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 WPH14. It consists of 10 multiple choice questions, a few 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 fourth paper produced for this unit. The third paper was not set as an examination, but it was made available as a secure assessment for centres in summer 2021.

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, 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

In general candidates’ performance in this section of the paper was similar to candidates’ performance in previous series.

Q7 was tricky, because candidates had to realise that the quantity plotted on the *y*-axis is binding energy *per nucleon*, whereas the question requires candidates to select the response that gives the *total* energy.

SECTION B

Q11

This question was generally well answered. In incorrect responses values for *I* and *L* were sometimes mixed up, and occasionally the square root was ignored.

In a small number of responses units were omitted. Candidates should be aware that final answers to calculations must include units. Units are provided in a "show that" question, so in these questions units are not assessed.

Q12

This question was answered well by many candidates. Some candidates did not make the link with power and so they ignored the values of time given in the question. In the vast majority of responses, the temperature difference was calculated correctly.

It is not necessary to convert the temperature to kelvin if a temperature difference is being calculated. However, in some responses 273 was added to their temperature difference, leading to an incorrect answer.

Q13(a)

The correct answer was mostly obtained, but some candidates forgot to convert from u to kg before substituting their calculated difference in mass into $\Delta E = c^2\Delta m$.

As this is a "show that" question, candidates should have known to quote their answer to one more significant figure than the "show that" value given in the question. However, in some responses the final answer was only quoted to 2 sf.

Q13(b)

Only a minority of candidates realised that this question hinged on an understanding of momentum conservation. In the best responses seen, candidates were able to apply momentum conservation and energy conservation successfully to demonstrate that the kinetic energy of the alpha particle just after the decay was 5.4 MeV. The conclusion was sometimes omitted.

In responses that did not complete the algebra to show that the kinetic energy was 5.4 MeV, marks were generally scored for statements that energy and momentum were conserved in the decay.

In some responses candidates tried to show the velocity was less than the speed of light. References to binding energy and $\Delta E = c^2\Delta m$ were also seen.

Q14(a)

The vast majority of candidates scored full marks on this question. In a minority of responses, the value for temperature was not converted into kelvin, and occasionally the Coulomb's law constant *k* was used instead of the value for the Boltzmann constant.

In some responses attempts to use $pV = nRT$ were seen. To complete the question as stated requires values for R and N_A to be known, as well as the relationship $n = N/N_A$.

Q14(b)

Some candidates didn't know where to start with this question, but those who did generally used the information given in the question to calculate the correct ratio. The most common error was to use 60.5% of the mean square speed rather than 60.5% of the root mean square speed.

Some candidates were able to work out the molar masses of the two gases from their knowledge of chemistry. A ratio worked out by this method did not gain credit.

Q15

This question tests candidates' ability to link ideas together logically. There are up to 4 marks for the indicative (physics) content and up to 2 marks for linkage. Candidates who stated correct indicative content, tended to structure their arguments logically. Hence linkage marks were clear to award.

Candidates often used quite imprecise language in their descriptions. References to particles, atoms and molecules in place of nuclei were seen fairly often. Similarly, candidates should know that conditions in the core of a star are extreme, and therefore reference to very high temperature and very high density is expected.

References to the energy of the nuclei often omitted to state that kinetic energy was being referred to. Similarly, a number of descriptions just referred to "enough" energy.

Although students understood that there was a (very) high density, they rarely stated the origin of this. The rate of collision was mentioned but all too often the reason why this is important was missed. Some candidates were referring to pressure, rather than density.

It was apparent some students had learnt about experimental fusion reactors as references to containment and magnetic fields was often included somewhere in the response.

Q16(a)

Some candidates choose an incorrect sequence, maybe because they didn't understand what was meant by "rotating that the Sun was rotating about its axis. Others mixed up the relationship between relative movement and shift in wavelength.

Q16b

Many candidates understood that the effect was due to Doppler shift. However, the command word in the question is "explain" and so a simple statement that a Doppler shift is occurring only scored 1 mark.

Some candidates stated that the emitted (rather than the received) radiation was bigger or smaller. Some mixed up "red shift" with "blue shift".

Some incorrect answers centred around the idea that the sun is at different temperatures and linking to Wiens law. Some linked the effect linked to distance rather than relative motion.

Q16c

Most candidates attempted method 1 or 2. Most were able to calculate the time in seconds or days and also find a velocity using the circumference of the orbit. Most candidates knew that a conclusion is needed, as this is an "assess" question. However, some obtained a correct answer of 27.8 days, but didn't make any comment on this value.

Q17a

Most candidates realised they had to take measurements at 6-month intervals, diagrams were good but sometimes didn't make this clear. The reference to distant stars was most commonly omitted. The need to know a value for the Earth-Sun distance was usually stated explicitly, but sometimes in passing by referring to an astronomical unit when showing a trig calculation.

Q17b

Most candidates knew that the age of the universe is the reciprocal of the Hubble constant. The words 'galaxy' and 'recessional' tended to be seen somewhere when talking about velocity, but not so often a direct statement that distant galaxies recede. In some responses there were references to stars, although a reference to galaxies is required in this question.

In explaining how the Hubble constant is determined it was quite common to see a reference to the Hubble equation rather than a reference to a graph. There is considerable scatter around the data points, and so substituting values of v and d for a single galaxy into the Hubble equation would not lead to an accurate value for H_0.

Some candidates missed the point of the question and focused on how we know the distances to galaxies rather than what this information can tell us about the age of the universe. Hence references to the inverse square law as a way of calculating distances featured in some candidates' responses.

Q18(a)(i)

This calculation was usually done correctly, although occasionally working was missing. It is expected that candidates will use g = 9.81 N kg^{-1}, which most candidates did. A few candidates used g = 9.8 N kg^{-1}, which is acceptable. The use of g = 10 N kg^{-}1 is not acceptable and was seen in only a few responses.

Q18(a)(ii)

Although most candidates knew the conditions for simple harmonic motion in outline, essential detail was often missing. The most common example of this was making reference to displacement without specifying where the displacement was measured from. Equilibrium points or equilibrium position is fine, but equilibrium on its own is not.

Q18(a)(iii)

This question was generally well answered, with most responses scoring 2 marks. Some candidates forgot to add the mass of the crib and the mass of the baby together to calculate the total mass that was oscillating. Some responses were seen in which the Boltzmann constant or the Coulomb's law constant was substituted into the formula.

Q18(b)

Many candidates didn't understand what the question was about, and so they failed to talk about oscillations. Most discussed general properties of springs such as elastic limit, plastic deformation, and breaking stress. Some considered more general safety aspects, such as making sure there was some sort of buffer so that the baby didn't get hurt. A few candidates thought it was about resonance, and a few thoughts that it was to do with the mass of the crib.

Q19(a)(i)

This should have been an easy question at this level, but some candidates had problems in balancing the proton numbers. Other were unsure about the nucleon number of a β^- particle.

Q19(a)(ii)

The word 'much' was often missed out. Candidates tried to over complicate things referring to binding energy, conservation of energy and momentum but without reference to the masses of the particles.

Q19(b)

This question was well answered. Confident candidates calculated the decay constant in $year^{-1}$ which saved some time conversions. In a few responses A and A_0 had been substituted into the formula incorrectly.

Although candidates usually maintained an appropriate number of significant figures as they worked through the calculation there was a tendency to give 1 sf answers on the answer line. Although the number of significant figures is generally only important in "show that" questions in this unit, candidates should be wary of quoting final answer to only 1 sf.

Q19(c)

Most candidates calculated the percentage transmission correctly, as 30%. However, some went on to calculate 100 – 30 = 70% and use this as the comparison.

Conclusions were sometimes vague, some saying that it was close therefore it was sufficient. Some candidates made conclusions without actually doing any analysis of the data or even referring to the graph. Effectively these candidates had read the command word in the question as "explain" rather than "deduce".

Q20(a)

Although many candidates were aware that a main sequence star is fusing hydrogen in its core, it was relatively frequent to see a reference to the core omitted. Occasionally fission rather than fusion was referred to.

A number of circular arguments were seen, with references to the HR diagram. Other responses that did not score included references to a balance between radiation pressure and gravitational forces and statements that it is where a star will spend most of its life.

Q20(b)(i)

As this is a "show that" question, candidates should have expressed their answer to 3sf (as the "show that" value was given to 2 sf). However, some candidates gave 6.9×10^8 m as their answer.

Common reasons for missing out of marks included not squaring the radius or omitting the Stefan constant. In addition, too many candidates were unaware of the correct formula for surface area of a sphere. πr^2, $2\pi r^2$, $2\pi r$ and even $4\pi r^3/3$ were all seen.

A few candidates gave the formula for *L* and then their answer, without showing any substitutions. In a "show that" question it is expected that candidates will show some of the method of solution. Bald answers to 3 sf did not score full marks.

Q20(b)(ii)

The points made about Stefan's law are equally valid for this question. Nonetheless, Wien's law was generally applied correctly.

Some candidates used ratios in their solution, which was an elegant way to arrive at the final answer.

Q20(b)(iii)

Most candidates were able to compare their calculated wavelength with the wavelength range of red light and pass comment on it not being in that region. Most candidates seemed unaware of the black body radiation curve, and a common assumption seemed to be that all of the radiation emitted by the star is at a wavelength equal to λ_{max}. The conclusion of many was that the Sun would not be a red giant star.

Q20(c)

Although it was expected that candidates would give an explanation in words, the most frequent way to score the marks was to derive an expression for the orbital period and then to comment on how a decreased mass would affect this.

Some candidates misread the equation and considered what would happen to *T* if *r* were to change.

Q21(a)(i)

This question was answered well by most candidates. The most common errors involved forgetting to add *r* to *h* or not changing km to m, but a few candidates used *g* rather than *G* as the constant in the potential equation. Some candidates calculated the field strength rather than the potential.

Most candidates gave answers to 3 (or more) sf, but some just gave their value to 2 sf. In a "show that" question the calculated value should have (at least) one more significant figure than the value given in the question.

Q21(a)(ii)

The most common error was to use *mgh*, with $g = 9.81 \text{ N kg}^{-1}$.

Q21(b)

Most responses seen derived the Kepler equation. Unfortunately, when substituting numbers into this equation quite a few candidates forgot to square theπ. Bizarrely, some candidates tried to use the equation for a pendulum to form a conclusion.

It was disappointing to see a number of responses in which the calculations were performed accurately, but no conclusion was stated.

Q21(c)

Candidates clearly knew about the types of orbits but struggled to link to actual advantages or disadvantages.

Many candidates misread the question and gave the advantages and disadvantages of placing the satellite in a geostationary orbit.

In general, there was more knowledge of geostationary satellites than there was of polar satellites, and often is wasn't clear if an advantage or a disadvantage was being stated,