Examiners' Report/
Principal Examiner Feedback

Summer 2014

Pearson Edexcel GCE
Chemistry Unit 6PH02 Paper 01R
Physics at Work

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. 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. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. 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 our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2014
Publications Code US039714

General

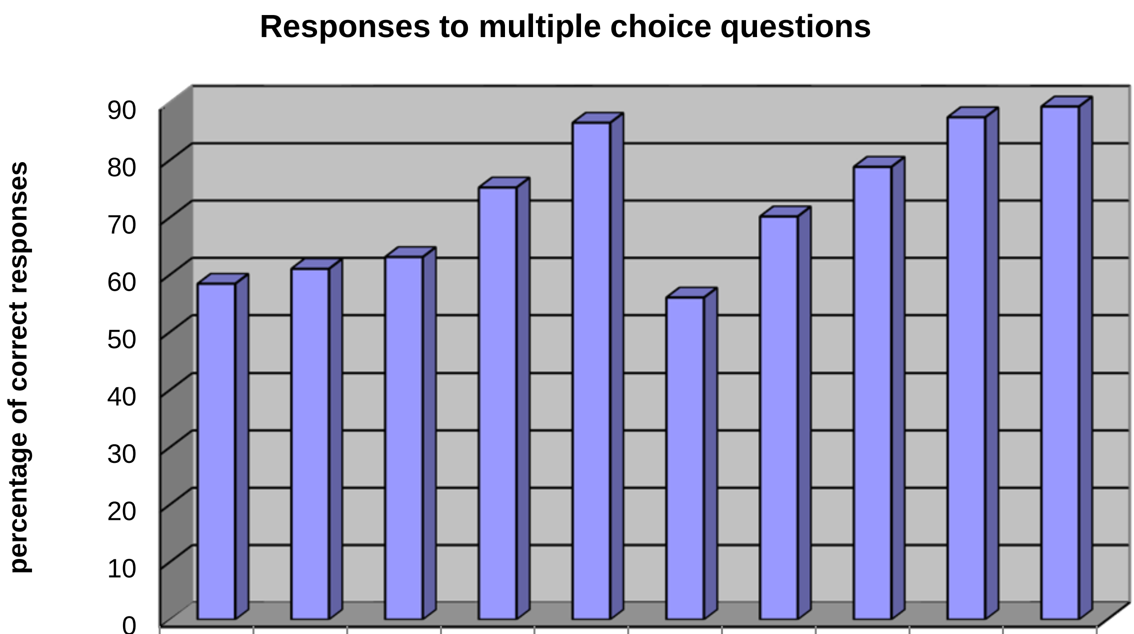
The assessment structure of Unit 2, Physics at Work is the same as that of Unit 1, Physics on the Go, consisting of Section A with ten multiple choice questions, and Section B with a number of short answer questions followed by some longer, structured questions based on contexts of varying familiarity.

This paper allowed candidates to demonstrate their knowledge of content across the whole specification for this unit, showing progression from GCSE and answering questions to the depth appropriate to their level of understanding.

There was some evidence of students quoting answers from mark schemes to previous papers when they were not entirely relevant to the questions in this paper, e.g. 'reference to $E = hf$', part of a mark scheme from a previous series, appeared exactly so in answers to questions 13 and 17. While past papers and mark schemes are most useful preparation, students must use them to help them learn the Physics rather than learn the actual mark schemes.

A number of responses were seen where students recognised the situations and had some recall of techniques, explanations and terminology, but imprecise detail and failure to express themselves clearly prevented the award of marks.

SECTION A - Multiple Choice



	1	2	3	4	5	6	7	8	9	10
percentage	58	61	63	75	87	56	70	79	88	89

Some questions were more challenging, but the preferred incorrect choices may reveal some areas for development. In the following questions a large majority of candidates with incorrect answers made the same choice.

Question 1

The majority choice for incorrect responses was answer C, where the columns contained ‘atomic line spectra’ and ‘photoelectric effect’. Both phenomena involve interactions between photons and electrons, so it is not easy to see how they were classified differently, but students who chose this rather than B clearly have not made the necessary connection for atomic spectra.

Question 2

D was the most common incorrect response. Perhaps the standard diagram of a standing wave in a pipe made students think of transverse waves.

Question 8

While a large majority chose the correct answer, those who did not do so tended to select answer B. They probably selected it because of the factor of 2, as in the path difference.

Other incorrect choices were more evenly spread.

SECTION B

Question 11

Nearly all candidates were able to give the relationship between the stated currents as an equation, and half of them were able to give an explanation in terms of charge.

Some of the candidates had an idea of the charge explanation, but could not express it sufficiently clearly for a mark. Time was frequently not referred to at all or referred to in a way that did not make it clear that it was the same time. References were seen to conservation of energy and the rules for current in series circuits.

The best answers set out a series of equations linking conservation of charge to the equation for current at a junction.

Question 12a

Most of the students used distance = speed x time, but about half did not apply the factor of 2 to the distance. Occasionally the speed of sound was used and a few candidates omitted the unit.
12b As this has been asked several times in unit 2, it is a bit surprising that only a third of the entry got the correct, straightforward answer.
A number of answers lacked the detail to gain a mark – 'so you can measure the time taken', 'so it is easier to measure the pulse time'.

Question 12c

Only about one in five made a reasonable suggestion.

A common response was to say that infrared has a higher frequency or that visible light has a longer wavelength. Both are incorrect and candidates did not say why they thought the suggestions were relevant. They may have been thinking of greater precision with smaller wavelength.

Some thought that infrared had a higher speed or could travel further and a few thought that a temperature rise caused by infrared could be an advantage in some way.

Question 13

The majority of candidates got at least one mark, usually for describing the emission of electrons, and about half got a second mark, sometimes for describing the work function or threshold frequency, but usually for using $hf = \varphi$. Although it had been expected that they would use the work function to find the threshold frequency, many started from a known wavelength of visible light or ultraviolet radiation to find a corresponding work function. Most of the candidates who used the equation arrived at a correct answer, but some did not get a mark because they omitted the unit. They often continued the question well, with a third getting at least 4 marks and a quarter getting 5 or more. The most commonly omitted part was the link between one photon and one electron. The final comparison was often attempted, but it was not always clear enough for a mark.

In the calculation, a number of students included the kinetic energy of an electron, using the speed of light.

Question 14a

This calculation was completed successfully by the great majority of candidates. Those who went wrong usually calculated the inverse of the required answer. As they were not necessarily familiar with this procedure, the answer of 0.05 s need not have seemed unreasonable.

Question 14b

The energy calculation was, again, completed successfully by the majority. In part (ii), the requirement to perform a calculation of 210 x 2.3 J was not recognised by some, although a majority still completed the whole calculation.

Question 15a

It appears doubtful that many of the candidates have carried out this practical as only one in ten made a sensible suggestion of a limitation related to this context. Many just cited ‘human error’ or said it would not be accurate. The most commonly credited suggestion was for saying that the protractor only measured to the nearest degree, but the significance of this in terms of precision was not often described.

Question 15b

As usual, candidates were more comfortable with the calculations and the majority completed both successfully. The critical angle proved slightly easier than the speed of light, even though they were effectively using an equation not given, since they rarely quoted sin 90°.

The unit was sometimes omitted for the speed of light.

Question 15c

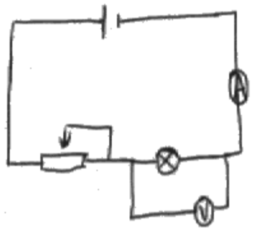
While a majority gained at least one mark, poor expression and imprecise use of technical vocabulary cost many candidates one or more additional marks. The most frequent mark was for describing repeated reflection, often in quite a roundabout way. The next was for total internal reflection and the next for the angle of incidence being greater than the critical angle, although this was a point of confusion for a number of candidates.
Some examples of poor expression and lack of precision are:

- the angle of incidence is greater than or equal to the critical angle
- the light is bent using total internal refraction
- the light is internally refracted
- the light has an angle of incident greater than the critical angle which results in zero reflaction (sic)
- every single time when it reaches the side of the block it refracts at 90° because the angle of incidence is greater than the critical angle

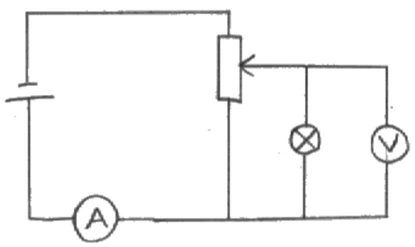
Question 16a

The majority got at least two marks for the circuit, but only two fifths got three marks. This is a very commonly used circuit and they should have had quite a bit of experience in using it, so it is somewhat surprising.

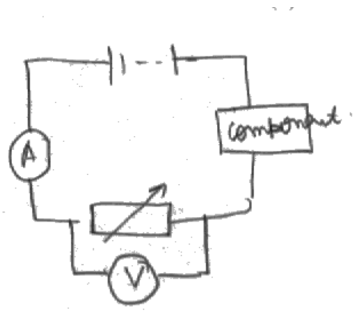
The arrangements for achieving a variable power supply were often quite unorthodox wiring arrangements, but, when included, they generally worked.



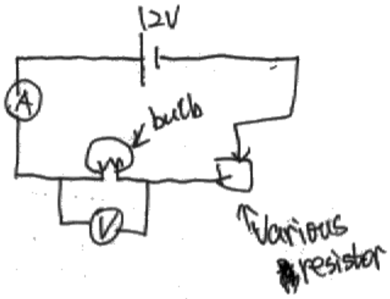
Meters were usually connected correctly, but sometimes the bulb was missing or the ammeter connected before a parallel section so that it measured the wrong current.



The meters were sometimes used to determine the resistance of the wrong component.



Standard symbols were not always used.



Question 16bi

Only about a fifth gained any credit here, usually for answers relating to the graph not being a straight line. A common erroneous suggestion was that it was incorrect because the gradient is *I*/*V*, so its inverse should be used.

Question 16bii

The great majority completed this successfully, although some lost a mark because their graph reading was a bit inaccurate.

Although the question stated that use of the gradient was incorrect, a number of students still used precisely that method.

Question 16c

This is a standard explanation at this level and GCSE, so it was disappointing that, while the majority got at least one mark, only about half extended that with a second mark. The most common marks were the first two on the mark scheme – increased resistance and increased temperature. As to the rest, candidates generally had an idea of the explanation, but poor expression and imprecise use of technical vocabulary again cost marks. In particular, descriptions relating to the amplitude of oscillation of lattice ions and frequency of collisions of electrons with lattice ions often lacked the comparative element with respect to the prior situation; they just described collisions and oscillations without indicating an increase. Others were vague about what was vibrating or which particles were colliding with which. Often the increase in resistance was caused by the electrons vibrating more or because electrons had more collisions with electrons. Sometimes it was because it was more difficult for electrons to get through or it was due to increased friction.

Question 17a

It was surprising, after many similar questions about spectra in the past, to see that only a third of candidates achieved a score on a question where a standard answer could have gained most of the marks without requiring any particular contextual references.

Candidates in the upper range generally described photon absorption and electron excitation, often mentioning discrete energy levels as well, although some just said that different elements have different energy levels. The points that photon energy = difference in energy levels and only certain differences are possible were not often seen sufficiently clearly. $E=hf$ was sometimes quoted without being linked to photon energy.
The photoelectric effect was sometimes described in part.

Question 17bi

A good majority completed all the steps of the calculation straightforwardly, although a few stumbled over the conversion to eV. Some were not awarded the final mark because they did not identify both levels clearly, e.g. just saying ‘the electrons are in level 2’ did not get the mark.

Some candidates made a lot of work for themselves and calculated the frequency for different combinations of levels until they found one that matched.

Question 17bii

With about a quarter gaining at least 1 mark, a good proportion had some idea of this, although there were difficulties expressing their ideas. The most commonly credited answer was that when electrons fall to a lower level energy is released.
A number of students linked the negative energy to the negative charge of an electron.

Question 17c

Although only a third scored on this question, rather more at least mentioned the Doppler effect, red shift or blue shift, and others described frequency or wavelength changes but the wrong way round.
For those gaining marks, the most common was for correctly linking a change in frequency or wavelength with direction of motion. The way it is used in practice, including reference to the standard spectra for elements, was very rarely described.

Question 18a

This was a familiar explanation recalled more successfully than some others, with a third gaining full marks and half getting at least three. The great majority identified it as a standing wave and most of those mentioned nodes and antinodes. The fact of two waves meeting was often stated. Superposition wasn't mentioned as often as interference.

Students sometimes referred to waves being 'out of phase' when they should have said 'in antiphase' but they usually got the mark anyway for nodes and antinodes.

Question 18b

Nearly all candidates used the wave equation, but some missed out on further marks because they did not take into account that the fundamental frequency involved a length equal to half the wavelength and omitted the factor of 2 in their calculations. Occasionally a candidate halved the length instead of doubling it.

Question 18ci

Although a third of the students could identify this as a node, they did not generally expand on its significance in this context.

Question 18cii

A good majority of candidates identified the new frequency correctly. There were some very good answers to part iii, but they were relatively infrequently seen.

Question 18d

With a quarter gaining a first mark and a quarter of those going on to a second, this was not well answered with respect to the particular context. A large number of students seem to have learned a range of general criticisms of experimental data to quote, frequent examples here being to just say it is not accurate without saying in what way as the problem or to refer to errors in general. Precision was rarely identified as a key point with the divisions on this scale.

Summary

- This paper has demonstrated the need to learn definitions, like photon and work function, thoroughly so they can be quoted fully when required.
- Candidates are encouraged to use past papers and mark schemes, but they should not expect to be able to repeat sections of previous mark schemes verbatim in the answers to new contexts.
- They should learn standard descriptions of physical processes, such as changing resistance with temperature, the photoelectric effect and spectrum formation, and be able apply them to specific situations, identifying the parts of the general explanation required to answer the particular question.

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

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