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Examiners' Report
January 2011

GCE Physics 6PH02 01

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Introduction

There were some more easily accessible questions on this paper with some very straightforward calculations and most candidates sitting this paper were able to demonstrate their knowledge and understanding of the full range of topics in this unit.

There was evidence of good progression from GCSE. The responses for all questions covered the full range of marks allowable with full marks being seen on all question parts. Overall the mean mark was much higher than the paper for January 2010 and this is reflected in the grade boundaries. Having said that, there were some more challenging parts to the paper to ensure that there was good descrimination over the whole ability range. Full marks were less common in parts of questions that required explanations.

On the theory papers we do not penalise too many significant figures since this is addressed in the practical unit. However, it is good practice for candidates to think about significant figures on all papers and answers should be given to the same number of significant figures as are used in the question.

Section A

In increasing order of difficulty, the multiple choice questions were 1, 7, 3, 8, 4, 6, 2, 9, 10 and 5. Questions 1, 7, 3 and 8 were answered correctly by a sizeable majority, questions 4,6 and 2 by a good majority with the remaining getting a minority correct response.

Q5 was about a series and parallel arrangement of lamps and what happens to current when one lamp breaks. The majority of candidates chose answer A, thus demonstarting the fact that they do not realise that if the resistance of a circuit changes, the current also changes.

Q10 was about resistance changes for a component and working out resistance at a point and where overall resistance was increasing or decreasing. The common wrong answer was C, so candidates knew the resistance at a point but not how it was varying.

Question 11

In (a) very few candidates related their knowledge to the question asked, i.e. they did not use information from the diagram but just quoted a definition of a longitudinal wave usually in terms of compressions and rarefactions. There was hardly any mention of molecules.

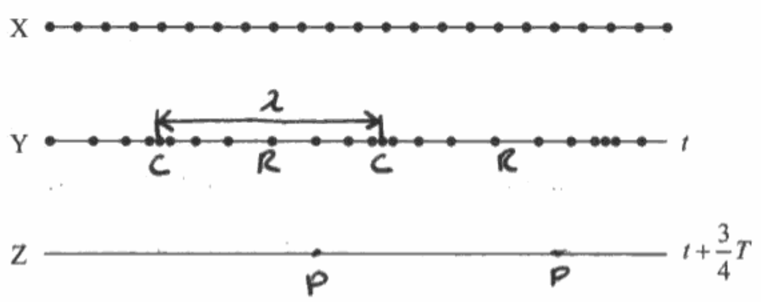
In part (b) many candidates did not realise that compressions and rarefactions refer to a single point and instead thought they covered broad areas, sometimes the whole wave. Others who did realise it had to be a single position were often lacking in precision, especially the second R. The wavelength indication was generally better but sometimes it was from a compression to the next but one compression, perhaps a confusion with standing waves where node to node is half a wavelength.

Part (c) was very poorly answered with many blank responses and not many drawing two points a wavelength apart. Despite being asked to label these points P, some were labelled C, T or nothing. For a straightforward question on the basics of waves the mean mark of 3 was very disappointing.

11 In the diagram, line X represents the equilibrium positions of a line of molecules in a solid.

A sound wave of wavelength λ and frequency f passes through the solid from left to right.

Line Y represents the positions of the same molecules at a time t.



(a) Explain how the diagram shows that the wave is longitudinal.

(1)

The molecules travel in the same direction as the wave is progressing

(b) On line Y

(i) identify **two** compressions and label them C;

(ii) identify **two** rarefactions and label them R;

(iii) label the wavelength λ of the wave.

(3)

(c) The period of the wave is T.

On the line Z mark the positions of two compressions at a time $t+\frac{3}{4}T$ and label them P.

(2)

(Total for Question 11 = 6 marks)

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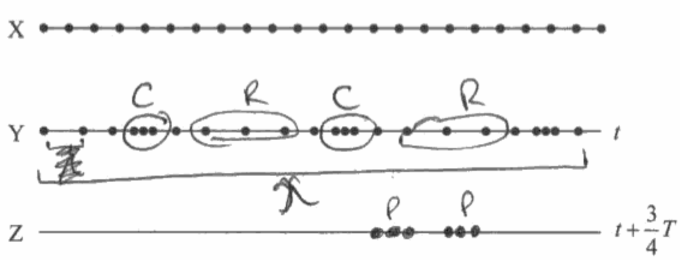
Examiner Comments

This candidate does score the mark for (a) but has a badly positioned R, so scored 2 marks for (b) as well as 2 marks for (c)

11 In the diagram, line X represents the equilibrium positions of a line of molecules in a solid.

A sound wave of wavelength λ and frequency f passes through the solid from left to right.

Line Y represents the positions of the same molecules at a time t.



(a) Explain how the diagram shows that the wave is longitudinal.

(1)

The diagram shows the particles moving in a straight line along the wave.

(b) On line Y

(i) identify **two** compressions and label them C;

(ii) identify **two** rarefactions and label them R;

(iii) label the wavelength λ of the wave.

(3)

(c) The period of the wave is T.

On the line Z mark the positions of two compressions at a time $t + \frac{3}{4}T$ and label them P.

(2)

(Total for Question 11 = 6 marks)

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Examiner Comments

An example of the cluster approach to compressions and rarefactions

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Examiner Tip

Remember that compressions and rarefactions are identified by a single point.

Question 12(a)

A lot of completely correct answers were seen. Although a simple calculation, the candidates did have to realise the need to use the speed of light which is in the data sheet and not given in the question and also the conversion of MHz.

The number of candidates who used the speed of sound in air was less than in previous years, so perhaps the message is getting through that candidates need to think about using the data sheet.

Question 12(b)

This question was not very well answered. The challenge for candidates was to realise that this was a question about diffraction which unfortunately quite a lot did not, thereby not gaining any marks. This is the first time that there has been a question about diffraction around a building or obstacle and the answers seen demonstarted poor understanding.

Diffraction is an edge effect, dependant on wavelength. Hardly any candidates realised that to get good reception the two diffracted waves from the edges needed to overlap and that was a combination of the amount of diffraction and the separation of the waves. i.e. the size of the building or hill.

*(b) Obstacles such as buildings and hills can make it difficult to receive some radio signals with shorter wavelengths.

Explain why this is less of a problem for this radio station.

(3)

The wavelength of this radio wave is quite large so will be able to diffract around buildings and hills.

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Examiner Comments

This candidate has realised that the effect is due to diffraction and gets 1 mark.

*(b) Obstacles such as buildings and hills can make it difficult to receive some radio signals with shorter wavelengths.

Explain why this is less of a problem for this radio station.

(3)

Shorter wavelengths diffract ~~at~~ less around obstacles that are big eg) builings.
However due to it's big wavelength of 1515.2m, the diffraction should be more allowing these radio waves to cover a larger area around such obstacles.

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Examiner Comments

This represents a minimum answer to get three marks, very rare.

Question 13(a) (i)

This question was answered reasonably well, with many candidates able to quote the range of human hearing. Some candidates thought it was below the audible range, and others lost the mark because they refered to a threshold without specifying that they meant the upper.

(i) The ultrasound used has a frequency of 4.5 MHz.

State why waves of this frequency are called ultrasound.

(1)

They are ~~above~~ outside the range of sound in which we can hear.

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Examiner Comments

This could be above or below the range and so did not get a mark.

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Examiner Tip

Learn definitions and make sure your answers are specific.

(i) The ultrasound used has a frequency of 4.5 MHz.

State why waves of this frequency are called ultrasound.

(1)

Because they are inaudible to humans, they are beyond a human's natural hearing range.

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Examiner Comments

Another example that is not specific enough.

Question 13(a) (ii)

The majority of candidates got full marks here, with the common mistake being a lack of understanding that the wave has to travel to the boundary and back.

Question 13(a) (iii)

The markscheme was tightened up compared to when a similar question was set on the first paper for this specification. This is an example of a mark scheme being applicable for a given paper. The key factor is that one pulse must return before the next and that was the only answer that was accepted.

Question 13(b)

This question was answered well on the whole, with many getting 1 mark for part (i) and at least one mark for (ii). Marks were lost in (ii) sometimes because a comparison wasn't made, or more often because candidates used frequency and wavelength as their two examples, whereas they are alternative ways of saying the same thing. Very few candidates realised that ultrasound is a mechanical wave and wrote 'X-rays are part of the EM spectrum, ultrasound aren't.

(ii) State **two** other differences between X-rays and ultrasound.

(2)

- X-rays are transverse waves
- ultrasound are longitudinal waves
- X-rays are electromagnetic waves when as ultrasound are a form of sound waves.

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Examiner Comments

the comparison with electromagnetic is mechanical. This scored 1 mark

(b) Another way of obtaining information about the internal structures of the human body is by the use of X-rays.

(i) Give **one** property of X-rays which makes them more hazardous to use than ultrasound.

(1)

~~shorter wavelength → higher frequency~~
polarises cells in the body

(ii) State **two** other differences between X-rays and ultrasound.

(2)

X-rays have shorter wavelength
X-ray have higher frequency

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Examiner Comments

The candidate thinks there are two differences, but they are not independant and so only count as one difference.

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Examiner Tip

Because of the wave equation, if a wave has a shorter wavelength it must have a higher frequency. You can only use this equation for one difference.

Question 14(a)

This was a straightforward substitution into the resistance formula with a unit conversion. Most candidates scored full marks but quite a few wouldn't have, if it hadn't been a 'show that' question. They initially missed the unit conversion but when they didn't get the right answer sensibly, they went back and made the unit conversion.

Question 14(b)

The meaning of the NCT was generally correct but candidates did have to refer to the resistance's temperature and not just when it gets hot. Many candidates missed the point that it is the current that causes the heating effect. When a question tells candidates that a variable is kept constant, they should realise that this is a clue that they should refer to an equation in their answer.

For the second mark, credit was given for candidates who talk about an increase in the number of charge carriers but quoting $I = nAqv$ did not help them since there is no reference to potential difference in that equation. This was a question where the quality of written communication was assessed.

(b) (i) Pencil lead has a negative temperature coefficient of resistance.

Explain what this means.

(2)

As the temperature of the lead increases its resistance decreases.

*(ii) A piece of pencil lead is connected in series with an ammeter and a power supply.
The power supply is turned on. After a few minutes, although the potential difference across the pencil lead does not change, the current in the circuit increases significantly.

Explain why the current increases.

(3)

$I = \frac{V}{R}$ As current flows through the pencil lead its temperature increases, this causes its resistance to decrease. $\text{Current} = \frac{\text{Potential Difference}}{\text{Resistance}}$, Current and Resistance are inversely proportional and therefore when then resistance decreases the current increases.

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Examiner Comments

An excellent answer that score all three marks.

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Examiner Tip

If a question tells you that a quantity is constant, use an equation that the quantity is in.

*(ii) A piece of pencil lead is connected in series with an ammeter and a power supply.
The power supply is turned on. After a few minutes, although the potential difference across the pencil lead does not change, the current in the circuit increases significantly.

Explain why the current increases.

(3)

~~I=nAqv~~ (constant) As the temperature increases in the ~~current~~ lead the no. of charge carries in the lead increases and therefore the current increases with it because A, q and v all remain constant.

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Examiner Comments

This scores 1 mark for increase in number of charge carriers.

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Examiner Tip

Use the infromation given in the equation i.e. potential difference is constant and refer to V=IR

Question 15(a) -(b)

Both parts were generally well answered, with the majority of candidates scoring full marks. Many candidates chose to answer (b) using E =VIt rather than the more simple E =Pt.

Question 15(c)

There were many methods seen in answer to this question, with quite a few candidates scoring three marks for the calculation. The common wrong answer was three minutes, because candidates did not realise that reducing the p.d. would also reduce the current.

The question was about energy/power and so candidates need to think in terms of a power equation. The last part of the question again required candidates to refer to an equation, preferably $E = V^2/R$ but V=IR was accepted. Despite the question saying that resistance stayed the same, many candidates tried to answer this in terms of increased resistance.

(c) Different countries supply mains electricity at different voltages. Many hotels now offer a choice of voltage supplies as shown in the photograph.

(i) By mistake, the kettle is connected to the 110 V supply. Assuming that the working resistance of the kettle does not change, calculate the time it would take for the same amount of water to reach boiling point.

(3)

~~P=IV P=4.55×110=500.5W 1,000=2110I~~

W=ItV ~~1000/110 = 9.10A~~ P=500.5W

W=(4.55×110)t $1.80\times10^5 = 500.5t$

$t = \frac{1.80\times10^5}{500.5} = 90090000\,s = (\div 60) = 1501500\,m$

25,025 h x X V=110 R=48.4 $I = \frac{110}{48.4}$ I=2.27A

P=110×2.27=250W W=250t $\frac{1.8\times10^5}{250} = t$

t=720s (÷60) = 12m

Time = 12 minutes / 720s

(ii) Explain what might happen if a kettle designed to operate at 110 V is connected to a 220 V supply.

(2)

Providing that the plug is fused, as $I=\frac{V}{R}$, an increased V means a larger I. This will cause the fuse to blow as the current will be too high.

ResultsPlus Examiner Comments

A very complex way to get to the answer but it is correct. This also scored two marks for the last part because there is a reference to an equation.

Question 16(a)

This is the fourth paper for this specification and on all the papers there has been a question where candidates are expected to talk about the oscillations/vibrations associated with a wave, particularly in a question about polarisation.

It is therefore disappointing that so many candidates failed to include this in their answers. Also there were too many vague references to 'the direction of the wave'. Candidates need to specify either the direction of travel of the wave or direction of energy transfer.

16 (a) Light from the Sun is unpolarised.

Explain what is meant by unpolarised.

(2)

There are electromagnetic waves travelling on many different planes. Polarised light travels on only one plane.

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Examiner Comments

A lot of candidates answered in terms of planes rather than directions but there must be a reference to the oscillations/vibrations associated with the wave.

16 (a) Light from the Sun is unpolarised.

Explain what is meant by unpolarised.

(2)

Polarised light is light which has been restricted to one plane of oscillation. Unpolarised light can oscillate in ~~any plane~~. any plane.

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Examiner Comments

An answer that scored 2 marks

Question 16(b)

Candidates who realised that a polarising filter was required, usually included the need to rotate it but few specified how much rotation (in degrees) was needed for a particular change of intensity. There was a lot of use of two filters, which was obviously an incorrect method but was given one mark for realising that polarising filters were required.

*(b) When a ray of light from the Sun is incident on a block of ice, most of the light is refracted into the ice. Some of it is reflected. The light that is reflected is partially plane polarised.

Describe a test to confirm that the reflected ray is partially plane polarised.

(3)

look through a polaroid filter at the ice, Slowly rotate the filter 360°. If the light appeared to get darker then lighter, or ~~the~~ lighter then darker then the light has been partially polarised.

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Examiner Comments

This scores 2 marks but is not specific enough about the change in intensity with angle rotation since it would change 4 times in a 360° rotation.

(3)

If you ~~have a~~ get a polarising light filter and look at the light reflected off the ice, when you can see the glare through the filter turn the filter 90° one way, if you can no longer see the glare / light reflected off the block of ice you know that the reflected ray is partially plane polarised.

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Examiner Comments

A three mark answer.

Question 16(c)

The infromation given in (b) that the light was partially plane polarised was essential to the answering of (c) but not many candidates chose to make any reference to it. Many candidates just wrote about what happens when polaroids are held up to unpolarised light and this did not gain any credit in this question.

(c) Some skiers wear sunglasses with polarising lenses. These sunglasses reduce the amount of reflected light entering their eyes.

Suggest how these sunglasses work.

(2)

the polarising lenses have filters to block out the glare off the snow which involves polarising the light into one plane before it reaches their eyes but still letting enough light through so they can see.

(Total for Question 16 = 7 marks)

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Examiner Comments

No reference to the reflected light being partially polarised and focusses on how the lenses themselves cause polarisation.

(c) Some skiers wear sunglasses with polarising lenses. These sunglasses reduce the amount of reflected light entering their eyes.

Suggest how these sunglasses work.

(2)

Because reflected light is partially polarised, the polarising lenses are at 90° to the rays thus cutting out the reflected light ~~bad~~ and removes glare.

(Total for Question 16 = 7 marks)

ResultsPlus

Examiner Comments

A 2 mark answer

Question 17

The calculations in this question were more complicated with both of them requiring two steps. The more able candidates coped well and scored full marks, but for many the calculations proved too challenging.

The first calculation required them to calculate the amount of charge from Q = It and then use the charge on an electron to work out the number of electrons. All too often, the charge was given as the answer.

In the second calculation, quite a few candidates were able to use E=hf to find the energy of one photon but were then completey baffled as to what to do with the 10 W power. Candidates seemed to be ignorant of the relationship between energy and power.

17 (a) A student uses a computer for an average of 5 hours every day. The battery supplies a current of 3.5 A to the computer.

Calculate how many electrons flow through the computer's battery in 5 hours.

(4)

$I = \frac{Q}{t}$ $Q = It$

$= 3.5 \times (60 \times 60 \times 5)$

$= 3.5 \times 18000$

$= 63000\ C$

Number of electrons = ...

(b) The computer's screen emits visible light photons with an average frequency of 5.5×10^{14} Hz. The power of the light emitted is 10 W.

Calculate the number of photons emitted per second from the computer screen.

(3)

number of photons = Power supply/flux / energy of photon

$E = hf$

$= (6.63 \times 10^{-34}) \times (5.5 \times 10^{14})$

$= 3.6465 \times 10^{-19}\ J$

or

$= 2.28\ eV$

$n = \frac{P}{E}$

$n = \frac{10}{2.28}$

$= 4.39$

$3.6465 \times 10^{-19} \div 1.6 \times 10^{-19}$

$= 2.28\ eV$.

Number of photons = 4.39

(Total for Question 17 = 7 marks)

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Examiner Comments

A common wrong answer, getting as far as the total charge in (a). In (b) the energy has been found and then converted to eV. However this has been used with the 10W so this answer scores 2 marks.

Question 18(a) (i)

A very easy mark that nearly all candidates scored.

Question 18(a) (ii)

This was meant to be another easy mark with the answer being the speed of light. Whilst the majority did score the mark, it was interesting to see the lengths some candidates went to to come up with an answer.

(ii) State the speed of the photons.

(1)

$5.4 = \frac{1}{2}mv^2 \quad v^2 = \frac{5.4 \times 2}{9.11 \times 10^{-31}} = 1.185... \times 10^{31} \quad v = 3.44 \times 10^{15}$

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Examiner Comments

This candidate is trying to use the KE formula to find a speed and uses the mass of an electron.

Question 18(a) (iii)

Candidates had to refer to quite a few points to get this mark i.e. minimum energy, single electron and surface of metal. Less than half of candidates scored the mark, mainly due to no reference to a surface or reference to electrons rather than an electron. This is a definition that candidates should be able to learn.

(iii) What is meant by the work function of a metal?

(1)

- Minimum amount of Energy Required to Free electrons from the Surface of a metal.

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Examiner Comments

More than one electron, mark is lost.

(iii) What is meant by the work function of a metal?

(1)

The minimum amount of energy required to liberate electrons from the metal.

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Examiner Comments

Multiple electrons and no mention of surface.

Question 18(b)

This was a calculation that discriminated at the top end of the ability range with the most able candidates scoring 5 marks. Many candidates did not realsie that the energy in eV was the difference between the two values given in the question.

Candidates tried to use Einstein's photoelectric equation with many convoluted incorrect calculations being attempted. A full error carried forward was allowed for the candidates' energy value, used to find the speed of the electron even though for many, this was a value far in excess of the speed of light. This was because knowing that nothing travels faster than the speed of light, is in the A2 specification. Having said that, many candidates were unable to use the kinetic energy formula to find a speed.

(b) An electron is emitted from the surface of the zinc.

(i) Calculate the maximum kinetic energy of the electron in joules.

(3)

$5{\cdot}4eV = 5{\cdot}4 \times 1{\cdot}6 \times 10^{-19} J = 8{\cdot}64 \times 10^{-19}$

$4{\cdot}3eV = 4{\cdot}3 \times 1{\cdot}6 \times 10^{-19} = 6{\cdot}88 \times 10^{-19}$ $\quad 8{\cdot}64 - 6{\cdot}88 = 1{\cdot}76J$

Maximum kinetic energy = 1·76J

(ii) Calculate the maximum speed of the electron.

(2)

~~$E = \phi + \frac{1}{2}mv^2$~~ $\quad E_k = \frac{1}{2}mv^2$

$= \quad 1{\cdot}76 = \frac{1}{2} \times 9{\cdot}11 \times 10^{-31} \times V^2$

$V^2 = 3{\cdot}86 \times 10^{30}$ $\quad V = 1{\cdot}965676942 \times 10^{15}$

Maximum speed = $1{\cdot}97 \times 10^{15} ms^{-1}$ (3sf)

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Examiner Comments

This candidate multiplies by e before subtracting so scores 2 marks but just loses the powers of ten. Correct calculation of speed from the answer to (i) so scores 2 marks here as well.

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Examiner Tip

Practice rearranging the KE formula to find speed.

(b) An electron is emitted from the surface of the zinc.

(i) Calculate the maximum kinetic energy of the electron in joules.

(3)

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

$4.3 - 6.63 \times 10^{-34} \times 4 \times 10^{-19} = E_K$

Maximum kinetic energy = 4.3 J

(ii) Calculate the maximum speed of the electron.

(2)

$4.3 = \frac{1}{2}mv^2$

$V = \sqrt{\frac{8.6}{9.11 \times 10^{-31}}} = 3.07 \times 10^{15}\ ms^{-1}$

Maximum speed = $3.07 \times 10^{15}\ ms^{-1}$

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Examiner Comments

An example of a candidate trying to use Einstein's photoelectric equation. No marks for (i) but another correct use of equation to find speed.

Question 18(c)

50% of the candidates knew that the speed of the electron would not change when the intensity of the light increased. Not surprisingly, most of the remaining 50% thought that the speed would increase, some x2, some x4.

Question 19(a) (i)

The whole of this question was not answered as well as it should have been, perhaps because the candidates were put off by the context. Candidates should know that there will be a number of context based questions particularly towards the end of the paper and they need to focus on what is being asked. Part (b)(i) was a very straightforward calculation which many made no attempt to do.

In (a)(i) a lot of candidates realised that they had to do something with 1.53 and 414 but instead of multiplying, they divided ending up with a smaller wavelength in air rather than a bigger one. No thought was given to whether the answer was correct.

Question 19(a) (ii)

Question (a)(ii) was referring to the light in the plastic but many candidates chose to use the wavelength in air that they had calculated in (i).

Since the question was about the relationship between path difference and phase difference, candidates were not penalised for using the wrong wavelength. However most candidates focussed on the half a wavelength and divided by two, forgetting that the light travels twice the distance so requiring them to divide by four.

Question 19(a) (iii)

Answers to this part were generally good, with many candidates scoring both marks. A few candidates thought there would be constructive interference and some who weren't sure said there would be both constructive and destructive interference, thereby scoring no marks.

Question 19(b)

This was a straightforward calculation of a critical angle, but many candidates either got it wrong or did not even attempt the question. Candidates are expected to know that total internal reflection occurs in the more dense medium and so candidates who had rays in air scored no marks.

(b) Some of the reflected light will not hit the plastic-air boundary at 90°.

(i) Calculate the critical angle of the plastic-air boundary.

(2)

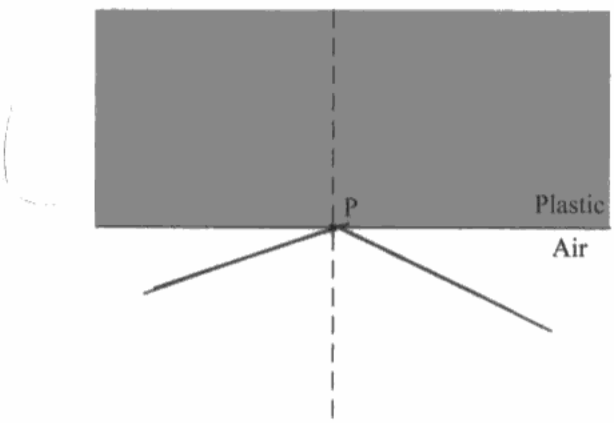
$\frac{1}{1.63} = \sin c$

$c = 40.8°$

Critical angle = 40.8°

(ii) On the diagram below, show what happens to a ray of light which hits the plastic-air boundary at point P at an angle greater than the critical angle.

(2)



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Examiner Comments

Calculation of angle correct but no marks for the diagram.

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Examiner Tip

Total internal reflection occurs in the more dense medium.

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