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Examiners' Report
June 2018

GCSE Science 1SC0 2PH

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Introduction

This was the first examination of paper 2, at Higher Level, for the new specification. Questions were set to test candidates' knowledge, application and understanding from these 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. There was a new emphasis, too, in the inclusion of questions designed at targeting candidates' knowledge and understanding of practical work. 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. The assessment of candidates' mathematical skills involved recall of some equations and became more demanding as the paper progressed. There was one extended open response questions, worth six marks.

Successful candidates:

- were well-acquainted with the content of the specification
- had been engaged with practical work during their course
- were competent in quantitative work, especially in being able to recall and rearrange equations and use numbers in standard form
- recognised key command words such as "describe" and "explain" and constructed their responses accordingly.
- were willing to apply physics principles to the novel situations presented to them

Less successful candidates:

- had gaps in their knowledge of the topics of this paper
- had gaps in their procedural knowledge, relating to their practical work
- failed to set out calculations in a logical way that could be easily followed by the examiner.
- 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 misconceptions, with the aim of aiding future teaching of these topics.

Question 1 (a) (i)

This question was based on a core practical: the determination of the specific heat capacity of water. Candidates were given a drawing of apparatus that could be used and were required to state, for one mark each, the three quantities that needed to be measured. An additional mark was given for clear detail of how at least one of those measurements could be made.

1 (a) A student uses the apparatus in Figure 1 to determine the specific heat capacity of water.

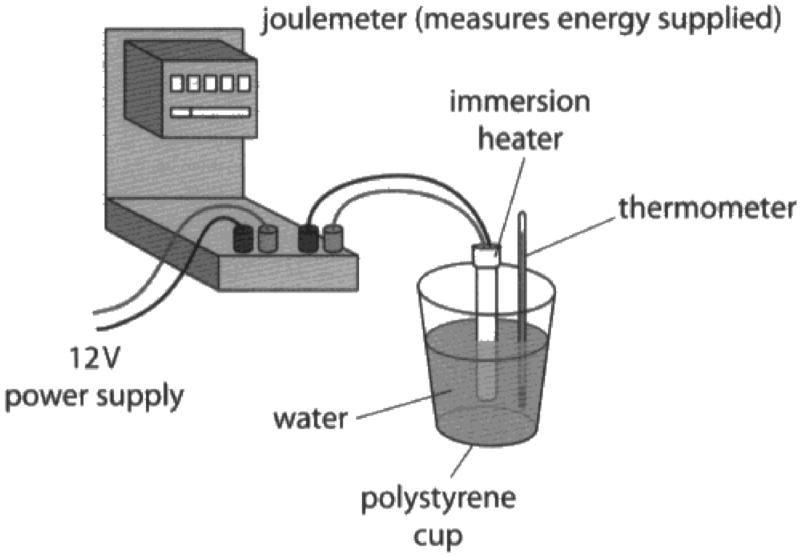

Figure 1

(i) State the measurements needed to calculate the specific heat capacity of water.

(4)

The change in temperature of the water (final temp - initial temp), the mass of the water in the cup and the change in thermal energy measured on the joulemeter.

specific heat capacity = $\frac{\text{change in thermal energy}}{\text{mass} \times \text{change in temp}}$.

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Examiner Comments

This has measurement of mass of the water, energy supplied (joulemeter reading) and temperature for 3 marks plus the extra detail concerning measuring the start and end temperatures for the 4th mark.

Question 1 (a) (ii)

The apparatus in the drawing had a number of shortcomings and candidates were asked to state two adaptations which recognised these shortcomings and suggested improvements.

These could include

a) reducing thermal energy transfer to the surroundings; for example, insulating the cup or adding a lid

b) ensuring consistent energy transfer to the water; for example, stirring the water or ensuring the heater is fully submerged

c) increasing the precision of measurements; for example using a more sensitive thermometer.

Question 1 (c)

Candidates were required to select and use the correct equation linking the change in thermal energy required to melt ice, mass of ice and the specific latent heat of fusion of ice. Partial credit was given for answers that clearly showed selection and use of the correct equation but with an incorrect final evaluation resulting from an error in either converting g to kg and/or an error in handling values in standard form.

(c) Another student decides to melt some ice.

The student melts 380 g of ice at 0 °C.

The specific latent heat of fusion of ice is 3.34×10^5 J/kg.

Calculate the thermal energy needed to melt the ice.

Select an equation from the list of equations at the end of this paper.

(2)

$Q = m \times L$

$Q = 380 \times (3.34 \times 10^5)$

$Q = 126920000$

$Q = 0.38 kg \times (3.34 \times 10^5)$

$Q = 129200$

thermal energy needed = 129200 J

ResultsPlus
Examiner Comments

This response selects the correct equation, converts the unit correctly but makes a power of ten error. Scores 1 mark.

(c) Another student decides to melt some ice.

The student melts 380 g of ice at 0 °C.

The specific latent heat of fusion of ice is 3.34×10^5 J/kg.

Calculate the thermal energy needed to melt the ice.

Select an equation from the list of equations at the end of this paper.

(2)

~~mass x specific heat capacity x change in temp.~~

~~$380g \times (3.34 \times 10^5) \times$~~

mass x specific latent heat

~~380g →~~

380g → kg = 0.38

0.38 kg × (3.34 × 10^5 J/kg) = 126920 J

thermal energy needed = 126920 J

(Total for Question 1 = 9 marks)

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Examiner Comments

This response gets to the correct equation eventually and deals with the unit change and the standard form correctly. 2 marks.

Question 2 (a)

Candidates were required to use the equation supplied to calculate kinetic energy given the velocity and mass. Partial credit was given for answers that clearly showed a correct substitution in the equation but that had an incorrect final evaluation.

Question 2 (c)

Candidates were required to recall and use the equation linking work done with force and distance.

Partial credit was given to answers that clearly showed substitution of correct values into a correctly recalled equation but did not rearrange the resulting expression correctly.

(c) The cyclist starts to cycle again.

The cyclist does 1600 J of useful work to travel 28 m.

Calculate the average force the cyclist exerts.

work = 1600
Distance = 28 m

wd

(3)

Force = $\frac{\text{work done}}{\text{distance}}$ f d

work done = force × distance

1600 = force × 28

$\frac{1600}{28}$ = 57.142857

average force = 57.14 N

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Examiner Comments

The working is clearly displayed here and the final answer is correct. 3 marks.

Question 2 (d)

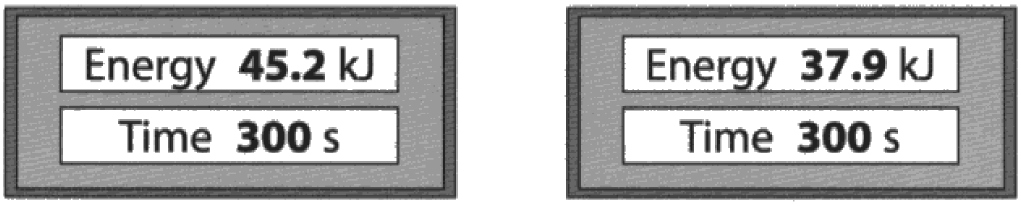
Candidates were required to extract information given in two displays of energy transferred and time taken to draw the conclusion that the (average) power developed in session 1 was greater than that in session 2 because more energy was transferred in the same amount of time.

Full credit was given to candidates who calculated the power in each case to support their conclusion as well as to candidates who correctly explained their reasoning in words.

(d) An athlete uses a training machine in a gym.

The display on the machine shows the time spent on the machine and the amount of energy transferred during a training session.

Figure 3 shows the displays for two different sessions by the same athlete.



session 1 session 2

Figure 3

Explain what the displays show about the average power of the athlete in each of these two sessions.

(2)

The average power is larger for session one because the amount of energy transferred was larger. The average power for session two is smaller because the amount of energy transferred is smaller.

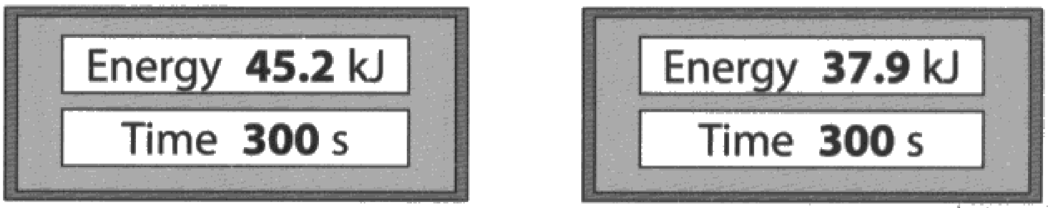
ResultsPlus
Examiner Comments

This candidate correctly states that the power in session 1 is greater but neglects to mention the same time interval. Scores 1 mark.

(d) An athlete uses a training machine in a gym.

The display on the machine shows the time spent on the machine and the amount of energy transferred during a training session.

Figure 3 shows the displays for two different sessions by the same athlete.



session 1 0·1506

session 2 0·1263

Figure 3 $p = \frac{E}{t}$

Explain what the displays show about the average power of the athlete in each of these two sessions.

(2)

in session 1 the athlete has a higher average power than in session 2 as his energy is more during session 1 in the same time period
(power = energy ÷ time)

ResultsPlus
Examiner Comments

A concise, accurate explanation, scoring both marks.

Question 3 (a)

Examiners were looking for a clear description of how to demonstrate that a magnetic material such as iron can become an induced magnet, but that the effect is only temporary.

3 (a) A student has a bar magnet, a piece of iron the same size as the magnet, and some paper clips.

Describe how the student could use these items to demonstrate temporary induced magnetism.

(3)

~~The stodent, will use + put the bar magnet with the piece of iron, and then the~~

The student will place the bar magnet next to the iron piece, this will allow for a temporary induced magnet, the paper clips will then attract to the iron and the bar magnet as the bar magnet allows for the iron to have a ~~mag~~ temporary magnetic field, if the bar magnet is removed the paper ~~clippings of~~ clips ~~of the~~ on the iron will come off as it has lost its ~~magn~~ magnetism.

ResultsPlus
Examiner Comments

This shows how to make the induced magnet, how to show it is a magnet and how to show it is temporary.

Question 3 (b) (i)

Candidates were given a drawing of some familiar apparatus being used in what was probably an unfamiliar way. They were required to devise an experimental procedure that involved two different topics: electromagnetism and elasticity.

Examiners were looking for clear descriptions of the measurements that could be made in this investigation including a clear description of how the extension of the spring from its natural length can be measured. Candidates were not required to make any predictions, nor to explain how a particular hypothesis could be tested. However, credit was given to those answers that recognised that the extension of the spring could be used to determine the force of attraction.

(b) A student sets up the apparatus shown in Figure 4.

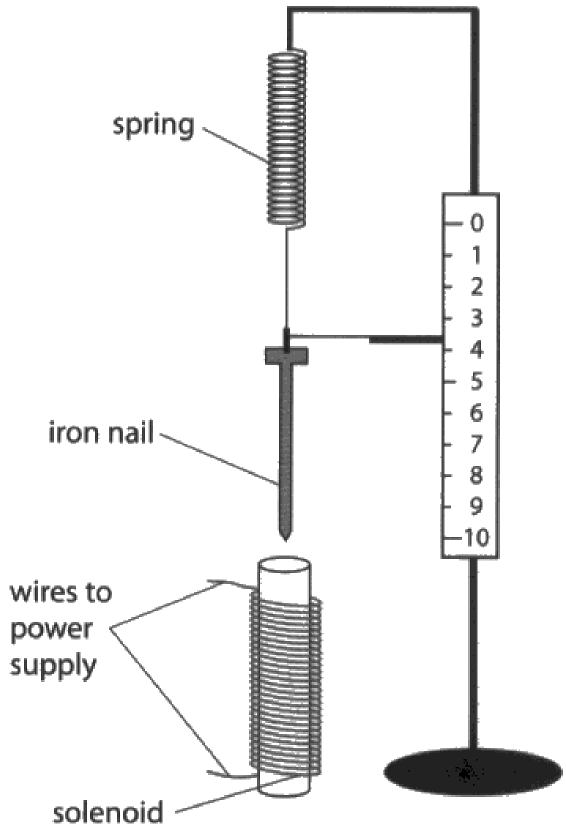


Figure 4

(i) When the current in the solenoid is switched on, the solenoid attracts the iron nail.

Describe how the student could use this apparatus to investigate how the size of the current in the solenoid affects the force of attraction between the solenoid and the iron nail.

(4)

They could vary the current passing through the solenoid, measuring it with an ammeter, and then measure the distance moved by the iron nail on the ruler. Repeating the experiment with different amounts of current. Each time keeping the voltage, spring, iron nail, and turns in the solenoid the same.

ResultsPlus
Examiner Comments

This candidate goes some way to describing what should be measured and how it should be measured but lacks detail such as how the measurements relate to force. Scores 3 of the 4 marks available.

Question 3 (b) (ii)

Candidates were required to select and apply the equation relating energy transferred in stretching a spring to the extension of the spring and the spring constant. Partial credit was given to answers that clearly showed correct substitution into the correct equation but contained an error in the final evaluation, usually resulting from incorrect conversion from cm to m.

(ii) The spring constant of a different spring is 24 N/m.

The spring is extended from its unstretched length by 12 cm.

Calculate the energy transferred in extending the spring by 12 cm.

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

(2)

$E = \frac{1}{2} \times k \times x^2$

$E = 0.5 \times 24N \times 0.12^2$

$= 0.1728 J$

energy transferred = 0.1728 J

ResultsPlus
Examiner Comments

Here the correct equation is selected from the list at the end of the paper, the correct values are substituted correctly, including the unit change and the final answer is correct. 2 marks.

(ii) The spring constant of a different spring is 24 N/m.

The spring is extended from its unstretched length by 12 cm.

Calculate the energy transferred in extending the spring by 12 cm.

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

(2)

$0.5 \times$ spring constant $\times$ (extension)^2.

$0.5 \times 24 \times \overset{144}{(12)^2} = 1728$

energy transferred = 1728 J

ResultsPlus
Examiner Comments

The working is clearly shown here, allowing the examiner to see that the only error is the unit conversion. This scores 1 mark.

ResultsPlus
Examiner Tip

Showing working clearly helps you to do the calculation and the examiner to possibly award marks if the final answer is not correct.

Question 4 (a) (i)

This question assessed the ability of candidates to resolve two collinear forces.

Question 4 (a) (ii)

This question required candidates to demonstrate how to find, graphically, the resultant of two mutually perpendicular forces.

(ii) The aeroplane is descending.

Figure 6 shows a diagram of the resultant vertical and horizontal forces on the aeroplane as it is descending.

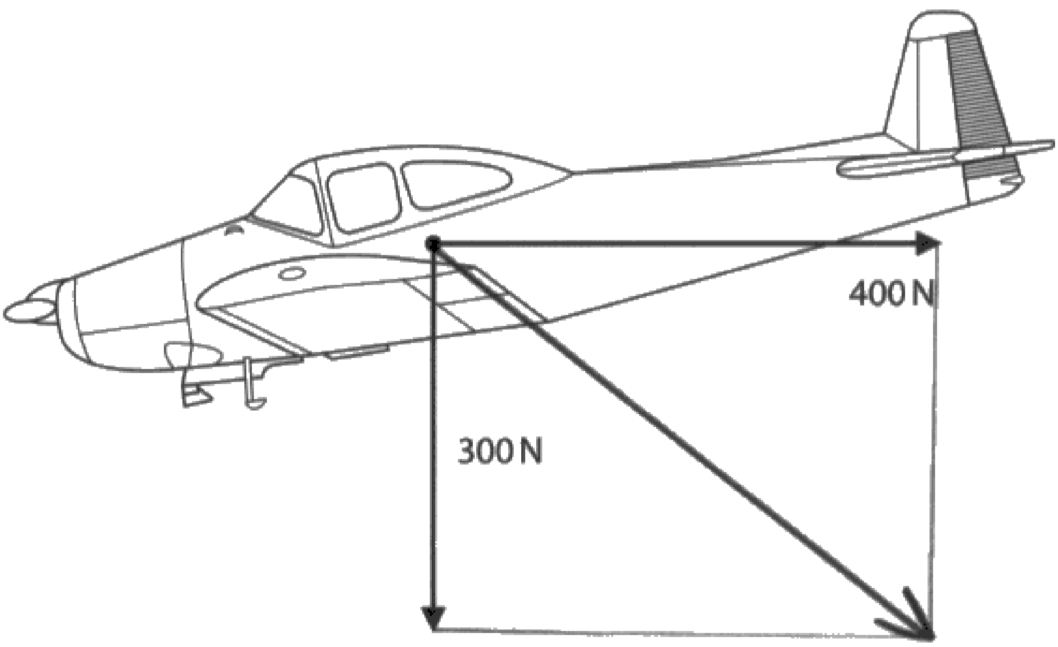


Figure 6

Complete the diagram to show the resultant of these two forces.

(1)

ResultsPlus
Examiner Comments

This shows the construction lines and the resultant force clearly marked with an arrow.

Question 4 (a) (iii)

Candidates were required to recall and apply the equation linking change in gravitational potential energy to mass and change in height above the ground.

Question 4 (b) (i)

This was a two-stage calculation requiring recall and application of the equation for efficiency and the equation linking power, energy and time. Partial credit was given for answers that clearly made progress through the stages even if the final evaluation was incorrect.

(b) The aeroplane is powered by an engine that burns fuel.

The fuel supplies a total of 6500 kJ of energy every minute.

The efficiency of the engine is 0.70 (70%).

(i) Calculate the power output of the engine.

Give your answer in kW.

(4)

6500 kJ = 6500000J × 0.7

0.70

= 4550000 = work done

$$\text{Power} = \frac{4550000}{60}$$

$= 75833.\dot{3}$ W

$75833.3 \div 1000$

$= 75.8\dot{3}$

power = 75.83 kW

ResultsPlus
Examiner Comments

The working, including the two distinct stages, is clearly shown here with obvious attention being paid to the correct units throughout. All 4 marks scored.

(b) The aeroplane is powered by an engine that burns fuel.

The fuel supplies a total of 6500 kJ of energy every minute.

The efficiency of the engine is 0.70 (70%).

(i) Calculate the power output of the engine.

Give your answer in kW.

(4)

~~P = Energy trans / time~~

Effiency = useful / total

$0.70 = \frac{x}{6500}$

$0.70 \times 6500 = 4550$

power = 4550 kW

ResultsPlus
Examiner Comments

The working clearly shows the first stage, scoring 2 marks, but does not go on to calculate power.

Question 4 (b) (ii)

Examiners were looking for an understanding that, in an engine, the input energy is greater than the useful output energy because some energy is dissipated in less useful ways.

Question 5 (a) (ii)

Candidates were required to recall and apply the equation linking current, time and charge. Partial credit was given to answers that clearly showed correct substitution into the correctly recalled equation but having an error in either conversion of mA to A and/or seconds into minutes.

(ii) The resistor remains connected for a period of time.

The current in the resistor is 200 mA.

A total charge of 42 C flows through the resistor.

Calculate, in minutes, the time taken for this amount of charge to flow through the resistor.

$I = \frac{200mA}{1000} = 0.2\,A$ **(3)**

$Q = 42\,C$

$Q = IT$

$T = \frac{Q}{I} = \frac{42}{0.2} = 210s.$

$\frac{210}{60} = 3.5$

time = 3.5 minutes

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Examiner Comments

Correct equation, rearranged and unit conversions done. Scores 3 marks.

Question 5 (a) (iii)

Candidates were required to recall and apply the equation linking energy transferred, charge moved and potential difference.

Question 5 (b)

Examiners were looking for an explanation that linked the collision of electrons with the lattice to an increase in the vibration of the lattice. Examiners would also credit answers that described the kinetic energy of the electrons decreasing as a result of collisions with the lattice.

(b) The resistor becomes warm while there is a current in it.

Explain why the resistor becomes warm.

(2)

A resistor contains a lattice of vibrating ions. There are many electrons flowing through the resistor. As these electrons try to pass through the ions, ~~the~~ they collide with the ions and transfer energy to them. This cause ions to vibrate more which increases frequency of collision. That's why resistor is warm.

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Examiner Comments

One of the few responses to score both marks.

Question 5 (c)

Candidates were required to analyse the values of resistance, current and potential difference given in order to deduce that the two resistors must have been connected in parallel. There were a number of different successful approaches seen; the most common was to calculate the effective resistance of the combination as being 5 ohms and then to apply understanding that the effective resistance of resistors in parallel is less than the resistance of each one.

(c) Figure 7 shows a cardboard tube with a wire coming out from each end.

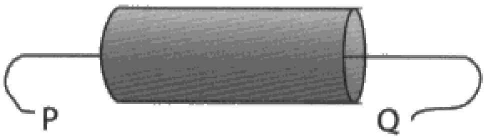

Figure 7

There are two 10 ohm resistors inside the cardboard tube.

A potential difference of 6.0 V is connected between P and Q.

There is a current of 1.2 A in the wires.

Deduce how the resistors have been arranged inside the cardboard tube.

(3)

~~V = 1/Q 20. 1.2 + 1.2 = 2.4~~ V = IR

~~V = RIR 20 × 1.2 = 20 ÷ 2.4 =~~

6 ÷ 1.2 = 5 ~~10 × t~~.

They are connected in parallel because the resistance is half that of each individual resistor.

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Examiner Comments

This candidate tries a few possible ways to solve the problem then, by calculating the total resistance, reaches a conclusion and expresses it well. 3 marks.

Question 6 (a) (i)

Candidates were required to apply their understanding of series circuits to calculate the potential difference across one of the lamps in the circuit.

Question 6 (a) (ii)

This was a complex calculation that could be carried out by recall and application of the equation linking current, power and potential difference and then the equation linking current, potential difference and resistance. Successful candidates tended to be those that showed each stage in their calculation.

series

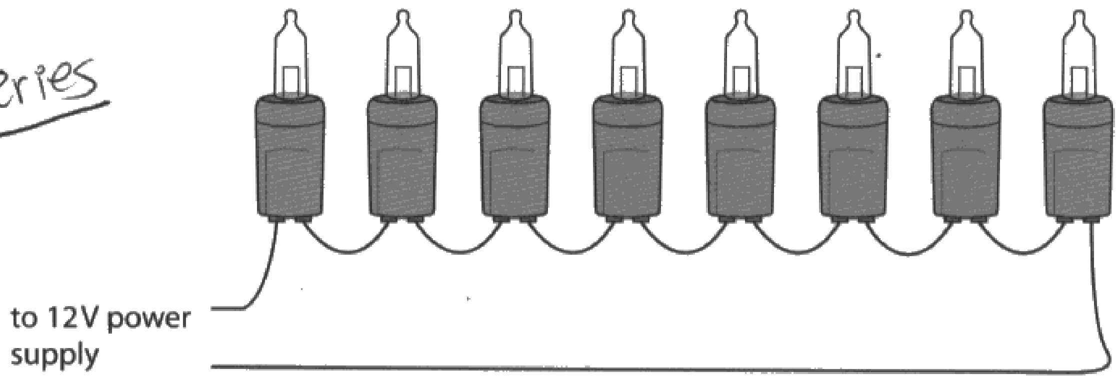


Figure 8

(i) Calculate the potential difference across each lamp.

(1)

8 lamps

$\frac{12}{8} = 1.5$

potential difference = 1.5 V

(ii) The power output of each lamp is 0.75 W

Calculate the resistance of each lamp.

(4)

EP = current x voltage

EP = current² x resistance

~~$\frac{0.75}{1.}$~~ $\frac{0.75}{1.5} = 0.5A$

$\frac{0.75}{(0.5^2)} = 3\Omega$

3Ω

resistance = 3 Ω

ResultsPlus
Examiner Comments

This candidate took a slightly different route to the correct answer.

P = VI was used to calculate the current which was then substituted into P = I^2R to calculate the resistance. 4 marks.

Question 6 (b)

In this extended open response question, candidates were required to explain how to carry out this core practical and support their description with a circuit diagram. They were not required to describe the way in which the resistance of a lamp varied with the current through the lamp.

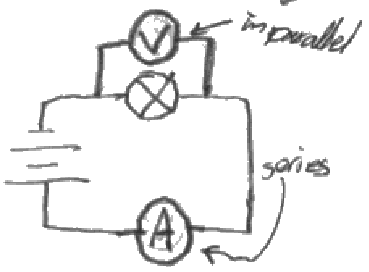
Level 2 responses included an accurate circuit diagram, a description of how current and potential difference is measured and a clear reference to how a set of readings could be obtained by varying the potential difference across the lamp.

Level 3 responses were those that continued the description to include detail about how the resistance could be calculated from the measurements made.

Level 1 answers contained some details about the procedure but either had incomplete or incorrect circuit diagrams and/or did not give sufficient detail about how the measurements could be made.

*(b) Explain, with the aid of a circuit diagram, the method a student could use to investigate how the resistance of a single lamp changes with the potential difference across the lamp.

(6)



V= IR. You measure the potential difference and the current using the voltmeter and ammeter then you Find the resistance with $R=\frac{V}{I}$. You then change the potential difference by increasing the voltage using more batteries and see how the resistance changes.

ResultsPlus Examiner Comments

This response shows a correct circuit diagram, says which readings to take, how to calculate resistance and how to change the potential difference.

Level 3, 6 marks.

ResultsPlus Examiner Tip

It is not always necessary to use all the answer space provided in a six mark question. This is a concise answer, based on sound understanding of what is required, practical knowledge and careful thought before writing.

Paper Summary

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

- make sure that they have a sound knowledge of the fundamental ideas in all the topics
- get used to the idea of applying their knowledge to new situations by attempting questions in support materials or previous examination papers
- when describing a practical procedure, make sure they are clear about what is to be measured and how the measurements will be taken. (Q3bi)
- when suggesting improvements or extensions to a practical procedure, make sure they are relevant to the context of the question. (Q 1aii)
- where a question involves a calculation, make sure they understand the physics of the situation before recalling or selecting an equation to use calculation and realising that in some calculations, two steps involving two equations might be needed. (Q4bi)
- make sure that they recognise SI prefixes such as m and k and n and how to handle these in calculations.
- use the marks at the side of a question as a guide to the form and content of their answer.

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