Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

November 2021

Pearson Edexcel Advanced GCE
In Physics (9PH0)
Paper 2: Advanced Physics II

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Introduction
The assessment structure of Advanced Paper 2 is the same as that of Paper 1, consisting of ten multiple choice questions and a number of short answer questions followed by longer, structured questions based on contexts of varying familiarity.

This paper allowed candidates of all abilities to demonstrate their knowledge and understanding of Physics by applying them to a range of contexts with differing levels of familiarity.

Candidates at the lower end of the range could complete calculations involving simple substitution and limited rearrangement, including structured series of calculations, but could not always tackle calculations involving several steps or other complications, such as converting °C to K. They also knew some significant points in explanations linked to standard situations, such as the conditions for maintaining fusion in stars, but frequently missed important details and did not always set out their ideas in a logical sequence, sometimes just quoting as many key points as they could remember without particular reference to the context.

Steady improvement was demonstrated in all of these areas through the range of increasing ability and at the higher end all calculations were completed faultlessly, and most points were included in ordered explanations of the situations in the questions.

Section A - multiple choice question
The percentages with correct responses for the whole cohort are shown in the table.

Question	Percentage of correct responses (%)
1	37
2	62
3	54
4	53
5	76
6	66
7	46
8	51
9	25
10	22

More details on the rationale behind the incorrect answers for each multiple choice question can be found in the published mark scheme.

Question 11
Most students were able to extract sufficient data from the question and apply the relevant formulae to calculate the frequency for a pendulum of a given length. Only about half of the candidates, however, determined the correct final answer. Some candidates knew that the two parts of the swing needed to be calculated separately but encountered difficulty in combining them to achieve an overall result and other incorrectly identified the required length for the shorter half of the cycle, taking the length from the support to the rod instead of from the rod to the pendulum bob. Some candidates did not use the correct unit and so failed to be awarded the final mark.

Question 12
Most candidates made a good start to the question, applying the formula $\Delta Q = L\Delta m$ to calculate the heat transferred from the steam on condensing. Most candidates could also apply $\Delta Q = mc\Delta\theta$ to the heated milk and equate this to energy transferred from the condensing steam. A substantial minority did not go on to include the energy transferred from the condensed steam as it cooled to the final temperature of the latte.

Students occasionally used the stated temperature rather than a temperature change and a number of them made things more complicated by converting temperatures to kelvin.

Question 13
While most students clearly had a basic appreciation of the principles being explored in this question, based directly on a specification point and with no other context, relatively few scored at all highly.

The majority of candidates gained credit for reference to high temperature, although a few said high heat, but some gave the other requirement as high pressure rather than high density. Candidates were less successful at explaining why these conditions are required. The marks obtained were limited by a lack of detail and failure to use precise language in their explanations. For example, although energy was referred to often, it was not generally specified as kinetic energy. Students mentioned 'overcoming forces' but did not tend to mention that these were because of the positive charges of the nuclei. The need for high density was rarely discussed in terms of either collision rate or sustaining fusion.

Question 14a
A number of candidates were able to complete the calculation and draw the appropriate conclusion, but many were limited by neglecting upthrust in the formula describing the situation, weight = upthrust + drag. Quite a few remembered the overall formula for this situation, not required by the specification, and applied it successfully, but some got part of that formula wrong and therefore could not be awarded marks for the intermediate stages.

Question 14b
The great majority of candidates correctly stated that viscosity of a liquid is greater at a lower temperature and about half of these went on to say that the maximum speed would be lower. Most of the remaining candidates knew that speed would be affected, but did not express this with sufficient clarity or in sufficient detail for the mark, for example not specifying maximum speed and just saying it would move more slowly, or saying it would take longer to reach terminal velocity.

Question 15
About a third of candidates gained full marks for question 15, reflecting good overall knowledge and understanding and the ability to demonstrate and apply them.
In part a, some students thought they needed to perform an intensity calculation.

Some students did not complete the final fourth root calculation correctly. Some arrived at the correct final calculated value but did not make the explicit comparison required for the final mark.

Part b was straightforward for students, sometimes with error carried forward from part a, although the unit was sometimes omitted, or an incorrect prefix used.

In part c, plotting the position of the star was generally straightforward, but some students chose the wrong division of the logarithmic scale on the luminosity axis. When plotted correctly, the star was always identified as a red giant.

Question 16a
There were a number of stumbling blocks for the majority of students attempting this determination. Some candidates treated the graph as if both axes started at zero and simply took the coordinates of one point on the line to use in calculating the gradient and some used triangles that were too small to give an accurate answer. Other candidates successfully calculated the gradient but did not know how to use it to determine the Planck constant because they effectively did not know how to use the stopping potential in place of maximum kinetic energy in Einstein's equation.

Question 16b
Only about a third of the entry were able to make any headway with this question, generally being awarded a single mark. Most candidates simply repeated the information in the question or made general references to uncertainties. They did not often discuss the specific effect of the stated problems on the recorded potential difference, as required. When they did mention this, they did not appreciate that, say, if all the recorded potential differences were too high this did not necessarily mean that the final gradient would be too high.

Question 17a
Candidates were split fairly evenly between those who could complete the calculation for full marks and those who did not score anything. They did not seem to appreciate that the mass of the orbiting star could be 'cancelled out' when equating gravitational and centripetal force. Some incorrect applications attempted included the pendulum equation and use of the Hubble constant.

Question 17b
Those who could apply the concept of gravitational potential, about two thirds, were generally able to complete part i successfully, although some only calculated the potential at one of the points. A few attempted to use a calculation based on work = force times distance with gravitational field strength at one point multiplied by the change in distance.

In part ii, students often had a problem with relating the change in gravitational potential to the change in kinetic energy when they didn't know the mass of the star. The approach in the mark scheme shows one way of eliminating mass from the calculation and another that could have been used was to assume a mass of 1 kg, or any other nominated value.

Question 17c
Most candidates appeared to reason that the star is too far away for parallax, so Hubble's law should be applied, completely failing to recall that this is for distant galaxies where we can assume recessional speeds proportional to distance. Where candidates stated that the star is close enough for the use of parallax, they rarely went on to justify this in terms of accurate measurement of angles, as required for the mark.

Question 18a
A good majority of the entry were able to tart this by calculating the required excess pressure, but they did not all then add atmospheric pressure to determine the total pressure.

Question 18b
When students adopted a pV/T = constant approach they were generally able to complete this calculation successfully, although some neglected to carry out the required conversion of temperatures to kelvin. Quite a few candidates attempted to use V/T = constant, ignoring the pressure change entirely and despite the clue of having calculated pressure in part a and being given a value of pressure in the data for part b. While candidates may sometimes be given a list of values for a given quantity and be asked to choose the correct one, in general questions they would do well to assume that all data given is relevant to the question.

Question 18c
The majority of candidates were able to complete this straightforward derivation required in the specification. Some candidates, however, showed confusion between different quantities with different versions of the letters N and M, such as n for number of moles and N for number of particles, when applying kinetic theory of gases formulae.

Question 18d
About half of candidates were able to tackle this with the correct approach. Of those, about half gained full marks, the most common errors among the others being missing the final unit, failing to take a square root or using the temperature in degrees Celsius.

Question 19ai-ii
Nearly all candidates made very good headway on this question, nearly all calculating the focal length, although a few had a problem with units, and nearly half achieving full marks for the two parts.

Errors in part ii included using power as f in the lens equation and using addition with $1/f$ and $1/v$ rather than subtraction. Some candidates had problems with the use of mm and cm in the same question.

Question 19aiii
Only a minority of candidates were able to make relevant points in their responses to this question. They generally failed to appreciate that with the freshwater there was

an increased difference with the refractive index of the lens material, so there would be greater refraction. Most interpreted the situation as being one where there would be less refraction because of the lower refractive index of seawater. Their answers were generally consistent with their deduction, so they typically said that there would be less refraction so the focal length would be longer and so on.

Question 19aiv
Most candidates calculated the speed of light in seawater correctly, some failing to receive both marks because they didn't include the unit.

Question 19b
About half of the candidates stated that the oscillations are in a single plane or that the oscillations are in a single direction, but they rarely went on to complete the statement correctly.

Most frequently seen was 'oscillations are in a single plane, perpendicular to the direction of propagation' which could only apply to a single point if it were true. It appears that these students were conflating the descriptions of polarised and transverse waves in their answers. Some candidates only made the first point in either version of the mark scheme. Less successful candidates said that polarised waves only travelled in one direction or only moved in one direction.

Question 20ai-ii
Most candidates correctly calculated the decay constant for two marks, but there were varying degrees of success with part ii. Candidates generally demonstrated their understanding of count rate and were able to apply it to correct for background radiation. A good number continued to calculate the number of nuclei required to produce this rate using the previously calculated decay constant and most of these went on to determine the mass for this number of atoms. Nearly a sixth of the candidates were able to apply the ratio of the areas to get to the final answer correctly, scoring 8 marks for parts i and ii.

Question 20aiii
Relatively few candidates made significant criticisms of the method used, and generally only one point was made. Candidates generally recognised that alpha radiation is not very penetrating, but they did not state specifically how that is significant in this case in terms of the number detected.

Question 20b
A good proportion of the candidates were able to complete this calculation fully, and nearly half were able to get as far as applying $\Delta E = c^2\Delta m$ to the correct mass change to calculate energy. Some candidates forgot to take the final square root. A number of candidates seemed entirely unperturbed to calculate a speed greater than the speed of light and, therefore, automatically incorrect.

Based on their performance on this paper, candidates are offered the following advice:

- Be sure you know the command words and understand the level of required response for each of them, e.g., ‘explain’ would mean a candidate must say why something happens and not just describe what happens. There will always be at least two linked marking points for a question asking you to ‘explain’.
- Where you are asked to come to a conclusion by command words such as ‘determine whether’ or ‘deduce whether’ using numerical data, you must complete your calculations, then explicitly compare the relevant values and then make a clear statement in conclusion – ‘Calculate, Compare, Conclude’.
- Learn standard descriptions of physical processes, such as ‘polarisation’ or ‘fusion’, and be able apply them with sufficient detail to specific situations, identifying the parts of the general explanation required to answer the particular question in a given context.
- In questions with mixed quantities, be sure to convert all values to standard SI base units or derived units, e.g., convert years or days to seconds and °C to K for gases.
- Be sure to know the standard SI prefixes and be able to apply the correct power of ten.
- Physical quantities have a magnitude and a unit, and both must be given in answers to numerical questions.
- When substituting in an equation with a power term, e.g. $<c>^2$, don’t suddenly miss off the index when substituting or forget it in the calculation, such as by failing to calculate a square root.
- Check that quantitative answers represent sensible values and to go back over calculations when they do not, such as for a speed greater than the speed of light.

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