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Examiners' Report/
Principal Examiner Feedback

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IAL Physics

Unit 5: Physics-Creation/Collapse

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The assessment structure of WPH05 mirrors that of other units in the specification. It consists of 10 multiple choice questions, a number of short answer questions and some longer, less structured questions. As 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 paper gave candidates the opportunity to demonstrate their understanding of a wide range of topics from this unit, with all of the questions eliciting responses across the range of marks. However marks for questions 13, 14b, 15a, 15d, 17e, 18bi, 18c, and 18d tended to be clustered at the lower end of the scale.

Calculation and ‘show that’ questions gave candidates an opportunity to demonstrate their problem solving skills to good effect. Some very good responses were seen for such questions, with accurate solutions which were clearly set out. Occasionally in calculation questions the final mark was lost due to a missing unit. Most candidates understood the convention that in the “show that” questions it was necessary to give the final answer to at least one more significant figure than the value quoted in the question.

Once again there were examples of candidates disadvantaging themselves by not actually answering the question, or by not expressing themselves using suitably precise language. This was particularly the case in extended answer questions such as 13b, 18c, and 18d where candidates sometimes had knowledge of the topic, but could not express it accurately and succinctly. Candidates could most improve by ensuring they describe all aspects in sufficient detail and always use appropriate specialist terminology when giving descriptive answers.

Scientific terminology was used imprecisely and incorrectly in a number of responses seen on this paper. In particular, descriptions of energy transfer implying that energy is lost were commonly seen.

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 with a different one, they should indicate clearly where that response is to be found.

The response to the multiple choice questions was generally good with 5 of the questions having 70% or more correct answers and none with less than 50% correct answers. In order of highest percentage correct they were Q6(90%), Q9(90%), Q10(86%), Q1(81%), Q4(73%), Q2(69%), Q5(69%), Q8(68%), Q7(58%), & Q3(53%).

There was evidence of candidates learning previous schemes in the expectation of earning 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 are written for examiners, and so sometimes refer to what examiners expect to see rather than giving a complete answer.

E.g. “ref to $F = \frac{L}{4\pi d^2}$”. The expected answer from the candidate would be to relate the equation to the situation described in the question and identifying the meanings of the symbols used.

Q11

This was a straightforward question for most candidates. However, some candidates evaluated λ_2/λ_1 rather than $\Delta\lambda/\lambda$ and it was not uncommon to see a substitution of 595.6 nm rather than 587.5 nm in the denominator. A small number of candidates used the wrong equation completely. The equations $v = Hd$ and $v = f\lambda$ were commonly seen.

Q12a

This question involved a tricky mathematical manipulation. Most candidates attempted to use $pV = NkT$, although they often failed to get the correct answer for ΔN. The most common response was to substitute the temperature difference of 35K into $\Delta N = pV/k\Delta T$ to obtain 5.23×10^{26} as their answer. Some calculated ΔT by subtracting one temperature from the other, and then adding 273 to the difference.

The usual way to obtain the correct answer was to calculate the numbers of molecules at the two temperatures separately. Sometimes candidates did not quote enough significant figures to get an accurate difference.

Occasionally a substitution of the wrong value of k was seen. In a small number of cases candidates attempted to use $pV = nRT$. Although this approach could have scored full marks, it usually resulted in a maximum of 3 marks, as candidates did not use the Avogadro number to calculate ΔN from Δn.

A small proportion of candidates attempted alternative methods to that given in the mark scheme. In some cases it was apparent that candidates were obtaining a mathematically correct solution without paying heed to the actual physical situation. For example, some worked out a pressure difference and used that to calculate ΔN. Candidates should be careful to ensure that their method of solution is clear. This is particularly important if their final answer is incorrect and method marks are to be awarded.

Q12b

The marks were almost evenly distributed between candidates scoring and those not scoring. The majority of those gaining the mark stated that the air behaved as an ideal gas. The most common error was to state that the mass remained constant. A number of candidates stated the correct assumption but then added 'since mass remains constant' and so could not be awarded the mark. Some candidates gave assumptions of the kinetic theory such as 'the molecules are identical', and so did not gain this mark.

Q13a

Most candidates realised that Wien's law was required to measure the temperature of the star, but the significance of λ_{max} was not well understood. Many candidates confused λ_{max} with maximum wavelength. Some simply just stated 'the wavelength of light can be obtained from spectra'. In neither case could mp1 be given.

Only a minority of candidates recognised that the H-R diagram would give them the luminosity of the star. It was a common misconception that the radius of stars could be measured, and so many stated that Stefan's law could be used to determine the luminosity.

Q13b

The limitations of the parallax method were rarely mentioned, although candidates recognised that the use of a standard candle was a good method for very distant stars. A small number of candidates confused trigonometric parallax with the use of standard candles to measure distances to stars. Others spent time discussing the use of Cepheid variable stars, giving unnecessary detail relating to how the luminosity of such a star is known.

It was disappointing to see so many candidates miss out on mp3 because they had simply stated the equation $F = L/4\pi d^2$ without bothering to define symbols or to rearrange it in terms of d. This is despite comments to this effect being made in the Examiners' report on previous occasions in which a similar question was set.

Q14a

The calculation in part (i) was well answered with all candidates understanding the convention that in a "show that" question an answer must be given with at least 1 more significant figure than the value quoted in the question. However, part (ii) was poorly answered, with far too many candidates stating that "energy is lost to the surroundings". Candidates should be aware that at this level it is necessary to refer to energy transfer mechanisms rather than give meaningless statements implying that energy disappears.

Q14b

Responses to this question suggest that the relationship between precision and uncertainty is poorly understood by a number of candidates. The term 'precision' was often taken to mean the lowest temperature that could be measured, or that because there were two sig figs the thermometer was better than one with ± 0.1K precision.

Only a very few were aware that there is an uncertainty in two readings and the effect this has on the total uncertainty Those who were went on to calculate and comment on the large percentage uncertainty to be expected in the student's determination of the temperature difference.

A few candidates thought that a thermometer of precision 0.25K meant that the thermometer must be suitable, since it can be read to 2 decimal places whereas the temperature rise of 0.6K is only to 1 decimal place.

Q15a

There was a tendency for candidates to give the general properties of alpha radiation rather than to apply them to the specific context given in the question.

Many candidates saw 'low penetration' as the property of alpha radiation not as a consequence of high ionisation.

Q15b

Although a small proportion of candidates seemed unaware of the proton and nucleon numbers of an alpha particle, most candidates found it straightforward to balance this equation correctly.

Q15c

The best candidates were able to score full marks here. Most were able to determine the decay constant from the half-life and then go on to use the exponential equation.

In a number of cases $dN/dt = -\lambda N$ was used to find the initial number of unstable nuclei and then the exponential equation was used. Candidates often made arithmetic errors in this process or failed to use $dN/dt = -\lambda N$ with their value for the number of nuclei to find the activity after 30years.

Candidates should be aware that activity varies exponentially in a similar way to the number of unstable nuclei; hence it is unnecessary to calculate the number of nuclei present.

Many candidates having worked out the correct answer then went on to divide the answer by 30 years (in seconds).

Weaker candidates often calculated the number of radioactive atoms initially present and then attempted a power = energy/time calculation using 30 years as the denominator.

Most candidates realised that they needed to convert eV to J at some stage in the calculation.

Q15d

Candidates were stronger on disadvantages of the lithium battery than on advantages. It proved difficult to award the first marking point because many candidates, having realised that the lithium battery did not produce alpha radiation, failed to use the word ionising.

There were many GCSE style responses seen, such as no danger of mutations to cells/ damage to cells/cancer/less radiation than plutonium,/safer for the environment cheaper, none of which included sufficient physics for a mark to be given.

Q16a

The usual errors were seen here: forgetting to square the value of r, unit errors, and problems with powers of ten (mostly due to leaving r in km).

Q16b

Although this should have been a straightforward question many candidates dropped at least 1 mark here. Equations were quoted but without any explanation and there was a lack of clarity about the direction of the gravitational force.

To gain mp1 candidates needed to identify clearly that it is the gravitational force provided by Jupiter that keeps Europa in orbit.

Q16c

Many candidates were able to equate the two equations for force but had difficulty in simplifying the expression and so they were unable to score the last mark. Once again, wrong answers often stemmed from power of 10 errors.

Some candidates tried (incorrectly) to use the value of *g* from Q16a as the local value of g at the distance of Europa's orbit. Candidates who calculated this as 0.28 ms^{-2} usually went on to gain full marks. Others who successfully made T the subject lost some marks by using Europa's mass instead of that of Jupiter.

Some candidates had memorised $T^2 = (4\pi^2 r^3)/GM$ and could use it successfully. However, the danger in this method of solution was that quoting the expression incorrectly (as some did) would lead to a score of zero.

Q16d

Most realised that the relevant equation was $F = L/4\pi d^2$ but some could go no further. For those who could take the next step common mistakes were to fail to square the factor of 5.2 or ending up with the inverse of the answer by failing to manipulate the equation correctly.

Q17a

Considering that this is a standard definition it was surprisingly poorly answered. Candidates should be encouraged to learn standard definitions such as this. Common statements which did not gain credit included "it must obey Hooke's law" and "there must be no damping".

Q17b

Better candidates realised that to get full marks they had to mark the amplitude on the y-axis as well as calculate the period and mark it correctly on their time axis. A not insignificant number of candidates failed to add any detail to either axis meaning that they could score a max of 2 marks. Candidates should realise that a 4 mark question will require more than a sine/cosine curve.

A small proportion of candidates drew a poor or a non sinusoidal graph. In some cases there was too much damping, and in others too few cycles were shown.

Q17c

This was generally well answered, although some candidate used $v_{max} = A\omega \sin(\omega t)$ from the back of the exam paper and had problems in finding the sine of an angle in radians. Candidates should have realised that in this case $\sin(\omega t) = 1$.

Some candidates used the correct equation but left the amplitude in cm whilst still giving their final unit (incorrectly) as m s^{-1}.

A reasonably common incorrect method seen was where candidates equated GPE to KE and then used 0.1 as their height to obtain an answer of 1.41 ms^{-1}. A small number of candidates treated the situation as one of linear motion, and used $v = d/t$ to find a value for *v*.

Q17d

Candidates often scored the first mark by specifying B, but giving spurious reasons. For example the idea that arrow will follow downwards path and therefore is more likely to hit the apple at B or, in a similar vein, the archer should aim at ‘A’ and the arrow is then likely to hit B.

O was chosen by a number of candidates, often with the reason that the apple goes through O more often than any other point.

Q17e

This question was poorly answered, with few candidates gaining full marks. Many candidates started their response by stating the principle of conservation of energy, so scoring the first mark. Many also understood that the damping effect meant energy dissipation and so could score the second mark. However, it proved difficult to award the third marking point, as although many candidates understood that viscous drag must be present to lead to the damping they failed to mention work had to be done to overcome this force.

Some quoted the principle of conservation of energy without explaining how it applied to the damping and others discussed the interchange between KE and PE without referring to damping.

Many candidates said that energy was ‘lost’, which is unacceptable at this level. Candidates should understand that the principle of conservation of energy demands that all energy must be accounted for, and that work done against resistive forces leads to a transfer of energy out of the oscillating system.

Q18a

Candidates answered this question confidently, with the vast majority scoring both marks. Candidates who lost the first mark did so by positioning X on the main sequence, demonstrating a lack of awareness of where white dwarfs lie on the diagram.

Q18bi

In general this was poorly answered, mainly as a result of candidates being unaware of the need to include proton and nucleon numbers for all of the product particles.

It was common to see candidates using “n” for neutrino and “p” for positron.

Q18bii

Most candidates found a mass difference but many were confused by the mass units and needlessly multiplied by c^2.

Nevertheless most candidates realised that MeV needed to be converted to Joules. Occasionally candidates erroneously divided (rather than multiplied) by 1.6×10^{-19} to achieve this conversion.

Q18c

This question was poorly answered with very few scoring full marks. Many candidates did not gain mp2 because they did not mention proton/nuclei in their response but instead referred to atoms/particles or even molecules. Lack of the term "strong (nuclear) force" or not mentioning the idea of protons/nuclei needing to be close enough lost them the third marking point.

Candidates who lost out on the first marking point were mainly due to not using the idea of rate in their answer. Common incorrect responses included the idea that high density means there is a large number of protons in a small area so protons can come close enough for fusion to take place. However, there did appear to be more awareness of the effect of density on collision rates than in previous exams where this specification item has been tested.

Some candidates did not relate their explanations to either density or temperature, leaving it open as to which condition led to which effect.

Q18d

Some very good answers were seen here. However, some candidates just wrote down everything they knew about fission and fusion. The misspelling of fission and fusion sometimes rendered the candidate's answer as completely ambiguous.

Most candidates had some idea of the advantages of fusion but responses referred to vague environmental issues, as well as discussing the disadvantages of fusion (which were not asked for).

A common misconception was that energy released per fusion was higher than energy released per fission. Other candidates demonstrated that they understood that fusion involved more energy than fission but failed to point out that this was for the same mass of reactant.

Many candidates did not link the radioactive products to storage/disposal/transportation problems so lost out on mp4.

The idea that fission uses fuel that is renewable whereas fusion uses fuel that is non-renewable was quite common. Candidates should beware of using technical words in an inappropriate context.

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