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Examiners' Report
June 2023

Int GCSE Physics 4PH1 2PR

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Introduction

The examination was written to assess across the full range of grades from 1 to 9. Consequently, some questions were written to be challenging whilst others were designed to be more straightforward and accessible. A range of different question types were included in the examination such as objective and multiple choice, calculations and both short and long written responses. Approximately 20% of the marks available in the examination were for candidates demonstrations of experimental skills and understanding. Candidates were provided with a full list of the formulae to be used in this examination.

Successful candidates were well-acquainted with the content of the specification and could recall facts whilst applying their understanding to new and complex situations. They were competent in performing quantitative work and could rearrange and substitute data into given formulae to obtain the correct answer. Successful candidates also showed evidence of undertaking all the required practicals themselves and could produce detailed, coherent methods whilst recalling the relevant results of these experiments.

Less successful candidates showed gaps in their knowledge of topics and either had limited experience or could not recall information from the required practical tasks. These candidates often did not address the demands of the question and overlooked the importance of the command words being used.

Question 1 (a)

Most candidates scored full marks in this straightforward question at the start of the paper. Most errors involved the units of acceleration and moments. The units of power was the most well-known.

Question 1 (b)(i)

Two thirds of all candidates gave suitable descriptions of the difference between scalars and vectors. However, some candidates mixed up vectors and scalars, getting them the wrong way round. Some candidates only stated a fact about vectors but failed to provide a statement on scalars to fully answer the question.

Question 1 (b)(ii)

A great proportion of candidates gained the mark for naming a suitable scalar. Popular answers were speed, mass, and distance. Common amongst the wrong responses were weight, acceleration and velocity.

Question 2 (a)

More than half of all candidates knew that the chemical energy store of the fuel decreases when natural gas is burned.

Question 2 (b)

Most candidates scored at least 2 marks in this question. However, candidates often did not score Mark Point 1 (an advantage of natural gas). Answers were often too generic (low cost, easy to get/make/can be made in large amounts/efficient). Some candidates confused natural gas with biogas and then described it as renewable. Others confused wave power with hydroelectric power or tidal power. Wave power was commonly described as 'renewable' and 'weather dependent' gaining Mark Point 6 and Mark Point 8. Natural gas was usually 'non-renewable' or connected to greenhouse gases.

(b) Burning natural gas and the movement of water waves can both be used to generate electricity.

Discuss the advantages and disadvantages of these two methods of generating electricity.

(4)

~~Natu~~ Burning natural gas can produce sufficient supply of electricity and can generate large amount of energy. Burning natural gas may produce ~~green house~~ greenhouse gases such as CO_2 ~~and~~ causing global warming.
Movement of water waves is renewable and would not damage the environment.
It generates electricity less efficient than burning natural gases.

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Examiner Comments

This response was awarded 2 marks for a disadvantage of natural gas and an advantage of wave power. The comment about gas providing a sufficient supply of electricity is too vague and lacks focus. Similarly, the reference to wave power being less efficient is also too vague.

(b) Burning natural gas and the movement of water waves can both be used to generate electricity.

Discuss the advantages and disadvantages of these two methods of generating electricity.

(4)

Movement of water waves such as ~~includes~~ hydroelectric power ~~and~~ are renewable and doesn't produce greenhouse gases unlike natural gas where greenhouse gas may be produce to cause pollution and is unrenewable. However, movement of water may not be as reliable compared to natural gas ~~as~~ because movement of water generating electricity is dependent on weather and wave speed, while natural gas could be used anytime. Natural gas is more expensive than movement of waterwaves to generate electricity. (Movement of water is cheaper).

ResultsPlus
Examiner Comments

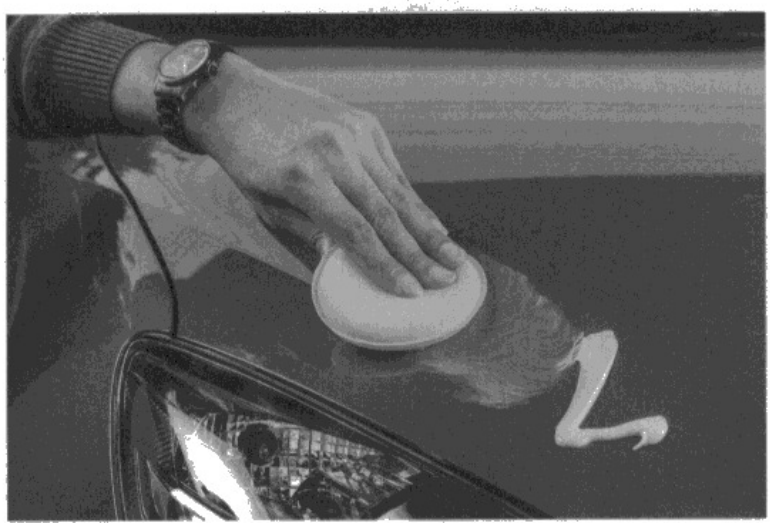
This response was awarded full marks. The candidate has given a suitable advantage and disadvantage for both methods of generating electricity.

Question 3 (a)

Candidates scored marks with an even distribution across the mark range of 0-3 in this question. Marks were commonly earned for 'metal is a conductor/ plastic is an insulator' and for the idea of electrons being transferred. Earthing was sometimes mentioned, but the process of flow of electrons to earth was often not well described. Many candidates tried to answer Mark Point 3 as the sponge being charged and not the plastic.

3 A cleaning product is applied to a car using a sponge pad.

The sponge pad is rubbed against the car to apply the cleaning product.



(a) Some parts of the car are made of metal and other parts are made of plastic.

The metal parts of the car are earthed.

Explain why the pad becomes charged when rubbing the plastic parts, but not when rubbing the metal parts.

(3)

Plastic are insulator, it is bad of condut electricity. When the pad ~~robb~~ rub with that part, electrons will transfer and move, so it will became charged and the charge can't move. However, metals are conductors and they are earthed so electrons can tranfer from earth (or to the), so it will be balanced and it is neutural.

ResultsPlus
Examiner Comments

An excellent response that addresses all four marking points.

Question 3 (b)(i)

The majority of candidates obtained the correct value in this calculation, but often a power of ten error in the unit conversion of mJ to J lead to only 2 marks being awarded. Weaker candidates made mistakes in substitution into the formula E = Q x V or rearranged the formula incorrectly.

(b) The sponge pad is held near a metal post that is connected to the ground.

The sponge pad discharges with a small spark through the air to the metal post.

(i) The sponge pad stores 5.0 mJ of energy in its electrostatic store.

The voltage between the sponge pad and the metal post is 6000 V.

Calculate the charge transferred by the spark.

~~Q x 7~~ $E = Q \times V$. $Q = \frac{E}{V}$. (3)

$\frac{5.0 \times 10^{6}}{6000} = 833.3 \approx 833$

charge transferred = 833 C

ResultsPlus Examiner Comments

This response scored 2 marks. The candidate has mistaken millijoules for megajoules and, therefore, incorporated a power of ten (POT) error in their final answer.

ResultsPlus Examiner Tip

Candidates should know to convert to standard units in calculations. Candidates should be familiar with the prefix milli (m) and know how to convert this into standard units.

(b) The sponge pad is held near a metal post that is connected to the ground.

The sponge pad discharges with a small spark through the air to the metal post.

(i) The sponge pad stores 5.0 mJ of energy in its electrostatic store.

The voltage between the sponge pad and the metal post is 6000 V.

Calculate the charge transferred by the spark.

(3)

$E = QV$

$\frac{5}{1000} = 6000\ Q$

$Q = 8.33 \times 10^{-7}\ C$ #

charge transferred = 8.33×10^{-7} C

ResultsPlus
Examiner Comments

A fully correct answer that was awarded 3 marks.

Question 3 (b)(ii)

Most responses involved bringing the sponge near an uncharged insulator, usually paper pieces, and seeing attraction. However, some candidates described rubbing the sponge with another insulator or bringing near a charged insulator. Weaker candidates confused electrostatics with magnetism.

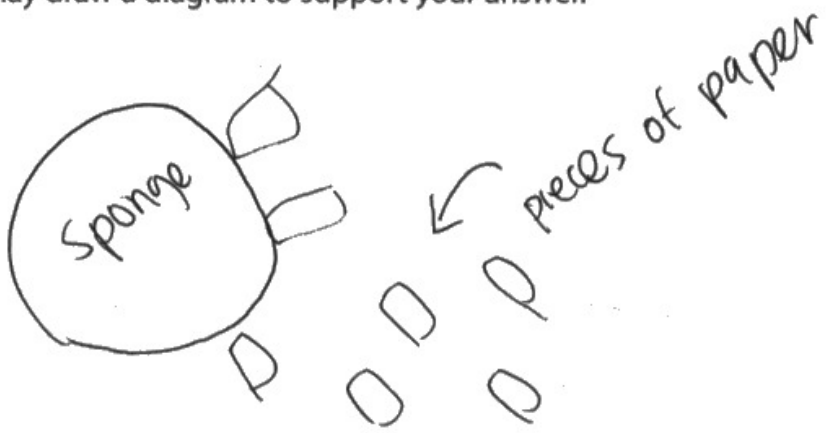
Most candidates who cited the thin water stream test inferred that water was repelled and not attracted to the sponge, which was penalised in the second marking point.

(ii) The small spark between the sponge pad and the metal post demonstrates that the sponge pad is charged.

Describe a different experiment that could demonstrate that the sponge pad is charged.

You may draw a diagram to support your answer.

(2)



- place the charged sponge near pieces of paper that have no charge
- If the sponge is truly charged it would attract the induced opposite charges of the paper, hence why the pieces of paper stick.

ResultsPlus
Examiner Comments

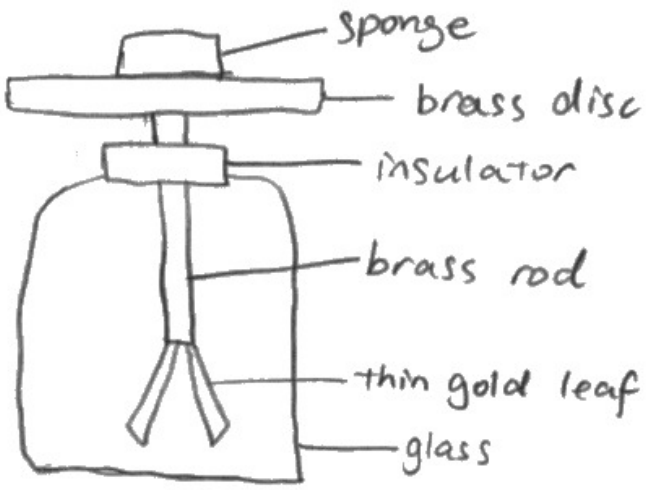
This was a common response. The use of small pieces of paper and observing their attraction to the sponge was sufficient for 2 marks.

(ii) The small spark between the sponge pad and the metal post demonstrates that the sponge pad is charged.

Describe a different experiment that could demonstrate that the sponge pad is charged.

You may draw a diagram to support your answer.

(2)



Use an electroscope. Put the sponge on the brass disc. If the sponge is charged, the two pieces of thin gold leafs would move away from each other.

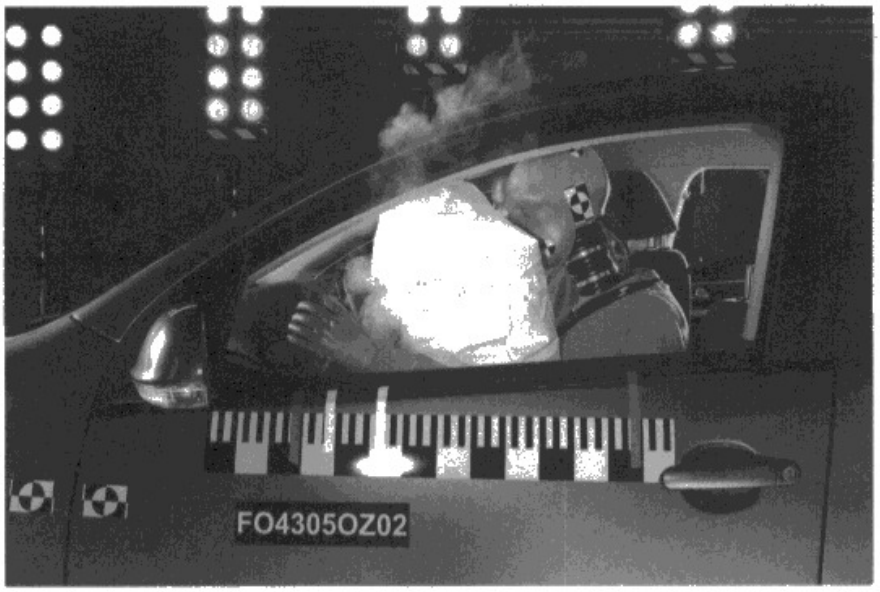
ResultsPlus
Examiner Comments

Some candidates used a gold leaf electroscope in their response. This example shows a suitable process to prove the sponge pad is charged.

Question 4 (a)

The formula in Q04(a)(i) was included in the formula booklet and very few mistakes were made when writing it down. In Q04(a)(ii), the substitution and rearrangement marks were awarded to most candidates. The most common mark lost was for evaluating their answer, and they either gave 78 or 80 as their final response. While 78.5 was accepted, it is incorrect rounding but a lot of candidates gave this as their final answers. Candidates generally had good layout/structure in their responses to show their working.

4 The photograph shows a dummy during a test of the safety features of a car in a collision.



(Source: © fStop Images GmbH/Alamy Stock Photo)

Before the collision, the dummy in the car is travelling at a velocity of 14 m / s.

The dummy has a momentum of 1100 kg m / s.

(a) (i) State the formula linking momentum, mass and velocity.

(1)

momentum = mass x velocity.

(ii) Show that the mass of the dummy is approximately 80 kg.

(3)

$1100 = m \times 14$

$m = \frac{1100}{14}$

$m = 80 (kg.) (2sf.)$ ✱

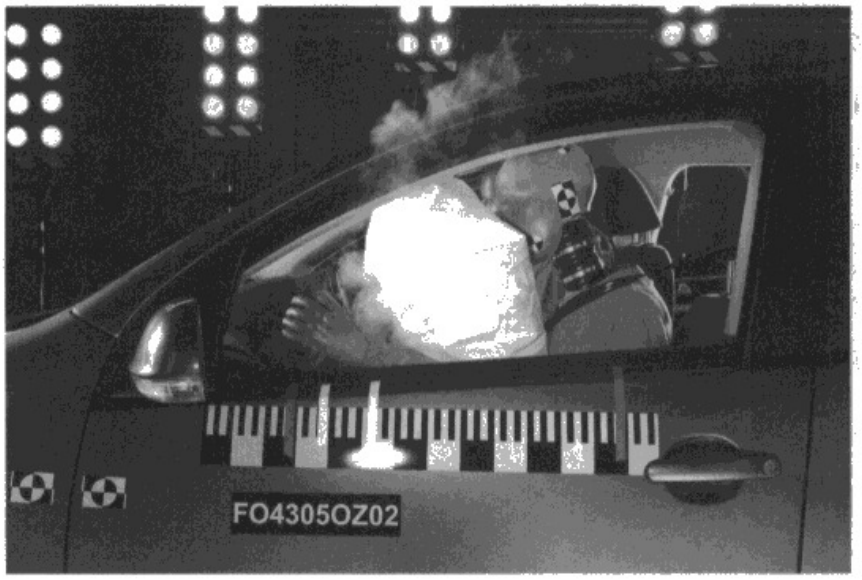
ResultsPlus
Examiner Comments

This candidate only received 2 marks in Q04(a)(ii). Their final evaluation is given to the same number of significant figures as the value given in the question.

ResultsPlus
Examiner Tip

In "show that" style calculations, candidates should evaluate their final answer to more significant figures than the value given in the question so that they can show that this rounds to the given value.

4 The photograph shows a dummy during a test of the safety features of a car in a collision.



(Source: © fStop Images GmbH/Alamy Stock Photo)

Before the collision, the dummy in the car is travelling at a velocity of 14 m/s.

The dummy has a momentum of 1100 kg m/s.

(a) (i) State the formula linking momentum, mass and velocity.

(1)

$p = mv$

(ii) Show that the mass of the dummy is approximately 80 kg.

(3)

$1100 = m \times 14$

$m = \frac{1100}{14}$

$m = 78.6\ kg$

$m = 79\ kg\ (2\ s.f.)$

ResultsPlus
Examiner Comments

This response scored full marks. The working is clearly laid out in Q04(a)(ii) and the final evaluation is given to more significant figures than the value given in the question.

Question 4 (b)

Most candidates submitted a correct numerical answer. Some candidates tried the route of calculating their own momentum change with mixed results. Some candidates confused the letter m (mass) with momentum or forgot to multiply mass by velocity. A small number of powers of ten errors in the decimal conversion of kN to N were seen.

Question 4 (c)

Most candidates scored at least 1 mark for a reference to the collision time being increased by the air bag. However, only the most able candidates were able to score the second mark. The change in momentum was often said to decrease rather than the **rate** of change of momentum. Those candidates who used the formula as the basis of their explanation usually overlooked that momentum change was the same.

There were also many irrelevant discussions about pressure, kinetic energy etc included in candidates' responses.

(c) The car being tested is fitted with airbags.

Using ideas about momentum, explain how an airbag reduces the force experienced by the dummy in the collision.

(2)

Airbags increases the contact time, momentum stays the same.
Force = change in momentum / time.
Force is reduced.

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Examiner Comments

This response scored 1 mark. The candidate has used the formula as the basis of their explanation, but the reference to momentum staying the same is incorrect.

(c) The car being tested is fitted with airbags.

Using ideas about momentum, explain how an airbag reduces the force experienced by the dummy in the collision.

(2)

airbag increases the time taken for momentum to change. Since change in momentum remains the same, and time increases, this reduces the force since $F = m\left(\frac{v-u}{t}\right)$ this decreases rate of change of momentum

ResultsPlus
Examiner Comments

An excellent response that was awarded full marks. The candidate has, again, used the formula as the basis of their explanation and, this time, included a valid reference to the change in momentum being the same (as without an air bag). They have also recognised that this leads to a decreased rate of change of momentum.

Question 5 (a)

Many candidates gave a well-revised response and scored full marks. However, a significant number of candidates tried to describe the variables in the equation and their relationship with mixed levels of clarity. There was often an omission of either the unit mass or unit temperature change.

5 This question is about specific heat capacity.

(a) State what is meant by the term **specific heat capacity**.

(3)

Specific heat capacity is the amount of energy needed to raise the temperature of 1kg of a substance by 1°C (celcius)

ResultsPlus
Examiner Comments

A textbook response that scored full marks.

Question 5 (b)(i)

Most candidates arrived at a value of 3.77 or 3.8°C earning all 3 marks. A few candidates were not able to rearrange the equation and there were occasional decimal rounding errors (3.77 = 3.7).

Question 5 (b)(ii)

Two thirds of all candidates failed to score in this question. Common errors included using the word 'heat' in place of 'energy' for 'energy transfer' and numerous variations of measurement errors being suggested.

Question 6 (a)

Lots of candidates thought copper was magnetic, or just stated it was a conductor. A few tried to talk about electromagnetic induction. Some candidates discussed that the shape of the wire (straight) resulted in circular magnetic fields with no north or south poles. The direction of current wasn't often mentioned, although many candidates stated that the right hand rule could be used to find the direction of the magnetic field if the direction of current was known.

Question 6 (b)(i)

Most candidates did not score in this question. Many wrote about wearing insulating gloves to prevent electric shocks/burns, wearing goggles, not touching wires, earthing equipment/themselves, using fuses and making sure there was no water around the apparatus. Candidates also proposed adding resistors to the circuit and not using maximum currents. There were also quite a few vague responses about staying away from the apparatus.

Question 6 (b)(ii)-(biv)

Candidates performed well in these questions. The majority correctly calculated the mean current and expressed it to three significant figures in Q06(b)(ii). In Q06(b)(iii), some candidates lost marks for choosing inappropriate scales using multiples of 3 whilst others lost marks for not including units with the label on the y-axis. The plotting of the data was usually completed without error.

Lines were mostly drawn well in Q06(b)(iii), although not always with an equal distribution of points around the line.

Question 6 (b)(v)

Many candidates were able to gain 2 marks for demonstrating mathematically (through ratios or gradients etc) that 3A was indeed a reasonable estimate, along the way stating or inferring that 1kg = 1000g. However, only the most able candidates scored a third mark for critically assessing the validity of the extrapolation, but a number of candidates did identify proportionality.

Very few candidates considered whether the presented trend in the data would continue significantly beyond the range of data already shown in the question.

(v) The student predicts that a load of 1.0 kg will fall when the current in the electromagnet is 3.0 A.

Comment on the student's prediction.

(3)

This is a suitable prediction. The line of best fit shows a directly proportional relationship between the mass of the load and the mean current used. One of the results show that a load of 500g will fall at 1.5A. ∴ 500g x 2 = 1000g = 1kg

1.5A x 2 = 3A

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Examiner Comments

An excellent answer that was awarded 3 marks.

Question 7 (a)

Most candidates scored full marks in this question. Most were aware that options A and F were beyond the range of human hearing, but some candidates did not tick all of the boxes B-E and so only scored 1 mark.

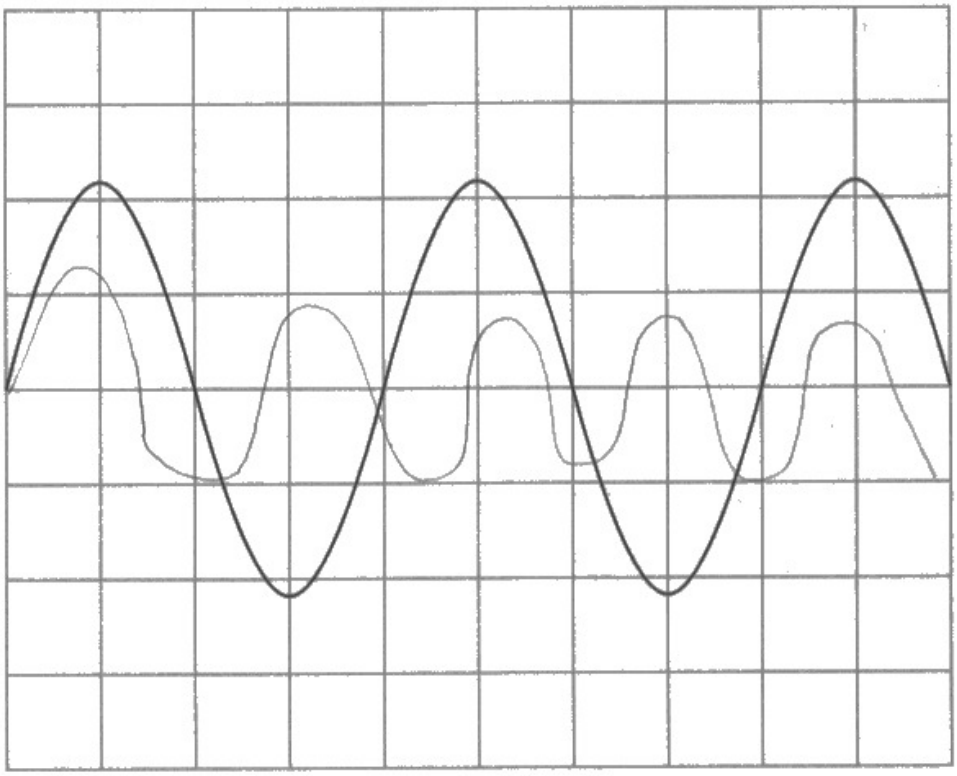
Question 7 (b)

Most candidates produced suitable wave form sketches to score full marks. The most common error was not having a longer wavelength for the lower pitch sound. Some candidates did not take enough care over their sketch, which presented problems when assessing whether their wave had a lower frequency than the original wave.

(b) The diagram shows the screen of an oscilloscope when a sound wave is detected.

Add to the diagram by drawing the trace of another sound wave that has a lower pitch and is quieter than the sound wave shown.

(2)



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Examiner Comments

This response scored 1 mark for the first marking point. The frequency is not constant but it is consistently higher than the original wave.

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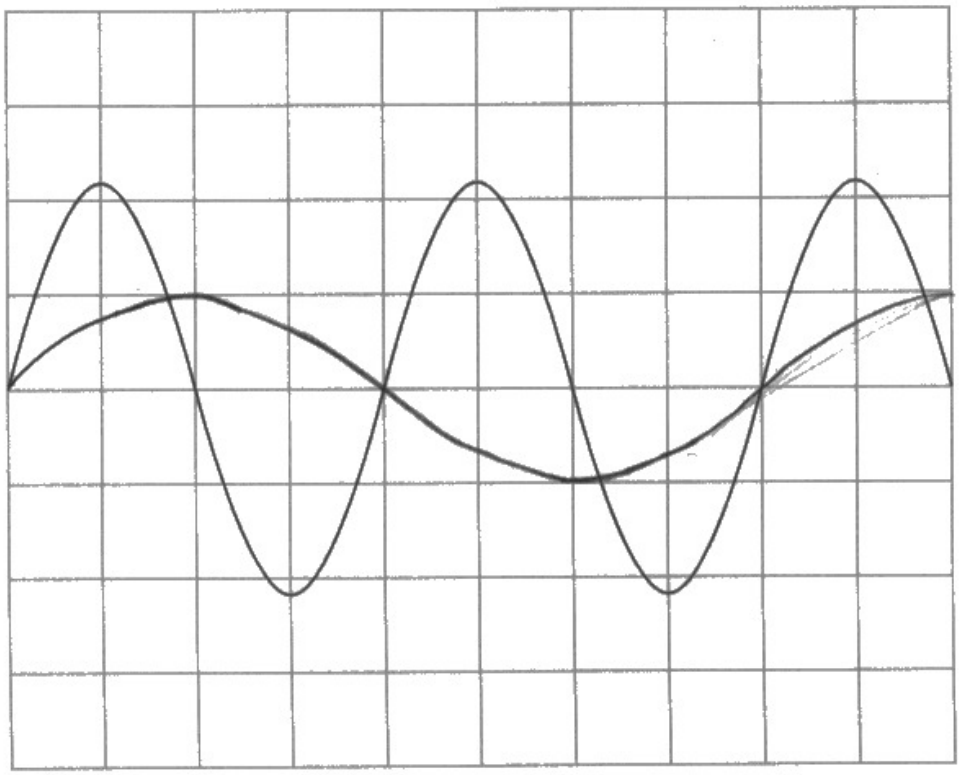
Examiner Tip

Candidates should take care when drawing waveforms on oscilloscopes. The grid can be used to provide reference points for drawing accurate waves.

(b) The diagram shows the screen of an oscilloscope when a sound wave is detected.

Add to the diagram by drawing the trace of another sound wave that has a lower pitch and is quieter than the sound wave shown.

(2)



(b)

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Examiner Comments

An excellent response that scored 2 marks. The wave has been drawn carefully using the grid to guide the sketching.

Question 7 (c)

It was pleasing to see candidates make strong attempts at these linked calculations and most candidates scored full marks. Some candidates did not convert the temperature into kelvin in Q07(c)(i), which lost them one mark. Weaker candidates experienced difficulties rearranging the formula in Q07(c)(ii).

(c) The speed of sound in air varies with temperature.

A student finds a formula in a textbook that links the speed of sound waves in air to the temperature of the air, measured in kelvin.

speed of sound in air = (0.606 × temperature in kelvin) + 166

(i) Calculate the speed of sound when the air temperature is 46 °C.

(2)

$(0.606 \times 46°C) + 166 = 193.876\ m/s$

speed of sound = 193.876 m/s

(ii) Calculate the wavelength of a sound wave with a frequency of 15 000 Hz when the air temperature is 46 °C.

(3)

$f = \frac{v}{\lambda}$

$\lambda = \frac{v}{f} = \frac{193.876\ m/s}{15000\ Hz} = 0.013\ m$

wavelength = 0.013 m

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Examiner Comments

This candidate only scored 1 mark in Q07(c)(i). However, they have used their answer correctly in Q07(c)(ii) to score two marks in this part.

Question 8 (a)(i)

Only a third of all candidates scored the mark in this question. Incorrect responses were most often focussing on comparing the two stars using the data from the table, eg discussing colour, mass or absolute magnitude. Lots of candidates tried to talk about red shift. Another incorrect response, though less frequent, was getting the distances the wrong way round, eg A is further away, or only saying that the distances were different without elaborating.

Question 8 (a)(ii)

Most candidates correctly identified D as the supernova and this was their only mark. Very few candidates expressed that the star had (much) more mass than the sun, often identifying it as 'bigger than the sun', 'large', and 'the largest' or 'has the most mass'. The comparison to the sun was required for the mark.

The correct interpretation of the absolute magnitude figure was expressed by only a very few candidates. If discussed at all, it was usually interpreted as the lower (more negative) the figure, the dimmer (cooler) the star is. Some candidates thought that a negative figure meant the star was receding from the earth.

Many candidates incorporated irrelevant ideas about colour and temperature in their answer, which limited the number of marks to two.

(ii) **Using information from the table, explain which star is in the supernova stage of its evolution.**

(3)

D. Because it has the largest solar mass which is larger than than the mass of the sun. Only stars will mass larger than sun will turn into supernova, stars A, B, C will turn into white dwarf. D also has the lowest absolute magnitude which means it is brightest

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Examiner Comments

This response was awarded full marks. The candidate has provided a comprehensive justification of why star D is in the supernova stage of its evolution.

Question 8 (b)

There were numerous independent marking points available for this three-mark question which meant that most candidates scored something, and many scored well, even for relatively succinct answers. Most marks were scored for the idea of hydrogen running out/fusion stopping and for an explosion (supernova). Red super giants were commonly mentioned as well.

However, the sequence of events was often confused. **Core** collapse/contraction was rarely mentioned (usually star contracts/star collapses). There was much discussion about the variously described inwards and outwards forces at different stages of the sequence, which was often correct but not relevant detail. Most candidates that mentioned helium fusion placed it correctly at the red super giant phase.

Fusion of intermediate mass elements at the end of helium fusion was almost never referenced, although some candidates mentioned the iron mass limiter prior to supernova. Core collapse and fusion of heavier elements prior to supernova explosion was rarely mentioned.

(b) Explain how a main sequence star evolves into a supernova.

(3)

Once the main sequence of a stars life has ended, after fusing all of the available hydrogen nuclei within the star, gravity begins to once again push into the star causing the pressures to reach so high that ~~at nuclei larger than hydro~~ helium nuclei begin fusing to form carbon, although its larger than hydrogen, creating a Red Super giant star. Once this phase is complete, the star will explode into a supernova.

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Examiner Comments

This comprehensive response shows a strong understanding of the sequence of events between the main sequence and supernova stages of a star's evolution.

Question 8 (c)(i)

It was very encouraging to see more than half of all candidates score at least 3 marks in this challenging calculation. However, the use of the wrong reference wavelength limited the number of marks awarded to 3. Weaker candidates exhibited problems when rearranging the formula or not knowing how to calculate the change in wavelength.

(c) Astronomers have used supernovas in distant galaxies to investigate the expansion of the universe.

(i) Light emitted from a supernova at a wavelength of 7.774×10^{-7} m was detected at Earth with a wavelength of 7.780×10^{-7} m.

Calculate the speed at which the galaxy containing this supernova was moving away from the Earth.

[speed of light = 3.0×10^{8} m/s]

(4)

$$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$$

$$\frac{7.774 \times 10^{-7} - 7.780 \times 10^{-7}}{7.780 \times 10^{-7}} = \frac{v}{3.0 \times 10^{8}}$$

$$v = 231400 \text{ (4 sf)}$$

speed = 231400 (4sf.) m/s

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This response scored 3 marks. The candidate's only error was using the incorrect value for the reference wavelength.

(c) Astronomers have used supernovas in distant galaxies to investigate the expansion of the universe.

(i) Light emitted from a supernova at a wavelength of 7.774×10^{-7} m was detected at Earth with a wavelength of 7.780×10^{-7} m.

Calculate the speed at which the galaxy containing this supernova was moving away from the Earth.

[speed of light = 3.0×10^{8} m/s]

(4)

$$\frac{7.780\times10^{-7} - 7.774\times10^{-7}}{7.774\times10^{-7}} \times 3.0\times10^{8}$$

$= 231541$ m/s

$= 232000$ (m/s) (3s.f)

speed = 232000 (3s.f) m/s

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A fully correct answer, which was awarded 4 marks.

Question 8 (c)(ii)

This question differentiated well and proved challenging to most candidates. The most common misunderstanding seemed to be that candidates did not differentiate between the amount of **change** in wavelength and the actual wavelength itself when describing the amount of red shift. A typical statement would be 'light from distant galaxies has a longer wavelength', which was given in the question. Marks were frequently awarded for the isolated statements that 'the universe is expanding' and 'was once at a single point', although the connection to the evidence for these assertions were not explicit.

(ii) The astronomers investigated supernovas that showed a red-shift in the wavelengths detected in different galaxies.

The astronomers discovered that the red-shifted light detected from supernovas in nearby galaxies had shorter wavelengths than the red-shifted light detected from supernovas in galaxies further away.

Explain how this discovery supports the Big Bang theory.

(4)

The red-shifted light detected from supernovas in nearby galaxies had shorter wavelengths shows that the galaxies are moving away from us and due to Doppler effect, we observed the discovery. That means the whole universe ~~is~~ was at one single point at first, but then it started to expand and galaxies are moving away from each other, which supports the Big Bang theory.

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This response scored 2 marks for the ideas that the universe is expanding and originated from a single point. The candidate has not linked the information given in the question to justify why the universe is expanding.

(ii) The astronomers investigated supernovas that showed a red-shift in the wavelengths detected in different galaxies.

The astronomers discovered that the red-shifted light detected from supernovas in nearby galaxies had shorter wavelengths than the red-shifted light detected from supernovas in galaxies further away.

Explain how this discovery supports the Big Bang theory.

(4)

The further the distance of galaxy, the greater the red shift. The greather the red shift, the faster the galaxies are moving away. This means distance of the galaxy is directly proportionate to speed of the galaxs moving. as wavelengths are increasing. This shows galaxies moving away. This shows that universe is expanding. It also shows universe started from a single point in time, a long time ago.

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Examiner Comments

This excellent response uses the information given in the question to justify that the universe must be expanding. The response scored full marks.

Paper Summary

Based on their performance on this paper, candidates should:

- Take note of the number of marks available for each question and use this as a guide for the amount of detail expected in the answer.
- Take note of the command word used in each question to determine how the examiner expects the question to be answered, for example, whether to give a description or an explanation.
- Be able to use the formulae listed in the specification confidently in terms of substitution, rearrangement and evaluation.
- Know the SI units for physical quantities and be able to convert from non-SI units to SI units when required.
- Show all working so that some credit can still be given for answers that are only partly correct.
- Take advantage of opportunities to draw labelled diagrams as well as, or instead of, written answers.

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