Examiners' Report
June 2011

GCE 6PH02 01

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Introduction

This paper enabled candidates of all abilities to demonstrate their knowledge and apply their understanding of the specification and gave everyone access to marks in all questions. Responses demonstrated a good bank of physics knowledge carried over from candidates' GCSE courses. There was good progression with these topics to AS level, and there was a good understanding of the new concepts that the candidates had been taught. The overall mean mark for this paper is 6.6 marks higher than the same paper for June 2010 which is reflected in the grade boundaries. This paper differentiated between all abilities with questions such as 17 challenging the most able candidates. The calculation questions were mostly attempted and scored higher than those requiring an explanation across all ability ranges.

This paper did not penalise for significant figures as this is addressed in the practical unit. Correct use of significant figures when calculating a quantity or quoting an answer as well as accurately rounding an answer up or down when reading from a calculator are important skills and should be reinforced throughout the teaching of the course.

Section A

The multiple choice items in order of difficulty were: 1, 8, 7, 4, 10, 2, 6, 3, 9 and 5. The vast majority of candidates could answer questions 1 and 8 and at least half the candidates could answer correctly questions 7, 4, 10, 2 and 6.The remaining responses were answered correctly by fewer than half of the candidates.

Question 3 required the candidates to describe the displacement between two points, half a wavelength apart on a spring with a wave travelling along it. The majority of candidates chose response B, demonstrating that they did not understand the difference between the direction of wave propogation and wave displacement for a longitudinal wave. Accurate knowledge of this topic was also demonstrated later on in the paper with question 14.

Question 9 required the candidates to compare the drift velocities of 2 wires of different cross sectional areas in series in a circuit. The most common incorrect response seen was C demonstrating that the candidates knew that the drift velocity was double in the thicker wire than the narrow wire but were unable to express their answer as a correct ratio, showing poor number manipulation skills.

Question 5 was answered correctly the fewest number of times and, as repeated with question 15ciii, demonstrates the difficulty candidates have in working out the effect on both the voltage and current in a circuit when the resistance of a component has been altered. This question does not test a candidates knowledge of thermistors beyond that expected at GCSE.

Question 11 (a)

(a) This calculation was well answered with some incorrect units seen. Some candidates did have difficulty rearranging the equation and then did not score any marks if they substituted values into an incorrectly rearranged formula.

(a) Calculate the charge that flows in the lightning conductor during this time.

(2)

$I = \frac{\Delta Q}{\Delta t}$ $\Delta Q = I \times t = 15000 \times 3 \times 10^{-2}$

Charge = 450 C

ResultsPlus

Examiner Comments

A good answer. Equation quoted, re-arranged and substituted into correctly. Final answer and unit correct. 2 marks.

(a) Calculate the charge that flows in the lightning conductor during this time.

(2)

$15000 \div 3 \times 10^{-2} = 500\,000$

Charge = 500 000 C

ResultsPlus

Examiner Comments

This candidate has not quoted the formula and has just divided the current by the time.

ResultsPlus
Examiner Tip
Select the correct formula from the back of the question paper and write it down. Substitute in the correct values and then rearrange to make the quantity that you are finding the subject of the equation.

ResultsPlus
Examiner Tip
Incase you do not manage to calculate the final answer correctly, for most questions, method marks for correct use of a formula can be awarded.

Question 11 (b) (c)

(b) Most candidates managed to calculate the correct length from the formula and the majority of these candidates remembered to subtract 1m from their length to give the correct height of the statue. Errors with the calculation mainly involved confusing resistance and resistivity.

The mark for the assumption was not awarded as much, with many candidates referring to the equation and calculation rather than the context of the statue. The most common incorrect answer was that the cross sectional area is uniform and constant temperature. This was often left blank by candidates.

(c) Most candidates scored this mark having some idea why the lightning conductor was longer than the statue, however, their choice of scientific words in place of strikes or attract such as 'absorb' needed more thought. Few candidates actually tried to give a general correct statement about lightning taking the shortest path or strikes the highest point.

(b) The lightning conductor is 1 m taller than the statue and is made from copper, which has a resistivity of $1.7 \times 10^{-8}\ \Omega\ m$. The lightning conductor has a cross-sectional area of $1.5 \times 10^{-4}\ m^2$ and a resistance of $2.7 \times 10^{-3}\ \Omega$.

Calculate the height of the statue and state an assumption that you have made.

(4)

$R = \frac{\rho L}{A}$ $\quad 2.7\times10^{-3} = \frac{1.7\times10^{-8} \times L}{1.5\times10^{-4}}$

$L \times 1.7\times10^{-8} = ~~+8~~\ 4.05\times10^{-7}$

~~$L =$~~ ~~$\frac{18}{1.7\times10^{-8}}$~~ $L = 23.82m$

Height of statue = 22.82m

Assumption: The temperature is constant.

(c) Suggest why the lightning conductor is taller than the statue.

(1)

~~to make~~ This will make a higher resistance, reducing the flow of current. To protect the whole statue.

ResultsPlus

Examiner Comments

(b) Calculation carried out correctly. Assumption given relates to the physical property of the metal and not the length/position of the wire.

ResultsPlus

Examiner Comments

(c) Incorrect comment on current in wire once lightning has struck it. The question was looking for a comment relating to the idea that lightning takes the shortest path, whereas the candidates have confused this with a discussion of lightning taking the path of least resistance.

(b) The lightning conductor is 1 m taller than the statue and is made from copper, which has a resistivity of 1.7×10^{-8} Ω m. The lightning conductor has a cross-sectional area of 1.5×10^{-4} m² and a resistance of 2.7×10^{-3} Ω.

Calculate the height of the statue and state an assumption that you have made.

(4)

$R = \rho l / A$ $\quad l = \frac{RA}{\rho} = \frac{2.7\times10^{-3}\,\Omega \times 1.5\times10^{-4}\,m^2}{1.7\times10^{-8}\,\Omega m}$

$RA = \rho l$

$= 23.8\,m$

$23.8\,m - 1\,m = 22.8\,m$

Height of statue = 22.8m

Assumption: The lightning conductor is perfectly ~~ve~~ straight and vertical

(c) Suggest why the lightning conductor is taller than the statue.

(1)

The lighting would be attracted to closet material that has a lower resistance than air so if it (the lightning conductor) wasn't higher than the statue, it might be attracted the statue instead.

(Total for Question 11 = 7 marks)

ResultsPlus
Examiner Comments

(b) Correct calculation, unit and assumtion.

ResultsPlus
Examiner Comments

(c) Correct statement of physics and then discussed in terms of if the wire was shorter than the statue. 1 mark.

(4)

length of rod – $R = \frac{\rho l}{A}$

$(2.7 \times 10^{-3}) = \frac{(1.7 \times 10^{-8})(l)}{(1.5 \times 10^{-4})}$

$\frac{(2.7 \times 10^{-3})(1.5 \times 10^{-4})}{(1.7 \times 10^{-8})} = l$

$l = 23.823....$

length of statue = 23.8 – 1 = 22.8

Height of statue = 22.8 m

Assumption: That the area is constant throughout the rod. and that the resistance is constant.

(c) Suggest why the lightning conductor is taller than the statue.

(1)

As lightning will strike the taller object (first), so the lightning rod has to be taller to protect the statue. If it was smaller the lightning would strike the statue instead of the rod.

(Total for Question 11 = 7 marks)

ResultsPlus
Examiner Comments

(a) Calculation correct, equation substituted into and then rearranged.

ResultsPlus
Examiner Comments

Typical incorrect assumption relating to the cross sectional area.

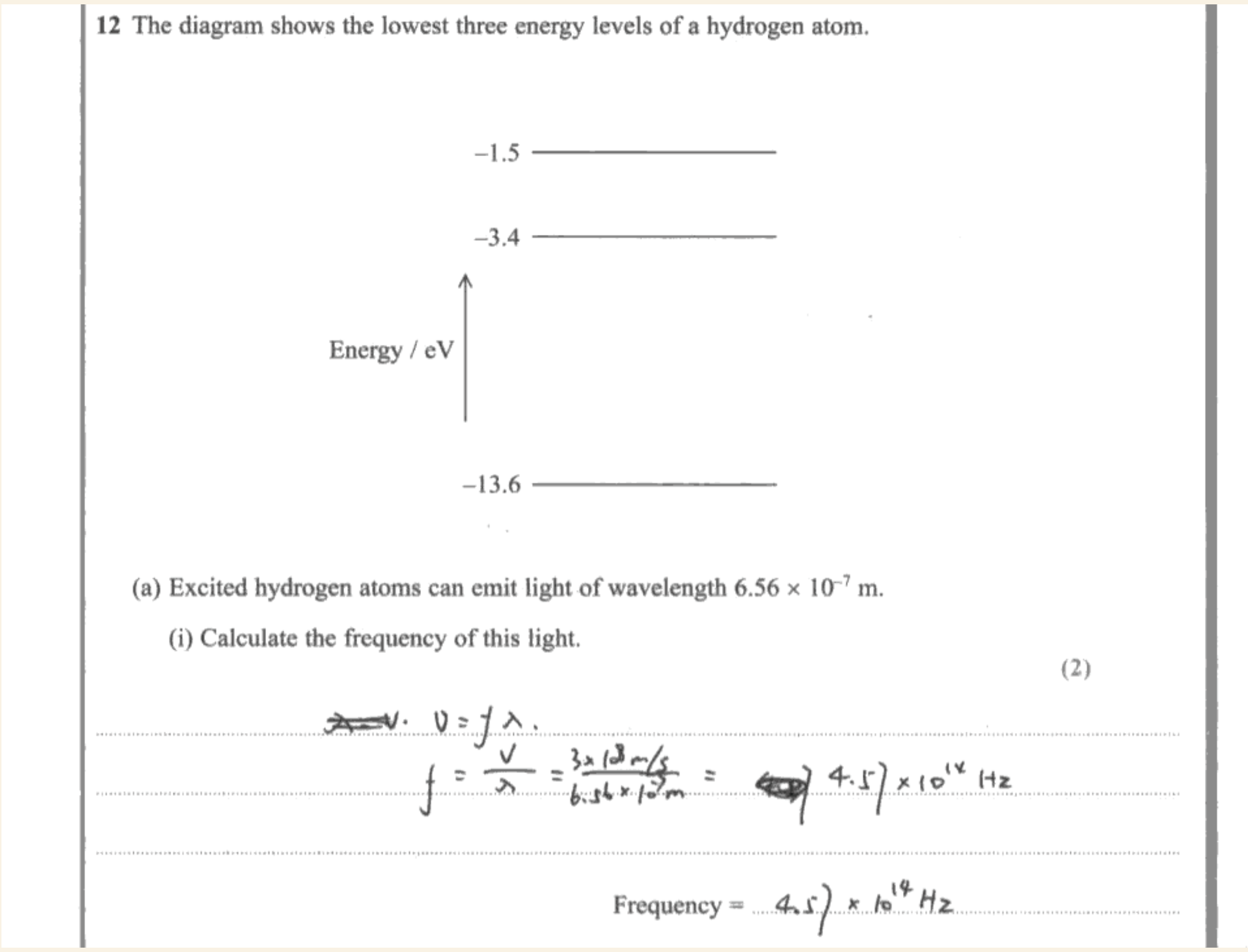
ResultsPlus
Examiner Comments

(b) Idea that lightning will strike the highest point. 1 mark.

Question 12 (a) (i)

Most candidates managed to score the full 2 marks here. Candidates managed to successfully select the speed of light from the data sheet. Candidates that only managed to score 1 mark lost the mark mainly through errors of power of ten, either in the substitution of the speed of light or misreading or omitting the power of 10 when reading their final answer from the calculator. Very few incorrect answers were due to omitted units.

Some candidates used E=hf with the energy given in part (ii) to calculate the frequency. This method scored 2 marks but is not to be encouraged as there could be a change in conditions between parts in a question which a candidate could miss.



12 The diagram shows the lowest three energy levels of a hydrogen atom.

(a) Excited hydrogen atoms can emit light of wavelength 6.56×10^{-7} m.

(i) Calculate the frequency of this light.

(2)

$v = f\lambda$

$f = \frac{v}{\lambda} = \frac{3 \times 10^{8} \text{ m/s}}{6.56 \times 10^{-7} \text{ m}} = 4.57 \times 10^{14}$ Hz

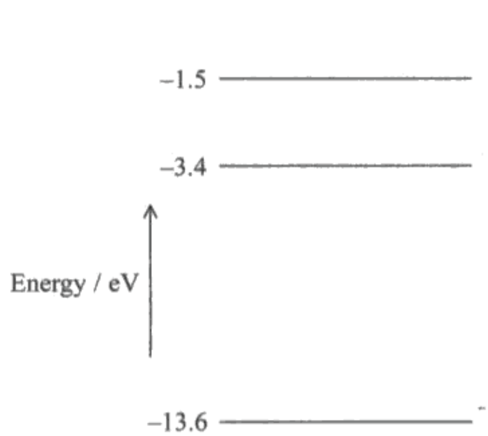
Frequency = 4.57×10^{14} Hz

ResultsPlus

Examiner Comments

Equation correctly quoted, rearranged and substituted into. 2 marks.

12 The diagram shows the lowest three energy levels of a hydrogen atom.



(a) Excited hydrogen atoms can emit light of wavelength 6.56×10^{-7} m.

(i) Calculate the frequency of this light.

(2)

$v = f\lambda$

$f = \frac{v}{\lambda}$ $f = \frac{3 \times 10^8}{6.56 \times 10^{-7}}$

$3.0 \times 10^8 = f \times 6.56 \times 10^{-7}$

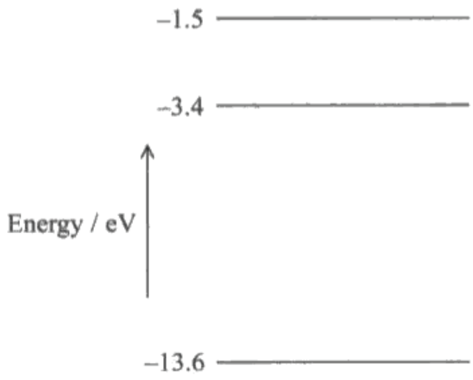
$= 4.5731 \ldots$

Frequency = 4.57 Hz

ResultsPlus Examiner Comments

Carelessness when copying the answer from the calculator meant that the power of 10 was missing from the final answer.

12 The diagram shows the lowest three energy levels of a hydrogen atom.



(a) Excited hydrogen atoms can emit light of wavelength 6.56×10^{-7} m.

(i) Calculate the frequency of this light.

(2)

$-13.6 \times (1.6 \times 10^{-19}) =$ [redacted] (-2.176×10^{-18})

$(-2.176 \times 10^{-18}) = (6.63 \times 10^{-34}) \times f$

$f = \dfrac{(-2.176 \times 10^{-18})}{(6.63 \times 10^{-34})} = -3.282 \times 10^{15}$

Frequency = -3.282×10^{15}

ResultsPlus

Examiner Comments

Incorrect attempt to use E=hf as the candidate did not realise that the energy had been given to them for this frequency of light. As this method uses data from another part of the question, no credit could be given for using the formula E=hf.

ResultsPlus

Examiner Tip

All the data you need to answer that part of the question will have been given to you. You do not need to look ahead for information.

Question 12 (a) (ii)

Most candidates managed to convert from joules to eV correctly. Realising that the energy levels involved were the -1.5 eV and the -3.4 eV most did not see the significance of the *from* and *to* written on the answer line. Whether they did not rememeber that the light was being emitted rather than absorbed, or just did not understand the difference between the two mechanisms, they mainly wrote the energy levels in the wrong way round on the answer line.

Many candidates just assigned the given energy levels numbers without indicating on the diagram which energies these levels corresponded to. Answers such as from 3 to 2 were common. In these situations, unless a correct conversion from J to eV or an energy transition in eV converted to joules were seen, no marks could be awarded for this question.

(ii) The energy of a photon of this frequency is 3.03×10^{-19} J.
By means of a calculation determine which electron transition emits this photon.

(2)

$1eV = 1.60 \times 10^{-19}$ $\quad (3.03 \times 10^{-19}) \div (1.6 \times 10^{-19}) = 1.89$

$3.4 - 1.5 = 1.9$

from -1.5 to -3.4

ResultsPlus
Examiner Comments

Energy correctly converted from J to eV.

ResultsPlus
Examiner Comments

Substitution of energy levels shown, albeit the wrong way round, and then written into answer line in correct order.

(ii) The energy of a photon of this frequency is 3.03×10^{-19} J.
By means of a calculation determine which electron transition emits this photon.
(2)

$\frac{3.03\times10^{-19}}{1.6\times10^{-19}} = 1.9$

$-1.5 - -3.4 = 1.9$

from -1.5 to -3.4

ResultsPlus
Examiner Comments

Correct energy in eV, levels have even been subtracted from each other the correct way round but the candidate has failed to see the significance of the positive 1.9 as a difference of the energy levels and has then gone on to write them in the wrong way round on the answer line.

ResultsPlus
Examiner Tip

When using energy levels, make sure that you know first whether the transition is due to an emission or an absorbtion so you know which way the electron has moved.

(ii) The energy of a photon of this frequency is 3.03×10^{-19} J.
By means of a calculation determine which electron transition emits this photon.

(2)

E = hf   -3.4 - -13.6 = 10.2 × 1.60×10⁻¹⁹

-1.5 - -3.4 = 1.9 × 1.60 × 10⁻¹⁹

from ~~[illegible]~~ -1.5 to ~~[illegible]~~ -3.4

ResultsPlus
Examiner Comments

Energy transition worked out first and then converted from eV into joules. No value seen of the energy in joules but this is just an interim mark for the method and no answer in joules is required. Correct transition seen. 2 marks.

Question 12 (b)

Most candidates managed to score at least 1 mark for this question. Given that this question is based on a topic that many candidates would have been taught during their GCSE course, it was requiring no further knowledge. However, many thought that the question was not about red shift and the Doppler Effect but, in the context of the earlier parts question, was referring to the use of absorbtion spectra to identify elements in stars. Hence answers where they talked about the galaxy containing different elements to that of the sun were seen.

Candidates whose thinking was on the right track and had the idea that this was redshift etc. did not always relate their findings to the galaxy and jumped straight to the standard response that the universe is expanding. As the expansion of the expansion of the universe is not in the specification for this module, we were looking for an understanding that with the Doppler Effect, with an increasing wavelength, the object is moving away from the observer. Therefore relating the physics to the context of the question, it has to be the galaxy moving away. Some candidates were aware of the inability of the observer to tell whether it is the galaxy moving away from us or we were moving away from the galaxy. Both explanations scored the mark.

(b) The spectrum of light from the Sun has a dark line at a wavelength of 656 nm. In the spectrum of light received from a distant galaxy, the corresponding line appears at a wavelength of 690 nm.

Explain what the observation tells us about this galaxy. Do not include calculations in your answer.

(2)

~~The watets~~ – A wave will be observed to have a higher wavelength when the observing is getting futher from the source
– The wavelength has increase so red-shift has taken place according to the doppler effect
– So the galaxy is moving away

(Total for Question 12 = 6 marks)

ResultsPlus

Examiner Comments

Good answer. Scores 2 marks.

(b) The spectrum of light from the Sun has a dark line at a wavelength of 656 nm. In the spectrum of light received from a distant galaxy, the corresponding line appears at a wavelength of 690 nm.

Explain what the observation tells us about this galaxy. Do not include calculations in your answer.

(2)

That the galaxy is expanding because the wavelengths are moving towards the red end of the spectrum, known as the Red Shift.

(Total for Question 12 = 6 marks)

ResultsPlus
Examiner Comments

The candidate has the correct idea that the change in wavelength has caused a redshift but has confused the ideas of the universe expanding and the galaxy is moving away from us.

ResultsPlus
Examiner Comments

Just 1 mark awarded for the idea of red shift.

(b) The spectrum of light from the Sun has a dark line at a wavelength of 656 nm. In the spectrum of light received from a distant galaxy, the corresponding line appears at a wavelength of 690 nm.

Explain what the observation tells us about this galaxy. Do not include calculations in your answer.

(2)

This observation tells us that this galaxy has a similar star to our sun as our sun consists mainly of Hydrogen and the wavelength recieved from the distant galaxy is similar to the wavelength of light emitted from excited hydrogen atoms.

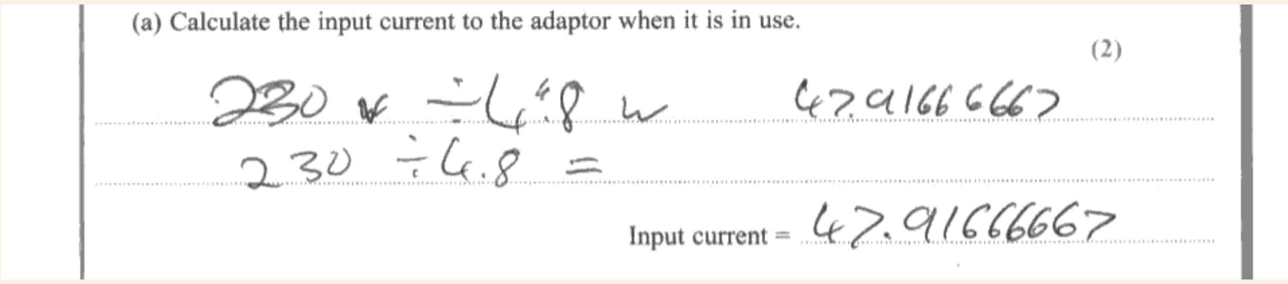
(Total for Question 12 = 6 marks)

ResultsPlus
Examiner Comments

Misunderstanding of the term 'corresponding line' so that the candidate thinks that the question is asking them to compare the composition of the star and the galaxy. 0 marks.

Question 13 (a)

This question was answered very well with most candidates scoring the full 2 marks. Candidates chose to display the answer in a variety of ways, with 0.021 A, 2.1 mA and 2.1 x 10^{-3} A seen.


(a) Calculate the input current to the adaptor when it is in use.

(2)

230 V ÷ 4.8 W 47.91666667

230 ÷ 4.8 =

Input current = 47.91666667

ResultsPlus

Examiner Comments

This candidate has rearranged the equation incorrectly and then substituted in the values. This was the most common reason for canddiates to lose mark. As the formula is given in the back of the booklet, this reinforces the need for the good practice of quoting, substituting and then rearranging a formula.

Question 13 (b)

(bi) This question seemed to confuse candidates as many were thinking about the 3 mark question from last June's paper and showed from first principles that volts x amps = watts. Here we were just looking for a simple equivalence of units from quoting P = VI and then substituting in the correct units. Both methods scored the mark. Some candidate showed that VI is measured in VA but forgot to mention that the power is measured in watts.

(bii) Answered well. The majority of candidates scored the 2 marks. Any 1 mark responses seen were due to the omission of the % with the answer.

(biii) Most candidates were awarded a mark here. It was good to see so few responses with 'transferred to the surroundings' and that candidates trying to apply energy changes to context of the question. Some candidates did show a lack of understanding of the mechanism of the charger and referred to the power loss due to the internal resistance of the battery which did not score a mark.

(b) The adaptor's output is labelled as 5 V   0.1 A   0.5 V A

(i) Show that the unit V A is equivalent to the watt.

(1)

$V = E/Q = J/As = JA^{-1}s^{-1}$

$JA^{-1}s^{-1} \times A = Js^{-1}$

$W = Js^{-1}$

(ii) Calculate the efficiency of the adaptor.

(2)

$100 \times \left(\frac{P_{out}}{P_{in}}\right)$ $\left(\frac{0.5}{4.8}\right) \times 100 = 10.4167\ \%$

Efficiency = 10.4 %

(iii) Suggest a reason why the efficiency is less than 100%.

(1)

There is a large internal resistance of the adaptor resulting in a large number of 'lost volts'.

ResultsPlus
Examiner Comments

b(i) Answered using first principles. Scores 2 marks
b(ii) Correct ratio of powers x 100 , 2 marks.
b(iii) Source of energy loss identified but the candidate has not related this to the efficiency by mentioning that there is a power loss or energy loss due to the internal resistance of the adaptor. No mark awarded.

(b) The adaptor's output is labelled as 5 V 0.1 A 0.5 V A

(i) Show that the unit V A is equivalent to the watt. (1)

P = VI volts – V, Amps – A, whatts

W = VA

(ii) Calculate the efficiency of the adaptor. (2)

5V out / 230V in × 100

5 / 230 = 0.0217 × 100

Efficiency = 2.17 %

(iii) Suggest a reason why the efficiency is less than 100%. (1)

Because some of the energy is used for different sources.

ResultsPlus
Examiner Comments

b(i) P = VI seen and W = VA. 1 mark.
b(ii) Ratio of voltages used and not power. 0 marks.
b(iii) Too vague. we needed to see a cause or a specific energy transfer.

ResultsPlus
Examiner Tip

Remember that efficiency is a percentage based on the ratio of the input to output energies or powers as given on the formula sheet in the back of the exam paper.

(b) The adaptor's output is labelled as 5 V 0.1 A 0.5 V A

(i) Show that the unit V A is equivalent to the watt.

(1)

According to the equation $P = VI$

$W = V \times A$

$0.5VA = 5V \times 0.1A$

(ii) Calculate the efficiency of the adaptor.

(2)

$\frac{4.8}{5} \times 100 = 96\%$

Efficiency = 96%

(iii) Suggest a reason why the efficiency is less than 100%.

(1)

The battery has an internal resistance which is not negligible.

ResultsPlus

Examiner Comments

b(i) 1 mark.
b(ii) Ratio of input power to output voltage used. 0 marks.
b(iii)Internal resistance of the battery mentioned as the candidate has not fully understood how the charger works. Also no mention of energy or power loss due to this cause.

ResultsPlus

Examiner Tip

If you are describing an efficiency it has to be in terms of power or energy.

ResultsPlus

Examiner Tip

Try to spend a little more time thinking about what is going on in the example you are given before answering the question. Although you will have learnt the physics that you are being tested on, the application may be new to you and you need to understand how, in this case, the charger works.

Question 14 (a-b) (i)

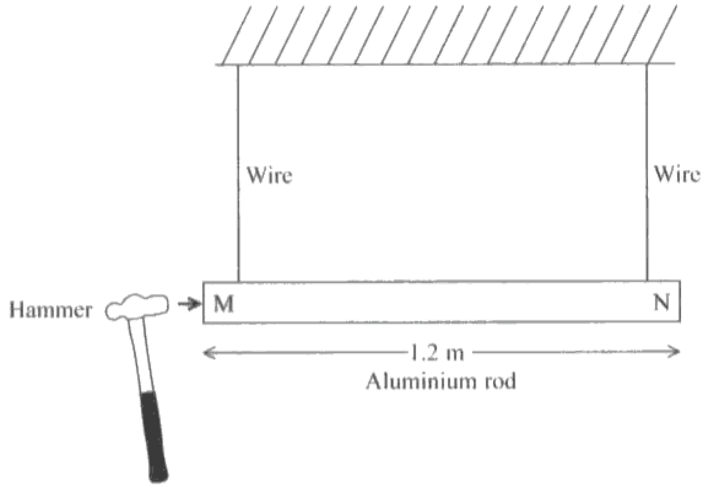
(a) A very detailed description was required to score both marks. Most candidates scored 1 mark for a partial definition of both transverse and longitudinal waves. Most candidates who missed out on the second mark failed to say what the direction of travel was for i.e. the wave.

b(i) Most candidates managed to identify that it would be a longitudinal wave travelling through the rod. However, nearly all candidates did not understand the mechanism of the hammer hitting the rod horizontally to cause the longitudinal wave and chose to describe the criteria for a longitudinal wave instead, repeating the answer to part (a) and scoring a maximum of 1 mark.

A longitudinal wave has vibrating particles which oscillate along the direction of propagation in a series of compressions and rarefactions e.g. sound waves whereas transverse waves oscillates at right angles to the direction of propagation e.g. light waves. Transverse waves can travel in a vacuum, longitudinal waves cannot.

(b) A teacher sets up the following demonstration to show that the speed of sound in an aluminium rod is greater than in air.

An aluminium rod MN of length 1.2 m is suspended horizontally by two wires as shown in the diagram.



A wave pulse is made to travel along the rod and reflect from end N. The wave pulse is produced by hitting end M gently with a hammer so that the hammer remains in contact with end M until the reflected pulse returns.

(i) State and explain whether the wave pulse is transverse or longitudinal.

(2)

Longitudinal as particles are made to vibrate and the wave begins with a compression (hammer hitting the end) and the wave compresses and rarefacts / oscillates along the direction of propagation.

ResultsPlus

Examiner Comments

A rare example of a candidate who managed to score both marks for both sections.
b(i) The candidate has realised that the hammer hitting the rod causes a compresssion so the wave must be longitudinal. Without mentioning the hammer in the is answer it was very difficultt to score the mark as we were looking for the cause and then the effect i.e. a longitudinal wave. As the hammer caused the waves, it really is required for this explanation.

14 (a) Describe the difference between a transverse wave and a longitudinal wave.

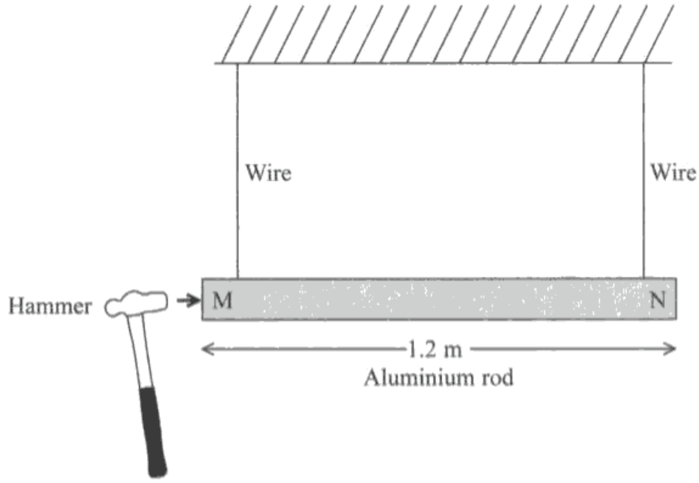
(2)

x A transvers wave ossilates perpendicular to direction of travel

x A ~~[illegible]~~ longitudinal wave ossilates in the direction of travel.

(b) A teacher sets up the following demonstration to show that the speed of sound in an aluminium rod is greater than in air.

An aluminium rod MN of length 1.2 m is suspended horizontally by two wires as shown in the diagram.



A wave pulse is made to travel along the rod and reflect from end N. The wave pulse is produced by hitting end M gently with a hammer so that the hammer remains in contact with end M until the reflected pulse returns.

(i) State and explain whether the wave pulse is transverse or longitudinal.

(2)

x ~~lon~~ The wave pulse is longitudinal. This is because the hammer hitting the metal is causing particles to vibrate passing on the energy.

ResultsPlus
Examiner Comments

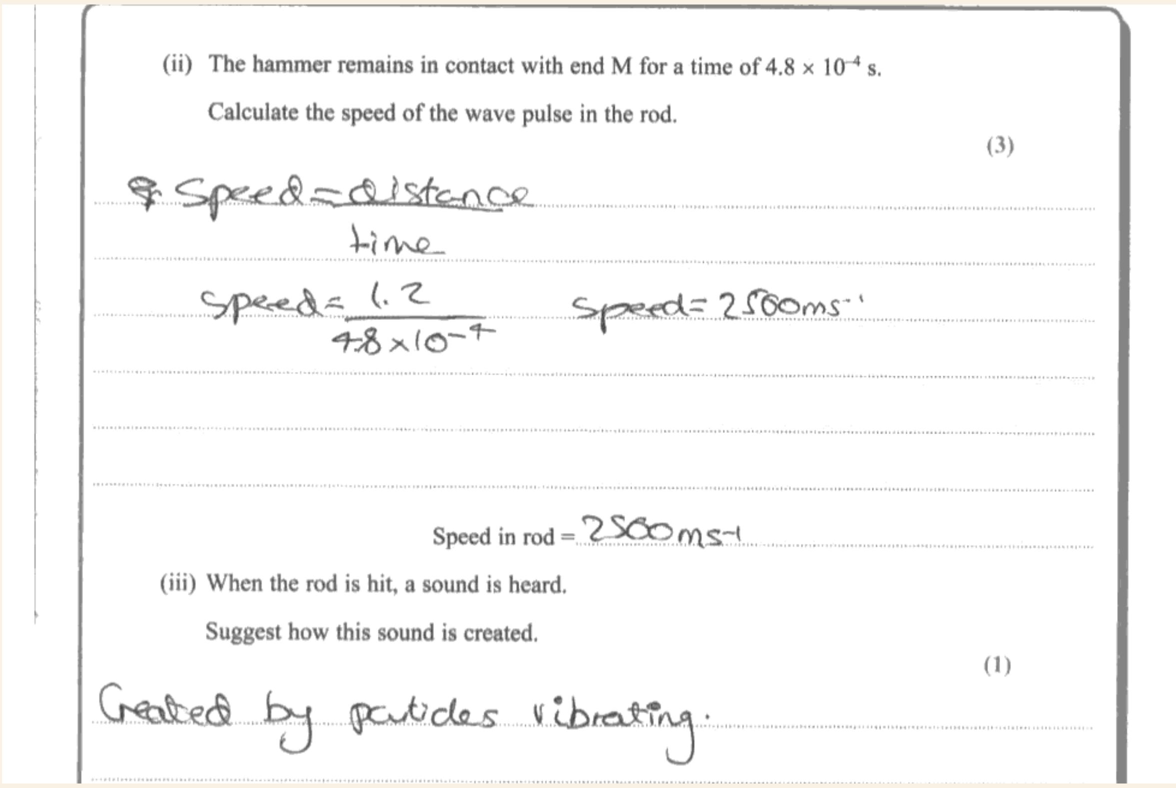
(a) Incomplete definition. Scores just 1 mark.
(b)(i) Correct wave identified. Candidate has started to describe what it happening but has missed out the missing link of the hammer and the compression.

Question 14 (b) (ii-iii)

(b)(ii) Most candidates could successfully use the equation speed = distance/time. However many candiates forgot that the wave was travelling to the end of the rod and back again, hence forgetting to halve the distance or double the time. Most scores seen were either 1 or 3 depending on if they had remembered this.

As in the context of earlier and later parts of this question, some candidates tried to use $c=f\lambda$ which did give the correct answer but scored no marks.

(b)(iii) Most candidates misread this question and thought that it was asking them to describe how the sound is heard rather than how it is created. Many responses were in terms of vibrating air molecules rather than vibrations of the atoms in the rod.



(ii) The hammer remains in contact with end M for a time of 4.8×10^{-4} s.

Calculate the speed of the wave pulse in the rod.

(3)

$Speed = \frac{distance}{time}$

$speed = \frac{1.2}{4.8 \times 10^{-4}}$ $speed = 2500 ms^{-1}$

Speed in rod = 2500 ms^{-1}

(iii) When the rod is hit, a sound is heard.

Suggest how this sound is created.

(1)

Created by particles vibrating.

ResultsPlus
Examiner Comments

(ii) Distance has not been doubled or time halved.1 mark only.
(ii) Correct idea but they could be referring to the air or the rod. Not specific enough to describe the cause of the sound. 1 mark.

(ii) The hammer remains in contact with end M for a time of 4.8×10^{-4} s.

Calculate the speed of the wave pulse in the rod.

(3)

hammer remains in contact until pulse returns so time period = 4.8×10^{-4} s. ~~T=1/f~~ $f = \frac{1}{T} = 2083.3$ Hz (1dp)

length of aluminium rod is 1.2 m so wavelength is 1.2 m.

$v = \lambda \times f$ $v = 1.2 \times 2083.3...$

$v = 2500 ms^{-1}$

Speed in rod = 2500 ms^{-1}

(iii) When the rod is hit, a sound is heard.

Suggest how this sound is created.

(1)

when the rod is hit it causes vibration in the rod ~~which~~ which form a standing wave that causes a sound.

ResultsPlus
Examiner Comments

(ii) c = fλ method used so no marks.
(ii) 2 marks.

Question 14 (c)

This question was answered very well with most candidates scoring at least 1 mark, mainly for identifying that the wave has been reflected. Very few diagrams seen, these were mostly unlabelled so were unable to be given any credit. Although the concept of standing waves could be described well, there was some discussion of phase and coherence, which was ignored but did show some confusion between standing and progressive waves. SuperIMposition (which is incorrect) seen fewer times than usual. The ideas of the wave reflecting, or higher ability candidates discussing it in terms of two waves travelling in opposite directions, and nodes and antinodes were the most common ideas to be seen. Fewer candidates mentioning the same frequency.

(c) A standing wave is set up in the rod.

Explain how a standing wave is formed.

(3)

When a wave travels from one end to another, it reflects back, causing the reflected wave and the original wave sent to superpose. The positions of the crests and troughs remain constant and a series of anti-nodes (due to constructive interferance) and nodes (due to destructive interferance) are formed, this, in turn, is a standing wave.

(Total for Question 14 = 11 marks)

ResultsPlus
Examiner Comments

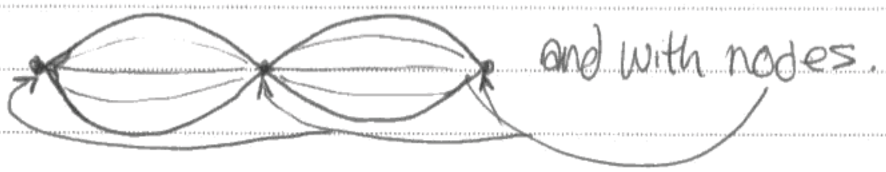
A typical answer scoring all 3 marks.

(c) A standing wave is set up in the rod.

Explain how a standing wave is formed.

(3)

Where a wave appears to be 'still' yet it is not, just has a definitive end and retraces it's path so it looks like this:



(Total for Question 14 = 11 marks)

ResultsPlus

Examiner Comments

Diagram attempted but not completely labelled. An arrow identifying the antinodes and another showing that the 2 frequencies would have scored this response 2 marks. As it stands it gets no marks.

ResultsPlus

Examiner Tip

Always label diagrams in detail when attempting to use them as part of an explanation.

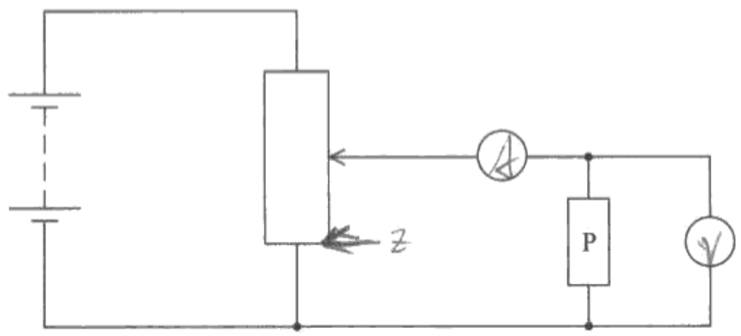
Question 15 (a)

(a)(i) Nearly every candidate labelled the voltmeter and ammeter the correct way round.

(a)(ii) Over half the candidates were unable to label Z correctly. The likelyhood for a candidate , for seeing 0 volts on the voltmenter, would be to place Z at the top or bottom end of the resistor but on most incorrect responses, Z was placed randomly around the circuit.

The concept of potential dividers continually confuses candidates from year to year and needs to be addressed, whether it be through additional practical work or simpler examples given initially when it is taught so that candidates can appreciate the fundamental idea that the voltage across such a device can change, depending on how much of the device is in the part of the circuit that the volmeter is connected across.

15 (a) The diagram shows the circuit used to investigate how the current varies with potential difference for an electrical component P. The circuit contains an ammeter and a voltmeter.



(i) On the diagram, label the ammeter A and the voltmeter V.

(1)

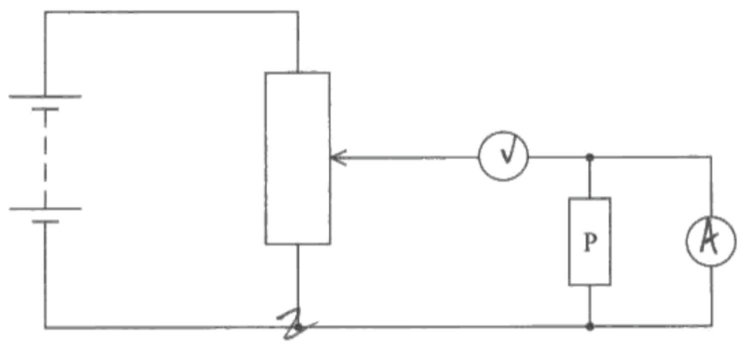
(ii) The position of the contact of the potential divider is moved so that the reading on the voltmeter becomes zero. Label this position Z.

(1)

ResultsPlus
Examiner Comments

(i) and (ii) both correct.

15 (a) The diagram shows the circuit used to investigate how the current varies with potential difference for an electrical component P. The circuit contains an ammeter and a voltmeter.



(i) On the diagram, label the ammeter A and the voltmeter V.

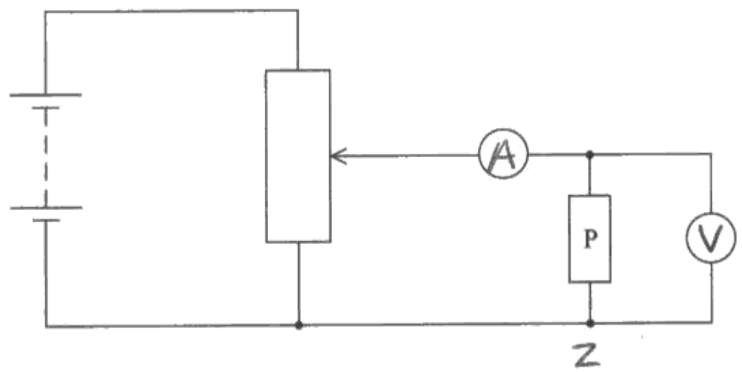
(1)

(ii) The position of the contact of the potential divider is moved so that the reading on the voltmeter becomes zero. Label this position Z.

(1)

ResultsPlus
Examiner Comments

(ii) Although the position of Z is not exactly on the resistor, as the reading on the voltmeter would also be 0 volts, this postition was allowed for the mark.



(i) On the diagram, label the ammeter A and the voltmeter V.

(1)

(ii) The position of the contact of the potential divider is moved so that the reading on the voltmeter becomes zero. Label this position Z.

(1)

ResultsPlus
Examiner Comments

A typical incorrect answer.

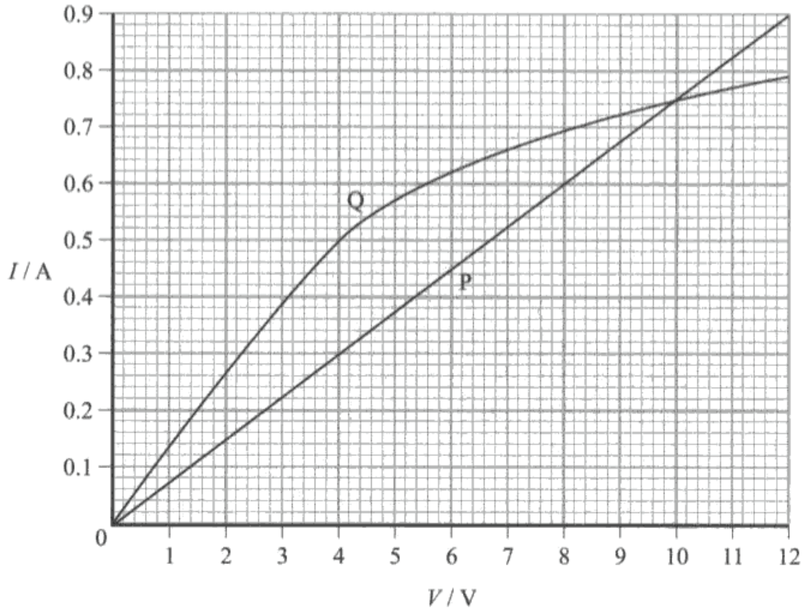
Question 15 (b)

(b)(i) Virtually all candidates could read the correct value from the graph. Resistance was usually found correctly. Some candidates did try to find the gradient of the graph, scoring only 1 mark for use of the formula V=IR.

(b)(ii) Candidates found this question more challenging, many trying to describe the shape of the graph rather than explaining its shape. Some candidates did think that the graph was ohmic at small currents and a mark was given for this. Most candidates could identify that the temperature was increasing but not identify that it was the current causing the increase and not the voltage as commonly seen. Most candidates managed to get a mark for the idea that the resistance is increasing. At this point only the most able candidates were able to get the last marking point about the rate of increase of the current decreasing. Many attempted to describe the decreasing gradient but were too vague, just mentioning a smaller increase in current as the voltage increases.

This problem with describing rates was repeated in question 16aii as to try to describe non linear graphs without a mention of rate is much more difficult. It is expected that candidates will be taught to comment on trends/pattern seen with data obtained in the practical aspect of the course (6PH03, section d, statement A5)and an understanding of the terms linear, proportional, directly proportional, rate is expected from candidates.

(b) The graph shows how the current I varies with potential difference V for two electrical components P and Q.



(i) State the value of the current for which the resistance of P is the same as the resistance of Q and determine this value of resistance.

(3)

Current = 0.75 A

R : V/I

R = 10/0.75 = 13.3

Resistance = 13.3 Ω

*(ii) Component Q is a filament lamp. Explain the shape of its graph.

(3)

I is proportionate to V but not directly therefore there is a constant to calculate for total internal resistance.

ResultsPlus

Examiner Comments

(b)(i) 3 marks.
(b)(ii) No marks as candidate has just attempted to describe the shape of the graph and not explain it.

ResultsPlus

Examiner Comments

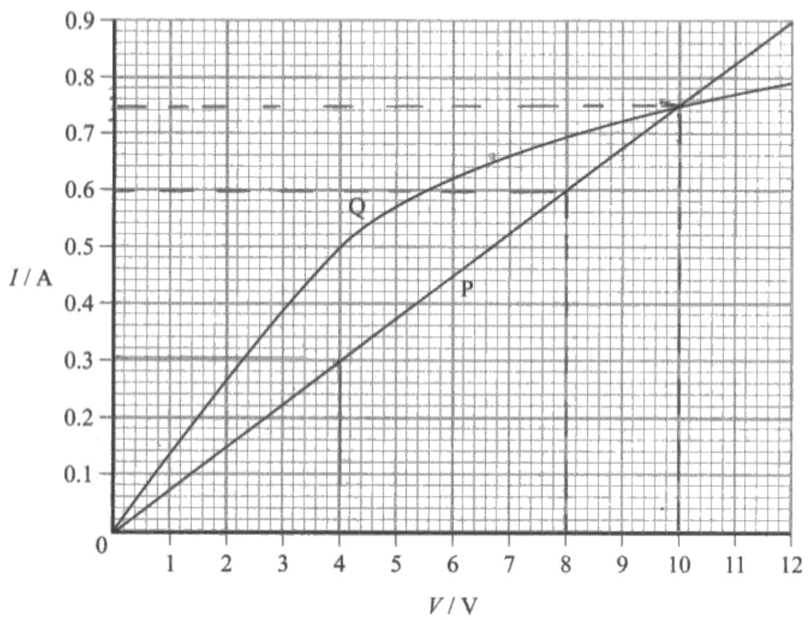
A range of features presented, but the answer could have been improved with reference to 'nearshore', 'background 'etc – which would provide more structure to the answer.

ResultsPlus

Examiner Tip

In this case you need to see what has increased initially (the voltage) and then what has increased as a result of this increase (the current) and then describe the effect that the increased current has on the material eg heating effect, resistance increases and then relate this back to the graph eg the rate of increse of current now decreases.

(b) The graph shows how the current I varies with potential difference V for two electrical components P and Q.



(i) State the value of the current for which the resistance of P is the same as the resistance of Q and determine this value of resistance.

(3)

Current = 0.75 A

~~I=~~ $V = IR$

$R = \frac{V}{I}$ $\qquad \frac{10}{0.75} = 13.\dot{3}$

Resistance = 13.3 Ω

*(ii) Component Q is a filament lamp. Explain the shape of its graph.

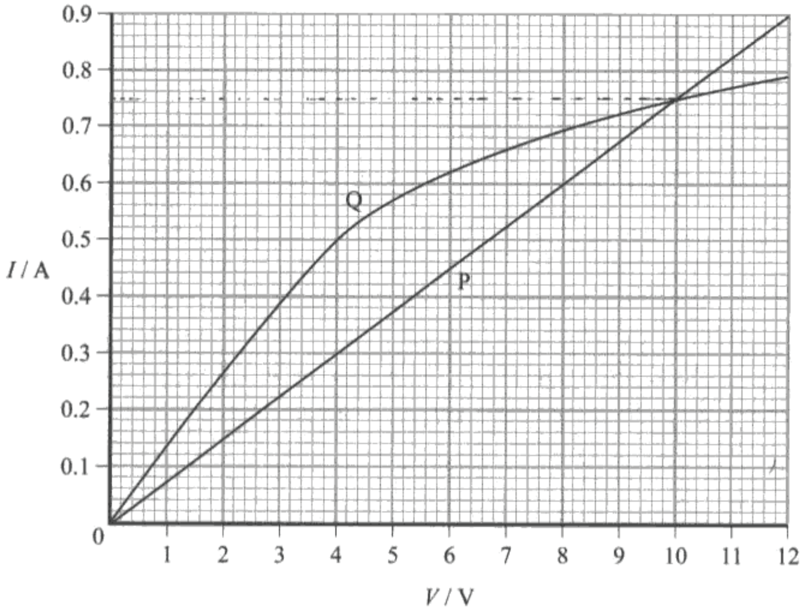
(3)

As the potential difference across the lamp is increased, so does the temperature, as temperature rises the resistance increases (due to increased interactions between ions in the lattices). As the relationship V=IR shows, ~~the~~ shows an increased resistance means that a lower current is produced to create the same p.d

ResultsPlus
Examiner Comments

(b)(i) All 3 marks.
(b)(ii) The candidate has implied that temperature increases due to the increasing voltage but correctly identified that the resistance increases. 1 mark.
They have attempted to describe the decreasing rate of increase of current but have not quite described the idea that for the same voltage increase, at higher voltages, a lower current is produced.

(b) The graph shows how the current I varies with potential difference V for two electrical components P and Q.



(i) State the value of the current for which the resistance of P is the same as the resistance of Q and determine this value of resistance.

(3)

Current = 0.75 A

9.9/0.75 = R = 13.2

Resistance = 13.2 Ω.

*(ii) Component Q is a filament lamp. Explain the shape of its graph.

(3)

~~Res~~ The current quickly increases with low current as the temperature is low, however, as the current increases so does the temperature which causes resistance to increase. This means current rises at a lower rate with increases in voltage giving the graph ~~its~~ it's curved shape.

ResultsPlus

Examiner Comments

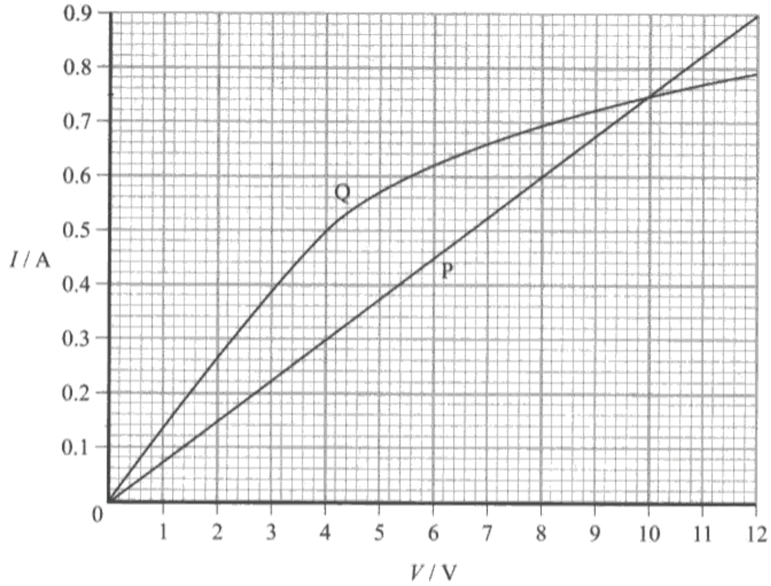
(b)(i) 3 marks.
(b)(ii) 3 marks, increase in current at a lower rate correctly described.

Question 15 (c) (i-ii)

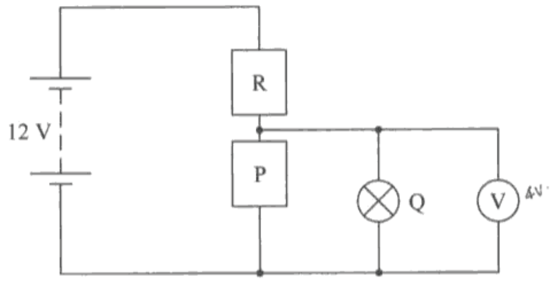
(c)(i)This question was not well answered and, along with 15ciii demonstrates a poor understanding of Kirchoff's laws. Most candidates failed to realise that they had to read two currents from the graph, those who did find 0. 3A and 0.5 A did usually remember to add them together. Candidates were also seen to read the current from the graph at 8V and getting an answer of 0.6A, not realising that the graph is not for component R but for P and Q.

(c)(ii) Candidates managed to score better in this question as the incorrect current found in part (c)(i) was allowed as an error carried forward. The most difficult part for the candidates was to realise that, as they were finding the resistance of R, they had to use the potential difference across R of 8V and not 4V. Once the values to be used were identified, candidates could use V=IR successfully but often did not score any marks for this question as they did not have the correct voltage.

(b) The graph shows how the current I varies with potential difference V for two electrical components P and Q.



(c) A potential divider consisting of component P and a resistor R is connected to a 12 V supply. The lamp Q and a voltmeter are connected to the circuit as shown.



The supply has a negligible internal resistance. The reading on the voltmeter is 4.0 V.

(i) Use the graph in part (b) to determine the current in the resistor R.

(2)

~~V=4V~~ 12V − 4V = 8V

~~I=0.5I~~ I = 0.6 A.

~~R = V/I = 4/0.5 = 8 Ω~~

Current = 0.6 A

(ii) Calculate the resistance of the resistor R.

(2)

$R = \frac{V}{I} = \frac{8V}{0.6A} = 13.3\ \Omega$

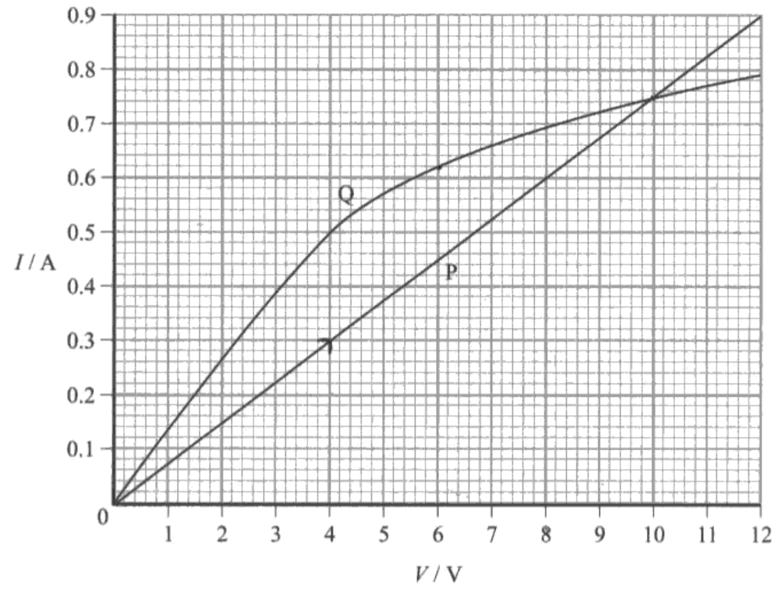
ResultsPlus
Examiner Comments

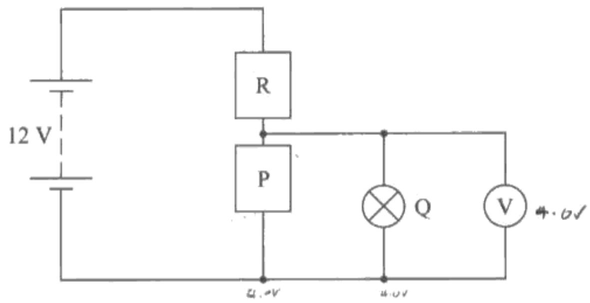
(c)(i) Incorrect voltage of 8V used to read from the graph. No marks.
(c)(ii) Correct use of V=IR with the incorrect current from part (i) and the correct voltage of 8V. 2 marks.

ResultsPlus
Examiner Tip

As there is not a graph for the pd across R remember that the current through R is the sum of the individual currents through P and Q which can be found from the graph.

(b) The graph shows how the current I varies with potential difference V for two electrical components P and Q.





The supply has a negligible internal resistance. The reading on the voltmeter is 4.0 V.

(i) Use the graph in part (b) to determine the current in the resistor R.

(2)

V = 4.0 V

∴ Current = 0.3 A

Current = 0.3 A

(ii) Calculate the resistance of the resistor R.

(2)

R = V/I = 4/0.3 = 13.3 Ω

Resistance = 13.3 Ω

ResultsPlus

Examiner Comments

(i) Only 1 current read from the graph. both currents are needed for the first mark.
(ii) 4 V is the voltage across P and Q and not R so no marks.

Question 15 (c) (iii)

Over half the candidates gained a mark for identifying that the reading increases. The explanations that accompanied this statement were mostly incorrect with many candidates describing how the current only has to go through 1 component so will increase so there will be an increase in the voltage. Any attempts to describe the effect in terms of current did not score. Good answers correctly described how the resistance of p is now greater than when it was in parallel, voltage increases across P and hence voltmeter reading increases.

(iii) The lamp Q is removed.

Explain, without further calculation, how the voltmeter reading would change.

(3)

The amount of voltage would remain the same, as lamp Q is removed. This is because ~~as~~ the voltage would remain the same, as the circuit is parallel.

ResultsPlus

Examiner Comments

Scores no marks.

(3)

The reading would increase as the resistance in Q would be removed meaning the ~~resistance across the voltmeter~~ Total resistance across the section the voltmeter was reading across would have increased as ~~decreased and~~ ~~by $R = \frac{V}{I}$ if I is constant as it is in this case~~ then adding resistors in parallel you add $\frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_T}$. This would mean the Total resistance increases if Q is removed and by $R = \frac{V}{I}$ if I is constant as it is the Voltage also increases

(Total for Question 15 = 15 marks)

ResultsPlus

Examiner Comments

Scores 3 marks. The candidate has clearly discussed and understood the change of resistance of the section the voltmeter is connected across and hence the increase in voltage and voltmeter reading.

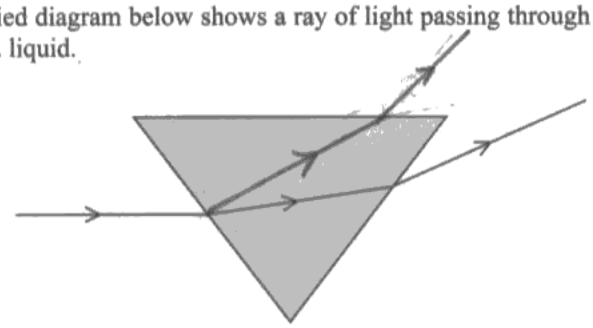
Question 16 (a) (i)

This was mostly answered well with candidates able to show the greater refraction at both boudaries caused by the increase in density of the sugar concentration. For the second refraction boundary some candidates drew a line leaving the prism, parallel to the other exiting ray, not realising that it would have a greater angle of refraction as the refractive index had increased.

Some diagrams were seen where the lines had been drawn without a ruler, just as a candidates would never draw in a ray during a pactical without a ruler, they should extend this to theoretical work when completing ray diagrams. All candidates should bring a ruler to an A level Physics exam.

16 (a) Refractometers are used in the food manufacturing industry to measure the concentration of sugar in different drinks. As the concentration of sugar increases, the refractive index of the liquid also increases. A simple refractometer uses a hollow prism shape that can be filled with different liquids.

(i) The simplified diagram below shows a ray of light passing through a prism filled with a liquid.



The liquid is replaced with one of a higher sugar concentration.

Using the same incident ray, draw the new path through the liquid and out of the prism.

(2)

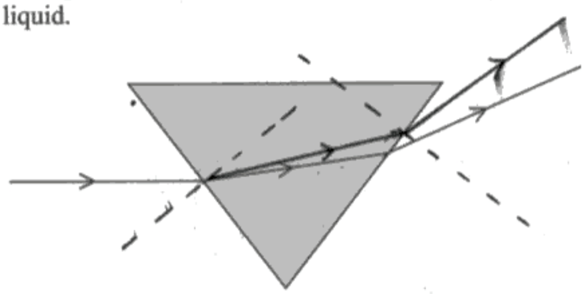
ResultsPlus

Examiner Comments

Unlikely that the change in density would be so great to cause the ray to reach the top face of the prism, however, the refraction at the first boundary has increased so 1 mark. The refracted ray on exiting the top face does not bend away from the normal so no mark awarded for that ray.

16 (a) Refractometers are used in the food manufacturing industry to measure the concentration of sugar in different drinks. As the concentration of sugar increases, the refractive index of the liquid also increases. A simple refractometer uses a hollow prism shape that can be filled with different liquids.

(i) The simplified diagram below shows a ray of light passing through a prism filled with a liquid.



The liquid is replaced with one of a higher sugar concentration.

Using the same incident ray, draw the new path through the liquid and out of the prism.

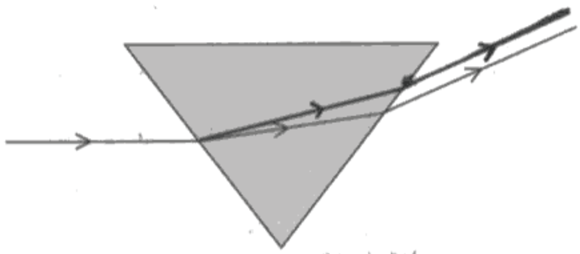
(2)

ResultsPlus
Examiner Comments

A good answer, scores 2 marks for the 2 correct refracted rays drawn.No marks were awarded for seeing any normals but the candidate here was not able to draw either correctly.

16 (a) Refractometers are used in the food manufacturing industry to measure the concentration of sugar in different drinks. As the concentration of sugar increases, the refractive index of the liquid also increases. A simple refractometer uses a hollow prism shape that can be filled with different liquids.

(i) The simplified diagram below shows a ray of light passing through a prism filled with a liquid.



The liquid is replaced with one of a higher sugar concentration.

Using the same incident ray, draw the new path through the liquid and out of the prism.

(2)

ResultsPlus
Examiner Comments

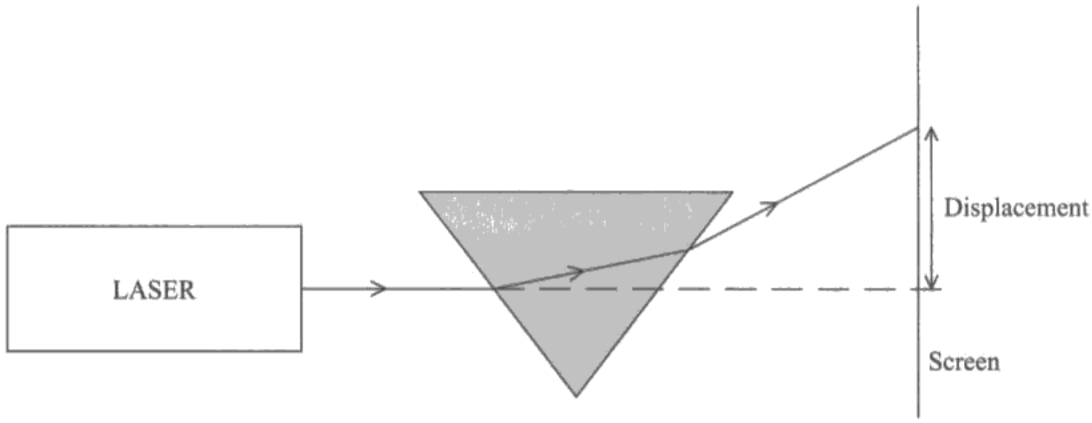
Exiting ray is parallel to the original ray. Just 1 mark.

Question 16 (a) (ii-iii)

(a)(ii) Most candidates could identify that as the concentration increased the displacement increased. In this question we were not asking the candidates to explain the shape of the graph but describe the relationship between 2 variables. Therefore, a further comment to describe how one increased in relation to the other was required. Answers such as not linearly, exponentially, displacement is proportional to $\%^2$ were acceptable as a way to describe the increase. Again, attempts at describing the increasing rate of increase of displacement with concentration scored poorly unless rate was mentioned.

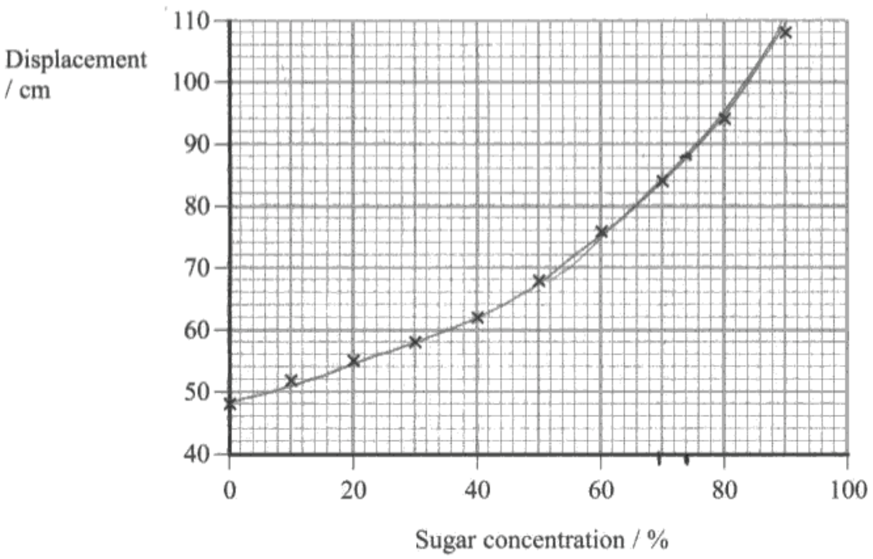
(a)(iii) A curve of best fit was expected for these 2 marking points. 68% and 72% were seen from some candidates as the percentage of sugar concentration when the displacement is 88 cm. Candidates had not realised that one 2mm square represented 2 % and not 1% of the concentration.

(ii) In practice, a laser beam is shone through the empty prism. The position of the emergent ray is marked on a screen. The prism is filled with a liquid of a known sugar concentration and the displacement on the screen is recorded.



This is repeated for a number of different known concentrations.

The graph shows how the displacement varies with the sugar concentration.



Describe how the displacement varies with sugar concentration.

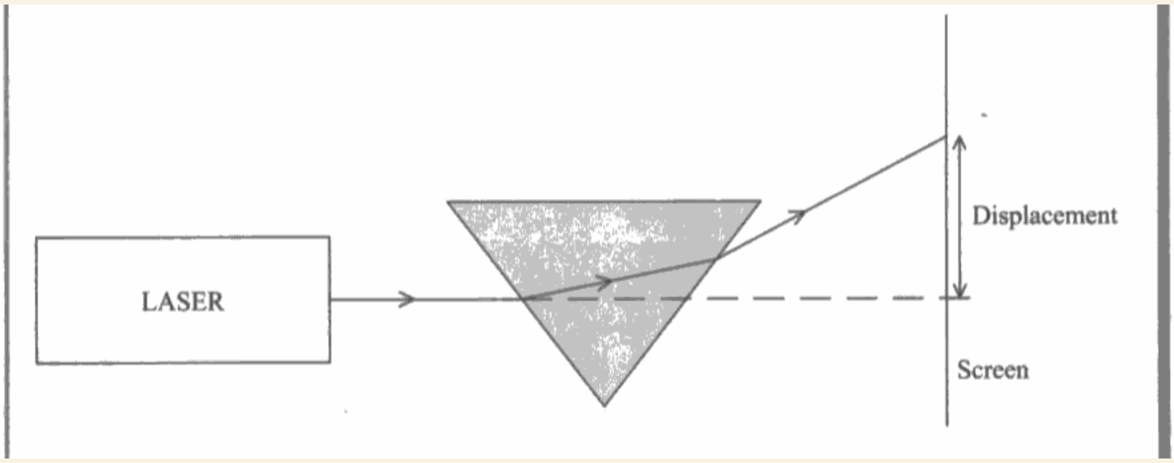
(2)

As the sugar concentration increases, the displacement increases

ResultsPlus

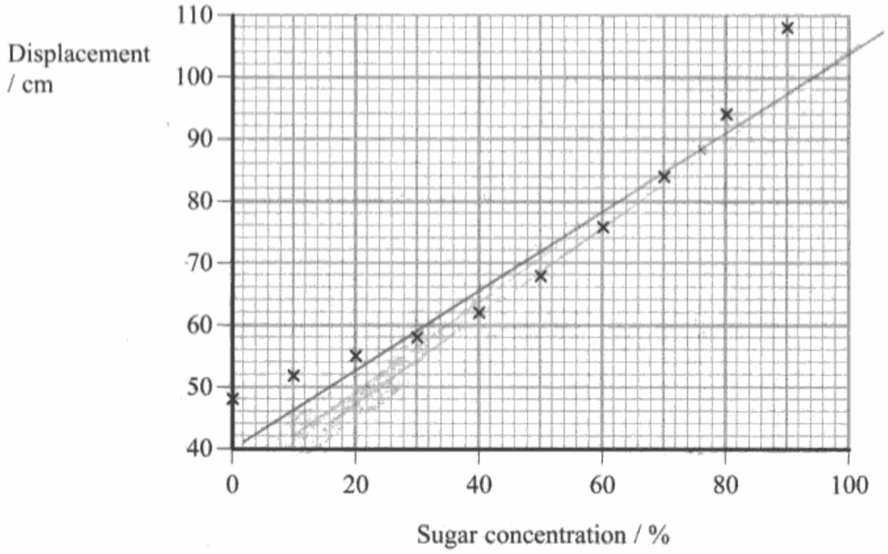
Examiner Comments

(ii) Basic answer scoring just 1 mark for a simple comment that as the concentration increases so does the displacement.
(iii) Curve of best fit drawn and a value in the accepted range for the concentration. 2 marks.



This is repeated for a number of different known concentrations.

The graph shows how the displacement varies with the sugar concentration.



Describe how the displacement varies with sugar concentration.

(2)

the higher the concentration of sugar the larger the displacemnt, it has a positive corelation

(iii) A sample of unknown concentration produced a displacement of 88 cm.

Draw the line of best fit on the graph and use it to find the sugar concentration of the sample.

(2)

Concentration = 77%

ResultsPlus

Examiner Comments

(ii) 1 mark for an increase in concentration the larger the displacement. The candidate has tried to extend their answer by mentioning correlation which does not get them the second mark for this description.

(iii) A line of best fit can include a curve if that is the trend that the data has.Here a line has been drawn and not a curve, so no marks awarded.

ResultsPlus

Examiner Tip

When you are asked to describe how one quantity varies with another use terms such as proportional, directly proportional, linear, non-linear, exponential and increasing/decreasing rate.

Correlation is a statistical term that just describes how well the data fits the relationship and does not describe the actual relationship so do not use it at all.

Question 16 (a) (iv)

This question required the candidates to explain how moving the prism would change the displacement on the screen. Many candidates did successfully manage to describe this. Incorrect answers mainly involved discussions of fair testing, precision, accuracy and reliability. Other incorrect answers given were where the candidate had realised what would happen but had not related their answer to the context of the question i.e. the variables involved and they had just mentioned that the angle would change. The experiment requires the displacement to be measured so the effect on the displacement should be discussed.

(iv) Give a reason why the distance between the screen and the prism must be kept constant.

(1)

because if you change the distance, you will change the displacement

ResultsPlus
Examiner Comments

Good answer, 1 mark.

(iv) Give a reason why the distance between the screen and the prism must be kept constant.

(1)

If it is not kept constant then the angle at which the light leaves the prism could change.

ResultsPlus
Examiner Comments

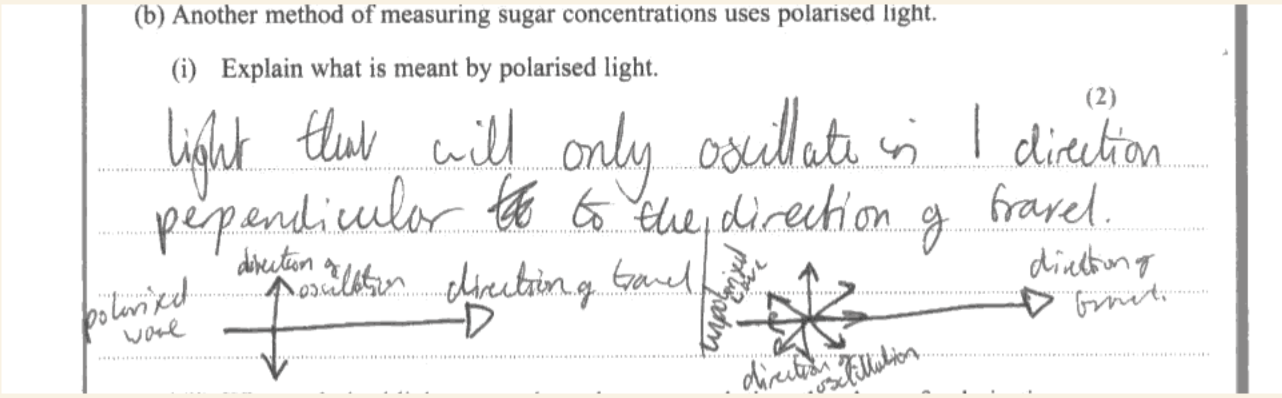
Scores no marks.

ResultsPlus
Examiner Tip

The experiment is to measure the displacement so discuss the effect that changing the position would have on the dependent variable i.e the displacement.

Question 16 (b) (i)

The majority of responses scored just 1 mark by explaining that the oscillations/vibrations are in either just 1 plane or 1 direction only. Very few went on to get the second mark which required the candidates to explain that the plane is in the direction of travel or the vibrations are at 90° to the direction of travel.


(b) Another method of measuring sugar concentrations uses polarised light.

(i) Explain what is meant by polarised light.

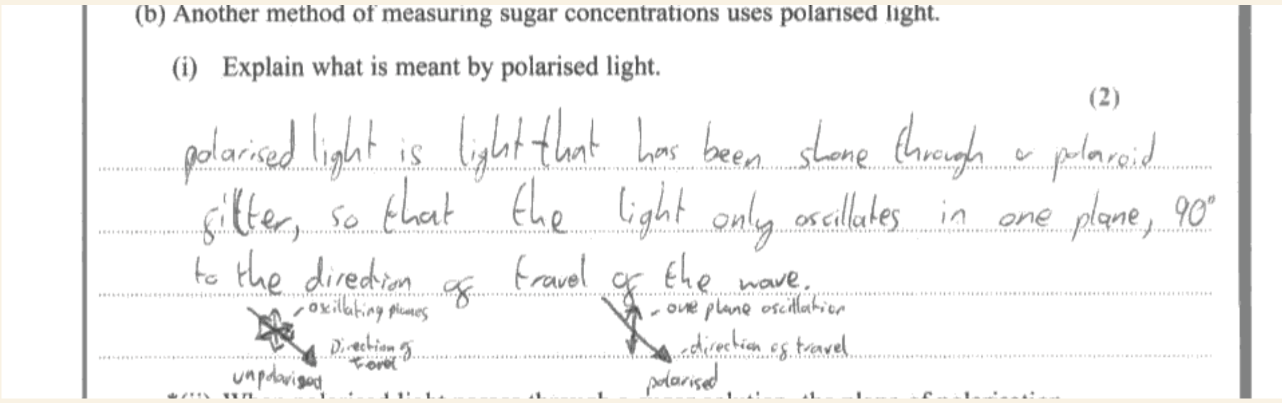
(2)

light that will only oscillate in 1 direction perpendicular ~~to~~ to the direction of travel.

ResultsPlus

Examiner Comments

2 marks awarded. Much simpler and more successful way to get full marks than a definition using in terms of planes.


(b) Another method of measuring sugar concentrations uses polarised light.

(i) Explain what is meant by polarised light.

(2)

polarised light is light that has been shone through a polaroid filter, so that the light only oscillates in one plane, 90° to the direction of travel of the wave.

ResultsPlus

Examiner Comments

To gain the second mark the candidates had to develop their explanation that the first mark was awarded for. The extra explanation is not in terms of the plane of vibration but the direction of travel of the wave so just 1 mark awarded.

Question 16 (b) (ii)

Descriptions of experiments always cause candidates problems. Some candidates had obviously carried out a similar practical, many using polarimeters, which did give these candidates an advantage but they often failed to describe a methodical way to find the angle. Most candidates were able to score a mark for mentioning polarising filters but most failed to mention that the polaroid, without the sugar solution had to be rotated and effectively calibrated. Many knew to place the sugar solution between the light source and the filter and then rotate the filter. Descriptions of the angle to be measured were variable and there had to be a clear position from which to measure the new angle. Just a mention of 'measure the angle of rotation' was a repeat of the stem of the question and did not gain the mark. Some mentions of rotating the sugar solution rather than the polarising filter seen.

*(ii) When polarised light passes through a sugar solution, the plane of polarisation rotates through an angle.

Explain how to measure this angle of rotation.

(4)

First, shine a light through an empty prism ~~normal solution of a known concentration~~ and place one polarising filter infront of it.

Rotate the polarising filter and mark the points on a paper the places of minimum intensity.

At each 90° turn, the light should be either having minimum or maximum intensity.

Then, add the sugar solution in the prism.

Rotate the polarising filters once again and mark the angle which gives minimum intensity.

Using a protracter, ~~and a ruler~~ measure the angle of rotation relative to the first angle.

(Total for Question 16 = 13 marks)

ResultsPlus

Examiner Comments

Scores all 4 marks, a very clear, methodical description involving rotating the polaroid filter with and without the sugar solution present. They did refer to maximum intensity without any further measuring device to identify where this would be but a mention of a maximum or minimum as the filter is rotated was sufficient. Very clear explanation about what angle is to be measured. Mention of a protractor here which was very rare.

ResultsPlus

Examiner Tip

When describing practical work, apart from describing a step by step method of the process, remember not to rush the end where you are describing accratelу how to take the measurements. Remember to mention what measuring device you are using, even if it is just as simple as a ruler or protractor.

*(ii) When polarised light passes through a sugar solution, the plane of polarisation rotates through an angle.

Explain how to measure this angle of rotation.

(4)

~~A line could be drawn to represent the incident beam of light~~

A polaroid filter could be used. It should be rotated until parallel with the polarised light before entering the solution, this would indicate which angle the plane of polarisation is at in the incident ray. The same should be done after the beam has left the solution. The difference between the two angles should be the ange of rotation.

ResultsPlus

Examiner Comments

This type of response was very common and only scored 1 mark for a mention of the polaroid. The candidate mentioned rotating the polaroid but the parallel was too vague and no mention of a maximum or minimum intensity of light. They have understood the method but have not been clear enough at each stage to gain the mark.

Question 17 (a)

Many candidates found this question a challenge. Although most candidates could describe some aspect of the photoelectric effect, few managed to describe the points that were being questioned and give relevant points. It was very disappointing to see candidates attempt to answer their entire question without the mention of a photon.

Descriptions of the photon intensity mainly referred to there being more photons with a greater intensity with no mention of photons per second. A great deal of responses successfully described the one photon to one electron idea. This question did identify that the candidates find describing the energy of the released photelectrons and the energy of the photons more challenging with confusion that the kinetic energy depends upon the frequency of the photons rather than the photon energy. Very few candidates related their answers to Einstein's photelectric equation which would have been a logical starting point, as with any question on this subject, to relate to the variables involved e.g. intensity and KE.

17*(a) In a demonstration, ultraviolet light is incident on a zinc plate and electrons are emitted.

The intensity of the ultraviolet light is increased.

Explain the following observations:

- the number of electrons emitted per second increases
- the maximum kinetic energy of an electron does not change.

(4)

as the photons of ultraviolet light hit the zince plating they give the zinc atoms energy. and so the electrons become excited and leave the orbit of the zinc atoms. As the intensity of light is increased the more photons of light are given off per second and so more photons hit the zinc plate each second and so more electrons are given off per second. however each photon of ultraviolet light still has the same amount of energy and so the electrons released do too.

ResultsPlus
Examiner Comments

This candidate has described the increase in the number of photons per second due to the greater intensity but did not mention the one to one relationship between photons and electrons, 2 marks. They have attempted to describe the second bullet point but did not score as they have not explained why the photons have the same energy.

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Explain the following observations:

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- the maximum kinetic energy of an electron does not change.

(4)

The number of electrons emitted per second increases as with increased intensity there are more charge carriers per unit volume.

The maximum kinetic energy of an electron does not change as this is not affected by the intensity of the incident ray. The frequency of the ray has an effect on the kinetic energy of the electrons.

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Examiner Comments

This response scores 0. No mention of photons at all, they have referred to them as charge carriers. The canddiate has the idea that the frequency effects the KE but have not explained why.

Question 17 (b) (i)

This question was answered well by most candidates. Quite a few candidates selected aluminium and zinc even though they had successfully worked out the energy value.

(b) The table shows the work functions of four metals.

Metal	Work function / 10^{-19} J
Aluminium	6.53
Caesium	3.36
Potassium	2.30
Zinc	6.88

(i) Determine which of these metals would emit electrons when illuminated with visible light of frequency 5.88×10^{14} Hz.

(3)

$\phi = hf_0$

$= 6.63 \times 10^{-34} \times 5.88 \times 10^{14} Hz$

$= 3.90 \times 10^{-19}$ J

∴ Caesium would emit electrons ~~be~~

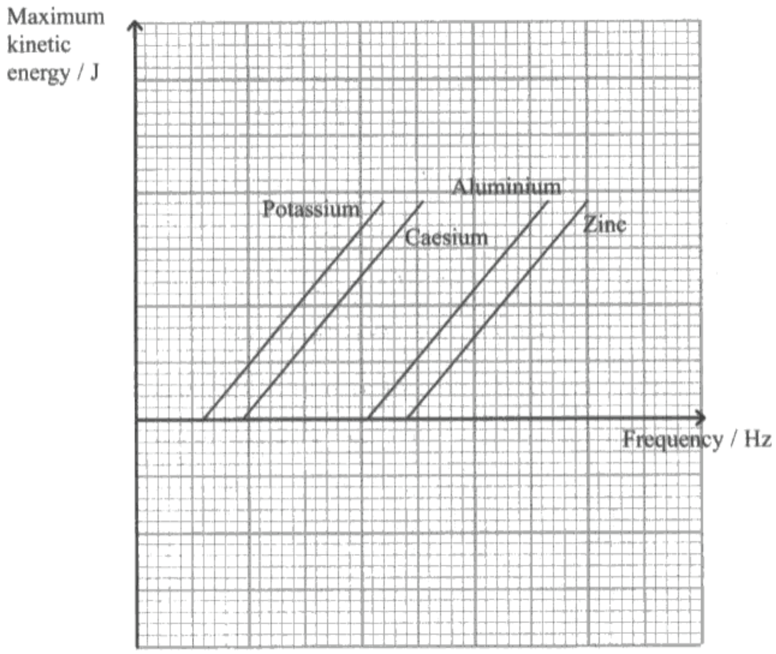
ResultsPlus
Examiner Comments

Correct energy calculated but only 1 metal selected. 2 marks.

Question 17 (b) (ii)

Again, as with question 17a candidates find describing a particular aspect of the photoelectric effect more challenging. Answers that started off with Einsteion's photoelctric equation were at a advantage as most canddiates then saw the need to rearrange it into a y=mx + c format. Candidates who did not refer to this equation at all rarely scored more than 1 mark for just remembering that the gradient of these lines is Plank's constant or that zinc has the highest work function.

(ii) The graphs show how the maximum kinetic energy of the emitted electrons varies with the frequency of incident light for the four metals.



Use the relationship $hf = \frac{1}{2} mv^2 + \varphi$ to explain the relative positions of the graphs and why they are all parallel.

(3)

$hf = \frac{1}{2} mv^2 + \phi$

~~y = mx + c~~ $y = mx + c$

~~y = hf − ϕ~~ $\frac{1}{2} mv^2 = hf - \phi$

∴ the gradient of each line = h which is planck's constant therefore each line on the graph is parallel.

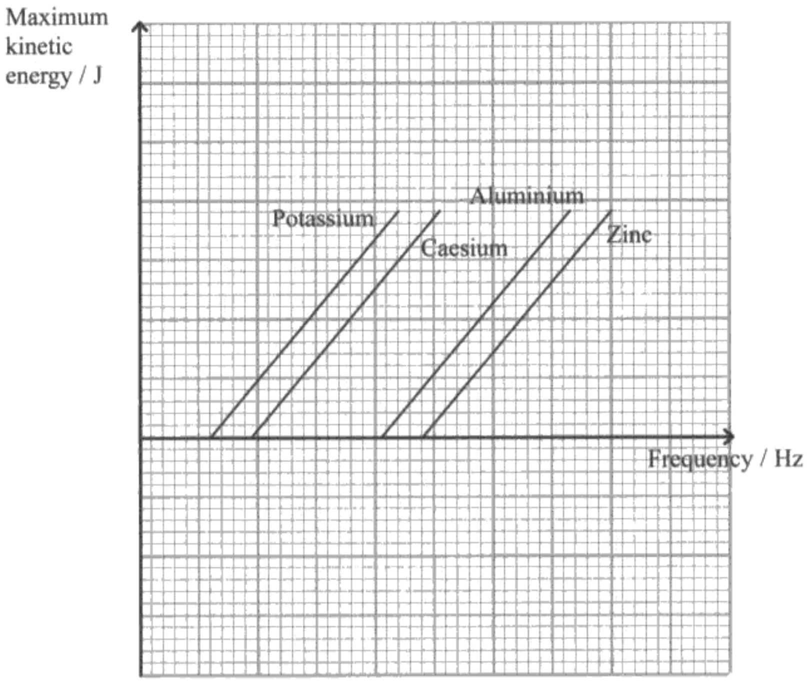
− ϕ is the y intercept so metals with smaller work functions ~~frequ~~ require a ~~smaller frequency to~~ photon with a smaller frequency to release electrons from them and therefore their electrons have greater K.E max at smaller frequencies than those metals with higher work functions as shown from the position of the graphs.

ResultsPlus

Examiner Comments

A good answer scoring 3 marks.

(ii) The graphs show how the maximum kinetic energy of the emitted electrons varies with the frequency of incident light for the four metals.



Use the relationship $hf = \frac{1}{2} mv^2 + \varphi$ to explain the relative positions of the graphs and why they are all parallel.

(3)

They are all parrallel because hf is the phcton energy and ~~they are all emitted~~ they all ~~have~~ need different frequancys needed to ~~get~~ emit electrcns. This means ones with a higher frequancy have a higher Ø as h stays constant and so does ½mv², because they all have the same kinetic energy.

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Examiner Comments

This candidate has some basic understanding of the significance of hf and Φ but, without the equation to guide them through the different aspects of the graph they have struggled and did not score any marks.

Question 17 (b) (iii)

The candidates needed to make a relevant comment about the type or nature of the radiation needed to emit as photoelectron from zinc and then conclude that caesium will do this with visible light for a second mark. Candidates tended to give general comments from which a sensible comment about the zinc could usually be extracted. The second mark was more difficult to award as the candidate needed to apply their knowledge and use the data that had been given earlier in the question. On seeing the mention of a lab, many candidates discussed cost and safety. Many candidates only discussed one metal and did not give a comparison between them as is suggested in the question.

(iii) A school laboratory has a photoelectric cell for student use. The metal plate in the photoelectric cell is made of caesium and it can be used with a set of filters to obtain a graph similar to the one in (ii).

Explain why the metal plate is made of caesium rather than zinc.

(2)

It is more easier to break a surface electron free than zinc for students to use as less frequency is required which makes it more suitable for a school lab.

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Examiner Comments

The candidate has identified that caesium needs a lower frequency but has not explained why this is more suitable for a school lab.

(2)

• Caesium has a lower work function than zinc and will emit electrons while light is in the visible range.
• Zinc would only emit photoelectrons for UV light which is harmful (causes DNA damage), so wouldn't be safe for student use.

(Total for Question 17 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS

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Examiner Comments

Good answer.The two metals have been compared in terms of the the light they need to release a photoelectron.

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