Examiners' Report
Principal Examiner Feedback

January 2023

Pearson Edexcel International Advanced Subsidiary 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 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.

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, 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.

In Q1 candidates needed to know that the background count rate is random and so increasing the counting time increases the accuracy of the count rate.

In Q2 many candidates thought that the ratio of molecular masses was important, although the mean molecular kinetic energy is only determined by the temperature of the gas.

SECTION B

Q11

This question was well answered, with the vast majority of candidates scoring full marks. In part (a), 273 was sometimes added to the temperature difference. Candidates should be aware that the intervals on the kelvin and Celsius scales are identical, so there is no need to convert temperatures to kelvin when calculating a temperature difference. In part (b) vague responses such as "energy loss" were often a reason for the mark not being awarded.

Q12(a)

This should have been straightforward. However some candidates equated the gravitational potential energy to a centripetal force rather than the kinetic energy of the molecules.

Q12(b)

Part (b)(i) was usually awarded 2 marks, but this was rarely the case for part (b)(ii). In part (b)(ii) many candidates confused escape velocity with r.m.s. velocity, and so thought that molecules were travelling faster than the escape velocity on average. This led these candidates to an incorrect conclusion.

The most common way to score a mark was to state that the r.m.s. velocity is less than the escape velocity. However, most candidates who realised this, did not appreciate that there is a range of molecular velocities and so some molecules will be travelling much faster than the r.m.s. velocity and so would be traveling fast enough to escape.

Q13

The responses seen confirmed that most candidates were able to apply the Doppler shift equation correctly and then link the recessional velocity to the distance suing the Hubble equation. Occasionally responses were seen in which candidates mixed up the emitted wavelength with the observed wavelength. Although this causes only a small difference in the calculated value of the velocity, it is nonetheless an incorrect application of the Doppler equation.

There were a number of possible methods by which the website statement could be checked for accuracy. The most straightforward was probably to calculate a value for the distance in light years and to make a comparison with the stated value.

Candidates should note that, as this question uses the command word "assess", a definite conclusion is required for the final mark to be awarded. In addition, in this example, a correctly calculated value was also required.

Q14 (a)

Most candidates drew a horizontal line at 19 mJ, although some drew this line at other energy values. Most, but not all, candidates used a ruler so that their line was straight. Although this was not essential for the mark to be awarded, candidates should draw/annotate diagrams as carefully as possible. It is expected that a ruler would be an essential drawing instrument for all candidates.

Q14 (b)

Many candidates realised that they had to read off the elastic potential energy at 1.0 cm and then subtract this value from 19 mJ. However, it was rare to see a correct final answer for the velocity.

Q15(a)

The vast majority of candidates either stated that dark matter has mass or that it exerts a gravitational force. Most candidates also stated that it does not emit electromagnetic radiation, but in some responses this was stated ambiguously. A small number of candidates confused dark matter with black holes and some responses speculated on what dark matter might be.

Q15(b)

GeV / c^2 is a unit that candidates seem less familiar with. Most candidates correctly used a factor of 1.6×10^{-19} to convert eV into joule, but there was considerable uncertainty on whether to multiply or divide the stated value by c^2.

Q15(c)

Many candidates were aware that it is the density (and not simply the mass) of the universe that is important in determining the ultimate fate of the universe, and many correct references to the average density compared to the critical density were seen. Most responses alluded to the link to the amount of dark matter, but few actually stated that it is the uncertainty in the amount of dark matter that leads to the average density being uncertain.

Q17(a)

Most candidates were able to make some progress in this calculation. The most common method of solution was to use p/T = a constant. Only a minority of students forgot to convert the temperature form ^{o}C to K. Some candidates calculated the final pressure correctly, but then omitted to calculate the increase in pressure, as required by the question.

Q17(b)

This question required candidates to produce a coherent and logically structured answer. Out of the total of 6 marks, 4 marks may be awarded for physics content and 2 marks may be awarded for the degree of structure seen in the response. Most candidates gave part of the required explanation, although essential detail was often omitted.

When describing the effect of increasing the temperature on the movement of the molecules it was common for candidates to simply state that the speed of the molecules increase, although it is the mean or average speed that increases. Similarly, most particles realised that the rate of collision would increase, but many were referring to the collisions between molecules rather than to the collisions between molecules and the container walls.

In many responses it was stated that the increased forced on the walls of the container led to an increased pressure, but didn't justify this statement by making reference to pressure being force per unit area.

Some candidates ignored the reference to their answer requiring a reference to the motion of the air molecules and simply based their response on the equation $pV = NkT$.

Q18(a)(i)

This question tested a well-known method for determining the distances to nearby stars, and many candidates had learnt the essential features of the method. The most common omission was the absence of a reference to the distant stars in the background. These stars are essential for the method, as they provide a fixed background against which the relative movement of closer stars can be determined.

Q18(a)(ii)

Only a minority of candidates realised that the movement of the stars was too small for Tycho Brahe to measure.

Q18(b)(i)

This is a standard definition, although a small minority of students confused the idea of a standard candle with the method of standard candles. The method of standard candles requires astronomers to know the luminosity of the stellar object that they are using as a candle. Hence the required answer was simply to state that a standard candle is a stellar object of known luminosity.

Q18(b)(ii)

Many candidates found it necessary to state once more that the standard candle is a stellar object of known luminosity. However, most did not think to state that a suitable candle must first be located in the galaxy under consideration.

The usual confusion between luminosity and intensity was apparent in a number of responses. Radiant flux was accepted as a correct term for intensity, but flux-linkage was not!

Q19(a)

Many candidates made reference to resonance and the amplitude of vibration becoming larger without realising that these two features were stated in the question. The question required candidates to give the conditions that would lead to resonance i.e. an increasing amplitude of vibration.

As the question was set in context it was expected that candidates would refer to the car in their answer, although some candidates just gave a generic description of the conditions for resonance which was not deemed to be sufficient for MP1.

Q19(b)

Most candidates were able to score partial credit for this question. However, there was much confusion as to which mass to use when. Also many candidates seemed to think that equations of simple harmonic motion should be applied to the linear motion of the car as it was driven along the road, and so they missed out on the final 2 marks.

Q19(c)

Many responses to this question just gave a vague indication that energy was dissipated. It was expected that candidates would be able to identify that the first stage of this process is that energy is transferred from the oscillation of the car body to the suspension or dampers. The key feature of a damping system is that energy is dissipated so that energy is not returned to the oscillating system.

Q20(a)

There were a number of ways of answering this question, as is usually the case for questions that use the command word “deduce”.

The most common method was to calculate the maximum force that could be exerted between the spheres and then to compare this with the smallest force that could be measured.

Another method was to calculate the separation necessary for the smallest force that could be measured to be produced. Both methods were used successfully in a number of responses seen.

Less common was an attempt to calculate a value for G that would enable the force to be measured and to compare this with the standard value for G. In all cases a conclusion consistent with the calculated values was essential for the final mark to be awarded.

Q20(b)(i)

This was managed successfully by many candidates, although for some the link between the units supplied and the standard units remained quite vague.

Q20(b)(ii)

Most candidates calculated the percentage difference between the values. This was rather a large value (9.4%) so it was expected that candidates would suggest that the physicists'' conclusion was not valid. However, many said that this was less than 10%, which made it reasonable and so a conclusion that stated that the conclusion was valid was equally creditworthy.

Q21(a)(i)

This was usually well answered. Most candidates used the value of λ_{max}. with Wien's law correctly.

Occasionally the final value was only given to 2 s.f., which meant that the second mark was not available. Candidates should remember that the answer to a "show that" question must be given to at least one more significant figure than the value quoted in the question.

Q21(a)(ii)

Although formulae for areas and volumes are not provided in the equation list, A level physics students should know that the equation for the surface area of a sphere is $A = 4\pi r^2$. However many incorrect substitutions were seen ranging from πr^2 through to $4/3\ \pi r^3$. The most common approach was to calculate a ratio of intensities, but some candidates compared their value for the intensity of radiation received at Kapteyn-b with $0.4I$*E*. Either method was acceptable.

Q21 (b)

Most candidates scored well on this question, but some candidates omitted the units for their calculated value of *g*. Others did not make a definite conclusion. Candidates should be aware that in a "deduce" question a clear conclusion should always be stated.

PAPER SUMMARY

Based on their performance on this paper, candidates should:

- learn the equations for the surface area and volume of a sphere.
- where questions ask for a description or explanation, be particularly careful to use appropriate scientific terminology.
- in 'show that' questions, include all substitutions and all stages in the working.
- ensure they have a thorough knowledge of the physics for this unit.
- read the question carefully and answer what is asked.

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