Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Physics (WPH15) Paper 01

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Introduction

The assessment structure of WPH15 mirrors that of unit 4. 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.

This is the second time the specification has been examined and, as in the first assessment of this unit, the paper included questions on two topics that are new to this paper: gravitational potential in Q17(a)(ii) and specific latent heat in Q12(b). The responses seen for both these questions were generally better than when these topics were first assessed.

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 deduce, evaluate or assess, the final mark could sometimes not be awarded on otherwise good responses because a final appropriate comment was missing.

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 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

On average candidates scored 7 out of 10 in this section, giving a mean facility of 0.72

Five questions had a facility greater than the mean: Q3 (0.89), Q4 (0.81), Q6 (0.79), Q8 (0.72), and Q9 (0.74).

Four questions had a facility close to the mean: Q1 (0.68), Q2 (0.68), Q5 (0.66), and Q10 (0.64).

Q7 was the question with the lowest facility (0.56). Option A was a strong distractor in this question, presumably because some candidates believed that an object in orbit is "weightless". This is a common misconception arising from not fully understanding orbital motion as a freefall situation.

SECTION B

Q 11

The most efficient way to answer this question was to use a ratio method, as detailed in the published mark scheme. Most responses seen adopted this method, although it was relatively common to see the factors of 2.6 and 9.3 being used incorrectly.

Some candidates used the value of g at the Earth's surface to calculate a value for the mass of the Earth which they then used to calculate the radius of Mars. Some other resourceful candidates realised that the mass of the Earth was given in Q17. Either of these methods applied correctly gained full credit.

Q 12(a)

This was well answered, with correct responses seen across the entry. Almost all understood that in a 'show that' question, it is essential to show working and to give the final answer to at least one more significant figure than the 'show that' value.

Q 12(b)

This part to the question was more challenging. The best responses seen set their work out clearly and logically, and as a result obtained the correct numerical value for the mass. Many used their value of ΔE from (a), although some calculated this directly in this part. A few candidates realised that the energy transfer to boil the water could be calculated directly by using $\Delta\theta = (100 - 87.7)$ K as the temperature difference.

Many candidates realised that it would be necessary to use both $\Delta E = mc\Delta\theta$ and $\Delta E = L\Delta m$, although a number of candidates seemed unfamiliar with problems in which latent heat and specific heat capacity changes both occurred. Many candidates who did use both equations simply calculated ΔE for the temperature rise of the water and then used this as the energy available to boil the water.

Q 13 (a)

Most candidates answered this question correctly, although some made errors in the powers of the base units and so didn't score the mark. Some candidates gave alternative SI units such as Nm or J, and so scored zero.

Q 13 (b)(i)

This should have been a straightforward use of the simple pendulum equation. However, some candidates misread the question and took 1.00 s as the period of the pendulum. Those candidates who used the correct value of 2.00 s for the period usually arrived at the correct answer.

Sometimes candidates tried to rearrange the expression for the period before substituting values. There is no problem with this, as long as the expression is correctly rearranged. However, it should be noted that if values are substituted into an incorrect expression then the "use of" mark is not awarded.

Q 13 (b)(ii)

Many candidates assumed that this question related to the practical difficulties in determining the period of a pendulum. Hence many responses that referred to reaction time, large uncertainty is measuring the period etc. were seen. However, no experimental method was specified and so it is impossible to speculate on whether reaction time etc. would impact upon the use of the 'seconds' pendulum as a basis for the metre.

Amongst the small number of responses seen that scored a mark for this question, the most common reason given was that *g* varies depending upon location.

Q 14(a)

The majority of responses scored all 3 marks, but there were still a few students who did not convert a Celsius temperature to convert to kelvin correctly.

Q 14(b)

This was often attempted with a correct method. Too often percentage of gas molecules removed was given, rather than the percentage of gas molecules remaining in the cylinder. Candidates should be sure to read the question correctly.

Q 15

Question 15 begins by outlining a radioactivity experiment that candidates should be familiar with. It then gives a graph which shows how the log of the count rate depends upon the thickness of an iron sheet placed between the source and the detector.

This is an example of a "deduce" question in which candidates are required to come to a judgement or conclusion from information given to them. As always with such questions there is more than one way in which this can be done.

The expected method was to use the graph to determine a value for the absorption coefficient μ and then to use this to calculate a value for the half thickness. However, it is possible to start with the half thickness value given in the question and to do a reverse calculation. Whichever method selected; the final mark is for a conclusion that is consistent with their calculated value.

Some candidates struggled to make a start on this question. A number of candidates were confused by the energy of the gamma rays which they were given and wasted time trying to do something with the 1.1 MeV.

Others had no real idea of how they could complete the whole problem but realised that calculating a value for the gradient of the graph or reading off a value for the intercept would be useful things to do. Often such candidates also carried out a log expansion of the expression given in the question.

A pleasing number of candidates completed all parts of the problem and made an appropriate conclusion to gain all 6 marks.

Q 16(a)(i)

This question can be answered with a straightforward definition, although it was clear from the responses seen that many candidates had not learnt this definition.

A common way to miss out on MP1 was to omit to state that it was the wavelength received (and not the emitted wavelength) that experiences an increase.

A number of candidates stated that "light is shifted towards the red end of the spectrum", which may be true for some wavelengths and not for all. This may be an example of candidates taking a simplified idea from GCSE and not upgrading their understanding at this level.

Q 16(a)(ii)

This was a well answered question, with not much that could go wrong for the majority. Occasionally a power of 10 error or a missing unit for the final answer meant that the final mark was not awarded.

Q 16(b)

Overally, this question was poorly answered. Some clear, very good responses were seen, but many who were on the right track didn't manage to say enough for both marks.

Too many candidates read the question superficially and thought that it was to do with an expanding universe or dark matter.

Q 17(a)(i)

This is an example of an extended calculation with the command "assess". Once again, such questions have a number of correct solutions, and it is encouraging to note that almost all responses showed that candidates had an understanding of how to apply Newton's law of gravitation to a satellite in a circular orbit.

There was often confusion about times, with many candidates not realising that the orbital period of the satellite had to be compared in some way to $1/16^{th}$ of the period of the Earth rotating about its axis (1 day).

Some candidates had learnt the equation that relates to Kepler's 3^{rd} law, but this is not an equation that is included on this specification. Fully correct solutions starting with this equation would, of course, score full marks. However, candidates who were not able to use this equation to come to a correct conclusion might have missed out on some intermediate marks.

Candidates should be aware that credit is not normally given for "use of" equations not included in the specification, and so solutions to problems should start with equations that are included in the specification.

Q 17(a)(ii)

As in a similar question set in the first examination of this unit, some candidates attempted to use $\Delta E_{grav} = mg\Delta h$. This expression is only valid for a uniform gravitational field. It is a reasonable approximation to use it for a very small region of a non-uniform field. To attempt to use it in this question, candidates would have to determine an average value for g as the satellite falls to the surface of the Earth. A small number of candidates used this method and were given credit. However, candidates using g as 9.81 N kg^{-1} in this equation scored zero.

Some candidates did realise that they needed to use the expression for gravitational potential. Some produced fully correct solutions, but others forgot to multiply the change in gravitational potential by the mass of the satellite to calculate the change in potential energy.

Candidates should be aware that rounding errors can lead to large differences in the calculated value when the difference between two similar numerical values is taken. Candidates who obtained a final value of 3.0×10^{10} J as a result of rounding errors were not awarded the final mark.

Q 17(b)

Answers to this question were often too vague for 2 marks to be awarded. Most candidates were able to score MP1 by identifying the large drag force acting on the satellite. Fewer candidates were able to give sufficient detail to score MP2.

Quite a lot of poor responses were expressed in terms of gravitational potential energy being converted to kinetic energy and this somehow causing a heating effect. Such responses were not given any credit.

Q 18(a)

Despite the specification making explicit reference to an understanding of the conditions for simple harmonic motion, and this definition having been a frequent question in the past, many students used vague terminology and omitted a clear reference to equilibrium ‘position’.

Q 18(b)(i)

Responses to (i) and (ii) were generally good, although there was a tendency in (i) to use the equation $v = -A\omega \sin(\omega t)$ rather than $v_{max} = A\omega$. Candidates should be aware that for maximum velocity, $\sin(\omega t) = 1$.

Similarly, in (ii) it was relatively common to see $a = -A\omega^2\cos(\omega t)$ being used rather than putting $\cos(\omega t)=1$ and using $a = -A\omega^2$.

Those candidates who attempted to use the sine or cosine forms of the equations by substituting their value of ω and a time into the equation sometimes calculated the correct answer (when the sine or cosine function happened to be equal to 1), but usually ended up with an incorrect numerical value.

Q 18(c)(i)

This was a synoptic question from unit 1 material, intended to set the scene for parts (ii) and (iii) of the question. However, it was clear that many candidates had forgotten the definition of an elastic material.

The usual definition is that when the deforming force is removed the material returns to its original size and shape. Many candidates omitted a reference to the deforming force being removed. It was also common to see a reference to the original shape, but not the original size. In some responses a reference to the original position was made, which perhaps relates to spring stretching experiments. However, "position" doesn't really work without the context of stretching a spring.

Q 18(c)(ii)

Another standard description, which most candidates reproduced accurately.

Q 18(c)(iii)

This question was poorly answered. If the context had been setting a stretched string into resonant oscillation many more candidates would probably have scored both marks. However, the context was unfamiliar and so most responses did not score highly.

Q 19(a)(i)

The vast majority of candidates were able to balance this equation correctly and score 2 marks. Some candidates used 0 for the nucleon number and −1 for the proton number of the β^- particle. Some had the correct numbers for the β^- particle, but struggled to complete the arithmetic to obtain correct values for the potassium and calcium.

Q 19(a)(ii)

In general this question was well answered. Some very strange versions of the mass difference calculation were seen from some candidates, but many who didn't obtain the correct numerical value for the energy, but who set their working out clearly with substitutions shown, were still able to score the process marks.

Q 19(a)(iii)

Good answers to the question were rarely seen. Many candidates thought that they had to use their answers to (ii) in some way, whereas it was (i) that really led on to this part of the question. Most candidates ignored the existence of the antineutrino in the nuclear equation, but the very best responses noted that there were 3 particles in the final state.

Few candidates realised that the kinetic energy given to the recoiling nucleus was roughly constant (and negligible, on account of the very large mass of the calcium compared to the other two particles). So the random split of energy between the β− particle and the antineutrino was not identified by many.

Q 19(b)(i)

Almost all responses showed a correct calculation of the decay constant and many were able to complete the calculation using the activity equation to calculate the activity of the sample.

Some candidates forgot to convert the half-life into seconds. Some used the number of seconds in 1 year in place of the half-life when calculating a value for the decay constant.

Q 19(b)(ii)

Again, some good responses to this question were seen.

Many candidates tackled this question by calculating the activity after 50 years rather than by the method used in the example of calculation shown in the mark scheme. Some used the activity of the school source instead of the activity of the sample of potassium.

Q 20(a)

A majority of candidates were able to identify an approximate position on the Hertzsprung-Russell diagram for the location of a star similar to the Sun. Marking the position anywhere in a reasonably sized area was sufficient to gain the mark. However, some candidates placed the star too high or too low on the main sequence. Some candidates even chose the red giant or white dwarf area for the location of the star.

Q 20(a)(ii)

This question requires candidates to show that they can structure their answer clearly, with make appropriate linkages between the indicative content (IC) points that they make.

The command word in this question is *explain* and, as in other questions with this command word, detail was lacking in many responses. In particular weaker responses tended to describe how the diagram would change in appearance, rather than to link these changes to the processes occurring in the interior of the stars.

There was evidence of some candidates simply reproducing a learned set of notes on star evolution, rather than focusing on the actual question being asked.

Some candidates had added to the diagram as part of their explanation, and this was generally helpful in producing a clear response. Statements about hydrogen and helium fusion often very vague and sometimes insufficient for IC1 & IC4.

As in other topics that build on work first met at GCSE there is evidence of candidates not moving on from a GCSE description/explanation to one that is detailed enough for this level.

Q 20(b)(i)

It was disappointing to see that many candidates ignored the data presented in the graph and chose instead to use the two wavelengths values given in the text of the question. As these two wavelengths do not represent an emitted wavelength and a corresponding received wavelength, such candidates could not be given any credit. This may be because candidates were pushed for time and so didn't read the question carefully enough.

Of these candidates who did use data given in the graph, some read off both wavelengths and carried out two velocity calculations to determine an average velocity. This was good practice, although not essential, as full marks could be gained from using one wavelength from the graph.

Although correct numerical answers were often obtained, the final mark for the direction of Andromeda relative to the Earth was only rarely awarded.

Candidates should be aware that if a vector quantity is required by the question, then the direction as well as the magnitude is usually required. This should be particularly obvious in Doppler questions, in which shifts can be positive or negative depending upon the relative motion.

Q 20(b)(ii)

Generally, this question was poorly answered. This may be a result of it being the final question on the paper.

There was widespread confusion between intensity and luminosity, and in responses that referred to the equation linking radiation intensity with distance it was rare to see any of the terms in the equation defined.

References to flux rather than intensity were given full credit, although the use of the ambiguous term "brightness" was not.

Many candidates who wrote enough for MP1 and MP2 to be awarded forgot to say whether the claim was valid or not and so missed out on MP3.

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