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Examiners' Report June 2023

GCSE Physics 1PH0 2H

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June 2023

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Introduction

This was the sixth year of examining this specification, paper 2 of Physics, higher tier.

Questions were set to test candidates' knowledge, application and understanding from nine topics in the specification:

- Topic 1 – Key concepts of physics.
- Topic 8 – Energy – Forces doing work.
- Topic 9 – Forces and their effects.
- Topic 10 – Electricity and circuits.
- Topic 11 – Static electricity.
- Topic 12 – Magnetism and the motor effect.
- Topic 13 – Electromagnetic induction.
- Topic 14 – Particle model.
- Topic 15 – Forces and matter.

It was intended that the examination paper would allow every candidate to show what they knew, understood and were able to do. Within the question paper, a variety of question types were included, such as objective questions, short answer questions worth one or two marks each and longer questions worth three or four marks each. Several questions assessed candidates' knowledge of practical procedures, notably Q2(a) on electrical circuits, Q3(d) concerning the determination of the density of an object, Q7(a) an experimental set-up to measure compression of a spring, and Q9(b) an investigation to measure work done when lifting a weight by a pulley system. The standard of answers on practical questions was variable with some candidates showing good procedural knowledge, whilst for others there was a clear lack of familiarity shown, especially with the more challenging questions asking candidates to apply practical skills in an unfamiliar situation. Candidates continued to do well with most calculation questions, although some did not cope well with the units involved.

Successful candidates were:

- Well-acquainted with the content of the specification.
- Skilled as a result of having been engaged with practical work during their course.
- Competent in quantitative work, especially in using equations.
- Well-focused in their comprehension of the question-at-hand.
- Willing to apply physics principles to the novel situations presented to them.

Less successful candidates:

- Had gaps in their conceptual knowledge of the topics of this paper.
- Had gaps in their procedural knowledge relating to their practical work.
- Were uncertain about SI units and when to convert them to sub or multiple units.
- Did not focus sufficiently on what the question was asking.
- Found difficulty in applying their knowledge to new situations.

This report will provide exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification will come from responses which highlight successes and pitfalls, with the aim of aiding future teaching of these topics.

Question 1 (a)(ii)

Candidates usually wrote about electrons being transferred from the base to the cloth. Previous questions on this topic have often considered the object being rubbed rather than the cloth. This may account for the fact that many neglected to mention friction in this question.

(ii) Explain why the cloth has become negatively charged.

(2)

By friction, the electrons in the plastic base transfered to the cloth, so the cloth gained electrons, making it negatively charged

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Examiner Comments

A simple, fully correct answer that scored both marks. Examiners saw very many answers like this.

Question 1 (b)

Most candidates reasoned that electrons had moved from the cloth to the star but fewer stated that the charge was then conducted through the metal. Instead, many thought that the metal star had an overall positive charge that attracted electrons from the cloth or that friction was responsible for the charge transfer.

(b) The person then holds the metal star and rubs it with the charged cloth.

The cloth loses its charge.

Explain why the cloth loses its charge.

(2)

The cloth loses its charge as its gained electrons then get transferred to the metal star. This is due to ~~t~~ friction and metals ~~be~~ having positively charged ions

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Examiner Comments

There is a mark for writing that the electrons are transferred (from the cloth) to the metal star. However this is not due to friction and the metal star was not positively charged.

1 mark out of 2

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Examiner Tip

Remember that charge movement due to friction between two materials can occur if both are insulators. Conductors like the metal star, will not be charged by friction.

The star is made out of metal, and metal is a good conductor, therefore the electrons are discharged into the metal.

ResultsPlus
Examiner Comments

This is a better answer. The charges are conducted away from the cloth by the metal star. It scored 2 marks.

ResultsPlus
Examiner Tip

The key words here are metal is a good conductor.

Question 1 (c)

Negative charge was usually correctly shown on the left hand side. Fewer candidates realised that induction would result in a charge separation on the particle which also results in positive charge to the right of the negative charge.

(c) The charged plastic base attracts some dust from the air.

Figure 2 shows a magnified view of part of the surface of the plastic base and a dust particle.

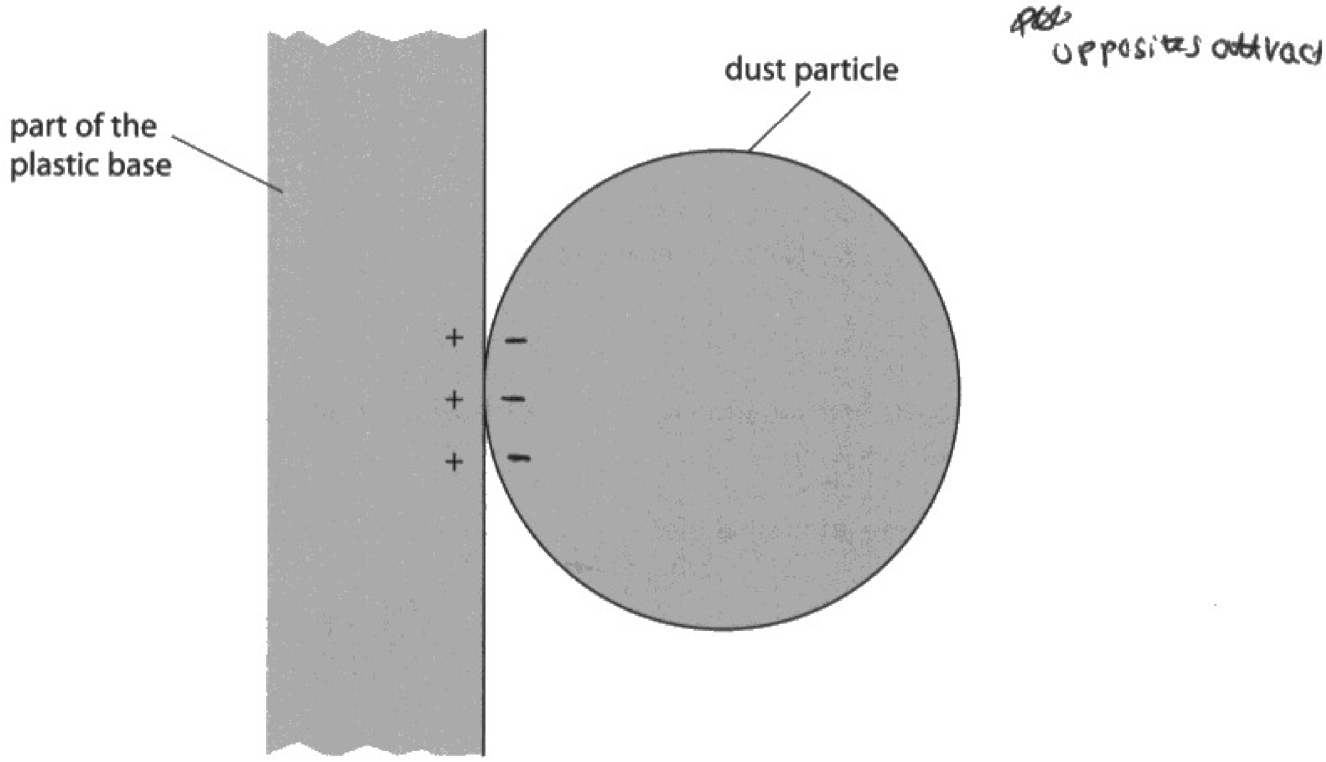


Figure 2

Some of the charges on the plastic base are shown but the charges induced on the dust particle are not shown.

Draw the charges induced on the dust particle in Figure 2.

ResultsPlus
Examiner Comments

A partly correct diagram. An induced negative charge is drawn on the side of the dust particle nearest to the positively charged base.

However this implies that the dust particle now has an overall negative charge which is not correct.

(c) The charged plastic base attracts some dust from the air.

Figure 2 shows a magnified view of part of the surface of the plastic base and a dust particle.

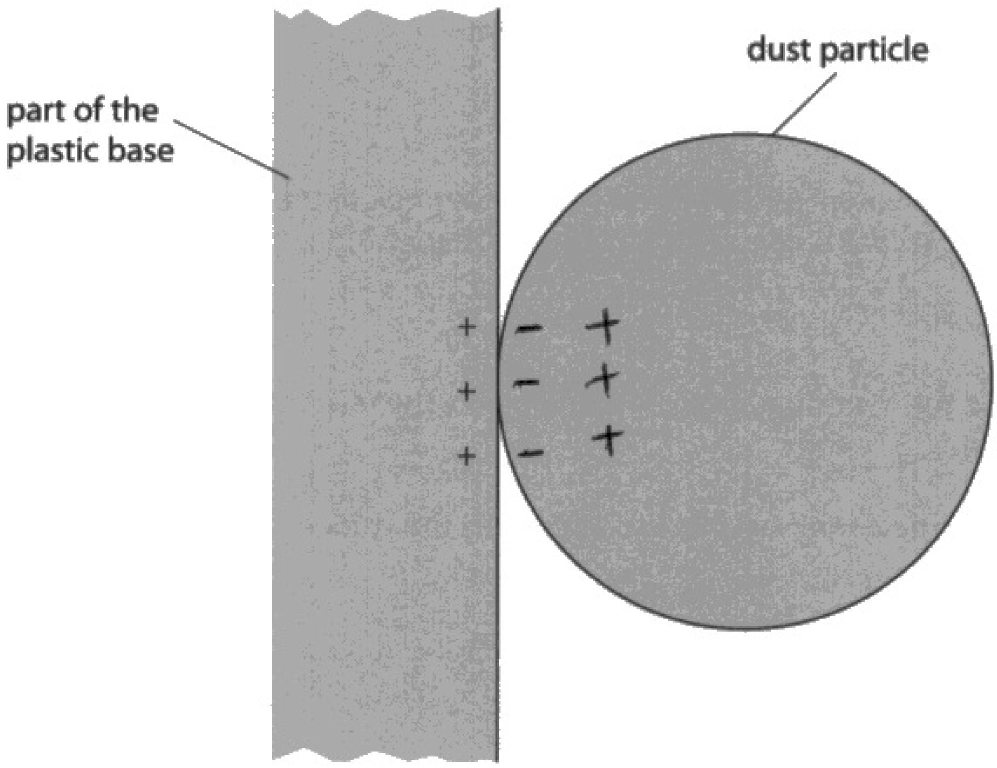


Figure 2

Some of the charges on the plastic base are shown but the charges induced on the dust particle are not shown.

Draw the charges induced on the dust particle in Figure 2.

ResultsPlus
Examiner Comments

A fully correct diagram. The positive charges on the base have attracted negative charges to the left hand side of the dust particle leaving behind positive charges. This results in a separation of charge but the total number of positive and negative charges on the dust particle still balance.

Question 2 (a)

Most candidates drew a complete circuit and the ammeter was usually correctly connected in series with the other components. The voltmeter was less often connected correctly. The most common errors were to either connect it across the variable resistor or across the battery; neither of which would allow the pd across the wire to be determined. Examiners frequently saw very neatly drawn circuits.

2 (a) Figure 3 shows some of the apparatus that students use to determine the resistance of a piece of iron wire.

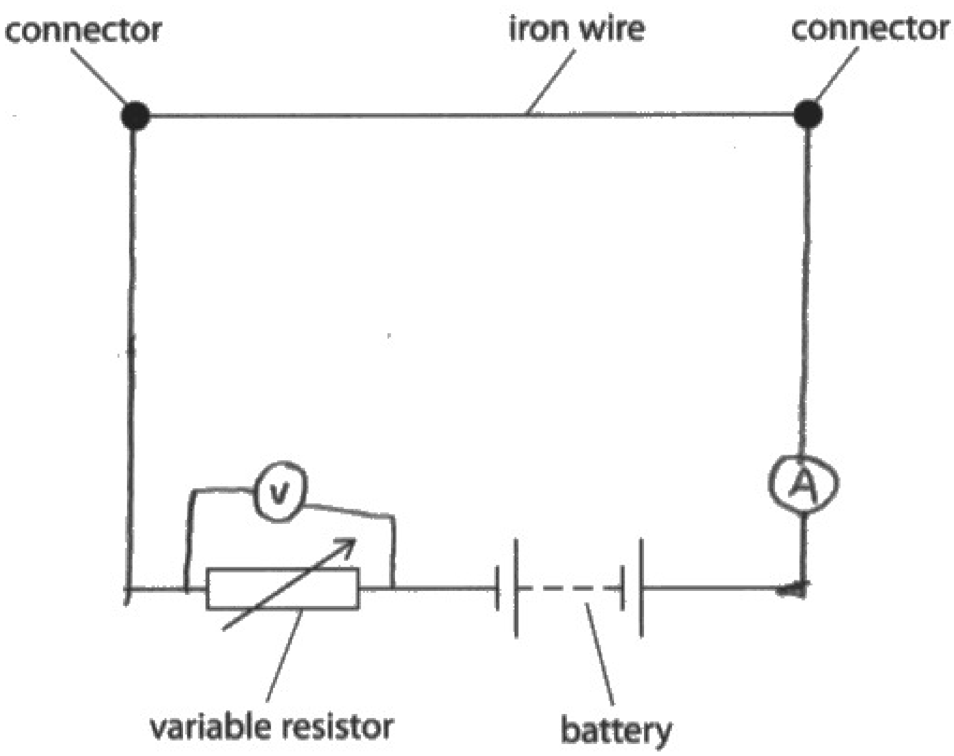


Figure 3

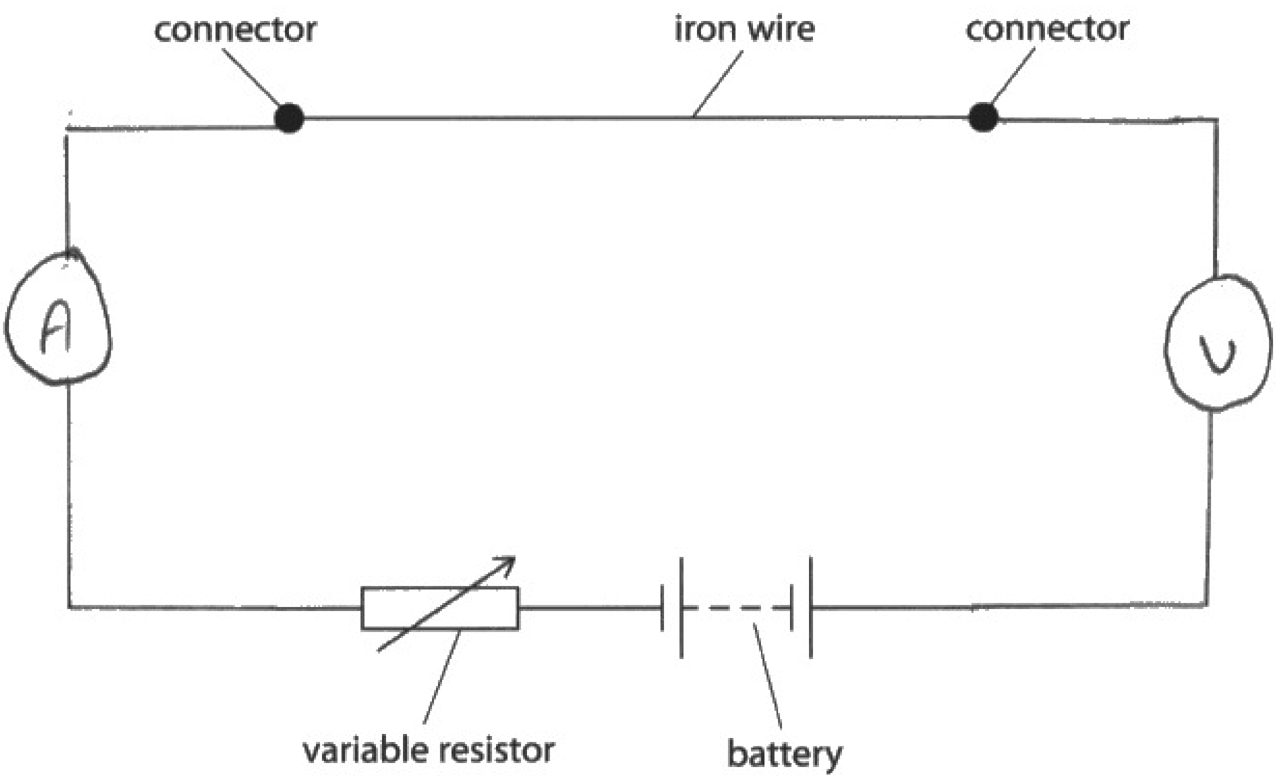
Add connecting wires, a voltmeter and an ammeter to complete the circuit in Figure 3 so that the students can determine the resistance of the piece of iron wire.

ResultsPlus Examiner Comments

Although the ammeter is in series and so can measure the current in the circuit, the voltmeter is across the variable resistor and not the iron wire.

ResultsPlus
Examiner Tip

A voltmeter can only measure the potential difference between the points where it is connected. Make sure you place it across the component you are trying to measure.



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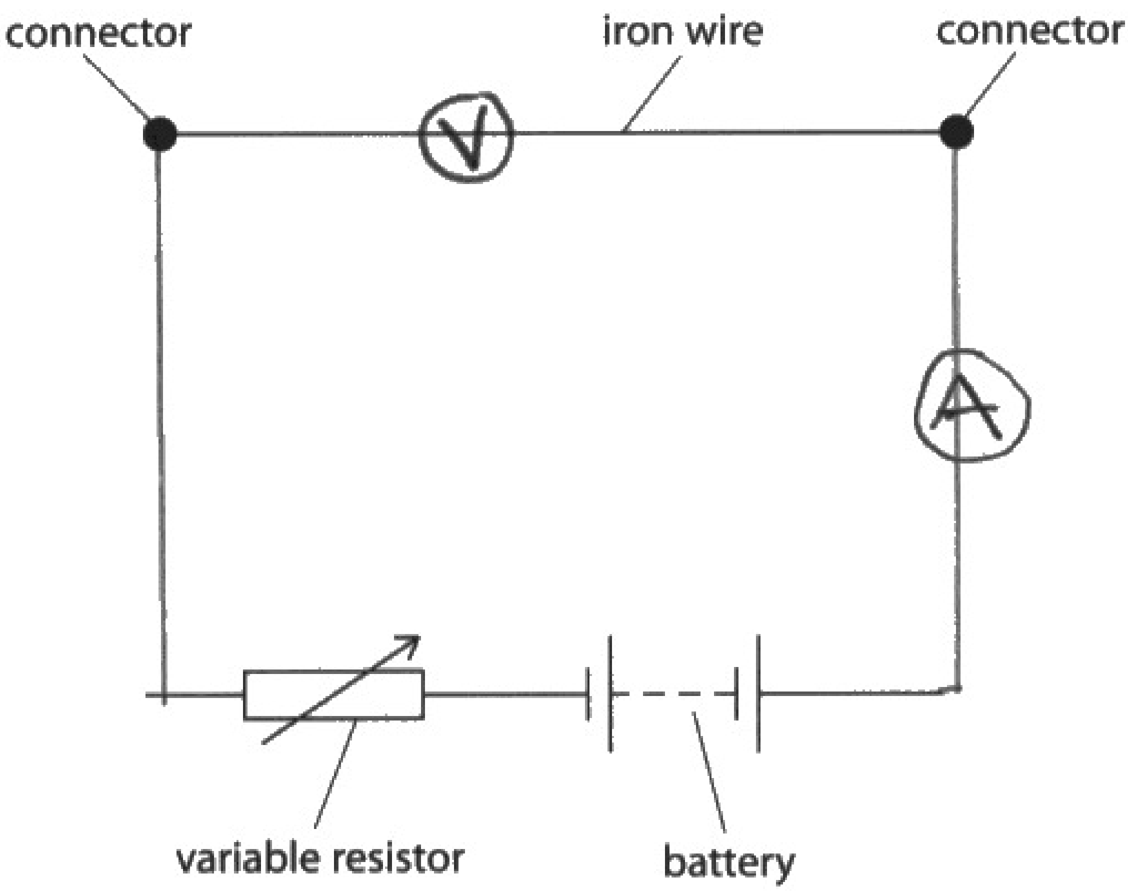
Examiner Comments

This was also commonly seen.

ResultsPlus
Examiner Tip

A voltmeter is never connected in series. It has such a high resistance that there can be no current in the circuit.



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Examiner Comments

Although the candidate seemed to know that the voltmeter needed to make a measurement for the iron wire, it has been placed in the middle of the wire.

Question 2 (b)(ii-iii)

There was a range of possible lines of best fit and examiners would accept any straight line that, if extended, gave a resistance between 2.8 ohms and 3.2 ohms at 100cm and crossed the horizontal axis between 0 and 6cm.

A neat line of best fit was drawn by most candidates and the resistance of 100 cm of wire correctly found from the graph. Partial credit was also given for correctly reading the value at 100cm from a line that was not in the acceptable range.

(ii) Figure 4 shows a graph of the results.

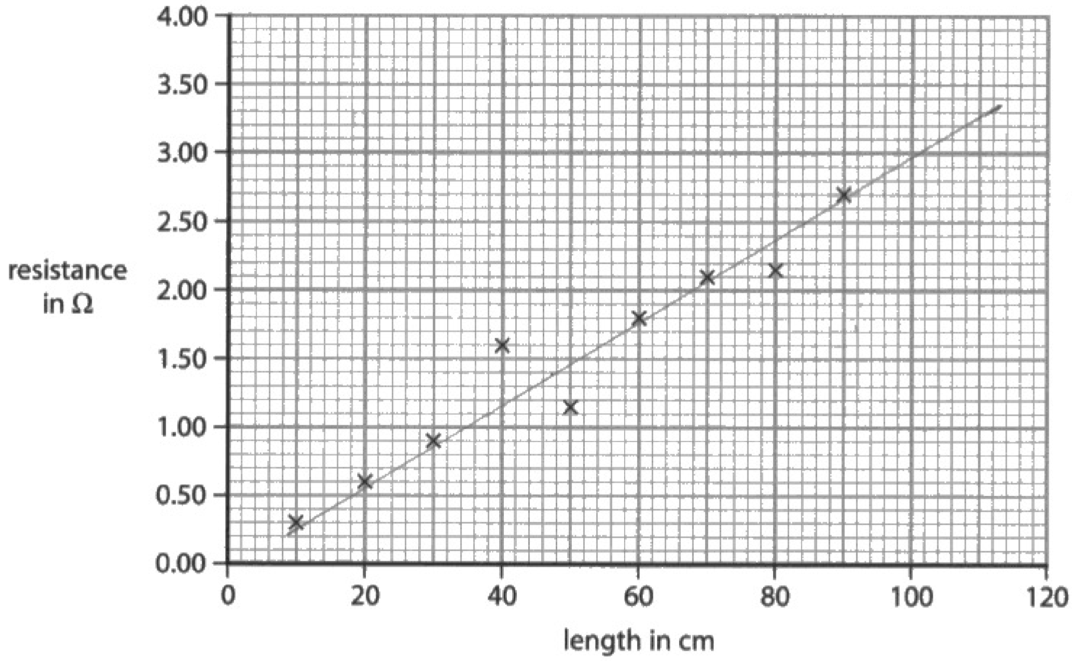

Figure 4

Draw a straight line of best fit on Figure 4.

(1)

(iii) Use Figure 4 to estimate the resistance of a 100 cm length of the iron wire.

(1)

resistance = 3.00 Ω

ResultsPlus Examiner Comments

A nice straight line that goes through or close to as many points as possible and a correct reading of the graph to predict the resistance of 100cm of wire.

(ii) Figure 4 shows a graph of the results.

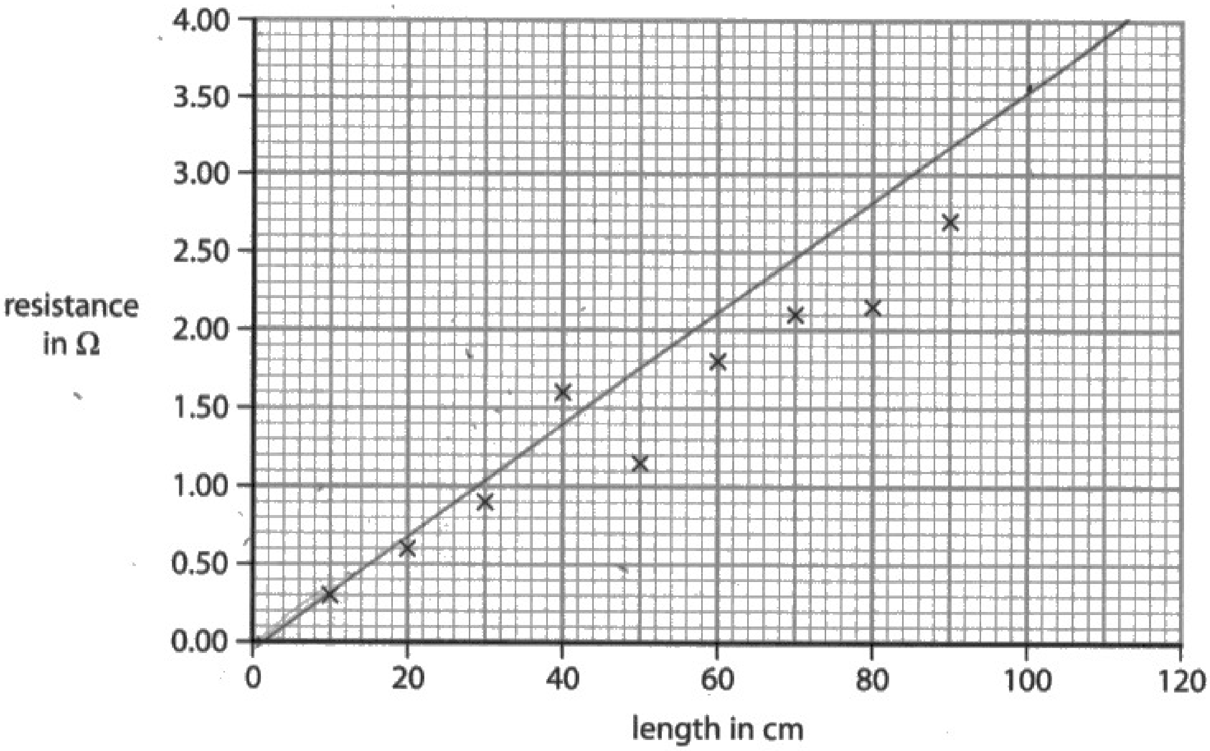

Figure 4

Draw a straight line of best fit on Figure 4.

(1)

(iii) Use Figure 4 to estimate the resistance of a 100 cm length of the iron wire.

(1)

resistance = 3.55 Ω

ResultsPlus
Examiner Comments

This line misses too many points to score in part (ii). There are many more points below the line than above. However the candidate has correctly used the line to predict the resistance of 100cm of wire and so scored 1 mark in part (iii).

Question 2 (b)(iv)

Candidates should recall from practical investigations of measuring resistance that a large current in the resistor being investigated causes that resistor to heat up and that this would cause its resistance to change. Therefore, the inclusion of an additional variable resistor in the circuit would enable the current to be reduced by increasing the overall resistance of the circuit. In this question the resistance being investigated is that of the iron wire.

Although most candidates had the idea of reducing current, very many seemed to confuse the variable resistor with a thermistor and described its function in terms of an automatic current limiting device controlling temperature rather than it being altered by the investigator during measurements. Examiners also saw very many, incorrect, references to "slowing down the current".

(iv) The variable resistor shown in Figure 3 is used to prevent the iron wire from becoming too hot.

Explain how the variable resistor is used to prevent the iron wire from becoming too hot.

(2)

- If the wire becomes to hot the variable resistor can increase the resistance meaning less current flows through the wire
- This means fewer electrons collide with ions and less energy is lost as thermal energy

ResultsPlus
Examiner Comments

A correct answer that describes using the variable resistor to reduce the current by increasing the resistance in the circuit and so scored both marks. The last sentence is almost correct; a better statement would say "fewer electrons per second collide with..."

If the heat increases past a certain point, the variable resistor will detect this and decrease its resistance, to stop as much current going through the wire.

ResultsPlus
Examiner Comments

This answer has the correct idea of reducing the current but incorrectly states that this is done by decreasing the resistance. It also implies that the variable resistor is changing its resistance on its own rather than being adjusted by the person carrying out the investigation.

Question 2 (c)

The calculation of resistance was correctly carried out by almost all candidates.

Question 3 (b)

Although most candidates were able to use the equation given to calculate density, there were often attempts to convert the units of volume (m^3) and mass (kg) from the SI units given in the question to other units such as g or cm. Even though this was unnecessary, full credit was given where the unit given for volume was consistent with the value calculated for density. Nevertheless, candidates are advised to use SI units in all calculations unless instructed specifically to convert to units with multiple or sub-multiple unit prefixes such a G or m.

(b) An object has a mass of 7.22×10^{-2} kg and a volume of 2.69×10^{-5} m^3.

Calculate the density, ρ, of the object.

Use the equation

$$\rho = \frac{m}{V}$$

7.22×10^{-2} kg $= 72.2$g 2.69×10^{-5} $m^3 = 26.9$ cm^3

State the unit. **(3)**

$$\frac{72.2}{26.9} = 2.68401$$

density = 2.68 unit g/cm^3

ResultsPlus
Examiner Comments

A fully correct answer; however the candidate has converted from the SI units of kg and m into g and cm. This was not wrong but it does run the risk of making a mistake in the conversion and losing a mark unnecessarily.

State the unit.

7.22×10^{-2} kg = 7.22×10^{-5} g

2.69×10^{-5} m^3 = 2.69×10^{-11} cm^3

$$\frac{7.22 \times 10^{-5}}{2.69 \times 10^{-11}} = 2684014.87$$

density = 2684014.87 unit ~~cm~~ g/cm^3

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Examiner Comments

The candidate has tried to convert from SI units of kg and m into g and cm but has used incorrect powers of ten.

ResultsPlus
Examiner Tip

The SI units of mass are kilograms, the SI units of length are metres. You do not need to convert to other units unless the question asks you to do so.

Use the equation

$$\rho = \frac{m}{V}$$

State the unit. **(3)**

$\rho = \dfrac{(7.22 \times 10^{-2})}{(2.69 \times 10^{-5})}$ $= 2684.01487$

$= 2684$

kg/m^3

=

density = 2684 unit kg/m^3

ResultsPlus
Examiner Comments

Se below.

ResultsPlus
Examiner Tip

A correct calculation with the correct SI unit of density.

Question 3 (c)(ii)

Kinetic theory was understood at a simple level by most candidates with many answers describing particles moving around in a liquid. The language used was often imprecise however and phrases such as “with lots of energy” were commonly seen. There was almost no reference to the particles having a range of speeds. Very many answers referred to bulk properties of liquids such as “they take the shape of the container”. This does not describe the motion of the particles in the liquid. Additionally, many answers described the process of melting rather than the motion of particles above the melting point.

(ii) Describe the motion of particles in liquid aluminium (above 660 °C).

(2)

The particles are able to flow ~~over~~ over ~~a~~ eachothe
and will take the shape of the bottom of its ~~a~~ container

ResultsPlus
Examiner Comments

Here is an acceptable description of motion; "the particles... flow over each other" but "take the shape of the container" does not describe the motion of the particles.

(ii) Describe the motion of particles in liquid aluminium (above 660 °C).

(2)

The particles are not in a fixed position and so are free to move. They are not arranged regularly. They move randomly

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Examiner Comments

There is one mark for describing the motion as "... (particles) move freely". Although it is true that the particles are not in a fixed position, this does not add anything else about the motion of the particles.

Question 3 (d)

This is a core practical. Full marks could be scored by making any two suggestions from "measure the volume of water in the measuring cylinder before adding the metal", "make sure all the metal is immersed" and "subtract the volume before from the volume after".

Very many candidates scored full marks.

Some candidates tried to describe a different method such as using a displacement (Eureka) can. This would not score any marks.

Some candidates suggested making measurements that were not part of the question.

(d) A student determines the volume of a piece of metal by measuring the volume of water that it displaces.

The student wrote the following in his notebook.

I put some water into a measuring cylinder. I put the piece of metal into the water in the measuring cylinder. I took the reading of the new water level in the measuring cylinder. This was the volume of the piece of metal.

The student's description is incomplete.

Suggest **two** sentences that the student could have included to provide a more complete description of the correct procedure.

(2)

1 I measure the volume of water ~~before~~ in the measuring cylinde before adding the piece of metal.

2 I measure the mass of the piece of metal before adding it into water in measuring cylinder -

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Examiner Comments

The candidate has underlined the key words "measuring the volume" in the question. This is a good idea.

Unfortunately the answer then suggested measuring the mass of the metal. This would not help with measuring the volume of the metal.

Only the first mark was scored.

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Examiner Tip

Make sure your answer matches the question.

Question 4 (a)(ii)

This question assessed understanding of the relationship between force, area and pressure in the context of the pressurised cabin of an aeroplane.

The calculation of pressure caused very few difficulties.

Question 4 (a)(iii)

Good answers stated that the pressure of the air would be the same on both large and small windows but the force on the window with a smaller surface area would be less. Less complete answers would correctly describe a smaller force but not complete the explanation by referring to the pressure being constant. Examiners saw many good answers however confusion between pressure and force was often seen with many candidates writing that the "pressure is spread over a smaller area therefore the force would be greater".

(iii) On the same aeroplane, a different window has a smaller surface area.

Explain how the force due to the air pressure inside the cabin on the small window differs from the force on the larger window.

(2)

There is less force as the pressure stays the same but surface area decreases, so pressure × area gives a smaller value for force.

ResultsPlus
Examiner Comments

A correct answer that scored both marks.

(iii) On the same aeroplane, a different window has a smaller surface area.

Explain how the force due to the air pressure inside the cabin on the small window differs from the force on the larger window.

(2)

The force would be greater on a smaller surface area because there is more pressure on a smaller surface area.

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Examiner Comments

Here force and pressure have been confused with each other. Answers like this were frequently seen and scored no marks.

ResultsPlus
Examiner Tip

Make sure you understand the difference between pressure and force.

Question 4 (a)(iv)

Although most candidates showed a force in a direction that was at right angles to the window, a mark was often lost by drawing the arrow some distance away from the point rather than at the point as asked for in the question.

(iv) Figure 6 shows a cross-section through the aeroplane including one window.

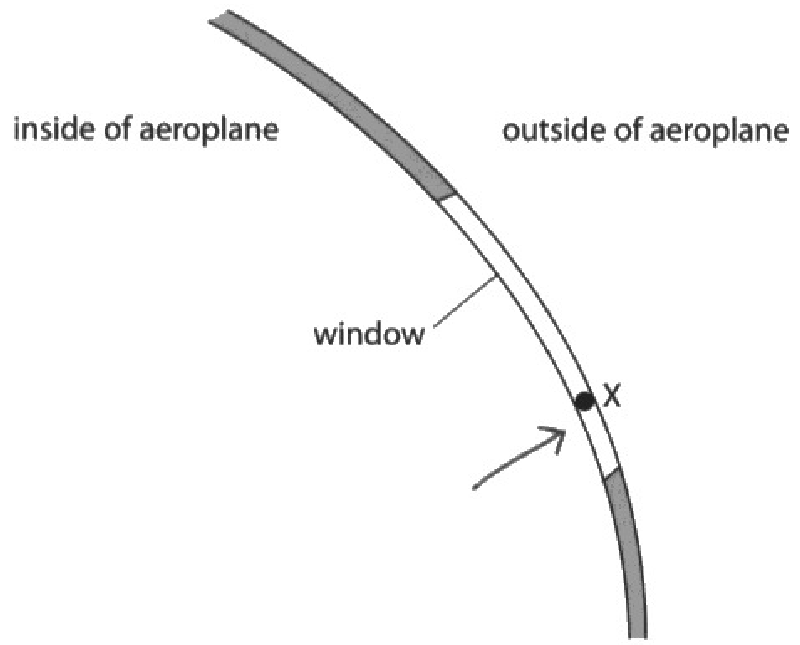

Figure 6

Draw an arrow on Figure 6 to show the direction of the resultant force due to the air pressure inside the cabin on the window at point X.

(2)

ResultsPlus
Examiner Comments

Although the force is correctly shown as an arrow pointing towards the outside of the aeroplane, the arrow does not show the force **at** point x but instead stops in front of it. It also points towards some other point on the window. This scored only 1 of the possible 2 marks.

ResultsPlus
Examiner Tip

Be careful when drawing a diagram to show the force acting at a point. The arrow must either start or end at the point where the force acts.

(iv) Figure 6 shows a cross-section through the aeroplane including one window.

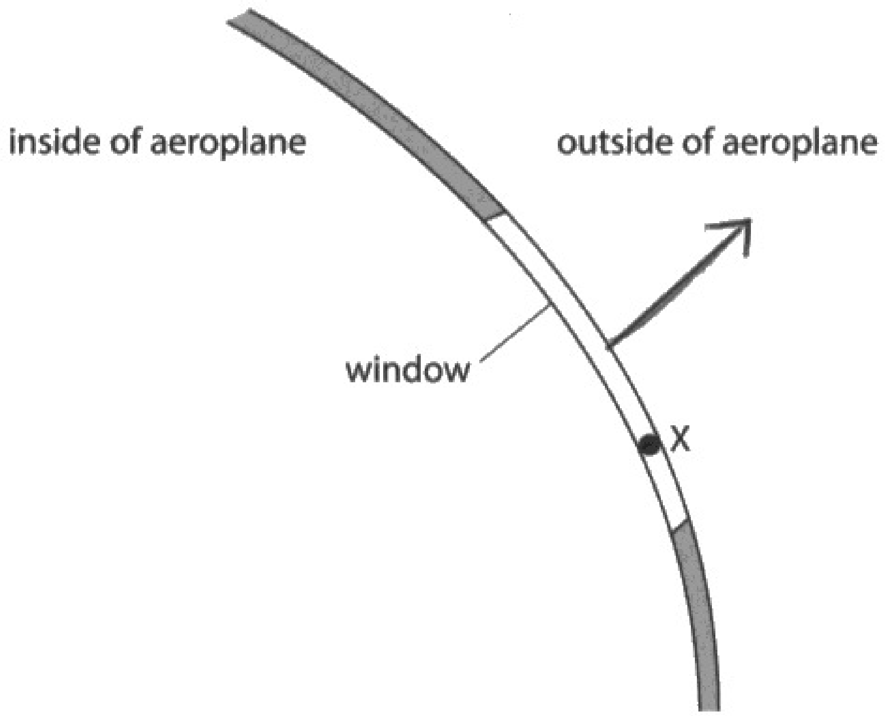

Figure 6

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ResultsPlus
Examiner Comments

Although the force is correctly shown as an arrow pointing towards the outside of the aeroplane, the arrow does not show the force at point x but instead at some other point on the window. This scored only 1 of the possible 2 marks.

ResultsPlus
Examiner Tip

Be careful when drawing a diagram to show the force acting at a point. The arrow must either start or end at the point where the force acts.

Question 4 (b)(i)

This is now a common type of graph interpretation question. One mark for the trend (in this case decreasing) and a second mark for stating that, since it is a curve, it is non-linear. The third mark is for using data from the graph in support.

(b) Figure 7 shows the atmospheric pressure at different heights above the Earth's surface.

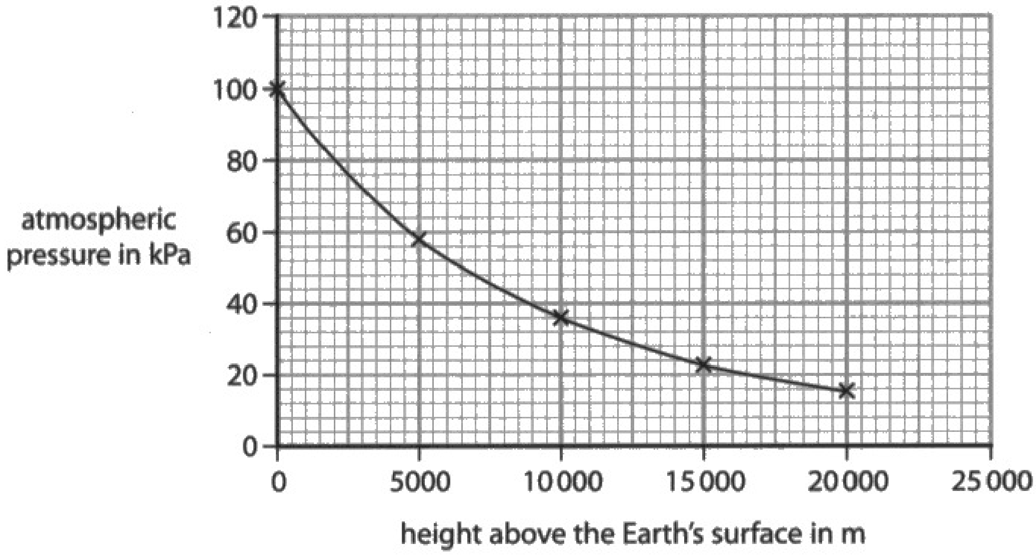

Figure 7

(i) Describe how the atmospheric pressure changes with height above the Earth's surface.

Use data from Figure 7 to support your answer.

(3)

As height above the Earth's surface increases, atmospheric pressure decreases. It is a non-linear relationship - as height increases, the decrease in pressure decreases. For example, from 0-5000m, pressure decreases from 100KPa to 58KPa, a decrease of 42KPa but from 15,000 to 20,000m, pressure decreases from 22KPa to 16KPa, only a 6KPa decrease for the same height

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Examiner Comments

A clear answer that describes the trend and uses data to support this.

The atmospheric pressure decreases as the height increases. At 0m, the pressure it high at 100kPa whereas when the height is high at 20,000m the pressure is low at 16 KPa.

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Examiner Comments

This uses data to support the description that pressure decreases with height to score 2 out of 3 marks.

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Examiner Tip

When a graph has a curved line rather than a straight line it is "non-linear".

(b) Figure 7 shows the atmospheric pressure at different heights above the Earth's surface.

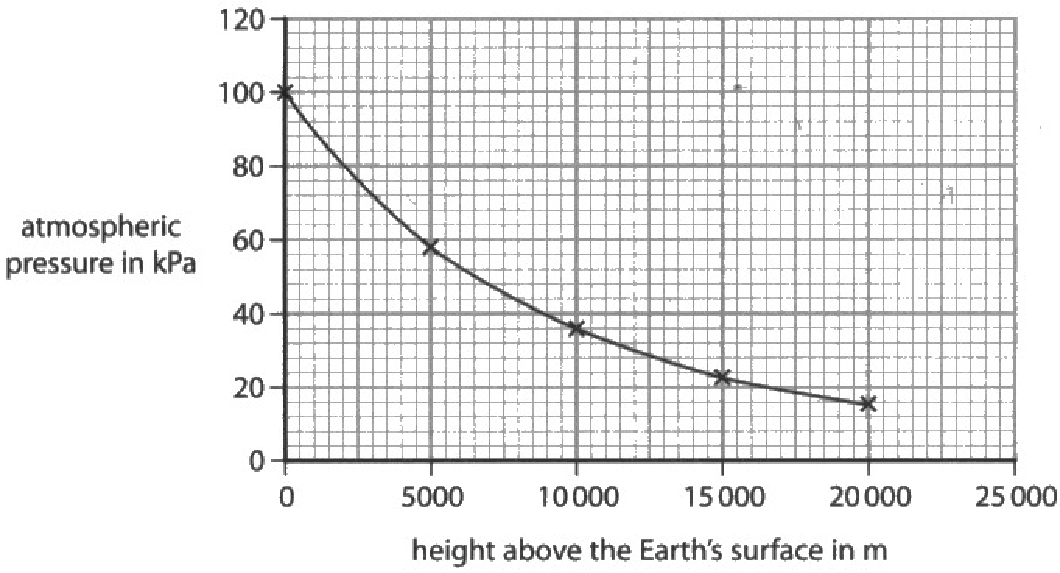

Figure 7

(i) Describe how the atmospheric pressure changes with height above the Earth's surface.

Use data from Figure 7 to support your answer.

(3)

As the height above the Earth's ~~pressure~~ surface increases, the atmospheric pressure decreases. The graph is non-linear.

ResultsPlus
Examiner Comments

The trend is correctly described for one mark and the statement that it is non-linear scores a second mark. If the candidate had given values from the graph to support this then it would have scored the third mark.

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Examiner Tip

If a question asks you to use data then you need to give some values to support your answer.

Question 4 (b)(ii)

Credit was given for answers that either explained why the density of the atmosphere decreased with height above the ground (e.g. lower temperature, thinner air) or why the height of the air column above the plane was less (e.g. fewer particles above). A surprising number suggested that a smaller force of gravity was responsible. Although there is a decrease in the value of *g* as distance from the Earth's surface increases, the effect of this on air pressure is negligible compared with either the change in air density or height of the air column above.

(ii) Suggest **one** reason why the atmospheric pressure changes with height above the Earth's surface.

(1)

Fewer particles because less ~~at~~ of the atmosphere is above the object so the weight of them is lower.

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Examiner Comments

"Fewer particles" would not be enough to answer this question, but the answer continues with "less **above** and so weight is lower" and scores the mark.

Question 5 (a)

Most candidates drew field lines with arrows in the correct direction. Poorly drawn fields often had overlapping lines and therefore only scored 1 out of a possible 2 marks for this question.

5 (a) Figure 8 shows two magnets with their N poles facing each other.

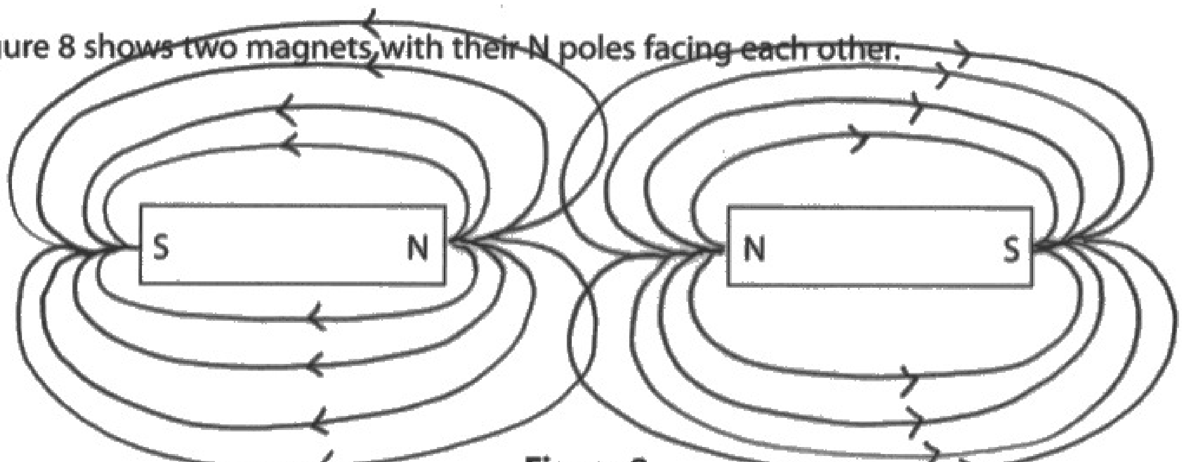

Figure 8

On Figure 8, draw the shape and direction of the magnetic field between the two magnets.

(2)

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Examiner Comments

Although the direction of the field lines is correctly away from the N poles of each magnet, some of the lines are crossing each other and also come from the same points in the middle of the poles of the magnets. This scored only 1 out of a possible 2 marks.

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Examiner Tip

Take care when drawing magnetic (or electrostatic) field lines. The lines never touch each other and never overlap or cross.

5 (a) Figure 8 shows two magnets with their N poles facing each other.

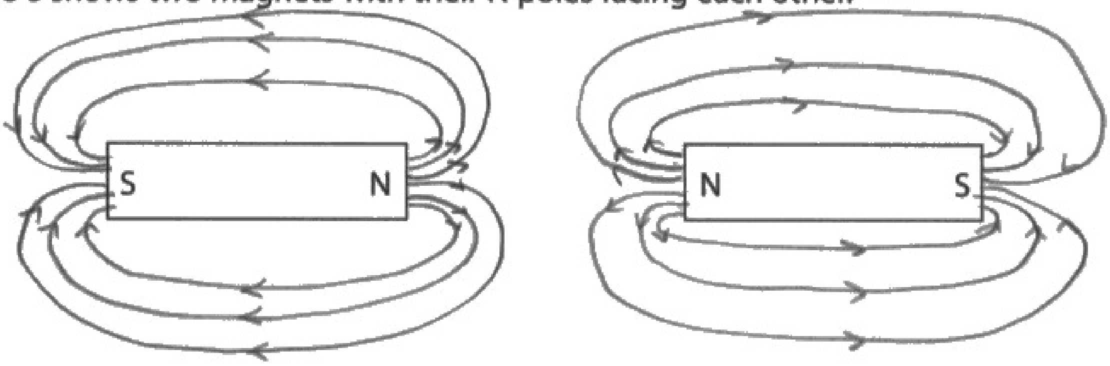

Figure 8

On Figure 8, draw the shape and direction of the magnetic field between the two magnets.

(2)

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Examiner Comments

This was an acceptable drawing that scored both marks.

Question 5 (b)

A good description of the forces on the upper magnet would state that the fields of the two magnets interacted or simply that the upper magnet was in the magnetic field of the lower magnet. This would result in an upward force due to repulsion by the lower magnet that was balanced by the downward force due to gravity.

Many answers had the words "magnetic fields" but usually in terms of repelling. This can score one mark for "repulsion" but not another mark for the interaction between fields.

(b) Figure 9 shows a toy that has a plastic cylinder, a plastic base and two similar magnets. Each of the two magnets is in the shape of a ring.

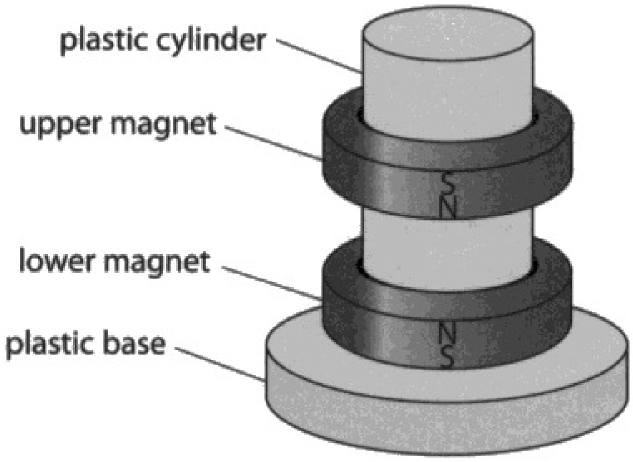

Figure 9

The upper magnet seems to float in the air above the lower magnet.

Describe the forces acting on the upper magnet.

Use the idea of magnetic fields in your answer.

(3)

The upper magnet is experiencing a gravitational force pulling it downwards that is balanced by the repelling force between the two magnets. This force is caused by the magnetic fields of both magnets intersecting with the like poles facing eachother, this causes the magnets to push each other away, causing the repelling force.

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Examiner Comments

This is good clear description. Examiners were pleased to see many answers like this and had no hesitation in awarding 3 marks out of 3.

The upper magnet is reppelling the lower magnet. This is because the two North poles are facing each other, and when two ~~m~~ magnets of the same pole face eachother, the two forces repell, causing the upper magnet to float. The upper magnet is also in the presence of the lower magnets magnetic field. This causes a force to be exerted ~~onto~~ when the two magnets repel

ResultsPlus
Examiner Comments

This answer had the correct idea of **interaction** between magnetic fields for one mark and a force of repulsion for a second mark. However it did not mention the force of gravity acting downwards nor the idea of two forces being in equilibrium.

Question 5 (c)(ii)

Almost all candidates were able to correctly select and use the equation linking force, length, current and magnetic flux density.

Question 6 (b)(i)

The principle of moments was generally well understood.

The biceps muscle provides a force to balance the weight of the forearm.

The weight of the forearm can be represented as a single force.

Figure 13 shows a diagram representing the forces and distances involved.

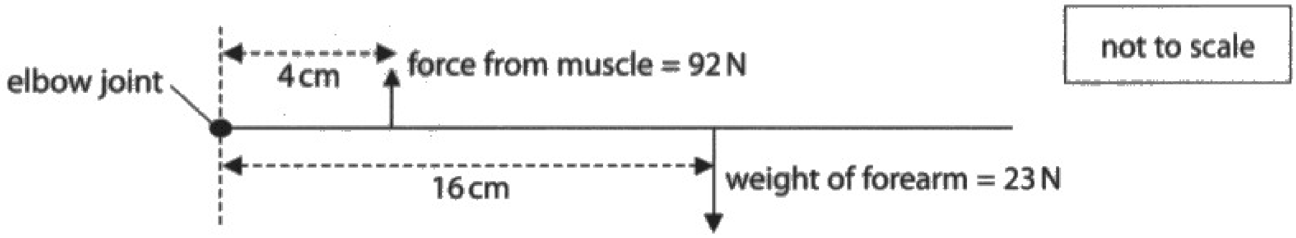

Figure 13

(i) Use the principle of moments to show that the system shown in Figure 13 is in equilibrium.

(2)

4 × 92 = 368 and 16 × 23 = 368 meaning both forces have the same moment meaning they are in equilibrium.

ResultsPlus
Examiner Comments

A clearly laid out answer that scored full marks. The question simply said "Use the principle of moments...". The answer did not need a statement that "clockwise moments = anticlockwise moments" in this case.

ResultsPlus
Examiner Tip

Show diagram and answer.

(i) Use the principle of moments to show that the system shown in Figure 13 is in equilibrium.

(2)

Clockwise moments = 16 x 23 = 368

Anticlockwise moments = 4 x 92 = 368

∴ are equal so is at equilibrium

as Clockwise moments = 368 = anticlockwise moments.

ResultsPlus
Examiner Comments

Another clear and fully correct answer that also includes the statement that clockwise moments = anticlockwise moments. Once again, it scored full marks.

Some candidates tried to answer in terms of ratios of forces and distances.

(i) Use the principle of moments to show that the system shown in Figure 13 is in equilibrium.

(2)

It's in equilibrium because the force from muscle is 4 times the weight of forearm and the two lengths are 4 times each other.

ResultsPlus
Examiner Comments

Although it is true that one force is 4 times the other and one length is 4 times the other, this answer does not mention moments and does not calculate either moment.

ResultsPlus
Examiner Tip

Questions that ask you to use the principle of moments will expect you to show a calculation of moments using force x distance.

Question 6 (b)(ii)

Candidates were required to apply the principle of moments to a scenario involving forces in a human arm. They were generally confident in doing so and most could demonstrate that the system was in equilibrium when the hand was empty and then go on to calculate the new bicep force when the hand was holding a ball. Two approaches were possible. One way was to calculate the total clockwise moment and then calculate the bicep force needed to provide an equal and opposite anticlockwise moment. A second way was to calculate the moment of the ball and then calculate the additional bicep force need to balance that moment. Then the total bicep force can be found by adding this additional force to the force already existing.

Calculate the force from the muscle that is needed to keep the system in Figure 14 in equilibrium.

(3)

$16 \times 23 = 368$

$32 \times 15 = 480$

$368 + 480 = 848$

$4 \times F = 848$

$F = 848 \div 4$

$= 212N$

force = 212 N

ResultsPlus
Examiner Comments

The total clockwise (downwards) moment has been calculated to be 848 (Nm). Then the (upwards) force required to produce an equal but opposite (anticlockwise) moment has been calculated to be 212N. Full marks.

ResultsPlus
Examiner Tip

Always try to show your working clearly as in this answer.

Calculate the force from the muscle that is needed to keep the system in Figure 14 in equilibrium.

(3)

$0.32 \times 15 = 4.8$

$3.68 + 4.8 = 8.48$

$120 + 92 = 212$

$\frac{4.8}{0.04} = 120$

force = 212 N

ResultsPlus
Examiner Comments

The candidate has converted from cm to m. This is good practice but not essential in moment calculations provided that the units are consistent all the way through.

Here the additional clockwise moment due to the ball has been found (4.8 Nm) and then the additional force from the muscle needed to balance that moment was calculated (120 N).

This was then added to the muscle force when the hand was empty (92 N) to arrive at a total force of 212 N.

Question 6 (c)(i)

Archimedes' principle when applied to flotation was poorly understood. The majority of candidates did not appreciate that for an object floating in water, the upthrust must be equal to the weight of the object regardless of the density of water.

Question 6 (c)(ii)

Although many candidates knew that seawater was more dense that fresh water, few could go on to explain that, for the same weight of water, the volume of seawater displaced would be less than the volume of fresh water. Many answers compared the density of water with the density of the ball. This may be used to explain why the ball floats but not the difference between floating in seawater and fresh water.

(ii) Explain why there is less of the ball below the surface of the seawater than below the surface of the fresh water.

(3)

~~There~~ seawater is denser than fresh water, as salt and other minerals are dissolved in it. This means that the ball needs to displace less seawater in order to float, ~~as~~ than fresh water, as it is less dense. The ball is displacing the same weight of seawater and fresh water, as it is still floating on both.

ResultsPlus
Examiner Comments

An acceptable answer. There is a mark for comparing the density of seawater and fresh water. There is a mark for the ball displacing the same weight of seawater and fresh water.

The third mark is for recognising that the ball displaces a smaller volume of seawater than fresh water. Although the candidate wrote "less seawater" rather than "smaller volume of seawater", this was acceptable in this case.

(ii) Explain why there is less of the ball below the surface of the seawater than below the surface of the fresh water.

(3)

because the sea water is denser, less volume has to be displaced ~~by~~ to ~~equal~~ keep the ball floating

ResultsPlus
Examiner Comments

Two out of three marks here. One for seawater being denser. One for less volume displaced.

(ii) Explain why there is less of the ball below the surface of the seawater than below the surface of the fresh water.

(3)

Sea water has a higher density then fresh water, This means that as the ball is placed on the sea water, ~~less volume~~ enough upthrust is generated by displacing ~~different volume~~ less volume of water than required in fresh water.

ResultsPlus
Examiner Comments

Almost three marks here. If the candidate had written "enough upthrust to equal the weight of the ball" rather than just "enough upthrust" then it would have scored full marks.

It scored 2 marks.

Question 7 (a)(i)

Although this question involved a spring being compressed rather than being extended, most candidates selected and used the correct equation linking the change in length with force and spring constant. A common error was to either ignore the fact that the extension was given in mm or convert to m incorrectly.

The question asked for the answer to have an appropriate number of significant figures. Since the values given were both to two significant figures the answer should also be to two significant figures.

7 (a) Figure 16 shows part of the inside of a pen.

The pen contains a spring that can be compressed.

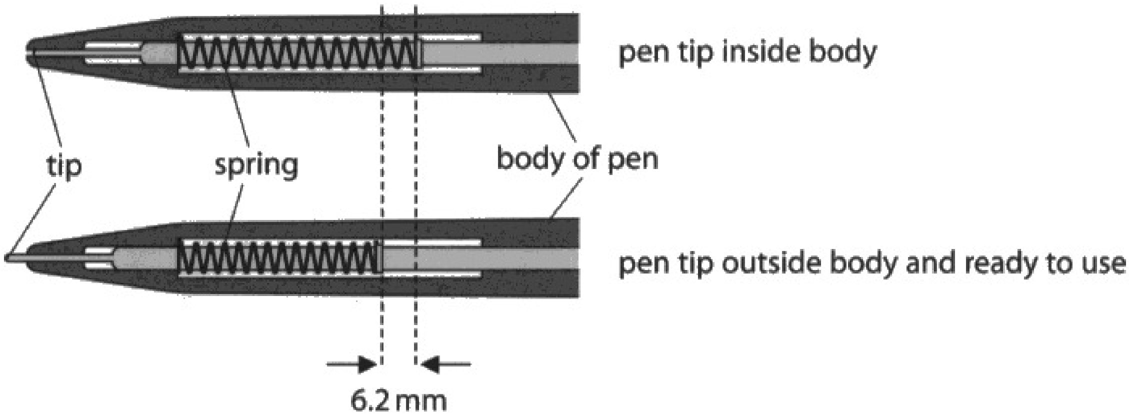

Figure 16

The spring constant of the spring is 260 N/m.

(i) Calculate the force needed to compress the spring by the amount shown in Figure 16.

Give your answer to an appropriate number of significant figures.

(3)

force exerted on the springs = spring constant × extension

= 260 × 0.062 m =

= 16.12

force = 16 N

~~6.6×10 = 66 cm~~

6.2 mm ÷ 10 = 0.62 cm ÷ 10 = 0.062 m

ResultsPlus
Examiner Comments

An almost correct answer.

The correct equation has been selected and the given values substituted to score the first mark.

The length of 6.2mm has been converted to 0.062m which is not correct (it should be 0.0062 m) and so the calculated value is wrong.

However the value obtained on a calculator, 16.12, has been correctly expressed to two significant figures: 16.

This scores a mark for knowing how to choose the appropriate number of significant figures.

2 marks out of 3

$0.5 \times k \times d^2$

$0.5 \times 260 \times 6.2 \times 10^{-3} = 0.806$

force = 0.81 N

ResultsPlus
Examiner Comments

The wrong equation has been used and so no marks for the calculation.

However the answer has been expressed to two significant figures and so scores one mark.

ResultsPlus
Examiner Tip

If you can show that you understand significant figures then you can often score a mark for this important maths skill.

(3)

6.2mm = 0.0062m

$F = k \times x$ $260 N/m \times 0.0062m = 1.612N$

$\approx 1.6N$

force = 1.6 N

ResultsPlus
Examiner Comments

A fully correct answer for the full 3 marks.

Question 7 (a)(ii-iii)

Although candidates would be familiar with the core practical investigating the extension of a spring, they may well be less familiar with investigating compression of a spring. This question assessed ability to apply understanding of practical techniques. Creditworthy suggestions often described ways of reducing parallax error such as the use of a pointer attached to the top of the spring with its tip very close to the ruler or using a flat object between finger and spring which also extended to touch the ruler. Other suggestions recognised that using a finger to apply the force would be likely to cause fluctuations that would make reading the length difficult and that this could be addressed by using a weight on top of the spring. There was, however, evidence that the difference between accuracy and precision is poorly understood with incorrect suggestions such as “use a ruler with smaller division to make it more accurate”. Candidates are advised that they should avoid describing improvements in terms of accuracy and focus on practical techniques.

(ii) A student removes the spring from the pen and investigates the compression of the spring.

Figure 17 shows the equipment and the procedure that the student uses.

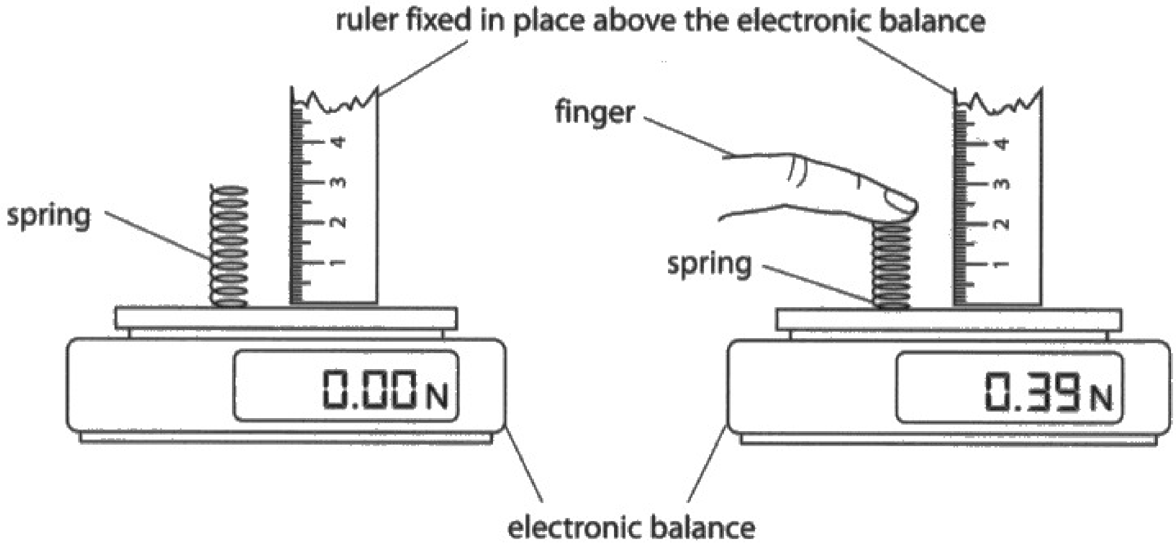

Figure 17

The student presses down on the spring to change its length.

The electronic balance measures the force applied to the spring.

Describe how the student can determine the change in length of the spring.
You may add to Figure 17 to help your answer.

(3)

Measure the length of the spring before the sodent pressed it down with a ruler, then measure the length of the ruler after it had been pressed down with a ruler then original length − final length = change length.

(iii) The student finds it difficult to make an accurate measurement of the change in length of the spring using the equipment as shown.

Describe **one** way that the student could improve the procedure.

(2)

Use a different ruler with smaller increments to accuratly measure the change in length.

ResultsPlus
Examiner Comments

The ruler shown was graduated in mm. It could not have smaller increments that could be read by eye.

No marks here

The student could move the spring closer to the ruler, to make it easier for him to measure the lengths.

ResultsPlus
Examiner Comments

There is a mark for moving the spring closer to the ruler but no second mark for how that change is used.

It needed to say something like "reduce parallax error" or perhaps "so the top of the spring is right next to the ruler".

ResultsPlus
Examiner Tip

"Make it easier" may be why you move it, but this will not score a mark. You need to say **how** it will improve, not why.

(ii) A student removes the spring from the pen and investigates the compression of the spring.

Figure 17 shows the equipment and the procedure that the student uses.

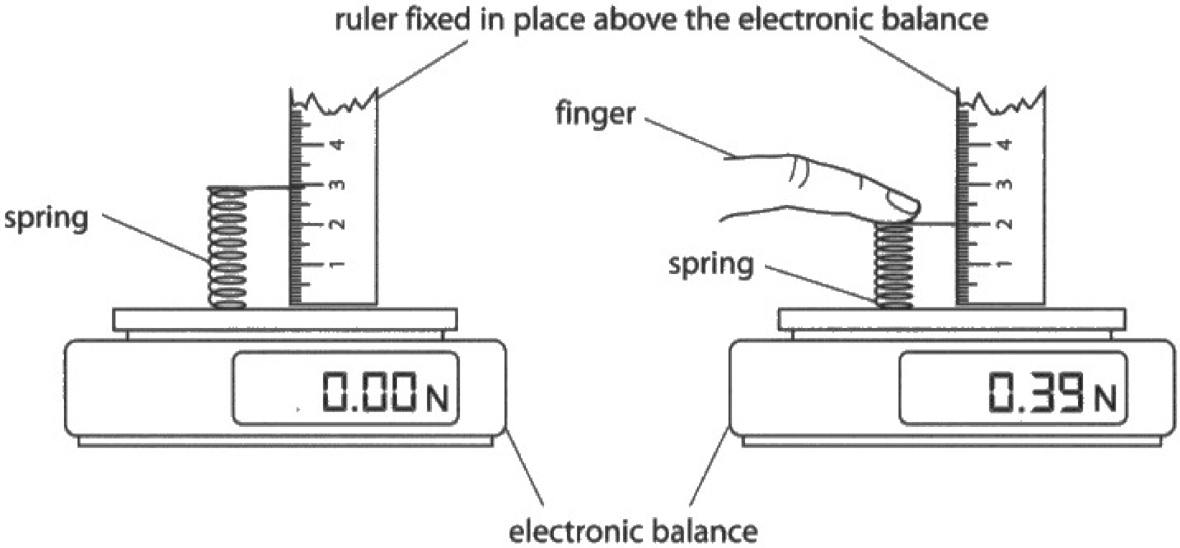

Figure 17

The student presses down on the spring to change its length.

The electronic balance measures the force applied to the spring.

Describe how the student can determine the change in length of the spring.
You may add to Figure 17 to help your answer.

(3)

Before compressing the spring measure its length on the mass with the fixed ruler then when compressing measure its length again from the bottom of your finger. then do final length - initial length to find the change in length.

(iii) The student finds it difficult to make an accurate measurement of the change in length of the spring using the equipment as shown.

Describe **one** way that the student could improve the procedure.

(2)

Use a hook and hang the spring with a fixed ruler next to it and then add know masses to the hook until the spring extends.

ResultsPlus
Examiner Comments

This was a common answer. Candidates tried to change the investigation from measuring compression as shown to one they were more familiar with: measuring the extension of a spring.

No marks here

(2)

Place a ruler or stick on top of the spring and read along it to the ruler fixed in place ~~[illegible]~~ and see where it reads.

ResultsPlus
Examiner Comments

This was a sensible suggestion which described the improvement fully.

Full marks

Describe how the student can determine the change in length of the spring.
You may add to Figure 17 to help your answer.

(3)

The student should add a force on the spring then ~~the~~ but beforehand they should have measured the original length as the student should measure the new length after the force and teake away the new length by old length then repeat this but change the amount of force

(iii) The student finds it difficult to make an accurate measurement of the change in length of the spring using the equipment as shown.

Describe **one** way that the student could improve the procedure.

(2)

Add a weight on the spring as a humans will not be able to keep a constant force applied therefore giving inaccurate results whereas a weights force will remain constant

ResultsPlus
Examiner Comments

A sensible suggestion that describes the improvement (add a weight on the spring) and how it is used (to keep a constant force).

Full marks

Describe how the student can determine the change in length of the spring.
You may add to Figure 17 to help your answer.

(3)

the student can measure the length of the spring without applying any force, then measure it whilst appying force. you can then find the difference between these lengths to find the change in length.

(iii) The student finds it difficult to make an accurate measurement of the change in length of the spring using the equipment as shown.

Describe **one** way that the student could improve the procedure.

(2)

The student could move the spring closer to the ruler or move the ruler closer to the spring so it is easier to record an accurate result.

ResultsPlus
Examiner Comments

There is one mark for moving the ruler or spring. Answers often mentioned improving accuracy. This does not score a second mark.

ResultsPlus
Examiner Tip

You will not score marks for writing about better accuracy. Usually the reason for an improvement to a procedure is to improve accuracy. You need to say **how.**

Question 8 (a)(i)

Candidates usually selected the equation to calculate kinetic energy and substituted the values given. The most common error was to not convert the calculated value from J to kJ as instructed.

(i) Calculate the kinetic energy, in kJ, of the car.

(2)

KE (J) = ½ x mass (kg) x speed² (m/s)²
= ½ x 1200 x (16.0)²
= 153600 J ⟶ 153.6 kJ

kinetic energy = 153.6 kJ

ResultsPlus
Examiner Comments

A nice clear and fully correct answer.

(i) Calculate the kinetic energy, in kJ, of the car.

(2)

$\frac{1}{2} \times \text{mass} \times (\text{speed})^2$

$\frac{1}{2} \times 1200 \times (16)^2 = 153600$

kinetic energy = 153600 kJ

ResultsPlus
Examiner Comments

The correct equation has been selected and the values given substituted to score the first mark.

However, the candidate gave the answer in J rather than converting to kJ as asked.

1 mark only

ResultsPlus
Examiner Tip

Check that you give the answer in the units stated.

Question 8 (a)(ii)

Candidates usually selected the equation linking energy, power and time and then substituted the values given. This was then usually rearranged to calculate a time in seconds. The most common error was to not convert 126 MJ into J and/or not convert the calculated value in seconds into hours as asked.

(ii) On a journey, the car transfers energy from the battery at an average rate of 17.5 kW.

The battery in the car transfers a total of 126 MJ of energy before it becomes discharged.

Calculate the time taken for the battery to become discharged on this journey.

Give your answer in hours.

(2)

power = ~~pow~~ energy transferred ÷ time taken

$\frac{126000000}{17500} = 7200\,s$ $7200 \div 60 = 120$ $120 \div 60 = 2$

time taken = 2 hours

ResultsPlus
Examiner Comments

See below.

ResultsPlus
Examiner Tip

A calculation that converted kJ, MJ and s correctly to score full 2 marks.

Give your answer in hours.

(2)

17.5 kW = 17500 W
126 MJ = 126000000 J

7200 ÷ 360 = 20

$$\frac{126{,}000{,}000}{17500} = 7200$$

time taken = 20 hours

ResultsPlus
Examiner Comments

Almost correct. MJ and kW were correctly converted but the conversion from seconds to hours was not right.

1 mark scored.

Give your answer in hours.

(2)

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

Power (W) = energy transferred (J) ÷ time taken (s)

17.5 = 126 ÷ time

$= \frac{126}{17.5} = 7.2$ (hrs)

time taken = 7.2 hours

ResultsPlus
Examiner Comments

Here the candidate has simply divided the two numbers without converting them from MJ and kW and s.

It scored 1 mark for rearranging the equation.

ResultsPlus
Examiner Tip

Look carefully at the units given; especially multiples like k (kilo) and M (Mega).

Mistakes are often made when converted values have lots of zeros.

(ii) On a journey, the car transfers energy from the battery at an average rate of 17.5 kW.

The battery in the car transfers a total of 126 MJ of energy before it becomes discharged.

Calculate the time taken for the battery to become discharged on this journey.

Give your answer in hours.

(2)

~~17.5~~ 17.5 kW = 17500 W

126 MJ = 1,2600,000

$\frac{1,26,0000}{17500} = 72$

time taken = 72 hours

ResultsPlus
Examiner Comments

Here the candidate correctly converted 17.5kW into 17500W.

The conversion for MJ was not correct (it should have six zeros not five) and then this was copied into the division with another zero missing.

There was a mark for using the correct equation but not a mark for the evaluation (which also did not convert from s to h).

ResultsPlus
Examiner Tip

Practice with your calculator using the EXP button to enter powers of ten directly rather than using lots of zeros. You are less likely to make mistakes.

Question 8 (a)(iii)

This question considered energy transfers in the context of an electric car. When the car is slowing down, the kinetic energy of the car must be decreasing and therefore how might this be used to increase the energy stored in the battery? Marks could be scored by describing energy transfer from kinetic energy to the chemical energy store of the battery as the car slows down. Although knowledge of how a dynamo works is not needed to answer this question, marks could also be scored by describing how the device, when acting as a dynamo, would cause an electric current in the wires that would recharge the battery. It was common to see answers that went into detail of dynamo construction such as split ring commutators without mentioning an electric current or recharging the battery.

(iii) Figure 20 shows an electrical device connected to the wheels of an electric car.

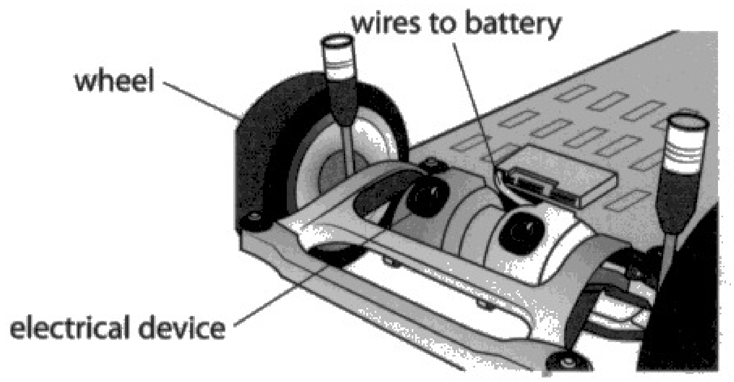

Figure 20

The electrical device is used as a motor when the car accelerates and as a dynamo when the car decelerates.

Explain how using the device can help to increase the time that the car can be driven before the battery becomes discharged.

(2)

Dynamos are direct current generators. In electric cars, when you decelerate, you can convert some of the kinetic energy back into the electrical energy store of the battery recharging it a little, which can be used to make you go further later.

ResultsPlus
Examiner Comments

This answer accurately describes the transfer between two energy stores. In the context of this question examiners would accept "electrical energy store" of the battery as well as "chemical energy store" since it was clear that there was an electrical energy pathway involved.

Explain how using the device can help to increase the time that the car can be driven before the battery becomes discharged.

(2)

Decelerating doesn't require energy from the battery, but the wheels still rotate, so the ~~use of~~ ~~a~~ dynamo will collect that excess energy to be transferred to the battery.

ResultsPlus
Examiner Comments

This answer has the idea of using energy that would otherwise be wasted for 1 mark. It does not say what energy (stores) are involved however.

Question 8 (b)(i)

This question required an evaluation using the equation linking energy transfer, voltage, current and time. Candidates could calculate the time required to transfer the given amount of energy to arrive at an answer of 21 000 s and then compare this time to 6 hours; either by converting the time of 21 000 s into 5.8 h or converting 6 h into 21 600 s. The most common error was either to fail to convert J into MJ and/or seconds into hours. Partial credit was given for comparing an incorrect time with the claimed time provided that the units of the calculated time were stated in the answer. An alternative method, chosen by only a few candidates, was to calculate the energy that could be transferred in 6 hours to arrive at an answer of 120.6 MJ and compare that to the 126 MJ required to charge battery. This was almost always done correctly with no errors in units.

Candidates could calculate the energy that could be transferred in 6 hours.

(b) The battery can be recharged at a charging point.

The charging point provides an average current of 15.0 A to the battery, at a potential difference (voltage) of 400 V.

It is claimed that 126 MJ of energy can be transferred to the battery in less than 6 hours.

(i) Comment on this claim.

Use this equation to support your answer

$$t = \frac{E}{I \times V}$$

6 hours = 21600 sec

(3)

$E = I \times t \times V$

$= 15 \times 21600 \times 400$

$= 1.296 \times 10^{8}$ J

$= 129.6$ MJ

In 6 hours 129.6MJ is provided, this means 126 MJ can be provided in under 6 hours.

ResultsPlus
Examiner Comments

A clearly laid out answer that showed 129.6 MJ could be transferred in 6 hours and so it would take less time to transfer 126 MJ.

Full marks

Candidates could calculate the time taken to transfer 126 MJ.

(i) Comment on this claim.

Use this equation to support your answer

$$t = \frac{E}{I \times V}$$

126MJ =

126,000,000J

(3)

$6 = \frac{126}{6{,}000\text{watts}}$

400 x15 = 6,000W

126,000,000 ÷ 6000 = 21,000s

21,000 ÷ 3600 = 5.8h

This statement is true as it takes

5hours and 48 minutes.

ResultsPlus
Examiner Comments

Another clear answer that scored full marks.

There was no need to state that 5 hours 48 minutes is less than 6 hours.

It was possible to score 2 marks out of three if an incorrectly calculated time was used to make a valid comment.

It is claimed that 126 MJ of energy can be transferred to the battery in less than 6 hours.

$126 mJ = 126000 J$

(i) Comment on this claim.

Use this equation to support your answer

$$t = \frac{E}{I \times V}$$

time = $\frac{\text{energy}}{\text{current} \times \text{voltage}}$

$$\frac{126\,000 J}{15 \times 400} = 21$$

$= 21$ hours

(3)

This claim is incorrect, the battery if takes 21 hours for 126mJ of energy to be transfered to ~~in~~ the battery.

ResultsPlus

Examiner Comments

Although the values given have been substituted into the equation for one mark, there are two mistakes here.

The conversion from MJ to J was incorrect and the answer was given as hours.

Nevertheless the calculated value of 21 hours is indeed more than 6 hours and so the comment, based on the calculation, is valid.

2 marks out of 3.

(i) Comment on this claim.

Use this equation to support your answer

12600000 = energy

15 = current

400 = voltage

$$t = \frac{E}{I \times V}$$

(3)

$$\text{Time} = \frac{12600000}{15 \times 400} = 2100 \div 60 = 35$$

Incorrect ~~cl~~ claim.

ResultsPlus Examiner Comments

There is a mark for substituting the given values into the equation, although there is an error in the number of zeros for energy (it should have six zeros, not five).

There also seems to be an attempt to convert the seconds into a bigger unit of time by dividing by 60.

However the candidate did not say what the calculated time units were. If it had been minutes then 35 minutes is less than 6 hours. If it had been hours then 35 hours is more than 6 hours.

The examiner could not guess what the candidate had found and so could not award the last mark for the comment.

ResultsPlus Examiner Tip

Always give units to calculated answers (unless the unit have already been printed for you).

Question 9 (a)(i)

Although the scenario which involved lifting a barrel using a pulley system was probably unfamiliar to many candidates, almost all found no difficulty in calculating the work done from the values and equation given.

Question 9 (a)(ii)

Most candidates were clearly confident in using the equation for efficiency.

Question 9 (a)(iii)

Candidates we required to consider ways in which useful work done might be less than total work done other than through friction. Acceptable answers included either doing work against gravity by raising the pulley or rope itself or doing work in stretching the rope. A large majority of candidates however suggested energy transfers such a "heat produced" or "squeaky pulley wheels" which are, of course, a result of friction.

(iii) Some energy is wasted due to friction.

Suggest **another** reason why some energy is wasted in using this pulley system.

(1)

Energy is wasted through heat.

ResultsPlus
Examiner Comments

It is true that in mechanical processes, energy is "wasted through heat". But this is due to friction. The question asked for **another** reason why energy is wasted.

(iii) Some energy is wasted due to friction.

Suggest **another** reason why some energy is wasted in using this pulley system.

(1)

The weight of the rope causes wasted energy as the person will have to lift this alongside the bana thus wasting energy.

ResultsPlus
Examiner Comments

This is a much better answer.

Question 9 (b)

Candidates were asked to devise an investigation into a pulley system which was very similar to that given in the previous part of the question. A suitable method would be to first use the spring balance to determine the weight of the metal cubes. Then attaching the metal cube and spring balance to opposite sides of the pulley system, determine the force applied by the spring balance. The ruler would be used to measure the distances moved by each end of the pulley system enabling the work done at each end of the system to be calculated. A level 1 response would describe a suitable arrangement of cubes and spring balance. A level 2 response would go on to describe some relevant measurements that could be used to find work done. A level 3 response would go on to describe how the measurements could be processed to determine the efficiency and how it varied with weight of cubes. Examiners saw a good range of responses with many at level 3. There were a significant number of candidates who seemed to describe an investigation into the stretching of a spring and simply attached the cubes to spring balance without using the pulley system. Answers such as this would sometimes have sufficient detail to reach the lower end of a level 2.

*(b) A student has the equipment shown in Figure 22.

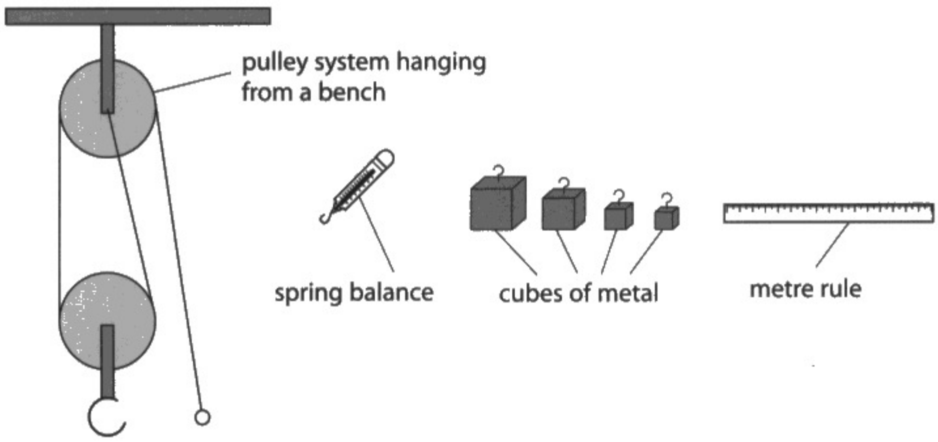

Figure 22

Devise an experiment to investigate how the efficiency of the pulley system varies with the weight of metal being lifted.

Your answer should include how you will use your measurements.

(6)

Hook the Spring balance onto the pulley System. Place the Meter rule vertically and next to the Spring balance. ~~Add~~ Add Cubes of Metal to the bottom of the pulley System. ~~record the~~ record the results of the Spring balance and Meter rule, place more weight onto the experiment to get more results. Make Sure you ~~m~~ take the Measurements at eye level to ensure accuracy

ResultsPlus
Examiner Comments

This level 1 answer describes how the equipment is used. However, there is no description of how data is obtained other than “record the results of the spring balance” which does not say what is being measured nor when the measurement is being made. If the candidate had written "pull with a spring balance and take a reading from it" then benefit of doubt could be given and the answer would have been at the lower end of level 2.

2 marks

Many answers described obtaining some data but the data could not be processed in the way suggested in the rest of the answer.

Connect the spring balance to the end of the pulley rope. Attatch a cube of metal to the hook at the ~~one to the left~~ end of the one you will be lifting. ~~put the~~ Use the meter ruler to measure how high the metal block is pulled. Note the value on the spring balance and repeat all again with the other 3 ~~4~~ cubes, whilst using the meter ruler to pull them up the same height (to make it a fair test). Use ~~[illegible]~~ ~~determine~~ $E = \frac{1}{2} \times K \times x^2$ to determine energy transfered and then efficiency $= \frac{\text{useful energy transfered}}{\text{total energy transferred}}$.

ResultsPlus
Examiner Comments

This level 2 answer describes how the equipment is used. It also shows how some data is obtained; measure how high the block is pulled and read the spring balance when it is pulled.

However this data cannot be processed in the way suggested (using the formula ½ k x^2) since the value of k is not known.

4 marks

Attach ~~the~~ a metal cube to the bottom of the pulley and attach the spring balance to the rope. Using the metre rule ~~measure~~ ~~pu~~ and the spring balance pull the metal cube up 1m and measure the reading on the spring balance. Repeat for all 4 cubes. Then, using the weight of the blocks and the formula work done = force × distance, calculate the work done ~~on~~ on the blocks. Next use the same formula with readings from the spring balance to find work done by the person. Now use the efficiency formula (efficiency = $\frac{\text{work done on the blo}}{\text{work done by the person}}$ ×100) to find the ~~e~~ efficiency. Repeat calculations for all 4 blocks and compare results.

(Total for Question 9 = 11 marks)

ResultsPlus
Examiner Comments

This level 3 answer clearly describes how the equipment is used and how to obtain data: use a metre rule to measure the distance the metal cube rises and use the weight of each cube. This data could be processed in the way described to determine the work done on the cube. The spring balance readings would give the force required by the person, but there is no mention of measuring the distance moved by the spring balance and so the work done by the person cannot be found. Nevertheless, the mark scheme allows for credit being given for using the efficiency equation provided at least one value for work done can be calculated, which is indeed the case in this answer.

6 marks

Question 10 (a)(ii)

Very many candidates attempted to answer this question in terms of electrical quantities such as current, voltage and resistance. However, it appeared that electrical resistance was being seen in terms of resistance to motion and it was very common to read answers that stated that the lamp would increase resistance in the circuit. This is incorrect since a lamp has very much less resistance than a voltmeter. Examiners were looking for the idea that the lamp required an energy transfer to produce light and this additional energy must be provided by doing additional work in turning the dynamo. It was also possible to gain credit from a discussion of how an induced current in the rotating coil in the dynamo produces a magnetic field that interacts with the field of the magnet in the dynamo in a way that opposes the movement of the coil. Examiners saw very few examples of this.

(ii) The teacher connects the dynamo to a lamp.

It is now more difficult for the teacher to rotate the handle.

Explain why it is more difficult to turn the dynamo when it is connected to a lamp.

(2)

This is because more energy must be produced to transfer light energy to the lamp therefore it takes more energy from the teacher to rotate the handle therefore they will have to work harder meaning it will be more difficult.

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A complete answer that scored the full 2 marks

(ii) The teacher connects the dynamo to a lamp.

It is now more difficult for the teacher to rotate the handle.

Explain why it is more difficult to turn the dynamo when it is connected to a lamp.

(2)

the dynamo is supplying the lamp with energy /current, so the handle needs to be turned more to increase the turning of the coil, this ~~to~~ increases the current and p.d in relation to the increased demand from the lamp.

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Examiner Comments

This has the idea of energy be transferred in the lamp for 1 mark but describes the handle needing "to being turned more" which is too vague for another mark.

(ii) The teacher connects the dynamo to a lamp.

It is now more difficult for the teacher to rotate the handle.

Explain why it is more difficult to turn the dynamo when it is connected to a lamp.

(2)

There is more resistance in the circuit. which makes it harder to generate current.

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Examiner Comments

This type of answer was seen very often. With just a voltmeter in the circuit there would be almost no current in the circuit. The resistance of a voltmeter is extremely high. Changing the voltmeter for a bulb decreases the resistance.

Question 10 (b)

Candidates were clearly familiar with the transformer equations and almost all answered this question correctly.

Question 10 (c)

Candidates were required to compare the actions of a loudspeaker with a microphone. The simplest level 1 response would describe a loudspeaker producing sound waves and a microphone accepting sound waves. A level 2 response would describe the motion of movable cone in terms of electrical signals received and produced. A level 3 response would go on to discuss the interaction between the magnetic field around the coil and the magnetic field of the magnet. Examiners saw very many level 3 answers, often with great detail about the relationship between the frequency of the sound waves and the frequency of the alternating current signal in the coil. Level 2 responses tended to describe the principles of operation of the loudspeaker more fully than those of the microphone.

*(c) Figure 26 shows a picture of an electrical device and a simplified drawing of the important parts.

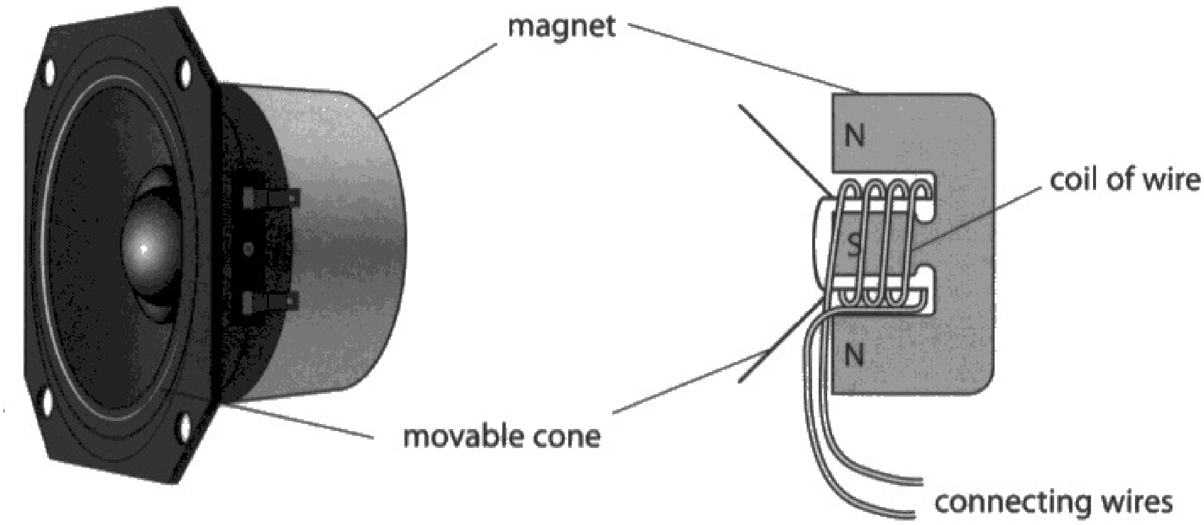

Figure 26

The device can be used as a loudspeaker or it can be used as a microphone.

Compare how the device operates when used as a loudspeaker with how the device operates when used as a microphone.

(6)

When the device operates ~~a loud~~ as a loudspeaker, it outputs the sound sensed from the microphone whereas, when ~~it's~~ it operates as a microphone, it ~~ia~~ takes in the sound which is then ~~oup~~ outputted by the loudspeaker. The speaker acts as a receiver to the microphone and the microphone is the ~~tras~~ ~~tram~~ transmitter.

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This is a typical answer at Level 1. There are two basic facts but no principles or details of how either device operates.

2 marks

~~[illegible]~~ microphones produce electrical currents identical to the sound waves, whereas loudspeakers produce sound - waves identical to the electical currents. For microphones, the soundwaves enter the cone ~~[illegible]~~ and cause the diaphragm to vibrate, this induces a current due to electromagnetic induction and the current is sent through the connecting wires. For loudspeakers, the current produces vibrations in the diaphragm which cases the movable cone to vibrate, which produces soundwaves identical to the current.

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Examiner Comments

This answer gives some principles of operation of the microphone by mentioning electromagnetic induction. It also mentions a principle of the loudspeaker by describing vibrations of the cone producing sound waves.

This is a typical Level 2 response.

To reach Level 3 it would need further details; perhaps explaining how electromagnetic induction is a result of a coil moving in a magnetic field.

This Level 3 answer gives details of how the loudspeaker operates. It describes the interaction of the field produced by the coil and the field of the magnet which results in vibrations. The details of operation of the microphone is less complete but still has a description of the principles of the induced current in the coil.

It was acceptable for the details of one device to be less complete than the other provided they were both referenced.

For a loudspeak, it requires alternating current. The alternating current in the coil of wire produces a magnetic field, which interact with the magnetic field of the magnet, causing the movable cone to vibrate as the magnetic field change direction, producing a force. The force leads to the vibration of cone, causing vibration in air particles to produce sound waves. Oppositely, for a microphone it uses the vibration of movable cone from sound wave to move the coil of wire. The coil of wire in a magnetic field is induced with alternating current as it moves back and forth. Therefore alternating current is produced through microphone.

(Total for Question 10 = 12 marks)

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Examiner Comments

See above.

Paper Summary

Overall this exam gave ample opportunity for candidates to display their knowledge and understanding at grades 4-9; particularly in the topic areas of electricity, electromagnetism and forces. Less confidence was shown in the understanding of Archimedes' principle and energy transfers other than “kinetic to potential and thermal”.

Based on their performance on this paper candidates should make the most of opportunities afforded in school laboratories where they become acquainted with practical work from the specification. This concerns both core practicals and the suggested practicals. It would benefit candidates to always question ‘What is the purpose of this experiment?’, making sure that they are clear in their minds about it.

The use of wrong units caused candidates to miss out on some marks. Candidates do need to know what the S.I. prefixes stand for. In this exam even the prefixes kilo and Mega were not known by some candidates.

Candidates seem to need more practice on handling powers of ten in their calculations. They should be able to use their calculators with numbers in standard form when needed. It often helps to put answers in standard form rather than risk writing too many or too few 000s in an answer.

Candidates also need to have the mathematical skill of being able to round off results of calculations to an appropriate number of significant figures.

In constructing explanations, candidates need to take note of the marks allocated to a particular question and respond with a corresponding number of points in their answer.

Candidates should take opportunities, where they can, to use diagrammatic illustrations to aid and prompt their explanations.

Grade boundaries

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

https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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