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Examiners' Report
June 2019

IGCSE Single Science 4SS0 1P

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Introduction

This was the first Physics examination for the new International GCSE Single Award Science qualification. Questions were set to assess candidates' knowledge, understanding and application of Physics from all eight topics in the specification. The statements in these topics have been taken from the Double Award specification.

- Topic 1 - Forces and Motion.
- Topic 2 - Electricity.
- Topic 3 - Waves.
- Topic 4 - Energy, Resources and Energy Transfer.
- Topic 5 - Solids, Liquids and Gases.
- Topic 6 - Magnetism and Electromagnetism.
- Topic 7 - Radioactivity and Particles.
- Topic 8 - Astrophysics.

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.

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, could recall relevant formulae and rearrange these 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)

The majority of candidates could interpret the symbol for gallium-67 to extract the correct number of protons and neutrons. A small number of candidates thought that the mass number gave the number of neutrons and, therefore, only scored 1 mark.

Question 1 (b)

Most candidates struggled to explain why a gamma-emiting source would be effective as a medical tracer. Less than half of all candidates communicated that it is the high penetrating ability of gamma that makes it effective and only the most able went further to explain that this meant it could be detected outside of the body.

(b) When gallium-67 decays it emits gamma radiation.

Explain why this makes it an effective medical tracer.

(2)

Gamma radiation has low ionizing power ~~but~~ and is used in medical treatment to treat cancer and mutate cells, gallium-67 can be used to do this as it has high penetration power and range.

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Examiner Comments

This candidate has given several properties of gamma radiation, but has included its high penetration power to score 1 mark.

(b) When gallium-67 decays it emits gamma radiation.

Explain why this makes it an effective medical tracer.

(2)

Gamma radiation has a long range as it has high penetrative power so it can be detected from outside the body.

ResultsPlus
Examiner Comments

This is an excellent response that scored 2 marks. The high penetration of gamma radiation is referred to and correctly linked to it being detectable outside of the body.

Question 1 (c)

Candidates were required to apply their knowledge of isotopes in Q01(c) and most knew that gallium-68 had more neutrons than gallium-67. Some candidates stated that gallium-68 had more neutrons and protons, which was not given credit. Only the most able gave a further detail in their description by recognising that gallium-68 has **one** more neutron than gallium-67.

(c) Gallium-68 is another radioactive isotope of gallium that can be used as a medical tracer.

Describe the difference between the nucleus of gallium-68 and the nucleus of gallium-67.

(2)

The nucleus of gallium-68 has more neutrons than gallium-67. Gallium-68 is bigger than gallium-67.

ResultsPlus
Examiner Comments

This response received the first mark only.

(c) Gallium-68 is another radioactive isotope of gallium that can be used as a medical tracer.

Describe the difference between the nucleus of gallium-68 and the nucleus of gallium-67.

(2)

Gallium 68 - has one more neutrons than Gallium 67. Making Gallium-68 bigger.

ResultsPlus
Examiner Comments

This response contains the necessary additional detail to be awarded 2 marks.

ResultsPlus
Examiner Tip

When 'describe' is used as the command word the examiner is looking for details to award more marks.

Question 2 (a)

Candidates struggled with this application of x-rays and less than half chose the correct word to complete these sentences.

Question 2 (b)

A large number of candidates thought that the patient was safe in Q02(b) because the film absorbed the x-rays so they were not exposed to them. Other candidates thought that the presence of the dentist in the room would affect the quality of the image produced by the x-rays. Neither of these suggestions were given credit. A third of all candidates recognised that x-rays were harmful and clarified this with an appropriate hazard, eg causing cell damage or cancer. Some candidates knew that the dentist's exposure to x-rays would be far greater due to taking multiple x-rays and these candidates were awarded the second mark.

(b) Explain why the dentist has to leave the room before taking the x-ray image but it is safe for the patient to stay in the room.

(2)

The reason why is because the dentist might get exposure by gamma radiation, which mutation cells, causes ~~which~~ cancer.

ResultsPlus
Examiner Comments

This candidate was awarded 1 mark for the correctly named hazard of x-rays, but they did not fully explain why the risk to the dentist is greater.

(b) Explain why the dentist has to leave the room before taking the x-ray image but it is safe for the patient to stay in the room.

(2)

The dentist will be exposed to the x-rays more times than the patient so will leave as it is safer.

ResultsPlus
Examiner Comments

This candidate understood that the risk to the dentist is greater due to their greater exposure, but fails to give a hazard of x-rays. The response scored 1 mark only.

(b) Explain why the dentist has to leave the room before taking the x-ray image but it is safe for the patient to stay in the room.

(2)

The dentist constantly takes x-rays and with prolongued use, can cause cancer or mutation. The patient is subjected to x-rays for a very short time and is at a much lower risk due to this. When he leaves the room, the x-rays will not effect him.

ResultsPlus
Examiner Comments

This response comprehensively answers the question and was awarded 2 marks.

Question 2 (c) (i)

The majority of candidates knew the formula linking wave speed, frequency and wavelength. Some candidates could not be given the mark due to expressing the formula as a triangle (useful for revision, but mathematically invalid), or using non-standard symbols.

(c) The x-rays used have a frequency of 3.5×10^{16} Hz.

(i) State the formula linking wave speed, frequency and wavelength.

(1)

$$f = \frac{WS}{WL}$$

ResultsPlus
Examiner Comments

This response was not given any credit due to the use of non-standard symbols.

ResultsPlus
Examiner Tip

If candidates are unsure which symbols to use they should write formulae using words instead. Non-standard symbols will not be given credit.

(c) The x-rays used have a frequency of 3.5×10^{16} Hz.

(i) State the formula linking wave speed, frequency and wavelength.

(1)

$$v = f \times \lambda$$

wave speed = frequency x wavelength.

ResultsPlus
Examiner Comments

This candidate has written the formula in words and in symbols. Both versions are correct, so the mark was given.

Question 2 (c) (ii)

More than half of all candidates did not gain any credit in Q02(c)(ii) due to using an incorrect formula. The most successful candidates rearranged the relevant formula correctly and handled the data given in standard form to obtain the correct final answer. A significant number of candidates used their calculator incorrectly when dividing numbers in standard form and their answers contained a power of ten error, limiting them to 2 marks.

(ii) X-rays have a speed of 3.0×10^8 m/s.

Calculate the wavelength of these x-rays.

(3)

$$\text{wavelength} = \frac{\text{wave speed}}{\text{frequency}}$$

$$= \frac{3.0 \times 10^8}{3.5 \times 10^{16}}$$

$$= 8.57 \times 10^{23}$$

wavelength = 8.57×10^{23} m

ResultsPlus
Examiner Comments

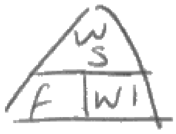
This response scored 2 marks. All of the candidate's working is correct but they have used their calculator incorrectly when evaluating the final answer.

ResultsPlus
Examiner Tip

Candidates should be familiar with using their calculator to process data given in standard form.

(ii) X-rays have a speed of 3.0×10^8 m/s.

Calculate the wavelength of these x-rays.



(3)

$$\text{wavelength} = \frac{3.0 \times 10^8}{3.5 \times 10^{16}} \rightarrow 300000000$$

$$= 8.57 \times 10^{-9}$$

wavelength = 8.57×10^{-9} m

ResultsPlus
Examiner Comments

A fully correct solution that scored 3 marks.

Question 2 (d)

Candidates who were awarded the first mark in Q02(d) most frequently referred to speed, or transverse waves. Where this was not awarded it was due to the candidate simply repeating the stem of the question.

The second mark was awarded more often. Most candidates remembered that x-rays have the highest frequency. The mark was not awarded when candidates discussed the different uses rather than properties. In some cases where wavelength or frequency was compared this was the wrong way around, eg x-rays having a longer wavelength than radio.

(d) X-rays are electromagnetic waves.

Radio waves are also electromagnetic waves.

State one other similarity and one difference between x-rays and radio waves.

(2)

similarity same wave speed in a vaccum

difference different wavelengths where radio waves have a longer wavelength than x rays.

ResultsPlus
Examiner Comments

This candidate has given a valid similarity and difference to score 2 marks.

(d) X-rays are electromagnetic waves.

Radio waves are also electromagnetic waves.

State one other similarity and one difference between x-rays and radio waves.

(2)

similarity Both electromagnetic waves are transverse waves.

difference Radio waves are not harmful where as x-ray are harmful.

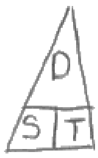
ResultsPlus
Examiner Comments

This candidate has given an alternative, but equally valid, similarity and difference to also score 2 marks.

Question 3 (a) (i)

The majority of candidates knew the formula linking speed, distance and time. Candidates who were not awarded the mark usually gave an incorrect rearrangement of the formula.

(a) (i) State the formula linking average speed, distance moved and time taken. **(1)**



ResultsPlus
Examiner Comments

Triangles such as this are a useful tool for revision and rearranging formulae, but will not be awarded the mark when the formula itself is requested. This response scored 0 marks.

(a) (i) State the formula linking average speed, distance moved and time taken. **(1)**

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

ResultsPlus
Examiner Comments

This response scored 1 mark.

Question 3 (a) (ii)

Most candidates were awarded at least 1 mark for reading a correct pair of values from the graph. However, most candidates did not notice that the line on the graph did not start from the origin and, therefore, were limited to a maximum of 2 marks. Most candidates understood that their unit had to match the quantities used in their calculation, but a significant number of candidates expressed kilometres per minute as km/m, which was not given credit.

(ii) Calculate the average speed of the aeroplane during this part of its journey.

Give a suitable unit.

(4)

distanced moved from 300 to 700

distance = 400

Time taken = 60 − 30 = 30

Speed = $\frac{400}{30}$

average speed = 13.33 unit km/m

ResultsPlus
Examiner Comments

This response scored 3 marks. The candidate has read the information from the graph correctly and used it to obtain the correct value of speed expressed in kilometres per minute. However, the symbols used are not acceptable and the candidate was not awarded the mark for their unit.

ResultsPlus
Examiner Tip

Candidates should only use symbols if they are sure the symbols are correct.

(ii) Calculate the average speed of the aeroplane during this part of its journey.

Give a suitable unit. **(4)**

300 to 700 = 400 km

30 to 60 = 30 minutes

400 ÷ 30

average speed = 13.3̇ unit km/minute

ResultsPlus
Examiner Comments

This response was awarded all 4 marks. In this response the unit is correct as the candidate has written minutes as a word, rather than using an incorrect symbol.

(ii) Calculate the average speed of the aeroplane during this part of its journey.

Give a suitable unit. **(4)**

Speed = $\frac{400 \text{ km}}{30 \text{ mins}}$ ∴ 400 km = $\frac{400000 \text{ m}}{1800 \text{ s}}$

$\frac{400000 \text{ m}}{1800 \text{ s}}$ = 222.2̇

average speed = 222.2̇ unit m/s

ResultsPlus
Examiner Comments

This response also scored all 4 marks. The candidate has unnecessarily converted the units of the quantities into metres and seconds, but their given unit is consistent with these.

ResultsPlus

Examiner Tip

When given the opportunity to include their own unit with a calculation, candidates should keep their working as simple as possible and only convert units if absolutely necessary.

Question 3 (b)

Q03(b) was answered poorly by a significant number of candidates who misinterpreted the question and did not actually refer to pressure in their answers. Other candidates thought that temperature and pressure had an inverse relationship and, therefore, stated that the pressure would decrease. The more successful candidates understood that the pressure would increase as the height decreased and the most able candidates could offer some reasons as to why this happened. These candidates often referred to the speed of air particles increasing as the temperature increased, but the idea of them colliding more often with the aeroplane was rarely seen.

(b) During the flight, the height of the aeroplane decreases.

As the height of the aeroplane decreases, the temperature outside the aeroplane increases.

Explain how the air pressure outside the aeroplane changes as the height of the aeroplane decreases.

(3)

As the height of the aeroplanes decreases, the temperature increases. Therefore, the air pressure outside the aeroplane increases because the particles in the air gain kinetic energy and start to collide with eachother and hit the aeroplane at a higher rate than before. Thus, pressure increases as the height of the aeroplane decreases

ResultsPlus
Examiner Comments

This is a high level response that was awarded 3 marks. The candidate knows that the pressure will increase and goes further to give a comprehensive explanation as to why this happens.

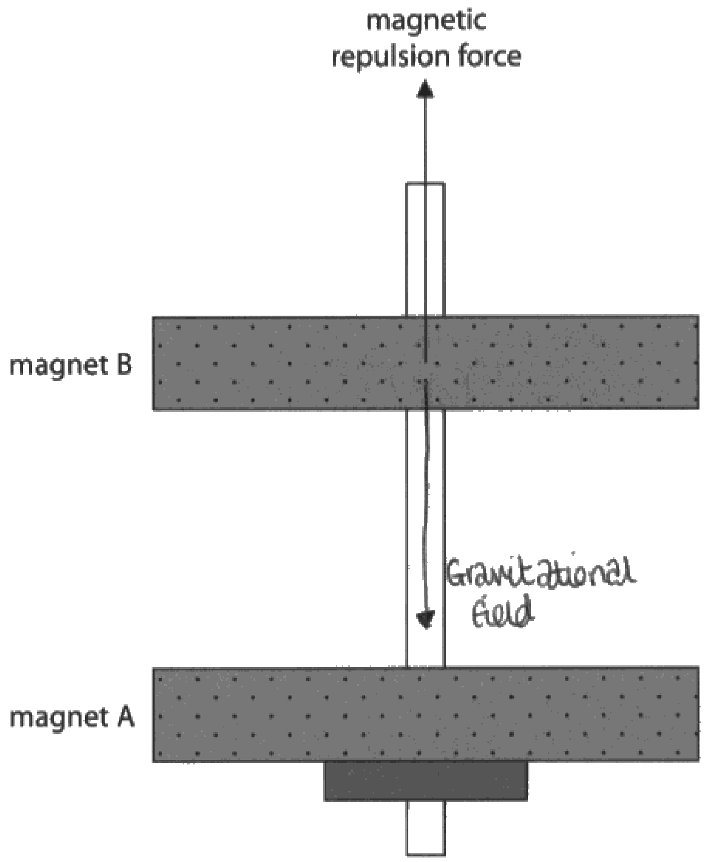
Question 4 (a)

Q04(a) discriminated well and most candidates were able to score at least 1 mark for recognising how the energy stores of the magnet differed from when it was at the top of the shaft.

Question 4 (b)

Very few candidates were able to score both marks in this question. Although most candidates understood that the other force acting on the magnet should be downwards, the name of this force was not well known. Many candidates simply labelled it as 'gravity', which was not given credit. Only the most able candidates understood that the forces on the magnet should be balanced and, therefore, that their downwards arrow should be the same length as the upwards arrow.

(b) This is a diagram of the toy shown in photograph 1.



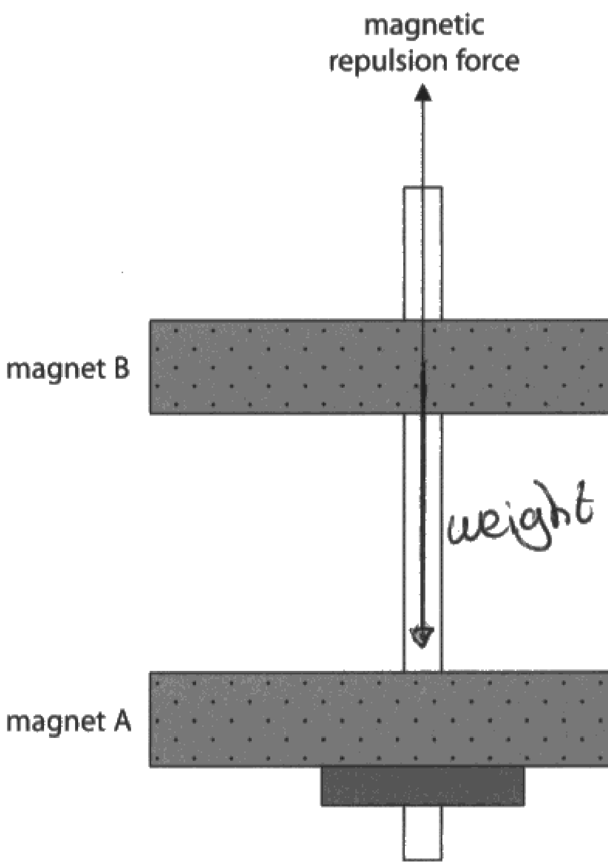
One of the forces acting on magnet B is shown.

Draw another labelled arrow on the diagram to show the other force acting on magnet B.

ResultsPlus
Examiner Comments

This response scored 1 mark. The length of the downwards arrow is correct, but it has not been named correctly.

(b) This is a diagram of the toy shown in photograph 1.



One of the forces acting on magnet B is shown.

Draw another labelled arrow on the diagram to show the other force acting on magnet B.

ResultsPlus
Examiner Comments

This response scored 2 marks. The downwards force is correctly named and the length of the force arrow is equal to the upwards force arrow.

ResultsPlus
Examiner Tip

Candidates should be aware that the length of force arrows represents the size of the force.

Question 4 (c)

Q04(c) discriminated well between candidates and most candidates were able to score at least 1 mark, usually for knowing that a ruler would be required in the investigation. There was some confusion surrounding the identification of the independent and dependent variables, but the more successful candidates communicated their understanding of these well. A significant number of candidates suggested to take repeat readings and to plot a graph, which earned them additional marks. Some candidates used the opportunity to draw a diagram to great effect and pieces of equipment were frequently credited when seen in the diagram, even if they had not been referred to in the written part of the response.

(c) The student adds a 10 g mass on top of magnet B when it is stationary above magnet A and observes that the distance between the magnets decreases.

He carries out an investigation to see how the distance changes as more masses are added.

Describe a method for the student's investigation.

In your answer, you should refer to

- the measuring equipment required
- the independent and dependent variables
- a way to check the reliability of the data

You may draw a diagram to help your answer.

(5)

The measuring equipment that should be use in this investigation is a ruler. ~~Check~~ ~~to~~ measure the height of the gap between magnet A and B before the mass was added. measure the amount of mass added towards the toy in each stage. Meareure the height of the gap between the magnets after more masses are added. Stop when the gap is completely filled. The independent variable of this experiment is the amount of mass added and the depended variable is the distance between the magnets. Inorder to check the reliability of the data repeat the experiment.

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Examiner Comments

This response scored 3 marks. Mark point 1 was awarded for the use of a ruler, mark point 4 was awarded for the correct identification of the independent variable and mark point 5 was awarded for the correct identification of the dependent variable. Although the candidate has mentioned repeating the experiment, there is no mention of obtaining mean values or identifying anomalies. The response could be improved by naming additional equipment (possibly in a diagram), and addressing the third bullet point in the question to a higher standard.

ResultsPlus
Examiner Tip

If candidates are given the option of drawing a diagram, especially in an experimental method, they should attempt to draw one. Marks can be awarded from the diagram as well as the written part of the response.

(c) The student adds a 10 g mass on top of magnet B when it is stationary above magnet A and observes that the distance between the magnets decreases.

He carries out an investigation to see how the distance changes as more masses are added.

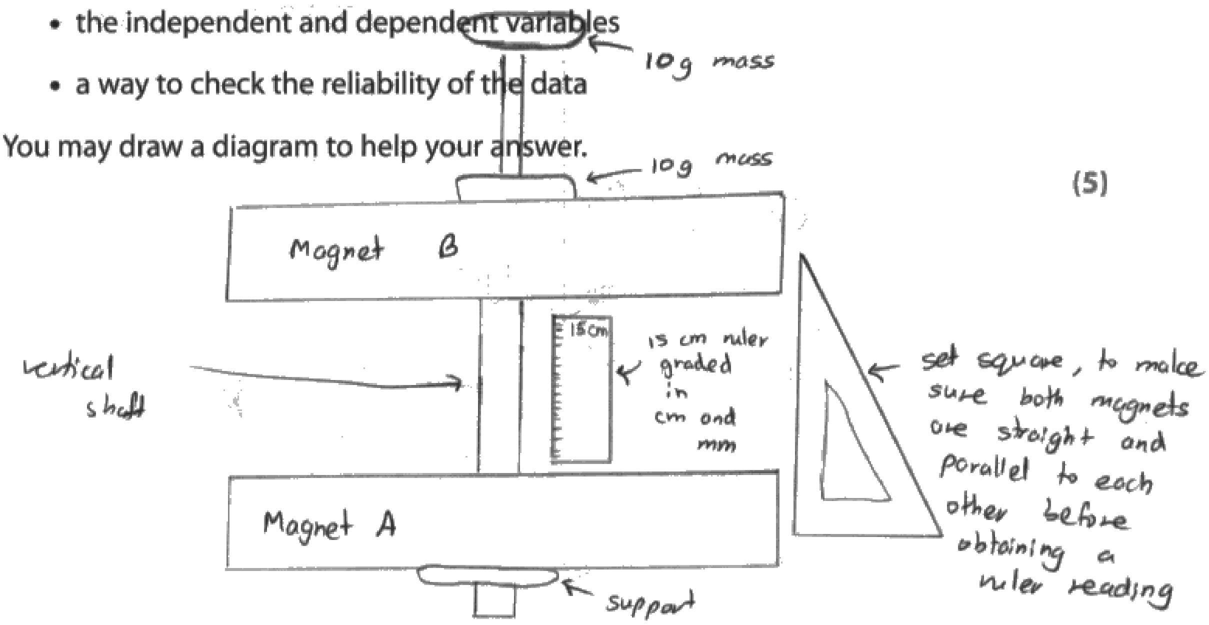
Describe a method for the student's investigation.

In your answer, you should refer to

- the measuring equipment required
- the independent and dependent variables
- a way to check the reliability of the data

You may draw a diagram to help your answer.

(5)



The students needs to note down the distance between the 2 magnets A and B each time he adds a 10g weight using a ruler graded in cm and mm. His results should be written down in cm accurate to the nearest 1 dp. The independent variable is the mass on top of magnet B while the dependent variable is the distance between the two magnets. He should repeat the reading for each 10 g mass thrice and obtain an average distance moved. He should place the mass carefully without dropping it onto the magnet and he should not consider anomaly reading when obtaining an average. He can use a set square to make sure the magnets are parallel. After obtaining an average he should plot a line graph. He needs to ~~repeat~~ keep adding masses until the magnets touch each other or until 100g (10 masses). The graph would be a non-linear relationship as it would be in a curve.

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Examiner Comments

This response scored 5 marks and is a good example of a comprehensive method. The diagram immediately scores mark point 1 and mark point 3 for the use of a ruler and set square. Mark point 4 and mark point 5 are also awarded for the correct identification of the independent and dependent variables. The candidate also scores mark point 6 and mark point 7 for their suggestion of repeating the readings to obtain an average and plotting a graph of their results.

(c) The student adds a 10 g mass on top of magnet B when it is stationary above magnet A and observes that the distance between the magnets decreases.

He carries out an investigation to see how the distance changes as more masses are added.

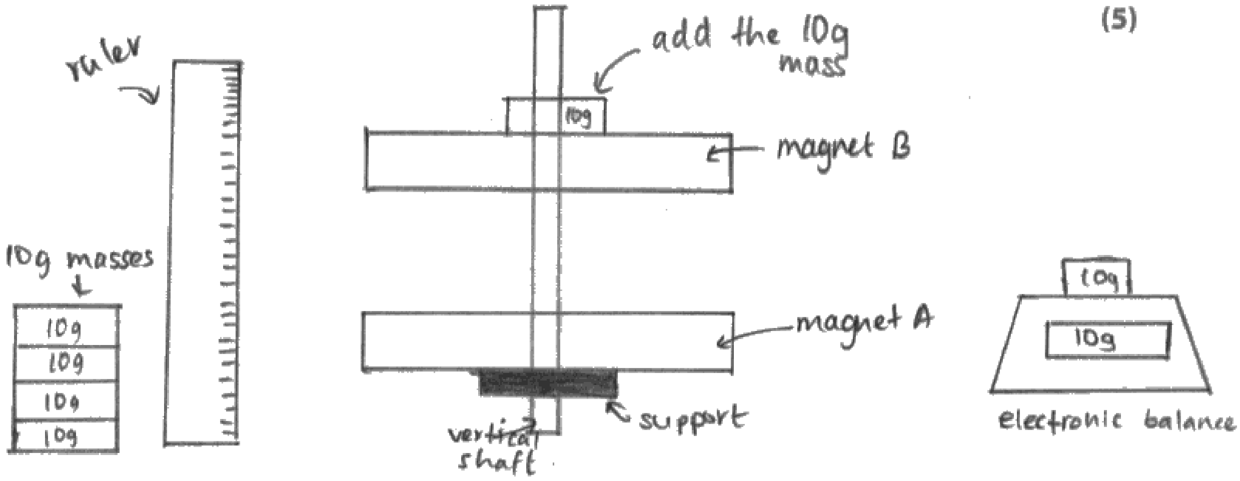
Describe a method for the student's investigation.

In your answer, you should refer to

mass
- the measuring equipment required — distance
- the independent and dependent variables
- a way to check the reliability of the data

You may draw a diagram to help your answer.

(5)



Take the mass and the weigh it. Use the 10g masses and place it over magnet B. Place 10g by 10g, and record the distance between the two magnets. You can use a ruler with markings in centimetres to measure the distance. The independent variable will be the amount mass added and the dependent variable will be the distance between the two magnets (magnet A and B). This experiment can be repeated with each mass and the distance can be measured. In the end you can find the average distance for each mass added to make your data more reliable.

ResultsPlus
Examiner Comments

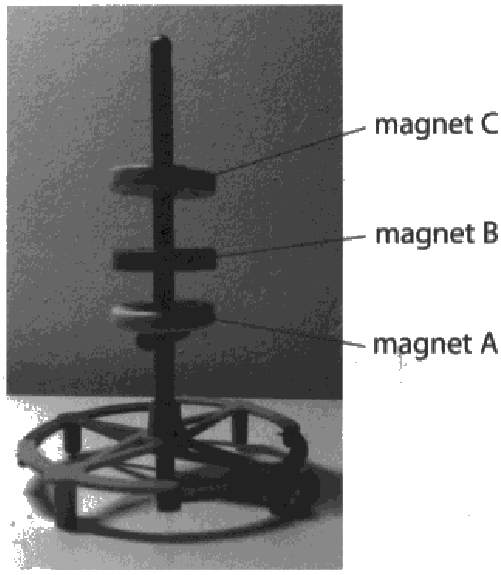
This response also scored 5 marks. The diagram scores mark point 1 and mark point 2 for the clear use of a ruler and a balance. The variables are correctly identified to score mark point 4 and mark point 5. Mark point 6 is awarded for repeating the experiment to obtain average readings.

Question 4 (d)

This question was challenging, but it was encouraging to see most candidates score at least 1 mark for understanding that magnet C exerted a downward force or repelled magnet B. Beyond this, most candidates thought that the distance between magnets B and C was greater than between magnets A and B because magnet C was stronger than magnet A, which was not given credit. The most successful candidates understood that there were two downwards forces acting on magnet B and, therefore, the upwards force had to increase to balance the system.

(d) The student removes the masses from magnet B.

He then adds magnet C on to the vertical shaft.



Photograph 2

Photograph 2 shows that when magnet C is added, magnet B moves further down the shaft until it is at rest again.

Explain why the distance between magnet A and magnet B has decreased.

(3)

Magnet C repels magnet B when it is added. So this adds a magnetic repulsion force on magnet B which is acting downwards. The magnetic repulsion force from A does not change. So the forces that acting on magnetic B upwards does not change while the forces that acting on it downwards increases. Therefore the resulant force acting on B has a direction of downwards so magnet B moves down and becomes closer to magnet A.

(Total for Question 4 = 13 marks)

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Examiner Comments

This response scored 3 marks. The candidate gives a comprehensive explanation of why magnet B starts to move downward to gain mark point 1, mark point 2 and mark point 3.

Question 5 (a)

Only a quarter of all candidates knew that nuclear fusion was responsible for changing hydrogen nuclei into helium.

Question 5 (b)

Some candidates listed all the possible evolutionary stages after the main sequence in their response to Q05(b), including stages that are beyond the limits of the specification, eg black holes. Only a third of all candidates were awarded 1 mark or more. These candidates typically knew that the Sun would evolve into a red giant and the most able candidates also knew that it would later become a white dwarf.

(b) Describe the evolution of the Sun when it leaves the main sequence.

(2)

All the hydrogen gets used up which causes the main sequence star (Sun) to expand even further and become a red giant. the red giant then eventually turns into a white dwarf.

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Examiner Comments

This response scored 2 marks. The candidate clearly communicates the evolutionary stages the Sun will progress through after it leaves the main sequence.

Question 5 (c)

Most candidates were able to calculate the approximate mass of hydrogen in the Sun's core in Q05(c)(i). However, few candidates knew how to use this value to estimate the time until the Sun leaves the main sequence and other candidates overlooked the request to express their answer to one significant figure. A small number of candidates calculated an implausibly short time as their answer to Q05(c)(ii), but did not think to question its sensibility. The most successful candidates structured their working clearly and gave accurate answers, demonstrating their ability to work with data given in standard form.

(c) The Sun's core has a mass of approximately 7×10^{29} kg.

Approximately 75% of the mass of the core is hydrogen.

(i) Calculate the approximate mass of hydrogen in the Sun's core.

(1)

$75 \times 7 \times 10^{29} = 5.25 \times 10^{31}$

mass of hydrogen = 5.25×10^{31} kg

(ii) When most of the hydrogen nuclei in the Sun's core have been changed into helium nuclei the Sun will leave the main sequence.

The Sun's core loses approximately 9×10^{19} kg of hydrogen each year.

Estimate the time until the Sun leaves the main sequence.

Give your answer to one significant figure.

(2)

$5.25 \times 10^{31} \div 9 \times 10^{19} = 5.8 \times 10^{49}$

$= 6 \times 10^{49}$

time = 6×10^{49} years

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Examiner Comments

This response scored 0 marks in Q05(c)(i) due to the candidate calculating 75% incorrectly. However, the candidate has attempted to use this value correctly in Q05(c)(ii) and could potentially have still achieved 2 marks for this part. Unfortunately, the candidate has made an error when using their calculator to divide numbers in standard form, and the response scores 1 mark only for giving their answer to the correct number of significant figures.

(c) The Sun's core has a mass of approximately 7×10^{29} kg.

Approximately 75% of the mass of the core is hydrogen.

(i) Calculate the approximate mass of hydrogen in the Sun's core.

(1)

$\frac{75}{100} \times 7\times10^{29} = 5.25\times10^{29}$

mass of hydrogen = 5.25×10^{29} kg

(ii) When most of the hydrogen nuclei in the Sun's core have been changed into helium nuclei the Sun will leave the main sequence.

The Sun's core loses approximately 9×10^{19} kg of hydrogen each year.

Estimate the time until the Sun leaves the main sequence.

Give your answer to one significant figure.

(2)

$\frac{5.25\times10^{29}}{9\times10^{19}} = 5833333333$

5833333333 → 6000000000

time = 6×10^{9} years

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Examiner Comments

This is a model response that scored full marks.

Question 6 (b)

The linked calculations in Q06(b) allowed the most able candidates to demonstrate their ability, whilst weaker candidates usually scored at least 1 mark. The efficiency formula was well known and most candidates scored a mark when substituting their energy value from Q06(b)(i) into Q06(b)(iii). The need to convert the time and power values into SI units was overlooked by the majority of candidates, but it was pleasing to see the conversions being attempted in other responses. Some candidates were unsure whether they should give their final answer as a decimal or a percentage in Q06(b)(iii) and they often omitted the percentage symbol despite multiplying by 100 in their working.

(b) The engine of a car burns petrol, which transfers energy usefully from the chemical store of the petrol to the kinetic store of the car.

The useful power output of car P's engine is 47 kW.

(i) Calculate the useful energy output of car P's engine during a 15 minute period. **(3)**

usefull energe = useful power output × time period

705 = 47 × 15

useful energy output = 705. J

(ii) State the formula linking efficiency, useful energy output and total energy output. **(1)**

$$\text{Efficiency} = \frac{\text{useful energy output}}{\text{Total Energy output}} \times 100$$

(iii) During the 15 minute period, 2.0×10^8 J of energy is transferred from the chemical store of the petrol.

Calculate the efficiency of car P's engine. **(2)**

$$\frac{705\ \text{J}}{2.0 \times 10^8\ \text{J}} \times 100$$

efficiency = 3.525×10^{-4} %

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Examiner Comments

This candidate has not converted the values for either power or time in Q06(b)(i), but has used the formula correctly to score 1 mark. The formula given is correct and scores 1 mark in Q06(b)(ii). The candidate's incorrect answer for the useful energy output has been used correctly in Q06(b)(iii) and they have correctly expressed their final answer as a percentage to score 2 marks.

ResultsPlus
Examiner Tip

Candidates should be able to convert physical quantities into standard (SI) units when using formulae to complete calculations.

(b) The engine of a car burns petrol, which transfers energy usefully from the chemical store of the petrol to the kinetic store of the car.

The useful power output of car P's engine is 47 kW.

(i) Calculate the useful energy output of car P's engine during a 15 minute period.

(3)

$$47000 = \frac{E}{900}$$

$$= 42{,}300000$$

useful energy output = 42300000 J

(ii) State the formula linking efficiency, useful energy output and total energy output.

(1)

$$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy output}} \times 100$$

(iii) During the 15 minute period, 2.0×10^8 J of energy is transferred from the chemical store of the petrol.

Calculate the efficiency of car P's engine.

(2)

$$\frac{42.3 \times 10^6}{2 \times 10^8} \times 100$$

efficiency = 21.15%

ResultsPlus
Examiner Comments

This response scores full marks. Both unit conversions are attempted correctly in Q06(b)(i) and the rest of the candidate's work is accurate and easy to follow.

Question 6 (c)

Most candidates scored at least 2 marks in this data interpretation question by forming two correct conclusions between speed, power output and mass which was often correctly expressed. However, the majority of these candidates failed to support their conclusions with data from the table. Where candidates did use data, they often wrote which car had the largest/smallest mass and speed rather than concluding the relationship between the two.

(c) The student extends her investigation by collecting data for cars P, Q, R and S.

She records the useful power output of their engines, their masses and their maximum speeds.

The table shows her data.

Car	Engine useful power output in kW	Mass in kg	Maximum speed in m/s
P	47	721	41
Q	92	1143	51
R	194	915	62
S	198	1226	68

Using information from the table, discuss the relationships between useful power output, mass and maximum speed.

(4)

As the useful power output increases the mass also increases.

As the mass increases the maximum speed increases.

Therefore the conclusion can be made that when the useful power output increases the mass and the maximum speed also increases.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate has given two correct relationships between the variables, but has not justified them with any information from the table.

(c) The student extends her investigation by collecting data for cars P, Q, R and S.

She records the useful power output of their engines, their masses and their maximum speeds.

The table shows her data.

Car	Engine useful power output in kW	Mass in kg	Maximum speed in m/s
P	47	721	41
Q	92	1143	51
R	194	915	62
S	198	1226	68

Using information from the table, discuss the relationships between useful power output, mass and maximum speed.

(4)

As the speed of the cars increase, the useful power output of the engine also increases ~~as~~ for example, car P has a maximum speed of 41 and the useful power output is 47 kW compared to car S which has a higher maximum speed at 68 and a higher useful power output at 198 kW. There is no clear relationships of ~~the mass~~ a higher or lower mass of the car increasing or decreasing speed or useful power output.

ResultsPlus
Examiner Comments

This response also scored 2 marks. This candidate has given the correct relationship between speed and power and quoted relevant data from the table to support this. However, this is the only relationship discussed and, therefore, no further marks were given.

(c) The student extends her investigation by collecting data for cars P, Q, R and S.

She records the useful power output of their engines, their masses and their maximum speeds.

The table shows her data.

Car	Engine useful power output in kW	Mass in kg	Maximum speed in m/s
P	47	721	41
Q	92	1143	51
R	194	915	62
S	198	1226	68

Using information from the table, discuss the relationships between useful power output, mass and maximum speed.

(4)

As seen, more the useful power output, and more mass, the maximum speed increases; because as shown Car P has 47 kW and a mass of 721 kg whilst its speed is only 41 m/s. In comparison Car S with a mass of 1226 kg and useful engine output of 198 kW results in its maximum speed to be 68 m/s. However as seen in Car Q, the engine output is less but mass is high (1143) so the speed results in 51 m/s. But if the output energy is high and mass is low like Car R - the maximum speed shall still be high (62 m/s).

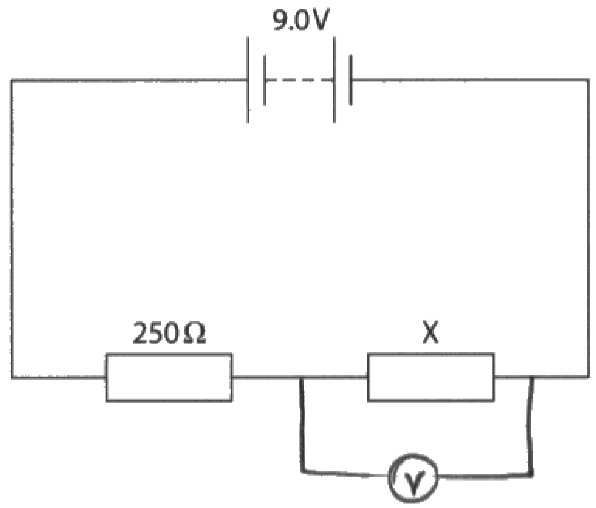
ResultsPlus
Examiner Comments

The combined statements in this response give two correct relationships between the quantities and these are supported with relevant data to gain 4 marks. The candidate has also discussed the possibility of an anomaly in the data. Overall, an excellent answer.

Question 7 (a)

The majority of candidates drew the symbol for a voltmeter in series with resistor X and consequently did not score any marks. Most candidates who knew that voltmeters should be connected in parallel correctly drew the voltmeter in parallel with resistor X to score both marks. A surprising number of candidates did not know the correct symbol for a voltmeter.

7 The circuit diagram shows a 9.0 V battery connected in series with a 250 Ω resistor and another resistor, X.



(a) Draw a voltmeter on the circuit diagram to measure the voltage of resistor X.

ResultsPlus
Examiner Comments

The correct symbol for a voltmeter has been drawn in parallel with resistor X to score 2 marks.

ResultsPlus
Examiner Tip

Candidates should know how to connect voltmeters and ammeters correctly in electrical circuits.

Question 7 (b)

Q07(b) required candidates to apply a two-step calculation to solve a series circuit problem. Two methods could have been used to obtain the resistance of resistor X:

- Finding the total resistance of the circuit and then subtracting 250Ω from this.
- Finding the voltage across the 250Ω resistor first to find the voltage across resistor X, then applying Ohm's law to deduce its resistance.

The first method was preferred by candidates and it was encouraging to see a significant number get at least halfway through the calculation by finding the total resistance of the circuit. Only some candidates knew to then subtract 250Ω from this to obtain their final answer.

(b) The current in the circuit is 0.012 A.

Calculate the resistance of resistor X.

(4)

Voltage = current × resistance

resistance = $\frac{9.0}{0.012}$

resistance = 750 Ω

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate has correctly used Ohm's law to find the total resistance of the circuit, but does not understand that the resistance of the 250Ω resistor should be subtracted from this.

(b) The current in the circuit is 0.012 A.

Calculate the resistance of resistor X.

(4)

$V = IR$

$R = \frac{V}{I}$

$= \frac{9}{0.012} = 750\,\Omega$ ← total resistance

$750 - 250 = 500\,\Omega$ ← resistance of x

resistance = 500 Ω

ResultsPlus
Examiner Comments

This response scored all 4 marks and demonstrates the most popular method of solving the problem.

(b) The current in the circuit is 0.012 A.

Calculate the resistance of resistor X.

(4)

$V = IR$

$V = 0.012A \times 250\,\Omega$

$V = 3V$

voltage of x = $9V - 3V = 6V$

$\frac{V}{I} = R$

$\frac{6V}{0.012A} = R$

$500\,\Omega = R$

resistance = 500 Ω

ResultsPlus
Examiner Comments

This response also scored 4 marks. This approach was less frequently seen, but is equally valid.

Paper Summary

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

- Take note of the number of marks given for each question and use this as a guide as to 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 familiar with the formulae listed in the specification and be able to use them confidently.

- 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.

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

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