Examiners' Report
June 2016

GCE Physics 6PH05 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

- See students' scores for every exam question.
- Understand how your students' performance compares with class and national averages.
- Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus.
Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2016

Publications Code 6PH05_01_1606_ER

Introduction

The assessment structure of 6PH05 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 12(b), 13(b), 14(b), 16(b), and 18(d) tended to be clustered at the lower end of the scale.

In general, 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 solutions which were well crafted, clearly set out and accurate.

Occasionally, in calculation questions the final mark was lost due to a missing unit. Candidates understood the convention that in the "show that" question 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 16(b) and 17(b), where candidates sometimes had knowledge of the topic, but could not express it accurately and succinctly. Candidates could most improve by ensuring they understand 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. Once again there was confusion demonstrated between atoms, molecules, nuclei and particles. At A2 level it is to be expected that, where candidates use such terms, they do so with accuracy.

In addition, descriptions of energy transfer implying that energy is lost were commonly seen.

It is clear that some candidates do not spend enough time reading the question before they start to write their answer. In question 11(a) some responses ignored some of the data given in the question stem.

The space allowed for responses was usually sufficient. However, candidates need to remember that the space provided does not have to be filled. 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 responses to the multiple choice questions were generally good with six of the questions having 80% or more correct responses.

In order of highest percentage correct they were, Q3 (97%), Q1 and Q6 (96%), Q8 (88%), Q4 (85%), Q7 (81%), Q9 (77%), Q10 (67%), Q5 (62%) and Q2 (26%).

Q2 involved finding a ratio of energies from some data given in the question. Candidates sometimes got this ratio the wrong way around, or sometimes they forgot to square the amplitude ratio.

Question 11 (a)

This question was well answered, with many candidates scoring full marks. The usual reason for not awarding full marks was that the energy used to increase the temperature of the saucepan was ignored. Occasionally candidates made unnecessary conversions from °C to K. Although a final answer in kelvin could score full marks, any mistakes in the conversion sometimes meant that the final mark was not awarded.

(a) The pan and raspberries are initially at a temperature of 22 °C. - 295 K.

Calculate the theoretical rise in temperature of the raspberries after being heated for 5 minutes. – 300 s.

specific heat capacity of copper = 386 J kg^{-1} K^{-1}

specific heat capacity of raspberries = 3890 J kg^{-1} K^{-1}

(3)

$P = \frac{E}{t}$

$Pt = E$

$650 \times 300 = E$

$E = 1.95 \times 10^5$ J.

$E = mc\Delta T$

$\frac{E}{mc} = \Delta T$

$\frac{1.95 \times 10^5}{2.85 \times 3890} = \Delta T$

$\Delta T = 17.6$ K.

Rise in temperature = 17.6 K.

ResultsPlus
Examiner Comments

In this response the candidate has not included the saucepan in their calculations, so their final answer is incorrect.

8 (a) The pan and raspberries are initially at a temperature of 22 °C.

Calculate the theoretical rise in temperature of the raspberries after being heated for 5 minutes.

specific heat capacity of copper = 386 J kg^{-1} K^{-1}

specific heat capacity of raspberries = 3890 J kg^{-1} K^{-1}

(3)

$P = \frac{E}{t}$ $= Js^{-1}$ $\frac{\Delta E}{t} = \frac{mc\Delta\theta}{t}$ $\Delta\theta = \text{~~17.67K~~} = 16.95\,K$

$= 17\,K$ 3sf

$\Delta E = 5 \times 60 \times 650\,W = 195000\,J$

$mc\Delta\theta_1 + mc\Delta\theta_2 = \Delta E$ $\theta_1 = \theta_2$

$195000 = \Delta\theta(1.08 \times 386 + 2.85 \times 3890)$

Rise in temperature = 17.0 K

ResultsPlus

Examiner Comments

This response is worth all 3 marks.

Question 11 (b)

Those candidates who had ignored the energy used to heat the saucepan in part (a) often gave this as the reason for the actual temperature rise being less than their calculated value.

Candidates sometimes made vague reference to efficiency not being 100% or talked about energy being lost.

(b) State why the actual rise will be less than this.

(1)

energy lost to external sources, sound

(Total for Question 11 = 4 marks)

ResultsPlus
Examiner Comments

This response does not score any marks.

ResultsPlus
Examiner Tip

Refer to energy transfer rather than energy loss. Be sure to specify where the energy is transferred to

(b) State why the actual rise will be less than this.

(1)

Energy will not be completely transferred to the pan and the raspberries it will go to the surrounding

ResultsPlus
Examiner Comments

This response gains the mark.

Question 12 (a)

This question was well answered by many candidates. There was a slightly greater proportion of correct answers seen from candidates calculating the product of atomic mass and the specific heat capacity, than by candidates calculating this product and then using it to check the other specific heat capacity values in the table. Candidates who only checked out two rows in the table were only awarded 1 mark.

12 The table shows data for a number of metals.

Metal	Specific heat capacity / J kg^{-1} K^{-1}	Atomic mass / u
Aluminium	910	27.0
Copper	386	63.5
Silver	233	108

It is stated in a textbook that the specific heat capacity of a metal is inversely proportional to its atomic mass.

(a) Show that this statement is approximately correct.

(2)

$C = \frac{k}{m}$ ∴ $cm = k$

Al : $910 \times 27 = 24570$

Cu : $386 \times 63.5 = 24511$ $c = \frac{24570 + 24511 + 25164}{3}$

Silver Ag: $233 \times 108 = 25164$ $= 24748.3$

ResultsPlus
Examiner Comments

Both marks are awarded here.

12 The table shows data for a number of metals.

Metal	Specific heat capacity / J kg^{-1} K^{-1}	Atomic mass / u
Aluminium	910	27.0
Copper	386	63.5
Silver	233	108

It is stated in a textbook that the specific heat capacity of a metal is inversely proportional to its atomic mass.

(a) Show that this statement is approximately correct.

(2)

$910 = K\frac{1}{27}$ $K = 27 \times 910 = 24570$

$24570 \times \frac{1}{63.5} = 387 \approx 386$

$24570 \times \frac{1}{108} = 228 \approx 233$

ResultsPlus
Examiner Comments

This is an alternative way to gain 2 marks.

ResultsPlus
Examiner Tip

Always complete calculations fully - particularly in a "show that" question.

Question 12 (b)

This was a challenging question that most candidates struggled to get started with. Those candidates who started by explaining what we mean by internal energy per atom or the specific heat capacity of a metal were awarded 1 mark, but often were unable to go any further with their explanation.

(b) A simple model suggests that, at a given temperature, the internal energy per atom should be the same in all metals.

Explain how this accounts for the relationship between specific heat capacity and atomic mass.
↳ c.

(2)

'c' = is the amount of of Energy needed to raise 1 kg by 1°C (or 1K) Internal Energy is the sum of potential and kinetic energy. this would mean that as $c \propto \frac{1}{u}$, and so at a given Temperature the mass becomes irrelevant and the relationship is not true.

(Total for Question 12 = 4 marks)

ResultsPlus

Examiner Comments

This is a typical response, in which 1 mark can be awarded for a definition of specific heat capacity, but little else.

Question 13 (a)

This was a straightforward calculation which most candidates were able to carry out successfully. Occasionally g = 10 N kg^{-1} was used, resulting in just 1 mark being awarded.

Question 13 (b)

Some candidates attempted to explain the observation given by reference to Kepler's law. Simply stating that,

without any supporting evidence, was not considered enough for a mark. On the other hand, a brief derivation of this equation could result in 2 marks being awarded.

(b) Explain why a more massive Moon would have no effect on the time taken for the Moon to orbit the Earth.

(2)

→ Kleper's law (3rd).

$T^2 \propto r^3$, so it's not dependent on the mass of the the moon, it only depends on the radius and if the radius is constant then it will have no effect on the time period.

ResultsPlus
Examiner Comments

No justification is given here, we only have a form of Kepler's Law quoted as a reason for the statement.

(b) Explain why a more massive Moon would have no effect on the time taken for the Moon to orbit the Earth.

(2)

As the gravitational force is given by $F = \frac{GM_1M_2}{r^2}$ and it acts as ~~an~~ a centripetal force $F = \frac{mv^2}{r}$, these two forces are equal, $\frac{GM_1M_2}{r^2} = \frac{mv^2}{r}$, and M_2, mass of the moon is cancelled out. V can be represent as $V = r\omega$ and $\omega = \frac{2\pi}{T}$, where T is the time period. As V remain the same, T will stay the same.

ResultsPlus

Examiner Comments

This response says enough for 2 marks to be awarded.

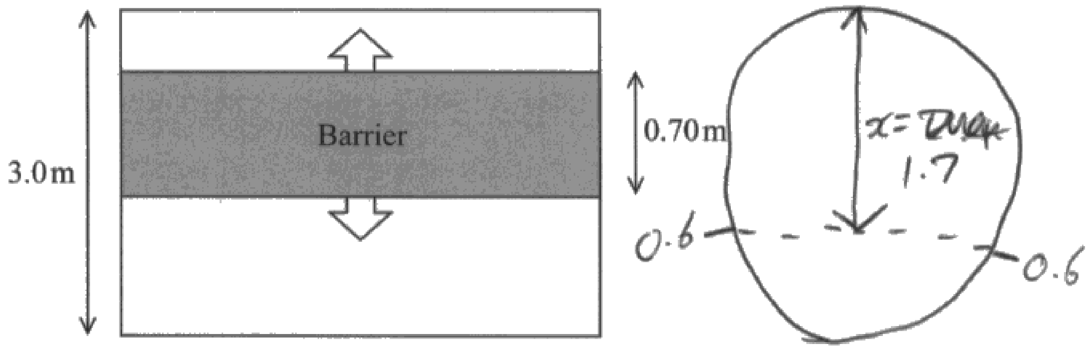
Question 13 (c)

Some candidates focussed on the size of the gravitational force and others on the effect on the tides. In describing the effect on the tides it was not accepted that tides would be "stronger", unless the word stronger was qualified in some way, since this is a key word with a particular meaning in this specification. A variety of other ways of describing more extreme tides was accepted.

Question 14 (a)

This is a standard definition and candidates should be ready to state this without difficulty. However, it was common to see just 1 mark being awarded, on account of the point from which displacement is measured not being specified.

14 In a television game show contestants have to pass under a barrier. The barrier has a vertical height of 0.70 m and moves up and down with simple harmonic motion.



(a) State the conditions which must be met for an object to move with simple harmonic motion.

(2)

Acceleration of an oscillating object must be proportional to the displacement from its equilibrium position and directed towards this equilibrium position.

ResultsPlus
Examiner Comments

This response scores 2 marks.

ResultsPlus
Examiner Tip

Be specific and use technical terms wherever possible.

Learn the conditions for effects such as s.h.m, resonance and so on.

Question 14 (b)

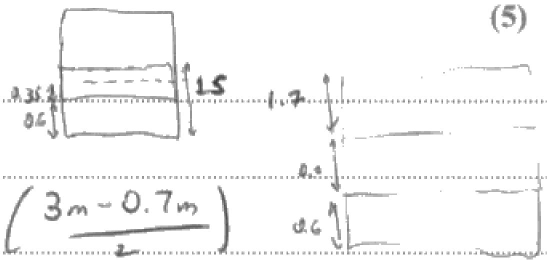
This was a challenging open ended calculation. Although many candidates struggled with this calculation it was pleasing to see that some candidates were able to produce well expressed, concise solutions to this problem. The best solutions seen often involved a diagram annotated with key quantities.

(b) The bottom edge of the barrier is initially in contact with the ground and moves up to a height of 2.3 m before returning back to its starting position. The bottom edge of the barrier touches the ground every 4.5 s.

A contestant requires a space at least 0.60 m high to get under the barrier.

Calculate the maximum time this contestant has to get under the barrier.

(5)



One oscillation = 4.5 s

$\omega = \frac{2\pi}{T} = \frac{4}{9}\pi \text{ rad s}^{-1}$

$A = 1.15 \text{ m} \quad \left(\frac{3\text{m} - 0.7\text{m}}{2}\right)$

Taking the top as positive

$x = A\cos\omega t$

$-0.55 = 1.15\cos\left(\frac{4}{9}\pi \times t\right) \quad \therefore \cos^{-1}\left(\frac{-0.55}{1.15}\right) = \frac{4}{9}\pi \times t$

$\frac{4}{9}\pi \times t = 2.0697$ or 4.2137

$t = 1.48\text{s}, 3.02\text{s}$

1.54 s spent less than 0.6 m

2.96 s spent more than 0.6 m

Maximum time = 2.96 s

ResultsPlus
Examiner Comments

Although this is rather a messy solution, all the elements are present and the final answer is correct.

(b) The bottom edge of the barrier is initially in contact with the ground and moves up to a height of 2.3 m before returning back to its starting position. The bottom edge of the barrier touches the ground every 4.5 s.

A contestant requires a space at least 0.60 m high to get under the barrier.

Calculate the maximum time this contestant has to get under the barrier.

(5)

$T = 4.5\,s$ $\quad x = a\cos\omega t$

$\omega = \frac{2\pi}{T} = \frac{2\pi}{4.5}$ $\quad 0.6 = 2.3\cos\frac{4\pi}{9}t$

$= \frac{4\pi}{9}$ $\quad t = \frac{9\cos^{-1}\left(\frac{0.6}{2.3}\right)}{4\pi} = 0.93597\ldots s$

$2t = 1.87\,s$ = time unable to get under the barrier

time able to get under barrier = $T - 1.87 = 4.5 - 1.87 = 2.63\,s$

Maximum time = 2.63 s

ResultsPlus
Examiner Comments

This is worth 2 marks, for the two "use of" marks. The amplitude of the barrier and its maximum displacement from the equilibrium position are both identified incorrectly, and so the final answer is incorrect.

Question 15 (a) (i)

Most candidates were aware that α -radiation is very ionising and not very penetrating. Since the context of the question relates to radiation sources outside of the body it was expected that candidates would refer to α -radiation being stopped by the skin layer (rather than references to paper or 5 cm of air).

(a) The physics teacher checks the internet to assess the risks to students of using the sources.

(i) Explain why Am-241 only poses a health risk when ingested or inhaled.

(2)

alpha radiation is very ionising so it can't leave the body via the skin. It stays in the body. Alpha radiation is ionising so it can damage the DNA of healthy cells causing healthy cells to die.

ResultsPlus
Examiner Comments

This response has alpha radiation leaving rather than entering the body.

Question 15 (a) (ii)

Most candidates were able to state that γ-radiation is very penetrating, although some candidates focussed on it not being very ionising. Again, the context of the question indicates that a reference to the penetrating power of the radiation is required.

(ii) State why external exposure to the Co-60 source is dangerous.

(1)

Gamma radiation "higher frequency" is very dangerous as it causes cell mutation and is not stopped ~~by~~ unless ~~as~~ a concrete wall is used.

ResultsPlus
Examiner Comments

This response does not gain any marks.

ResultsPlus
Examiner Tip

Always relate answers to the context given in the question.

(ii) State why external exposure to the Co-60 source is dangerous.

(1)

Co-60 emits gamma radiation, these are not blocked by dead skin cells and so have the possibility to ionize internal cells.

ResultsPlus

Examiner Comments

This response has enough for the mark to be awarded.

Question 15 (a) (iii)

It was pleasing to see that most candidates were aware of the safety implications of experimenting with radioactive sources. However, some of the precautions suggested by some candidates were a little over the top (lead lined protective clothing) and some insufficient (aluminium lined boxes). Some candidates were unsure how to describe “long tongs”, and a variety of words equivalent to “tongs” were accepted.

Question 15 (b)

Most candidates stated that random means that we cannot know which nuclei will decay next, although they mostly thought that this is what the student had said. Nonetheless their statement was accepted for MP1. Some candidates thought that we could know when the activity of the source would be at a safe level by measuring the activity with a Geiger counter. Although this is strictly true, the use of the word “determine” in the question stem was meant to direct candidates to a consideration of the theoretical ways in which we might determine if the activity were at a safe level.

Question 16 (a) (i)

This is a question that has been asked before and most candidates' responses included all the essential detail. Diagrams were often used to good effect, although some candidates gave perfectly good explanations in words alone. Common omissions from the responses seen included no reference to the need to know the distance from the earth to the Sun and no reference to distant, fixed stars.

(a) (i) Explain how Earth-based parallax measurements can be used to determine the distance of the Pleiades star cluster from the Earth.

(3)

• measure the angle of the apparent change in position of the star from earth 6 months appart.

• Trigonometry: $\frac{1AU}{\tan\theta} = d$

(1AU = average distance from earth to sun.)

ResultsPlus
Examiner Comments

This response contains all the essential detail of the method and so scores full marks.

ResultsPlus
Examiner Tip

A well drawn, correctly labelled/annotated diagram can often help to score full marks in a question.

(a) (i) Explain how Earth-based parallax measurements can be used to determine the distance of the Pleiades star cluster from the Earth.

(3)

You measure the angle the cluster appears to have moved by relative to background stars that are much further away. This is done when the Earth is at opposite ends of its orbit of the Sun. As you know the distance from the Earth to the Sun (1 AU) you can then use trigonometry to determine the distance to the star cluster.

ResultsPlus

Examiner Comments

Although there is no diagram included, there is enough in this description for full marks to be awarded.

Question 16 (a) (ii)

Many candidates thought that if the stars are too far away the angles would be too small to measure. In fact it is the change in the angular position that becomes too small to measure. Answers referring to the parallax angle being too small to determine were accepted.

Question 16 (b)

This was a poorly answered question, with many responses centred on a general discussion rather than the specific situation described in the question. Many candidates missed the fact that the Pleiades star cluster is now thought to be closer than was originally thought. Once they had recognised that the cluster is closer than had been thought, most candidates deduced that the cluster is not as luminous as had been thought. The implications of this then follow on, although some candidates got themselves in a muddle over how the distances changed. Some potentially good responses were spoiled by reference to changes in brightness and distance, rather than increases or decreases in these quantities. In addition brightness and luminosity were often used interchangeably by some candidates.

*(b) Since 1989 the Hipparcos satellite has been measuring the distances to a range of stars and star clusters. Using results from Hipparcos a more accurate distance of 392 light-years has been obtained for the Pleiades star cluster. This changed the luminosities of stars in the Pleiades star cluster as calculated by astronomers.

Explain how this variation in distance measurement has implications for our measurements of distance to the farthest galaxies.

(4)

Since the ~~distance~~ recorded distance has decreased, the luminosity of the stars in Pleiades has also decreased. We measure the distance to the farthest galaxies using $F = \frac{L}{4\pi d^2}$ and, if the luminosity for these distant galaxies is different, then the distances are also different. ~~Also~~ We obtain Luminosity using standard candles, ~~and thus these luminosity values change if~~ Also, if the Pleiades star cluster is closer, then, for ~~the~~ the same angle (θ) in trigonometric parallax, the distant galaxies have to be closer.

(Total for Question 16 = 8 marks)

ResultsPlus
Examiner Comments

This response is close to gaining full marks, although the luminosity of distant galaxies is said to be different rather than overestimated, and so this is worth just 3 marks.

ResultsPlus
Examiner Tip

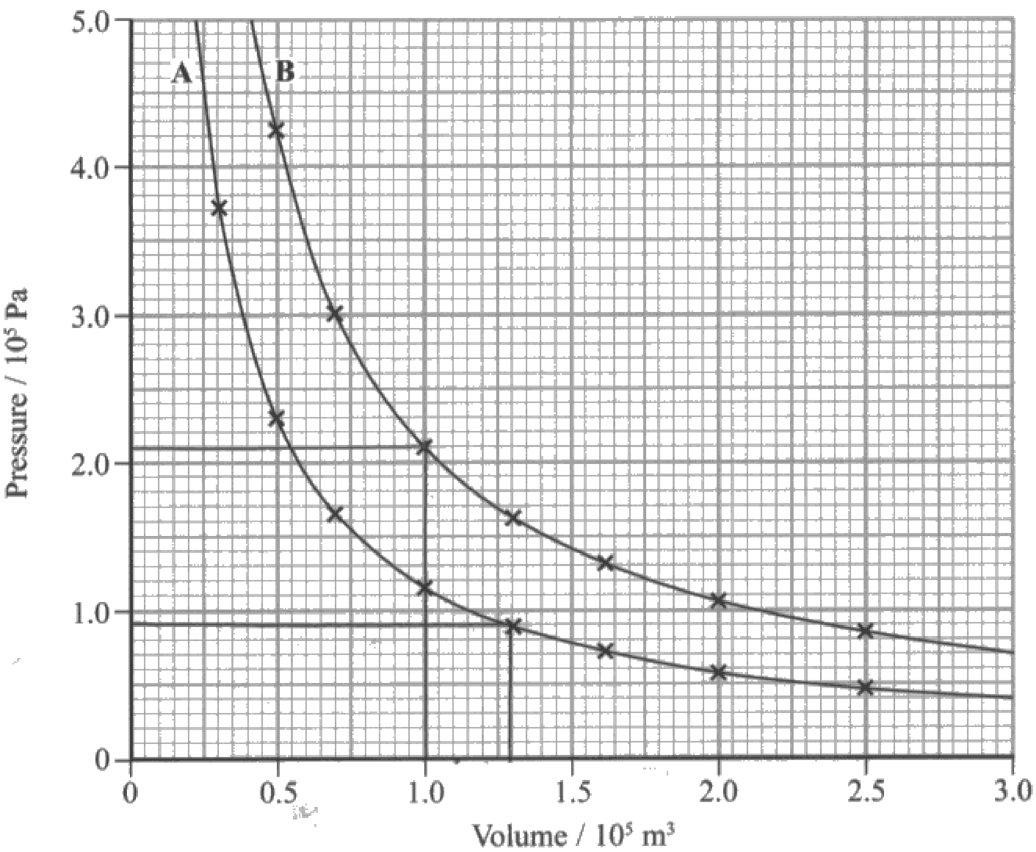
Plan your answer to a question like this before you start to write. Planning your response will help you to write your answer out logically and with a minimum of repetition.

Question 17 (a)

(i) This was a well answered question, with most candidates able to use the pressure equationand score all 4 marks. Some candidates forgot to convert the temperature into K, and so obtained an incorrect final answer.

(ii) This was another well answered question, with the vast majority of candidates scoring full marks.

17 The graph shows the variation of pressure with volume for a sample of air at two different fixed temperatures. The air behaves as an ideal gas under these conditions. The number of molecules of air in the sample is constant. For curve A the temperature of the sample is 25 °C.



(a) (i) Use the graph to determine the number of molecules of air in the sample.

(4)

$pV = nkT$ $\quad T = 25 + 273 = 298K$

$n = \frac{pV}{kT}$ $\quad$ When $V = 1.3 \times 10^5 m^3$

$n = \frac{0.9 \times 10^5 \times 1.3 \times 10^5}{1.38 \times 10^{-23} \times 298}$ $\quad P = 0.9 \times 10^5 Pa$

$n = 2.85 \times 10^{30}$

Number of molecules of air in sample = 2.85×10^{30}

(ii) Use the graph to determine the temperature of the sample for curve B.

(2)

$P_B = 2.1 \times 10^5$

$V_B = 1.0 \times 10^5$

$\frac{P_B V_B}{T_B} = \frac{P_A V_A}{T_A}$

$T_B = \frac{T_A P_B V_B}{P_A V_A} = \frac{298 \times 2.1\times10^5 \times 1.0\times10^5}{1.3\times10^5 \times 0.9\times10^5}$

Temperature of sample = 535 K

ResultsPlus

Examiner Comments

This response scored full marks.

ResultsPlus

Examiner Tip

When reading values from a graph show the points that you have chosen to read.

Question 17 (b)

Questions asking candidates to explain pressure changes in terms of molecular momentum changes have been set previously. Some candidates replicated previous mark scheme answers that referred to average molecular kinetic energy increasing. References to particles instead of atoms, the collisions between atoms rather than with the walls of the container, and the change in momentum rather than the rate of change of momentum were seen all too frequently.

*(b) When the sample of air is cooled at constant volume, the pressure exerted by the air decreases as the temperature falls.

Explain, including ideas of momentum, why the pressure exerted by the air decreases.

(4)

Because kinetic energy is directly proportional to temperature. This means increased R Temperature means increased ke. If the particles have more ke, due to $ke = \frac{1}{2}mv^2$, their speed increases. This means, due to $p = mv$, their momentum increases. Due to the equation $f = \frac{p}{t}$, when they collide with the walls of the container they exert a greater force, so pressure increases

ResultsPlus

Examiner Comments

This response states that the kinetic energy increases rather than decreases. There is a reference to particles rather than atoms. This is probably a poorly remembered version of a mark scheme to a question set in a previous examination.

ResultsPlus

Examiner Tip

Read through your answers to ensure that what you have written makes sense.

Bullet lists are often good ways of expressing key features of any effect.

*(b) When the sample of air is cooled at constant volume, the pressure exerted by the air decreases as the temperature falls.

Explain, including ideas of momentum, why the pressure exerted by the air decreases.

(4)

· as temperature cools average kinetic energy of molecules decreases so their velocity decreases
· collision rate with walls of container decreases and rate of change of momentum when molecules collide with walls decreases
- so force exerted on container walls decreases, hence pressure exerted by the air decreases

ResultsPlus
Examiner Comments

This response scores all 4 marks.

Question 18 (a) (i)

Many candidates realised that Spica star and Vega are both examples of a main sequence star, although some candidates classified Vega as a red giant star. Although it was accepted that the position of Vega placed it towards the giant stars, it would be wrong to call it a *red* giant star as it is hotter than the Sun which is a yellow/white star.

Question 18 (a) (ii)

The stars were accurately positioned by most candidates, although it is clear from some of the responses seen that many candidates are unaware of the nonlinearity of a log scale.

18 The table shows the properties of three stars.

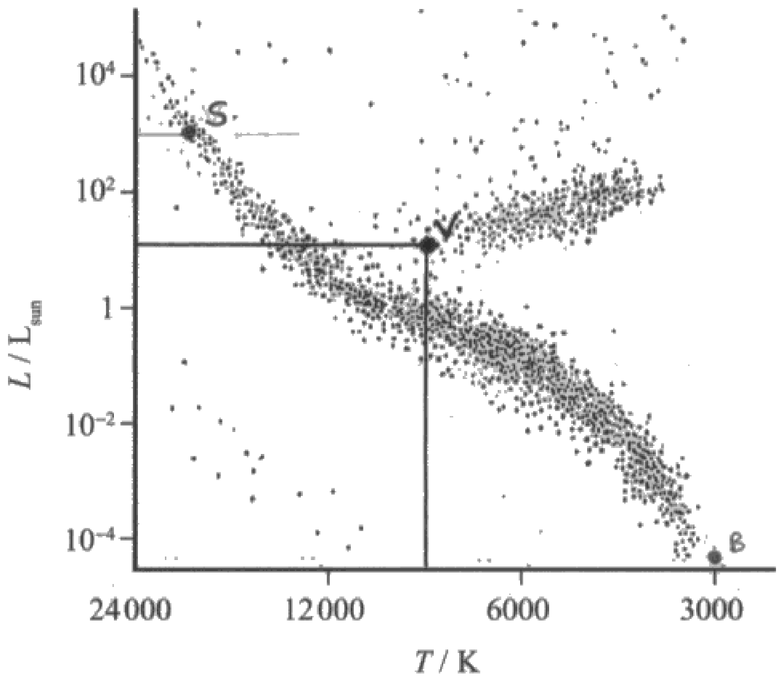
Star	Luminosity / L_{Sun}	Temperature / K	Type of star
Spica (S)	2.25×10^3	22,500	main sequence
Vega (V)	50.1	9,500	red giant
Barnard's Star (B)	4.33×10^{-4}	3,000	Red Dwarf

(a) (i) Complete the table.

(2)

(ii) Use the letters S, V, and B to mark the approximate position of each star on the Hertzsprung-Russell diagram.

(1)



ResultsPlus
Examiner Comments

This response was just at the edge of the region for Vega to be plotted and score 1 mark for (ii). The candidate has placed Vega halfway between 1 and 100 on the luminosity axis, indicating that they are not sure how logarithmic scales work. Perhaps as a result of positioning Vega in the cluster that most candidates would recognise as giant stars, the candidate has identified vega as a red giant in (i).

ResultsPlus
Examiner Tip

Make sure that you can use log scales correctly.

Question 18 (b)

The calculation was carried out successfully by most candidates. Some candidates omitted a unit for the wavelength, which made the value rather meaningless in terms of a range on the em-spectrum. Most candidates just assumed that 970 nm was in the red region of the visible spectrum, rather than being in the infrared region.

(b) By means of a calculation show that Barnard's Star would appear as a red star in the sky.
↑λ.
(3)

$\lambda_{max} T = 2.898 \times 10^{-3}$

$\lambda_{max} = \dfrac{2.898 \times 10^{-3}}{3000} = 9.66 \times 10^{-7}$ m.

this λ (wavelength) falls in the red end of the spectrum.

ResultsPlus
Examiner Comments

A correct calculation for 2 marks, but red rather than infrared identified.

ResultsPlus
Examiner Tip

Consider carefully the magnitude of any numerical quantities that you calculate.

Question 18 (c)

Most candidates were able to use the equation correctly, but the values that they used for the luminosity of Vega were often incorrect. Some candidates used the luminosity of the Sun and some used the 50.1 value given (in terms of the Sun's luminosity) in the question. Some candidates indicated in their substitution that they intended to raise the temperature to the fourth power, but then did not do so when they performed the calculation.

There are two versions of the Stefan-Boltzmann equation quoted in the formula list: $L = 4\pi r^2\sigma T^4$ and $L = A\sigma T^4$. Some candidates chose to use the second equation to find A, but then used $A = \pi r^2$ to find r, hence obtaining an incorrect final answer.

(c) Calculate the radius of Vega.

luminosity of the Sun = 3.85×10^{26} W

(2)

3.85×10^{26} $L = 4\pi r^2 \sigma T^4$

$\sqrt{\dfrac{3.85 \times 10^{26} \times 2.25 \times 10^{3}}{4\pi\sigma(9500)^4}} = r$

$r = 1.22 \times 10^{10}$ m

Radius of Vega = ...

ResultsPlus

Examiner Comments

The answer is incorrect and the "use of" mark cannot be given as the candidate has not substituted a value for the stefan constant into the equation.

Question 18 (d)

Most candidates referred to $F = L/4\pi r^2$, but did not define the symbols used in the equation. Candidates referring to the inverse square law were able to demonstrate a logical argument much more straightforwardly.

(d) Vega appears to be much brighter than Spica in the night sky, although Spica has a much greater luminosity.

Explain why this is the case.

(3)

Vega is much closer to us than Spica and since $F = \frac{L}{4\pi d^2}$, our received radiation flux from Vega will be more than that from Spica, so it appears brighter.

ResultsPlus

Examiner Comments

Just 1 mark here.

ResultsPlus

Examiner Tip

Always remember to define the meanings of symbols that you use in an answer.

Question 19 (a)

This was generally well answered, although there were a significant minority of responses that did not gain both marks. As candidates first start to balance nuclear equations before they meet the content of this unit, maybe it is an aspect of the specification that is overlooked when preparing for the assessment.

Question 19 (b) (i)

The most common response seen was to "account for background radiation" which was insufficient. Candidates needed to communicate the idea that the background count rate was increased due to the presence of background radiation. Many expressed this by stating that the background count rate had to be subtracted from the recorded count rate. Some candidates got close to this by stating that background radiation had to be subtracted from the recorded count rate, but this was not close enough for a mark to be awarded.

Question 19 (b) (ii)

The two alternatives given in the mark scheme were seen quite frequently, although some candidates made reference to the background count rate.

Question 19 (b) (iii)

A number of excellent responses were seen to this question, although some candidates calculated the elapsed time as 66 years instead of 65 years. Some candidates calculated a value for the decay constant, but progressed little further than this. In calculating the decay constant λ, many candidates converted the half-life into seconds, obtaining a value for the λ in s^{-1}. Since they then obtained a value for the time elapsed in s, many converted this back to years. Those candidates who calculated λ in yr^{-1} calculated a value for the age of the sample directly in years.

(iii) Calculate what the corrected activity of 1 m^3 of water from the same pool would have been in 1950. No further water has been added to the pool since 1950.

(4)

$A = A_0 e^{-\lambda t}$ $\lambda = \frac{\ln 2}{T_{\frac{1}{2}}} = \frac{\ln 2}{12.3y}$

$t = 65y$

$A_0 = \frac{A}{e^{-\lambda t}} = \frac{1.08}{e^{\left(-\frac{\ln 2}{12.3} \times 65\right)}} = 42.1\,Bq$

Corrected activity = 42.1 Bq

ResultsPlus
Examiner Comments

This scores all 4 marks.

(iii) Calculate what the corrected activity of 1 m³ of water from the same pool would have been in 1950. No further water has been added to the pool since 1950.

(4)

$T = \overset{6}{\cancel{3}}5y$ $\quad A = A_0 e^{-\lambda t}$

$1.08 = A_0 e^{-\frac{\ln 2}{12.3 \times 365 \times 24 \times 3600} \times 65 \times 365 \times 24 \times 3600}$

$A_0 = 39.7\ \text{Bq}$

Corrected activity = 39.7 Bq

ResultsPlus
Examiner Comments

Although this calculation should yield the correct answer, the candidate makes an arithmetic error and so the final mark is not awarded. This may be as a result of needlessly converting times into seconds.

ResultsPlus
Examiner Tip

Always check if quantities need to be expressed in SI units before you substitute into equations.

Question 19 (c) (i)

This was a very well answered question, with the vast majority of candidates scoring full marks. A small minority of candidates missed out the conversion from u to kg before applying the Einstein energy equation.

(c) Tritium is used in nuclear fusion experiments. A large amount of energy is released in its reaction with deuterium.

$$^{3}H + {}^{2}H \rightarrow {}^{4}He + n$$

Nucleus	Mass / u	
n	1.0087	B
^{2}H	2.0136	C
^{3}H	3.0155	D
^{4}He	4.0015	E

(i) Calculate the energy, in J, released when a tritium nucleus undergoes fusion with a deuterium nucleus.

(4)

$E = mc^2$ mass n = $1.0087 \times 1.66\times10^{-27} = 1.67\times10^{-27}$ kg

$^{2}H = 3.34\times10^{-27}$ kg

$^{3}H = 5.01\times10^{-27}$ kg

$^{4}He = 6.64\times10^{-27}$ kg

$(5.01\times10^{-27} + 3.34\times10^{-27})\times(3\times10^{8})^2 - (6.64\times10^{-27} + 1.67\times10^{-27})$ kg $\times(3\times10^{8})^2$

$7.51\times10^{-10} - 7.49\times10^{-10}$

Energy released = 2.8237 J

ResultsPlus
Examiner Comments

This is a correct solution apart from the power of 10 being omitted from the final answer.

Question 19 (c) (ii)

In answering this question some candidates seemed to be focusing on a particular experiment rather than the conditions for fusion in general. Candidates often did not make reference to the energy needed for nuclei to overcome the electrostatic repulsive forces (hence the need for a very high temperature).

(ii) Explain the conditions necessary for a nuclear fusion experiment to maintain a continuous power output.

(2)

High temperature to overcome the electrostatic ~~attraction~~ repulsion between the nucleus and strong magnetic fields to hold the substance and avoid them touching the container ~~and~~ walls and cool down. A constant supply of Hydrogen isotopes would mean contnus output as density is greater, and so is pressure, which are ~~d~~ also essential.

(Total for Question 19 = 14 marks)

ResultsPlus
Examiner Comments

This response comes close, but does not meet any of the marking points.

ResultsPlus
Examiner Tip

When outlining a process you need to be clear what is happening at each stage. A bulleted list is often helpful.

(ii) Explain the conditions necessary for a nuclear fusion experiment to maintain a continuous power output.

(2)

An extremely high temperature is required for fusion as this gives the molecules enough energy to fuse and also overcome the strong electrostatic repulsion. A high density is also required to maintain a large collision rate and keep the fusion process going.

ResultsPlus
Examiner Comments

There is enough here for MP1 and MP3, and so this response scores full marks.

Paper Summary

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

- Ensure they have a thorough knowledge of the physics for this unit.
- Read the question and answer what is asked.
- For descriptive questions, make a note of the marks and include that number of different physics points.
- Show all their workings in calculations.
- For descriptive questions, try to base the answer around a specific equation which is quoted.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL.