collisions per second, for example.

Decreased concentration of one of the reactants means….
- there are **less particles per unit volume** (particles/mL) in one solution
- less particles/volume means **less collisions per second** (less frequent collisions)
- the fewer collisions per second, the less reactions take place
- the less reactions, the lower the rate and the more time the overall reaction takes to occur.

For surface area it is all about the amount of particles **immediately exposed** for collisions. Small marble chips have many more calcium carbonate particles immediately exposed for acid particles to collide with, than (the same mass of) large marble chips. This means **more collisions/second** or more frequent collisions and therefore a faster rate of reaction.

For a higher temperature **particles are moving faster** and have a greater average E_K. Not only are the collisions more frequent (**more collisions/time**) but the **collisions have more energy** (NOT more force orare more forceful!!!) so more of them are effective collisions, leading to a reaction, i.e. **more effective collisions/time**.