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Examiners' Report

January 2010

GCE Physics 6PH02

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January 2010

Publications Code US022973

General Comments

This paper gave candidates the opportunity to demonstrate their understanding of a wide range of topics from this unit. All of the questions elicited responses across the range of marks. As a general comment, marks were often not awarded, not necessarily because of errors but because candidates responses were not detailed enough. Another common problem was that in a number of questions the candidates did not answer the question that was asked. This was particularly so in Q11 and 13.

This was the first time that unit 2 was not sat immediately after unit 1 and was the first paper to be given the extra ten minutes. This meant that most of the candidates did attempt all of the questions. Blank pages, if they did occur were few with their occurrence scattered, suggesting lack of understanding rather than lack of time.

The space allowed for responses was usually sufficient with correct answers often requiring much less space than provided. Students need to remember than writing sizes and styles vary considerably so the space provided does not have to be filled. When candidates either need more space or want to replace an answer with a different one, they should indicate clearly where that response is.

In general candidates scored better on the calculation type question rather than the descriptive ones. There were few unit errors but candidates should be encouraged to think about how they set their work out, so that if mistakes are made, the examiners can clearly see how the candidate has worked, so that credit can be given for correct physics. Weaker candidates' manipulation of equations is often poor and this can often mean that marks are lost.

In descriptive questions, the use of bullet points should be encouraged and candidates should not waste time by writing out the question. Some questions ask for an explanation of why a specified effect occurs. There is no mark to be gained by restating this effect.

Candidates were more able this time to use the data that is provided at the back of the paper with the formula sheet. Although students don't have to recall the equations, it is helpful to actually know them when planning an answer to a question. There are quite a few definitions and laws in this unit that students need to know and should be able to recall using standard wording.

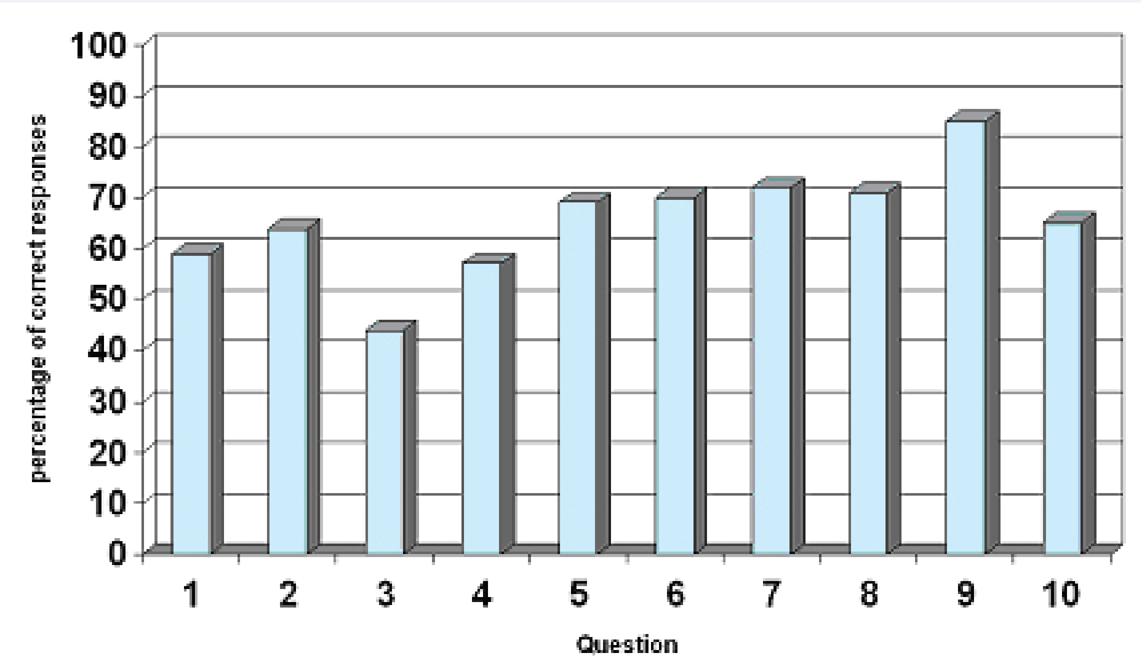
Candidates should be encouraged to pause and think before writing an answer and also to re read what they have written. Have they answered the question that has been asked, has what has been written actually make sense and have they provided enough physics facts for the number of marks available?

Section A

The majority of candidates did attempt all of the multiple choice questions but a small number did leave some questions unanswered.

In increasing order of difficulty, the multiple choice questions were 9, 7, 8, 6, 5, 10, 2, 1, 4 and 3. Perhaps it is not surprising that Q3 proved to be the most difficult since candidates had to identify a statement that was not true. However Q1 was a straightforward, factual recall question about SI base units which should have scored much higher indicating a lack of factual learning by the candidates.

Responses to Multiple Choice Questions



Section B

Question 11(a)

A significantly large number of candidates could not state Ohm's Law. Although mathematically, resistance is defined by the equation $R=V/I$, this equation is not a statement of Ohm's Law. Apart from the candidates who merely quoted the equation, a large number of candidates tried to use the equation and stated that resistance was directly proportional to potential difference.

11 (a) State Ohm's law.

(2)

If the temperature is constant, the resistance is directly proportional to the potential difference

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Examiner Comments

This is a typical answer which shows that the student does not know Ohm's Law but the answer scored one mark for the temperature constant comment.

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Examiner Tip

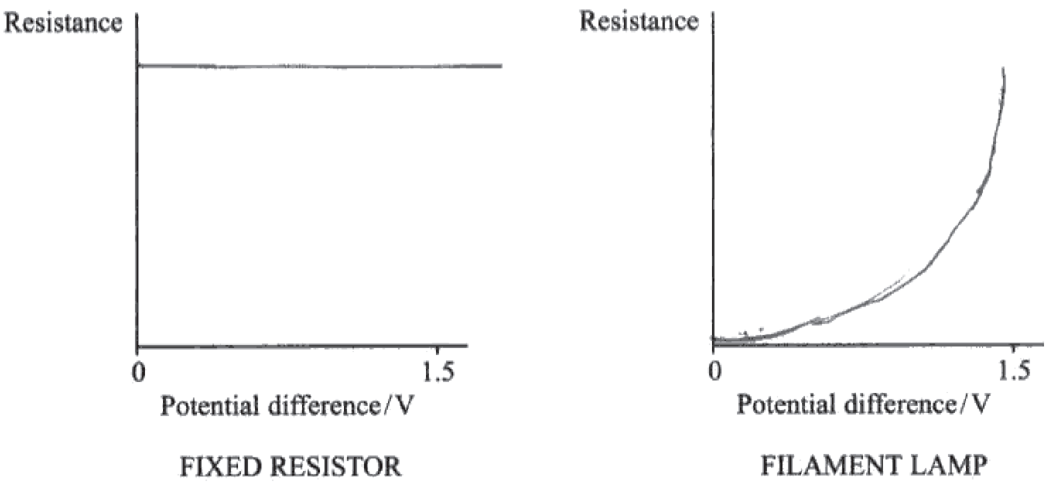
Make sure that students have a list of definitions and Laws to learn.

Question 11(b)

The majority of candidates misread this question and assumed that current –potential difference graphs were being asked for. For the minority who did read the question and drew the correct graph for the fixed resistor, hardly any realised that for the filament lamp, an initial non zero value of resistance was needed.

(b) Using the axes below sketch graphs to show how resistance varies with potential difference for a fixed resistor and a 1.5 V filament lamp.

(3)



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Examiner Comments

This is the correct resistance graph for the filament but the resistance of the filament lamp has a value when the potential difference is zero.

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Examiner Tip

Candidates need to read the question carefully

Question 11(c)

This was generally well answered, with many candidates scoring both marks. Some candidates answered along the lines of 'it didn't demonstrate Ohm's Law because current was not proportional to potential difference'. While this is a correct statement, it isn't an explanation and so did not gain any marks. Marks were also lost when candidates merely referred to the temperature or the resistance changing rather than in this case, them both increasing.

Question 12(a)

In order to get this mark, candidates needed to refer to both plane-polarised and unpolarised light. Any question on polarisation needs to include a reference to oscillations or vibrations. Having said all that, this was a one mark part, so answers referring to planes or directions were accepted.

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Examiner Tip

This would have been easier for candidates if they had definitions of plane –polarised and unpolarised light.

Question 12(b)

Very few candidates scored three marks. Those who understood about Polaroid filters and could talk about the correct alignment of the filters, to remove the reflected rays, scored 2 marks. Then, having eliminated the reflected light, they merely stated 'so the fish can be seen'. However, they were told this in the question and so get no marks for just restating what is given. They needed to say something specific about the light from the fish.

However many candidates tried to answer this question in terms of how Polaroid sunglasses polarise light rather than how they can be used to eliminate already polarised light. In this case at best candidates scored one mark for reference to elimination of the reflected light.

(b) Explain how Polaroid sunglasses can enable the fish to be seen.

(3)

Light reflects of the water in the sea and is partially polarised, e.g in the horizontal plane. Polaroid sunglasses contain a filter in the plane perpendicular to that of the reflected waves and therefore do not let the light through. This reduces glare and allows the fish to be seen.

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Examiner Comments

An example of a candidate who scores the first two marks for the alignment of the filters and the removal of the reflected light. However there is nothing specific about the light from the fish.

Question 13(a)

This was generally well answered with the majority of candidates scoring full marks. Errors were mainly due to candidates giving 1/R as their answer.

Question 13(b)

This was often answered in terms of the voltmeter having a very high resistance so it hardly takes any current etc. The question asked about the resistance of a combination of two resistors in parallel with a voltmeter and so need to be answered in terms of the resistors in parallel formula. This formula is given but when used should be written using the context of the question i.e. there should be reference to one of the terms being $1/R_{voltmeter}$.

(b) This resistance combination is used in an electrical circuit. A student measures the potential difference across the combination with a high resistance voltmeter. Explain why the resistance of the combination is hardly changed by the addition of the voltmeter.

Voltmeters are designed to have a very high resistance, and as they are connected in parallel, if the resistance of the voltmeter is Rv, the formula is: $\frac{1}{10}+\frac{1}{100}+\frac{1}{R_v}=\frac{1}{R}$
This means an extremely large value for Rv would have a negligible effect on R.

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Examiner Comments

This candidate has used the correct formula and put it into context. However has failed to make the point that the reciprocal of a very large number is negligible. Again the question tells the candidate that there is hardly any change so specific statements are needed.

Question 14(a)

This scored quite well although with care, more students could have scored full marks. There were three marks available so three different points needed to be made. Some candidates fill the available space with a very detailed explanation of one point only and think they have given a full answer.

14 Frequencies below the audible range for humans are called infrasound. Infrasound is produced by earthquakes.

(a) Describe how sound waves travel through air.

(3)

Sound waves are longitudinal therefore particles oscillate parallel to the direction of motion. Sound waves consist of rarefractions; the point where waves are further apart and compressions; where waves are closer together. They travel by continuously repeating the rarefractions & compressions as they oscillate.

(b) State what is meant by frequency.

(1)

Frequency is the number of oscillations per second of a wave

Candidates need to clearly differentiate the direction associated with the oscillations/vibrations and the direction of energy transfer of the waves. Too often poor statements, such as 'sound waves move parallel to the direction of the waves' are made.

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Examiner Comments

The mark scheme had four possible marking points for the three marks available. In this clip the reference to direction is not precise enough but the other three marking points are made do this did score full marks.

Question 14 (b)(c)

Most candidates knew the definition of frequency. Mistakes were made in saying amount instead of number or referring to a given time, rather than one second or unit time. Again, this is a definition that can be learnt. Candidates who didn't know the definition tried to answer it in terms of being equal to the reciprocal of period or from the equation $v=f\lambda$. The calculation of speed of infrasound in the ground was usually correct.

Question 14(d)

Candidates seem to forget that the questions are structured and one part will help the next part. This part of the question required students to realise that animals could detect infrasound and that they had early warning because the speed (which candidates had just calculated was so fast). It was very rare for candidates to make any reference to the speed of the waves so at best candidates scored only 1 mark here.

(d) In 2004, a huge earthquake produced a very large tidal wave which swept across the Indian Ocean towards Sri Lanka. Many large animals in Sri Lanka moved away from the coast before the tidal wave hit.

Suggest a reason for the animals behaving in this way.

(2)

Animals have a better sense of hearing than humans. They probably detected the sound and ground vibration which would have been below the hearing range of humans.

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Examiner Comments

This is a typical answer which only refers to the detection of the sound but makes no reference to the speed.

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Examiner Tip

Candidates need to ensure that they write at least as many valid points as there are marks for the question.

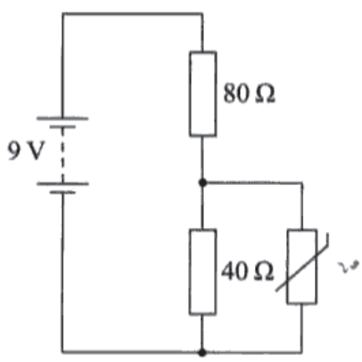
Question 15(a)

Another calculation which was generally well answered. Candidates need to be suspicious of answers that give a p.d. greater than the e.m.f. of the battery! A lot of candidates chose to do this calculation by finding the current in the circuit and then the p.d. across the 40 Ω resistor. A small but significant number of candidates found the current using just the 80 Ω resistor with the 9V. This shows that some candidates have a very poor grasp of even the most simple of circuits.

Question 15(b)

Answers generally lacked sufficient detail. Only a minority of candidates seemed able to methodically work their way through the argument, including all the relevant steps such as the essential one that the e.m.f./p.d. had to be constant for a larger total resistance to result in a smaller current. Candidates needed to think about what happened to the parallel combination first and after that, the effect on the total resistance. All too often these two stages were missed and there were references to resistance increasing which were too vague.

(b) A thermistor is connected in parallel with the 40 Ω resistor as shown.



The thermistor is initially at a temperature of 100 °C and its resistance is 20 Ω. As the thermistor cools down, its resistance increases.

Explain what happens to the current through the battery as the temperature of the thermistor decreases.

(3)

As the temperature of the thermistor decreases, the resistance of thermistor increase, the total resistance ~~o~~ in series will increase. ~~the~~ Because the ~~perto~~ potential difference will not change, so the current will decrease. $R = \frac{V}{I} \Rightarrow I = \frac{V}{R}$

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Examiner Comments

The first sentence is a repeat of what is given in the question. The answer effectively begins half way along the second line. There is a correct reference to the p.d. staying constant but there is insufficient detail as to how the candidate has come to the conclusion that the total resistance will increase. Again, there are three marks so three different points must be made.

Question 16

This was a question that relates to a specific point in the specification 'How wave and photon models have contributed to the understanding of the nature of light'. In general this question was very badly answered with candidates spending most of their time regurgitating information that had already been given to them. There were too many vague answers referring to something depending on something else without specifying what kind of dependence. A common one was to say that the energy of the photon depended on the frequency of the light, whereas the relationship is that they are proportional. All a candidate had to say was that as the frequency increases, the energy of the photon increases. Very, very few candidates stated that one electron gives its energy to one photon but that is the fundamental building block of the particle nature of light. At best, candidates when talking about the wave theory, managed to imply that given enough time, an electron would be released but rarely were able to say that energy depends on intensity or that the energy is spread over the whole wave.

Question 17 (a)

Candidates are generally good at 'show that' questions, giving the answer to one more decimal place than given in the question. This question required students to use the value of e, given in the formula sheet. Some candidates still don't know what value to substitute into the equation. 'Show that' questions require candidates to show their calculation to at least one more decimal place than that given in the question. In this case, the calculation gave an answer of 2.77×10^{-7} m s^{-1}. The answer could be left like this, or written as 2.8×10^{-7} m s^{-1} but it was wrong to write the value as 2.7×10^{-7} m s^{-1}.

Question 17(b)

A comparison between two given values was required but some candidates did not make any comparison. In this case the values varied by a power of 108 so merely stating that one was larger/smaller than the other was not sufficient. The omission of the word 'more', meant that the first mark was not awarded. The stem of the question had defined n as the charge carrier density so candidates only had to refer to n in their answer. However they were penalised if they just referred to charge carriers rather than charge carrier density.

(b) An approximate value of v for a sample of silicon of the same dimensions, carrying the same current, would be 0.2 m s^{-1}.

Compare this value with the one for gold and account for the difference in the values.

(2)

$$n = \frac{1}{AvQ} = \frac{8\times10^{-3}}{(5.0\times10^{-6})\times(0.2)\times(1.6\times10^{-19})}$$

$$= 8.3\times10^{22}$$

Because the number of charge carriers per m³ is much less in silicon than in gold.

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Examiner Comments

This candidate has made no comparison but has done a time consuming calculation to show that n is much less for silicon, which is a fact that the student should know.

Question 17(c)

Most candidates scored 2 or 0 here because if the initial decision was that the resistance would increase, they were unlikely to score the mark for increased number of charge carriers.

(c) State and explain what happens to the resistance of a sample of silicon as its temperature increases.

(2)

The resistance of a sample of silicen will decrease as temperature increases. The electrons inside will move faster so v will increase, then I will increase, therefore ~~then~~ as the pd remains the same, resistance decreases.

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Examiner Comments

Having got the change in resistance correct this candidate is very confused about why

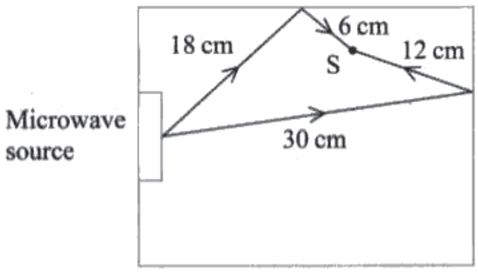
Question 18(a)

It was obvious that many students just did not know what was meant by coherent. Another definition for the list! The only requirement for waves to be coherent is that they have a constant phase relationship. Because so few candidates were scoring this mark we chose this time, to ignore comments about the waves having to have the same frequency/wavelength/amplitude. This might not happen in future. Explanations of standing waves were also poor with most candidates saying how a standing wave is produced rather than what it is. The easiest definition to give students is that a standing wave has no net transfer of energy.

Question 18(b)

This was a badly answered question. Despite the information given in the stem of the question about arriving by different routes and interfering very few candidates realised that they needed to work out a path differences and express this in terms of phase. Many of the candidates who did realise that the waves would cause destructive interference failed to show any calculations to explain this. Generally there was a lot of confusion between path difference and phase difference. Again far too many candidates are referring to 'out of phase' rather than antiphase.

(b) The diagram shows the path of two microwaves arriving at point S.



The wavelength of the microwaves is 12 cm.

Explain why S is a 'cold spot'. Assume that no other microwaves arrive at that point.

(4)

Path difference of waves = (30 + 12) − (18 + 6) = 18cm

This is 18/12 wavelengths = 3/2 wavelengths.

As this is an odd number of half wavelengths the two waves will be in antiphase at S, causing destructive interference and therefore S will be a 'cold spot'.

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Examiner Comments

A rare example of a student who scored all four marks

Question 18(c)

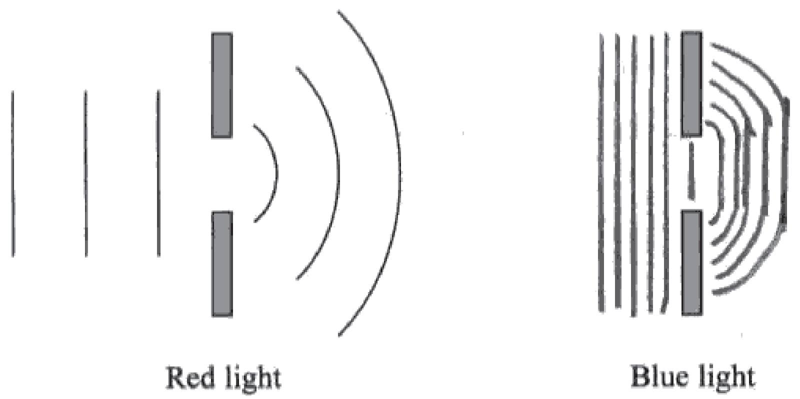
A common answer was 'because the cold spot was a long way from the source, when the food rotated around and was nearer the source, the intensity would be greater'. There was a very poor understanding of what was happening and when candidates did realise that the food rotated through a series of hot and cold spots, it was extremely rare to award the second mark. Most students just gave a reworded version of what the question had told them and so scored no marks.

Question 19(a)

The majority of candidates recognised the smaller wavelength but a lot of candidates thought that less diffraction would just change the shape of the wavefront and they didn't address the amount of spreading.

19 Wavefronts of light change shape when they pass around an edge or through a slit. This means that the light bends and the effect is called diffraction. The longer the wavelength of light, the more the light bends.

(a) The diagram on the left shows red light passing through a slit and undergoing diffraction.



On the diagram on the right, show the same effect for blue light.

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Examiner Comments

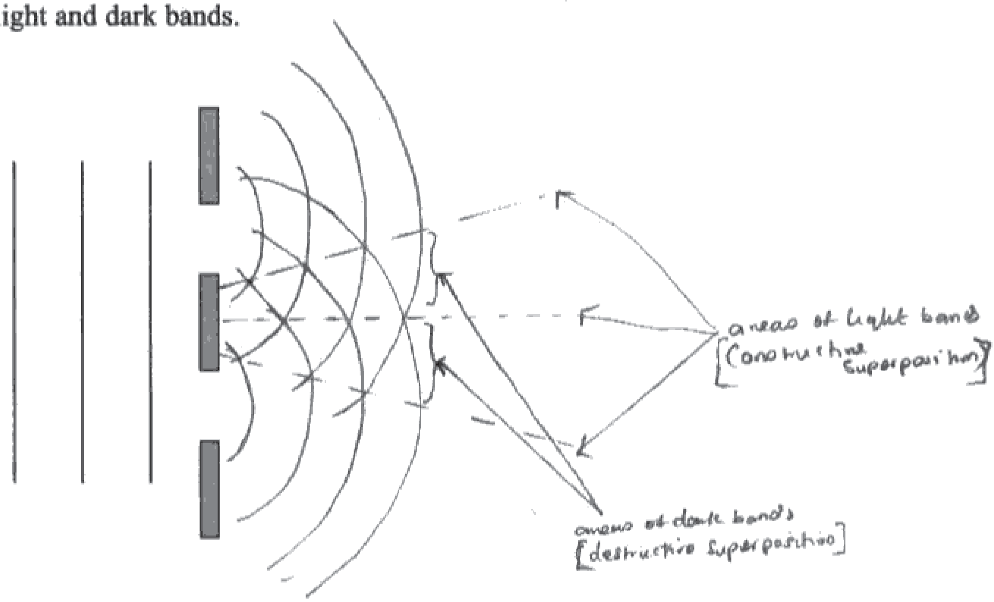
This gains the mark for the smaller wavelength. Although the candidate has tried to indicate less diffraction by drawing the central part of the wavefront as a straight line the actual spread of the wave is 180°, far more than for the red light. This meant that the 2nd mark wasn't given.

Question 19(b)

This was a very tricky diagram to draw and the pattern is only obvious if the drawing is accurately done. The first two marks were therefore awarded for a reasonable attempt to draw concentric arcs of circles with approximately constant wavelength. For many, these were the only two marks they scored. Even when the diagrams were reasonably accurate and the pattern could be seen, many candidates were unclear as where the dark and light bands would be produced.

(b) If the red light passes through two slits that are close together, the waves spread out, overlap and add together to produce a pattern of light and dark bands.

Complete the diagram below to show how two overlapping waves produce the pattern of light and dark bands.



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Examiner Comments

An example of a rare answer that scored all four marks. Although the exact line where destructive interference has not been drawn, the constructive interference lines have been correctly identified and so the bracketed area for destructive interference was accepted.

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Examiner Tip

The correct equipment, sharp pencil, rubber and ruler can be very beneficial.

Question 19(c)(i)

There were a significant number of correct answers here but those who lost the marks did so because they couldn't set up and manipulate an inverse proportional relationship, which is a mathematical skill that candidates should have. A common error was to divide the pair of readings, instead of multiplying them and then some candidates multiplied by this value, while others divided, so the two common incorrect answers were 0.20 mm and 0.8 mm.

Question 19(c)(ii)

Young's double slit experiment is not on the specification but that experiment was the context of this question with the structure taking candidates from single slit diffraction, through overlapping wavefronts and interference, to a given mathematical formula to be used. Knowledge of Young's double slit formula was of no help to the students; however it was quoted on many occasions, indicating that candidates had been taught it even though it is not on the specification. Quite a few candidates were able to identify that the dark bands would get closer and closer together (some repeating the calculation) but few were able to realise that they bands would be so close that we could no longer see them.

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Examiner Tip

If students are taught physics that is beyond the specification, it should be made clear to them exactly what is required for the examination so that they do not spend time learning material that will not be examined.

Question 20

This is the first time that a spreadsheet question has been set for this specification although they have appeared before on the Salter's Horner specification. With this type of question, candidates need to remember that they are given a lot of data in the spreadsheet which they may need to refer to more than once. The combination of an essential circuit diagram and the results table, meant that this question had to go over three pages and some candidates by the time they got to the end of the question had clearly forgotten about the given data.

Since this question is about spreadsheets, if candidates are asked for the value of a given cell, it should always be quoted to the same number of decimal places as are in the other cells in that column.

(a)(i)

A lot of candidates tried to show that the formula was correct by substituting numbers. Others were on the right lines but quoted $V/(R+r)$ instead of $E/(R+r)$.

(a)(ii)

This was mostly well done. Answers in terms of the cells or physics words were accepted. Errors were generally made when physics words were used because they didn't include load or internal when referring to a resistance.

(a)(iii)

This is where students need to know that the all the data in a column of a spreadsheet should be given to the same number of decimal places.

(b)

The majority of students did not realise that the route to the answer was through an equation. Those who quoted $V = E - Ir$ were the ones most likely to get 2 or 3 marks. Most students tried to answer it in general terms and were only likely to get the third mark of the marking scheme.

(b) Explain why the p.d. across the load increases as the current decreases.

~~As the current decreases the resistance in the load increase causing the p.d to rise.~~ As the resistance of the load increases the total current decreases, this causes the p.d across the load to rise. this is because the p.d is shared across both resistances, in the the same ratio as their ~~resistance~~ resistance.

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Examiner Comments

This student has a good understanding of what is happening but gives no formula or makes reference to the resistors being in series and r remaining constant. It scores 1 mark for the increasing load comment.

(c)

This section required candidates to look at the spreadsheet and describe what happened. They were not asked for an explanation so no equation was needed. Only a minority realised that this part was related to the data given in the spreadsheet. Those that did, often scored the first two marks and the best students could successfully use the same idea the get the next two marks.

6PH02

Grade	Max. Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	45	40	35	30	26

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