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Examiners' Report/
Principal Examiner Feedback

January 2015

Pearson Edexcel International
Advanced Level in Physics
(WPH05) Paper 01

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January 2014
Publications Code IA040650

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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.

This paper gave candidates the opportunity to demonstrate their understanding of a wide range of topics from this unit, with all of the questions eliciting responses across the range of marks. However marks for questions 12b, 13a, 15a, 13d, 15b, 16b, 17a, and 17cii tended to be clustered at the lower end of the scale.

Calculation and 'show that' questions gave candidates 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. Occasionally in calculation questions the final mark was lost due to a power of 10 error. In general candidates were able to give correct units for quantities that they calculated. Most candidates 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.

Once again, there were examples of candidates disadvantaging themselves by not actually answering the question, or by not expressing themselves using suitably precise language. This was particularly the case in extended answer questions such as 12b, 16bi, and 17cii where candidates sometimes had knowledge of the topic, but could not express it accurately and succinctly. Candidates could most improve by ensuring they describe all aspects in sufficient detail and always use appropriate specialist terminology when giving descriptive answers.

In some questions it was necessary to compare the magnitude of one quantity with another. Candidates often lost marks because they did not make this comparison clearly e.g. in 13dand 17cii.

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

The response to the multiple choice questions was generally good with 5 of the questions having 70 % or more correct answers and none with less than 50% correct answers. In order of highest percentage correct they were:
Q1 (96%), Q2 (88%), Q7 (84%), Q4 (75%), Q8 (72%), Q5 (69%), Q3 & Q9 (68%), and Q6 & Q10 (57%).

There was some evidence of candidates learning previous schemes in the expectation of earning marks. This was true in 16bi and 17cii, where answers were seen that related to the topic but not the context in which the question was set. Candidates 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.

Question 11

This was a straightforward question for many candidates. However, some candidates did not realise that they had been provided with a wavelength shift, and so they attempted to calculate a shift by subtracting λ from $\Delta\lambda$. A small number of candidates mixed up v and ω, and some failed to obtain the correct final answer As a result of using the diameter instead of the radius.

Question 12

(a) Most candidates were able to use $pV = n\mathrm{R}T$ correctly, although they sometimes had a power of 10 error in their final answer.
Occasionally a substitution of the wrong value of k was seen. In a small number of cases candidates attempted to use $pV = n\mathrm{R}T$. Although this approach could have scored full marks, it usually resulted in a maximum of 1 mark, as candidates did not use the Avogadro number to calculate N from n.

(b) This question was poorly answered in general. The most common way for candidates to gain a mark was by stating the second marking point. A considerable number were not awarded anything for the first marking point as a result of omitting any reference to "average". Despite referring to the rate of change of collisions and gaining the second marking point, many did not then go on to discuss the rate of change of momentum to gain the third marking point.

Question 13

(a) In order to gain this mark, candidates needed to refer to energy transfer resulting in a temperature increase. Although it was common to see references to an energy transfer from the ball to the bat, or an increase in temperature of the bat, the two statements were rarely given together.

(b) It was common for candidates to be awarded the first two marking points. Most but not all candidates realised that the temperature had to be expressed in Kelvin rather than Celsius. However, the vast majority were unable to complete the calculation successfully as they did not realise that they had to substitute into Wien's equations twice and then carry out a subtraction.

(c) This was a well answered question with most candidates gaining full marks.

(d) This was an example of a question where candidates were unable to relate the physics that they know to the context given in the question. A number of candidates tried to refer to the effect of heat capacity or thermal conductivity. However they needed to compare these properties for silicone tape and wood, rather than just to say something about the silicone tape. Hence, full marks were rarely awarded in this question part. The most common way to score a mark was to state that there would be a smaller temperature increase when the silicone tape was in place.

Question 14

(a) This should have been straightforward, although the use of a diameter instead of a radius value and power of 10 errors meant that many candidates only scored 1 mark for this question part.

(b)(i) This was quite a standard calculation, and it was pleasing to see that most candidates were able to carry out the calculation correctly. It should be noted that as a show that question it is necessary to see the relationship "derived" by applying the gravitational force expression. A small number of candidates showed incomplete steps in their calculation and so did not gain full marks.

(b)(ii) This question should not have given candidates too much difficulty, although answers were often incorrect due to the inverse ratio being found. Candidates should be careful when substituting into an expression such as $F = L/4\pi d^2$, since the inverse relationship results in the smaller orbit radius having the larger flux value at the surface of the planet. Some candidates were not awarded the final mark as they left their final answer incomplete by not calculating a decimal value.

Question 15

(a)(i) This was well answered, with nearly all candidates being able to balance the nuclear equation. However, there were errors in identifying particle X for some candidates with a beta particle being an unexpected common wrong response.

(a)(ii) It was encouraging to see that most candidates were able to complete the first few steps in this calculation correctly. Mass difference calculations are a standard type of calculation for nuclear decay processes, but the "twist in the tail" for this question was that the energy value calculated from the mass difference is negative.
Most candidates simply ignored the negative sign and added the energy value to the kinetic energy of the alpha particle, hence obtaining an answer that was much bigger than the correct value. Some candidates got confused with conversions and ended up with enormous power of 10 errors in their final answer.

(b) Most candidates were aware of a positron being a form of antimatter. Many stated that the positron is the anti-particle to an electron, and some gave its properties in comparison to an electron. Those candidates who did not gain this mark referred to

antimatter in vague terms, or said rather imprecisely that a positron was a positive electron.
The second part of the question was answered correctly by only a very small minority of candidates. Most candidates were either unaware of the nuclear changes when positron emission occurs, or they simply stated the changes when beta minus decay happens.

(c) The best candidates were able to score full marks here. Most were able to determine the decay constant from the half-life and then go on to use the exponential equation.
In a number of cases dN/dt = $-\lambda N$ was used to find the initial number of unstable nuclei and then the exponential equation was used. Candidates often made arithmetic errors in this process or failed to use dN/dt = $-\lambda N$ with their value for the number of nuclei to find the activity after 15 minutes.
Candidates should be aware that activity varies exponentially in a similar way to the number of unstable nuclei; hence it is unnecessary to calculate the number of nuclei present.

Question 16

(a)(i) Many candidates scored just half marks on this question, as they started their derivation with a statement that $\omega^2 = \sqrt{\frac{k}{m}}$ without any justification. It was obvious that some candidates just worked backwards from the equation that was given in the question. Some candidates quoted $T = 2\pi\sqrt{\frac{m}{k}}$ and worked onwards from there! Those who attempted a full derivation often lost a mark, either by forgetting the minus sign, or by not defining symbols.

(a)(ii) This was a straightforward question with most candidates scoring full marks. Those who lost a mark usually did so by making a power of 10 error somewhere in the calculation.

(a)(iii) This was generally well done, although common errors were in using the wrong mass in the equation.

(b)(i) The first two marking points were often awarded in this question, although the third marking point was seen much less often. The ability to relate correct physics to the context being considered is an important skill that candidates often struggle to achieve. Incorrect responses usually identified the context but left out the physics, or stated the physics in the abstract without referring it to the particular situation being considered in this question.

(b)(ii) Most were able to recognise that the amplitude should decrease with time. However the first mark for the shape of the graph was deemed essential as a prerequisite. As a result, many candidates scored zero for this question part.

Question 17

(a)(i) The conditions for fusion in stars should be well known. However there were still instances of poor language being used which resulted in marks not being awarded.

(a)(ii) This was surprisingly poorly answered. Candidates seemed to know very little about the process of gravitational collapse which leads to the conditions for fusion being achieved. There was much confusion with other ideas, such as mass being lost and released as energy. Other incorrect ideas revolved around potential energy between molecules, rather than gravitational potential energy.

(a)(iii) This was answered reasonably well, although most candidates struggled to gain credit for more than he first two marking points. The idea that the energy released per fusion is actually quite small seemed to elude most candidates, and so they did not think to refer to the very large fusion rate that enables a large power output to be achieved.

(b) The temperature scales were generally added correctly, although the identification of the two stars was less well done. Many candidates knew that stars at the top left of the main sequence are giant stars, although to gain the mark they needed to qualify this by stating blue giants. This then avoids the confusion with red giants which are located in a completely different part of the HR-diagram.

Marking A, B, C, and D onto the HR-diagram was mostly done well, although some candidates were very confused. This may have been due to the scales that they used for the temperature axis. Candidates should be able to identify star types from the groupings on the HR-diagram, without necessarily assigning a surface temperature to the stars.

(c)(i) This question part was well answered.

(c)(ii) This was poorly answered as candidates did not appreciate the importance of nearby standard candles in calibrating our other astronomical distance measurements. Those who did sometimes went on to lose marks due to referring to "changes" rather than "increases" or "decreases". A number of answers were seen which just referred to the relationship between the Hubble constant and the age of the universe.

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