Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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

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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 candidates 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 to otherwise correct 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. The questions in section B are set in a 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 response to gain full marks.

The space allowed for responses was usually sufficient. However, sometimes candidates started their response by repeating the question, so they struggled to get all of the relevant points in the space provided. Some candidates wasted space with false starts and then had to squash everything up.

Candidates solutions to the extended calculations were often jumbled. Candidates should be encouraged to set out their work clearly, logically and legibly.

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.

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

In general candidates' performance in this section of the paper was similar to candidates' performance in previous series. The mean mark for this section was 6 out of 10, with only Q4, Q6 and Q7 having a facility less than 0.6

Q4 required candidates to relate the direction of the damping force to the direction of either the velocity or the acceleration. Many candidates confused the damping force with the resultant force that acts on the mass.

Q6 required candidates to identify how gravitational potential and gravitation potential depend upon position, and should have been straightforward.

Q7 related to the weight of a satellite in orbit about the Earth. A number of candidates may have confused "weight" with "apparent weight", which may account for the poor response to this question.

SECTION B: Extended Response Questions

Q11

This question was generally well answered. A few candidates didn't realise that they were being asked to work out a value of $\frac{1}{2}m\langle v^2\rangle$, and proceeded to multiply or divide by N

Some candidates tried to use $pV = nRT$. Although it is possible to obtain a correct answer using this equation, we do not give this equation in the specification, not do we provide a value for the Avogadro constant in the data list. Consequently, many candidates who tried to use this equation were not able to obtain a correct value for the average kinetic energy of the molecules.

Q12

Those candidates who understood what to do usually scored 3 or 4 marks. However, many candidates tried to explain *why* p and V are inversely proportional.

Those candidates who did not realise that showing inverse proportionality would involve taking readings from the graph, just made comments like "as volume increases pressure decreases", which did not score any marks. Those that did take readings usually only took two pairs

Q13a

This question was not answered as well as might have been expected. Many responses seen suggested that some candidates may have not had enough practice with different types of calculation involving mass differences. Some candidates multiplied nuclide masses by the number of nucleons, Some seemed to be treating the masses as if they were in different units to unit given in the question (kg).

An incorrect mass deficit calculation, or omission of the 10^{-27} factor were common errors. Some candidates attempted to use a direct conversion between mass in u and energy in MeV, but usually failed to make progress beyond MP1.

Q13b

It was rare to be able to award marks for this question. Most candidates did not understand the question and so there were lots of different attempts at finding physics that could explain this.

Many candidates referred to energy being needed to convert to mass or energy, or to overcome electrostatic repulsion.

Other responses on completely the wrong track included reference to ionisation/penetration properties of alpha particles, binding energy, activation energy, and energy lost to surroundings.

Some candidates made a sensible reference to momentum conservation, for 1 mark.

Q14a

This should have been straightforward, but a number of candidates did not score the mark.

Some just stated that the wavelength of radiation emitted by the galaxy is longer than the wavelength of radiation from a source on the Earth. This is not the case; the radiation *emitted* by the galaxy has the same wavelength as radiation emitted on the Earth. However, the radiation *received* on the earth from the galaxy is longer than the radiation emitted by a source on the Earth.

Many candidates stated that there is an increasing redshift of radiation received from the galaxies. This gives the impression that the redshift from a particular galaxy increases over time, whereas the redshift increases with distance of the galaxy from the Earth.

Q14b

Most candidates struggled to evaluate the data presented in the graph. Many candidates saw the best fit line *as* the data and commented upon the line rather than the scatter of data about the line.

Those candidates who realised that the scatter was important usually couldn't articulate it in a way that would gain credit. The most frequent way to score a mark was to identify the gradient as the Hubble constant.

Q15

The six mark linkage question is challenging. Candidates should be encouraged to plan out their response before they begin to write. The best responses seen had evidence of this.

It is surprising however, that the chance to describe a core practical presented such a challenge. Very few candidates approached the description of the practical systematically.

Most candidates seemed to understand the basics of the experiment, but struggled with clarity and detail when writing it down. A good response should say what has to be measured, with what, and how the change would be made to happen,. However, so many responses omitted to address the simplest of ideas, like measuring temperature with a thermometer, or providing a realistic way of heating the thermistor up, or cooling it down.

Very few realised the significance of the temperature range of $0^{o}C$ – $100^{o}C$. Some candidates didn't read the question with sufficient care, and their whole answer was about a resistor not a thermistor. Some wasted time and space describing how the temperature would affect the resistance instead of how to investigate it. Most candidates described safety precautions instead of precautions to ensure accurate measurements

Q16a

This question was well answered. As this is a "show that" question, the final answer must be given to at least one more significant figure than the value quoted in the question. Units were not required.

In this question, at least 3 significant figures were required and, for those candidates who understood the basis of the calculation, the most common way of not obtaining full marks was to quote the final answer to less than 3 significant figures.

Q16b

In general, this question was well answered. Some candidates didn't realise the link between this question and the value of the power previously calculated. A few mixed up 75% and 25%. Sometimes the percentage was ignored altogether. A number of candidates erroneously added in the energy needed to heat the water up to 100^{o}C.

Q17a

This straightforward calculation question was generally answered well. A number of responses were seen in which values were substituted into the equation correctly but then the distance wasn't squared. Surprisingly there were issues with units for some candidates.

Q17b

There was a mixed reposes to this question. A number of candidates couldn't get started because they weren't sure of which physics principles to use.

Most candidates who understood what was required of them followed the approach outlined in the mark scheme. However, a significant number of candidates attempted a much longer method, calculating the gravitational force first, then using that value as the centripetal force to find v or ω and then to find T.

The question provided many opportunities to get the masses muddled and to use the wrong distances. Some candidates who had worked their way through the problem correctly missed out on the final mark, either by not making a conclusion at all, or by not including a comparison in their conclusion.

Q18a

This was well answered by some, but there were issues for many candidates. Drawing a diagram would have been helpful for some candidates, but this wasn't often seen. Too often candidates did not know the correct expression for the volume of a sphere. Use of an incorrect distance, often with a power of 10 error, was a common reason for marks not to be awarded.

Q18b

This question was poorly answered. There was confusion about which masses/radii to use, and many candidates did not seem to understand the distinction between potential and potential energy. Thankfully, the use of $\Delta E_{grav} = mg\Delta h$ was seen only rarely.

Q18c

It was anticipated that candidates would find this question straightforward. However, there was hardly any mention seen of work done for MP1. Even MP2 was a struggle for many candidates, with creative responses including reference to the asteroid travelling near to the speed of light and hence experiencing relativistic effects, and the asteroid getting closer to the Earth so the value of *g* increases. Candidates who thought that g increases often went on to conflate mass and weight by saying that the asteroid mass increases.

Q19a

Parts (i) and (iii) were well done, but in (ii) candidates struggled to use the nucleon/mass number of 137 with the conversion from u to kg.

A number of candidates attempted to use the molar mass and then use of Avogadro number, although they often ended up with an answer in grams that they thought was in kg.

Q19b

Very few candidates realised that, with a half-life of 30.1 years, the activity of the source would be approximately constant.

Many arrived at the correct answer by working out the number of decayed nuclei by using to exponential equation to calculate a value for N after 14 days. If this method was used, a large number of significant figures needed to be retained in the intermediate values, as the difference between N_0 and N is very small.

Q20a

This has become something of a standard question for this paper, and it is surprising that some candidates are still leaving out essential detail. Candidates should be aware that the displacement is measured from the equilibrium position/point. Too many statements just referred to displacement from equilibrium.

Q20b

Responses seen covered quite a wide range of methods. Many candidates attempted to use non-standard formulae with varying degrees of success.

The correct equation to use is given in the list at the back of the paper as $T = 2\pi\sqrt{\frac{m}{k}}$.

This equation seemed to be unknown by many candidates.

Q20c

As in other questions on the paper, energy arguments are generally very poorly made. Damping was the most commonly scored idea, but it was rare to see mention of work done.

Q21ai

This calculation involved a combination of two ideas for the claim to be assessed. A number of candidates were unaware that the formula for the surface area of a sphere is $4\pi r^2$.

It was common to see the luminosity formula written with T^4, but then the power of T omitted from the calculation.

Some candidates picked the wrong luminosity formula and worked out something to do with intensity.

Q21aii

It was expected that candidates would match the luminosity of the Sun with 1 on the L/L_{Sun} scale. Most did, but a little variation was allowed for the mark to be awarded. Locating the position of Betelgeuse was expected to be more challenging, although the number of responses in which Betelgeuse was incorrectly placed either above or below the Sun on the main Sequence was surprising.

Q21aiii

Most candidates stated that a main sequence star was fusing hydrogen, but not all specified that this is in the core of the tsar. Some responses just referred to fusion.

Some candidates described the diagonal band on the Hertzsprung-Russell diagram as a statement of what is meant by a main sequence star. This is correct but insufficient as an answer to the question, as they had been told this in the stem of the question.

Q21b

A number of good responses to this question were seen. Some candidates didn't know how to find the velocity of the star using their knowledge of circular motion. They used the given period to get a value for frequency, and then used that in $v = f\lambda$ to get a velocity.

Some candidates ground to a halt when they attempted to use the Doppler shift equation. They got the v/c part but, instead of using the given wavelength to find $\Delta\lambda$, they tried to do the full substitution with an unknown wavelength.

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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