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Examiners' Report
June 2011

GCE Physics 6PH08 01

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Introduction

This paper is written as the alternative to the internal assessment of practical work and to gain a good mark it is essential that candidates carry out a reasonable programme of practical work during their A level course. They need to carry out simple practicals to gain experience in taking basic measurements, this should include timing the period of oscillation of a system such as a mass on a spring or finding the density of an object such as for question 1. Only by actually doing the practical work will candidates be able to obtain the experience to answer the questions fully and gain high marks. They must also develop their ability to handle uncertainties and to plot graphs and again this is best done by practice. Many of the questions on the papers will use as examples ordinary laboratory work and we find that those candidates who score better are those who have done some practical work for themselves.

The coursework is a very good guide to what is required of candidates at this level and the

publication called 'Guidance for the A2 practical assessment' available from the Edexcel website at http://www.edexcel.com/quals/gce/gce08/physics/Pages/default.aspx under the Teacher Support Materials link and then Tutor support materials link should prove most helpful.
There will always be marks for planning exercises and for data handling as well as the uncertainty treatment detailed above. The paper this June comprised of questions that are typical of the sort of standard and task that will usually be asked. Generally at this level an answer must be precise, answers that are not precise will seldom have sufficient detail for the award of full marks. The detail required might be in the form of a well labelled diagram or the exact procedure for a practical method and this precise detail can be found in the Mark Scheme.

Question 1 (a)

Many candidates chose the appropriate instruments but did not justify their choice in terms of the task set by the question. Answers were often given in terms of precision but not in the context of the measurement being made in the question – it is important to quote values. The key aspect is to get both measurements to 3 significant figures, hence the need for 0.1 mm and then 0.01 mm, when candidates quote these figures without reason the mark is not awarded.

Here the candidates selects the most appropriate instruments correctly.

1 A student wishes to find the density of a metre rule.

The width of the rule is about 28 mm and the thickness is about 6 mm.

(a) In the table below write the names of the instruments you would use to make each of these measurements.

Measurement	Instrument
Width	venier caliper
Thickness	micrometer

Give a reason for your choices.

(2)

a vernier caliper has a precision of about 0.1 mm, ~~while~~ and the micrometer has a precision of 0.01 mm.

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Examiner Comments

The precision of the instruments is quoted correctly but no reason is given why this is the most appropriate for these measurements.

Give a reason for your choices.

(2)

Because vernier calliper have ~~accuracy~~ ~~uncertainty~~ accuracy of 0.01cm while micrometer screw guage have ~~uncertain~~ uncer accuracy of 0.01mm which is suitable to measure width of 28mm and 6mm respectively.

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Examiner Comments

This candidate mistakes accuracy for precision. It is the precision of the instrument that is being quoted, the accuracy will depend on how the instrument is used.

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Examiner Tip

Precision, accuracy and uncertainty are all different ideas. The uncertainty comes from the spread of repeated readings. Accuracy is how well the instrument has been used and precison is the smallest measuring division. Sometimes the values are the same but the ideas are different.

Give a reason for your choices.

(2)

Vernier calliper can measure up to 0.1 mm while micrometer screw gauge can measure up to 0.01 mm.

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Examiner Comments

This answer explains why the instruments give 3 significant figures for both measurements. This candidate is very close but again, does not refer to the measurement being made.

Question 1 (b) (c)

Many candidates got the right answer in part (b) and many more were close. The number of significant figures in the answer should mirror the number quoted for the data in the question – here 3 or4 SF. There were also common mistakes in the powers of ten when converting units and sometimes the length was overlooked when calculating the volume.

The %U in part (c) must come from the range of readings when these are repeated. The whole range or half the range are both acceptable ways of getting an estimate of the uncertainty. The precision of the instrument is only the same as the uncertainty when there is no repeat reading.

Adding the %U was done correctly by nearly all candidates.

An example of a good answer.

(b) The student records measurements from several positions along the rule.

Width/mm	28.2, 29.3, 28.9, 29.0, 29.1
Thickness/mm	6.04, 5.94, 5.97, 6.01, 5.99
Mass/g	106.4

Use these measurements to calculate a value for the density of the rule.

(3)

av. width $= \frac{29.3 + 28.9 + 29.0 + 29.1}{4} = \frac{116.3}{4} \doteq 29.1$ mm

thickness $= \frac{6.04 + 5.94 + 5.97 + 6.01 + 5.99}{5} = 5.99$ mm.

density $= \frac{106.4 \times 10^{-3}}{29.1 \times 10^{-3} \times 5.99 \times 10^{-3} \times 1} = 610.4$ kgm^{-3}

Density = 610.4 kgm^{-3}

(c) Estimate the percentage uncertainty in your value for the density. Assume the uncertainty in the mass is negligible.

(3)

% uncertainity for width $= \frac{(29.3 - 28.2)}{29.1} \times 100 = 3.78\,\%$

% uncertainity for thickness $= \frac{(6.04 - 5.94)}{5.99} \times 100 = 1.67\,\%$

% uncertainity for length $= \frac{1}{1000} \times 100 = 0.10\,\%$

% uncertainity for density $= 5.55\,\%$

Percentage uncertainty for the density = 5.55 %

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Examiner Comments

Here the candidate rejects the 28.2 mm reading as an anomaly and uses the remaining four values to find the mean correct to 4 SF (significant figures). The 28.2 mm value is used in estimating the uncertainties which are done well.

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Examiner Tip

Consider the SF, the answer should have as many as the data.

Here a good candidate makes an addition error.

(b) The student records measurements from several positions along the rule.

Width/mm	28.2, 29.3, 28.9, 29.0, 29.1
Thickness/mm	6.04, 5.94, 5.97, 6.01, 5.99
Mass/g	106.4

Use these measurements to calculate a value for the density of the rule.

(3)

Density = $\frac{\text{mass}}{\text{Volume}} = \frac{106.4}{28.9 \times 5.99 \times 1000}$

$= \frac{106.4}{173111}$

$= 6.146 \times 10^{-4}$ g mm^{-3}

Density = 6.15×10^{-4} gmm^{-3}

(c) Estimate the percentage uncertainty in your value for the density. Assume the uncertainty in the mass is negligible.

(3)

uncertainty in width = 28.9 ± 0.7 mm

% uncertainty = $\frac{0.7}{28.9} \times 100 = 2.42\%$

uncertainty in Thickness = 5.99 ± 0.05

% uncertainty = $\frac{0.05}{5.99} \times 100 = 0.835\%$

I am going to assume uncertainty in length is negligible as I would hope that metre rulers are actully 1m or 1000mm in length.

∴ Total uncertainty = $2.42 + 0.835 = 1.077\%$

Percentage uncertainty for the density = 1.08 %

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Examiner Comments

The units for part (b) do not matter as long as the powers of ten are correct, as they are here.
The candidate goes on to treat the uncertainties well but makes an elementary mistake in adding them, thus losing a simple mark. Notice that the uncertainty in width uses the difference between the mean and the furthest value - this is fine, as is using the range or half the range.

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Examiner Tip

Check your calculations - even the simple ones.

Question 2

This is an example of a question where there is a need for the precise detail to be filled in.

It is important that the question is read carefully, a number of candidates described an experiment to show that alpha particles were being emitted by describing absorption, this was not the question on this year's paper. This experiment had not been seen by many candidates some of whom mentioned 'switching on the alpha source'.

Nearly all candidates scored marks for background count & safety but went on to describe measurements for the background in far too much detail for this experiment. It is enough to say that when the count rate falls to background there are no more alpha particles being detected.

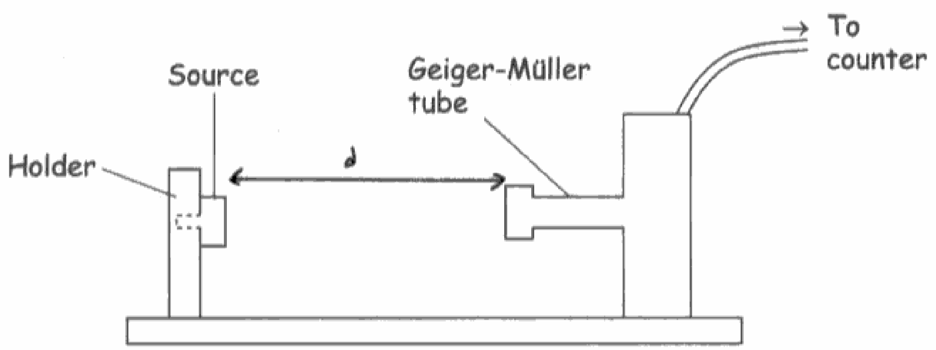
The more able candidates said that a graph of count rate against distance would show the range clearly when the count dropped to background

This question is best answered using the diagram as shown. Also bullet points are a very good way of structuring the answer. They enable the candidates to make their points in a clear and logical manner.

2 A student writes a plan to obtain a value for the distance travelled in air by alpha particles.

He plans to use an alpha particle source, a Geiger-Müller tube with a thin window and a counter.

His diagram is shown below.



He writes the following plan

Place the Geiger Müller tube in front of the source.

Measure the distance, d, from the source to the tube.

Measure the count.

Change d and take more readings.

His teacher says that the plan needs more detail.

Add more detail to improve this plan, include one safety precaution he should take.

You may add to the diagram if you wish.

(6)

* Place the GM tube in front of the source
* Measure the distance "d" from the source to the tube using meter rule which is placed horizontally with uncernity of (1mm) on each side.

* Measure back ground radiation
* Measure the count rate for different readings
* Measure count for specified time
* Subtract the back ground radiation from the count rate
* keep people away from the experiment
* The meter rule readings should be on the eye level

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Examiner Comments

The diagram is used with a dimension line with arrows and is labelled clearly.
Although bulleted, the points are not in order, does the candidate mean to measure background with the source in place? Also the candidate does not show how the range will be determined. It is common for candidates to lose their way through a long question and - as here - fail to answer fully.
Does the candidate mean to measure the count for the same specified time, each time? They would have scored an extra mark if they had been more precise in their answer, this answer lacks key details.

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Examiner Tip

Read the question again before checking your answer.

This candidate chose not to add to the diagram and although the answer was generally good, they lost marks through missing out steps.

His teacher says that the plan needs more detail.

Add more detail to improve this plan, include one (safety) precaution he should take.

You may add to the diagram if you wish.

(6)

- ~~make sure that distance between source and Geiger Müller tube~~
- Background count rate should be measured in long period in order to get its average value.
- Distance from the source to the tube should be measured ~~by~~ [several] ~~using~~ [time] by using metre rule to get its average distance.
- Then, ~~measure~~ [record] count rate at specific time.
- Substract count rate from background count rate.
- Take several readings for each count rate.
- Repeat experiment ~~by using~~ diff with different distance from source to Geiger Müller tube.
- ~~Radioacti~~ Precaution: Radioactive source should be handled by tongs.

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Examiner Comments

The distance was not shown on the diagam, this is worth one mark. They have not said how they will use the results to come to a conclusion - another mark lost.
Bullet points make their answer very clear and when checked this should trigger ideas about what might be added.

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Examiner Tip

If the question says '...add to the diagram..' it is always worth doing so.

Question 3 (a)

Precision is the key to all the answers at this level.

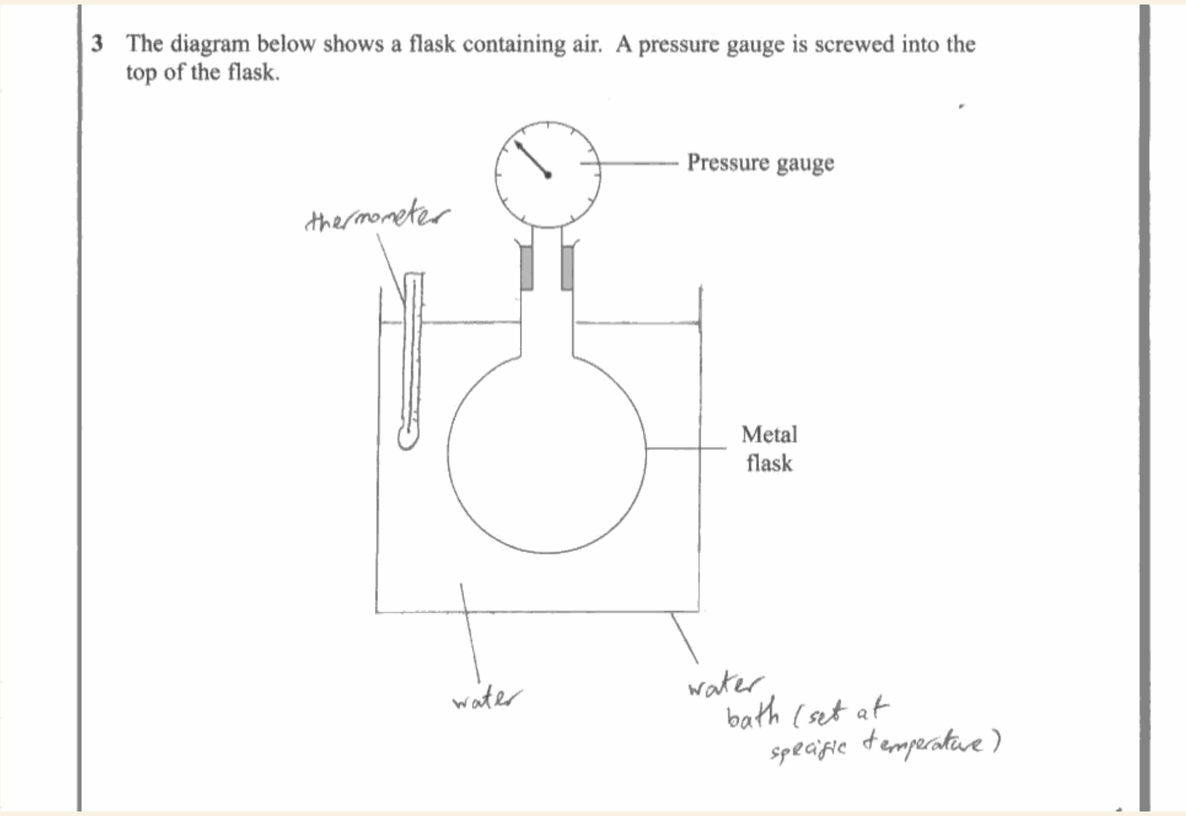
(i) Poor diagrams and vague indications such as adding ice were not awarded a mark. Diagrams were generally satisfactory but few candidates seemed to use a ruler. Specifically the water (or oil) in the bath must cover the flask and the source of heat must be described, usually as a Bunsen burner.

(ii) Candidates did not really address this question as asked and were expected to say that ice is added *to bring the temperature down to 0* ^{0}C, and describe the method to achieve 100^{o}C – boiling the water was a good answer. Again specific answers were awarded the mark.

iii) Candidates made this far too difficult and wanted to use gas laws in measuring temperature. It is enough to refer to the thermometer measuring the temperature of the water providing the gas is at the same temperature. It is a very good idea to add a thermometer to the diagram.

(iv) Stirring is not enough since the apparatus is too large for this to help the air reach the same temperature as the water. To allow for this to happen there must be a pause in the heating process and the heat source removed.

The diagram can be used to illustrate different parts of the overall answer. To do this well the additions need to be well drawn as they are here.



You are to plan an experiment to see how the pressure of the air in the flask varies with temperature.

(a) (i) Add to the diagram to show how you would vary the temperature of the air in the flask.

(2)

(ii) Describe how you would change the temperature over the range 0 °C to 100 °C.

(1)

For 0°C add ice only in water bath. For 100°C add boiled water in water bath. Also you can change the water bath ~~[illegible]~~ which is set at any temperature from 0 - 100°C

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Examiner Comments

The candidate is awarded a mark for suggesting a water bath and they then suggest using ice to get the temperature down to zero, this is a good specific answer.

They draw a thermometer in the diagram but then suggest they will determine the temperature by using the pressure measurement. The air should be at the same temperature as the water, so measuring the temperature of the water is the answer expected here. The word 'determine' is used in the question because it is not a direct measurement of the temperature of the air.

In part (iv) the candidate makes the usual comments about repeating readings and parallax. The crucial aspect for this experiment is to ensure the air has time to get to the same temperature as the water. Stirring, a common suggestion, will have no effect on this. This answer scores zero.

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Examiner Tip

Use the diagram as part of your answers.

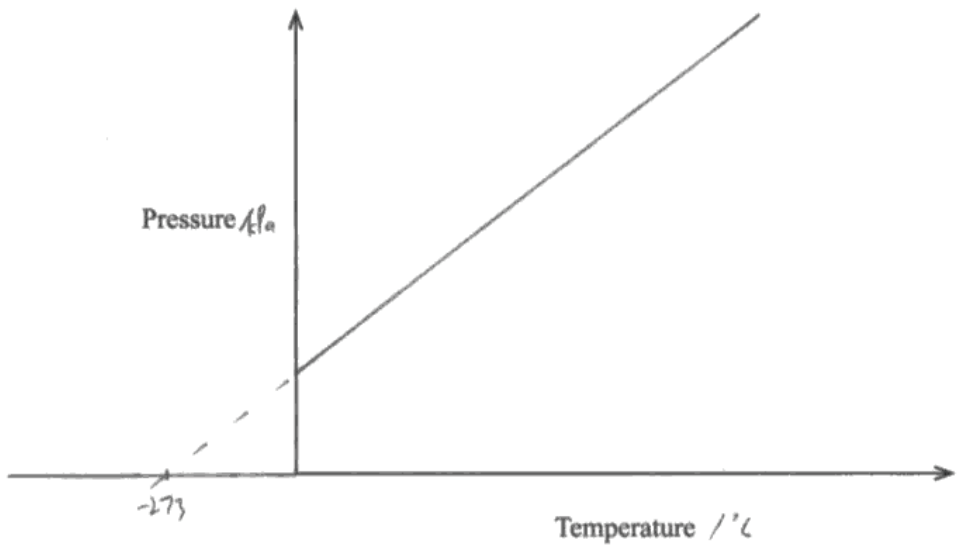
Question 3 (b)

This differentiated nicely, although a large number of candidates did not label the axes thus scoring only one – so long as their line was straight.

Labelling the axes was the key to this question.

(b) Use the axes below to show how you would expect the pressure of the air in the flask to vary with temperature.

(3)



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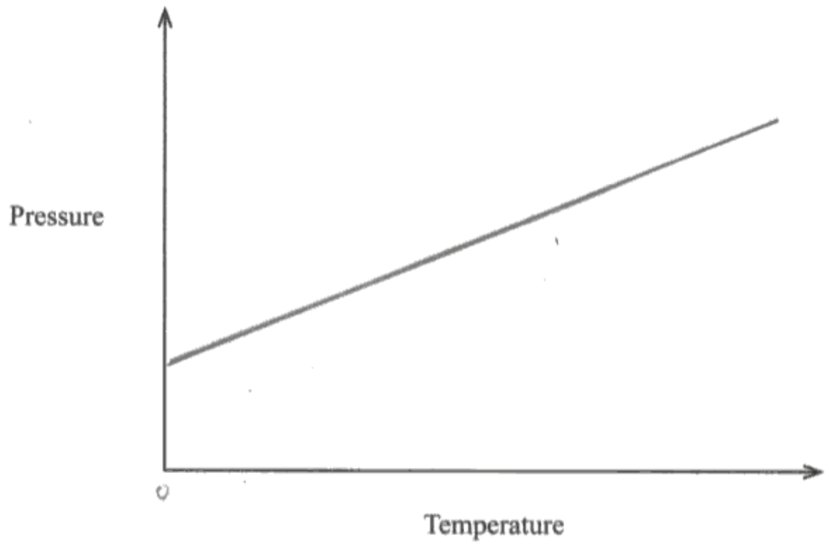
Examiner Comments

Here the label is Celsius and the graph shows a positive intercept on the pressure axis thus scoring all three marks.

(b) Use the axes below to show how you would expect the pressure of the air in the flask to vary with temperature.

(3)



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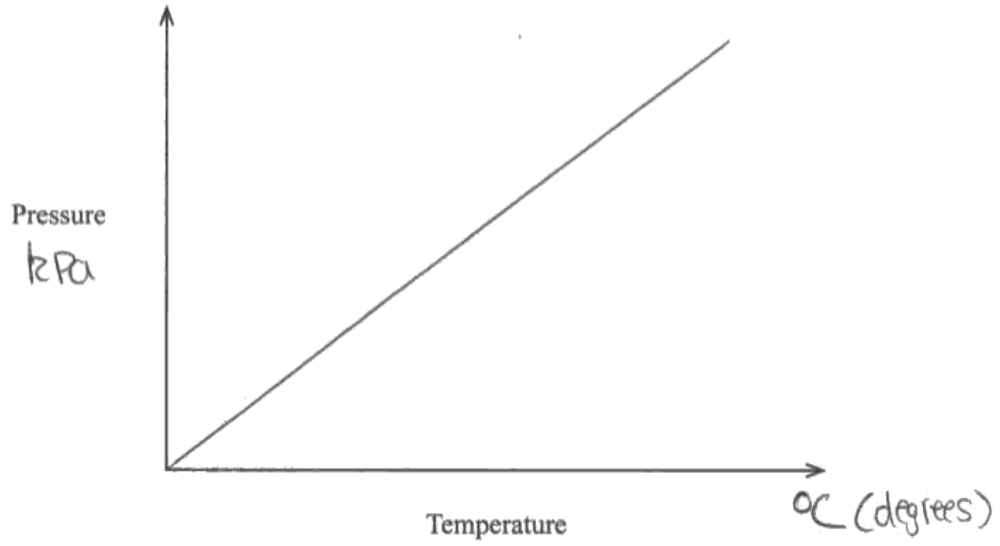
Examiner Comments

This graph scores only 1 mark because the line would be correct if the scale were Celsius but incorrect if Kelvin.

(b) Use the axes below to show how you would expect the pressure of the air in the flask to vary with temperature.

Positive, direct correlation through the origin. **(3)**



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Examiner Comments

This scores 2 marks because the temperature axis has a label and the line is straight. The line does not correspond to the label so the third mark is lost.
The word 'correlation' is entirely inappropriate here. Correlation suggests some trend or general pattern; here, even though there are no plots are shown, the suggestion is that the variables are directly proportional - in support of the theory - with a specific intercept (zero). This is much more powerful than a correlation would suggest.

Question 4 (a) (i)

Quite a few candidates missed out the unit but the powers of ten were generally well handled.

This shows the calculation laid out clearly.

With the switch in position X the capacitor is charged to 12 V. When the switch is moved to position Y the capacitor discharges through the resistor and the potential difference (p.d.) across the resistor falls steadily from 12 V.

(a) (i) Calculate a theoretical value for the time constant for this circuit.

(1)

$T = 220 \times 10^3 \times 100 \times 10^{-6} = 22$

Time constant = $22\ \Omega F$

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Examiner Comments

This is the correct calculation but the unit, although not incorrect, is not the SI unit for time and so the mark is lost.

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Examiner Tip

Always use the SI unit.

Question 4 (a) (ii)

There is provision in the specification for questions requiring knowledge and understanding; in fact there are 4 marks for Assessment Objective 1. So it was disappointing that so few had learned the definition required which forms the basis for this central topic that has many practical aspects. There was also confusion between the time taken to drop **to** 63% and the correct drop **by** 63%.

(ii) What is the significance of the time constant for such a discharge?

(1)

Time taken for the ~~charge and~~ charge and voltage ~~in~~ at capacitor to fall to 37% of original value ~~[illegible]~~

ResultsPlus

Examiner Comments

This is untidy but correct without contradiction.

(ii) What is the significance of the time constant for such a discharge?

(1)

Time constant is the time taken for the capacitor to fall to 37% of its original value.

ResultsPlus

Examiner Comments

This looks good but does not specify what is falling.

Question 4 (b) (i)

Generally done well with candidates explaining why a high resistance was needed with reference to the circuit. This was a good discriminator.

(b) She decides to check the theoretical value for the time constant T using a stopwatch, with a precision of 0.01 s.

(i) State why the voltmeter needs to have a high resistance.

(1)

~~To~~ So that no current flows through the voltmeter. So, that it does not reduce the potential difference value it is measuring.

ResultsPlus

Examiner Comments

This is an excellent answer stating the effect of the suggestion on the specific circuit.

ResultsPlus

Examiner Tip

Underline key words in the question.

Question 4 (b) (ii)

Once again candidates here need values to justify the comment that the precision of the stopclock is small. There must be a comparison, such as, compared to the precision of the method 0.1 s the precision of the stopclock 0.01s is small. **Or** the uncertainty in the readings for the time will be small compared with 22s.

Comments on stopclock by itself mean little and were not awarded the mark.

(ii) State why a stopwatch is suitable for measuring the time in this context. (1)

It has a high accuracy as the precision is 0.01 seconds. And since it takes a longer time to discharge it would be accurate.

(iii) State what she should do to make her value for T as reliable as possible

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Examiner Comments

Here accuracy and precision are confused and there is no comparison either.

(ii) State why a stopwatch is suitable for measuring the time in this context. (1)

The time is not extremely small, so a stopwatch is suitable for a human's response time in this ~~experi~~ circuit.

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Examiner Comments

This answer gets close but specific values are required.

(ii) State why a stopwatch is suitable for measuring the time in this context. (1)

Theoretical time constant is 22s, so a preci of 0.01s would be suitable as it would mea time to 4 s.f.

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Examiner Comments

The demonstration that 4SF is achieved is enough to get the mark.

Question 4 (b) (iii)

Drawing a graph will always reduce the uncertainty in your conclusion but if repeat readings are taken the candidate must say that a mean value will be calculated. Do not subtract reaction time which is a distraction here.

(iii) State what she should do to make her value for *T* as reliable as possible.

(1)

Repeat the experiment to obtain the mean value.

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Examiner Comments

This is a good succinct answer which scores the mark.

(iii) State what she should do to make her value for *T* as reliable as possible.

(1)

Take repeat readings of her value for T and take an average to remove any anomaly in her results.

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Examiner Comments

Another excellent answer.

(iii) State what she should do to make her value for *T* as reliable as possible.

(1)

She can plot a graph of ~~T~~ ~~vag~~ voltage against Time, then Calculate T. and she can repeat the experiment more than once and take average ~~results~~ results.

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Examiner Comments

Any graphical method will impove reliability since it requires more readings.

Question 4 (c)

The gradient is -1/RC, the omission of the minus sign was a common error. The link between the logarithmic equation and y = mx + c must be very clear to gain the second mark.

The link between the logarithmic equation and that for a straight line is made clear here and so both marks are scored.

(c) For a capacitor discharging through a resistor, the potential difference V across the resistor at time t is given by

$$V = V_0 e^{-t/RC}$$

Explain why a graph of ln V against t should be a straight line.

(2)

$$V = V_0 e^{-t/RC}.$$

$$\ln V = -\frac{1}{RC} t + \ln V_0$$

$$y = m x + c$$

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Examiner Comments
By identifying the variables specifically the gradient is obvious as well.

ResultsPlus
Examiner Tip
You must make the gradient clear.

(c) For a capacitor discharging through a resistor, the potential difference V across the resistor at time t is given by

$$V = V_0 e^{-t/RC}$$

Explain why a graph of ln V against t should be a straight line.

(2)

$$\ln V = \ln V_0 + \ln e^{-\frac{t}{RC}}$$

$$\ln V = \left(-\frac{1}{RC}\right)t + \ln V_0$$

$$y = m \; x + c$$

So a graph of $\ln V$ against t is a straight line with gradient $-\frac{1}{RC}$

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Examiner Comments
This is an ideal answer.

Question 4 (d-f) (i)

4(d) Most candidates quoted the log values correctly to 2 dp enabling an accurate graph to be plotted. Almost all the candidates used ln rather than log but the labelling of the axis must be ln(V/V) and nothing else will attract a mark. Silly scales cause plotting errors and it is almost never necessary to show the origin, the graph is for displaying the data. 4 cm for 0.5 Units caused a lot of misplotting when 1 cm to 0.1 worked perfectly well.

Joining the first and last points is often – as here – not the best line.

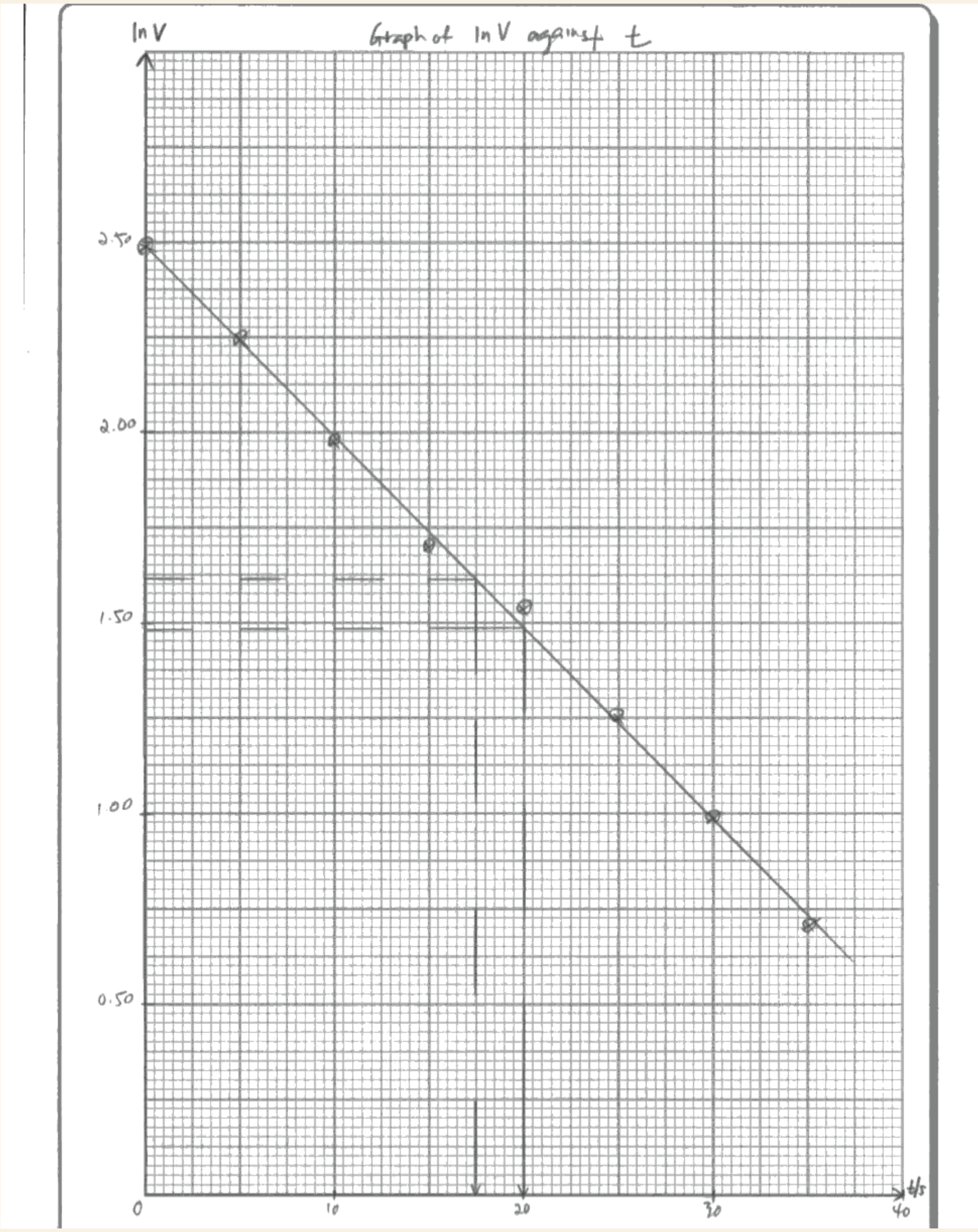
It is worth spending time on the graph since a lack of accuracy here leads to loss of marks later.

4(e)(i) The range of answers accepted was very tight so accuracy was important in measuring the triangle. It is better not to choose data points for graph values. 3 significant figures are required for graph work, in plotting the data points and in readings for the gradient. A surprising number found -0.05 as the gradient but only 1 SF is not enough for graph work.

4(e)(ii) A good number of candidates used the value 22 s as the denominator.

4(f)(i) Again 3SF is expected so ln 5 = 1.609 should be shown as 1.61. Candidates not showing anything on the graph lost both the marks and many candidates lost the 2nd mark because they were imprecise with their line, often using 1.6.

Accuracy in graph work is expected but not really shown here.



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Examiner Comments

The plot at 20 s is too high losing the plotting mark and the ln unit is wrong. Otherwise this is a good answer.
In (e)(i) the candidate chooses to find the 1/e value and then uses the logarithm of that to read the value for the half life. This is awarded the mark but a more common method is by finding the gradient of the line.
The graph is accurate enough for the value in the last part to be correct.

This is an example of graph work that is not up to the standard expected at A2.

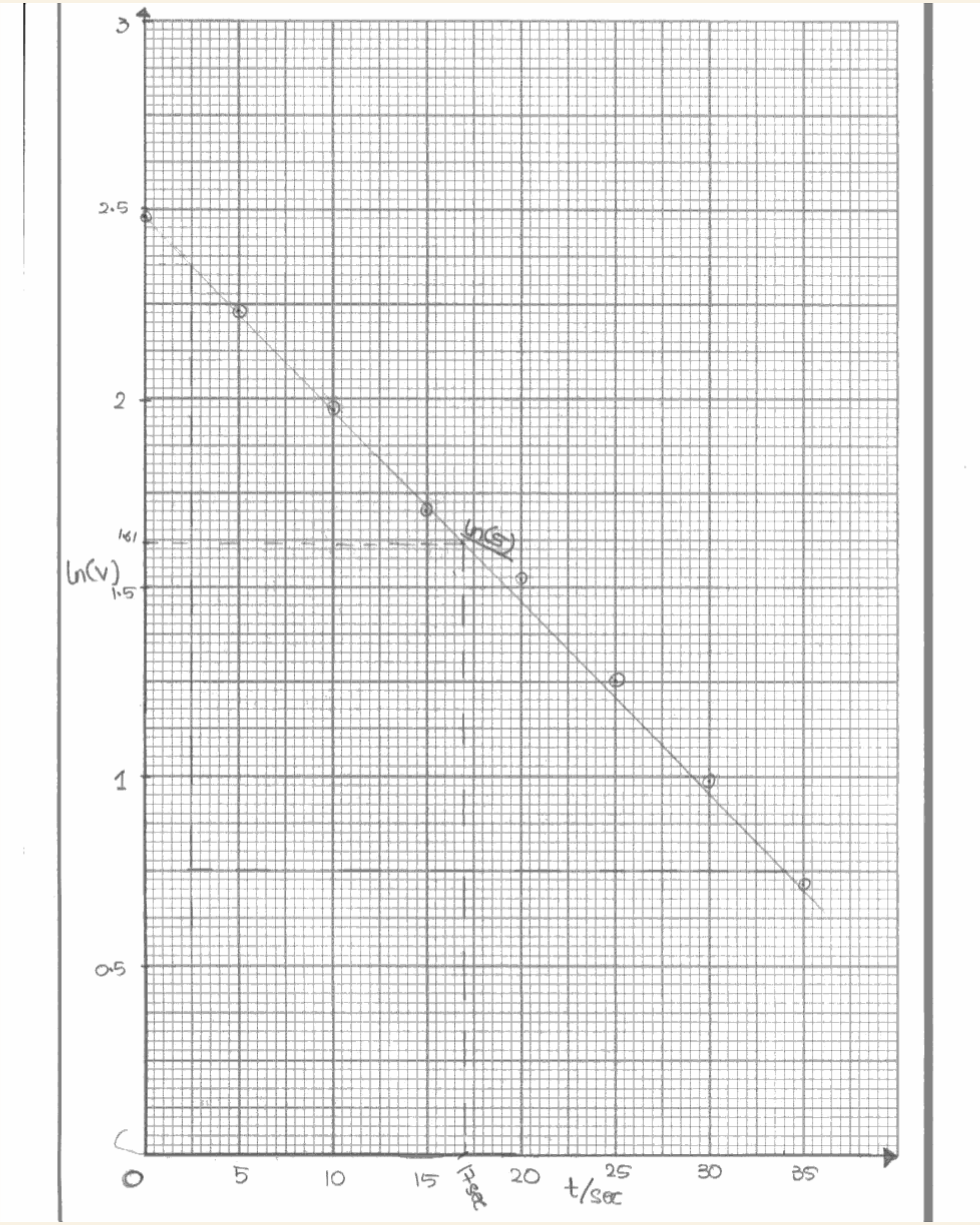
(d) The designer uses the circuit to obtain the following data.

t/s	V/V	ln(V)
0	12.00	2.49
5	9.41	2.24
10	7.16	1.97
15	5.49	1.70
20	4.55	1.52
25	3.49	1.25
30	2.68	0.99
35	2.04	0.71

Plot a graph on the grid opposite to show that these data are consistent with $V = V_0 e^{-t/RC}$.

Use the extra column in the table above for your processed data.

(4)


3
2.5
2
1.61
ln(v)
1.5
1
0.5
0
5
10
15
20
25
30
35
t/sec
ln(5)

(e) (i) Use your graph to obtain another value for the time constant. (2)

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.75 - 2.035}{34 - 2.5} = -\frac{16}{315}$

~~$-$~~$\frac{16}{315} = $ ~~$-$~~$\frac{1}{RC}$

$\therefore 315/16 = RC = \tau = 19.7\text{sec}$

Time constant from the graph = 19.7sec

(ii) Calculate the percentage difference between your value from the graph and the theoretical value from (a)(i). (1)

% difference = $\frac{22 - 19.7}{22} \times 100$

$= 10.5\%$

Percentage difference = 10.5%

(f) (i) Use your graph to find how long it takes for the p.d. to decrease to 5.0 V.

Add to your graph to show how you did this. (2)

ln(5) = 1.61

∴ from graph, it is going to take about 17 sec.

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Examiner Comments

The first logarithm value in the data table is incorrect. The unit on the ln axis is wrong too. The scales are well chosen as the plots are spread across the page in both directions. The line has one plot below it and at least four plots above it, so it is not the Line of Best Fit. This also causes the estimates in (e)(i) and (f)(i) to be wrong. Also in (f)(i) '..about 17 s...' is not the 3SF that is expected

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Examiner Tip

Take great care with graph work.

Paper Summary

The paper produced a good range of marks with more able candidates scoring higher marks on each question. Candidates should carry out the practicals described on this and other past papers in order to improve their marks on future papers since the techniques and treatment of uncertainties will remain much the same.

Grade Boundaries

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