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Examiners' Report
June 2023

GCSE Combined Science 1SC0 2PH

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Introduction

This was the second examination of paper 2, at higher level, for this specification.

Questions were set to test candidates ' knowledge, application and understanding from these 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 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. The inclusion of questions designed at targeting candidates ' knowledge and understanding of practical work continued. This included assessing their fundamental knowledge of practicals specified in the specification, together with further application, especially where they were asked to propose improvements to a procedure as in Q4(a)(iii).

The six-mark question, Q06c, tested their ability to devise an experiment in an unfamiliar situation.

Candidates coped well with most questions and did particularly well in the questions asking for calculations using equations.

Students ' knowledge of practical work shows improvement.

Successful candidates were:

- well-acquainted with the content of the specification
- had been engaged with practical work during their course
- competent in quantitative work, especially in using equations
- willing to apply physics principles to the novel situations presented to them
- recognised key command words such as “describe” and “explain” and constructed their responses accordingly
- 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
- misread and/or misunderstood the symbols used in equations
- failed to set out calculations in a logical way that could be easily followed
- did not focus sufficiently on what the question was asking
- found difficulty in applying their knowledge to new situations.

Question 1 (a)

In this opening question, examiners were looking for a voltmeter connected in parallel with the iron wire and an ammeter connected in series with the iron wire.

Most candidates scored at least 1 mark for the ammeter with a much smaller number, showing a correctly connected voltmeter, scoring 2 marks.

1 (a) Figure 1 shows some of the apparatus that students use to determine the resistance of a piece of iron wire.

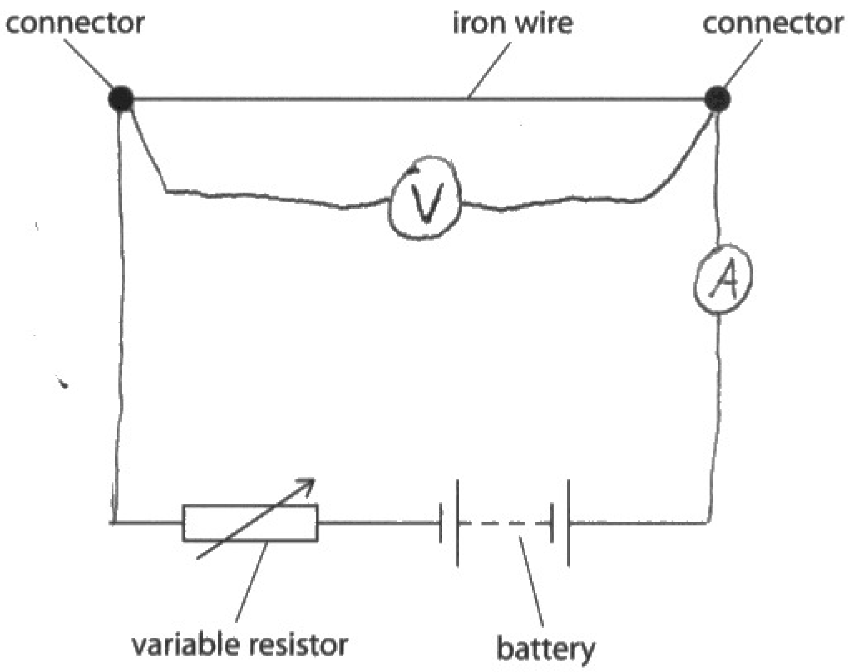

Figure 1

Add connecting wires, a voltmeter and an ammeter to complete the circuit in Figure 1 so that the students can determine the resistance of the piece of iron wire.

(2)

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Both meters connected correctly.

2 marks.

Question 1 (b)(i)

Fewer than half of candidates suggested a correct answer such as a metre rule for measuring the length of the wire.

Question 1 (b)(ii-iii)

The vast majority of candidates scored full marks here for a correctly drawn line of best fit and for estimating the resistance of 100 cm of wire from the graph.

(ii) Figure 2 shows a graph of the results.

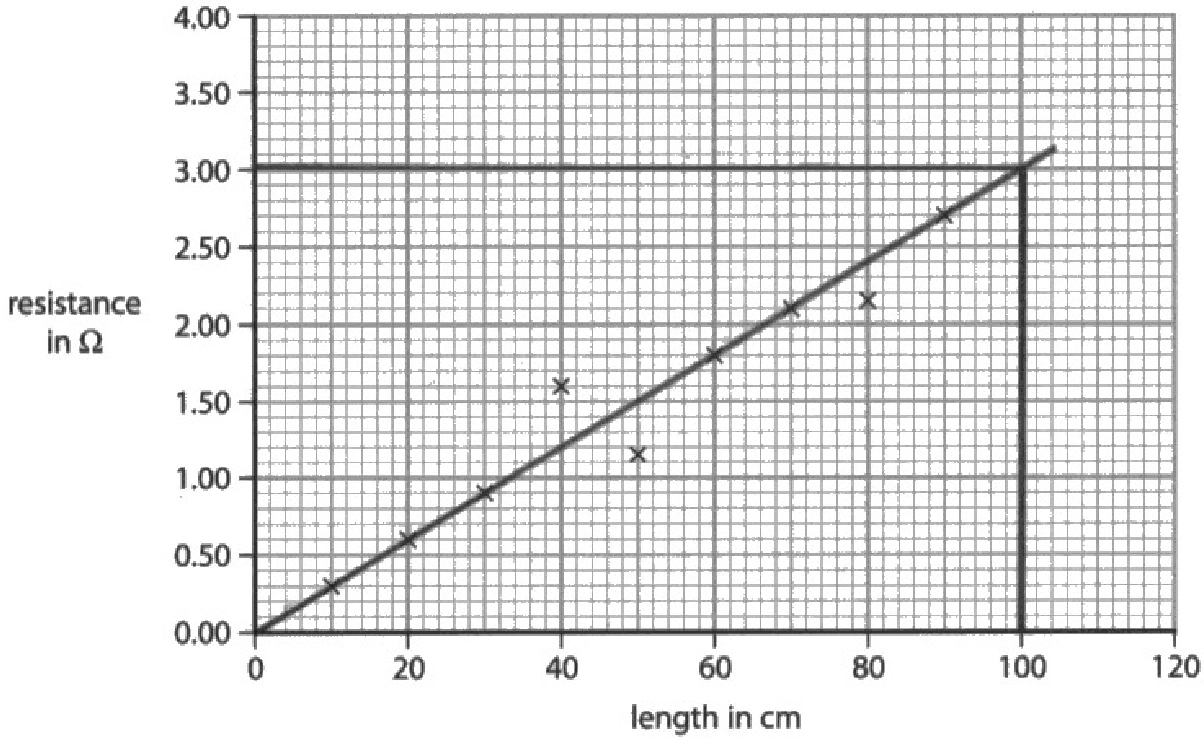

Figure 2

Draw a straight line of best fit on Figure 2.

(1)

(iii) Use Figure 2 to estimate the resistance of a 100 cm length of the iron wire.

(1)

resistance = 3.00 Ω

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Examiner Comments

Even though the lines are a bit heavy, this scores full marks.

2 marks.

Question 1 (b)(iv)

This proved to be challenging. Examiners were looking for a a connection between current and increase in temperature linked with the idea that the variable resistor could increase the resistance or keep the current small(er).

Fewer than half of candidates scored 1 or more marks.

(iv) The variable resistor shown in Figure 1 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)

An iron wire becomes to hot when too much current is flowing through it. Therefore a variable resistor prevents this by preventing too much current from flowing through the wire.

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This response links current and temperature and says that the variable resistor can keep the current low.

2 marks

Question 1 (c)

This was a straightforward calculation, involving a common rearrangement.

As expected, most candidates scored full marks for this.

(c) The potential difference (voltage) across another piece of wire is 1.56 V.

The current in the wire is 0.45 A.

Calculate the resistance of this piece of wire.

Use the equation

$$V = I \times R$$

(2)

V
I R

PD = 1·56V

C = 0·45A

R = ?

R = V / I

= 1·56 / 0·45

= 3·46̇

resistance = 3·47 Ω

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Examiner Comments

This response shows the rearrangement first then the substitution and successful evaluation.

2 marks.

Question 2 (b)

Most candidates were able to give the correct answer of 2680 with the correct unit of kg/m ^{3} .

The most common errors were an incorrect evaluation of the powers of ten, but these were rare, or failing to recall the correct unit for density eg using kg/m^{2} and this was even rarer.

(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

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

State the unit.

$$\frac{7.22 \times 10^{-2}}{2.69 \times 10^{-5}}$$

$= \cancel{264}\ 2684.01487$

$= 2684$

(3)

density = 2684 unit kg / m^3

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This is a good example of how to approach a calculation like this, including the unit.

3 marks.

Question 2 (c)(i)

Candidates found this item surprisingly difficult. Most candidates were unable to recall that 660 – (-273) = 660 + 273 = 933 °C.

The most common error was to subtract, ie 660 – 273 = 387 °C.

Question 2 (c)(ii)

The majority of candidates scored 1 mark on this question. This was usually for stating that the particles were moving freely or in random motion. The idea that particles were touching or sliding over each other was also well known. Those scoring 2 marks usually had both these ideas.

Question 2 (d)

This was well answered by many of the candidates. Many candidates were able to describe taking a reading of the water level in the measuring cylinder without the metal and then to subtract the two readings/volumes.

(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 took away the new volume of water from the old volume of water.

2 I took a reading of the water level before I put the piece of metal in.

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Correct answers, even if they are in the wrong order (allowed in the mark scheme).

2 marks.

Question 3 (a)

Here examiners were looking for at least 4 lines of the correct 'shape' between the N poles of the magnets with at least 2 arrows drawn on the lines, pointing away from the N poles.

The most common errors were drawing too many lines with the consequence that some lines overlapped, or drawing too many arrows and having at least one drawn in the wrong direction.

Just over half of the candidates scored at least 1 of the 2 marks available.

3 (a) Figure 3 shows two magnets with their N poles facing each other.

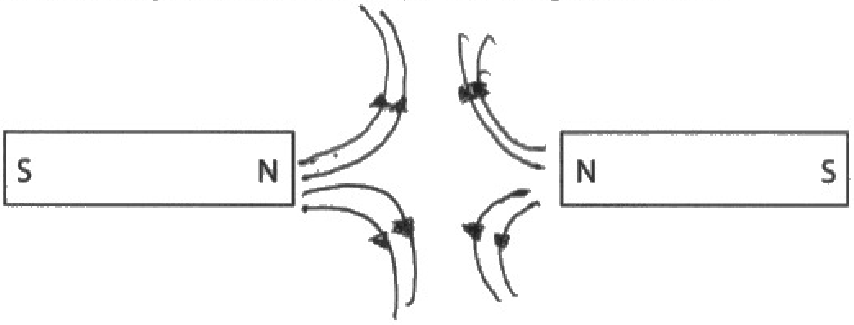

Figure 3

On Figure 3, draw the shape and direction of the magnetic field between the two magnets.

(2)

Even though the arrows do not touch the magnets, this is clear enough for both marks.

2 marks.

Question 3 (b)

This item was well answered by many of the candidates. Most candidates were able to state that like poles repel and so scored at least one mark. Many went on to state that this was due to the interaction of the magnetic fields of the 2 magnets to score a second mark. Far fewer were able to state that the repulsion must be balanced by the downward force due to gravity on the upper magnet.

(b) Figure 4 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.

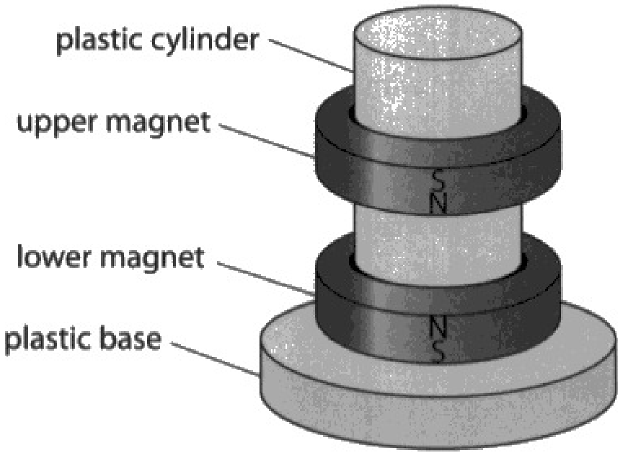

Figure 4

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 and lower magnet are repelling each other causing them to move away. the upper magnet is being prevented from moving further by gravity. both forces are in equilibrium causing the to ~~to~~ levitate

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Examiner Comments

Magnets repelling each other scores 1 mark.

Upper magnet being prevented from moving further by gravity scores 1 mark

Forces in equilibrium scores 1 mark.

Total 3 marks.

Question 3 (c)(i)

Fleming's left-hand rule applied to this situation gives

- force on the wire up(wards) or out(wards) from the magnet
- force on the magnet down(wards) or in(wards)

Fewer than half of the candidates scored 1 or more marks on this question.

Question 3 (c)(ii)

This was well answered by many candidates. Most were able to select the correct equation, substitute the correct values, then rearrange and get the correct answer.

(ii) The force on the wire is 0.15 N.

The current in the wire is 2.7 A.

The magnet produces a field with a magnetic flux density of 0.50 T.

Calculate the length of the wire in the magnetic field.

Use an equation selected from the list of equations given at the end of the question paper.

$$\frac{F}{B \times I} = l$$

(2)

$$F = B \times I \times l$$

$$0.15 = 0.50 \times 2.7 \times l$$

$$\frac{0.15}{0.5 \times 2.7} = l$$

length of the wire in the magnetic field = 0.11 m

ResultsPlus Examiner Comments

Clear steps in the working, leading to the correct answer.

2 marks

Question 4 (a)(i)

This was a calculation using the Hooke's law equation but with a spring in compression. Data had to be taken from the diagram, with a unit change for the compression. Candidates were asked to give their answer to an appropriate number of significant figures.

Most were able to score 1 or 2 marks with only a few scoring all 3 marks.

4 (a) Figure 6 shows part of the inside of a pen.

The pen contains a spring that can be compressed.

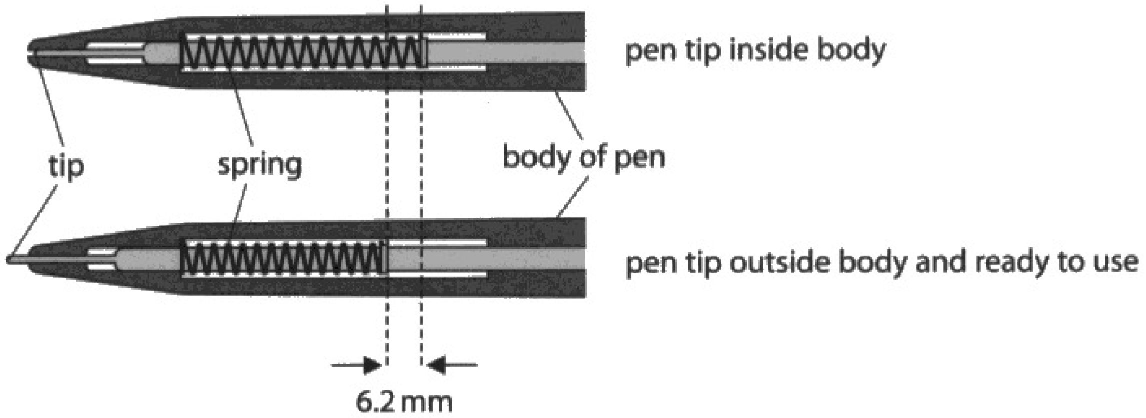

Figure 6

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 6.

Give your answer to an appropriate number of significant figures.

(3)

$F = k \times x$

$F = 260 \times 6.2 \times 10^{-3} = 1.612$

force = 1.6 N

$\frac{6.2}{1000} = 6.2 \times 10^{-3}$ m

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Examiner Comments

Clear working and unit conversion with the correct answer to 2 significant figures.

Question 4 (a)(ii-iii)

A practical based question in which candidates had to describe how to determine the change in length of a spring under compression and describe one way in which the procedure could be improved.

Most candidates, as expected, were able to score at least 3 of the 5 marks available.

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

Figure 7 shows the equipment and the procedure that the student uses.

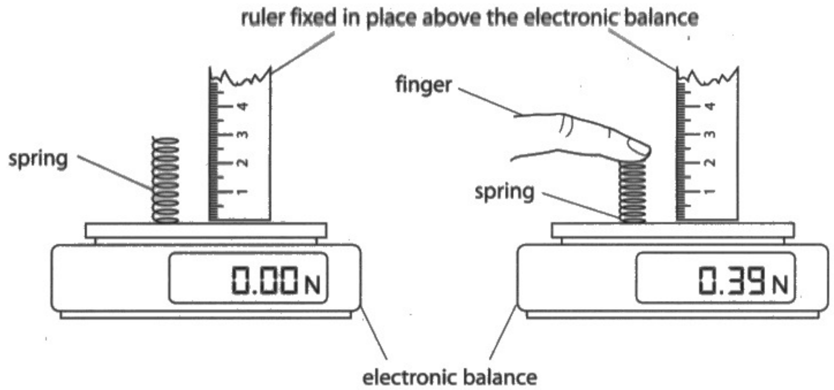

Figure 7

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 7 to help your answer.

(3)

before acting the force measure and look at the spring height in eye level and when compressing it measure and look again ~~at~~ in eye level, after height subtract before height to get the overall 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 weight or mass block to compress it instead as a finger has unequal and uneven level it's hard to tell the mark using a weight placing ~~on~~ on top can clearly see where the mark is at

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Examiner Comments

The description in (ii) is a little jumbled but still correct. In (iii) a suitable improvement is suggested.

In (ii), saying that the reading should be taken at eye level would also be on the way to an acceptable improvement.

Question 4 (c)

Finding a resultant force by completing a diagram was not well known, with fewer than half of candidates scoring any marks and only a few scoring 2.

(c) Figure 9 shows two forces, P and Q, acting at point X.

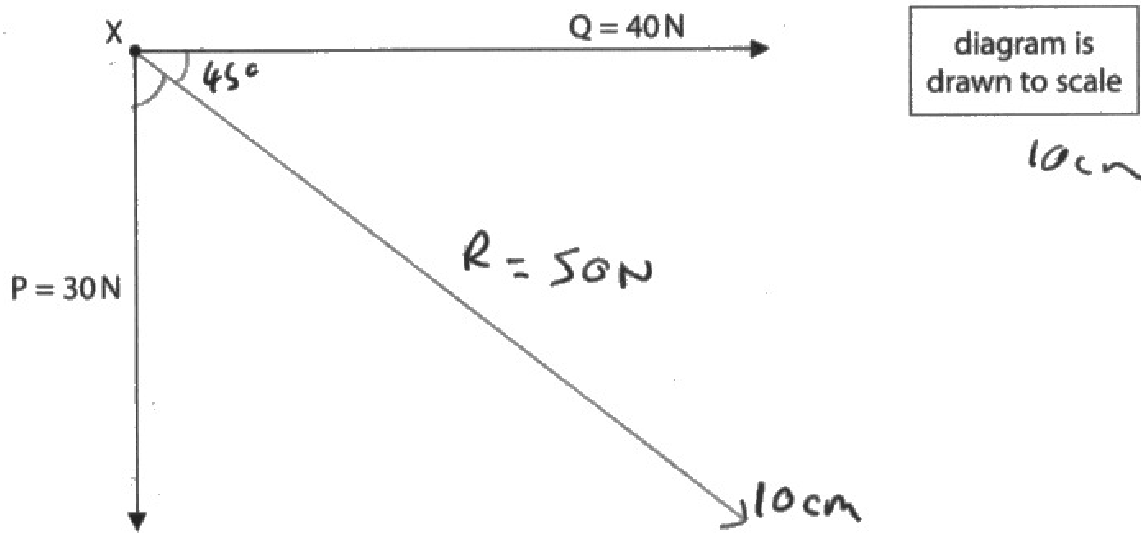

Figure 9

Complete the diagram in Figure 9 to show the size and direction of the resultant force, R, on point X.

(2)

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Examiner Comments

A clearly labelled arrow in the right direction with the value of the resultant force shown.

2 marks.

Question 5 (a)(i)

Candidates had to calculate the kinetic energy, in kJ, of a car.

Most could select the correct equation and substitute the correct values into it, scoring the first mark.

The majority of those candidates did **not** go on to convert their answer to kJ.

5 (a) An electric car is travelling at a speed of 16.0 m/s.

The total mass of the car is 1200 kg.

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

(2)

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

153.6 ~~Kg~~

kinetic energy = 153.6 kJ

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This was one of the relatively few responses that scored full marks.

2 marks.

Question 5 (a)(ii)

A complex calculation involving selecting and rearranging the equation and units involving MJ, kW and seconds with the answer requiring the unit to be given in hours.

A significant number of candidates were unable to select a relevant equation. Most scored at least 1 mark but, of those, only a small number went on to score both marks.

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

$E = 5 \times T$

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 → En.~~ Work ÷ time.

$E = QV$

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

$\frac{E}{P} = \frac{126\text{MJ}}{17.5\text{kW}}$

$\frac{126000\text{kJ}}{17.5\text{kW}} = 7200\text{s}$

$\div 60 = 120\text{M}$

$\div 60 = 2\text{h}$

time taken = 2 hours

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This response selected and rearranged the correct equation then did the substitution, converting the energy to kJ and leaving the power in kW.

The evaluation was first in seconds and then converted to hours.

A logical approach to a potentially difficult question.

2 marks.

Question 5 (a)(iii)

This was intended to be a challenging question in which candidates were required to analyse the changes in the way energy is stored when a system changes which in this case was a car slowing down.

Examiners were looking for references to the decrease in the kinetic energy of the car eventually contributing to recharging the battery.

The majority did not score but of those that did score an encouraging number scored both marks.

(iii) Figure 10 shows an electrical device connected to the wheels of an electric car.

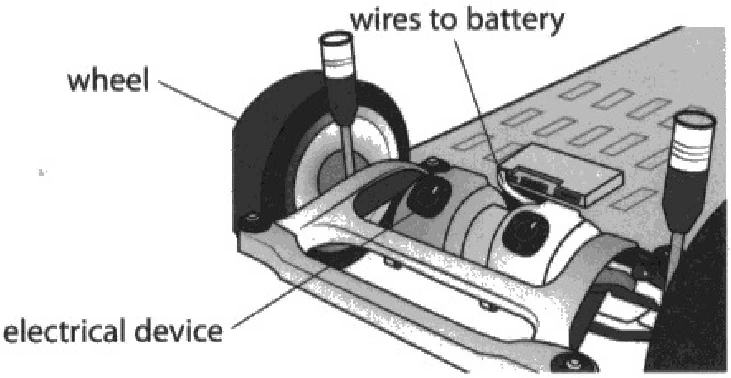

Figure 10

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)

When the car decelerates the kinetic energy is transferred to chemical energy in the battery and recharges it.

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A good analysis of the situation scoring both marks.

2 marks.

(iii) Figure 10 shows an electrical device connected to the wheels of an electric car.

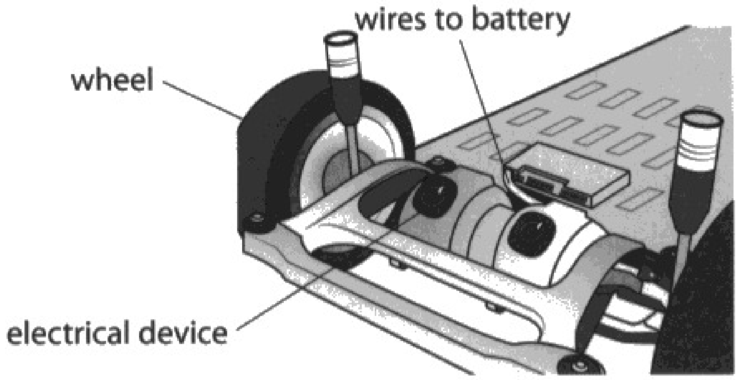

Figure 10

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)

kinetic energy From the Movement of the wheels can ~~t~~ be transfered into the device where it is added to the energy in the battery, increasing the batery life.

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The meaning here is perfectly clear and is worth full marks.

2 marks.

Question 5 (b)(i)

Candidates had to comment on a claim about the recharging time for a battery. They were given an equation to use in support of their comments.

If they made errors in their calculation, credit could still be gained for their comment, provided they were clear about the units involved.

Most candidates scored at least 1 mark with many going on to score 2 or 3.

(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

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

(3)

$$\frac{126{,}000{,}000}{15 \times 400} = 21000\,s$$

21,000 s
$5.8\dot{3}$ hr

This claim is true as it takes
$5.8\dot{3}$ hrs which is less than 6 hours

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This candidate calculates the recharging time correctly and in a unit that allows them to make a correct comment about the claim.

Question 5 (b)(ii)

This was a calculation where candidates had to refer back to the start of part (b) to get the relevant data.

Most were successful in this, scoring at least 1 of the 2 marks available.

(ii) Calculate the total charge that moves into the battery while it is being recharged.

Use the equation

$$E = Q \times V$$

(2)

$126,000,000 = Q \times 400$

$Q = \frac{126000000}{400}$

$= 315000$

charge = 315 000 C

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Examiner Comments

Correct data selected and the equation manipulated in correct units, resulting in the correct answer.

2 marks.

Question 6 (a)(i)

A straightforward calculation using a given equation but involving a rearrangement.

Most candidates scored full marks.

6 (a) Figure 11 shows a pulley system that enables a person to lift a heavy barrel.

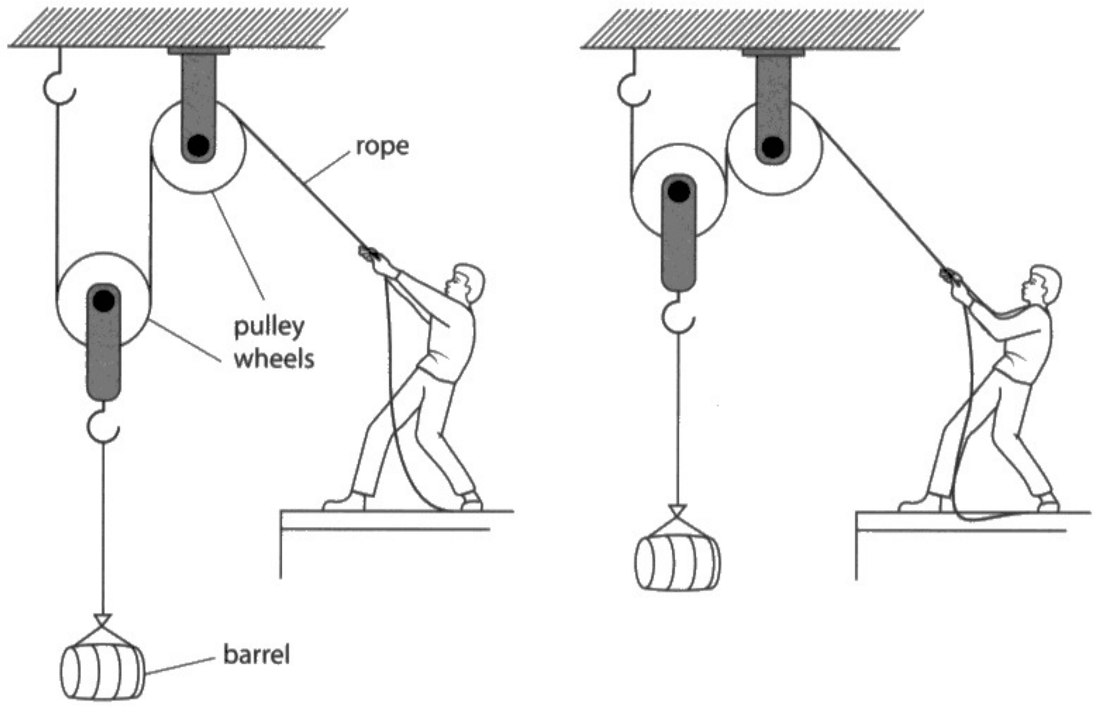

Figure 11

The person pulls down on the rope to make the barrel rise through 1.2 m.

The work done against gravity on the barrel is 1800 J.

(i) Calculate the weight of the barrel.

Use the equation

work done = force × distance moved in the direction of the force

(2)

~~work done = 1800J × 1.2m~~

~~work done = 2160N~~

$1800J = x \times 1.2$

$\frac{1800}{1.2} = 1500N$

weight of the barrel = ~~2160~~ 1500 N

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Clear substitution, rearrangement and correct answer.

2 marks.

Question 6 (a)(ii)

A more complex calculation using a given equation and rearrangement but still more than half the candidates scored at least 1 of the 2 marks available.

(ii) The efficiency of the system is 64%.

Calculate the total work done by the person.

Use the equation

$$\text{efficiency} = \frac{\text{(work done against gravity on the barrel)}}{\text{(total work done by the person)}} \times 100\%$$

(2)

$$64 = \frac{1800}{\text{total work done}} \times 100$$

$$\frac{180{,}000}{64} = \text{total work done} = 2812.5$$

work done = 2812.5 J

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Examiner Comments

This response shows the substitution first then the rearrangement followed by the correct answer.

Question 6 (a)(iii)

Here candidates had to suggest how energy might be lost in this system, other than energy wasted due to friction.

It was expected that this would be challenging and, in the event, it proved to be even more challenging than expected.

(iii) Some energy is wasted due to friction.

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

(1)

Energy could be wasted from the rope stretching.

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This was a good suggestion, referring to the rope stretching.

1 mark.

(iii) Some energy is wasted due to friction.

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

(1)

Because energy is also being used to pull up the pulley wheels

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This was good enough for energy used in lifting the bottom pulley.

1 mark.

Question 6 (b)

Part (b) was an open extended response question where candidates were asked to devise an experiment in an unfamiliar situation, an investigation into the efficiency of a pulley system. Part (a) was about a similar pulley system.

To achieve level 1, candidates had to mention at least two uses of relevant equipment.

To achieve level 2, candidates had to give details of at least **two** methods of obtaining relevant data, using the equipment.

To achieve level 3, candidates had to give details of at least **two** methods of obtaining relevant data, using the equipment and at least **two** descriptions of processing that data.

The majority of candidates were able to achieve level 1 or level 2 with only a few reaching level 3.

This response gives two methods of obtaining relevant data, using the equipment, ie measuring the weight of the cubes with the spring balance and measuring the height through which the cube moves.

The response then goes on to provide two descriptions of processing that data, ie finding the work done on the cube and using that in the efficiency equation.

Level 3, 6 marks.

*(b) A student has the equipment shown in Figure 12.

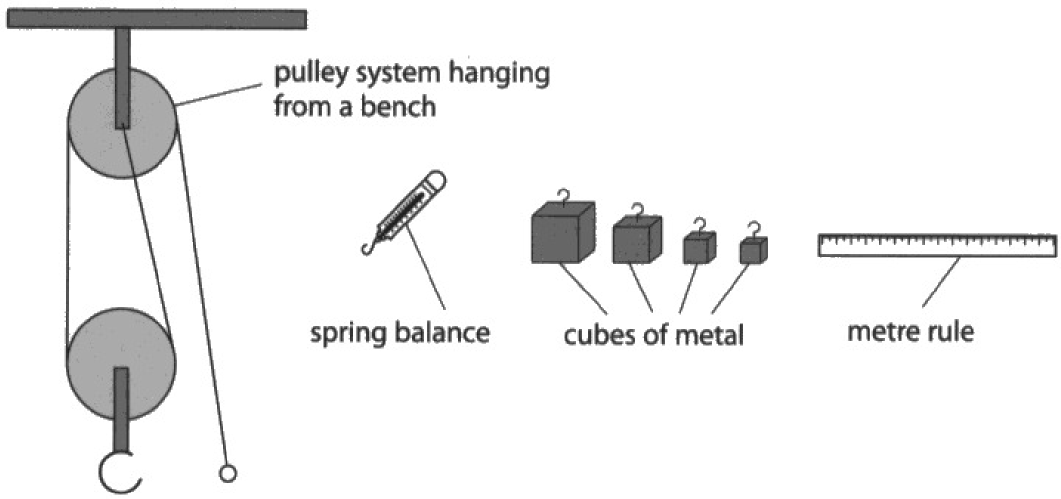

Figure 12

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)

• Using the spring balance, measure the weight of the smallest metal cube.

• Put cube of pully ~~att~~ and pull to a specific height ~~chosen to be used~~ that will not change throughout experiment, use ruler to make sure its at exact ~~bia~~ height.

• Use the height it rises and weight of cube~~s~~ to find~~s~~ out the work done. (force × distance moved)

• Use the work done to find out efficiency.

$\frac{(\text{work done})}{\cancel{(\text{us}}(\text{total work done by person})} \times 100\% = \text{efficiency}$

• Repeat experiment using different sized cubes.

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See above.

Paper Summary

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

1. Make sure that they have a sound knowledge of the fundamental ideas in all the topics
2. Get used to the idea of applying their knowledge to new situations by attempting questions in previous examination papers
3. When describing a practical procedure, draw a labelled diagram to help their answer
4. When suggesting improvements or extensions to a practical procedure, make sure they are relevant to the context of the question.
5. Q4(a)(iii) Where a question involves a calculation, make sure they write down the equation they are using (if not given in the question) and show each step in their working.
6. Make sure that they recognise SI prefixes such as m and k and n and how to handle these in calculations.
7. Use the marks at the side of a question as a guide to the form and content of their answer.

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