ResultsPlus edexcel

Examiners' Report
June 2012

GCE Physics 6PH02 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk for our BTEC qualifications.
Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

If you have any subject specific questions about this specification that require the help of a subject specialist, you can speak directly to the subject team at Pearson.
Their contact details can be found on this link: www.edexcel.com/teachingservices.

You can also use our online Ask the Expert service at www.edexcel.com/ask. You will need an Edexcel username and password to access this service. See the ResultsPlus section below on how to get these details if you don't have them already.

ResultsPlus

Get more from your exam results

...and now your mock results too!

ResultsPlus is Edexcel's free online service giving instant and detailed analysis of your students' exam and mock performance, helping you to help them more effectively.

- See your students' scores for every exam question
- Spot topics, skills and types of question where they need to improve their learning
- Understand how your students' performance compares with Edexcel national averages
- Track progress against target grades and focus revision more effectively with NEW Mock Analysis

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus.
To set up your ResultsPlus account, call us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk .

June 2012

Publications Code US032779

Introduction

The paper showed good progression from GCSE, allowing candidates across the ability range to demonstrate their knowledge and understanding of Physics in a range of relevant topics, the Multiple Choice questions in Section A ensuring breadth of coverage of the specification.

Section A

There was a broad correlation between performance in Section A and performance in the rest of the paper, with a fair proportion of candidates at A grade getting 10 correct answers and a typical E grade candidate scoring 5 or 6.

Question	Correct responses (%)
1	78
2	85
3	65
4	65
5	27
6	70
7	86
8	87
9	56
10	36

Questions 5 and 10 were particularly poorly answered across the ability range, with the favoured answers being A and C respectively.

In question 5 this suggests that many candidates did not read the question fully but just saw ‘Ohm’s law’ and looked for a straight line graph. Had they checked the axes it should have suggested to them that this could not be the correct answer, even if they couldn’t pick out graph D. It may be that many are not familiar with an x^2 graph, since the answers to question 18 often referred, incorrectly, to V^2/R, so they are aware of it.

In question 10 all of the answers may be true of a data logging system, but a full reading of the question shows that a number of readings are required during a period of one second. B, C and D represent improvements over a person taking measurements, but a human could never take repeated readings over this time scale, so A is the *best* answer, as asked for.

Question 11(a)

With just under half gaining at least one mark, many candidates seemed to have difficulty with interpreting the basic circuit diagram and what happened with different permutations of open and closed switches, although they presumably have had experience of identifying illuminated light bulbs in circuits with various switch combinations since Key Stage 3 or earlier. A frequent value for the first combination was zero, as if they thought there would be no current with A open and therefore no resistance, although we did not see infinite resistance given as the answer as one might expect in this case.

Candidates who interpreted the circuits correctly often had difficulty with calculating resistors in parallel and many who knew how to apply the formula from the list correctly did not give the answer in a simple form but left it in inverse form.

The table gives the four possible combinations of the two switches.
Complete the table to show the total circuit resistance for each switch combination.

(3)

Switch combinations	Total circuit resistance
A open. B closed	R
A open. B open	$2R$
A closed. B closed	$\frac{1}{R} + \frac{1}{R} = \frac{2}{R}$
A closed. B open	$\frac{1}{R} + \frac{1}{2R} = \frac{2}{2R} + \frac{1}{2R} = \frac{3}{2R}$

ResultsPlus
Examiner Comments

The candidate has been able to select and apply formula for the sum of the resistors in parallel, but has not found the inverse for answer.

The table gives the four possible combinations of the two switches.
Complete the table to show the total circuit resistance for each switch combination.

(3)

Switch combinations	Total circuit resistance
A open. B closed	R
A open. B open	$2R$
A closed. B closed	$(1/R + 1/$[illegible]$R)^{-1}$
A closed. B open	$(1/R + 1/2R)^{-1}$

ResultsPlus
Examiner Comments

While this answer has recognised the need to find the inverse for the final answer, these have not been put in their simplest form and represent partial answers, gaining no credit.

Question 11(b-c)

Whilst about half of the candidates gave a correct answer to part (c), there was much less success with part (b). A common error was to pick the power equation $P = I^2R$, perhaps thinking of 'Joule heating', and to state that the combination with the highest resistance therefore dissipates the most energy in a given time. The implicit assumption is that current remains constant, rather than potential difference. Most successful responses showed a realisation that the rate of energy dissipation is greatest for the lowest resistance, although they did not always justify this by reference to $P = V^2/R$, or the reduction in current and $P = VI$.

About half of the responses identified a reduction in output with an internal resistance, many of those justifying it by reference to 'lost volts', reduced current or increased total resistance. Many candidates, however, appeared to ignore the last part of the question, 'of the heater', and described increased output by the circuit as a whole due to the contribution of the output of the internal resistance.

(b) Explain which switch combination dissipates the most energy in a given time. (2)

Switch A ~~closed~~ open and switch B open forces the current to travel through ~~with~~ the highest value of resistance which will dissipate more energy as heat due to a higher force of friction

(c) The power supply is replaced by one with an internal resistance.

Explain what effect this change will have on the thermal energy output of the heater. (2)

~~The~~ More heat will be generated due to increased friction in the power supply

ResultsPlus
Examiner Comments

(b) This candidate correctly identifies the greatest resistance, but links it to the greatest rate of dissipation of energy, ignoring the effect on current.

(c) The situation is further misinterpreted. The question clearly refers to the output of the heater, but the candidate is including heat dissipation in the power supply.

ResultsPlus
Examiner Tip

A very old tip, but read the question carefully!

(b) Explain which switch combination dissipates the most energy in a given time.

(2)

When A closed, B closed, dissipates the most energy in a given time, resistance is smallest so more current can go through.

(c) The power supply is replaced by one with an internal resistance.

Explain what effect this change will have on the thermal energy output of the heater.

(2)

Total circuit resistance increase, so work done on resistance increase, output of thermal energy will increase as more energy lost from heat.

ResultsPlus
Examiner Comments

(b) The circuit with the smallest resistance has been correctly chosen, but the reason has not been given to satisfy the instruction to 'explain'.

(c) The effect on the resistance of the circuit has been identified, but the effect on the output of the heater alone has not been.

ResultsPlus
Examiner Tip

Remember to give reasons for effects and not just describe them when told to 'explain'.

Question 12

The majority scored at least 3 or 4 for the whole question, typically distributed between the parts. There was sometimes ambiguity in parts (a)(i) and (ii) when the word 'faster' was used because it could apply to speed or rate.

(a)(i) The increased energy of the electron was frequently stated, although not so often as maximum kinetic energy, but not so often explained by reference to increased photon energy. *E=hf* was often quoted without explanation of its significance. A number of candidates identified increased light energy, but not linked to photons, and thought there would be more electrons emitted.

(a)(ii) Candidates usually stated that more electrons would be emitted and frequently linked this to more photons, but they rarely linked either of these with rate or 'per second', and so only gained one mark.

(b) The great majority of candidates correctly identified at least one observation from the photoelectric effect and identified the relevance of photons or work function energy. Although some candidates struggled to order their responses logically, adopting a scatter gun approach of remembered facts, it was not unusual to award three marks for the particle part of the explanation with many more than three relevant points being made. The wave part was less well answered and frequently ignored.

Candidates should realise that full marks will not be awarded for a comparison type of question if both parts are not addressed.

Examiners observed that answers set out as a sequence of simple statements, such as a bullet point style, usually scored highly but were rarely seen.

12 Monochromatic light is shone onto the surface of a clean metal plate. The photoelectric effect results in electrons being emitted from the surface.

(a) State and explain the effect on the emitted electrons if

(i) the frequency of the light is increased

(2)

The electrons will have a higher energy

(ii) the intensity of the light is increased.

(2)

More electrons will be given off

*(b) Explain how the photoelectric effect supports the particle model of light and not the wave model of light.

(4)

Because after the electrons in the atom have recieved ~~the~~ energy they drop down a level. When they drop down a level they give out the energy as ~~a light particle~~. an individual light particle.

ResultsPlus
Examiner Comments

Scores 1, 1, 0. In the first two parts the instruction to state AND explain has not been followed, and the last part shows confusion with emission spectrum production.

ResultsPlus
Examiner Tip

Photoelectric effect and spectra both involve quanta of electromagnetic radiation, but you must be sure to know which is which.

12 Monochromatic light is shone onto the surface of a clean metal plate. The photoelectric effect results in electrons being emitted from the surface.

(a) State and explain the effect on the emitted electrons if

(i) the frequency of the light is increased

(2)

The electrons being emitted will have more kinetic energy as $E = hf = \phi + Ke$.
Photons have more energy

(ii) the intensity of the light is increased.

(2)

More electrons will be emmitted from the metal as there are more photons in the light *(b) Explain how the photoelectric effect supports the particle model of light and not the wave model of light.

(4)

- As the increase in intensity doesnt increase the energy of the electrons.
- The frequency affects the ~~elect~~ kinetic energy of the electrons.
- Light under a certain frequency wont emit electrons no matter how intense
- This gives the impression light is a group of discrete pockets of energy called photons which act as particles

ResultsPlus

Examiner Comments

Scores 2, 1, 2. The mark is lost in the second part through not mentioning rate or 'per second'.

In part (b) the case for waves is not addressed at all and there are only observations regarding photons and no interpretation.

ResultsPlus

Examiner Tip

When comparing phenomena your answer must refer to both of them.

Question 13(a-b)

The most common outcome in each part of question 13 was a full score, with the great majority gaining five marks for parts (a) and (b) and at least two marks for part (c). There were some problems with applying powers of 10, occasionally with kW but more frequently, if at all, with mm in the last part.

In part (b) candidates occasionally lost a mark by failing to include the unit with their answers. A minority of candidates chose the correct formula but got resistance and resistivity confused and some could not rearrange it. Some did not understand what was represented by the symbol rho and calculated the product of resistivity and length rather than length, apparently satisfied with the product of two variables rather than a single value.

13 The photograph shows a typical hairdryer.

(a) The hairdryer contains a heating element which consists of a long nichrome wire wound around an insulator. The heating element operates at 230 V and has a power rating of 1 kW.

Show that the resistance of the heating element is about 50 Ω.

(3)

$P = \frac{V^2}{R}$

$R = \frac{230^2}{1000}$

$= 52.9 \approx 50\ \Omega.$

(b) The nichrome wire has a cross-sectional area of 1.3×10^{-7} m^2.

Calculate the length of the wire.

resistivity of nichrome = 1.1×10^{-6} Ω m

(2)

$R = \frac{\rho l}{A}$

$1.1 \times 10^{-6} = \frac{50 \times L}{1.3 \times 10^{-7}}$

$L = 2.86 \times 10^{-15}$

Length = 2.86×10^{-15} m.

ResultsPlus

Examiner Comments

Resistance and resistivity have been reversed.

13 The photograph shows a typical hairdryer.

(a) The hairdryer contains a heating element which consists of a long nichrome wire wound around an insulator. The heating element operates at 230 V and has a power rating of 1 kW.

Show that the resistance of the heating element is about 50 Ω.

(3)

$P = VI$

$1000 = 230I$

$\frac{1000}{230} = I$

$4.348\text{A} = I$

$V = IR$

$\frac{V}{I} = R$

$\frac{230}{4.34} = 52.9\,\Omega$

So therefore about 50 Ω

(b) The nichrome wire has a cross-sectional area of 1.3×10^{-7} m^2.

Calculate the length of the wire.

resistivity of nichrome = 1.1×10^{-6} Ω m

(2)

$R = \rho l / A$

1.1×10^{-6} Ωm $= \frac{\rho l}{1.3 \times 10^{-7}}$

length of wire = 1.43×10^{-13}

Length = 1.43×10^{-3} m

ResultsPlus

Examiner Comments

Scores 3, 0. This answer treats the product of resistivity and length as a single quantity equivalent to length.

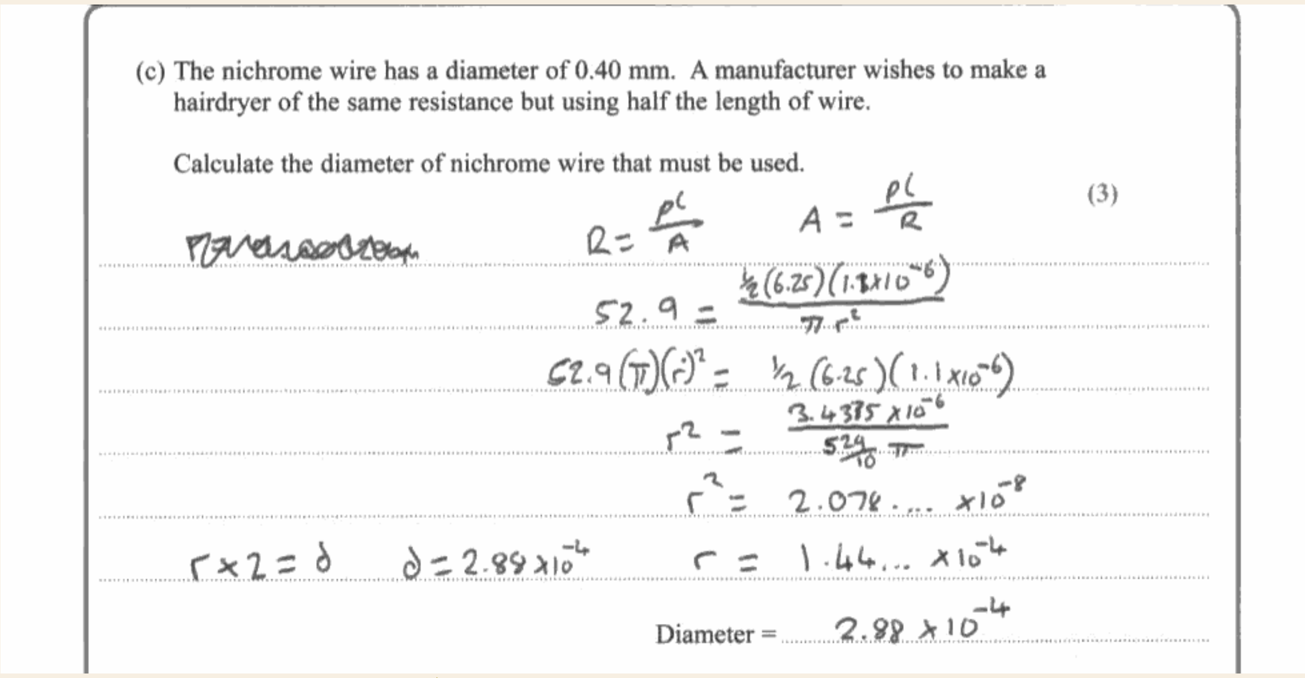
ResultsPlus

Examiner Tip

Be sure to learn what all the symbols in the supplied formulae stand for.

Question 13(c)

The normal approach in part (c) was to use the full resistivity equation rather than applying the ratio of area to length and a large majority got this far. Nearly half completed it successfully and about a sixth failed to apply the factor of two correctly to get from the radius to the diameter.


(c) The nichrome wire has a diameter of 0.40 mm. A manufacturer wishes to make a hairdryer of the same resistance but using half the length of wire.

Calculate the diameter of nichrome wire that must be used.

(3)

$R = \frac{\rho l}{A}$ $A = \frac{\rho l}{R}$

$52.9 = \frac{\frac{1}{2}(6.25)(1.1 \times 10^{-6})}{\pi r^2}$

$52.9(\pi)(r)^2 = \frac{1}{2}(6.25)(1.1 \times 10^{-6})$

$r^2 = \frac{3.4375 \times 10^{-6}}{\frac{529}{10}\pi}$

$r^2 = 2.078\ldots \times 10^{-8}$

$r \times 2 = d$ $d = 2.88 \times 10^{-4}$ $r = 1.44\ldots \times 10^{-4}$

Diameter = 2.88×10^{-4}

ResultsPlus
Examiner Comments

Correct working, but missing the unit.

ResultsPlus
Examiner Tip

Physical quantities must have a magnitude and a unit.

(c) The nichrome wire has a diameter of 0.40 mm. A manufacturer wishes to make a hairdryer of the same resistance but using half the length of wire.

Calculate the diameter of nichrome wire that must be used.

(3)

$\frac{6.3\,m}{2} = 3.15\,m$

$R = \frac{\rho L}{A}$

$A = \frac{\rho L}{R} = \frac{1.1\times10^{-6}\times 3.15}{53} = 6.537\times10^{-8}\,m^2$

$A = r^2 \times \pi$

$6.537\times10^{-8} = r^2 \times \pi$

$\sqrt{2.081\times10^{-8}} = r$

$r = 1.44\times10^{-4}\,m$

$1.44\times10^{-4}\,m \rightarrow 0.144\,mm$

Diameter = 1.44×10^{-4} m

ResultsPlus

Examiner Comments

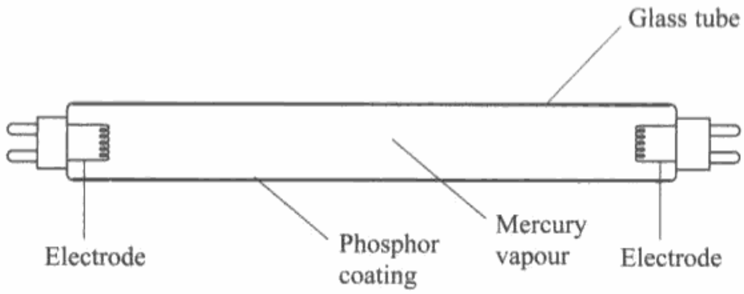
The radius has been correctly calculated, but the instruction to find the diameter has not been followed.

Question 14(a)

In question 14 some candidates clearly confused spectra with the photoelectric effect and there were problems with using the correct technical vocabulary for Physics or in giving specifically detailed explanations.

The majority of candidates suggested an increase of energy, although this was sometimes linked to more vibration or the absorption of photons. Nearly half gained the second mark for the movement to a higher energy level, but some just said 'another' energy level, or referred to a 'jump' between levels without specifying a higher level. Other candidates only mentioned shells. Quite a few candidates referred to the atoms becoming charged, which may have been linked to misapplication of the photoelectric effect.

14 The diagram shows the main components of a fluorescent light tube.



When the light is switched on, charge flows between the electrodes and the mercury atoms become excited. The mercury atoms then emit electromagnetic radiation.

(a) What is meant by *the mercury atoms become excited*?

(2)

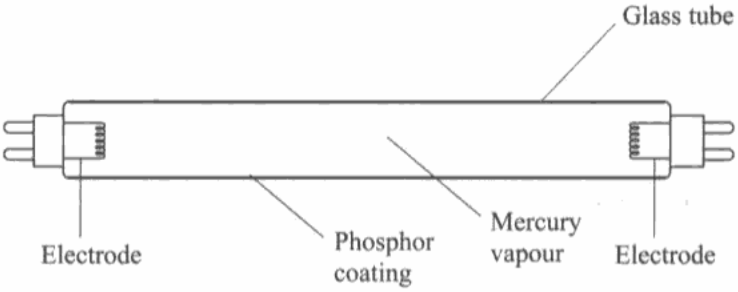
It means ~~they~~ that they absorb energy from the ~~moving~~ electrons that carry charge and the jump to different energy levels and so get excited.

ResultsPlus

Examiner Comments

This refers to a jump, but a jump can be down as well as up, so it is not sufficiently detailed.

14 The diagram shows the main components of a fluorescent light tube.



When the light is switched on, charge flows between the electrodes and the mercury atoms become excited. The mercury atoms then emit electromagnetic radiation.

(a) What is meant by *the mercury atoms become excited*?

(2)

The mercury atoms gain energy from the flowing of charges, and they will vibrate more.

ResultsPlus

Examiner Comments

This is an example of an answer that identifies energy gained but not its effect.

Question 14(b)

(b)(i)Having explained excitation in part (a), many candidates repeated this in part (b)(i), sometimes not getting as far as explaining emission. There was similar lack of detail in identifying a move to a lower level, or reference to shells only. The most common lost mark in this part, however, was in failing to identify the radiation emitted as more than just 'radiation' as already given in the question. Some answers referred to the emission, and sometimes absorption, of electrons, or even beta emission.

(b)(ii) Candidates did not usually score highly on this part, although some answers gave straightforward explanations because they had learned spectrum production thoroughly. Many candidates remembered 'discrete energy levels' and little else of merit. Others managed to quote $E = hf$, but did not explain its relevance. Some candidates identified specific distances between levels, or shells again, rather than differences in energy. Quite frequent references were made to work function energy or threshold frequency in parts ii and iii to explain the production of specific frequencies, showing confusion with the photoelectric effect.

(b)(iii) The straightforward answer 'different energy levels' was seen infrequently. Many candidates referred to different numbers of levels or different arrangements of electrons and different work function was also seen.

(b) (i) Explain how the excited atoms emit radiation.

(2)

As the atoms gain more energy, they release electrons which are emitted as radiation.

(ii) Explain why only certain frequencies of radiation are emitted.

(3)

Because the kinetic energy recieved from the charge flow between the atoms has to be above a certain theshold frequency for the ~~particles~~ electrons to be emitted as radiation, so not all frequencies are ~~[illegible]~~ emitted.

(iii) Some of the radiation is ultraviolet radiation which the human eye cannot detect. The phosphor coating absorbs the ultraviolet radiation and emits visible light.

Suggest why the phosphor coating emits different wavelengths from the mercury.

(1)

Because phosphor has a different electron configuration.

ResultsPlus

Examiner Comments

Scores 0, 0, 0

This refers to the emission of electrons, then goes on to show that the photoelectric effect is being considered, and finishes by talking about electron configuration without reference to energy.

(b) (i) Explain how the excited atoms emit radiation.

(2)

Excited electrons prefer to be more stable at the ground state thus the electrons will fall down discrete energy levels, emitting their energy as they dexite. The energy is then emitted as radiation. Normally visible light.

(ii) Explain why only certain frequencies of radiation are emitted.

(3)

Every atom has unique discrete energy levels which emit different wavelengths. Therefore only certain frequencies are emitted due to the falling of electrons to different energy levels. Thus only a certain frequency can be seen on the emission spectrum relating to the element. Thus we can distinguish different atoms from each other. The falling of ~~energy~~ electrons in energy levels create different wavelengths, the shorter the wavelength the higher the frequency.

(iii) Some of the radiation is ultraviolet radiation which the human eye cannot detect. The phosphor coating absorbs the ultraviolet radiation and emits visible light.

Suggest why the phosphor coating emits different wavelengths from the mercury.

(1)

As phosphor and mercury are different elements, they have unique discrete energy levels, thus different wavelengths are produced due to the falling of electrons in the energy levels.

ResultsPlus

Examiner Comments

1, 1, 1

(i) Identifies the drop in levels, but only refers to radiation emitted, which is already in the question.

(ii) The discrete energy levels are remembered, but they are not used to explain the observation.

(iii) Correct.

Question 15(a-b)

(a) There was evidence that most candidates had an understanding of the general principle, but this was not often translated into full marks. The great majority identified reflection at a relevant boundary and most of those linked the echo time to distance. There was a great deal of poor expression, with many answers describing the signal ‘bouncing’ from a surface. Relatively few dealt with building the image in any way and the third mark, if given, was usually for describing the timing between pulses.

(b) The Doppler effect was not applied well to this context, many candidates simply describing a stethoscopic process for listening to the heartbeat. The mark most commonly given was for a suggestion of a change of frequency or wavelength. A moving surface for the reflection of the wave was rarely specifically identified, repetition of ‘heartbeat’ from the question being common. Many answers described the change in frequency as a property of the direction of travel of the wave, rather than movement of the source. Some candidates confused sound with electromagnetic radiation, referring to ultraviolet radiation and sometimes even red shift.

15 The photograph shows the image of a fetus inside its mother's uterus. Ultrasound was used to produce this image.

(a) Explain how ultrasound pulses can be used to build up the image of the fetus in the uterus.

(3)

A pulse is used to distinguish specific shapes or borders. One pulse has to be sent and received before another can be sent, this is to prevent overlap of pulses. The differing densites of each surface will give an indication of shape and size.

(b) Explain how the Doppler effect is used to detect the heartbeat of the fetus.

(2)

If the object is moving towards you the size of the wavelength will get smaller so the frequency of the sound given will be higher. If the object is moving away the distance travelled by wavelength will be larger resulting in lower frequency. So by ~~hearing~~ listening to the pitch and frequency of heartbeat ~~the~~ it can be detected.

ResultsPlus
Examiner Comments

1, 1

This doesn't give any indication of how the pulses are used, for example to measure distances.

The Doppler effect is described satisfactorily, but the moving source needs to be identified.

15 The photograph shows the image of a fetus inside its mother's uterus. Ultrasound was used to produce this image.

(a) Explain how ultrasound pulses can be used to build up the image of the fetus in the uterus.

(3)

ultrasound pulses have ~~leng~~ longer wavelength and lower frequecy so it pass through the uterus and then bounce off the fetus & back to the computer to give an image of the fetus.

(b) Explain how the Doppler effect is used to detect the heartbeat of the fetus.

(2)

The heartbeat gets louder as you move closer because of an increase of frequency & as you move away the wavelength gets longer so the heart beat sounds quiter.

ResultsPlus

Examiner Comments

0, 1

In part (a) the word 'bounce' is used instead of reflect.

In (b) a change of frequency is identified, but the reason is linked to distance and confused with amplitude.

ResultsPlus

Examiner Tip

Use correct technical vocabulary.

Question 15(c)

This was intended as a straightforward application of the pulse-echo technique, but the factor of 2 was frequently misapplied, or even used twice. Some candidates took 'half the length of the ultrasound pulse' to be 'half the ultrasound wavelength' and applied the wave equation. The marks gained by students were fairly evenly split between zero, 1 for applying the speed equation and 3 for a correct answer.

(c) The smallest detail that can be seen on the image is half the length of the ultrasound pulse. The thumbnail on the fetus is 0.50 mm thick. The speed of ultrasound in the thumbnail is 2000 m s^{-1}.

Calculate the maximum pulse duration if the thumbnail is to be seen on the image.

(3)

speed = $\frac{\text{distance}}{\text{time}}$

time = $\frac{500\text{ m}}{2000}$ = 0.25 s

Total/max. time = 0.25 × 2 = 0.5 s.

Maximum pulse duration = 0.5 s.

ResultsPlus

Examiner Comments

Correct method, but a serious error of scale due to a mistake with the units. 0.5 s for a speed of 2000 m/s should ring some warning bells.

ResultsPlus

Examiner Tip

Apply the common sense test to answers.

(c) The smallest detail that can be seen on the image is half the length of the ultrasound pulse. The thumbnail on the fetus is 0.50 mm thick. The speed of ultrasound in the thumbnail is 2000 m s^{-1}.

Calculate the maximum pulse duration if the thumbnail is to be seen on the image.

(3)

$\frac{0.5 \times 10^{-3}}{2000} = 2.5 \times 10^{-7}$

$\frac{2.5 \times 10^{-7}}{2} = 1.25 \times 10^{-7}$

Maximum pulse duration = 1.25×10^{-7}

ResultsPlus

Examiner Comments

The factor of 2 has been misapplied and the final unit has been omitted.

Question 16(a)

This question was characterised by imprecise use of technical vocabulary despite a general understanding in many cases.

While a large majority gained one mark, this was often only for the obstacle or gap and only a half got both marks. As in previous series, bending of waves is not sufficient to describe the spreading of the waves. Some candidates used diagrams, but the question asked them to 'state' the meaning and without extensive labelling the diagrams did not often gain specific credit. As in previous series, some candidates think the waves travel through obstacles.

16 (a) State what is meant by diffraction.

(2)

The bending of light caused by ~~waves~~ travelling through different mediums

ResultsPlus

Examiner Comments

This shows why 'bending' is not accepted - it is more appropriate for refraction.

16 (a) State what is meant by diffraction.

(2)

The spreading out of waves, or the movement of waves through a slit.

ResultsPlus

Examiner Comments

The use of 'or' suggests alternative answers. It is not the examiner's responsibility to choose between answers supplied by the candidate.

Question 16(b)

Only half of the responses gained any credit, with only a third of those getting two marks. This is a standard definition and should be quoted easily, but half did not clearly describe that there must be two or more waves and the great majority did not identify the sum of displacements. If there was reference to addition it was more likely to be amplitude, but it was more common to read about either constructive or destructive interference.

(b) State the principle of superposition of waves.

(2)

~~Waves~~ Wavefronts a mutiple of $\lambda/2$ wavelengths apart cause constructive interference.

ResultsPlus

Examiner Comments

This is a typical answer which does not address the question as it is written.

(b) State the principle of superposition of waves.

(2)

Waves must be in phase, with the same frequency and wave length but be travelling in opposite directions

ResultsPlus

Examiner Comments

This sort of irrelevant extra detail was seen frequently. Candidates should note that superposition itself is not dependent on these conditions.

Question 16(c)

A majority gained at least two marks, but rarely more than three. The marks were most often for identifying diffraction by the rocks and correct reference to phase or path difference and constructive or destructive interference. The question directed candidates towards superposition, but it was often just quoted and not described in this context as occurring when waves from different gaps in the rocks met. Whether the question is about standing waves or interference from multiple sources as in this question, a standard answer includes the identification of more than one wave meeting and the effect for different phase or path differences. In fact, some candidates thought of this as a standing wave and described what happened when incoming waves met reflected waves. They should remember that this sort of interference, another example being Young's slits, also depends on diffraction which distinguishes it from superposition in a question about standing waves. The final mark, for linking the effect of the amplitude change on the sand, was rarely awarded.

Use the ideas of diffraction and superposition to explain why the sand surface becomes uneven.

(5)

The sand surface becomes uneven because of the waves. The waves have diffracted and caused superposition which have caused

ResultsPlus

Examiner Comments

This just uses the two key words in the question without any added context or explanation and so will not gain any credit.

ResultsPlus

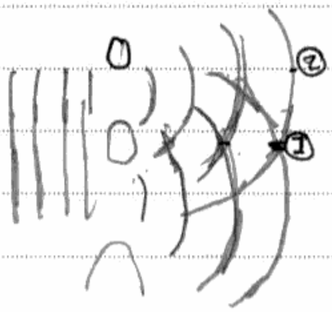
Examiner Tip

There are no marks for simply rephrasing the words in the question.

Use the ideas of diffraction and superposition to explain why the sand surface becomes uneven.

(5)

As waves first pass the rocks, diffraction occurs and the waves begin to spread out. When the waves meet, the waves either result in constructive or destructive interference. This means that the wave shows superposition in areas, so when the wave reaches the sand, the water moves the sand more in some areas resulting in uneven-ness. As the waves have bigger crest and troughs, this will create more uneven sand.



at ①, superposition occurs and this will have a larger effect on the sand. At ②, the wave has normal effect on the sand.

(Total for Question 16 = 9 marks)

ResultsPlus

Examiner Comments

This got three marks and shows a good general understanding. Candidates are expected to refer to phase difference to identify where constructive and destructive interference occur.

ResultsPlus

Examiner Tip

Learn the basic steps in explaining standard phenomena.

Question 17(a)

Surprisingly, only 70% of the candidates could identify refraction correctly, answers including reflection, total internal reflection, perhaps through not looking at point A as instructed, diffraction, and the intentionally ambiguous ‘reflaction’.

(a) Name the effect that is experienced by the red light at A.

(1)

Reflaction

ResultsPlus

Examiner Comments

This word is interpreted as an attempt to qualify for the mark whether it is for reflection or refraction and is never accepted.

ResultsPlus

Examiner Tip

Use correct terminology.

(a) Name the effect that is experienced by the red light at A.

(1)

Regraction ~~Dyffraction~~ (red shift)

ResultsPlus

Examiner Comments

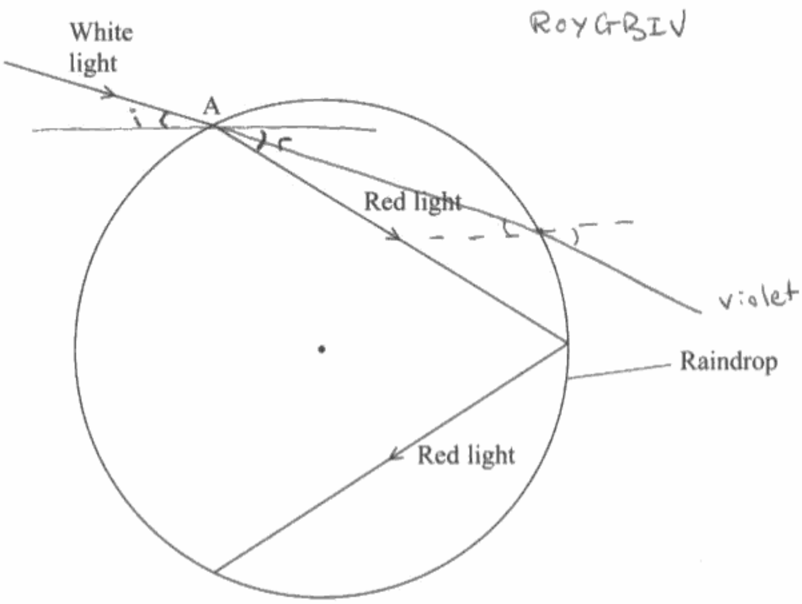
This is similar in presenting two answers. When a list is supplied, wrong answers will cancel any correct answers.

Question 17(b)

About half of the entry got two marks for part (b) overall, but very rarely four. Normals were frequently poorly drawn, often being drawn parallel to the long edge of the paper rather than through the centre of the circle, meaning they could not get the angle marks. The violet ray was as often drawn to the wrong side of the red ray, and sometimes not drawn at all. Total internal reflection was usually shown for the violet ray, but the instruction to show its path 'into the air' was as often ignored as followed.

17 Rainbows are seen when sunlight is dispersed by raindrops. The light is separated into different colours because they each take different paths through raindrops.

A ray of white light is incident on a raindrop. The diagram shows the subsequent path of the red light.



(a) Name the effect that is experienced by the red light at A. **(1)**

Total Internal Reflection

(b) (i) On the diagram label an angle of incidence with an *i* and an angle of refraction with an *r*. **(2)**

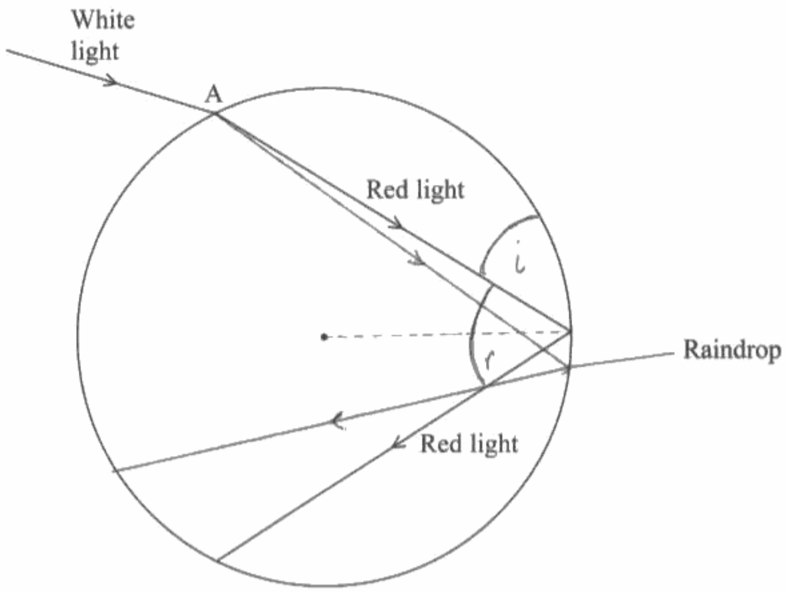
(ii) On the diagram draw the path that a violet ray of light would take, through the raindrop and into the air. **(2)**

ResultsPlus
Examiner Comments

0, 0. This normal is parallel to the short edge of the page and the violet ray is to the wrong side of red.

17 Rainbows are seen when sunlight is dispersed by raindrops. The light is separated into different colours because they each take different paths through raindrops.

A ray of white light is incident on a raindrop. The diagram shows the subsequent path of the red light.



(a) Name the effect that is experienced by the red light at A.

(1)

Total internal ~~refraction~~ reflection

(b) (i) On the diagram label an angle of incidence with an *i* and an angle of refraction with an *r*.

(2)

(ii) On the diagram draw the path that a violet ray of light would take, through the raindrop and into the air.

(2)

ResultsPlus

Examiner Comments

1, 1 A normal has been shown - but not at point A where the refraction takes place. The violet ray is going the right way, but does not leave the drop as instructed.

Question 17(c)(i)

Only a quarter of candidates described the critical angle satisfactorily in terms of the angle of refraction of 90 degrees. Many just said 'it is the angle when', ignoring its identification as an angle of incidence, and many thought it was the smallest angle for which total internal reflection occurs.

(c) (i) State what is meant by the critical angle.

(1)

the angle at which the angle of refraction is at 90° to the normal (total internal reflection occurs)

ResultsPlus

Examiner Comments

Up to the bracket this would be alright if it said angle *of incidence*. The bracketed part, being wrong, ensures no marks.

(c) (i) State what is meant by the critical angle.

(1)

Critical angle is the angle of incidence, when the angle of diffraction is at 90°

ResultsPlus

Examiner Comments

Probably a slip of the pen, but 'diffraction' spoils an answer which was looking good.

Question 17(c)(ii)

Three quarters calculated the critical angle correctly, even if sometimes by trial and error with the values given. Others were not successful in finding an appropriate permutation of the numbers and used sine of 1.3 degrees. A minority carelessly omitted the symbol for degrees, losing a mark as a unit error, and occasionally they wrote 50.3 ºC.

(ii) Calculate the critical angle for red light in the raindrop.

refractive index for red light in water = 1.3

(2)

$\frac{1}{\sin c} = \mu \qquad 1 = \mu \sin c \qquad \frac{1}{\mu} = \sin c$

$0.769230 = \sin c$

$\sin^{-1} = C$

$\sin^{-1}(0.769230) = 50.28486277$

Critical angle = ~~50.2~~ 50.285

ResultsPlus
Examiner Comments
Missing the degree sign is still a unit error.

(ii) Calculate the critical angle for red light in the raindrop.

refractive index for red light in water = 1.3

(2)

$\frac{1}{\sin C} = \frac{1}{\sin 1.3} = 44°.$

Critical angle = 44°

ResultsPlus
Examiner Comments
An example of trying the numbers to get a reasonable sounding answer.

Question 17(d)

The correct equation was almost universally applied, with occasional problems with rearranging, powers of 10 or including the unit.

(d) Red light has a frequency of 4.2×10^{14} Hz and travels at a speed of 2.2×10^{8} m s^{-1} in the raindrop.

Calculate the wavelength of the red light in the raindrop.

(2)

$f = 4.2 \times 10^{14}$ Hz $\quad v = 2.2 \times 10^{8}$ m/s

$v = f\lambda \quad \frac{v}{f} = \lambda$

$\lambda = \frac{2.2 \times 10^{8} \text{ m/s}}{4.2 \times 10^{14} \text{ Hz}} = \frac{11}{21} \times 10^{-6}$ M

Wavelength = $\frac{11}{21} \times 10^{-6}$ m

ResultsPlus

Examiner Comments

Fractional answers were accepted for the resistance in question 11, but generally, especially in this example, they must be given in decimal form.

(d) Red light has a frequency of 4.2×10^{14} Hz and travels at a speed of 2.2×10^{8} m s^{-1} in the raindrop.

Calculate the wavelength of the red light in the raindrop.

(2)

$\lambda = \frac{v}{f}$

$= \frac{2.2 \times 10^{8}}{4.2 \times 10^{14}}$

$\lambda = 5.238 \times 10^{7} \rightarrow 5.2 \times 10^{7}$ m

Wavelength = 5.2×10^{7} m

ResultsPlus

Examiner Comments

A slip with the powers of 10, but 50 million metres should seem unreasonable.

Question 18

About half the entry got five marks or more, with few scoring under three.

(a) While a Key Stage 3 pupil could find the fault in a circuit with cells of opposing polarity, this seemed to cause a major problem in this question with many, many candidates failing to determine the resultant emf as 7.4 V.

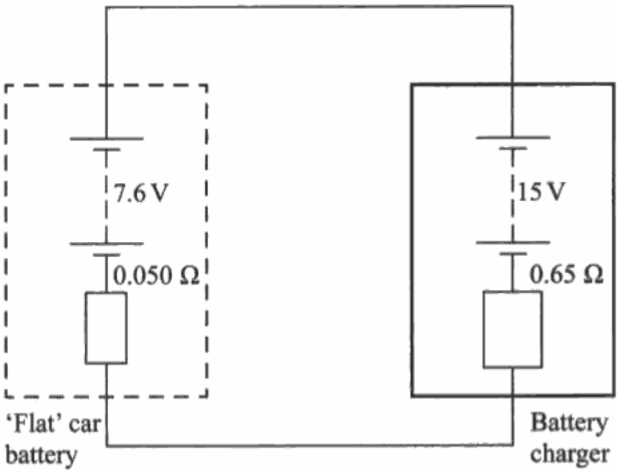
The total resistance as the sum of two resistors in series was rarely a problem, although some candidates treated them as resistors in parallel because of the way they interpreted the circuit. In nearly all cases candidates divided a potential difference by a resistance to calculate a current, although they did not always use the values from the preceding two sections.

(b) (i) Candidates' answers often started with, or showed some recollection of, a variation of $\varepsilon = V + Ir$, but it was rarely applied correctly. The product of current and resistance was usually calculated, but then the addition or subtraction was reversed. Sometimes the total resistance was used.

(ii) Candidates frequently applied current x potential difference, but despite 15 V being quoted the terminal potential difference was usually substituted, showing a misunderstanding of the required quantity. Many candidates who made this error went on to find the correct value for part (ii) while answering part (iii), evidence that they understood the principle but misinterpreted the question. Some candidates showed confusion between energy and power, using $E = VIt$, and applying unit time but never dividing by time subsequently, and the units J were sometimes given. $P = V^2/R$ was frequently used, unsuccessfully.

(iii) In this part it was not unusual to see the efficiency formula written down and nothing else, but many candidates made reasonable attempts to find suitable values for input and output power even if the preceding parts yielded little of value. The two routes to the answer in the mark scheme were both seen, and a number of candidates got part ii wrong but completed part iii completely correctly 'from scratch' and other found the 'wasted power' and used it with the answer from part ii to get the full marks with an error carried forward.

18 A 'flat' car battery of internal resistance 0.050 Ω is charged with a battery charger. The battery charger consists of a power supply (with negligible internal resistance) of e.m.f. 15 V in series with a resistor of resistance 0.65 Ω.



V = ε − Ir

The positive terminal of the car battery is connected to the positive terminal of the battery charger.

(a) (i) Determine the resultant e.m.f. of the circuit.

(1)

~~15V − 7.6V =~~ ~~15V − 7.6V = 7.4V~~

15 + 7.6 = 22.6V

Resultant e.m.f. = 22.6V

(ii) Determine the total resistance of the circuit.

(1)

1/R = 1/0.05 + 1/0.65 ~~R = 0.046~~ R = 46.4 mΩ.

Total resistance = 46.4 mΩ.

(iii) Calculate the initial charging current.

(2)

V = IR ~~I = V/R = 15V/0.65 =~~ I = V/R.

= 15V / 0.65Ω = 23.1A.

Charging current = 23.1A.

(b) The e.m.f. of the car battery quickly increases to 12.0 V and the charging current becomes 4.30 A.

(i) Show that the terminal potential difference across the battery charger is now about 12 V. $V = \varepsilon - Ir$

(3)

$V = \varepsilon - Ir$

$= 12 - (4.3A)(0.05\Omega)$

$= 11.785V$

$\approx 12V$.

(ii) Calculate the rate at which electrical energy is now being supplied by the 15 V power supply.

(2)

$P = IV$

$= 11.785V \times 4.3A$

$= 50.6755W = 50.6755 Js^{-1}$

Rate of energy supply = $50.68 Js^{-1}$

(iii) The wasted energy in this process is the energy dissipated in the internal resistance of the car battery and the series resistor in the battery charger.

Calculate the efficiency of the charging process when the current is 4.30 A.

(3)

$V = \varepsilon - Ir$ $\quad 12 - 11.785 = 0.215V$. $\quad P = IV$.

$= 12 - (4.3)(0.05)$ $\quad V = \frac{P}{I} = \frac{50.65}{4.3} = 11.786V$.

$= 11.785V$.

$P = IV \quad P = \frac{V^2}{R} \quad V^2 = PR \quad V = 5$.

$\frac{11.785 + 5.74}{27} \times 100 = 65\%$ $\quad V = 5.74$.

Efficiency = 65.0 %

ResultsPlus
Examiner Comments

0, 0, 1, 1, 1, 0

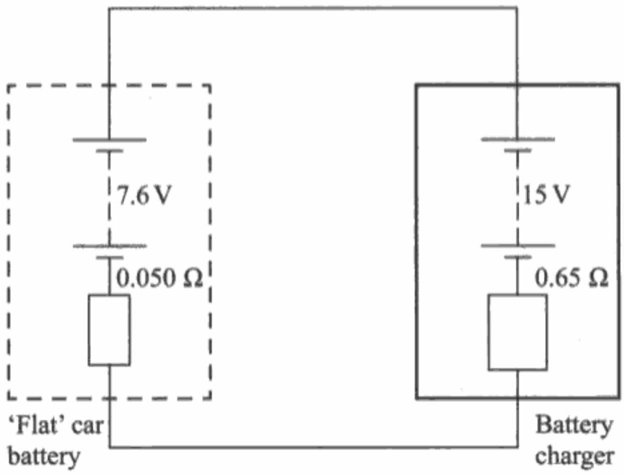
The emfs have been added and the resistances combined in parallel, showing two misunderstandings.

A current has been calculated, but not with the emf calculated.

Ir has been calculated, but subtracted where it should have been added.

There is use of P = IV for power, but the wrong pd, and the final answer shows a mix of quantities for efficiency.

18 A 'flat' car battery of internal resistance 0.050 Ω is charged with a battery charger. The battery charger consists of a power supply (with negligible internal resistance) of e.m.f. 15 V in series with a resistor of resistance 0.65 Ω.



The positive terminal of the car battery is connected to the positive terminal of the battery charger.

(a) (i) Determine the resultant e.m.f. of the circuit.

(1)

15 - 7.6

= 7.4 V

Resultant e.m.f. = 7.4 V

(ii) Determine the total resistance of the circuit.

(1)

0.05 + 0.65 = 0.7 Ω

Total resistance = 0.7 Ω

(iii) Calculate the initial charging current.

(2)

I = V/R = 7.4/0.7

= 10.6 A

Charging current = 10.6 A

(b) The e.m.f. of the car battery quickly increases to 12.0 V and the charging current becomes 4.30 A.

(i) Show that the terminal potential difference across the battery charger is now about 12 V.

(3)

$E = V + v \quad V = E - Ir$

$V = 15 - (4.3 \times 0.65)$

$= 12.2\ V$

(ii) Calculate the rate at which electrical energy is now being supplied by the 15 V power supply.

(2)

$P = IV$

$= $ ~~[illegible]~~ 15×4.3

$=$ ~~[illegible]~~ $= 64.5\ W$

$64.5\ W$

Rate of energy supply = ~~[illegible]~~

(iii) The wasted energy in this process is the energy dissipated in the internal resistance of the car battery and the series resistor in the battery charger.

Calculate the efficiency of the charging process when the current is 4.30 A.

(3)

$\text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$

wasted energy $P = I^2R = 4.3^2 \times 0.7 = 12.943$

$1 - \left(100 \times \dfrac{12.943}{64.5}\right) = 79.9\%$

79.9%

Efficiency = ~~[illegible]~~

ResultsPlus
Examiner Comments

Just to show it is possible, a full mark answer to end with.

Paper Summary

As in previous series, basic calculations such as those using the wave equation and resistance have elicited the best responses, although some candidates need to develop their algebraic skills. Candidates must be sure to include units in numerical answers.

While many written answers demonstrate understanding of new concepts, and therefore progression from GCSE, there is a requirement in many cases for considerable improvement in the precision with which technical vocabulary is applied. Some candidates need to practise setting out their answers in logical sequences, and might consider the ‘bullet point’ style as an aid to achieving this as they set out their arguments.

Basic definitions need learning until they can be repeated when called for. In this paper examples include superposition, diffraction and critical angle. Standard descriptions of various phenomena also need to be learned so they can be applied to given contexts. Examples from this paper include the photoelectric effect, emission spectra, pulse echo techniques and diffraction patterns. Care must be taken to understand the difference between the quantum phenomena of spectra and the photoelectric effect.

Grade Boundaries

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

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

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481
Email publication.orders@edexcel.com
Order Code US032779 June 2012

For more information on Edexcel qualifications, please visit
www.edexcel.com/quals

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Rewarding Learning