Examiners' Report
Principal Examiner Feedback

October 2024

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

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 question in which 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 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 Q2, Q3, Q5 and Q10 having a facility less than 0.6

Q2 required candidates to relate the properties of steel to its use in removing energy from a building during an earthquake. The context may have confused some candidates, as the answer comes directly from the specification.

Q3 required candidates to select a deduction that could be made from black body radiation curves. Candidates may have selected a correct statement of physics that did not follow from a consideration of the evidence provided.

Q5 required a simple calculation based on an understanding of gravitational potential. Presenting the information in the form of an equipotential diagram might have provided difficulty for some candidates.

Q10 required candidates to select a correct graph of velocity against time by interpretating a graph of force against time. The phase relationships involved make this tricky.

SECTION B: Extended Response Questions

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This question was not answered as well as had been expected. Many candidates seemed to be unsure of the relationship between the internal energy of a gas and the kinetic energy of the molecules in the gas. Molecules of an ideal gas do not have any potential energy and so it is only the kinetic energy that has to be considered.

Although many responses included a correct substitution into the expression $\frac{3}{2}kT$, this was often taken to be the internal energy of the gas rather than the mean kinetic energy of a single molecule of the gas.

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This question was similar to questions involving latent heat and specific heat capacity in previous series. This question was more challenging because the specific temperature at which the tin melted is not given in the question. This was dealt with effectively in the best responses seen, although many responses only gained the first two marks for use of the two equations. Those responses that scored full marks usually included a correct energy balance equation as part of the solution. It was helpful for this equation to be written as a word equation, as this helps to clarify the key physics principle of energy conservation.

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The vast majority of candidates found this question to be very challenging. The main issue was the need to develop ideas algebraically, due to the minimal numerical data provided in the question. The best responses seen used appropriate equations from simple harmonic motion theory to come to a correct conclusion.

It was hard to give credit in some responses because it wasn't clear which pendulum was which. Some responses were couched almost entirely in terms of circular motion which shares a number of equations with simple harmonic motion, without being exactly the same.

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The vast majority of responses demonstrated an understanding of the key principles that apply to this situation. However, not many responses took into account that the pressure at the bottom must include the atmospheric pressure. This meant that the most common score this this question was 3 marks.

Some attempted to use $p \propto T$ and $V \propto T$ separately, and did not obtain the correct answer. In some responses temperature was not converted into kelvin. Recall of the expression for the volume of a sphere was generally good, and few responses mixed up diameter and radius.

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(a) This was well answered by most candidates. Some responses did not include a sufficient number of significant figures in the final answer. Occasionally the equation for the surface area of a sphere was mis-remembered.

(b) This question was generally well answered. In some responses the difference between intensity and luminosity and which of these relates to brightness was not clear. The lack of a comparison of values in the conclusion was the reason for MP4 not being scored in some responses.

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(a) As this question focused on one of the core practical experiments it was expected that candidates would produce detailed responses. However, although a broad outline of the method was familiar to most candidates, the detail required was patchy. It was disappointing to see that 20% of the responses seen scored zero for this question.

For example, almost all responses mentioned a thermometer (and most of them could spell it correctly), but did not specify that the thermometer was used the measure the temperature. This may seem obvious, but this degree of detail was required.

Some candidates confused the thermistor with a thermometer, others thought the ohmmeter measured p.d. or current. Some even thought that the thermistor was the method of heating. Additional unnecessary circuit equipment, ammeters voltmeters etc. was often specified.

The concept of measuring resistance with the ohmmeter at the same time as measuring the temperature was rarely seen in full. Many responses referred to measuring at time intervals, but didn’t specify what was being measured. These responses often went on to state that a graph of ohmmeter reading against time should be drawn. Many said even more general things, such as ‘plot a calibration curve using the data’.

MP2, MP5 and MP6 were the marking points most commonly awarded.

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(a)(i) Most candidates scored at least one mark for this question. Most at least recognised the physics, even if it wasn’t well articulated.

Some responses seemed to be guesses, referring to ‘blue shift’ and ‘coming towards us’. There were a few who thought it was to do with it being a red giant.
(a)(ii) This question was much better answered than (i). For those candidates who knew which formula to use there was confusion about which wavelength should be in the denominator, and some responses did not include a difference in wavelength for the numerator. Misreading of the *x*-scale led to answers out of range in some responses.

(b) This question was not well answered, with many candidates not identifying a method that was suitable for distant galaxies. These candidates gave responses describing methods involving parallax, standard candles, Wien’s law etc.
Another issue was the way in which some students read the question. These students assumed that ‘use a knowledge of these shifts’ meant that the red shift is known. So these candidates did not mention MP1 at all.

18
(a) Variations on the theory involved in this question have been assessed many times in previous series, so it was surprising that many didn’t start by equating forces.

Those candidates who knew what to do were generally successful, although some conclusions lacked the comparison, or comment on what 7.2 days meant and so missed out on MP4.

Full credit given to candidates who calculated ω as in MS, then used it to calculate the angle covered in 8 days, then compared this with 2π and made an appropriate conclusion

Those candidates who had no idea how to proceed with the general solution usually scored MP3 for converting time between days and seconds.

(b)(i) The vast majority of responses seen scored both marks. Those not scoring full marks usually omitted enough significant figures in the answer or forgot to square *r*.

(b)(ii) This question was poorly answered. There was much confusion over the use of 50%. Many candidates thought this meant double, or others who thought that you could say it was 50% less (i.e. half). Some candidates who couldn't cope with the square.

Most successful responses led to a value of 4/9 or 44%; occasionally a value for the mass was calculated.

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(a) This was generally very well done.

(i) This question was very well answered. Sometime the final calculated value was not given to a sufficient number of significant figures.

(ii) Although many correct solutions were seen, some candidates didn't work out what the mass of the animal was using their value of the stiffness of the spring. i.e. they didn't realise that they needed to use what they had done in part (i). These candidates focused on the simple harmonic motion aspect and tried to use the simple harmonic motion equations without reference to the behaviour of the spring when stretching. Candidates should be aware that sub parts to questions are usually connected in some way.

(b) This question was generally well answered. Most candidates were aware that resonance was occurring and therefore were able to state the conditions for this. However, these candidates didn't always score MP1 because the driving/forcing element was only weakly implied.

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(a) On the whole this question was well answered.

(i) Some candidates seemed to be thrown by being given a 'peak intensity at a frequency of…' instead of λ_{max}. However, the best responses seen coped with this.

(ii) Most candidates labelled the Hertzsprung-Russell diagram accurately. Poor plotting accuracy was a common reason for this mark not being scored. It was expected that the point representing the position of the Sun would match with 1 on the relative luminosity axis and the (show that) temperature calculated in (i) on the temperature axis. Some candidates forgot that the temperature scale is in the reverse direction.

(iii) Most candidates annotated the Hertzsprung-Russell diagram correctly to indicate the positions of red giant and white dwarf stars. The main sequence was usually correctly indicated, but in some responses this was represented as a single point, whereas it was necessary to indicate in some way that this was a range to gain the MP1.

(b) Extended open response questions are seen as some of the more challenging aspects of the IAL assessment.

Some very neat, brief responses were seen. The best responses scored all 6 marks in only 4 or 5 lines of writing. Some candidates read more into the context than was intended and gave details of how the star came to be.

IC1 and IC2 were seen quite often, although it was relatively common for reference to fusion taking place in the core of the star to be omitted.

IC3 was rarely credited, as the link between a decreasing rate of fusion and contraction was often not made.

IC4 required a definite reference helium fusion starting once an increase in the temperature (in the core) had occurred.

IC5 should have been straightforward, but collapses and expansions were often muddled in many responses.

IC6 was one of the most consistently credited statements.

Overall it is clear than many candidates were not able to express clearly the progression through the stars stages of evolution. In particular there was significant confusion about how a star goes from the end of fusion to an expansion into a red giant.

Imprecise language was often the reason for indicative content not being credited. Not mentioning protons/nuclei; not mentioning ‘close *enough* to *fuse*’; missing ‘electrostatic’ or ‘repulsion’; not saying enough or high KE, but saying ‘increased’, similarly for collision rate.

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(a) (i) The vast majority of responses seen scores both marks for this question. Those that did not score both marks often had problems in balancing the bottom line of the nuclear equation, with the −1 for the beta particle proving tricky.

Sometimes candidates did not know neither nucleon number not proton number for a beta particle and scored zero. Sometimes these numbers were transposed.
(ii) This was very poorly done by the majority of candidates, but some method marks were scored, mostly MP1 and MP4.

There were many attempts at the mass defect calculation involving single nucleons, mixtures of masses, and nucleon numbers in odd combinations.
Some candidates wasted time changing everything to u and then back again to kg.
Some even persisted in trying to use the ‘931.5 MeV is 1u’ relationship and got themselves into all kinds of trouble.

(iii) MP1 was scored by a good number of candidates, even if they were unsure what they were doing, but only a few candidates realised they had to also divide by *A* to obtain the correct answer and score both marks.

(b) Some very odd time conversions were used in calculations of the decay constant. Some candidates seemed to think that they were given the half-life in hours, days or even years. However, it was usually possible to award MP1.
All kinds of errors were seen when candidates tried to use the exponential expression. Many candidates were confused by not being given a value for the initial number of nuclei, N_o. The exponential equation was also problematic for some.

Approaches adopted by candidates to score MP2 included:

- Ignoring things for which they had no value
- Guessing a value for N_0 (which might work, but not necessarily)
- Trying to cancelling the e (but not its power)

MP3 was successfully scored by those who candidates who managed to gain MP2, as long as they didn't make a mathematical or conversion error.

Having worked through to obtain a correct ratio, some candidates then failed to make an actual conclusion about the ratio being twice, or approximately 2 and hence the statement was true.

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.