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# Examiners' Report
# June 2013

# GCE Physics 6PH07 01

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# Introduction

The paper 6PH07 is the International Alternative to the Internal Assessment unit 6PH03 and it assumed that candidates will be familiar with appropriate apparatus and experiments. There were some excellent answers that showed that many candidates were familiar with appropriate apparatus and experimental techniques. However, some responses seemed to be based on questions from past papers, with little regard for the requirements of this paper.

Candidates should have access to rulers, pencils and erasers, and be familiar with conventions for drawing scientific diagrams and circuit symbols.

## *Question 6*

Few candidates referred to uncertainties as requested. It is important that candidates address the question set. Some responses to this question were limited to a comparison of the instruments and did not discuss the methods at all. Although these responses were quite full, they offered little more than the precision of a micrometer – usually given as 0.01 mm. Some responses did go on to include a useful idea about the averaging available in method B or perhaps the need to deal with a possible anomaly in method A.

In the few cases where the candidate did consider them, there was a good discussion of the uncertainties associated with both techniques. This usually led to correct calculations of the percentage uncertainty in each case.

This is a good answer which addresses uncertainties and justifies assertions.

**6** Two students are given 10 coins of the same type, a metre rule measuring in millimetres and a micrometer screw gauge. The diameter of each coin is approximately 20 mm.

They are asked to determine the best value for the diameter of one coin. Student A says that it is better to measure the diameter of just one coin using the micrometer. Student B suggests that they put the coins in a straight line and use the metre rule.

Discuss the advantages and disadvantages of each method. You should refer to uncertainties in your answer.

**(4)**

Using a ruler to measure the 10 aligned coins, will have a percentage uncertainty of $\frac{1}{200} \times 100\% = 0.5\%$. The advantage is that it takes an average value of the diameter of the 10 coins since it measures all of them and then divides by 10. The disadvantage is that the coins may not be perfectly aligned therefore having a slight error in our calculation. Using a micrometer we would have an uncertainty of $\frac{0.01}{20} \times 100\% = 0.05\%$. The advantage is that it's much more accurate to measure with a micrometer rather than a metre rule, but the disadvantage is that student A will measure the diameter of only one coin, therefore he does not take into consideration the other 9 coins to get an average

**(Total for Question 6 = 4 marks)**

**ResultsPlus**
**Examiner Comments**

This candidate has discussed the practical alternatives clearly.

**ResultsPlus**
**Examiner Tip**

Justify your assertions with calculations if you can.

Like the previous example this answer uses calculations to support comments made.

A micrometer screw ~~gta~~ gauge has a precision of 0.01 mm which is much less than the diameter. The percentage uncertainity is $\frac{0.01\text{ mm}}{20\text{ mm}} \times 100\% = 0.05\%$. To measure just 1 coin is easier than measuring 10 coins.

However, student A is not taking any averages. The micrometer may contain zero errors.

The meter rule has a precision of 1mm, which is also much less than the combined diameters. Its percentage uncertainity is $\frac{1\text{mm}}{200\text{ mm}} \times 100\% = 0.5\%$. Using a meter rule, average diameter ~~of~~ ~~10 c~~ of 10 coins is taken.

However, there could be parallax errors while taking readings. This procedure is also time consuming.

**(Total for Question 6 = 4 marks)**

**ResultsPlus**
**Examiner Comments**

This gains all four marks.

**ResultsPlus**
**Examiner Tip**

Make sure you comment on all parts of a question.

## *Question 7*

Candidates were generally well-prepared for this question.

Most drew a satisfactory diagram of the apparatus, although a few omitted to show any support for the spring. In some cases, candidates chose to draw the apparatus for stretching a wire and subsequently limited their achievement in later sections through inappropriate responses. Most suggested a set square or a balance as additional apparatus, both of which were acceptable.

The independent and dependent variables were usually correctly identified. A few candidates identified the variables correctly, but went on to assign dependence and independence wrongly.

Experimental descriptions were generally good, but some candidates limited their response to a simple discussion of the choice of measuring instrument related to its precision or range. The better responses included an explanation of the way to calculate extension. Fewer went on to include an explanation of how to record the force applied by a range of masses.

The candidates dealt with the data handling confidently, describing an appropriate graph and correctly relating its gradient to the spring constant. Weaker responses included graphs with reversed axes and omitted to reverse the gradient to match. A few candidates suggested separate calculations of spring constant from each pair of readings and were not rewarded.

Well-prepared candidates correctly related the uncertainty to the measurement of extension and included a sensible reason. Others gave vague responses without linking their ideas properly, e.g. simply stating “parallax” or “the ruler”.

Many of the “safety precautions” offered were really designed to protect the equipment or the laboratory rather than the experimenter. Responses should include a sensible way to reduce personal danger.

This is an example of a good answer.

**7** A student is asked to determine the spring constant of a spiral spring.

Write a plan for an experiment to do this using standard laboratory apparatus and a graphical method.

You should:

(a) draw a labelled diagram of the experimental set-up to be used, **(2)**

(b) list any additional apparatus you might need, **(1)**

(c) state what quantity is the independent variable and what quantity is the dependent variable, **(2)**

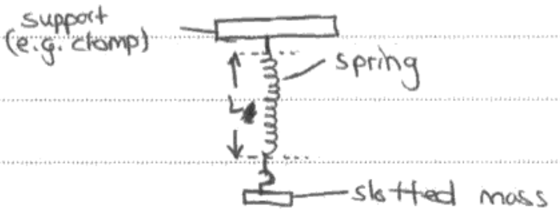
(d) describe how you would take your measurements and explain your choice of measuring instruments, **(4)**

(e) explain how the data collected will be used to find the spring constant, **(2)**

(f) identify the main sources of uncertainty and/or systematic error, **(1)**

(g) comment on safety. **(1)**

(a)




(b) The student would need a digital balance and a metre rule.

(c) Independent variable is the force (i.e. weight of mass)
Dependent variable is the extension of the spring

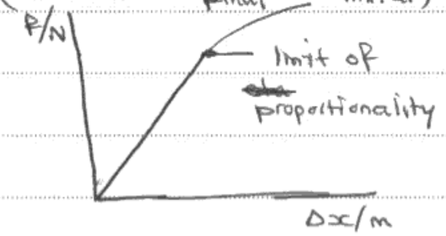
(d) The extension is calculated by first measuring the original length from the ends of the coils of the spring before any masses are added, and then subtracting that value from the new length of the spring after adding each corresponding mass. Both of these lengths ca measured using a metre rule as it has an appropriate scale with 1 mm being the smallest division.

The digital balance is used to measure the mass of each load as it too has a suitable scale with 0.01g being the smallest reading.

(e) A graph of force (weight of loads calculated by multiply the mass of the gravitational field strength 9.81 $ms^{-2}$) against the corresponding extension is plotted (extension = $L_{final} - L_{initial}$)

$$\frac{F}{\Delta x} = k$$

$$F = k\Delta x$$




compare $y = mx + c$

$y = F$ $x = \Delta x$ y-intercept = 0

and $m$ = gradient = spring constant = k

So the graph should be a straight line passing through the origin up to the limit of proportionality.

The gradient is calculated before the limit which is equivalent to the spring constant.

(f) Main sources of uncertainty include:

- The extension ($L_f - L_o$) as it has doubled the uncertainty
- Zero error upon reading from the balance
- Varying temperature

(g) This is generally a low risk experiment. However, toe protection should be worn to protect against falling masses, and goggles to protect against snapping wires.

**(Total for Question 7 = 13 marks)**

**ResultsPlus Examiner Comments**

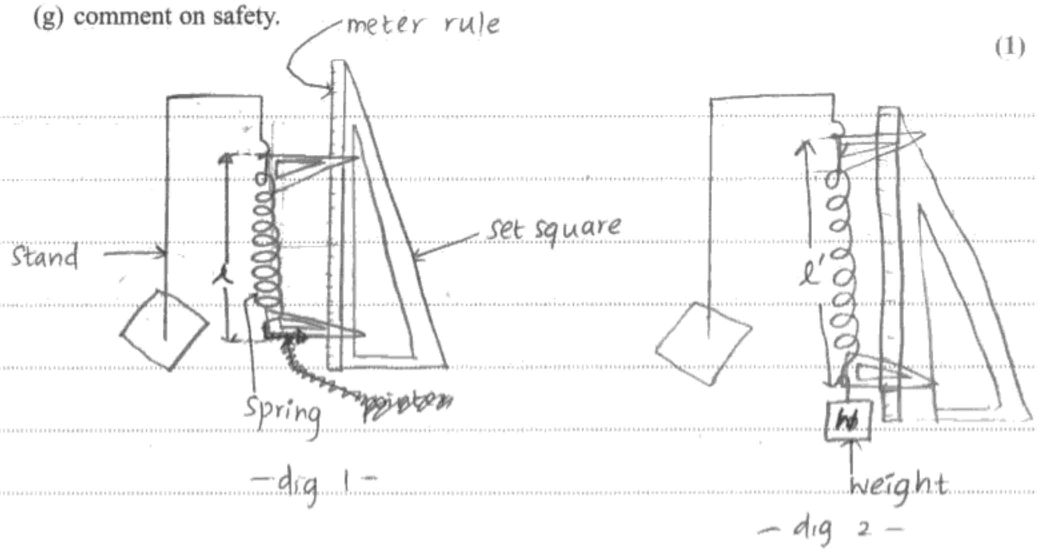
This answer gained full marks

**ResultsPlus Examiner Tip**

Try to structure your answer carefully.

This is another good answer.

(g) comment on safety. (1)




meter ruler, electronic balance, set squares, stand

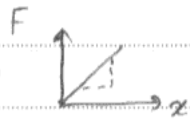
The force applied (the weight attached) is the independant variable. The dependant variable is the extension of the spring

The initial vertical length of the spring can be measured. ~~The~~ Each time a ~~weight~~ a known weight is attached to the spring and the new length l' ~~can be~~ is measured using the meter rule. Extension is equal to (l' − l). Extension must be calculated. To measure the weight (W) attached an electronic balance with a 0.01g precision is suitable. The initial length of the ~~wir~~ spring is long so a meter ruler with a precision of 1 mm can be used. To measure the new length due to extension also a meter rule is suitable. (If not a travelling microscope of 0.01 mm precision can be used to directly measure extension)

$F = kx$

Force F = W The force applied is varied. The (new length − initial length) is the extension (x)

$F = k(l' - l)$




$F = kx$

↑ ↑ ↑

$y = mx + c$

A graph of Force (weight attached) Vs extension $(l' - l)$ can be plotted. The gradient is equal to the spring constant) There may be parallax errors when reading the initial length(s) and the new length using the meter rule after weights are added. (If extension is directly measured the uncertainty will be very high) Safety goggles should be worn to protect eye from snapping of spring. Feet should be protected from falling weights.

**(Total for Question 7 = 13 marks)**

ResultsPlus

**Examiner Comments**

A clear description of how to find extension is given.

ResultsPlus

**Examiner Tip**

Use labelled diagrams in your answer where you can.

## *Question 8*

Most candidates could complete the data in the table, but some gave the wrong number of significant figures. The choice of unit caused much difficulty. Many omitted to invert their chosen unit of length. Very few were able to provide the correct multiplier with their inverted unit of length.

Most were able to explain how the gradient of the graph related to the constants. Some arguments were incomplete since they did not identify the constancy of *h*, *c*, and *e* as the cause of the linear relationship.

Graphs were generally drawn well. Axes were generally properly labelled with appropriate units. Unit errors made in part (a) were not penalised again. The choice of a suitable scale caused difficulty for some candidates as did drawing a line of best fit. Many lines were driven through the extreme points of the data range; others seemed attracted to a false zero given by the scale choice. Most candidates who chose sensible scales were able to plot their points with acceptable accuracy.

Well-prepared candidates calculated the gradient properly and went on to give the value for the Planck constant that is obtained from this data – which was not the accepted value. Some used the data from the table rather than the graph, others used unacceptably small triangles. The value obtained for the gradient was generally used properly. While most gave an appropriate number of significant figures in their answer, a large proportion of candidates omitted to include the unit

Many candidates were able to provide a sensible reason why their value was not the same as the accepted value for the Planck constant.

This candidate states clearly that *h, c* and *e* are constants.

**8** A school experiment to find an approximate value for the Planck constant $h$ uses light emitting diodes (LEDs) of different colours.

The results from one such experiment are shown in the table. The wavelengths $\lambda$ are taken from the data provided by the manufacturer of the diodes. The potential difference $V$ is measured across the LED when it just lights.

$1 \times 10^{6}\ m^{-1}$

| $\lambda$ /nm | $V$/V | $\lambda^{-1}$/ |
|---|---|---|
| 630 | 1.06 | 1.59 |
| 610 | 1.11 | 1.64 |
| 595 | 1.12 | 1.68 |
| 570 | 1.24 | 1.75 |
| 465 | 1.64 | 2.15 |
| 400 | 1.92 | 2.50 |

(a) Complete the final column of the table with the missing unit and values. **(3)**

(b) The equation used for the experiment is derived from

$$eV = hf$$

where $f$ is the frequency of the light emitted by the LED.

Explain why a graph of $V$ on the $y$-axis against $1/\lambda$ on the $x$-axis should be a straight line and show that the gradient of the line will be $hc/e$. **(3)**

$eV = hf \qquad V = y \qquad \frac{1}{\lambda} = x$

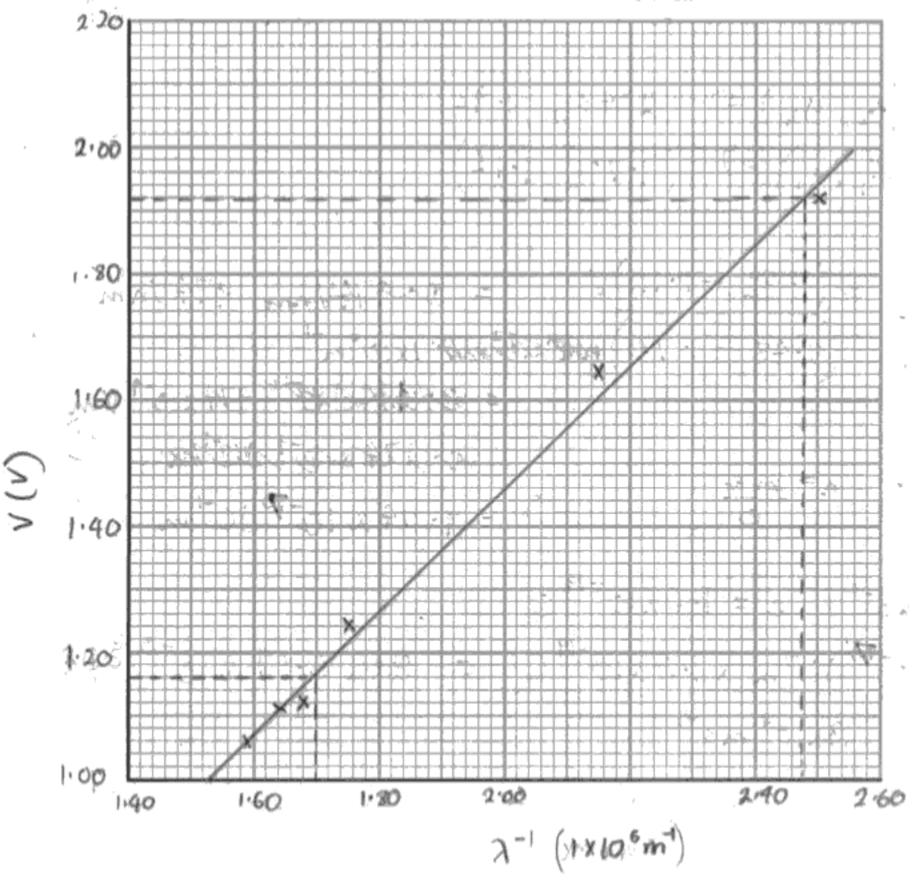
$V = \frac{hf}{e} \qquad f = \frac{c}{\lambda} \qquad \therefore \quad V = \frac{hc}{e} \times \frac{1}{\lambda}$

~~$y = mx$~~ $\qquad y = m \quad x$

Since h, c and e are all constants the gradient of the graph will be equal to $\frac{hc}{e}$.

(c) Plot the graph on the grid provided and draw a line of best fit.

**(5)**




(d) Use your graph to find a value for the gradient and use it to calculate a value for *h*.

**(6)**

Gradient of the graph = $\frac{hc}{e}$

Gradient : $(x_2, y_2) \Rightarrow (2.48, 1.92)$

$(x_1, y_1) \Rightarrow (1.70, 1.16)$

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{(1.92 - 1.16)\,V}{(2.48 - 1.70)\,1\times10^{6}\,m^{-1}}$ = 974 Vnm

= $974 \times 10^{-9}$ Vm

$m = \frac{hc}{e} \therefore h = \frac{me}{c}$

= $9.74 \times 10^{-[illegible]}$ JC$^{-1}$m

$c = 3\times10^{8}\ ms^{-1}$ $e = 1.6\times10^{-19}\ C$

$h = \dfrac{9.74\times10^{-7}\ JC^{-1}m \times 1.6\times10^{-19}\ C}{3\times10^{8}\ ms^{-1}} = 5.19\times10^{-34}\ Js$

$h =$ $5.19\times10^{-34}\ Js$

(e) The accepted value for $h$ is $6.63 \times 10^{-34}$ J s.

Assuming your calculations are correct, suggest why there is a difference between your value for $h$ and the accepted value.

(1)

The contact resistance of the circuit may have slightly altered the potential difference values recorded which would result in a systematic error. Additionally the LED might not have been giving out monochromatic radiation. The experiment also had not been repeated therefore there may have been random errors that have gone undetected.

**(Total for Question 8 = 18 marks)**

**TOTAL FOR SECTION B = 35 MARKS**

**TOTAL FOR PAPER = 40 MARKS**

**ResultsPlus**
**Examiner Comments**

This answer gained full marks.

**ResultsPlus**
**Examiner Tip**

Use large triangles when finding gradients.

This is another good answer.

| $\lambda$ /nm | $V$/V | $\lambda^{-1}$/ $\times 10^{-3}$ $nm^{-1}$ |
|---|---|---|
| 630 | 1.06 | 1.59 |
| 610 | 1.11 | 1.64 |
| 595 | 1.12 | 1.68 |
| 570 | 1.24 | 1.75 |
| 465 | 1.64 | 2.15 |
| 400 | 1.92 | 2.50 |

(a) Complete the final column of the table with the missing unit and values.

(3)

(b) The equation used for the experiment is derived from

$$eV = hf$$

where $f$ is the frequency of the light emitted by the LED.

Explain why a graph of $V$ on the $y$-axis against $1/\lambda$ on the $x$-axis should be a straight line and show that the gradient of the line will be $hc/e$.

(3)

$eV = hf$.

$\therefore V = \frac{hf}{e}$

$V = \frac{h}{e} \times f$

$V = \frac{h}{e} \times \frac{c}{\lambda}$

$V = \frac{hc}{e} \times \frac{1}{\lambda}$

$\downarrow \quad \downarrow \quad \downarrow$

$y \quad m \quad x$

$c = f\lambda$.

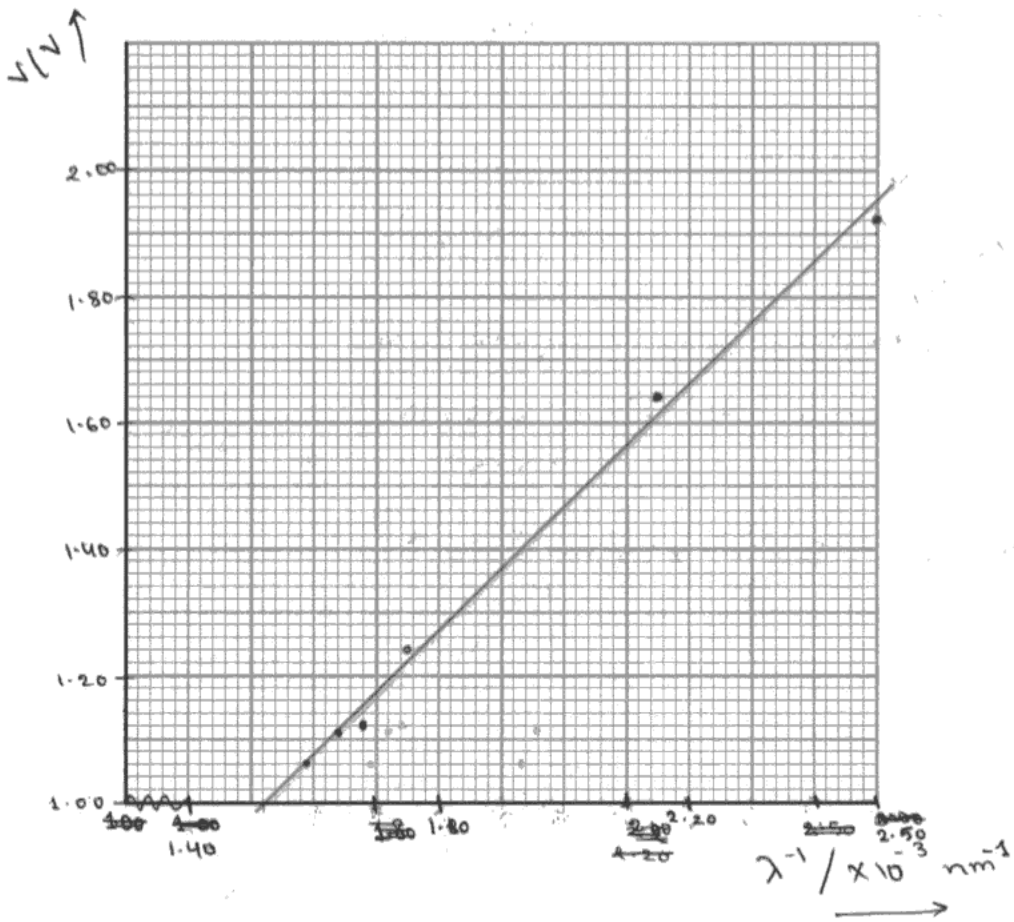
$\therefore f = \frac{c}{\lambda}$.

By comparing the equation with $y = mx$, gradient = $\frac{hc}{e}$.

Since $V \propto \frac{1}{\lambda}$ when h, c and e are constant, the graph will be a straight line.

(c) Plot the graph on the grid provided and draw a line of best fit.

(5)




TURN OVER FOR QUESTION 8(d).

(d) Use your graph to find a value for the gradient and use it to calculate a value for $h$.

(6)

Gradient $= \dfrac{(1.76 - 1)\ \text{V}}{(2.3 - 1.52) \times 10^{-3}\ \text{nm}^{-1}}$

$= 974.36$

$\dfrac{hc}{e} = 974.36 \times 10^{+9}$ ~~Vm~~

$hc = 974.36 \times 10^{9} \times 1.6 \times 10^{-19}$

$\therefore h = \dfrac{974.36 \times 10^{9} \times 1.6 \times 10^{-19}}{3 \times 10^{8}}\ \text{Js}$

$= 5.20 \times 10^{-34}\ \text{Js}$

(e) The accepted value for $h$ is $6.63 \times 10^{-34}$ J s.

Assuming your calculations are correct, suggest why there is a difference between your value for $h$ and the accepted value.

(1)

~~There was~~ One ~~of~~ or more of the wavelength, $\lambda$ provided by the manufacturer of the diode was wrong.

**ResultsPlus**
**Examiner Comments**

The line of best fit is correctly placed.

**ResultsPlus**
**Examiner Tip**

Full marks can be gained for concise answers as in part (e).

## Paper Summary

Advice for candidates

- Be familiar with standard form and the use of SI units, including multiples and submultiples.
- Look at the number of marks for each question and make sure you make that number of points in your answer.
- Be concise, use bullet points and address the question asked.

## Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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