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Examiners' Report
January 2012

GCE Physics 6PH07 01

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January 2012

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Introduction

This paper is designed to test the practical skills of international candidates and is based on Unit 3 of the specification. The space for each question is an indication of the length of the answer expected.

The multiple choice questions were generally well answered. Weaker candidates, however, performed less well on question 1 where they were expected to understand that one value should be ignored when finding the average.

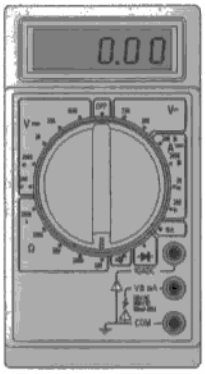
Question 6

The question asked candidates to discuss the advantages of digital and analogue meters when measuring the resistance of a wire. The best answers addressed this context and noted the value of the resistance given in the introduction. Candidates who performed well on this question had written a comparison for each mark – often in a table. However, many candidates restricted their scoring by giving identical points as the advantages of one method and the disadvantages of the other. The idea that a digital scale is direct reading (or the converse - that the analogue readings would require further calculation) was the most awarded mark. 'Systematic error' was often mentioned but rarely expanded upon. Many weaker responses included a reference to 'human error' but did not go on to consider what the human might be doing to cause the error. Many candidates considered a pair of analogue meters to be the cheaper alternative. This is not generally the case. Only a minority of candidates realised that taking two readings would generate more uncertainty than would a single reading. Many referred to the complexity of a multimeter (and 'the need for training') without referring to the need for the correct selection of terminals or scale.

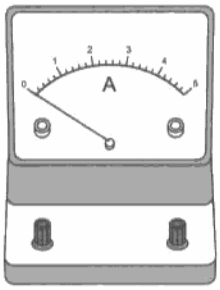
This candidate has set out the answer clearly and gains full marks.

6 A student is asked to determine the resistance of a wire.

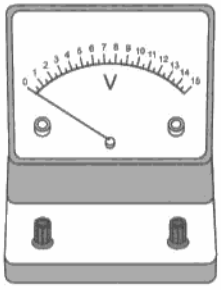
The student has to decide whether to measure the resistance directly, using a digital multimeter, or indirectly, using an analogue ammeter with an analogue voltmeter. The resistance is known to be between 5 Ω and 15 Ω.



Digital multimeter



Analogue ammeter



Analogue voltmeter

Discuss the advantages and disadvantages of each method of measuring the resistance.

(5)

Analogue ammeter and voltmeter

Advantage : More accurate result

DisAdvantage : ~~Does not~~ heat up the components easily.

Disadvantage : ~~Takes a longer time to~~ more steps needed to calculate (resistance = voltmeter reading / ammeter reading)

Disadvantage : Has a smaller range.

Disadvantage : less convenient (have to connect voltmeter and ammeter) circuit

Advantage : Batteries not needed

Disadvantage : May have zero / parallax error

Disadvantage : Not portable

Advantage : cheap~~er~~

Digital multimeter

Disadvantage : Result not so accurate

~~Dis~~advantage : Does not heats up the component easily

Advantage : Resistance can be calculated directly.

Advantage : Has a larger range.

Advantage : More convenient - (only have to connect multimeter.) circuit

Disadvantage : Need to use batteries.

Advantage : No parallax error / zero error

Advantage : portable

Disadvantage : Expensive

(Total for Question 6 = 5 marks)

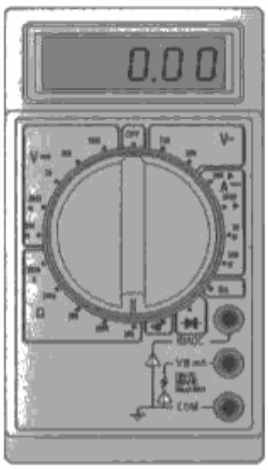
ResultsPlus
Examiner Comments

The first point would have been improved by referring to the scales on the instruments.

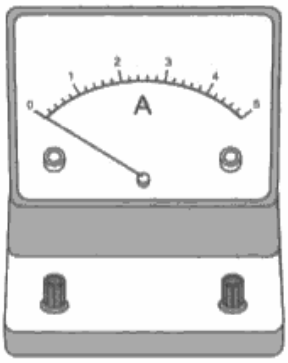
ResultsPlus
Examiner Tip

Try to use information shown in the question to make your answer more specific.

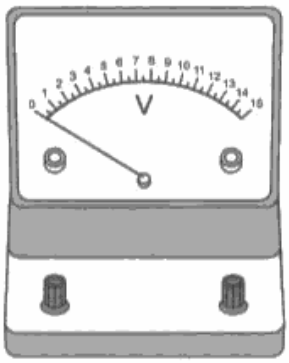
This candidate has used a different approach which also gains full marks.



Digital multimeter



Analogue ammeter



Analogue voltmeter

Discuss the advantages and disadvantages of each method of measuring the resistance.

(5)

For digital multimeter, it is easier to set up to measure the resistance of the wire directly whereas ammeter must be connected in series and voltmeter must be connected in parallel to get the value of resistance of the wire. It also reduces the parallax errors since only one ~~value~~ digital value ~~is~~ has to be taken, while for ammeter and voltmeter, ~~two reading~~ readings from ~~one~~ both of them must be taken, greatly increases the parallax errors. Moreover, digital multimeter gives the value to nearest precision, and no further calculation is required which is relatively simpler than using ammeter and voltmeter.

For voltmeter and ammeter, a graph could be drawn manually, so that, enables an average result to be taken and it also shows if any anomalies and resistance changes. Therefore, it gives a more comprehensive reading.

ResultsPlus
Examiner Comments

Parallax and zero errors are mentioned specifically, rather than in general terms.

ResultsPlus
Examiner Tip

Give reasons for any assertions you make.

Question 7

It is important that candidates read a question carefully to ensure they understand the context. Good answers used the headings of this question to structure their answers. Candidates who did not describe a graphical method or who described an experiment to measure viscosity at different temperatures were awarded marks where possible but could not access all.

7(a) Many candidates omitted to mention at least one of the required pieces of additional apparatus, although it often appeared as part of another section in the response. A substantial proportion of candidates suggested light gates which gained the mark for 'markers'. However, few went on to include the necessary timer. Many candidates received credit for sensible additions to the printed diagram on page 6.

7(b) This part was generally answered well. Some candidates spoiled their answer here by suggesting that the radius rather than the diameter of the ball could be measured directly.

7(c) Good candidates had no trouble scoring all 4 marks in this part. Others scored just 2 marks for linking correct quantities with instruments but making no reference to the precision.

7(d) The variables were correctly identified by many candidates. Some tripped themselves up, perhaps thinking ahead to the graph, and gave 'radius squared' as the independent variable. Several weaker responses mentioned the density of the oil, even though this was identified as 'given' in the introduction to the question.

7(e) The first mark was often scored earlier in a response. Many merely suggested substituting in the viscosity equation to find their value for viscosity rather than the graphical method required by the question.

7(f) The likely sources of error were identified clearly by many candidates – reaction time, zero error and parallax error were those most often seen. Few answers mentioned 'measurement' (of either length or diameter for instance) as a possible cause of uncertainty.

7(g) Many candidates failed to score here because their suggested precaution did not relate to a specified and appropriate hazard. A few correctly pointed out that this particular investigation is actually rather safe.

This is a well structured answer which gained all marks except the last.

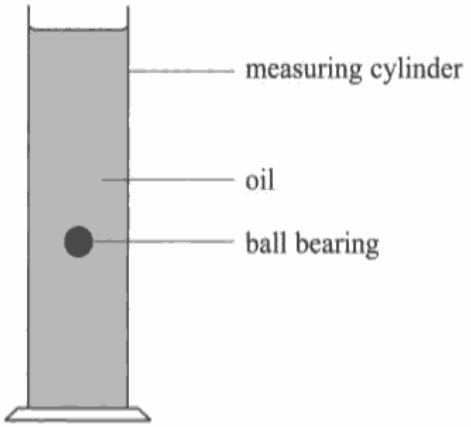
7 A student is asked to determine the viscosity of an oil at room temperature by dropping ball bearings into a long measuring cylinder filled with the oil.

The student is given the equation:

$$v = \frac{2}{9} r^2 \frac{g}{\eta} (\rho_b - \rho_o)$$

Where

v = velocity of ball bearing
r = radius of ball bearing
η = viscosity of the oil



The student has been given values for the density of the oil ρ_o and the density of the ball bearings ρ_b.

Write a plan for an experiment which could be used to determine the viscosity of the oil using standard laboratory apparatus and a graphical method.

You should:

(a) list any additional apparatus required, you may add to the diagram if you wish,

(2)

(b) state the quantities to be measured,

(1)

(c) for **two** of these quantities state and explain your choice of measuring instrument,

(4)

(d) state which is the independent and which is the dependent variable,

(1)

(e) explain how the data collected will be used to find the viscosity,

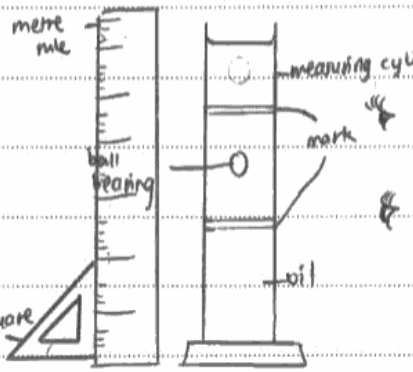
(2)

(f) identify the main sources of uncertainty and/or systematic error,

(2)

(g) comment on safety.

(1)



(a) rubber band, stopwatch, thermometer, a few different radius of ball bearings, metre rule

(b) ~~radius~~ diameter of the ball bearing, ~~is measured using micrometer screw~~ distance between the marks, volume ~~gauge~~ of the oil.

(c) diameter of ball bearing is measured by using micrometer screw gauge. micrometer screw gauge can measure the range of different diameter of ball bearings up to 0.01mm. Distance between the marks is measured using metre rule. It can measure the range of marks on the measuring cylinder, metre rule has range from 0 - 100 cm. Time taken is measured using stop watch. It can measure accurate up to 0.1s, it can measure the range of time needed for this experiment

(d) independent : radius of ball bearing.

dependent : time taken for ball bearings to fall within a fixed distance.

(e) radius of ball bearing is obtained by dividing each diameter value of ball bearing measured into half. ~~for the ball of the ball bearings~~

~~Velocity of ball bearing is calculated from distance travelled~~

Velocity of ball bearings are calculated by using formula $\frac{\text{distance}}{\text{time taken}}$.

a graph of velocity $/ms^{-1}$ against ~~radius~~ r^2/m^2 is plotted.

gradient represents $\frac{2}{9}\frac{g}{\eta}(\rho_b - \rho_o)$ where η could be calculated since g and $(\rho_b - \rho_o)$ are fixed.

~~(e)~~ (f) zero error due to micrometer screw gauge

parallax error when taking ~~marks~~ distance readings (on mark) ~~readings~~

Temperature is not constant throughout the experiment.

range of values measured is too small, it may not reach terminal velocity.

The diameter readings are not repeated to obtain average values.

ResultsPlus
Examiner Comments

The answer provides all the required information for parts (a) to (f).

ResultsPlus
Examiner Tip

Remember that you can add to the diagram to support your answer.

Another good answer although some pieces of apparatus are not mentioned at the beginning in part (a).

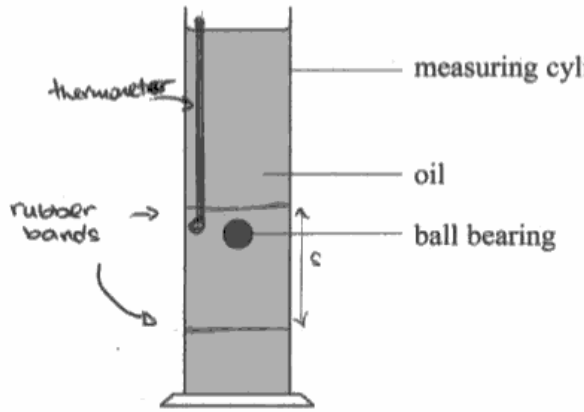
7 A student is asked to determine the viscosity of an oil at room temperature by dropping ball bearings into a long measuring cylinder filled with the oil.

The student is given the equation:

$$v = \frac{2}{9} r^2 \frac{g}{\eta} (\rho_b - \rho_o)$$

Where

v = velocity of ball bearing
r = radius of ball bearing
η = viscosity of the oil



The student has been given values for the density of the oil ρ_o and the density of the ball bearings ρ_b.

Write a plan for an experiment which could be used to determine the viscosity of the oil using standard laboratory apparatus and a graphical method.

You should:

(a) list any additional apparatus required, you may add to the diagram if you wish,
(2)

(b) state the quantities to be measured,
(1)

(c) for **two** of these quantities state and explain your choice of measuring instrument,
(4)

(d) state which is the independent and which is the dependent variable,
(1)

(e) explain how the data collected will be used to find the viscosity,
(2)

(f) identify the main sources of uncertainty and/or systematic error,
(2)

(g) comment on safety.
(1)

(a) A stopwatch would be required. Two rubber bands as markers. Thermometer to measure temperature. We also need ball bearings of diffendant diameter. A magnet to retrieve the ball.

(b) Quantities needed to be measured are time taken for ball bearing to travel from 1st rubber band to the second rubber band, the diameter of the ball bearing, and the temperature of the oil. The length of between the two rubber bands also needs to be measured.

(c) Time, t is measured using a stopwatch. This is because the precision of the stopwatch (0.1 s) is ~~suitable f~~ suitable for the experiment; and the stopwatch is cheap and readily available.

The diameter, d of the ball is measured using a micrometer screw gauge. This is to find r^2 (radius), ~~which~~ which equals $\frac{d^2}{4}$. The precision of the micrometer screw gauge (0.01 mm) is precise to measure a small diameter of the ball bearing. ~~It also has the ratchet~~

(d) Independant variable is the radius of ball bearing.

Dependant variable is the velocity of the ball bearing.

(e) The data is collected, and calculated, and tabulated,

V, velocity is given by $\frac{s}{t}$, where s is the distance between two rubber bands, and t is the time taken for the ball bearing to travel the distance.

r^2 is calculated from diameter, where $r^2 = \left(\frac{d}{2}\right)^2 = \frac{d^2}{4}$.

A graph of velocity against r^2 is plotted, where gradient is constant, which equals to $\frac{2}{9}\frac{g}{\eta}(\rho_b - \rho_o)$.

η can then be calculated, since constants g, ρ_b, and ρ_o are known.

(f) the ball bearing might not achieve terminal velocity at the point of measurement. Hence the value of v could be understated. The ball bearing could be in contact with the wall of the cylinder.

(g) The experiment is rather safe, except for the tall measuring cylinder which could be knocked over. Or it is slippery, this might cause a person to slip or drop objects.

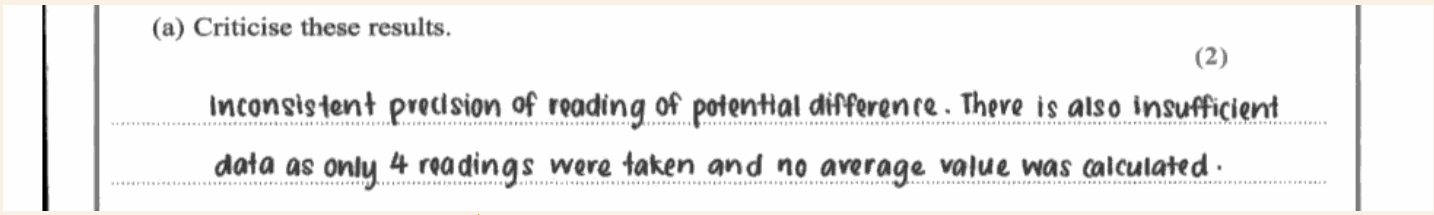
ResultsPlus
Examiner Comments
There is no mention of apparatus for measuring the distance fallen.

ResultsPlus
Examiner Tip
Remember all apparatus must be listed.

Question 8 (a)

Most candidates were able to gain marks in this question. Many realised that there were an insufficient number of readings and that there was an inconsistency in the precision of the data for potential difference. Many noted the lack of obvious repeat values, but few pointed out that the range was narrow. Some of the better answers included three or even four valid criticisms. A few candidates misunderstood the instruction and attempted to draw conclusions from the data instead.

This is a good answer which is clearly set out.



(a) Criticise these results.

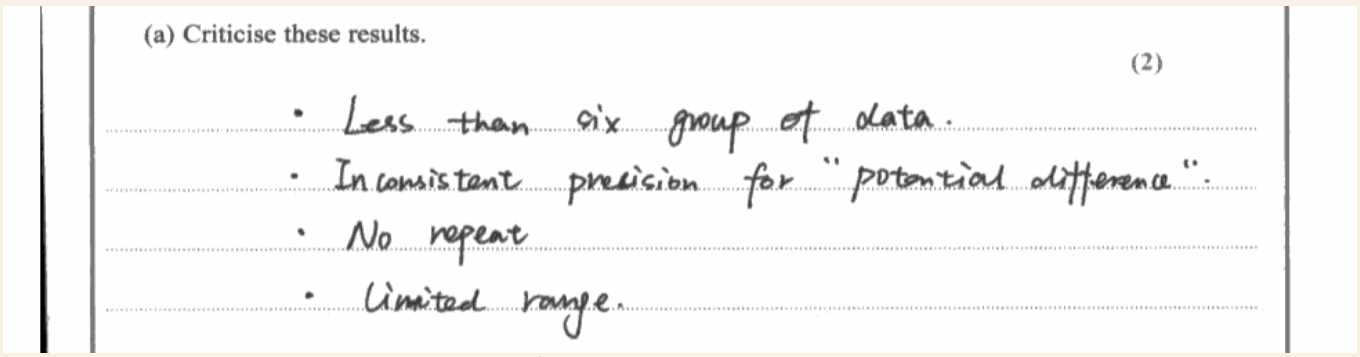
(2)

Inconsistent precision of reading of potential difference. There is also insufficient data as only 4 readings were taken and no average value was calculated.

ResultsPlus
Examiner Comments
This answer has made three good points.

ResultsPlus
Examiner Tip
Good answers can be quite short.

This is a well formatted answer.



(a) Criticise these results.

(2)

- Less than six group of data.
- Inconsistent precision for "potential difference".
- No repeat
- Limited range.

ResultsPlus
Examiner Comments
Although four correct points are made the maximum mark is 2.

ResultsPlus
Examiner Tip
Using bullet points is a good way to structure an answer in this paper.

Question 8 (b)

Despite the instruction to calculate, a large proportion of candidates seemed either to read the value directly from the graph, or to take the average of the values on either side. Candidates who calculated did not always go on to give their answer to the appropriate number of significant figures. Some truncated their value, instead of rounding up.

The candidate has calculated the missing value but has not used two significant figures.

(b) Complete the table below by calculating the missing frequency. (2)

Wavelength /nm	Potential difference *V*/V	Frequency *f* /10^{14} Hz
510	0.14	5.9
470	0.36	6.4
430	0.67	7
370	1	8.1

ResultsPlus
Examiner Comments
In this paper candidates are expected to use the appropriate number of significant figures in tables.

ResultsPlus
Examiner Tip
Check the values given to decide how may significant figures to use.

This answer gains full marks.

(b) Complete the table below by calculating the missing frequency. (2)

Wavelength /nm	Potential difference *V*/V	Frequency *f* /10^{14} Hz
510	0.14	5.9
470	0.36	6.4
430	0.67	7.0
370	1	8.1

$v = f\lambda$

ResultsPlus
Examiner Comments
Calculations are often required as here.

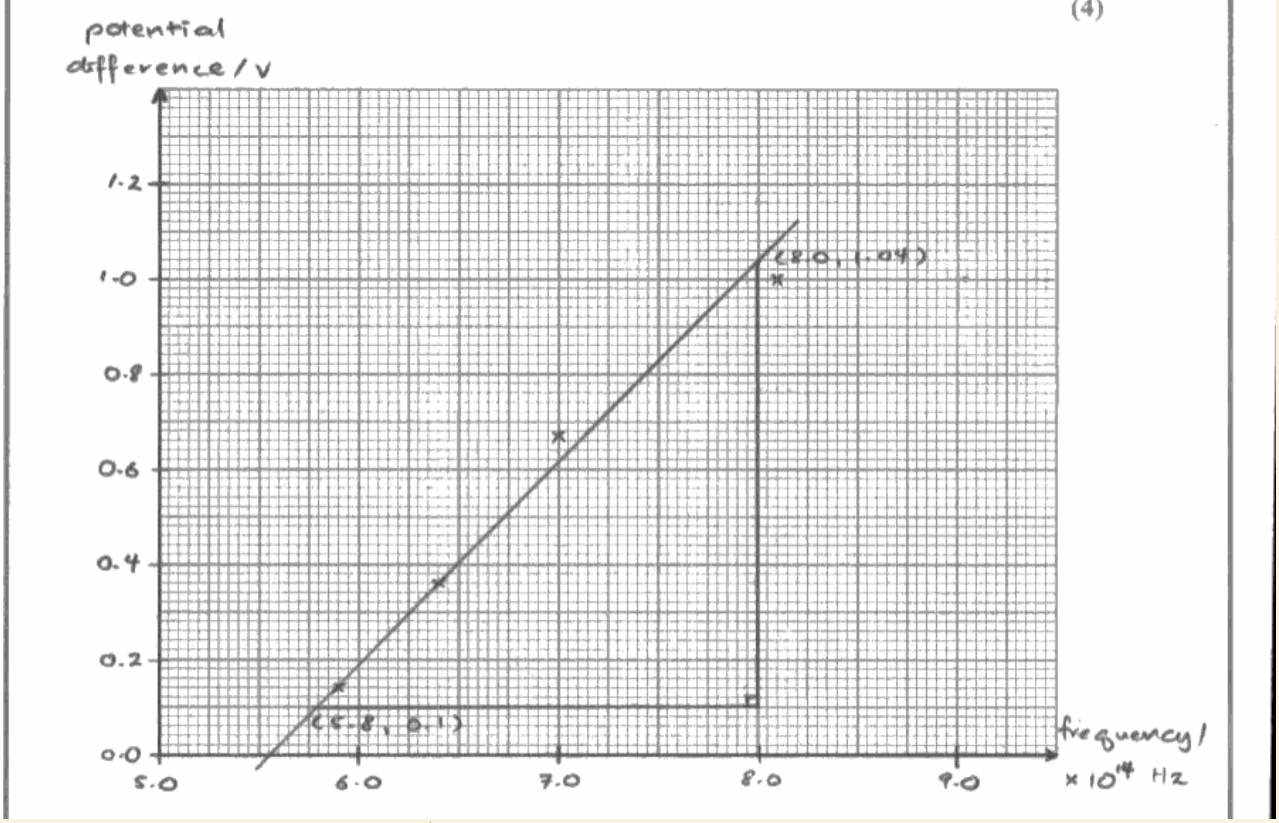
ResultsPlus
Examiner Tip
Remember to check information at the back of the paper for useful data and formulae.

Question 8 (c)

Few candidates managed to score full marks on this question. The labelling of axes was generally done well, but a poor choice of scale (especially by starting the frequency scale at zero) spoilt many attempts. Weaker responses often drew a poor line of best fit.

This answer gained full marks.

(c) Plot the values of potential difference V on the y-axis against frequency f on the x-axis on the graph paper below. Draw a straight line of best fit on your graph. (4)



ResultsPlus
Examiner Comments

This is a well plotted graph

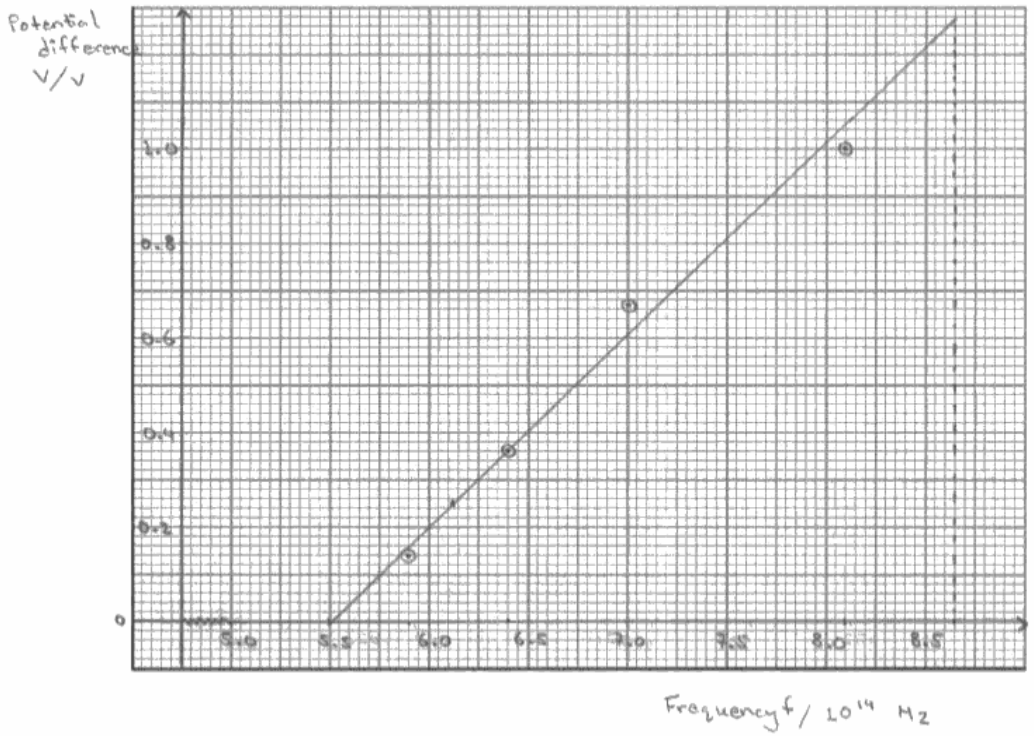
ResultsPlus
Examiner Tip

Remember that lines of best fit should be drawn so that points either lie on the line or are balanced on either side of the line drawn.

This is another good answer.

(c) Plot the values of potential difference V on the y-axis against frequency f on the x-axis on the graph paper below. Draw a straight line of best fit on your graph.

(4)



ResultsPlus
Examiner Comments

The line of best fit is well drawn.

ResultsPlus
Examiner Tip

Use large triangles for gradients.

Question 8 (d)

Many candidates managed to score a mark for properly comparing an equation to that for a straight line. A significant number simply stated that the two quantities were proportional, or that as one increased so did the other. Better responses also included a rearrangement of the given equation. Many candidates were successful although the occasional failure to divide by *e* throughout was seen. A few also scored only 3 marks by failing to clarify the final step.

This is a very clear answer which is well set out and includes all details.

(d) The student has been given the equation

$$eV = hf - \phi$$

Explain why the graph of V against f is a straight line and how the gradient can be used to find a value for the Planck constant.

(4)

from $eV = hf - \phi$

$V = \frac{h}{e}f - \frac{\phi}{e}$, # can be compared by using the equation of straight line, $y = mx + c$, where V is on the y-axis, f is on the x-axis, the gradient will be $\frac{h}{e}$ and the y-intercept will be $-\frac{\phi}{e}$.

Since the gradient of the graph of V against f is $\frac{h}{e}$, the Planck constant can be found by using the gradient of the graph multiply with the e, which is 1.6×10^{-19} C.

ResultsPlus
Examiner Comments

The candidate has used information given at the back of the paper.

ResultsPlus
Examiner Tip

It is a good idea to show that you know the value of constants.

This candidate has used arrows rather than words to make the comparison required.

(d) The student has been given the equation

$$eV = hf - \phi$$

Explain why the graph of V against f is a straight line and how the gradient can be used to find a value for the Planck constant.

(4)

$eV = hf - \phi$

$V = \frac{h}{e}f - \frac{\phi}{e}$

$y = mx + c$ therefore it is a straight line.

∴ Gradient $= \frac{h}{e}$

∴ Planck's constant can be found using $h =$ e x gradient.

ResultsPlus
Examiner Comments

It is often useful to identify the constant values in equations.

ResultsPlus
Examiner Tip

Using diagrams or arrows can help to make your meaning clear.

Question 8 (e)

Many candidates calculated the 'gradient' using values directly from the table, even though one or both points did not lie on the line they had drawn in the previous page. A significant number forgot about the power of 10. Those who went on to multiply the gradient by *e* often either forgot to include the unit of *h* or else gave an incorrect one. A common error was to state the unit as Js^{-1}.

This answer gained full marks.

(e) Use the gradient of your graph to determine the Planck constant. (3)

gradient = $\frac{\Delta Y}{\Delta X} = \frac{0.6}{7\times10^{14} - 5.5\times10^{14}} = \frac{0.6}{1.5\times10^{14}} = 4\times10^{-15}$

gradient × e = h.

$4\times10^{-15} \times 1.6\times10^{-19} = 6.4\times10^{-34}$ Js

ResultsPlus
Examiner Comments
A larger triangle could have been used.

ResultsPlus
Examiner Tip
When finding a gradient show the triangle you have used.

Although the graph would not have gained full marks in (c) it has been used well here.

(e) Use the gradient of your graph to determine the Planck constant.

(3)

gradient $= \frac{\Delta V}{\Delta f}$

$= \frac{0.8}{2.1 \times 10^{14}}$

$= 3.81 \times 10^{-15}$ Vs

h = gradient $\times$ ~~to~~ 1.60×10^{-19}

$= 6.10 \times 10^{-34}$ Js

ResultsPlus
Examiner Comments

The use of the gradient is clear but candidates should show their working in case they make a mistake in calculation.

ResultsPlus
Examiner Tip

Show all your working including how you calculated the gradient.

Question 8 (f)

Many mentioned the intercept for the first mark, although some suggested area under the graph. Not many went on to gain the second marking point. A common misconception was that the *y*-intercept was equal to

This answer uses the *x*-intercept.

(f) Explain how you could use a graph of V against f to find a value for the constant ϕ.

(2)

The value can be read off from the point at which, the line drawn cut the x-axis of the graph And it is the threshold frequency value, (f_0) By multiplying h by the Planck's constant, ϕ is calculated

$\phi = hf_0$.

ResultsPlus
Examiner Comments

A clear answer.

ResultsPlus
Examiner Tip

Try to give the name of constants.

This answer uses the *y* intercept.

(f) Explain how you could use a graph of V against f to find a value for the constant ϕ.

(2)

By taking the value of y intercept of the graph and multiplying it ~~by~~ with 1.6×10^{-19}.

y-intercept $= \frac{\phi}{e}$.

ϕ = y-intercept x e.

ResultsPlus
Examiner Comments

A clear response.

ResultsPlus
Examiner Tip

Make sure you understand the use of intercepts.

Paper Summary

Some excellent work was seen on this paper from candidates who had clearly been well prepared. Reading the question carefully is extremely important. Throughout the paper the best candidates supported their answers by giving reasons for their assertions.

Grade Boundaries

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