Experiment Planning

Dear ‘beloved’ students,

This is a cheatsheet for the experiment planning question in paper 5. An annoying fact is that the mark scheme is always slightly different in different years, so it is not practical for me to give you a standardised scheme of answer. But, I can still provide some help. The planning questions from paper 5(3) in 2017/2021 (I will call them q17 and q21)are used as examples.

Experiment planning questions always worth 7 marks. Usually you will be asked to investigate the effect of variable A on variable B. Variable A is the independent variable whose value can be **decided** by us, and then we need to **measure** the corresponding variable B, which is the dependent variable. (in different questions, it might be phrased like “the effect of A on B”, “how change of A will influence B”, “ how B is influenced by A”, in all these cases, A is independent, B is dependent).

In q17 (you can find it at the end), the independent variable is ‘number of layers’ , the dependent variable is ‘rate of cooling’.

Sometimes however, for example in the 2021 question, the independent variable is NOT given hence you MUST decide it by yourself. If that’s the case, one mark would be awarded by doing so. In q21, possible independent variables could be: length/thickness/width of the wooden strip, mass of the load.

You need to write a plan for your experiment, you can find a list of things that **MUST** be included in the question like this:

In your plan, you should:

- list any additional apparatus needed
- state the key variables to be kept constant
- explain briefly how to carry out the experiment, including how *D* is to be measured and any precautions that must be taken to ensure reliable results
- draw a table, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

The list varies in different years so make sure you read it carefully. However, you can only get 5 or 6 marks out of seven by doing so, another one mark or two would be awarded as additional points, this is the tricky part which is hard to standardise.

For you to get full mark here is MJ's experiment planning guideline:

- **Variables:** identify the independent variable, dependent variable and key control variables(at least 2 control variables).
- **Apparatus:** list any extra apparatus you need in your experiment.
- **Method:** for the first independent variable value, explain how you want to carry out the experiment with the apparatus provided and how you would do measurement. If calculation is needed, make sure you write out the equation you use.
- **Repeat 1:** repeat to get the average.
- **Repeat 2:** repeat with different independent variable values (usually at least 5 sets of data).
- **Table:** draw a table with column headings to record all the measurement and calculation results.
- **Analysis:** compare readings in the table/ plot a graph with axes labeled with units/ so that you can find the trend/effect.
- **Repeat 3:** repeat the entire experiment with different control variable values to see if the result is consistent.
- **Precautions:** how to make the experiment safe and accurate.

You can find two sample answers(in orange colour) at the end, study it and make sure you remember the steps.

PS. You will need this for your EOY exam and also for your final IGCSE Physics exam, it is not likely that I will be your G2 teacher, so make sure you can still find this file at the end of your G2 year.

Best
Mike Jiang

53/MJ/17 **(sample answer in orange)**

4 Plan an experiment to investigate how increasing the number of layers of insulation affects the rate of cooling of hot water in a beaker.

You are **not** required to carry out the experiment.

Write a plan for the experiment, including:

- the apparatus needed
- what you would measure
- the variables you would keep the same to ensure the comparison is a fair test
- instructions for carrying out the experiment
- how you would present your results
- how you would use your readings to reach a conclusion.

You may draw a diagram if it helps to explain your plan.

- **Variables:** identify the independent variable, dependent variable and key control variables(at least 2 control variables).

In this experiment, the independent variable is the number of layers of insulation, the dependent variable is the cooling rate of water. Initial temperature of water, volume of water, thickness of each layer of insulation should be kept constant as control variables.

- **Apparatus:** list any extra apparatus you need in your experiment.

I will need a beaker, a measuring cylinder, a thermometer and a stopwatch.

- **Method:** for the first independent variable value, explain how you want to carry out the experiment with the apparatus provided and how you would do measurement. If calculation is needed, make sure you write out the equation you use.

1. Use one layer of insulation on the beaker, pour 100ml of hot water into the beaker.
2. Put the thermometer into the water.
3. Wait until the temperature drops to $65^{\circ}C$, start the stopwatch.
4. Record the final temperature t_f after 5 minutes.

- **Repeat 1:** repeat to get the average.

5. Repeat the steps above and do the measurement once more to get the average final temperature t_{fa}.

- **Repeat 2:** repeat with different independent variable values (usually at least 5 sets of data).

Repeat step 1-5 with 2, 3, 4, 5 layers of insulation.

- **Table:** draw a table with column headings to record all the measurement and calculation results.

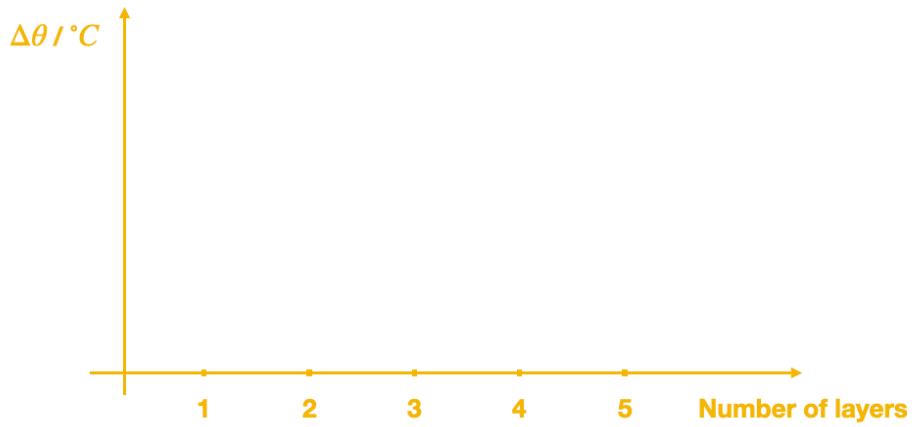
Calculate the temperature difference $\Delta\theta$ using $\Delta\theta = 65^{\circ}C - t_{fa}$, and fill in the table below.

Layers of insulation	First t_f / $^{\circ}C$	Second t_f / $^{\circ}C$	t_{fa} / $^{\circ}C$	$\Delta\theta$ / $^{\circ}C$
1				
2				
3				
4				
5				

- **Analysis:** compare readings in the table/ plot a graph with axes labeled with units/ so that you can find the trend/effect.

Compare readings in the table, check if $\Delta\theta$ is different with different number of layers, larger $\Delta\theta$ means larger cooling rate.

Can also plot a graph to see the effect of the number of layers:



- **Repeat 3:** repeat the entire experiment with different control variable values to see if the result is consistent.

Repeat the entire experiment with 150ml of hot water and check if the result is consistent.

- **Precautions:** how to make the experiment safe and accurate.

When making measurement, make sure eyesight is perpendicular to the thermometer to prevent parallax errors. And stir the water constantly so that temperature is evenly spread in the water.

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Question	Answer	Marks
4 MP1	**apparatus** beaker with insulation and thermometer and stopclock (or alternative) mentioned	1
MP2	**method** pour hot water into container measure temperature of hot water over period of time	1
MP3	repeat for additional layers	1
MP4	**results:** suitable table/graph/cooling curve	1
MP5	**control variables** any pair from: same initial temperature, same volume of water, same size/material/thickness of beaker, same thickness of each layer,	1
MP6 MP7	**additional points** any 2 from: how cooling rate calculated/how to compare cooling curves, read thermometer perpendicularly, thermometer at same depth (for repeat) thermometer not touching beaker, stir before reading thermometer, use of lid, minimum of 5 different thicknesses of insulation, repeat experiment with different sized beakers/different amount of water, sensible amount of water (50 cm^3 to 500 cm^3)	2
	Total:	7

53/MJ/21 **(sample answer in orange)**

4 A student investigates the factors affecting the deflection of a wooden strip clamped at one end.

Plan an experiment which enables him to investigate how **one** factor affects the distance *D* that the free end of the wooden strip moves downwards when loads are placed on it.

You are **not** required to carry out the experiment.

The apparatus available includes:

a variety of wooden strips that can be clamped as shown in Fig. 4.1
a set of masses with a hanger.

In your plan, you should:

- list any additional apparatus needed
- state the key variables to be kept constant
- explain briefly how to carry out the experiment, including how *D* is to be measured and any precautions that must be taken to ensure reliable results
- draw a table, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

You may add to Fig. 4.1 or draw another diagram if it helps to explain your plan.

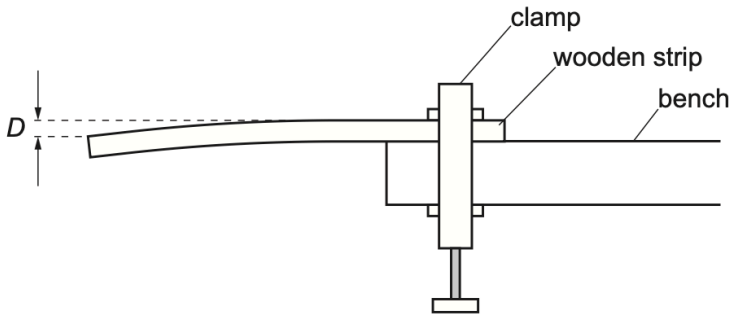


Fig. 4.1

- **Variables:** identify the independent variable, dependent variable and key control variables(at least 2 control variables).

The independent variable in this question could be the mass of the load. The dependent variable is the downward displacement D. Position of the load, thickness of the strip, length of the strip etc. should be kept constant as control variables.

- **Apparatus:** list any extra apparatus you need in your experiment.

I will need a meter rule to measure D.

- **Method:** for the first independent variable value, explain how you want to carry out the experiment with the apparatus provided and how you would do measurement. If calculation is needed, make sure you write out the equation you use.

1. Measure the original height of the left end of the strip L_o.
2. Hang a load of 100g on the strip
3. Wait until the strip comes to rest, measure the new height L of the left end.
4. The displacement D can then be calculated as $D = L_o - L$

- **Repeat 1:** repeat to get the average.

5. Repeat the steps above and do the measurement once more to get the average D value.

- **Repeat 2:** repeat with different independent variable values (usually at least 5 sets of data).

Repeat step 2 to 5 with loads of 200g, 300g, 400g and 500g.

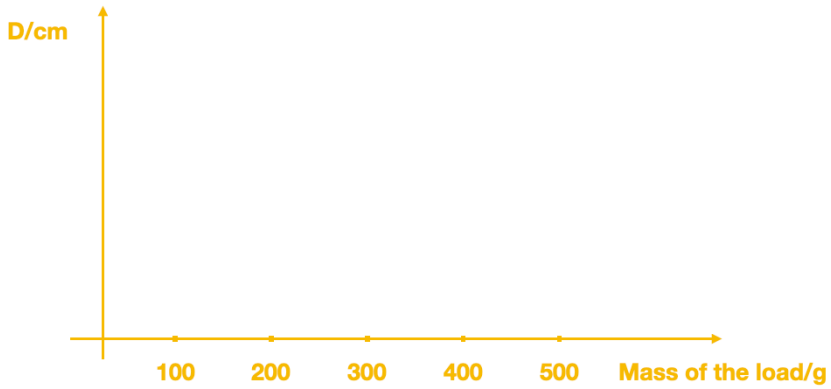
- **Table:** draw a table with column headings to record all the measurement and calculation results.

Fill in the table below:

Mass of the load / g	D / cm
100	
200	
300	
400	
500	

- **Analysis:** compare readings in the table/ plot a graph with axes labeled with units/ so that you can find the trend/effect.

Compare readings in the table, check if different mass results in different D value. Plot a graph and draw the line of best fit to see the trend.



- **Repeat 3:** repeat the entire experiment with different control variable values to see if the result is consistent.

Repeat the entire experiment with a strip with different thickness and check if the result is consistent.

- **Precautions:** how to make the experiment safe and accurate.

Make sure eyesight is perpendicular to the metre rule when making measurement. Make sure the strip will come back to its original position when loads are removed.

Question	Answer	Marks
4	MP1 **apparatus:** rule or equivalent	**1**
	MP2 **method:** identify independent variable detail of deflection measurement and how its measured	**1**
	MP3 repeat for new independent variable	**1**
	MP4 **control variable:** any variable appropriate to independent variable e.g. width of strip if thickness is the factor	**1**
	MP5 **table:** columns, with units, for independent variable, deflection	**1**
	MP6 **analysis:** compare readings in the table to see if change in factor produce change in deflection plot line graph (with axes specified)	**1**
	MP7 **additional point** (one from)**:** at least 5 sets of data taken repeat each measurement and take average 2nd appropriate control variable stated repeat experiment for different variation (e.g. different mass if thickness is factor) use of fiducial aid	**1**