How to plan an experiment

First, make sure you know what you're trying to find out. In this case, it is…

To measure the effect of temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid

There is absolutely no point in stating this again as the "aim" or "introduction". It merely wastes time, paper, ink and effort. What you **should** do first, however – before launching into a detailed description of how or why – is OUTLINE the procedure to be used so that the reader has some idea what is going on. You could include the diagram (which, if complete will get you **P4b**) at this stage. Something like this:

Outline

A sample of gas will be collected in a measuring cylinder over water. The carbon dioxide produced by reaction with sodium thiosulphate solution will displace water and the rate of production used as a measure of the rate of reaction. The reaction will be repeated in a water bath at various temperatures. The experiment will be repeated a minimum of three times.

Then consider the variables involved in the experiment. Remember,

- the **INDEPENDENT** variable is what you deliberately change (you must specify **how**),
- the **DEPENDENT** variable is what changes as a result (specify how it will be measured)
- and everything else must be **CONTROLLED**, i.e. kept constant. Here, you must choose the most important variables to keep constant, say **why** they must be kept constant and **how** this will be done.

Variables

Independent variable: This will be varied by carrying out the experiment in a water bath at several different temperatures of 20, 25, 30, 35, 40, 45 & 50°C.

Giving a suitable number and range of temperatures here also gets you **P6b**

Dependent variable: This will be measured by counting the number of bubbles emerging from the end of the delivery tube in one minute.

Controlled variable 1: concentration of sodium thiosulphate solution: With more dilute acid available, the gas will be produced more slowly. Therefore the same concentration of sodium thiosulphate solution – 2 cm³ of dilute solution in 20cm³ water – will be used for all runs of the experiment.

Controlled variable 2: mass of calcium carbonate: There are more gas particles in the mix here, more carbon dioxide will be produced and the rate of reaction will seem to be higher. Therefore the same concentration of gas generation – 2 g of fine powder in 20cm³ water – will be used for all runs of the experiment.

Controlled variable: nozzle. A smaller nozzle will produce more bubbles for a given volume of gas and therefore appear to make the rate of reaction greater. The same nozzle will therefore be used for every run of the experiment.

This lot will score **P6a(ii)**.

Then, describe the steps necessary to carry out the experiment. Since this is a plan, it is acceptable here to give instructions or even to say, "I will…". Numbered steps are fine – in fact preferable since it helps you to think clearly and me to follow what you're on about. Include safety precautions (needed for **P2**)in the appropriate place, not in a separate section.

Method

1. *Measure out 7.0 g of sucrose and dissolve this in 40cm³ of water in a 250cm³ beaker. (This stock solution will be used for all seven runs)*
2. *Add 2.0 g of yeast to the first tube, assemble the apparatus as in the diagram and stand in a water bath at room temperature (about 20°C). Leave the remaining tubes to come to the same temperature as the water and for the yeast to activate and start respiring.*
3. *Check that the yeast suspension has reached the correct temperature.*
4. *Connect the number of bubbles emerging from the nozzle in one minute and record this result in the results table.*

Note the precision to which the masses are given.

The next two steps are what you should do ideally – in practice you won't have time and you haven't made up enough solution.

5. *Repeat the measurement for a second minute and improve reliability.*
6. *If necessary, repeat again.*
7. *Wash out the tube with water, the yeast suspension with sucrose solution and repeat the whole experiment for the next higher temperature.*
8. *Continue in this way until the experiment has been carried out for all temperatures as above.*

In practice, you won't have time to do seven runs in succession, leaving each for 10 minutes to start bubbling. Instead, you can set up two or three at intervals of three minutes in separate water baths.

9. *Calculate the mean rate of respiration at each temperature and also the rate of respiration.*

Stating this lot gets you **P2** and **P4a(i)**. Explaining why each step is carried out thus gets **P6a(i)**.

Now it's quite clear what's going on, you can make your prediction of the results (**P4a(ii)**) and explain the scientific reasoning behind it. (**P6a(ii)**) "It says so in the book" or "It seems likely" are NOT scientific reasoning !