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Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Subsidiary Level In Physics (WPH15) Paper 01 Thermodynamics, Radiaton, Oscillations and Cosmology

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Grade Boundaries

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Introduction

The assessment structure of WPH15 mirrors that of WPH14. It consists of 10 multiple choice questions, a number of short answer questions and some longer, less structured questions.

As it is 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 includes the use of specific command words as detailed in the specification, Appendix 9: Taxonomy. It is recommended that centres ensure that their students understand what is required when responding to such questions. In this paper where the command word was deduced, evaluated, or assessed, the final mark could sometimes not be awarded on otherwise good responses because a final appropriate comment was missing.

Candidates should be encouraged to read questions carefully to ensure that their responses take into account all the relevant information. Section B questions are set in context. Candidates should be aware that the context of the physics in which the question is set and all supplementary information provided are essential for a complete response that could gain full marks.

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, they should indicate clearly where that response is to be found.

Although the space allowed for responses was sufficient, some candidates started their response by repeating the question, so they struggled to get all of the relevant points in the space provided.

Candidates should be encouraged to work with mark schemes in preparation for their exam. However, it is important that they understand that mark schemes do not provide model answers to questions. Mark schemes are written for examiners, and so sometimes refer to what examiners expect to see rather than giving a complete answer.

SECTION A: Multiple Choice Questions

7 out of 10 multiple choice questions were answered correctly by at least 60% of candidates

Q2, Q5, Q6 were less well attempted.

Q2 required knowledge of the use of stellar parallax to determine the distance to nearby stars. Just less than half of the responses seen chose the correct response.

Q5 required knowledge of the terms “random” and “spontaneous” as applied to radioactive decay processes. Just more than a third of the responses seen chose the correct response.

Q6 required candidates to use their knowledge of gravitational potential energy and kinetic energy as applied to an orbiting mass. It was necessary to appreciate that if energy is conserved, kinetic energy must increase if the potential energy decreases. Just more than half of the responses seen chose the correct response.

SECTION B: Extended Response Questions

Q11

In general this question was well answered, with almost half of the responses seen scoring full marks. Although the command word for this question is “describe”, many candidates gave far too much detail about what happens at each stage and how the evolution takes place. Such detail was not required for this question. Some candidates thought they had to include R in the path, although the question clearly states that stars are originally in area P. Common ways not to score full marks included omitting “red” from “red giants” or omitting “white” from “white dwarf stars”. Candidates should be aware that not all giant stars are red, and not all dwarf stars are white. N Some candidates omitted reference to P, Q, or S and just gave a general description of the evolutionary path of a main sequence star. Such responses were insufficient.

Q12

This question was well answered, with more than half of the responses seen scoring full marks. The first method on the mark scheme was more commonly seen than the ratio method. The most common reason for making little progress with this was by those students who failed to pick up the key word, “pendulum”, from the question. This led to a variety of incorrect approaches using any equations from the list at the back of the question paper that included *T*. A common incorrect response used circular motion instead of simple harmonic motion and calculated a value for a satellite in a low orbit about Venus. Such responses scored zero.

Q13

Most candidates realised that the calculation referred to in the question involved the red shift equation. In many responses the velocity of the galaxy was calculated, and in others the value of the red shift was calculated. Either approach was suitable. The vast majority of responses had the correct frequency in the denominator, although there was confusion as to whether the galaxy was approaching or receding from the Earth. Some candidates began by calculating a value for the two wavelengths, although some did not go any further and use these values in the red shift equation. If wavelengths were substituted into the red shift equation it was important that enough significant figures were retained. The data is given in the question to 4 significant figures, as values are subtracted when used in the red shift equation. Many candidates realised that the conversion from nm to m was unnecessary when substituting into the red shift equation, as the units cancel.

Q14

In general this question was well answered, with almost half of the responses seen scoring full marks. For those responses in which full marks was not scored, a common error was misunderstanding what the 2.00 g represented. Some candidates thought that it only represented the added nitrogen, rather than the total mass after the extra nitrogen was added. Some candidates attempted to use $pV = nRT$. This equation is not listed in this specification, and values for R and N_A, the Avogadro constant, are not provided on the question paper. These were potential barriers to obtaining a correct final answer.

Q15

It was rare to see more than 1 mark awarded for part (a). Those responses that gained marks tended to score MP1. The vast majority of candidates gave a fairly generic response in terms of basic energy transfer. or stated that the temperature of the banana was higher than the boiling point of the nitrogen.

Occasionally responses were seen in which reference was made to the banana providing the latent heat of vaporisation to change state. or an increase in molecular potential energy of the nitrogen molecules.

Part (b) was much better answered. with most responses seen scoring at least 2 marks and almost half of the responses scoring full marks. Responses which did not score full marks usually missed out on MP3 due to a failure to make an explicit comparison with the teacher's estimate.

Q16

Part (a) was generally well done with almost half of the responses seen scoring full marks. Most candidates were able to use both equations clearly and follow the solution through logically. It would seem that a greater proportion of candidates knew that the surface area of a sphere is $4\pi r^2$ than has sometimes been seen in previous series. When candidates tried combining the equations before substitution, it was common to see mistakes. In some responses the radius of the Sun was used in the intensity equation instead of the radius of the orbit. A common reason for not scoring the final mark was often a missing or incorrect unit.

More than half the responses seen scored full marks in part (b). As in part (a), most candidates were able to apply the relevant physics to this situation. Mathematical errors were a more common reason for missing out on marks than physics errors. A common time-wasting error was to add the radius of Pluto to the distance.

Q17

Part (a) of this question was poorly understood by the majority of candidates. Consequently less than a quarter of the responses seen achieved a non-zero score. Of those who did have the right idea, MP1 was most likely to be scored. Reference to contact forces were often lacking in enough detail for MP2 to be scored. The most common incorrect answer was based around gravitational field strength, with candidates assuming that the distance from Earth reduced *g* to a low or negligible value. Candidates knowledge of scale and understanding of what keeps a satellite in orbit were shown to be lacking in many of the responses seen.

Part (b) of this question was well answered, with more than half of the responses seen scoring full marks. Of those not scoring full marks a common error was to misunderstand the values given in the question, thinking that the 2.26 s represented just the astronaut. Some candidates also tried to add or subtract the times before using in the time period equation. As in Q16, some candidates tried to re-arrange the time period equation before substituting values. A common error when doing this was to not square the 2π. As a general rule it is usually better to show a substitution prior to re-arranging.

Q18

Most used the correct equation in part (a) and went on to obtain the correct temperature and or ratio value(s). More than half of the responses seen scored full marks. When MP3 was not scored it was because of the lack of a comparison of values, or the absence of a judgement.

In part (b) 3 marks was common due to responses missing MP2. Some responses confused the standard candle with the galaxy, or perhaps thought they were the same thing. A few confused the standard candle technique with the parallax method, in some cases trying to combine the two methods. In responses in which the intensity equation was referenced it was common for symbols not to be defined. If the intensity equation is used as part of the description of the method it is important that *L* is identified as the luminosity and *I* the intensity of radiation.

Part (c) was very well answered, with the vast majority of responses seen scoring full marks. The correct answer was often obtained with minimal working. Candidates should be aware that if the final answer is incorrect intermediate "use of" marks are only awarded if the steps to the final answer are shown.

Q19

It was expected that part (a) would be something that candidates could answer very easily, as it would be something that they had learnt. However, this was not the case, and less than half the responses seen scored a mark here. Most responses that scored marks talked about a decrease of mass. Very few spoke about binding energies correctly. It is clear that the concept of binding energy is not well understood, with lots of responses stating that the binding energy decreases in the fission process. Candidates should be aware that if they are going to use the term "fission" in their response, then they must explain what the term means.

Part (a) was not particularly well answered. Candidates who were fine taking readings from the graph then seemed not to know where to go next. In a large proportion of responses seen, it was common when calculating the difference in binding energy to only include the Sn nucleus and not the other nucleus. Those responses which did manage this calculation correctly often missed out on MP3 by not dividing by the number of nucleons to obtain a value for the binding energy per nucleon.

Part (c)(i) was very well answered, with more than three quarters of the responses seen scoring full marks. Responses which did not score full marks sometimes used −1, 0 for the β^- rather than 0, −1, and sometimes −1 and 38 were combined incorrectly to give 37 as the proton number of ^{90}Y.

Part (c)(ii) was well answered, with more than half of the responses seen scoring full marks. Some candidates only did part of the calculation, or incorrectly converted to J by dividing by the conversion factor rather than multiplying.

In part (c)(iii) most responses seen scored at least 2 marks. For those responses not scoring full marks a common error was an incorrect use of A/A_0. Another reason for missing out on full marks was making a conclusion that the claim was accurate. Even to 1 significant figure the claim is inaccurate. Some candidates insisted on converting everything to seconds – then usually confused themselves.

Q20

Part (a) required clarity of expression and a logical argument. This made the question challenging for many candidates. Although many candidates knew the physics content they often struggled to apply their knowledge to the situation.

Many responses included statements of how each radiation type behaves without relating the penetration properties of the radiation to the particular situation given in the question. Many responses just gave a 'GCSE' style answer, stating examples of materials that alpha, beta and gamma can or can't penetrate and/or generically referring to the relative penetrating power. In some of these responses, materials were mentioned that aren't even present in this context, e.g. concrete and lead. Many responses could have benefitted from being more methodical in the comments made on each type of radiation. Responses which scored full marks tended to be structured very well and commented on each type of radiation one at a time..

Part (b) of the question involved a graph plotted on logarithmic graph paper. It was clear that many, but not all, candidates were familiar with this type of graph plot. Most candidates attempted a gradient and knew that this is equal to μ. In general, if candidates made an attempt at a gradient calculation they usually obtained the correct value for μ. The second graph was often ignored, with many candidates just stating that the source was Xe after calculating μ, with no reference to photon energy. Some candidates wrote down 70 keV but didn't make a comparison to 80 keV and so the final mark was missed.

Q21

Part (a) is a linkage question. It is encouraging that the mean mark for this item was almost half marks. This may be because the context was reasonably familiar to candidates. However, there was evidence of responses made by candidates who had memorised previous mark schemes. These mark schemes were not completely applicable to this context, as seen in responses that referred to containment problems and the requirement for high magnetic fields. It is clear that the difference between 'nuclei' and 'nucleons' was not appreciated by all candidates, as some candidates used these terms interchangeably. In addition, invalid use of particles/molecules etc was seen, but just as common was not making any reference at all to what undergoes fusion. It was common for responses to just refer to a 'repulsive force' without clarifying that this force is an electrostatic force. A high/sufficient collision rate was often mentioned, but often without saying why it was needed. IC1 and IC5 were the most commonly seen indicative content points.

Part (b)(i) was answered well by some candidates, but the mean mark for this question was just 2 marks, and only a quarter of responses seen scored full marks. Errors in the calculation were most commonly one of two things; either Incorrectly calculating the mass difference, e.g. only factoring in one proton and one neutron, or dividing by c^2 to 'convert' the mass to energy. Many candidates who carried out the energy calculation correctly, then omitted to divide by 4 to obtain the final answer,

Part (b)ii) was the least well attempted question on the question paper, with threequarters of the responses seen gaining no marks at all. The responses seen emphasised how the topic of binding energy is poorly understood by many candidates. Quite a few responses made comments on overall binding energy rather than binding energy per nucleon. Some referred to the energy required to 'break bonds' or 'overcome forces', without actually saying that nucleon(s) is/are removed, or that the nucleus is broken apart.

PAPER SUMMARY

Based on their performance on this paper, candidates should:

- ensure they have a thorough knowledge of the physics for this unit.
- read the question carefully and answer what is asked.
- formulate a response that is consistent with the command word used in the question.
- be particularly careful to use appropriate scientific terminology in questions which ask for a description or explanation.
- include all substitutions and all stages in the working in ‘show that’ questions.

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