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Examiners' Report/ Principal Examiner Feedback

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IAL Physics WPH02/01

Unit 2: Physics at Work

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Introduction

This examination covered a wide range of specification items and allowed students to demonstrate their understanding at an appropriate level, discriminating well across the ability range. At the lower end, candidates could usually complete the majority of single step calculations, only encountering difficulty when additional contextual elements, like a factor of 2, were introduced. They could also recall the main features of standard descriptions and definitions, but failed to include sufficient detail. At the higher end, all calculations were completed, standard descriptions included most of the required detail and Physics principles were applied reasonably well to new contexts.

Section A

Question	Percentage of correct responses
1	26
2	66
3	89
4	59
5	41
6	71
7	78
8	66
9	86
10	35

Several questions had a definite preferred incorrect response.

Question 1
The majority of candidates selected B, misreading the x-axis of the graph as position.

Question 2
Most incorrect responses were B, suggesting time had not been considered, perhaps because it was written as ‘one hour.

Question 4
C was the preferred incorrect response, which shows the choice of a non-ohmic conductor, but suggests more careful learning of these graphs is required.

Section B

Question 11

The majority of candidates achieved one mark for stating that there should be a small current, many of them saying it would make it more accurate without explaining how. Very few went on to gain the second mark because they did not connect the small current through the voltmeter with a small current through the cell to describe the effect on the ‘lost volts’. A lot of answers described an incorrect circuit in which current either flowed through the cell or the voltmeter and others described the use of a voltmeter in a circuit with additional components.

Question 12

(a) Nearly all candidates completed the calculation correctly, although they often quoted it to four significant figures rather than two as suggested by the data. Occasionally the answer was quoted in degrees rather than as dimensionless.

(b) Only about half of the candidates got any credit for this part, many only discussing limitations or improvements and not both as required by the question.

Candidates giving the answer to part (a) as 1.5 noted that all of the values in the table are 1.5 to 2 significant figures and commented on the required precision, but this was rare. Candidates more frequently suggested using a wider range of plastics so one would match their answer more closely. A number suggested parallax errors, but, given that protractors have the markings on the underside which is in contact with the paper, this appeared to represent a stock answer rather than an appreciation of the situation in the question. Some answers implied criticism of the method in suggesting improvements but did not explicitly cite limitations as required.

The most common improvement mark, not always well expressed, was for suggesting the use of a range of angles. There was often an accompanying suggestion to plot an appropriate graph and use the gradient. Another common response was to suggest calculating a mean value, but the candidates frequently did not mention what was being averaged, i.e. refractive index rather than the angles. Some candidates imagined that they could use a protractor with a scale division of 0.1°, but this was not realistic. There were various suggestions to use a data logger, but no suggestions of an appropriate sensor.

Question 13

Marks in this question were frequently limited by lack of precision in the explanations and failure to use appropriate technical vocabulary.

(a) Candidates generally knew that polarisation was connected with restricting the number of planes, or directions, of oscillation. They rarely mentioned what was oscillating. The description was often a hybrid of polarisation and transverse waves, so that the single plane of oscillation was usually described as being at right angles to the direction of propagation rather than including it.

(b) Careful reading of candidates' responses sometimes allowed the awarding of one of the alternative marks, but they were often unstructured sets of statements that were usually correct, but not set out as an explanation of the context.
The most common mark was for noting that the light coming from under the water surface was (almost) unpolarised. The effect of the filter in terms of absorption or transmission was not made clear, reference frequently only being made to light reaching, or failing to reach, the eye. Candidates sometimes attempted to describe the alignment of the lens relative to the plane of polarisation of the light, but without sufficient clarity – usually because they did not include reference to 'plane of polarisation'. A number even seemed to be answering a question from a previous examination about lenses in 3D glasses.

14 (a) The great majority arrived at the correct answer without difficulty. A number dropped marks by misreading the graph. Some only quoted the answer as 0.3 m, to one significant figure, so they did not gain the mark requiring an additional significant figure in a 'show that' question.

(b) (i) Over half got both marks, many of the rest losing a mark by reference to waves bending, not accepted because of ambiguity with respect to refraction, or to waves passing through an obstacle.

(b) (ii) About three quarters got at least one mark, with a third getting two. Candidates usually managed to state that the male had a longer wavelength, but didn't express the effect of this with sufficient clarity.

15 (a) The great majority completed the calculation without difficulty.
(b) Most candidates calculated the current and substituted values into $I = nAvq$, but only about a fifth adjusted their answer to take account of the greater number of charge carriers.

(c) About two thirds of the candidates got at least one mark, with over half of these getting the second mark as well. It was common to state that resistance would be lower without sufficient justification, many describing the situation for a harder pencil rather than a softer pencil.

16 (a) Nearly half got a mark for a sensible reference to a quantum or packet of energy, but only a fifth linked it to electromagnetic radiation.
(b) (i) Imprecise descriptions meant that the majority did not get this mark. They often did little more than repeat the wording of the question, or they talked about the energy of an atom without the idea that only certain energies are allowed.
(b) (ii) The majority got at least half the marks for this section. The most common errors were selecting the wrong levels, missing the conversion from eV to J and losing track of the powers of ten in the calculation. A number only carried out the calculation and did not include the required written description of the process. A significant minority described the photoelectric effect in some detail rather than spectrum formation.

17 The majority got half the marks, with a quarter being awarded five out of six, although the final mark for the sixth point in the mark scheme was rarely awarded. Candidates had learned the photoelectric effect and could usually describe it well, but they then failed to focus on the requirements of the question. Things frequently mentioned included threshold frequency, one photon to one electron, the effect of change in intensity and/or frequency and how it supports the photon model – none of these having been asked for. Some answers were repetitions of previous mark schemes without being put in the required context – explanation of the terms from the equation. Some candidates described spectrum formation. A few said that photons combined with electrons to form photoelectrons.

Commonly lost marks were for:

- failing to mention where electrons were emitted from;
- saying that *hf* is energy, or even quoting $E = hf$, without linking to photons;
- discussing threshold frequency rather than work function;
- saying that ½ mv^2 is kinetic energy, but not linking it to electrons;
- describing the symbols from the equation individually.

Explanations of *max* were rarely attempted, and very rarely awarded a mark.

Question 18

(a) Candidates did not generally show a good understanding of the detail in this answer and about half of the entry got one mark, an eighth two marks and the rest zero with only a few scoring three.
A common response was to start by stating that current increased when the potential difference was applied, without appreciating that the current was zero until that point. Usually, this was the only mention of an increase. Collisions of electrons were sometimes mentioned, but more often with each other than with lattice ions and without an idea of increase. The connection between lattice ion vibration and temperature was not often made.

(b) (i)-(iii) The great majority scored at least five marks for this section, getting (i) and (ii) correct without difficulty. Nearly half completed (iii), but the rest often worked out the efficiency for the transfer of energy by heating and did not realise this wasn't the required answer.

(c) The great majority misinterpreted this question, appearing to think it asked how this procedure maximized efficiency. Some appreciated that there would be some energy transfers other than as light and by heating the water, but they did not state what they might be.

Question 19

(a) About half of the candidates got a single mark for their description of a longitudinal wave. Quite a few missed one of the marks by referring to vibrations being parallel to the movement of the wave, movement being ambiguous in this case as it could refer to the coils themselves, as when others wrote that the movement of the wave is parallel to the direction of propagation.

(b) Nodes were poorly described, with references to zero amplitude being uncommon and outnumbered by references to minimum displacement or vague suggestions of no movement.

(c) About half the entry got the first two marks, with most of the rest scoring one. Candidates had learned how standing waves are formed and described the waves travelling in opposite direction superposing (or interfering), but did not often describe the formation of nodes and antinodes in terms of phase difference.

(d) Most candidates were able to apply the equation correctly and arrive at the correct velocity. Those candidates who did not get the correct answer usually misidentified the wavelength, usually by counting 11 nodes and treating this as 5.5 wavelengths.

(e) A majority completed this calculation correctly, with those who did not usually forgetting to apply a factor of 2 for the pulse travelling up and back down the spring.

(f) Many candidates did not appreciate that a comparison requires reference to similarities and differences and only described the latter.
The majority got one mark, usually for comparing longitudinal and transverse waves, with a good number going on to score one more for noting the increase in wavelength. Other differences or similarities were rarely mentioned.

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