Examiners' Report
Principal Examiner Feedback

October 2018

Pearson Edexcel
International Advanced Level
In Physics (WPH05)
Paper 01 Physics from Creation to Collapse

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Introduction

The assessment structure of WPH05 mirrors that of other units in the specification. It consists of 10 multiple choice questions, a number of short answer questions and some longer, less structured questions. As an A2 assessment unit, synoptic elements are incorporated into this paper. There is overlap with circular motion and exponential variation in Unit 4, but also overlap with some of the AS content from Units 1 and 2.

The paper tested learners' understanding of a wide range of topics from this unit. All of the questions elicited responses across the range of marks. However, marks for questions Q11b, Q13aii, Q13b, Q14b, Q15a, Q15c, Q16bi, Q17b, Q17ci, Q18b, Q19b and Q19c tended to be clustered at the lower end of the scale.

Calculation and 'show that' questions gave learners an opportunity to demonstrate their problem-solving skills to good effect. Some very good responses were seen for such questions, with accurate solutions which were clearly set out. Learners understood the convention that in the "show that" questions it was necessary to give the final answer to at least one more significant figure than the value quoted in the question. Not all learners recognised the importance of showing all stages in their working in this type of question.

Once again there were examples of learners disadvantaging themselves by not expressing themselves using suitably precise language. This was particularly the case in questions such as Q11b, Q13aii, Q15c and Q18b, where learners sometimes had knowledge of the topic, but could not express it accurately and succinctly. There was evidence in this examination of learners' responses not gaining credit because the response didn't answer the question, as in Q15c. Learners should be encouraged to read the question carefully before they start to write down their response.

The space allowed for responses was usually sufficient. Learners should be encouraged to consider the number of marks available for a question, and to use this to inform their response. If learners either need more space or want to replace an answer, they should indicate clearly where that response is to be found.

The response to the multiple-choice questions was good, with 7 of the questions having 75 % or more learners selecting the correct response. In order of highest percentage correct they were Q2 (91%), Q6 (87%), Q5 (85%), Q3 (78%), Q7 (77%), Q9 (76%), Q1 (75%), Q4 (64%), Q10 (61%) and Q8 (52%).

Q4 tested ideas about radiation flux and trigonometric parallax. Q8 required learners to apply their knowledge of properties of materials to a particular situation, and Q10 required learners to interpret graphical information. Context and interpreting graphical information are aspects which generally increase the level of challenge of the question. However, grade 'A' learners scored well on each of these items.

Learners should be encouraged to work with mark schemes in preparation for their exam. However, it is important that they understand that mark schemes are written for examiners, and so sometimes refer to what examiners expect to see rather than giving a complete answer.

Q11(a)

It is clear from the responses to this question that the vast majority of learners are aware that a standard candle is a stellar object of known luminosity. However learners erroneously stated that this was a method of determining stellar distances.

Q11(b)

In general this question was not well answered. Many learners made no reference to locating a standard candle in the galaxy, and there was also confusion between luminosity and brightness. Some learners quoted the expression for radiation flux, but did not define symbols. In this context it is essential to identify F as the radiation flux and L as the luminosity.

Q11(c)

This question was correctly answered by most learners.

Q12(a)-(b)

This question was straightforward for most learners, with the vast majority scoring full marks. Those learners who didn't score full marks usually dropped marks in part (b) as a result of an incorrect re-arrangement of the power equation.

Q12(c)

Although many learners gave good responses to this question, a number of responses seen simply referred to an energy loss. A bald statement of energy loss was not enough to gain this mark, although if the statement was qualified by making reference to the surroundings then this was acceptable for this mark. Some learners made a vague reference to energy transfer. At this level it is expected that learners will be specific about the details of the energy transfer.

Q13(a)(i)

This should have been a straightforward application of the Doppler equation. However, many learners were unable to obtain the correct answer for the wavelength. This was usually because they mixed up the wavelength of the emitted light with the wavelength of the light that was received. A number of learners calculated the fractional change in wavelength by calculating the ratio of the velocity of Andromeda to the speed of light, but then added the wavelength change to 486.0nm rather than subtracting it.

When expressed to 3 significant figures the final answer is 486 nm. Although it had been expected that learners would retain the decimal place in their answer (to be consistent with the value of the wavelength given in the question) such learners gained both marks as long as their working was correct.

Q13(a)(ii)

Very few learners scored more than 1 mark here. Those learners who appreciated that the movement of the arms relevant to the centre of the galaxy would affect the wavelength shift often struggled to express this clearly. Many learners ignored the rotation of the galaxy and focused on the wavelength not being seen due to dark matter, cosmic dust or different atoms being present in the stars in the arms of the galaxy.

Q13(b)

Once again, very few learners scored more than 1 mark here. It was common to see references to dark matter, although learners often stated that dark matter was present without making any further comment. Learners should note the difference between a “state” or “describe” question from an “explain” question when formulating their answer.

Q14(a)

This rather standard question was generally answered well, with full marks being quite common. The most common reason for a response gaining less than full marks in (i) was an incorrect or missing conversion of temperature from Celsius to Kelvin. In (ii) there were many alternative ways of stating that no air escapes from the volleyball, and learners were usually awarded the mark.

Q14(b)

It was rare to see full marks for this question. Surprisingly this was usually because learners were unable to calculate the volume of a sphere correctly. A variety of different, incorrect expressions for volume were used. This ranged from treating the basketball as a cube, through to treating it as a cylinder. In some cases learners used expressions for area rather than volume. However, the substitution of an incorrect volume into the gas equation did allow 1 mark to be awarded.

Q15(a)

Answers to this question were often poorly expressed. It was clear that many learners had used these expressions to calculate values, but had little idea how to explain what was represented by the expressions.

Q15(b)

Most learners were able to substitute correctly into the appropriate equation, although 1 was the most common mark to be awarded. This is because learners either gave the units of speed rather than mean <u>square</u> speed, or they took the square root of their answer to give the <u>root</u> mean square speed of the molecules.

Q15(c)

This was a challenging question, and only learners at the top end of the grade range made significant progress. The question is similar to previous questions that have been set, and it is clear that many learners had learned that mark scheme and tried to modify it to apply it to this question. The strongest evidence of this was the fact that the question clearly states that the volume of the container is reduced <u>at constant temperature</u>, although many learners discussed a situation in which temperature was increasing or a decreasing. In the best responses seen work was set out clearly and logically either by following the sequence given in the mark scheme, or by reversing this sequence.

Q16(a)(i)

At the top end of the grade range many learners gained full marks for this question. However, many learners seemed unsure how to proceed in calculating the force constant of the spring, with many attempts seen which involved calculating the gradient of a tangent to the curve, or the area under the curve. Such attempts usually gained a mark for reading a pair of values from the graph.

Q16(a)(ii)

Full marks was often awarded for this calculation, although sometimes learners omitted the units. Some learners tried unsuccessfully to apply the equation for a simple pendulum here. This equation does not apply here (and is not included in the current specification).

Q16(b)(i)

This was poorly answered, with few learners describing an oscillation of decreasing amplitude and fewer bothering to explain why this occurred. Many learners just described what happens at the instant that the potato hits the pan.

Q16(b)(ii)

This should have been a relatively straightforward question to answer. Although many reasonable attempts at a sinusoidal graph with decreasing amplitude were seen, many learners struggled to maintain a constant time period for the oscillations over at least 2 cycles.

Q17(a)(i)

This is a standard derivation from the specification, and most learners were able to score full marks here. Given that it is a derivation, a convincing attempt at algebra leading to the final expression was expected, rather than simply writing down the two starting equations and then giving the answer.

Q17 (a)(ii)

Although there was nothing particularly difficult about this calculation, not all learners were able to obtain the correct final answer. The usual reason for this was a power of ten error due to the learner omitting the conversion from km to m before substituting into the equation. A small minority of learners forgot to square the radius, and some gave the wrong units for the field strength.

Q17 (b)

To obtain the correct answer to this calculation learners need to use the expression for the radiation flux. This equation includes the luminosity of the Sun, L_{sun}, although L_{sun} is not provided in the question. Learners at the top end of the grade range often realised that this value was not needed, as it would cancel. Others performed a calculation for L_{sun} which they then used in the radiation flux equation for a second time. Many learners were stumped by the apparent lack of information in the question and struggled to make any progress with this calculation.

Q17 (c) (i)

Although most learners recognised that they had to apply the Stefan-Boltzmann equation in this question the usual arithmetic errors were seen here as learners left the radius in km, or forgot to raise the temperature to the fourth power.

Q17 (c) (ii)-(iii)

Wien's law was generally applied correctly to obtain a correct answer. However, the unit for Wien's constant included in the equation (m K) seemed to encourage some learners to apply a factor of 10^{-3} (or 10^{3}) "conversion" to their answer.
The mark for naming the correct region of the electromagnetic spectrum in (iii) was awarded on the basis of an identified region commensurate with the learner's answer to (ii). Nonetheless, many learners seemed very unclear on the approximate wavelength ranges.

Q18 (a)

This was generally well answered, although some learners seemed unaware of the equation relation activity to the number of unstable nuclei. Hence in (i) some learners calculated a value for the decay constant and then attempted to use the exponential decay equation.

Q18 (b)

A significant minority of learners wrote nothing of relevance for this question. Most responses seen lacked any idea of a comparison despite the question asking learners to assess the suitability of these two isotopes. Most responses simply listed properties of gamma radiation, but lacked detail and lacked appropriate links to the context described in the question.

Q19 (a)

This was well answered by most learners, and it was common for full marks to be awarded. The most common way for learners to miss out on full marks was to omit reference to the isotopes identified on the graph, despite the question stating explicitly that the answer should include reference to information from the graph.

Q19 (b)

This should have been straightforward, but many learners misread the scale on the vertical axis of the graph and took the values as binding energy rather than binding energy per nucleon. When converting MeV to J some learners seemed to be unsure whether they should multiply or divide by the charge on an electron. Some learners just ignored this conversion completely.

Q19 (c)

In answering this question many learners were able to able to read values of binding energy (per nucleon) from the graph correctly, but were unsure whether energy is required or released in the process of forming/splitting a nucleus. As a result, it was common for the first but not the second marking point to be given credit.

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