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Examiners' Report
June 2024

GCSE Physics 1PH0 2H

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June 2024

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Introduction

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

Questions were set to test students’ 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. This year candidates were tested on two occasions about fundamental ideas, showing a weak grasp of those ideas (Q01b 'electric field' and Q06ai 'principle of moments'). A number of questions assessed candidates’ knowledge of practical procedures, notably Q02bi, electrical circuits, Q03d concerning measurement of volume, Q05bii concerning a set up to show the force on a wire carrying current in a magnetic field, Q07 by describing an experiment to determine gravitational potential energy, Q08a concerning I/V characteristics of a filament bulb, including use of dataloggers, Q09d concerning specific heat capacity determination, and Q010aii about an investigation involving electromagnetic induction. The standard of answers on practical questions has improved over the years.

Students continued to do well with most calculation questions although there were still many who did not show an understanding of significant figures and some who failed to convert g → kg and kJ → J, when such were needed.

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
- misread and/or misunderstood the symbols used in equations
- 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 (b)

This was a testing question.

Not many candidates could adequately explain what is meant by the term 'electric field'.

Candidates found it hard to recall that fields are where **force on a charge** is experienced.

(b) Give the meaning of the term **electric field**.

(1)

volume of space around an electrically charged object where another charged object feels a force

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Examiner Comments

A succinct and accurate meaning of the term 'electric field'.

(b) Give the meaning of the term **electric field**.

(1)

An electric field is the area of influence around an electrical charge - ie. the area in which if another charge is → bought into will experience a force.

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Examiner Comments

This is good also – the area where a charge will experience a force.

(b) Give the meaning of the term **electric field**.

(1)

the space around a charged ~~particle~~ object in which another object will experience a force

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Examiner Comments

Promising beginning, but then doesn't go far enough.

We needed where **a charge** experiences a force, not just **another object**.

Question 1 (c)(i)

Most candidates found this to be straightforward, and achieved success.

(c) Figure 2 shows the electric field around a point charge.

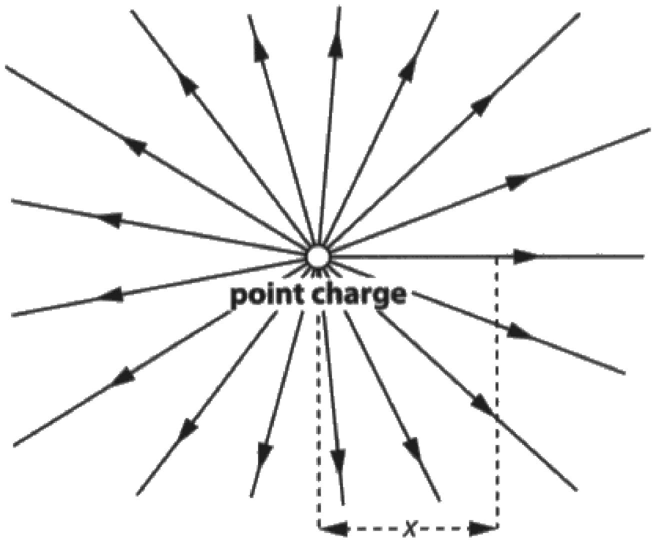

Figure 2

(i) State how Figure 2 gives evidence that the point charge is positive. **(1)**

The arrows are pointing away

ResultsPlus
Examiner Comments

This was a minimalist answer but if did suffice. The pointing away/pointing outwards was the essential point.

(c) Figure 2 shows the electric field around a point charge.

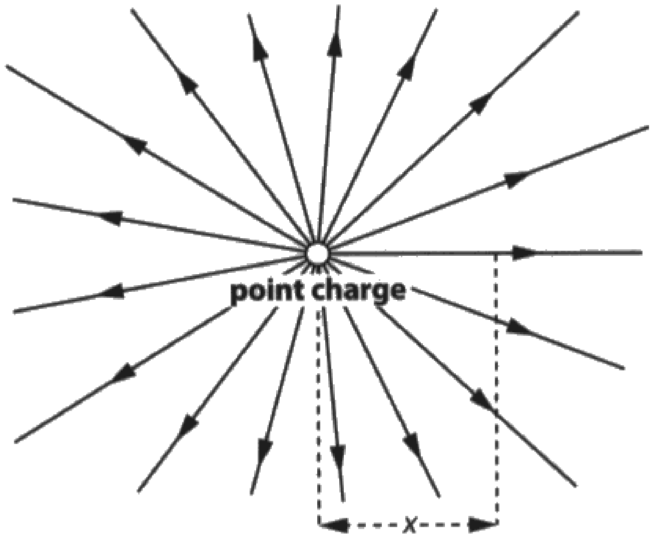

Figure 2

(i) State how Figure 2 gives evidence that the point charge is positive.

(1)

Because the direction of the electric field lines are going out from the point charge

ResultsPlus
Examiner Comments

This answer spells the evidence out in detail.

(c) Figure 2 shows the electric field around a point charge.

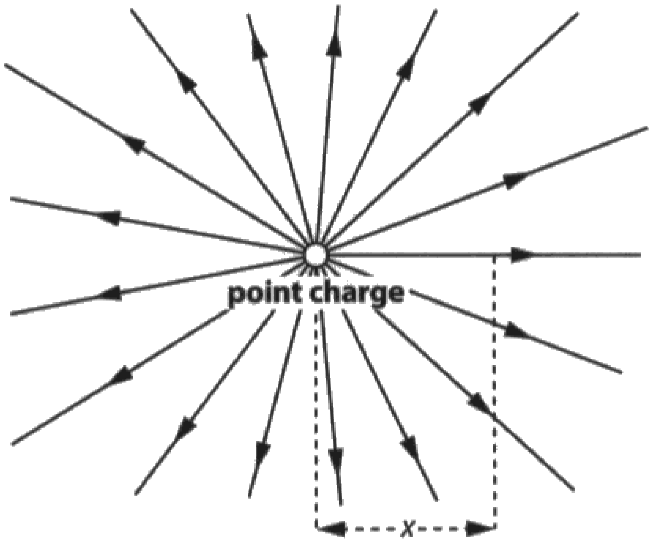

Figure 2

(i) State how Figure 2 gives evidence that the point charge is positive.

(1)

The arrows point away from the point and electricity flows from + to -

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Examiner Comments

This is sufficient for the mark.

The reference to 'electricity flows' was ignored.

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Examiner Tip

It is best to avoid the term 'electricity' altogether in physics explanation.

It is a word that is taken lots of different ways and is generally unhelpful.

Question 1 (c)(ii)

This was not as successfully answered as (i) but most succeeded with it.

(ii) In Figure 2, *x* is the distance from the point charge.

State how Figure 2 gives evidence that the electric field strength decreases as *x* increases.

(1)

Field lines get further apart which shows strength decreases as x gets further away

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Examiner Comments

This is the key point: (field) **lines** get further apart.

(ii) In Figure 2, *x* is the distance from the point charge.

State how Figure 2 gives evidence that the electric field strength decreases as *x* increases.

(1)

The lines are less dense the ~~further~~ more x increases

ResultsPlus
Examiner Comments

The alternative was to says 'concentration of lines gets smaller' (additional guidance).

This statement was equivalent to that.

(ii) In Figure 2, *x* is the distance from the point charge.

State how Figure 2 gives evidence that the electric field strength decreases as *x* increases.

(1)

the arrows ~~of~~ are further from ~~ea~~ eachother showing the electricfield strength decreasing

ResultsPlus
Examiner Comments

The mark scheme stipulates **lines** getting further apart as you go out.

There are no arrows further out to show this.

Reference to **lines** is needed.

Question 1 (c)(iii)

This question was very well answered.

Figure 3

The equation relating electric field strength to distance, x, is

$$\text{electric field strength} = \frac{A}{x^2}$$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3$ cm.

(2)

$$20{,}000 = \frac{A}{3^2}$$

$$20{,}000 = \frac{A}{9}$$

$$20{,}000 \times 9 = A$$

$$180{,}000 = A$$

A = 180,000 N cm²/C

(Total for Question 1 = 6 marks)

ResultsPlus
Examiner Comments

This response shows clear substitutions and subsequent rearrangement leading to a correct evaluation.

ResultsPlus
Examiner Tip

Set your work out logically like this and you will do well.

Figure 3

The equation relating electric field strength to distance, x, is

$$\text{electric field strength} = \frac{A}{x^2}$$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3$ cm.

(2)

field = $\frac{x}{3^2}$ ~~$\frac{2000}{3^2}$~~

$2000 = \frac{x}{3^2} = 18000$

A = 18000 N cm²/C

(Total for Question 1 = 6 marks)

ResultsPlus
Examiner Comments

1.8 to any other power of 10 scores 1 mark (additional guidance).

This allows for this candidate's wrong transcription of 2 000 for electric field strength when it should have been 20 000.

Figure 3

The equation relating electric field strength to distance, x, is

$$\text{electric field strength} = \frac{A}{x^2}$$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3$ cm.

(2)

$20{,}000 = \frac{A}{3^2}$

$3^2 \times 20{,}000 = 180000$

A = 18 000 N cm²/C

ResultsPlus
Examiner Comments

This candidate has a correct substitution and rearrangement.

Unfortunately, they copy down the wrong answer to the answer line.

ResultsPlus
Examiner Tip

What you write on the answer line is what will stand. Examiners don't know if you have applied some other ÷ 10 process in your mind.

Be careful what you write.

The equation relating electric field strength to distance, x, is

electric field strength $= \frac{A}{x^2}$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3$ cm.

(2)

$20{,}000 = \frac{A}{3^2}$

$\frac{20{,}000}{9} = A$

$A = 2222.\dot{2}$

A = 2222.2 N cm²/C

ResultsPlus
Examiner Comments

Correct substitution but wrong rearrangement, therefore denying both marks.

Mark scheme requires rearrangement and substitution for the first mark.

Figure 3

The equation relating electric field strength to distance, x, is

electric field strength = $\frac{A}{x^2}$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3$ cm.

(2)

$25000 = \frac{a}{3^2}$

$a = 25000 \times (3^2)$

$a = 225,000$

A = 225,000 N cm^2/C

ResultsPlus
Examiner Comments

The misreading from the graph scale means the rearrangement **and** substitution mark cannot be given, and therefore the evaluation mark cannot be given as well.

Figure 3

The equation relating electric field strength to distance, x, is

electric field strength $= \frac{A}{x^2}$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3$ cm.

(2)

~~50,000~~

$20{,}000 = \frac{A}{3}$

$A = 60{,}000$

A = 60,000 N cm²/C

ResultsPlus
Examiner Comments

This candidate omits to square the value of 3, so both marks are lost.

Question 2 (b)(i)

The vast majority of candidates got this correct, putting the voltmeter in parallel with the resistance.

(b) Some students investigate resistors in parallel.

The students set up a circuit containing **four** identical resistors.

The circuit used is shown in Figure 5.

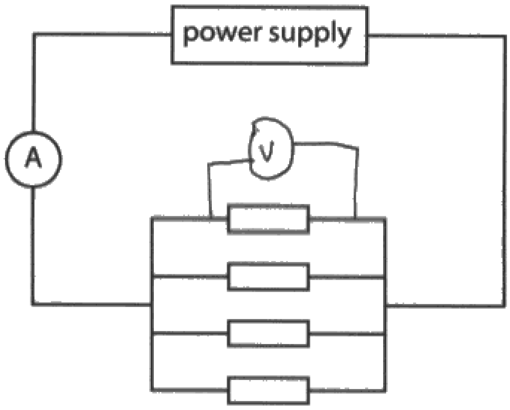

Figure 5

The students measure the current from the power supply and the voltage (p.d.) across the resistors.

(i) On Figure 5, draw a voltmeter connected to measure the voltage (p.d.) across the resistors.

(1)

ResultsPlus
Examiner Comments

This is where it should be – in parallel ie across the resistors.

(b) Some students investigate resistors in parallel.

The students set up a circuit containing **four** identical resistors.

The circuit used is shown in Figure 5.

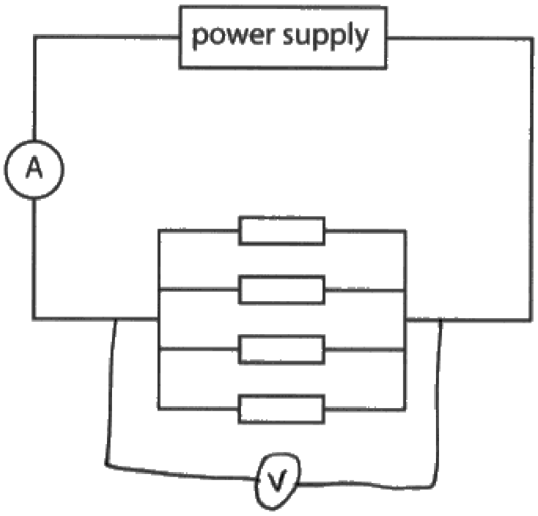

Figure 5

The students measure the current from the power supply and the voltage (p.d.) across the resistors.

(i) On Figure 5, draw a voltmeter connected to measure the voltage (p.d.) across the resistors.

(1)

ResultsPlus
Examiner Comments

There are other acceptable ways of placing the voltmeter in parallel with the resistors, like this one.

(b) Some students investigate resistors in parallel.

The students set up a circuit containing **four** identical resistors.

The circuit used is shown in Figure 5.

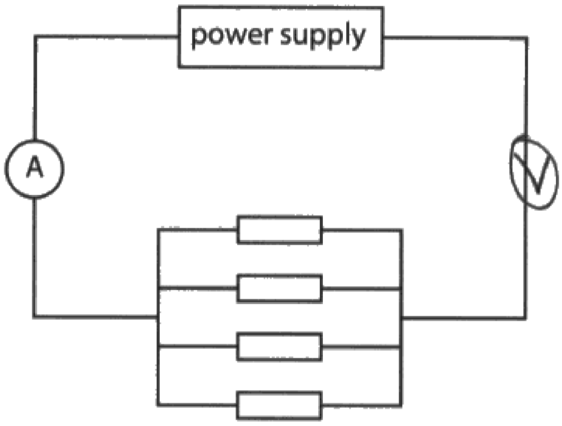

Figure 5

The students measure the current from the power supply and the voltage (p.d.) across the resistors.

(i) On Figure 5, draw a voltmeter connected to measure the voltage (p.d.) across the resistors.

(1)

ResultsPlus
Examiner Comments

This is a common error, made by many candidates in the circuits question.

ResultsPlus
Examiner Tip

Remember voltmeters are put across components.

Ammeters are put in sequence as shown in the already drawn part of the circuit.

Question 2 (b)(ii)

The currents shown in the table showed perfect conformity to doubling, then trebling and finally quadrupling as you go up the table.

Therefore the vast majority deduced that for 4 resistors the current would be 4 x 9.1 = 36.4 (mA)

The mark scheme allowed answers in the range 36 to 37 inclusive.

The students remove one resistor and measure the current and voltage again with only 3 resistors in the circuit.

They repeat the measurements of current and voltage with only 2 resistors in the circuit and then with only 1 resistor in the circuit.

Figure 6 is a table of their results.

number of resistors	current in mA	voltage in V
4		6.00
3	27.3	6.00
2	18.2	6.00
1	9.1	6.00

Figure 6

(ii) Using data from the table in Figure 6, predict the current from the power supply when there are 4 resistors in the circuit.

(1)

current = 36.4 mA

ResultsPlus
Examiner Comments

This shows the expected correct answer.

The students remove one resistor and measure the current and voltage again with only 3 resistors in the circuit.

They repeat the measurements of current and voltage with only 2 resistors in the circuit and then with only 1 resistor in the circuit.

Figure 6 is a table of their results.

number of resistors	current in mA	voltage in V
4		6.00
3	27.3	6.00
2	18.2	6.00
1	9.1	6.00

Figure 6

(ii) Using data from the table in Figure 6, predict the current from the power supply when there are 4 resistors in the circuit.

(1)

current = 40 mA

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Examiner Comments

This answer lies outside the accepted range.

It would be inappropriate to round off the answer to one significant figure.

ResultsPlus
Examiner Tip

Questions do sometimes ask for basic patterns in the data to be noticed, like this.

The students remove one resistor and measure the current and voltage again with only 3 resistors in the circuit.

They repeat the measurements of current and voltage with only 2 resistors in the circuit and then with only 1 resistor in the circuit.

Figure 6 is a table of their results.

number of resistors	current in mA	voltage in V
4		6.00
3	27.3	6.00
2	18.2	6.00
1	9.1	6.00

Figure 6

(ii) Using data from the table in Figure 6, predict the current from the power supply when there are 4 resistors in the circuit.

(1)

current = 32 mA

ResultsPlus
Examiner Comments

This also lies outside the acceptable range, this time going too low.

The students remove one resistor and measure the current and voltage again with only 3 resistors in the circuit.

They repeat the measurements of current and voltage with only 2 resistors in the circuit and then with only 1 resistor in the circuit.

Figure 6 is a table of their results.

0.659

number of resistors	current in mA	voltage in V
4	45.5	6.00
3	27.3	6.00
2	18.2	6.00
1	9.1	6.00

Figure 6

(ii) Using data from the table in Figure 6, predict the current from the power supply when there are 4 resistors in the circuit.

(1)

27.3 + 18.2 = 45.5 mA

current = 45.5 mA

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Examiner Comments

The candidate tries to see a pattern but goes wrong.

27.3 + 9.1 would have been correct.

Question 2 (b)(iii)

A majority of students scored 2 out of 3 in this one.

This was largely because they forgot to convert mA to A (x 10^{-3}).

(iii) Using data from the table in Figure 6, calculate the resistance of **only 1** resistor.

(3)

$V = IR$

$9.1\text{ mA} = 0.0091\text{A}$ ~~91000 A~~

$6 = 0.0091$ ~~91000~~ $\times R$

$R = 659.34$

resistance = 659.34 Ω

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Examiner Comments

This is a model answer.

First the candidate converts mA to A.

Then they substitute into V = IR.

Then they rearrange and finally evaluate.

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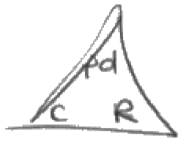
Examiner Tip

It will pay candidates well to follow such practice.

(iii) Using data from the table in Figure 6, calculate the resistance of **only 1** resistor.

(3)

pd = current × resistance



m × 10^{-3}

resistance = $\frac{pd}{current}$

~~9.1 × 1000 =~~

~~9.1 × 1000~~ = ~~9100~~

$\frac{6}{9.1}$ ~~= 0.659340~~

A 9.1 × 10^{-3}

mA 9.~~?~~1

$\frac{6}{9.1 \times 10^{-3}}$ = 659

resistance = ~~0.659~~ 659 Ω

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Examiner Comments

This answer is correct, not so well set out as the previous answer but effective.

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Examiner Tip

Note the use of 10-3.

It is important to be able to handle powers of 10 in physics calculations.

(iii) Using data from the table in Figure 6, calculate the resistance of **only 1** resistor.

(3)

potential difference = current × resistance.

$\frac{\text{voltage}}{\text{current}}$ = resistance.

$\frac{6}{9.1}$ = 0.659340659...

= 0.659 Ω (3.s.f)

resistance = 0.659 Ω

ResultsPlus
Examiner Comments

This demonstrates a typical answer that just loses out on the final mark through not converting mA to A.

(iii) Using data from the table in Figure 6, calculate the resistance of **only 1** resistor.

(3)

$V = I \times R$

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

$\frac{6}{9.1} = 0.659$

$\frac{6}{9100} = 0.0006$

resistance = 0.0006 Ω

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Examiner Comments

This also gets 2 marks for the initial substitution and rearrangement.

Note this question does not have significant figures tested so it does not lose out, on that account, in the answer.

(iii) Using data from the table in Figure 6, calculate the resistance of **only 1** resistor.

(3)

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

$6 = 0.91\,A \times R$

$6 \div 0.91 = 6.59$

resistance = 6.6 Ω

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Examiner Comments

There is a mistake converting the 9.1 mA here.

The mark scheme in the additional guidance states 'value rounding to 660 to any other power of 10 scores 2 marks'.

This applies here.

(iii) Using data from the table in Figure 6, calculate the resistance of **only 1** resistor.

(3)

V = I × R

R = V / I

~~R = 6 / 36.4~~

I = 36.4 mA

36.4 mA = 0.0364

6 / 0.0364 = 164.8351648

2dp = 164.84

resistance = 164.84 Ω

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Examiner Comments

Using the wrong value of current adversely affects the calculation.

Even the mark for 'allow substitution of correct values into a visible, incorrectly rearranged algebraic equation' cannot be given.

Question 2 (b)(iv)

Marks were spread across the board with this item.

It differentiated well.

(iv) Using data from the table in Figure 6, explain what happens to the **total resistance of the circuit** as the number of resistors in parallel decreases.

(3)

As the number of resistors decrease, the total resistance of the circuit ~~also decreases~~ increases $R = \frac{V}{I}$ due to the current decreasing. Resistance and current are inversely proportional, when V is fixed. $\frac{6}{9.1} > \frac{6}{27.3}$.

(Total for Question 2 = 9 marks)

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Examiner Comments

This answer achieves all the marking points squarely.

total R↑ because I↓ with V staying constant.

The added inversely proportional argument shows the excellent understanding this candidate has.

(iv) Using data from the table in Figure 6, explain what happens to the **total resistance of the circuit** as the number of resistors in parallel decreases.

(3)

Total resistance increases as number of resistors decreases.

(Total for Question 2 = 9 marks)

ResultsPlus
Examiner Comments

This gets marking point 1 only.

(iv) Using data from the table in Figure 6, explain what happens to the **total resistance of the circuit** as the number of resistors in parallel decreases.

(3)

As the number of resistors in parallel decreases, the total resistance of the circuit also decreases

(Total for Question 2 = 9 marks)

ResultsPlus
Examiner Comments

Wrong variation stated, no marks.

Many go down this wrong line of reasoning.

(iv) Using data from the table in Figure 6, explain what happens to the **total resistance of the circuit** as the number of resistors in parallel decreases.

(3)

It increases. the more resistors there are, the higher the current. With just 1 resistor, the current is 9.1, where with 4 resistors it's 36.4, 27.3 increase.

(Total for Question 2 = 9 marks)

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Examiner Comments

Mark point 1 met – total resistance increases.

The candidate then presents a reverse argument, which was accepted for mark point 2.

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Examiner Tip

The question at hand should be answered directly.

If the question asks what happens when the number of resistors decreases it is unhelpful to then argue what happens when that number increases.

Question 3 (a)

Many candidates achieved full success with this question.

3 (a) A coil of copper wire has a mass of 14.1 g.

The density, ρ, of copper is 8.96 g/cm^3.

Calculate the volume of the copper wire.

Use the equation

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

(3)

$$\frac{14.1}{V} = 8.96$$

$$\frac{14.1}{8.96} = 1.57$$

volume = 1.57 cm^3

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Examiner Comments

This is an example of a correct answer, with all the mark points being matched.

3 (a) A coil of copper wire has a mass of [redacted]

The density, ρ, of copper is [redacted].

Calculate the [redacted] of the copper wire.

Use the equation

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

volume = mass / density

density = mass / volume

(3)

$$\frac{14.1}{8.96} = 1.6$$

volume = 1.6 cm³

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Examiner Comments

The mark scheme says allow 1.6 for the evaluation mark.

The substitution and rearrangement are clearly seen.

3 (a) A coil of copper wire has a mass of 14.1 g.

The density, ρ, of copper is 8.96 g/cm^3.

Calculate the volume of the copper wire.

Use the equation

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

(3)

$8.96 = \frac{14.1}{V}$ $\frac{8.96}{14.1} = V$

$V = 0.635$

0.64

volume = 0.64 cm^3

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Examiner Comments

This gets one mark for the first substitution.

3 (a) A coil of copper wire has a mass of 14.1 g.

The density, ρ, of copper is 8.96 g/cm^3.

Calculate the volume of the copper wire.

Use the equation

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

(3)

~~volume = density / mass~~ ~~8.96 / 14.1~~

volume = mass x density = 126.336

14.1 x 8.96

volume = 126.384 cm^3

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Examiner Comments

This gets one mark for 'allow substitution of correct values into a visible, incorrectly rearranged algebraic equation for this mark only'.

Question 3 (b)

Most candidates scored 1 or 2 marks.

(b) Figure 7 gives information about the density of aluminium.

	density in g/cm^3
solid aluminium	2.70
liquid aluminium	2.38

Figure 7

Explain the difference between the density of solid aluminium and the density of liquid aluminium in terms of the arrangement of particles.

(2)

liquid aluminium has a lower density because the particles are further apart. This is because when bonds break the particles

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Examiner Comments

This scores 2 marks quite clearly.

Lower density of the liquid (1) with particles further apart (1)

(b) Figure 7 gives information about the density of aluminium.

	density in g/cm³
solid aluminium	2.70
liquid aluminium	2.38

Figure 7

Explain the difference between the density of solid aluminium and the density of liquid aluminium in terms of the arrangement of particles.

(2)

liquid aluminium is less dense because the particles arent in a fixed position and can rearange and not hold its shape

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Examiner Comments

Liquid aluminium less dense gets the first mark.

(b) Figure 7 gives information about the density of aluminium.

	density in g/cm³
solid aluminium	2.70
liquid aluminium	2.38

Figure 7

Explain the difference between the density of solid aluminium and the density of liquid aluminium in terms of the arrangement of particles.

(2)

Solid aluminium has less space inbetween the particles so they are more tightly packed together. In liquid, they are more free to move across each othere and aren't as close to eachother.

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Examiner Comments

Particles more tightly packed (in solids) gets the second mark point.

Question 3 (c)

Most candidates scored both marks here.

Factors of 10 out mainly occurred from a failure to convert g to kg.

(c) A student boils some water.

Calculate the amount of thermal energy needed to change 60.0 g of water to steam at its boiling point.

The specific latent heat of vaporisation of water, L, is 2.26×10^6 J/kg.

Use the equation

$$Q = m \times L$$

(2)

$60 \times 2.26 \times 10^6$

amount of thermal energy = 135600000 J

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Scores 1 mark – 'any other power' mark.

Failure to convert g → kg shown here.

(c) A student boils some water.

Calculate the amount of thermal energy needed to change 60.0 g of water to steam at its boiling point.

The specific latent heat of vaporisation of water, L, is 2.26×10^6 J/kg.

Use the equation

$$Q = m \times L$$

(2)

60×2.26

$= 135.6$

amount of thermal energy = 135.6 J

ResultsPlus
Examiner Comments

The candidate ignores powers of 10 altogether. Still gets a mark for 'any answer rounding to 1.4 to any other power of 10'.

(c) A student boils some water.

Calculate the amount of thermal energy needed to change 60.0 g of water to steam at its boiling point.

The specific latent heat of vaporisation of water, L, is 2.26×10^6 J/kg.

Use the equation

$$Q = m \times L$$

(2)

$\left(\frac{60}{1000}\right) \times 2.26 \times 10^6$

$= 135600$

amount of thermal energy = 135600 J

ResultsPlus
Examiner Comments

Converts g to kg.

Then gets the final correct value from the multiplication.

(c) A student boils some water.

Calculate the amount of thermal energy needed to change 60.0 g of water to steam at its boiling point.

The specific latent heat of vaporisation of water, L, is 2.26×10^6 J/kg.

Use the equation

$$Q = m \times L$$

(2)

60g × 2.26×10⁶ ~~= 135600000~~

÷1000

0.06 × 2.26×10⁶ = 135600

amount of thermal energy = 135600 J

ResultsPlus
Examiner Comments

Full marks, clearly signposting the conversion of g to kg.

Question 3 (d)

Most candidates scored 2 marks for this question.

Using Figure 8, estimate the volume of the modelling clay in cm^3.

You may assume that 1 litre = 1000 cm^3.

1750 − 1350 = 400 cm^3

(2)

volume = 400 cm^3

ResultsPlus
Examiner Comments

This candidate chooses the correct values, sets out the subtraction, and arrives at the correct evaluation.

Figure 8

Using Figure 8, estimate the volume of the modelling clay in cm^3.

You may assume that 1 litre = 1000 cm^3.

1750 − 1350 = 300

(2)

300 mL = 0.3 L → cm^3 = 300

volume = 300 ~~350~~ cm^3

(Total for Question 3 = 9 marks)

ResultsPlus
Examiner Comments

Reads off the numbers from the scale correctly, but then miscalculates.

First mark only awarded.

Figure 8

Using Figure 8, estimate the volume of the modelling clay in cm^3.

You may assume that 1 litre = 1000 cm^3.

(2)

1750 - 1450 = 300ml

300ml = 0.3l

volume = 0.3 cm^3

ResultsPlus
Examiner Comments

A mark is obtained on seeing the 1750 ml reading read off correctly.

Figure 8

Using Figure 8, estimate the volume of the modelling clay in cm^3.

You may assume that 1 litre = 1000 cm^3.

(2)

density = mass/volume

volume = mass/density

~~volume = 350/1000~~

~~volume = 0.35~~

volume = ~~0.35~~ 0.4 cm^3

(Total for Question 3 = 9 marks)

volume = 400/1000 = 0.4

ResultsPlus
Examiner Comments

Values read off correctly – see diagram.

Wrong ÷1000 at the end negates the second mark.

Question 4 (b)

Most got this correct, showing they could handle powers of 10 well.

Calculate the force the skate exerts on the ice

pressure of skate on ice = 4.8×10^7 Pa

area of blade in contact with ice = 1.2×10^{-5} m^2

Use the equation

force = pressure × area

Give your answer to 2 significant figures.

(3)

$4.8 \times 10^7 \times 1.2 \times 10^{-5}$

$= 576$

force = 580 N

ResultsPlus
Examiner Comments

A fully correct answer, with the correct significant figures evaluation.

Figure 10

Calculate the force the skate exerts on the ice

pressure of skate on ice = 4.8×10^7 Pa

area of blade in contact with ice = 1.2×10^{-5} m^2

Use the equation

force = pressure × area

Give your answer to 2 significant figures.

(3)

$4.8 \times 10^7 \times 1.2 \times 10^{-5}$

$48000000 \times 1.2 \times 10^{-5}$

force = 576 N

ResultsPlus
Examiner Comments

2 marks out of 3.

Just failing to quote to 2 significant figures at the end.

Figure 10

Calculate the force the skate exerts on the ice

pressure of skate on ice = 4.8×10^7 Pa

area of blade in contact with ice = 1.2×10^{-5} m^2

Use the equation

$$\text{force} = \text{pressure} \times \text{area}$$

1.2×10^{-2}

Give your answer to 2 significant figures.

(3)

$(4.8 \times 10^7) \times (1.2 \times 10^{-5})$

576

force = 5.76 N

ResultsPlus
Examiner Comments

'1 mark for 5.76 to any other power of ten'.

Power of 10 error.

Calculate the force the skate exerts on the ice

pressure of skate on ice = 4.8×10^7 Pa

area of blade in contact with ice = 1.2×10^{-5} m^2

Use the equation

$$\text{force} = \text{pressure} \times \text{area}$$

Give your answer to 2 significant figures.

(3)

$\frac{f}{P/A}$ = $4.8 \times 10^7 \times 1.2 \times 10^{-5}$ = 576

$\frac{576}{4.8 \times 10^7 \times 1.2 \times 10^{-5}}$ = 83333.33

force = 83333.33 N

ResultsPlus
Examiner Comments

Substitution mark awarded.

First multiplication OK, then decides upon a spurious division.

Question 4 (c)(i)

Many candidates noted the basic trend for a mark, but fewer were able to qualify that with a non-linearity idea.

(i) Using the graph, describe how atmospheric pressure changes with height above sea level.

(2)

- Non Linear
- As pressure increases, height decreases

ResultsPlus
Examiner Comments

Exemplary answer.

(i) Using the graph, describe how atmospheric pressure changes with height above sea level.

(2)

as height increases, pressure decreases. For example 100 kPa = 200m while 30 kPa = 8600m.

ResultsPlus
Examiner Comments

The basic trend is well described.

Sometimes quoting numbers, as evidence, is asked for, but not here.

(i) Using the graph, describe how atmospheric pressure changes with height above sea level.

(2)

As height abouve sea level increases, pressure decreases at a constant rate

ResultsPlus
Examiner Comments

Correct trend seen, but then the constant rate comment is wrong.

Question 4 (c)(ii)

The correct answer was seen in the vast majority of cases, this being 'accept any answer from 30 to 34 (kPa)'.

(ii) The top of Mount Everest is 8850 m above sea level.
Using the graph, estimate the atmospheric pressure at the top of Mount Everest.

(1)

pressure = 33 kPa

ResultsPlus
Examiner Comments

Within the acceptable range.

(ii) The top of Mount Everest is 8850 m above sea level.
Using the graph, estimate the atmospheric pressure at the top of Mount Everest.

(1)

pressure = 31 kPa

ResultsPlus
Examiner Comments

This also lies within the accepted range.

Question 4 (c)(iii)

This was a straightforward percentage calculation, successfully done by most.

(iii) On a different day, the pressure at sea level is 104 kPa and the pressure at a height of 2500 m is 74 kPa.

Calculate the percentage change in pressure from sea level to the height of 2500 m.

(2)

$\frac{(104-74)}{104} \times 100 = 28.846$

percentage change = 28.85 %

ResultsPlus
Examiner Comments

Correct calculation and evaluation seen here.

ResultsPlus
Examiner Tip

Take the difference divided by the reference amount – **from** the sea level, x 100 if % is needed.

(iii) On a different day, the pressure at sea level is 104 kPa and the pressure at a height of 2500 m is 74 kPa.

Calculate the percentage change in pressure from sea level to the height of 2500 m.

$\frac{74-104}{104} \times 100 = -28.85\%$

(2)

percentage change = −28.85 %

ResultsPlus Examiner Comments

Minus values are also accepted.

These arise since the change is a decrease, so what the candidate writes is perfectly correct.

(iii) On a different day, the pressure at sea level is 104 kPa and the pressure at a height of 2500 m is 74 kPa.

Calculate the percentage change in pressure from sea level to the height of 2500 m.

(2)

Sea level = 104
2500m ↑ = 74

→ $\frac{104-74}{74} \times 100$

percentage change = 40.540 %

ResultsPlus Examiner Comments

Additional guidance stipulates that this answer gets one mark.

This comes from using 30÷74.

(iii) On a different day, the pressure at sea level is 104 kPa and the pressure at a height of 2500 m is 74 kPa.

Calculate the percentage change in pressure from sea level to the height of 2500 m.

(2)

$$\frac{74}{104} \times 100 = 71.2\%$$

percentage change = 71.2 %

ResultsPlus
Examiner Comments

Mark scheme states 'award 1 mark for 71%'.

This is a compensatory mark.

This comes from taking 74÷104.

(iii) On a different day, the pressure at sea level is 104 kPa and the pressure at a height of 2500 m is 74 kPa.

Calculate the percentage change in pressure from sea level to the height of 2500 m.

(2)

height = y
pressure = x

$$\frac{\Delta y}{\Delta x} = \frac{2500}{104 - 74\text{ kPa}} = 83.\dot{3}$$

$$100 - 83.\dot{3} = 16.\dot{6}\%$$

percentage change = 16.67 %

ResultsPlus
Examiner Comments

This answer goes astray in mixing up height in metres with pressure values.

Question 4 (d)

Most candidates recognised that the density decreases as height increases.

Fewer gave the explanation because the particles are then further apart.

(d) Figure 12 is a model representing molecules of the Earth's atmosphere.

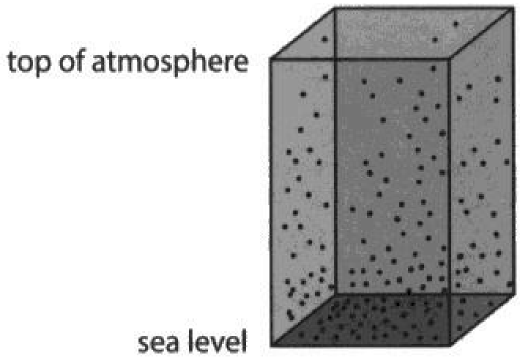


Figure 12

Use Figure 12 to explain how the density of the air varies with height above sea level.

(2)

As height increases, density decreases. We can see in Fig.12 that particles are more spread out ~~[illegible]~~ near the top of the atmosphere so there are less particles per unit volume compared to closer to sea level.

(Total for Question 4 = 11 marks)

ResultsPlus Examiner Comments

This is a complete answer, with a full linking explanation.

(d) Figure 12 is a model representing molecules of the Earth's atmosphere.

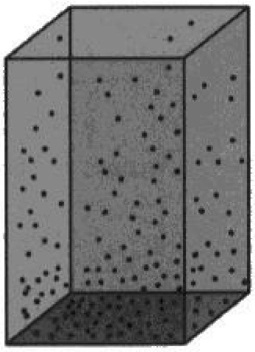


Figure 12

Use Figure 12 to explain how the density of the air varies with height above sea level.

(2)

The density of air decreases as you go higher. The density is at its highest on sea level. This is because there are fewer particles for a given volume as you go higher.

ResultsPlus
Examiner Comments

'Fewer particles for a given volume' is an accepted linking explanation.

(d) Figure 12 is a model representing molecules of the Earth's atmosphere.

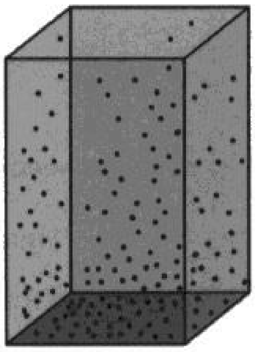


Figure 12

Use Figure 12 to explain how the density of the air varies with height above sea level.

(2)

As the height above sea level increases the density of the air decreases because at the bottom of the model there are more particles than at the top which means it is more dense at the bottom and more dense at the top.

ResultsPlus
Examiner Comments

This gets the first mark only.

The second mark would require relating to the number of particles **per unit volume**.

Question 5 (a)(i)

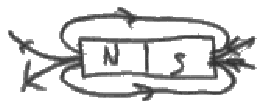
Most students got one arrow in the correct direction, usually the top one.

Not so many had the equatorial arrow pointing upwards.

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.



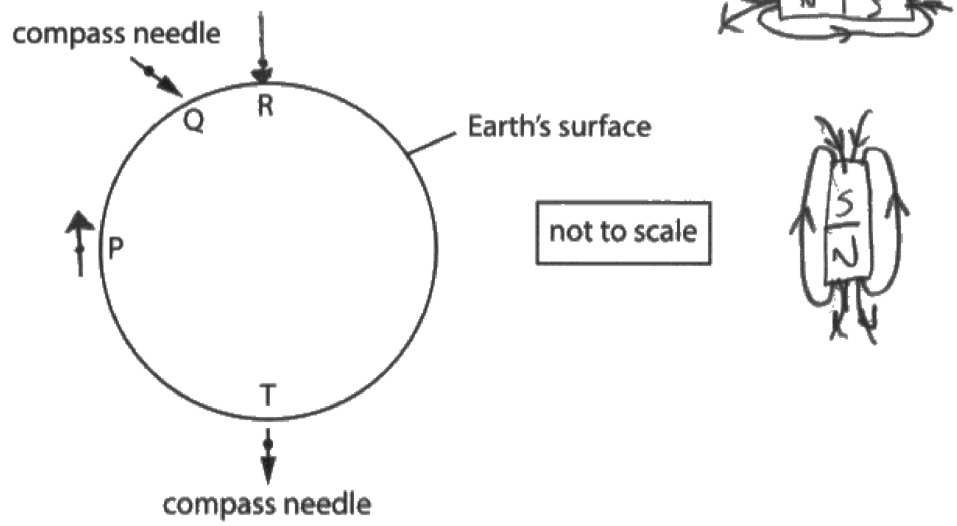


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

ResultsPlus
Examiner Comments

Both arrows are given with the correct directions.

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.

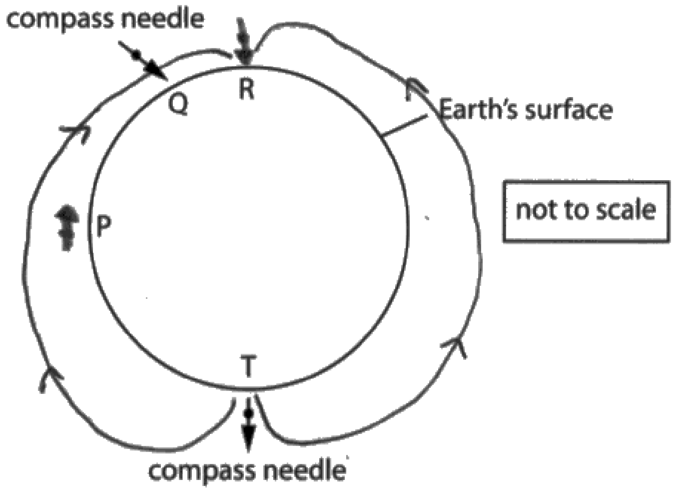


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

ResultsPlus Examiner Comments

This shows two perfectly acceptable arrows.

This is shown partly for the realisation that examiners had to see those arrows amid the other lines drawn by candidates.

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.

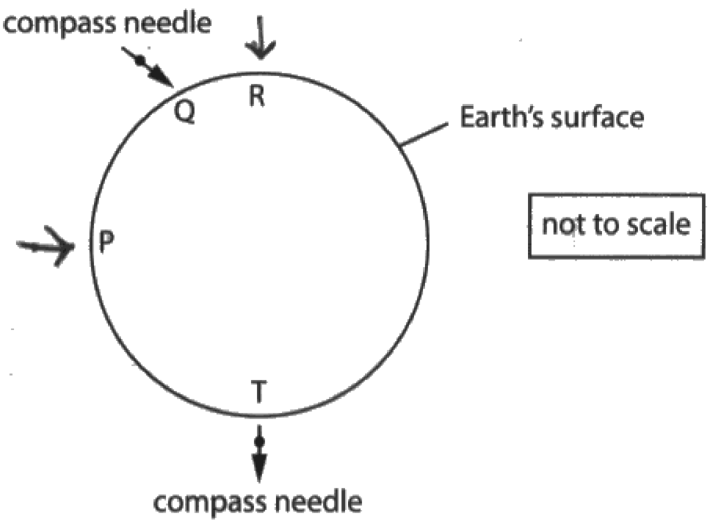


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

ResultsPlus
Examiner Comments

This is a typical common response, with the top arrow correct and the equatorial one incorrect.

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.

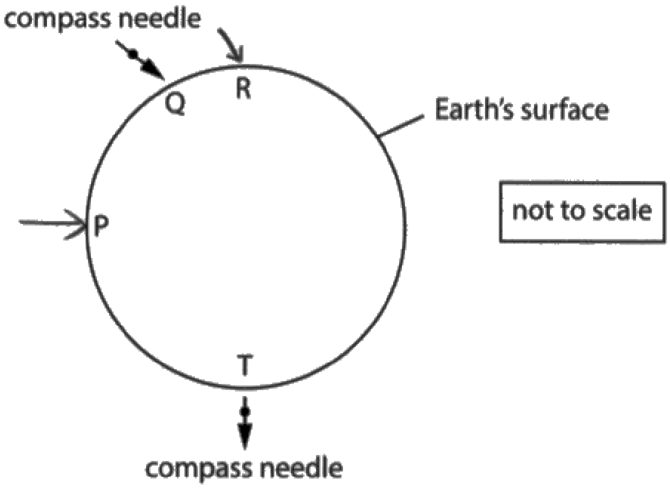


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

ResultsPlus
Examiner Comments

The top arrow needed to be shown acting vertically down, to within 10° or so as judged by eye.

Question 5 (a)(ii)

This gave rise to a mixed response, with only a minority getting three marks and a greater number than that getting 0 marks.

Examiners had to sort out explanatory points from amidst very variable writing.

Here are the marking points for ease of reference:

1. Earth has a magnetic field (1)
2. (Magnetic compass) needle/arrow points in the direction of the field (1)
3. (Earth's magnetic) field goes into Earth at Q and/or R – – comes out of Earth at T (1)
4. (Earth's magnetic) field runs parallel to Earth's surface at P (1)
5. Q and/or R are at (magnetic) south pole / T is at (magnetic) north pole (1)

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.

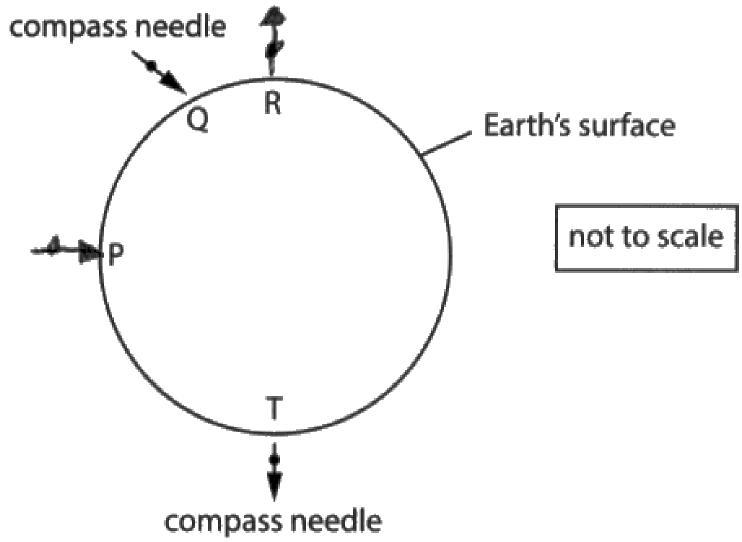


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

(ii) Explain why the arrows point in the directions you have drawn in part (i).

You may draw on Figure 13 to help your answer.

(3)

Because the North Seeking pole of the compass aligns itself with the Earth's field lines, causing it to point North, this is because the Earth's core is magnetic and produces its own magnetic field.
Earth's North Pole is actually a magnetic South pole.

ResultsPlus
Examiner Comments

This scores the full 3 marks.

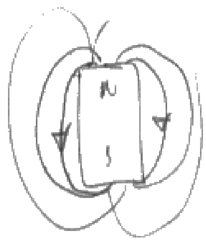
Mark points 1 and 2 are seen in the first sentence.

The last sentence matches mark point 5.

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.



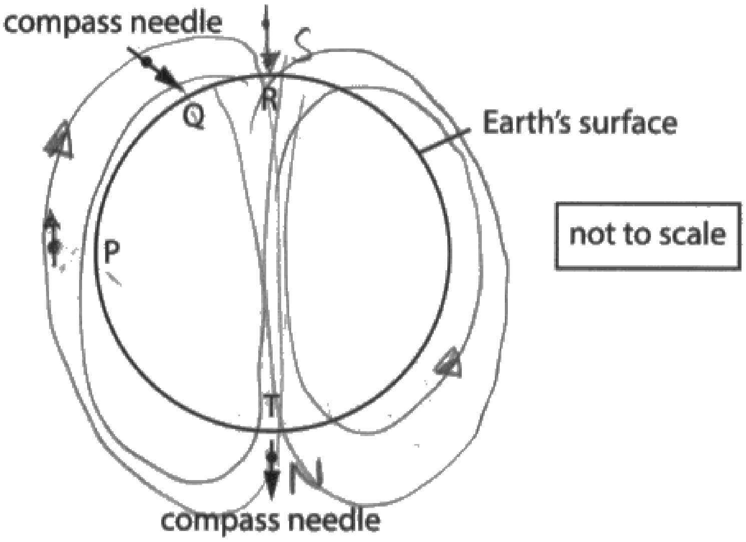


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

(ii) Explain why the arrows point in the directions you have drawn in part (i).

You may draw on Figure 13 to help your answer.

(3)

The earth has a north and south pole that magnetic makes a magnetic field which flows from north to south and means that a magnetic field is created, shown through the direction

ResultsPlus
Examiner Comments

This gets 3 marks with the diagram contribution.

In fact marking points 1,2 3 and 4 may be awarded from the diagram alone, before reference is made to their script.

We only see mark points 1 and 3 in the written script.

Maximum 3 marks obtained.

5 (a) Figure 13 represents the Earth.

Figure 13 shows **two** magnetic compass needles placed near to the Earth's surface, at points Q and T.

Each magnetic compass needle can rotate about its central dot.

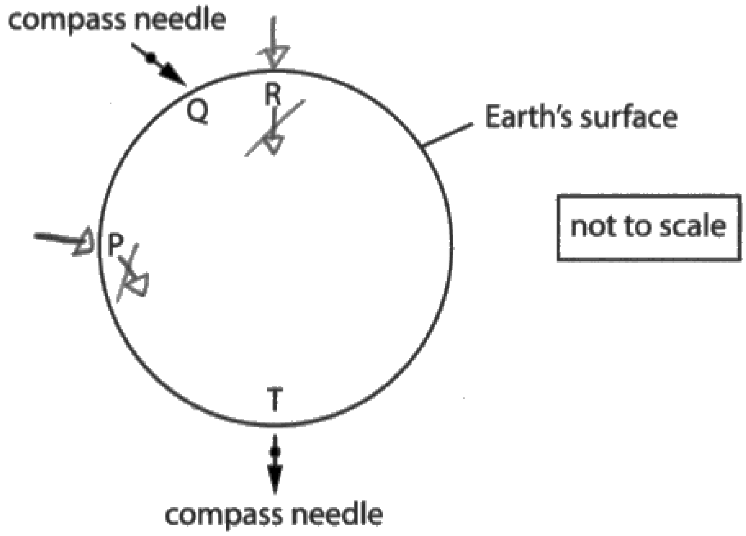


Figure 13

(i) A compass needle is placed at point P and another at point R, near to the Earth's surface.

On Figure 13, draw an arrow at point P and an arrow at point R to show the direction of the compass needle at each point.

(2)

(ii) Explain why the arrows point in the directions you have drawn in part (i).

You may draw on Figure 13 to help your answer.

(3)

The compass needle contains a small magnet that reacts to the ~~e~~ Earth's magnetic field as it is within it and the compass needle will point towards the South, which is the geographical north.

ResultsPlus
Examiner Comments

This gains 2 marks.

This shows mark point 1 and 5.

'Reacts to' is not the same as 'aligns itself with' (the field) and the additional guidance point 2 is not met because it doesn't say pointing to the south **pole of magnet**.

Question 5 (b)(i)

Fleming's left hand rule shows the force to be vertically up on the wire.

(b) Figure 14 shows a wire placed between the poles of a U-shaped magnet.

The wire is connected to a resistor and a battery.

The wire carries a current in the direction shown.

The wire is perpendicular to the magnetic field of the magnet.

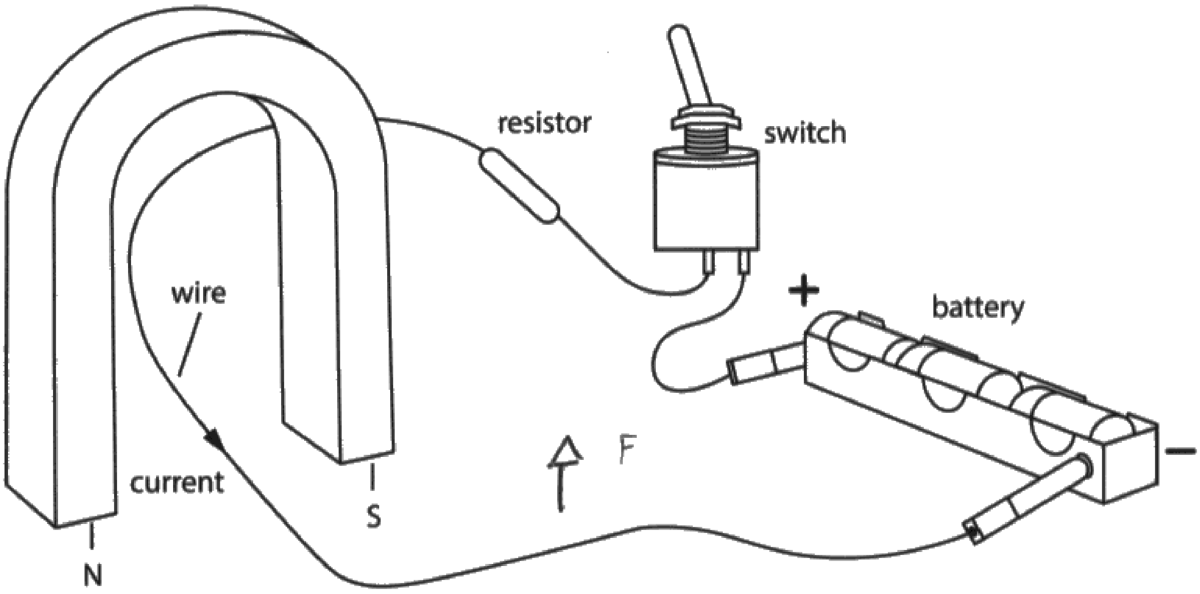


Figure 14

(i) Draw an arrow on Figure 14 to show the direction of the force, F, acting on the wire.

Label this arrow 'F'.

(1)

ResultsPlus Examiner Comments

The arrow points upwards.

Note the mark scheme states 'seen anywhere'.

(b) Figure 14 shows a wire placed between the poles of a U-shaped magnet.

The wire is connected to a resistor and a battery.

The wire carries a current in the direction shown.

The wire is perpendicular to the magnetic field of the magnet.

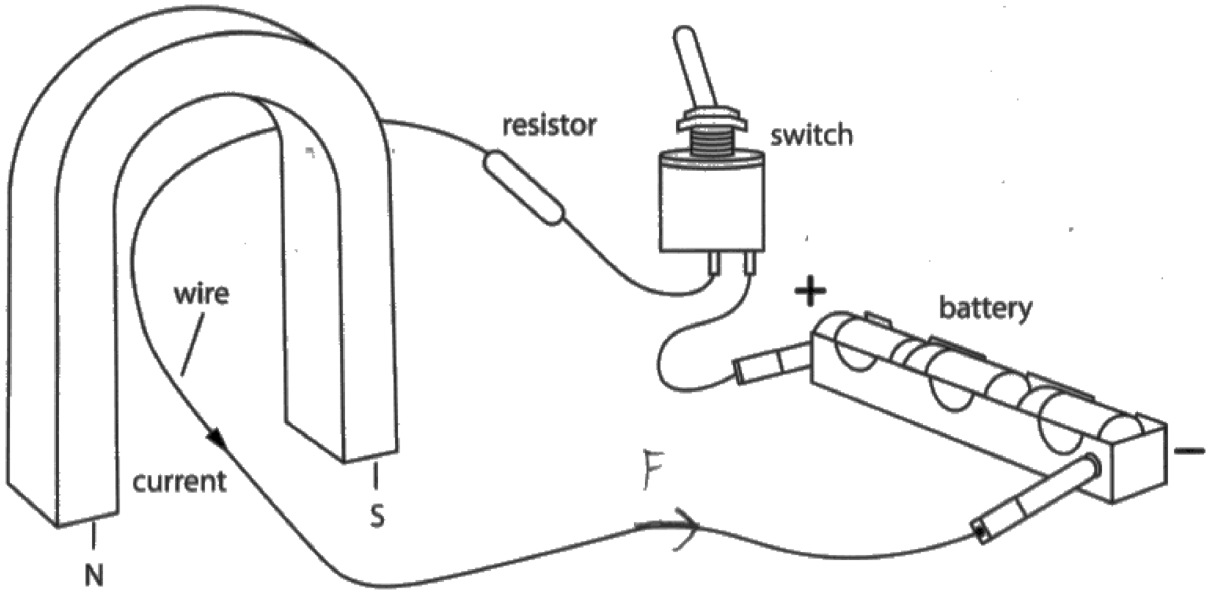


Figure 14

(i) Draw an arrow on Figure 14 to show the direction of the force, F, acting on the wire.

Label this arrow 'F'.

(1)

ResultsPlus
Examiner Comments

Arrow shown along the wire.

No mark.

(b) Figure 14 shows a wire placed between the poles of a U-shaped magnet.

The wire is connected to a resistor and a battery.

The wire carries a current in the direction shown.

The wire is perpendicular to the magnetic field of the magnet.

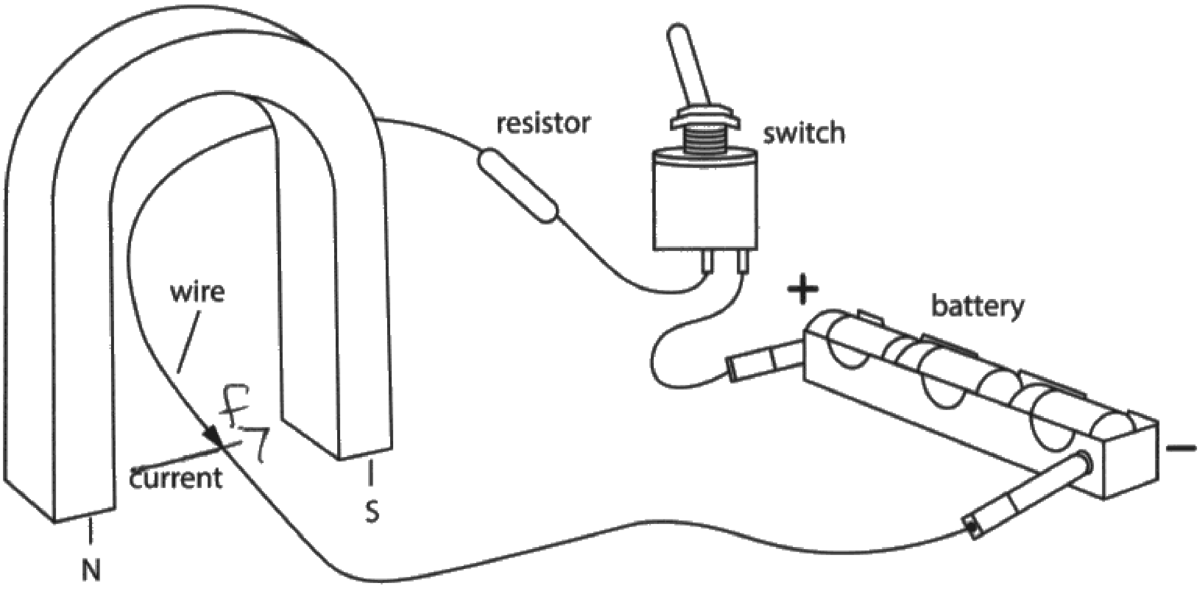


Figure 14

(i) Draw an arrow on Figure 14 to show the direction of the force, F, acting on the wire.

Label this arrow 'F'.

(1)

ResultsPlus
Examiner Comments

Arrow shown from N to S pole. The candidate appears confused with field direction.

Question 5 (b)(ii)

Practical action(s) were required.

Neither 'reverse the field' nor 'reverse the current' were acceptable in this connection. What you do (physically) with the apparatus was needed.

(ii) State **one** practical way of reversing the direction of force F.

(1)

By reversing the flow of the current, by flipping the battery to - and +.

ResultsPlus Examiner Comments

This demonstration of what you would do diagrammatically did help.

(ii) State **one** practical way of reversing the direction of force F.

(1)

rotate the mangnet so the northis on the right and sotle is on the left

![ResultsPlus Examiner Comments]

ResultsPlus
Examiner Comments

Well described **'what you would do'**.

(ii) State **one** practical way of reversing the direction of force F.

(1)

turn the battery around to swap the positive and the negative.

ResultsPlus
Examiner Comments

This is a clear enough description of a practical action that would send the current the other way.

(ii) State **one** practical way of reversing the direction of force F.

(1)

Turn the magnet upside down

ResultsPlus
Examiner Comments

This approach would not achieve the desired effect.

(ii) State **one** practical way of reversing the direction of force F.

(1)

Reverse the direction of the current

ResultsPlus
Examiner Comments

Not a practical, easy to action, proposal.

What do you **do** to achieve that?

Question 5 (b)(iii)

This was a straightforward rearrangement **and** substitution for one mark.

A correct evaluation got the second mark.

(iii) In Figure 14

- current in the wire = 3.2 A
- length of wire in the magnetic field = 0.042 m
- magnitude of the force on the wire = 0.078 N

Calculate the magnitude of the magnetic flux density between the two poles of the magnet.

(2)

$F = BIL$

$B = \frac{F}{IL}$ $\qquad \frac{\text{force}}{\text{current} \times \text{length}}$

$\frac{0.078}{(3.2 \times 0.042)} = 0.580357$

$= 0.58$ to 2dp

magnetic flux density = 0.58 T

ResultsPlus
Examiner Comments

Full marks, with clear working also shown.

(iii) In Figure 14

- current in the wire = 3.2 A
- length of wire in the magnetic field = 0.042 m
- magnitude of the force on the wire = 0.078 N

Calculate the magnitude of the magnetic flux density between the two poles of the magnet.

(2)

F = B x I x l

0.078 = B x 3.2 x 0.042

$B = \frac{0.078}{3.2 \times 0.042}$

B = 0.1344

$B = \frac{0.078}{0.1344}$

B = 0.05803...

magnetic flux density = 0.0580 T

ResultsPlus
Examiner Comments

The first mark point is seen, namely

(B =) 0.078

3.2 x 0.042

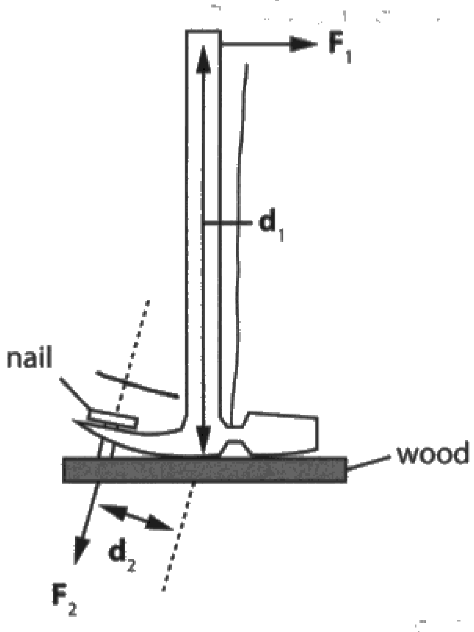
There is then an error calculating,

Question 6 (b)(i)

Many candidates missed saying **'sum of'** clockwise moments = **'sum of'** anticlockwise. That component of the definition is indispensable. Knowing that this applies to a system **in equilibrium is also necessary.**

The majority of candidates scored 0 in the question, revealing a gap and flaw in candidates' knowledge.

(b) Figure 15 shows a claw hammer about to remove a nail from a piece of wood.



f × d

Figure 15

(i) State the principle of moments.

(2)

The workdone perpendicular to the pivot x distance = moment

If the sum of the clockwise moment = sum of the

anti clock wise moment   the system is in eaquilibrium

ResultsPlus
Examiner Comments

This could be better expressed and we ignore the work done part.

However it does contain the two key elements needed in expressing the principle of moments. These are, in their words,

- 'sum of clockwise moment = sum of anticlockwise moment'
- 'the system is in equilibrium'.

(b) Figure 15 shows a claw hammer about to remove a nail from a piece of wood.

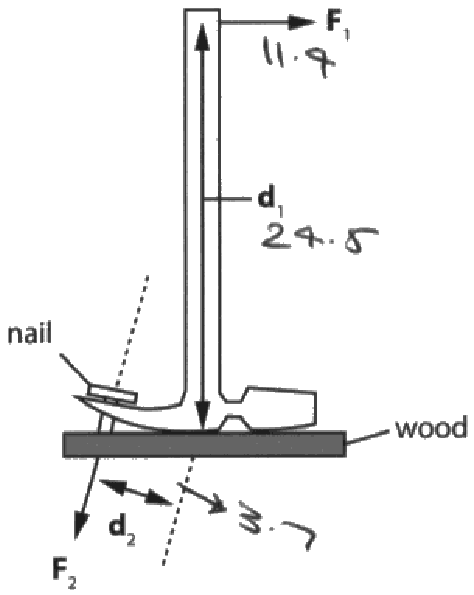


Figure 15

(i) State the principle of moments.

(2)

~~Sum~~ sum of moments clockwise = sum of moments anti-clockwise.

ResultsPlus
Examiner Comments

This response gets the first mark, including the vital 'sum of', but misses the 'in equilibrium' point.

(b) Figure 15 shows a claw hammer about to remove a nail from a piece of wood.

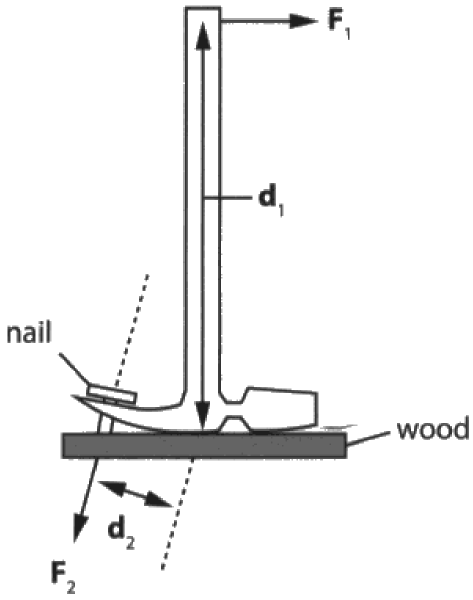


Figure 15

(i) State the principle of moments.

(2)

For all objects in equilibrium, the moments are equal for the ~~wood~~ nail, and for the hammer.
The further / larger the distance, the larger the moment.

ResultsPlus
Examiner Comments

This response misses the 'sum of' key idea. They do get the second mark though, 'for objects in equilibrium'.

Question 6 (b)(ii)

This contrasts with the previous part with a majority scoring 3 out of 3 marks here.

Candidates showed that they could apply the principle, without being able to express it in theory.

(ii) Calculate the force F_2 shown in Figure 15.

Use the following data

- $F_1 = 11.4$ N
- $d_1 = 24.5$ cm
- $d_2 = 3.7$ cm

(3)

$f_1 \times d_1 = f_2 \times d_2$

$\frac{f_1 \times d_1}{d_2}$

$\frac{11.4 \times 24.5}{3.7} = 75.48648649$

$F_2 =$ 75.5 (3sf) N

ResultsPlus
Examiner Comments

This exemplifies the necessary application of knowledge.

The answer is well expressed and well set out, leading to a correct evaluation.

(ii) Calculate the force F_2 shown in Figure 15.

Use the following data

- $\mathbf{F_1}$ = 11.4 N
- $\mathbf{d_1}$ = 24.5 cm
- $\mathbf{d_2}$ = 3.7 cm

(3)

$11.4 \times 0.245 = 2.793$

$$\frac{2.793}{3.7} = 0.75$$

F_2 = 0.75 N

ResultsPlus
Examiner Comments

The working here is along the right lines, but in one half of the equation the candidate has converted the distance into metres, whilst in the other half they retain centimetres.

Hence their evaluation ends up a factor of 100 out.

They were awarded the choice of equation together with rearrangement mark and were given a benefit of doubt mark over the substitutions, having made that just one slip.

(ii) Calculate the force F_2 shown in Figure 15.

Use the following data

- $F_1 = 11.4$ N
- $d_1 = 24.5$ cm
- $d_2 = 3.7$ cm

$mg = f \times d$

(3)

F_2 = ... N

ResultsPlus
Examiner Comments

The mark scheme states 'if no other mark scored, award one mark for **idea** of moment = force x distance'. In mark schemes, 'emboldened' means conveys the essence of a notion, which this candidate's shorthand equation does.

ResultsPlus
Examiner Tip

This shows you it is always worth expressing some knowledge with the overall aim of gaining marks.

Question 6 (c)(i)

Most candidates were fully successful in answering this question.

(c) Figure 16 shows a system of gears used in a clock.

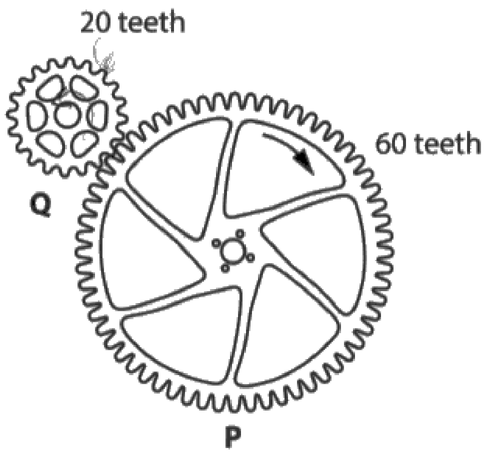


Figure 16

(i) Gear wheel **P** rotates clockwise at a rate of 1.0 revolution per **minute**.

Calculate the rotation rate of gear wheel **Q** in revolutions per **hour**.

(2)

~~1.0 ÷ 60 =~~ 60 ÷ 20 = 3

~~Q × 3 =~~ P × 3 = Q = 1.0 × 3 = 3.0 revolution per minute.

→ 3.0 × 60 = 180 revs per hour

rotation rate of **Q** = 180 revolutions per hour

ResultsPlus
Examiner Comments

The answer is correct, so full marks obtained.

ResultsPlus
Examiner Tip

Note how the candidate communicates the steps in their calculation.

- gear ratio calculated
- multiplies to get revs per minute
- sees answer requires revs/hour so x60 to get the final answer

Such clear communication always helps getting intermediate marks should a miscalculation occur.

(c) Figure 16 shows a system of gears used in a clock.

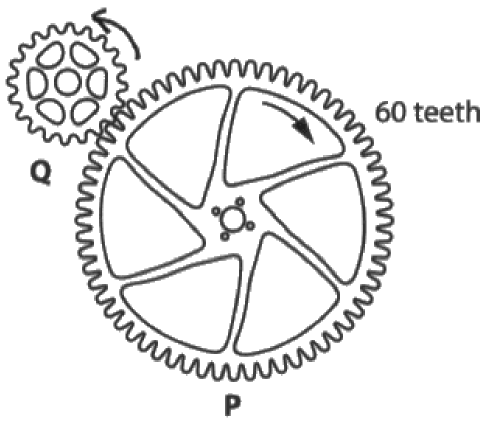


Figure 16

(i) Gear wheel **P** rotates clockwise at a rate of 1.0 revolution per **minute**.

Calculate the rotation rate of gear wheel **Q** in revolutions per **hour**.

(2)

$\frac{20}{60} = \frac{2}{6} = \frac{1}{3}$

$(\frac{1}{3} \times 1) \times 60 = 20$ rev/hr

rotation rate of **Q** = 20 revolutions per hour

ResultsPlus
Examiner Comments

The mark scheme stipulates 'allow 1 mark for answer of 20 (revs/hour) (from inverse ratio)'.

(c) Figure 16 shows a system of gears used in a clock.

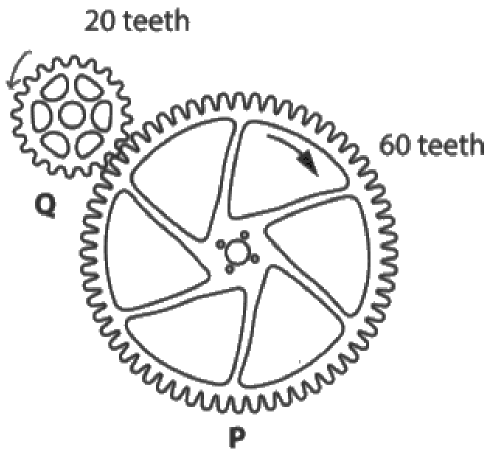


Figure 16

(i) Gear wheel **P** rotates clockwise at a rate of 1.0 revolution per **minute**.

Calculate the rotation rate of gear wheel **Q** in revolutions per **hour**.

(2)

$\frac{60}{20} = 3$

rotation rate of **Q** = 3 revolutions per hour

ResultsPlus
Examiner Comments

This response is given a mark for a use of the gear ratio of 3x.

Question 6 (c)(ii)

Many candidates achieved full success with this item, showing good ability in positioning.

(c) Figure 16 shows a system of gears used in a clock.

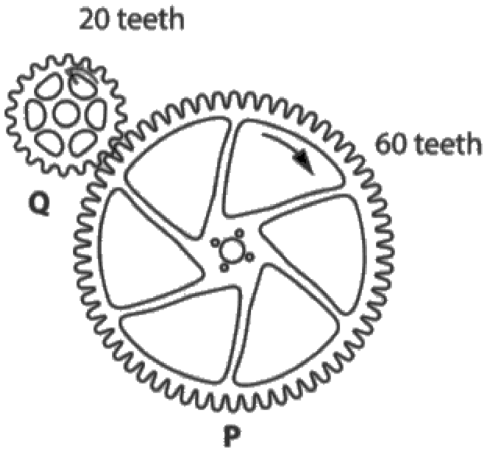


Figure 16

(ii) Describe how a gear wheel could be added to the system to give a clockwise rotation with **double** the rotation rate of gear wheel **Q**.

Your answer should refer to

- the position of the gear wheel
- the number of teeth in the gear wheel.

(2)

position the wheel ~~to~~ interlocking with only Q not P for clockwise rotation

10 teeth in the geer wheel

ResultsPlus Examiner Comments

Full marks, a perfect response.

(c) Figure 16 shows a system of gears used in a clock.

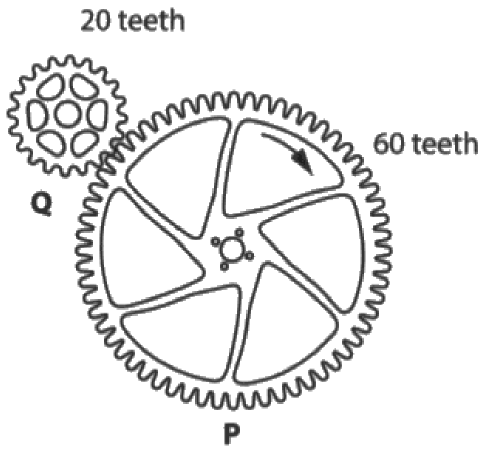


Figure 16

(ii) Describe how a gear wheel could be added to the system to give a clockwise rotation with **double** the rotation rate of gear wheel **Q**.

Your answer should refer to

- the position of the gear wheel
- the number of teeth in the gear wheel.

(2)

The wheel would have 10 teeth and be positioned as to where it's touching both Q and P.

ResultsPlus Examiner Comments

No mark for touching both P and Q. (It wouldn't work then.)

One mark for knowing it needed 10 teeth.

(c) Figure 16 shows a system of gears used in a clock.

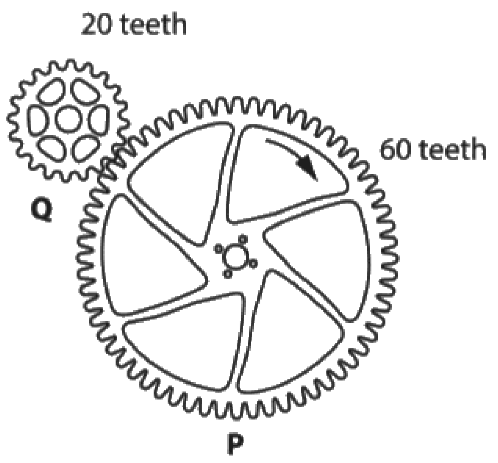


Figure 16

(ii) Describe how a gear wheel could be added to the system to give a clockwise rotation with **double** the rotation rate of gear wheel **Q**.

Your answer should refer to

- the position of the gear wheel
- the number of teeth in the gear wheel.

(2)

40 teeth - ~~give~~ next to the gear wheel Q

ResultsPlus Examiner Comments

One mark for next to gear wheel Q (see additional guidance).

(c) Figure 16 shows a system of gears used in a clock.

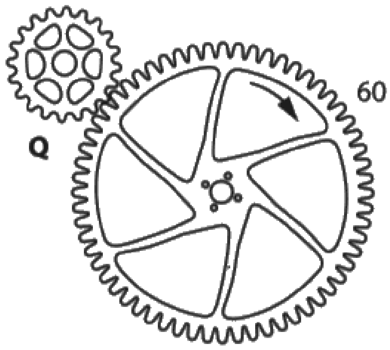


Figure 16

(ii) Describe how a gear wheel could be added to the system to give a clockwise rotation with **double** the rotation rate of gear wheel **Q**.

Your answer should refer to

- the position of the gear wheel
- the number of teeth in the gear wheel.

(2)

place the third gear wheel so its interlocking with gear Q but not P with 30 teeth

ResultsPlus
Examiner Comments

Interlocking with gear wheel q (only) certainly gets that mark, but wrong number of teeth chosen.

Question 7 (a)

Most students achieved full marks on this question, with some falling short on failing to give the answer to an appropriate number of three significant figures.

7 (a) Figure 17 shows an athlete training with a push sled.

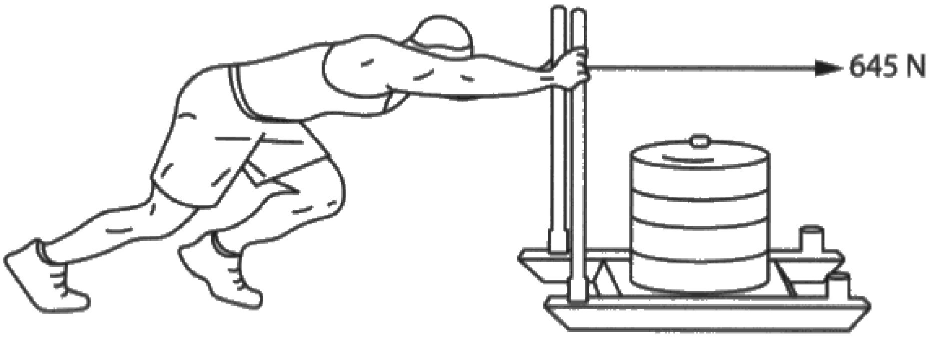


Figure 17

The athlete pushes the sled with a force of 645 N.

Calculate the distance the sled moves when the force of 645 N does 7440 J of work on the sled.

Give your answer to an appropriate number of significant figures.

(3)

work done = force × distance

$\frac{7440}{645} = 11.5|348837 2$

distance moved = 11.5 m

ResultsPlus
Examiner Comments

Full marks here:

- correct substitution
- correct rearrangement
- correct evaluation to three significant figures

7 (a) Figure 17 shows an athlete training with a push sled.

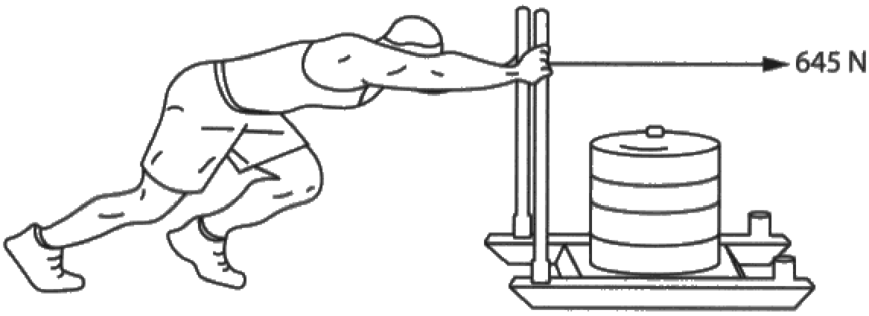


Figure 17

The athlete pushes the sled with a force of 645 N.

Calculate the distance the sled moves when the force of 645 N does 7440 J of work on the sled.

Give your answer to an appropriate number of significant figures.

(3)

7440J = 645 x d

11.53488372 = d

distance moved = 11.530 m

ResultsPlus
Examiner Comments

2 marks.

Just falls short on the appropriate number of significant figures mark.

ResultsPlus
Examiner Tip

All the numbers in the question are given to three significant figures.

To be consistent you should give your final answer to that same number of significant figues, ie it should be 11.5 (m) here.

Question 7 (b)(i)

There was a good spread of marks in this practically based question, worth 4 marks.

The mark scheme is produced here to help with the identification of marking points:

A description to include two clear statements of what is measured plus further details:

1. use scales/a balance to measure mass(es) (1)
2. use a (metre) rule to measure a distance / height (1)

Plus any two from

3. set balance to zero/tare (before placing masses) (1)

4. measure initial and final heights (1)

5. use of same reference point for height measurements (1)

6. clamp vertical rule/detail of checking rule is vertical (1)

7. selects GPE = m g (Δ)h (1)

(b) Figure 18 shows an electric motor lifting a set of masses.

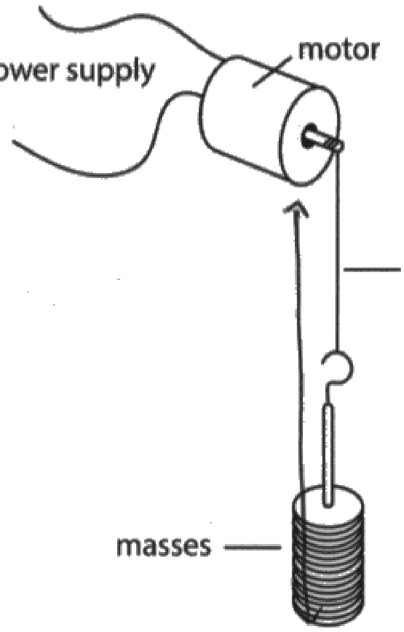


Figure 18

(i) Describe an experiment, using the apparatus in Figure 18, to determine the gravitational potential energy gained by the masses as they are lifted.

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 18 if it helps your answer.

(4)

the higher they are lifted the more gpe they have, but the more weight the harder it is to gain gpe

gpe = mass × gfs × height

measure the height from the ~~floor~~ top of the string to the bottom

measure the weight of the masses altogether

gfs is always 10N/kg on earth.

ResultsPlus
Examiner Comments

Measuring instruments omitted so no mp1 or mp2.

Awarded 1 mark for use of equation – mp 7.

ResultsPlus
Examiner Tip

When describing practical procedures always mention the instruments used in measuring. Here that would be metre rule for height and measuring scales for mass.

(b) Figure 18 shows an electric motor lifting a set of masses.

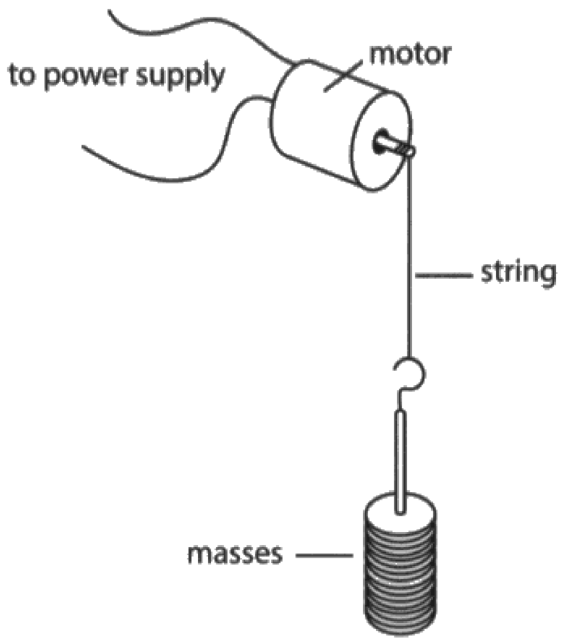


Figure 18

(i) Describe an experiment, using the apparatus in Figure 18, to determine the gravitational potential energy gained by the masses as they are lifted.

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 18 if it helps your answer.

(4)

GPE = mgh therefore if you increase the height of the masses from the ground, gpe will increase. since mass and ~~gravity~~ gravitational field strength are constant, the only change is height and as this increases, so does GPE. calculate it with this equation (GPE = mgh) and measure the height with a ruler. Do the mass x 10 x Δh which is found with the ruler to see the change in GPE as the height increases.

ResultsPlus
Examiner Comments

mp2 and mp7 are seen.

With the mass the candidate fails to mention the measuring instrument involved.

(b) Figure 18 shows an electric motor lifting a set of masses.

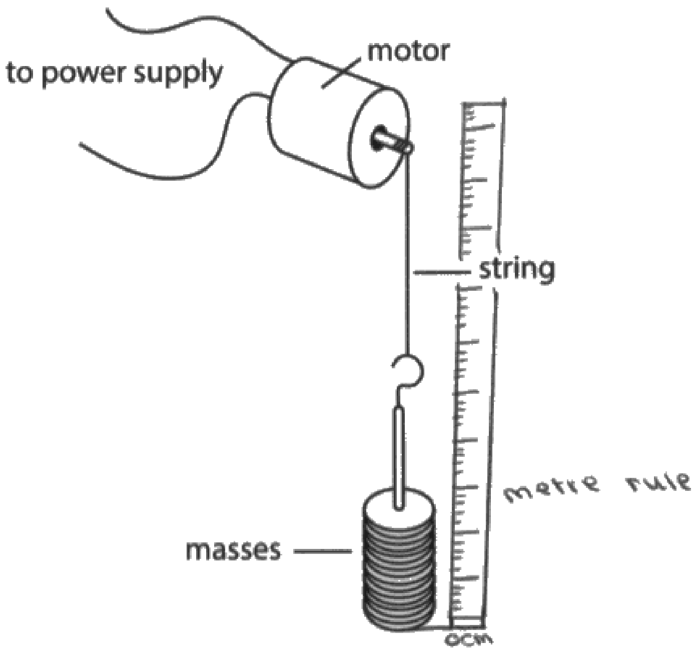


Figure 18

(i) Describe an experiment, using the apparatus in Figure 18, to determine the gravitational potential energy gained by the masses as they are lifted.

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 18 if it helps your answer.

(4)

$\Delta GPE = m \times g \times \Delta h$

To find the mass, the masses should first be weighed using a pan balance. A metre ruler should be used to measure the distance the masses travel upwards by when the motor is on, starting ~~at~~ with 0cm in line with the bottom of the masses and the final distance value also in line with the bottom. The above equation can then * *be used to calculate the GPE gained from these values, with the value of g being 9.8, as that is the gravitarional field strength on Earth.

ResultsPlus
Examiner Comments

This answer has mp1 and 2, followed by any two from mps 4,5 and 7 which are seen in the response.

An excellent answer here.

(b) Figure 18 shows an electric motor lifting a set of masses.

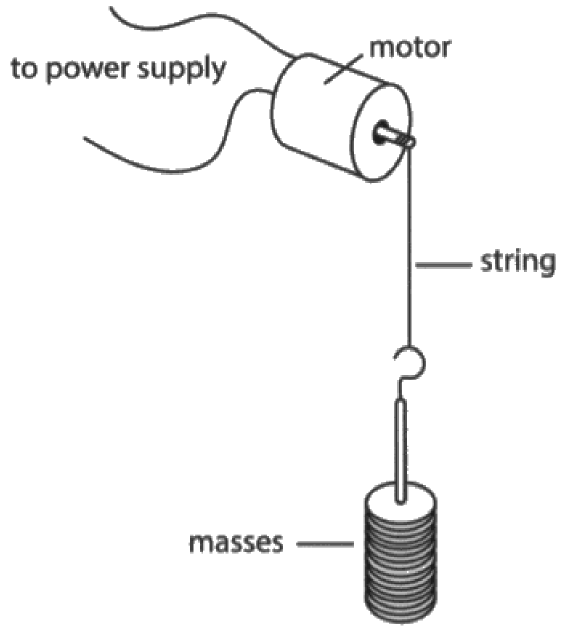


Figure 18

(i) Describe an experiment, using the apparatus in Figure 18, to determine the gravitational potential energy gained by the masses as they are lifted.

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 18 if it helps your answer.

(4)

• ΔGPE = m × g × Δh

• measure the mass of all the masses - do this by adding up the values of each mass

• turn power supply off, attach masses to string, and using a ruler measure the length at which they hang - from the top of the string. Turn on power supply, wait for masses to lift. Measure the new length (height) at which the masses are lifted. Subtract ~~original~~ new value from original to find the change in height.

• use equation ΔGPE = m × g × Δh - gravitational field strength value is ~~10~~ 9.8N. Put all values into equations and multiply to find GPE gained.

For accuracy, repeat using wider range of mass

ResultsPlus
Examiner Comments

Full 4 marks.

mp1 It is clear enough that the candidate adds up the standard mass values to get the total (see additional guidance on this mark)

mp 2 clearly seen, then mp4 and 7 are seen.

(b) Figure 18 shows an electric motor lifting a set of masses.

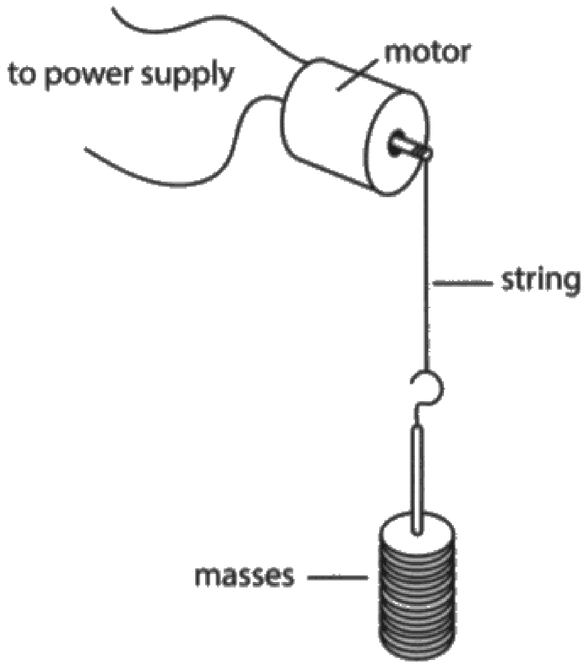


Figure 18

(i) Describe an experiment, using the apparatus in Figure 18, to determine the gravitational potential energy gained by the masses as they are lifted.

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 18 if it helps your answer.

(4)

- Measure increase in height using a meter rule
- Measure masses using balance if they are not labeled

multiply increase in height by mass and by 10 (gravitational field strength of earth) to get gravitational potential energy

ResultsPlus
Examiner Comments

mp1, mp2 and mp7 (in words) seen.

Hence 3 marks in total.

Question 7 (b)(ii)

A majority scored full marks on this one.

(ii) In one experiment, the change in gravitational potential energy of the masses was 5.8 J.

The total mass lifted was 320 g.

Calculate the vertical height the masses travelled through.

Use g = 10 N/kg.

(2)

$$5.8 = 0.32 \times 10 \times \Delta h$$

$$\frac{5.8}{3.2} = \Delta h$$

$$1.8125\text{m} = \Delta h$$

height = 1.81 m

ResultsPlus
Examiner Comments

Rearrangement and substitution mark clearly seen.

Correct evaluation also.

Full marks.

ResultsPlus
Examiner Tip

Well presented, so that an intermediate mark could have been given in the event of a miscalculation.

(ii) In one experiment, the change in gravitational potential energy of the masses was 5.8 J.

The total mass lifted was 320 g.

Calculate the vertical height the masses travelled through.

Use g = 10 N/kg.

(2)

GPE = mass x g x vertical height

5.8 = 320 x 10 x height

$\frac{5.8}{(320 \times 10)}$ = h = 0.0018≈5.8. = 0.002

height = 0.002 m

ResultsPlus
Examiner Comments

First mark point seen, namely

5.8

320 (x 10^{-3}) x 10

Unfortunately the candidate does not convert the g to kg and so misses the final evaluation mark.

Question 7 (b)(iii)

The vast majority of candidates were able to state a valid reason for this one.

(iii) The efficiency of the motor was 59%.

State **one** reason why the motor was not 100% efficient.

(1)

Energy is also transfered to heat in the motor and the surroundings by friction and not just to the masses' GPE as wasted energy

(Total for Question 7 = 10 marks)

ResultsPlus
Examiner Comments

Yes, 'heating (electrical or from frictional effects)' is seen for the mark.

(iii) The efficiency of the motor was 59%.

State **one** reason why the motor was not 100% efficient.

(1)

Friction in the motor lead to a loss of thermal energy being dissipated to the surroundings.

(Total for Question 7 = 10 marks)

ResultsPlus
Examiner Comments

Good answer again.

Many wrote words to the effect of 'heating (electrical or from frictional effects)', with most concentrating on the frictional effect.

Question 8 (a)

A good spread of marks occurred with this question.

Many candidates scored full marks.

The use of the old symbol for filament lamp did not prove to be a barrier to candidates.

If they wanted they could add the more usual lamp symbol to their circuit.

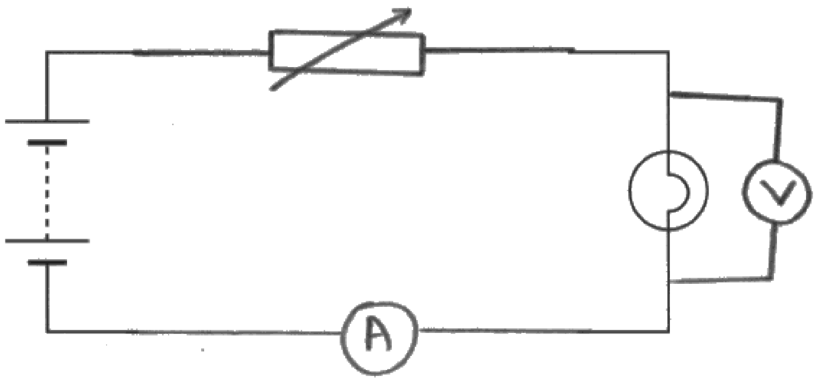
8 (a) A student investigates how current varies with potential difference across a filament lamp.

The student uses a power supply, a variable resistor, the filament lamp and two meters.

Part of the circuit diagram is shown in Figure 19.

Complete the circuit diagram needed for this investigation.

(3)



ResultsPlus
Examiner Comments

An example of the many fully correct answers seen.

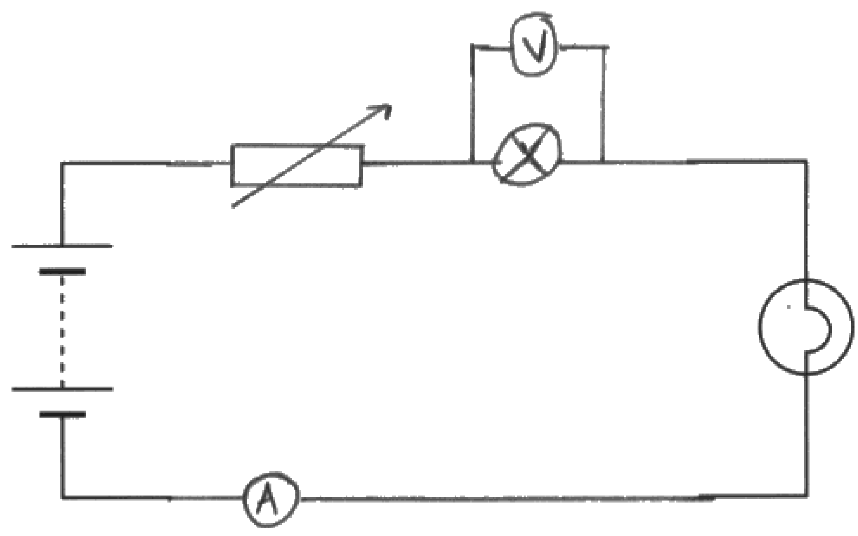
8 (a) A student investigates how current varies with potential difference across a filament lamp.

The student uses a power supply, a variable resistor, the filament lamp and two meters.

Part of the circuit diagram is shown in Figure 19.

Complete the circuit diagram needed for this investigation.

(3)



ResultsPlus
Examiner Comments

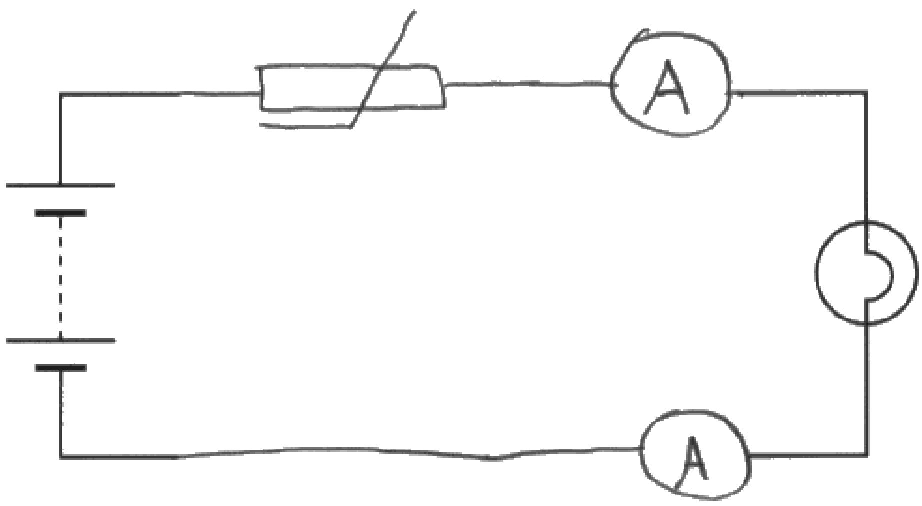
This was equally acceptable for full marks.

8 (a) A student investigates how current varies with potential difference across a filament lamp.

The student uses a power supply, a variable resistor, the filament lamp and two meters.

Part of the circuit diagram is shown in Figure 19.

Complete the circuit diagram needed for this investigation.



ResultsPlus
Examiner Comments

Only one mark here for an ammeter shown in series.

The variable resistor symbol is incorrect.

No voltmeter has been added.

Question 8 (b)(i)

A majority of candidates gave an acceptable advantage for using a data logger.

Speed of getting the readings was most often chosen, with some opting for the collection of much more data via the datalogger.

(b) Another student repeats the investigation in part (a) using a data logger.

The data logger records observations using sensors instead of meters. The sensors are connected to a computer to collect and display the observations.

The data logger collects 555 pairs of data in 2 minutes.

The results are shown in Figure 20.

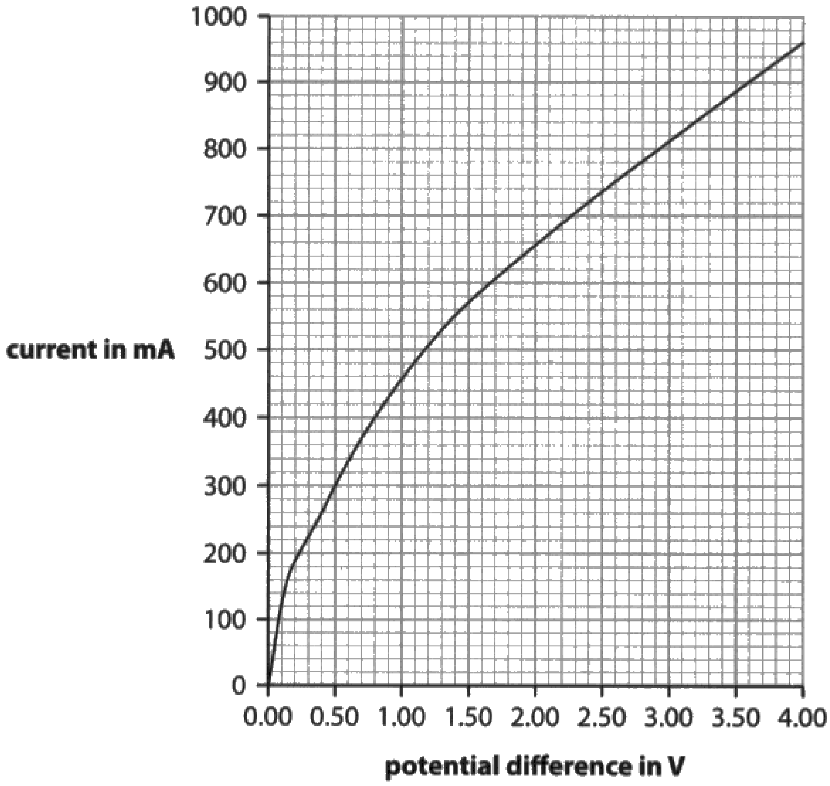


Figure 20

(i) Suggest **one** advantage of using a data logger instead of meters in this investigation.

(1)

The data loggers give more exact measurements so they are more accurate.

ResultsPlus
Examiner Comments

'More exact' or 'accurate' are not valid answers here.

The mark scheme states: ignore 'accuracy'.

(b) Another student repeats the investigation in part (a) using a data logger.

The data logger records observations using sensors instead of meters. The sensors are connected to a computer to collect and display the observations.

The data logger collects 555 pairs of data in 2 minutes.

The results are shown in Figure 20.

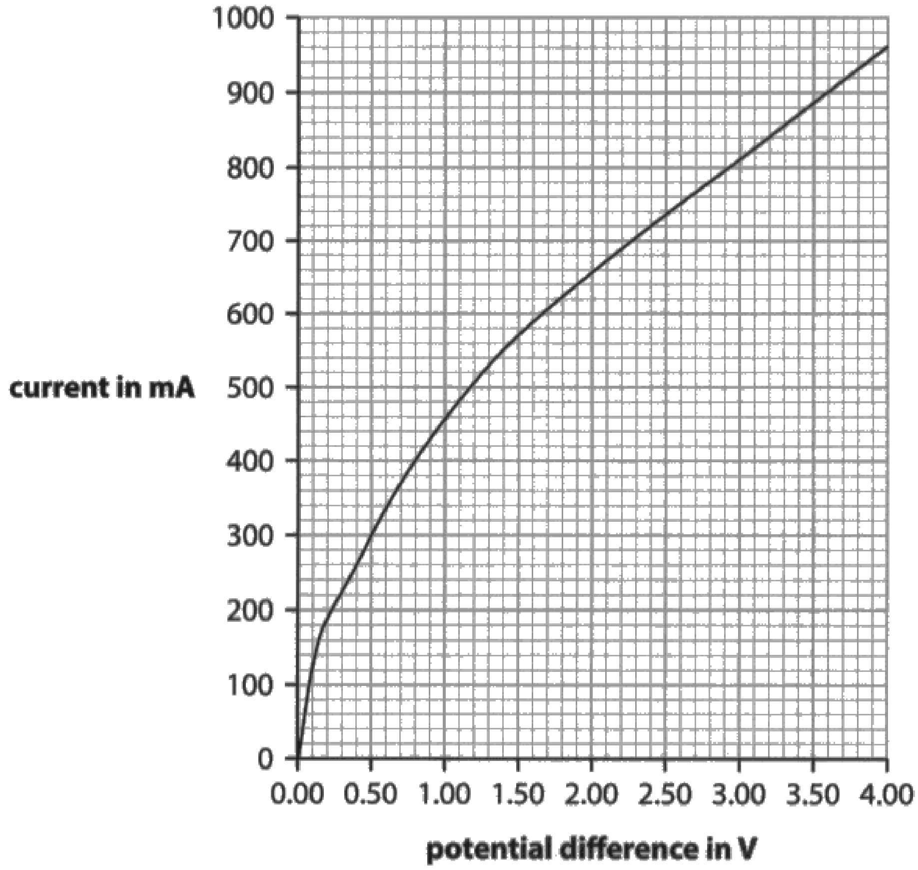


Figure 20

(i) Suggest **one** advantage of using a data logger instead of meters in this investigation.

(1)

It collects data more quickly

ResultsPlus Examiner Comments

The most commonly seen correct answer.

Question 8 (b)(ii)

This is a common question now which many candidates are familiar with.

Marks on this have been rising each year, with more and more students going beyond the basic variation description to talk about non-linearity for the second mark.

(ii) Describe how current varies with potential difference in the graph in Figure 20.

(2)

As potential difference increases, current increases in a non-linear pattern that becomes linear around 2.25V.

ResultsPlus
Examiner Comments

Both mark points addressed.

The observation of the graph showing more linearity after a certain point is an accurately well-observed one.

(ii) Describe how current varies with potential difference in the graph in Figure 20.

(2)

as potential difference increases, current increases. As the potential difference becomes higher, the rate of increase in the current decreases

ResultsPlus
Examiner Comments

This is a well expressed answer, in terms of changing gradient, worth two marks.

(ii) Describe how current varies with potential difference in the graph in Figure 20.

(2)

As potential difference increases the current increases slowly at the start then increases faster after the potential difference reaches 0.5V. The relationship is non linear. Positive correlation.

ResultsPlus
Examiner Comments

The non-linearity is adequately commented upon.

(ii) Describe how current varies with potential difference in the graph in Figure 20.

(2)

As current increases the potential difference also increases. There is a positive correlation.

ResultsPlus
Examiner Comments

This just gets mark point 1 for the basic trend in relationship.

(ii) Describe how current varies with potential difference in the graph in Figure 20.

(2)

as the pd increases so does

the ~~the~~ current, this is not preportional

ResultsPlus
Examiner Comments

The first mark point is awarded.

The answer does not go far enough in this question regarding non-linearity.

Question 8 (b)(iii)

Candidates found this challenging. All three marks were represented in good numbers though. The question differentiated well.

Those that got full marks observed the increasing resistance with increasing p.d., followed by using two data pairs to justify this assertion.

$0.5/0.3 = 1.6\ \Omega$
$4/0.96 = 4.16\ \Omega$

(iii) Use data from the graph in Figure 20 to show how the resistance changes with potential difference for the filament lamp.

(2)

As potential difference increases so does the resistance. At 0.5V resistance is at 1.6 Ω but at 4V resistance is at 4.16 Ω showing an increase in resistance.

ResultsPlus
Examiner Comments

This is a standard correct response, using data from the graph, given by many for full marks.

(iii) Use data from the graph in Figure 20 to show how the resistance changes with potential difference for the filament lamp.
(2)

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

as potential difference increase so does resistance. When p.d is 0.5 resistance is 0.00167 but when p.d is 2 resistance is 0.003 so resistance has increased

ResultsPlus
Examiner Comments

Matches mark points 1 and 2.

The lack of conversion from mA to A has not prevented them from getting the second mark point, which requires ' a second pair of values used to give another value for resistance showing that resistance increases as p.d. increases'.

(iii) Use data from the graph in Figure 20 to show how the resistance changes with potential difference for the filament lamp.
(2)

Resistance increases with potential difference, as the gradient $(\frac{1}{R})$ decreases.

ResultsPlus
Examiner Comments

This is a succinct, accurate response with the candidate having the sophisticated understanding that the gradient of the graph gives the inverse of resistance.

(iii) Use data from the graph in Figure 20 to show how the resistance changes with potential difference for the filament lamp.

(2)

the greater the potential differenc the less ressistance there is

ResultsPlus
Examiner Comments

Wrong trend asserted, no marks.

Question 8 (d)

This question was intended to test candidates of grades 8 and 9 level.

It proved effective in that. It was testing specification reference 10.6:

Recall and use the equation:

energy transferred (joule, J) = charge moved (coulomb, C) ×

potential difference (volt, V)

$E = Q \times V$

This yields the fundamental meaning, idea and definition of potential difference, which candidates were expected to start with.

(d) The unit of work is the joule.

Starting with the meaning of work, we may obtain an equivalent unit of work as Nm.

Using work = $F \times d$

unit of work = unit of force × unit of distance = Nm

J/C

The unit of potential difference is the volt.

Explain how, starting with the meaning of potential difference, we may obtain an equivalent unit of potential difference.

(2)

potential difference is the energy transferred per unit of charge. So, the unit of voltage is J/C because voltage = $\frac{\text{energy transferred}}{\text{charge moved}}$. J/C is the same units as volts.

ResultsPlus
Examiner Comments

This candidate follows the pattern set in the work example given.

They are very clear in their reasoning, fully worth the two marks.

(d) The unit of work is the joule.

Starting with the meaning of work, we may obtain an equivalent unit of work as Nm.

Using work = $F \times d$

unit of work = unit of force × unit of distance = Nm

The unit of potential difference is the volt.

Explain how, starting with the meaning of potential difference, we may obtain an equivalent unit of potential difference.

(2)

potential difference ~~the~~ = $\frac{E}{Q}$

unit of potential ~~the~~ difference = $\frac{\text{unit of energy}}{\text{unit of charge}}$ = $\frac{J}{C}$

~~the~~ ~~the~~ the equivalent unit is J/C

(Joules per coulomb)

(Total for Question 8 = 11 marks)

ResultsPlus
Examiner Comments

This candidate spells out what was expected to good effect, starting from the meaning of potential difference and proceeding to the equivalent unit J/C.

(d) The unit of work is the joule.

Starting with the meaning of work, we may obtain an equivalent unit of work as Nm.

Using work = $F \times d$

unit of work = unit of force × unit of distance = Nm

The unit of potential difference is the volt.

Explain how, starting with the meaning of potential difference, we may obtain an equivalent unit of potential difference.

(2)

potential difference is the amount of energy transferred per unit charge. $V = I \times R$.

volt = unit of current × unit of resistance = $A\Omega$.

(Total for Question 8 = 11 marks)

ResultsPlus
Examiner Comments

The candidate notes that the potential difference arises from energy transferred per unit charge, but then does not give the unit arising as Joule/Coulomb. The V = IR equation seems to have distracted them.

Question 9 (c)(i)

A majority of candidates scored full marks on this question.

(c) Figure 22 shows a storage heater.

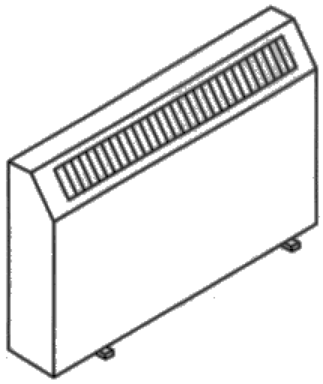


Figure 22

The storage heater contains bricks.

The bricks are heated electrically.

The electrical heater supplies 210 kJ of energy to each brick in the storage heater.

One brick has a mass of 5.8 kg.

The specific heat capacity for the brick is 860 J/kg K.

(i) Use this data to calculate the increase in temperature of the brick.

(2)

$\Delta Q = m \times c \times \Delta\theta$

$\Delta\theta = \frac{\Delta Q}{m \times c}$

$= \frac{210{,}000}{860 \times 5.8} = 42.1$

temperature increase = 42.1 °C

ResultsPlus
Examiner Comments

This represents one of the many fully correct responses, where 210 kJ is converted into 210 000 J for the calculation to yield the correct answer of 4.2 °C increase of temperature.

The storage heater contains bricks.

The bricks are heated electrically.

The electrical heater supplies 210 kJ of energy to each brick in the storage heater.

One brick has a mass of 5.8 kg.

The specific heat capacity for the brick is 860 J/kg K.

(i) Use this data to calculate the increase in temperature of the brick.

(2)

$Q = m \times c \times \theta$

$210 = 5.8 \times 860 \times \theta$

$\theta = 0.0421$

temperature increase = 0.042 °C

ResultsPlus
Examiner Comments

Quite a number of candidates scored one mark like this. The mark scheme states:

'4.2 to any other power of 10 scores 1 mark'

It was a common mistake to fail to convert kJ to J, so losing a mark.

ResultsPlus
Examiner Tip

Candidates should ask themselves whether their answer seems reasonable, in the light of the question.

Examiners do not expect candidates to calculate a miniscule rise in temperature for a brick.

This should alert them to question their numbers whereby they might see **kilo**joules and correct their answer.

Question 9 (c)(ii)

A variety of marks were obtained with this question. Most scored 1 out of 2.

(ii) The actual temperature increase will be smaller than you calculated in (i).

Explain why the actual temperature increase will be smaller than the value in (i).

(2)

This is because not all of the heat energy will be transferred to the bricks. Instead, ~~the~~ some heat may be lost to the surroundings so the change in thermal energy value may be lower in real life than what was used in this calculation, meaning actual temperature increase will be smaller than calculated.

ResultsPlus
Examiner Comments

This was a typical response scoring 2, with mark points 1 and 4 being matched.

(ii) The actual temperature increase will be smaller than you calculated in (i).

Explain why the actual temperature increase will be smaller than the value in (i).

(2)

~~energy is wasted as sound~~ the energy transfer is not 100% efficient so some energy will be wasted as sound, for example.

ResultsPlus
Examiner Comments

This matches mark points where it says 'ignore'

- energy is lost/wasted, unqualified
- not 100% efficient
- arguments about sound energy

Therefore no marks here.

ResultsPlus
Examiner Tip

Such points are insubstantial and don't address key explanations.

(ii) The actual temperature increase will be smaller than you calculated in (i).

Explain why the actual temperature increase will be smaller than the value in (i).

(2)

Some heat energy will be dissipated into the environment and surroundings So will be wasted.

ResultsPlus
Examiner Comments

This was a very common response, where mark point 4 was matched.

(ii) The actual temperature increase will be smaller than you calculated in (i).

Explain why the actual temperature increase will be smaller than the value in (i).

(2)

~~The bricks did not started to heat at from room temperature~~ Not all of the energy will be transferred ~~will be tr~~ to the brick some will dissapate into the surroundings

ResultsPlus
Examiner Comments

This was quite commonly seen where 2 marks were given.

Question 9 (d)

There was a variety of marks scored with this one, with more scoring 4 out of 6 than any other mark.

It was often evident when candidates had experience of this investigation, and when they had not.

An indicator of this was when some candidates proposed using bunsen burners as the heating device alongside joulemeters, an approach which would not measure energy input.

Realistic measurement of energy input was needed to access level 3, that is marks of 5 or 6.

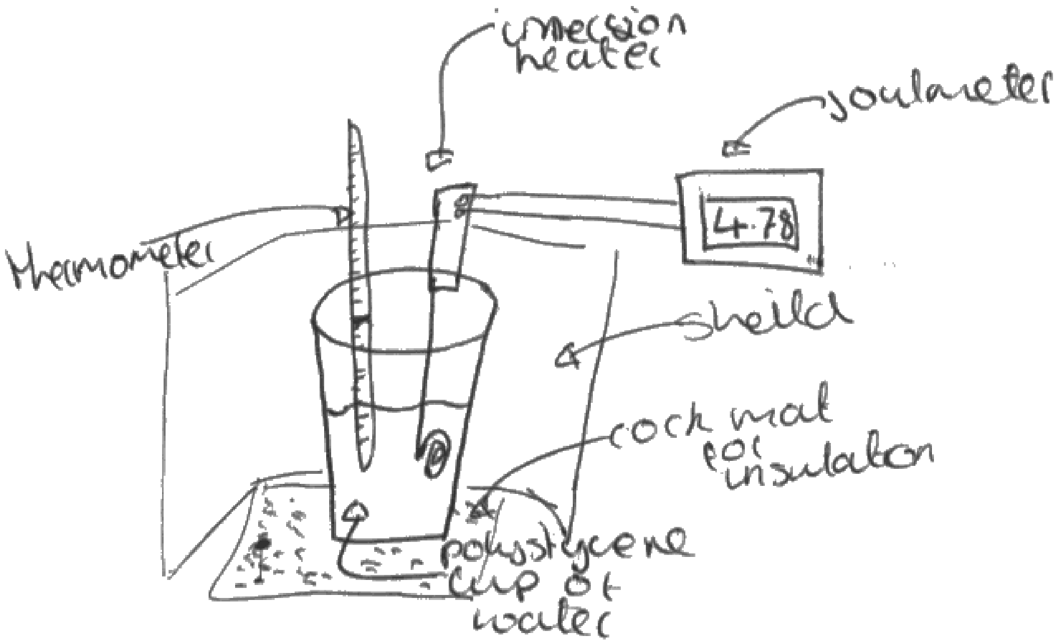
*(d) Describe an investigation to determine the value for the specific heat capacity of water.

Your answer should include details of

- the apparatus needed
- the experimental procedure
- how the value may be calculated from the measurements taken.

You may draw a diagram to help your answer.

(6)



Measure the mass of a certain volume of water. Then pour the water into the ~~cup~~ polystyrene cup. Then place a thermometer in the cup and take the initial reading for the start temperature. The ~~to~~ add an immersion heater to heat up the water 10°C. Record the joules required with a joulmeter. Then repeat the experiment control the same method. Use the equation

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

To make this more accurate add insulation in order to minimize the amount of heat loss to the surroundings. ~~the~~ An example is a heat shield or cork matt.

ResultsPlus Examiner Comments

This is a clear level 3 answer worth 6 marks with a realistic use of a joulemeter, measurement of a temperature difference and mass. The appropriate equation to calculate the result is also given.

More detail was possible, for instance on the measurement of mass. There is no ceiling to achievement and this easily has sufficient to fully match level 3.

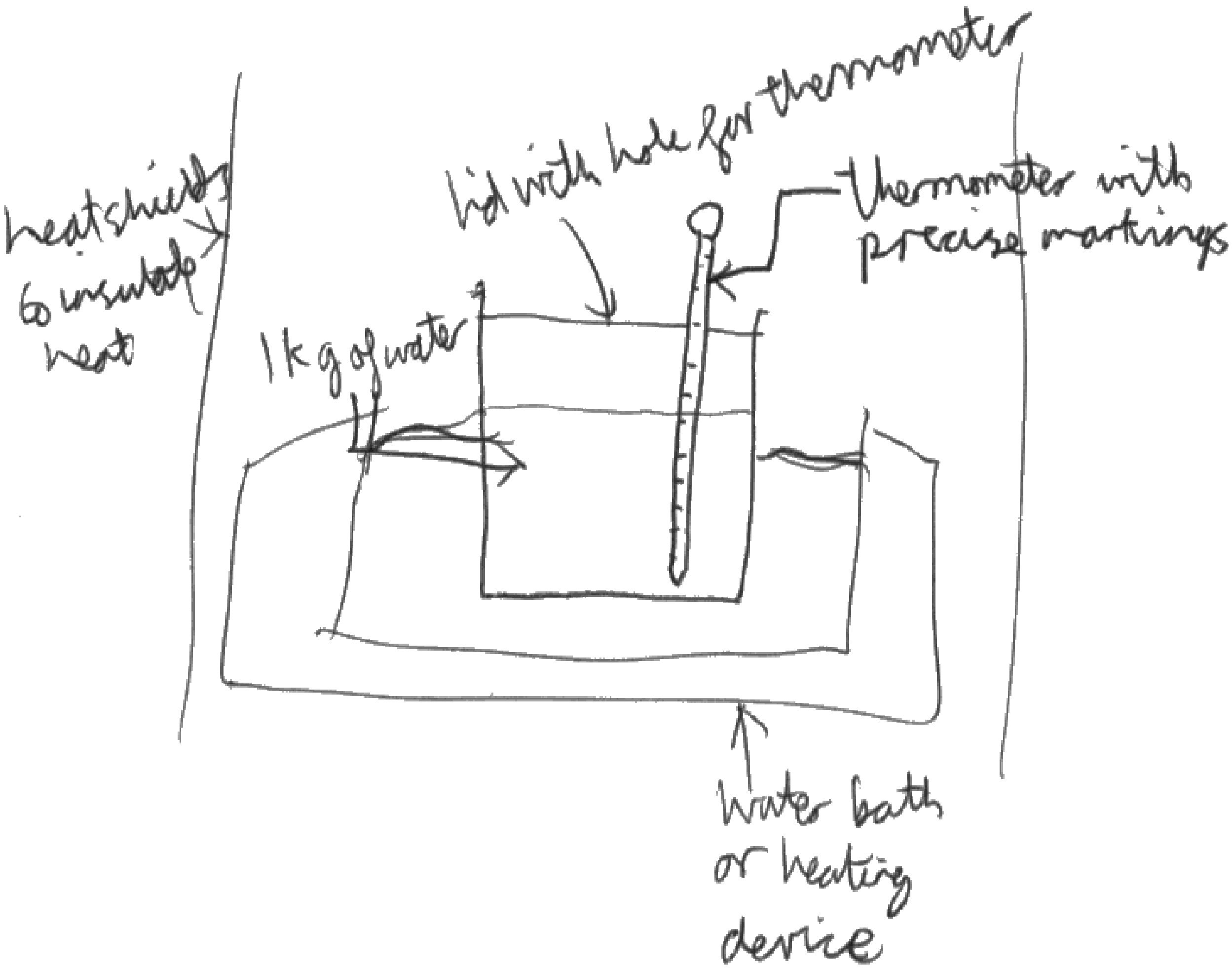
*(d) Describe an investigation to determine the value for the specific heat capacity of water.

Your answer should include details of

- the apparatus needed
- the experimental procedure
- how the value may be calculated from the measurements taken.

You may draw a diagram to help your answer.

(6)



Specific heat capacity is how much energy it takes to heat 1 kg of something by 1°C

to ~~calcutate~~ calculate this you must do :

Δthermal energy = mass × specific heat capacity × Δtemperature

which can be rearranged to

specific heat capacity = $\frac{\Delta \text{thermal energy}}{\text{mass} \times \Delta \text{temp}}$

Use a water bath or heating ~~so~~ method with a known power and work out energy transferred $P = \frac{E}{t}$

heat water in beaker with the heater / water bath / bunsen untill temp ~~is~~ rises by 10°C and note down thermal energy transfer to the water

divide both by 10 and ~~put~~ substitute into equation $\frac{\Delta \text{thermal E}}{1\text{kg} \times 1}$

to work out the specific heat capacity

you should use a thermometer, 1 kg of water (a in a beaker), a method of heating in which thermal energy transfered can be calculated and a lid and heat shields to insulate heat / stop heat loss to make the experiment more accurate.

ResultsPlus
Examiner Comments

This is a level 3 answer with measurement of temperature rise (difference) included as well as a desire to measure energy input. The latter was somewhat vaguely proposed, although a known power input with a time measured would have worked; that was not made explicit.

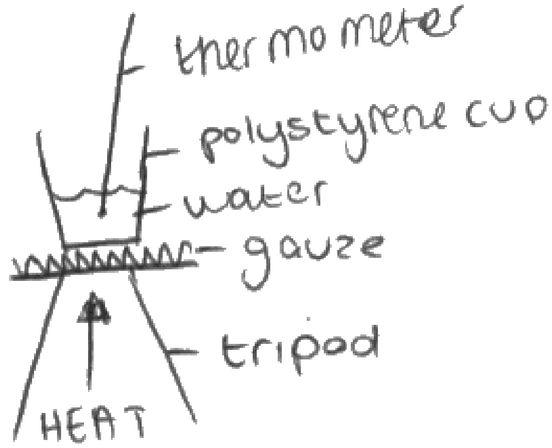
Hence partial level 3 for 5 marks awarded.

*(d) Describe an investigation to determine the value for the specific heat capacity of water.

Your answer should include details of

- the apparatus needed
- the experimental procedure
- how the value may be calculated from the measurements taken.

You may draw a diagram to help your answer.



~~* Then set up the apparatus shown in the diagram. Then use a bunsen burner to gently warm the water in the polystyrene cup and start a timer using a stopwatch. After every 10 seconds measure the change in temperature and record it. Repeat this until Do this for 2 minutes~~

First measure the mass of the water by placing the cup on a scale and setting it to 0. Add water and measure the mass and record it. Place the cup of water on the gauze and add a thermometer. Measure the initial temperature of the water and record it. Then use the bunsen burner to gently heat the water and start a timer using a stop watch. After 2 minutes, measure the temperature again. Change in temperature can then be calculated using final temperature − initial temperature. The change in thermal energy can be found online for the bunsen burner. Specific heat capacity can then be found using the equation

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

ResultsPlus
Examiner Comments

Good level 2 answer.

The proposal to look up the energy output of a bunsen burner online is unhelpful, hence this answer is limited to level 2.

*(d) Describe an investigation to determine the value for the specific heat capacity of water.

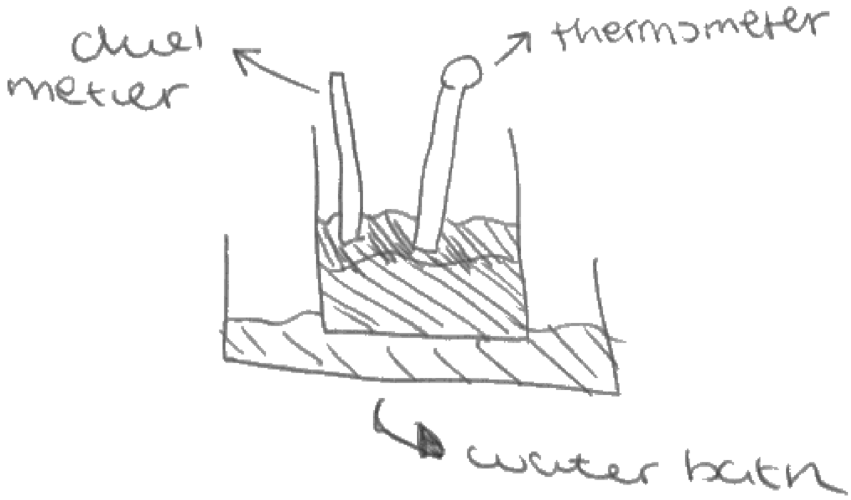
Your answer should include details of

- the apparatus needed
- the experimental procedure
- how the value may be calculated from the measurements taken.

You may draw a diagram to help your answer.

(6)

mass Δ Thermal Δ Temp



A: ΔQ

$m \times c \times \Delta\theta$

$$\frac{\Delta Q}{m \times \Delta Q}$$

measure the mass of the beaker itself and then measure it with the water and subtract (get mass of the water)

Measure the start the initial temp of water.

Put beaker into water bath (Bunsen Burner would be to fast)

Measure change in thermal energy with dual meter.

measure end temp of water

(initial - end temp = change in temp)

specific heat capacity = change in thermal energy / mass x change in temp

ResultsPlus
Examiner Comments

This is a classic example of where the median mark of 4 was given. The relevant equation, measurement of mass and temperature are all given but alongside this no reasonable way of finding ΔQ.

A clear level 2 for 4 marks.

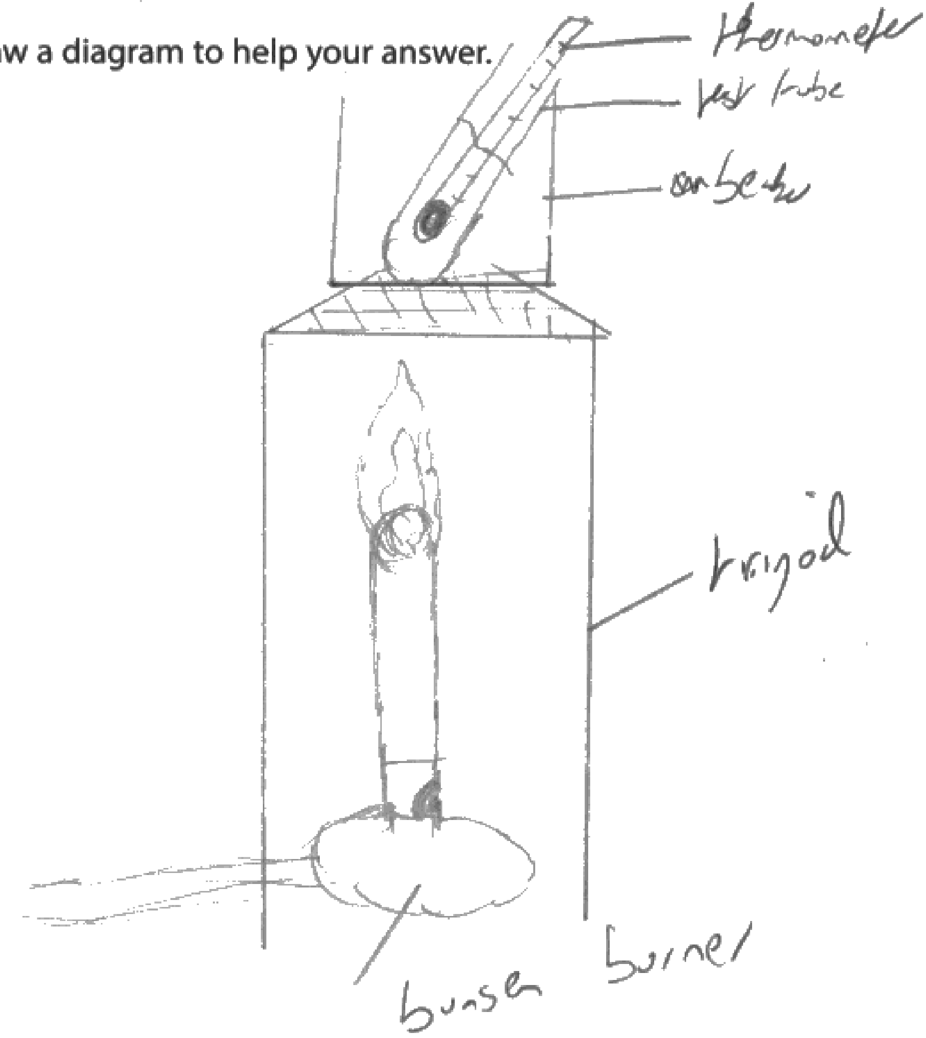
*(d) Describe an investigation to determine the value for the specific heat capacity of water.

Your answer should include details of

- the apparatus needed
- the experimental procedure
- how the value may be calculated from the measurements taken.

You may draw a diagram to help your answer.

(6)



bunsen burner

You should get a ~~water~~ bath and go put a test tube of water ~~in~~ above it. you should keep it there and measure it with a thermometer as the temperature ~~rising~~ rises. When it stops rising — that is your specific heat capacity. Then put your data into this equation — ~~[illegible]~~ change in thermal energy = mass × specific heat capacity × change in temp.

ResultsPlus
Examiner Comments

The inclusion of measuring temperature with the equation to be used helped secure this as a level 1 answer.

Level 1 for 2 marks.

*(d) Describe an investigation to determine the value for the specific heat capacity of water.

Your answer should include details of

- the apparatus needed
- the experimental procedure
- how the value may be calculated from the measurements taken.

You may draw a diagram to help your answer.

You will need ~~a~~ a thermometer to measure the temperature of the water. you will also need to measure the amount of water you use so you can work out the specific latent heat capacity. you should heat the water with a bunsen burner until the temperature of the water changes. you can then use the equation specific latent heat capacity = thermal energy for a change of state ÷ mass. this will allow you to work out ~~specific~~ specific latent heat for water.

ResultsPlus
Examiner Comments

This answer was a level 1 one.

There was mention of measuring temperature but the answer goes on to talk of an irrelevant specific latent heat.

The equation given was wrong and the use of a Bunsen burner was ineffective.

Minimum attainment even at level 1.

Question 10 (a)(i)

This had a varied response with relatively few getting the full 3 marks.

The explanation had 3 marks available out of a possible 5 on the mark scheme:

1) (magnetic) field lines cut/intercepted by coil (1)

2) induces a voltage/current (in the coil) (1)

3) voltmeter measures (induced) voltage/potential difference (1)

4) electrons (in the wire) experience a force/move in response to (a changing) field (1)

5) (induced) voltage/current changes magnitude/direction as magnet passes through (1)

10 (a) Figure 23 shows a magnet being dropped through a coil.

The coil is connected to a sensitive voltmeter.

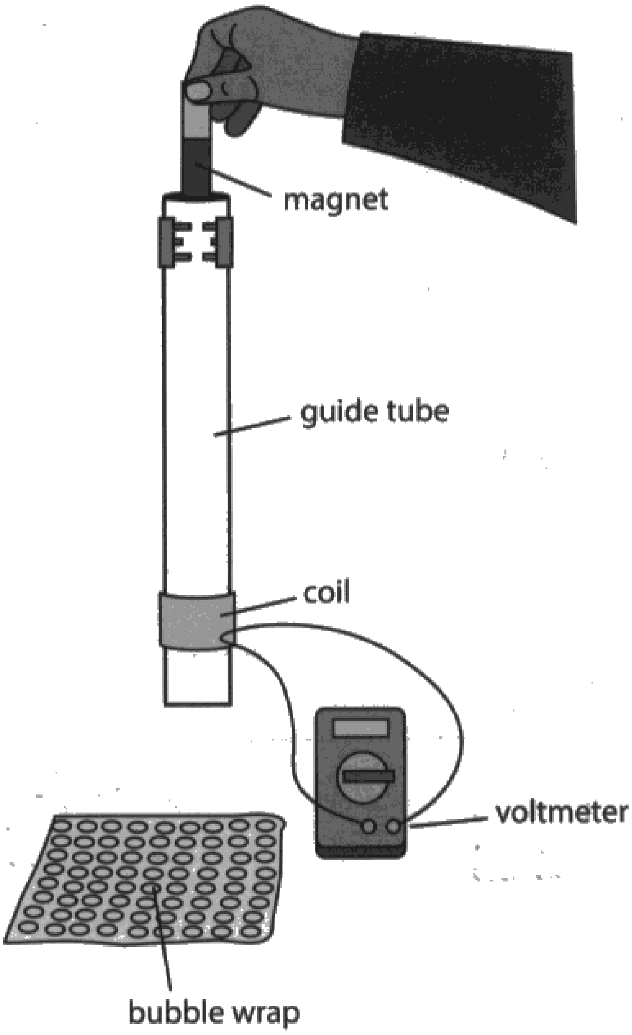


Figure 23

(i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

When the magnet passes through the coil it creates a changing magnetic field as the magnetic field lines are cut by the coil which according to electromagnetic induction induces a potential difference across the ends of the coil. The voltmeter measures potential difference, thus it detects a value.

ResultsPlus
Examiner Comments

This is a step by step, well articulated answer matching mark points 1, 2 and 3

mp1 'changing magnetic field lines cut by the coil'

mp2 'induces a potential difference across the ends of the coil'

mp3 'The voltmeter measures potential difference, thus it detects a value'

(i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

As the magnet falls through the Coil, it experiences a change in magnetic field thus Producing a Potiental diffrence, a voltmeter measures the Potiental diffrence that is induced in the Coil

ResultsPlus
Examiner Comments

This very much matches mark points

1, coil experiences a changing magnetic field

2, producing a p.d. . . . that is induced

and 3, the voltmeter **measures** that p.d.

Figure 23

(i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

magnetic field induces a potential difference *
within the coil as the magnetic ~~field~~ field
~~cuts~~ cuts through the coils, this induces a
current within the wire (as the magnet
moves in and out the wire)
*causing a reading to show as it detects a voltage

ResultsPlus
Examiner Comments

The written answer matches mark points 1,2 and 3.

The resultant voltage is being **detected** on the voltmeter is enough for mark point 3.

10 (a) Figure 23 shows a magnet being dropped through a coil.

The coil is connected to a sensitive voltmeter.

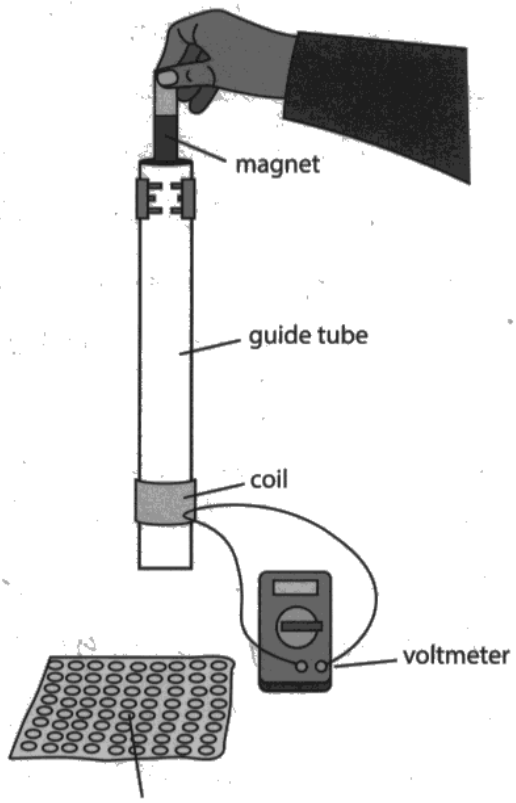


Figure 23

(i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

As the ~~wire~~ magnet passes through the coil the wire cuts perpendicularly through the magnetic field lines. This induces a voltage in the wire which is detected by the voltmeter

ResultsPlus
Examiner Comments

This follows the theme of mark points 1, 2 and 3 being matched, in this case quite succinctly, with the wire (of the coil) being cut by the magnetic field lines associated with the falling magnet.

10 (a) Figure 23 shows a magnet being dropped through a coil.

The coil is connected to a sensitive voltmeter.

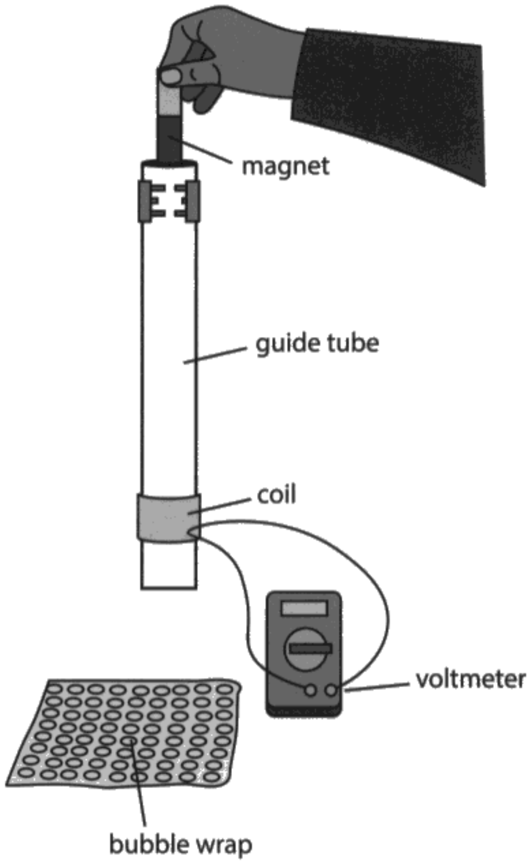


Figure 23

(i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

As when the magnet passes through the coil a current is induced through electro magnetic induction as the fields interact

ResultsPlus
Examiner Comments

This matches mark point 2 only.

The interacting magnetic fields statement is not enough for mp1 without a mention of the coil's involvement.

10 (a) Figure 23 shows a magnet being dropped through a coil.

The coil is connected to a sensitive voltmeter.

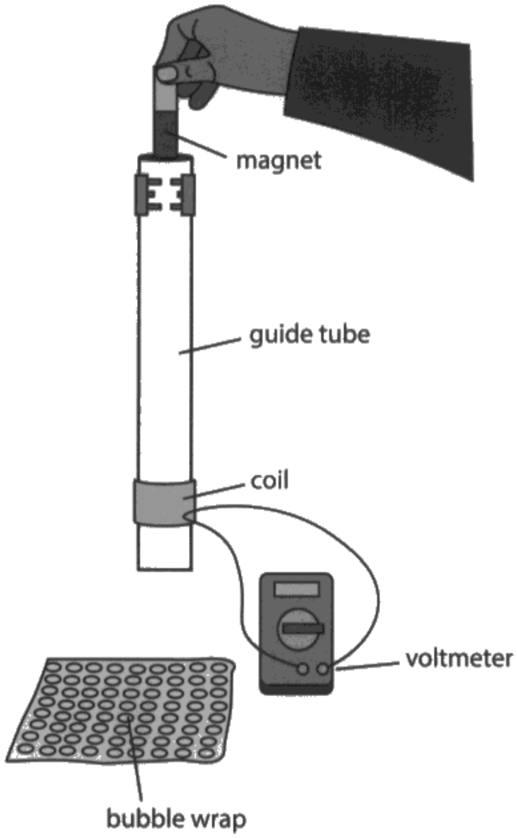


Figure 23

(i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

~~There is a voltage passing~~ The magnetic field ~~and~~ and the attraction between the magnet and coil is picked up as voltage.

ResultsPlus
Examiner Comments

This is just too vague, unfortunately.

No marks scored.

Question 10 (a)(ii)

This is a practical question where 4 marks may be obtained in any four of the following seven ways:

1. drop magnet from different heights (1)
2. use of metre rule (1)
3. change height in steps (eg of 5 cm) (1)
4. record (maximum) meter reading/voltage (1)
5. repeat readings for each drop and take an average (1)
6. set the digital voltmeter on a.c. (1)
7. plot an appropriate graph – eg voltmeter reading against height (1)

(ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.

Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4)

- use a meter rule to measure the height above the coil.
- hold the magnet at different heights within the guide tube.
- to do this you could use another permanent magnet to hold the magnet in place lower down the tube
- record the voltage each time
- repeat the experiment at different heights.
- create a graph for your results

ResultsPlus
Examiner Comments

Mark points 1,2 and 4 are seen and awarded.

(ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.

Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4)

the student should measure the height that the magnet is dropped from, and record what is read off the voltmeter. The student should then increase the height, and record the new reading on the voltmeter. The student should perform repeats to check their results, and should drop the magnet from a variety of heights.

ResultsPlus
Examiner Comments

Mark points 1 and 4 seen.

Mark point 1 repeated.

Repeat readings would need taking an average to gain mp5.

(ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.

Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4)

-Person 1 holds up a metre ruler alongside the guide tube. The 0cm mark should align with the bottom of the coil.
-Person 2 drops the magnet from different 10cm increments starting at the top of the metre ruler down to the edge of the guide tube. Voltage should be measured and recorded at each interval. A graph can then be plotted to show how height will affect the voltage, as a correlation will appear.

ResultsPlus
Examiner Comments

Four marks awarded, with mark points 1,2,3,4 and 7 seen.

Maximum mark is 4.

(ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.

Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4)

Drop the magnet from different heights and record the height and the PD reading it gives. Repeat 3 times and calculate a mean PD reading for each height. Ensure all of the same ~~m~~ equipment is used throughout and that the magnet is stationary when being dropped.

ResultsPlus Examiner Comments

Mark points 1,4 and 5 seen here.

(ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.

Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4)

The Student should drop the magnets from different heights. This would allow them to have a wider range of results and data.

ResultsPlus Examiner Comments

This just has 'drop the magnet from different heights' – mark point 1.

Question 10 (b)

There was a good spread of marks in response to this question. It was not as well answered as the other 6 marker, 9d, as a whole.

For most candidates, the weakest area was in describing how a transformer works, with few responses referring to a *changing* magnetic field in the iron core.

*(b) A transformer converts a voltage of 11 000 V to 230 V.

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

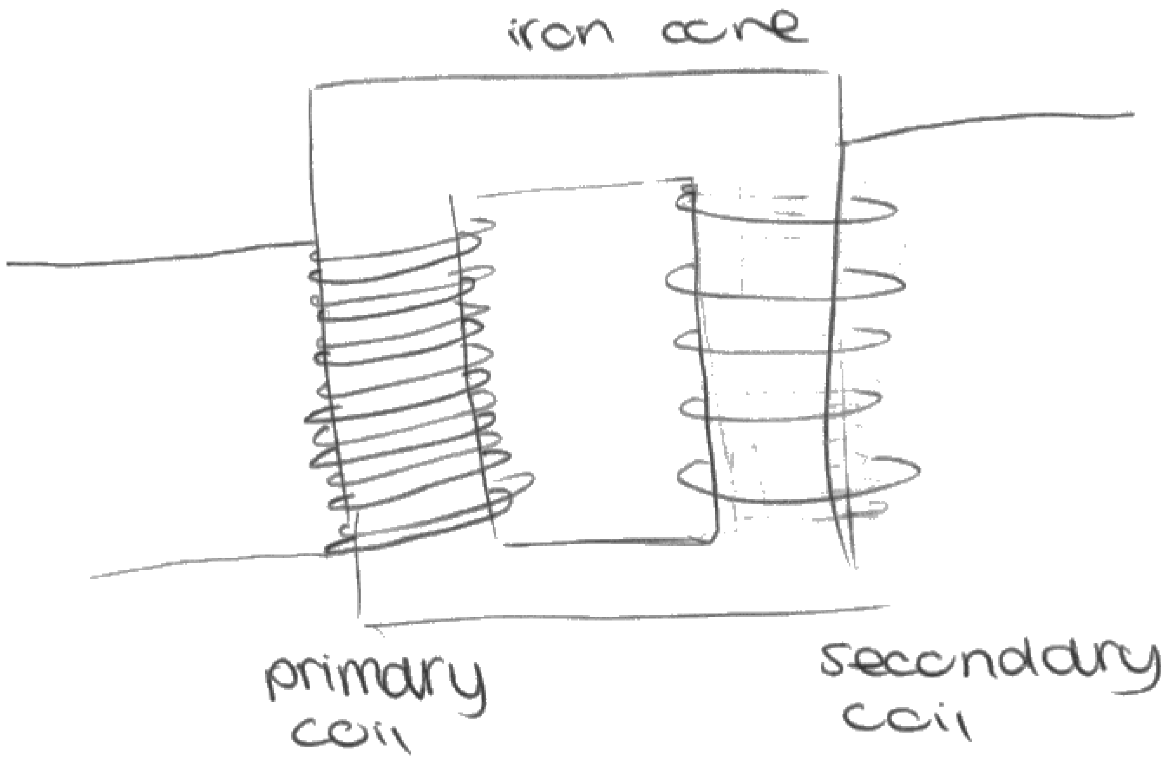
Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)

$$\frac{11\,000}{230} = \frac{1100}{23}$$



The step down transformer has a primary coil with more coils than the secondary coil, and they are wrapped around an iron core. The primary coil has an alternating current running through it. This also means that it has an alternating magnetic field which ~~has an alternat~~ enduces a alternating magnetic field in the iron core. Due to the alternating magnetic field in the iron core, this enduces a current in the secondary coil, but as there ~~is~~ are less coils ~~an~~ weaker voltage ~~alternating current~~ is produced.

To ensure the exact values of 230 V is obtained there will be 1100 turns on the primary coil and 23 on the secondary.

(Total for Question 10 = 13 marks)

ResultsPlus
Examiner Comments

This is an excellent level 3 answer.

To achieve level 3 all of the details that follow must be present:

- Structure: this was well described by this candidate, aided by their diagram
- How the transformer works: this answer concentrates on the role of the alternating magnetic field in the core which enables a secondary 'enduced' voltage and current (no marks lost for spelling error)
- Use of the ratio idea: the candidate spells out a possible number of turns on the primary – 1100, with 23 turns on the secondary, giving the desired voltage conversion.

ResultsPlus
Examiner Tip

Note the bullet points in the question.

Make sure each is addressed as this candidate did.

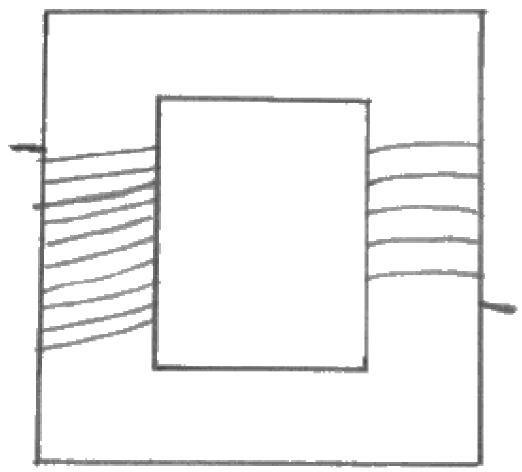
*(b) A transformer converts a voltage of 11 000 V to 230 V.

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.



Step - down transformer

A transformer is made up iron and has two sets of coils one for the primary voltage and current and one for the secondary voltage and current. This particular transformer is a step-down transformer and it decreases the voltage and increases the current. In order for a transformer to work, alternating current has to be passed through it as it'd create an alternating magnetic field which would then create a potential difference and a.c. current. The number of turns in the coil determines the voltage. $\frac{V_p}{V_s} = \frac{N_p}{N_s}$. This transformer has the correct amount of turns required in each coil to create an exact voltage of 230V. $\frac{11000}{230} = \frac{1100}{23}$ The primary coil could have 1100 turns and the secondary could have 23.

ResultsPlus

Examiner Comments

A full answer addressing each of the three expected inclusions with detail.

Level 3, 6 marks

*(b) A transformer converts a voltage of 11 000 V to 230 V.

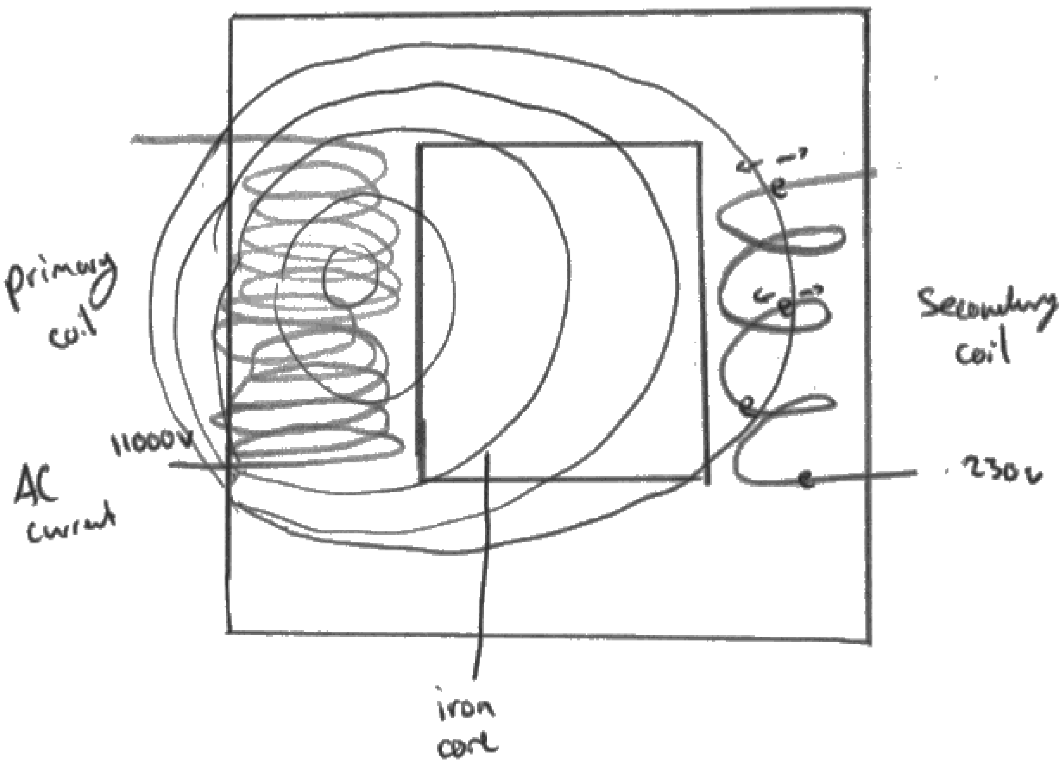
Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)



In a transformer there are two coils a primary coil and a secondary coil. This transformer is a step-down transformer so the primary coil is bigger (than more coils) than the secondary coil. When the current enters the primary coil it causes a magnetic field to be created. This magnetic field then interacts with the electrons in the secondary coil. Since the current going into the transformer is alternating current it causes the electrons to continuously move generating a current. Since there are less coils in the secondary coil there are less electrons in it meaning that there are less electrons induced and therefore a lower current induced than the primary coil. The exact voltage of 230V will created as the right number of coils will be in the secondary coil causing an output of 230V. There is also an iron core as it magnetizes and de-magnetizes quickly.

ResultsPlus
Examiner Comments

This is a level 2 answer. The structure and how the transformer works were considered. Unfortunately the turns ratio was not used. This limited the score to a maximum of 4.

*(b) A transformer converts a voltage of 11 000 V to 230 V. Electromagnetic induction

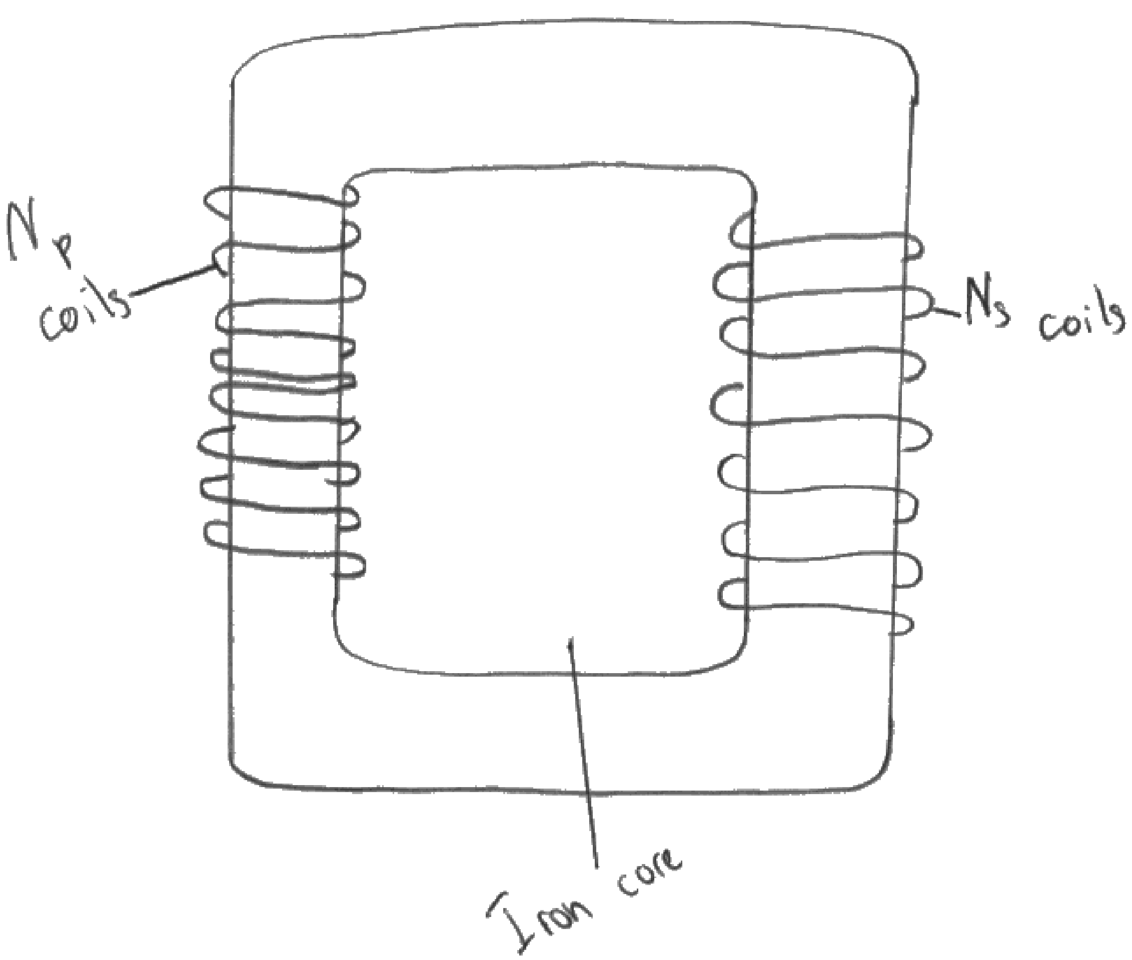
Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)



$\frac{V_p}{V_2} = \frac{N_p}{N_s}$

$\frac{1100}{230} = \frac{N_p}{N_s}$

The transformer can obtain the exact voltage by using a certain number of coils before and and after to change the voltage.

This transformer is a step down transformer as the voltage is reduced from the primary to the ~~Sec~~ secondary coils.
A transformer contains primary and secondary coils in addition to an iron core.
A transformer works by increasing or decreasing the resistance in order to change the voltage. This is done using an iron core.

ResultsPlus
Examiner Comments

A level 2 answer.

Construction dealt with effectively.

Turns ratio gone into (number of turns could have been more explicit)

The attempt to explain how it works via a spurious resistance argument results in this not having all the elements for a level 3.

Therefore this is limited to a maximum mark of 4.

*(b) A transformer converts a voltage of 11 000 V to 230 V.

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

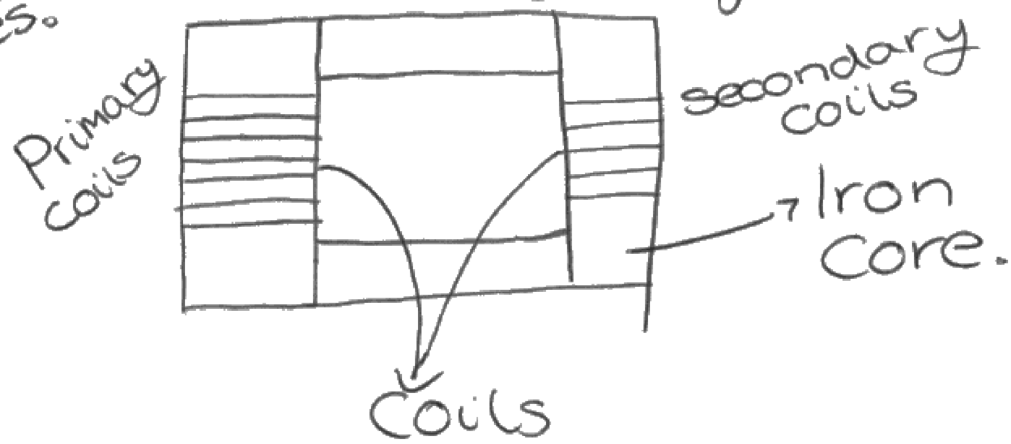
- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)

Consists of an iron core with coils on both sides.

Step-down transformer



★ $\frac{11000}{230} = \frac{N_p}{N_s}$ So if there were ten turns on the secondary coil you'd need 478 turns on the primary coil. They travel at a high voltage so they travel fast with ~~more~~ less energy loss (due to friction) and when stepped down to 230V, is safe in households.

Step-up transformers have more turns on the secondary coil to increase P.d

Step-down transformers are used to decrease the potential difference in a wire/coil. A transformer usually consists of an iron core (this is used as an induced magnet and is magnetically soft), & with a specific number of coils on both sides. For a step down transformer it contains more ~~coils~~ turns on the ~~left side~~ primary coil than on the ~~right~~ secondary as this will step-down the p.d (in this case from 11,000 to 230). This is done as the current passing through the primary coil causes a change in the magnetic field due to the motor effect and so this change ~~caus~~ induces a p.d in the secondary coil (but less turns decreases the voltage due to $V_p/V_s = N_p/N_s$). This calculation also explains how they specifically get it down to 230V. ✩

(Total for Question 10 = 13 marks)

ResultsPlus
Examiner Comments

All three elements analysed in detail to match level 3, thus 6 marks awarded.

The comment about 'motor effect' is not relevant. These open response items are not marked negatively. The contents are viewed holistically for the good physics therein.

The turns numbers of 478, for primary, and 10, for secondary, have been justified using the ratio equation by the candidate.

*(b) A transformer converts a voltage of 11 000 V to 230 V.

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)

The step up transformer increases the voltage up to 11000 v when it is travelling along the wires enabling a high amount of voltage to be conserved then the step-down transformer is used when the voltage is travelling to the mains supply which is used in our homes to decrease the voltage to 230v because 11000 v is not a safe voltage to be handled by us which is why the step-down transformer is used before it reaches our homes. In a transformer it has the number of turns in the primary coil is half the number of turns on the secondary coil which enables more voltage to be reduced when it reaches the secondary coil as the potential difference is equivalent to the number of turns in a transformer which is why more turns is less voltage.

(Total for Question 10 = 13 marks)

ResultsPlus
Examiner Comments

A level 1 answer.

A few basic relevant physics ideas presented:

- the step down transformer idea
- flawed turns ratio idea

Lacks any pertinent development of ideas.

*(b) A transformer converts a voltage of 11 000 V to 230 V.

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)

Use a step down transformer to decrease the potential difference

ResultsPlus
Examiner Comments

A single statement like this puts it in level 1.

There needs to be more than a single idea to achieve the full level 1.

Partial level 1 attainment, therefore 1 mark awarded.

*(b) A transformer converts a voltage of 11 000 V to 230 V.

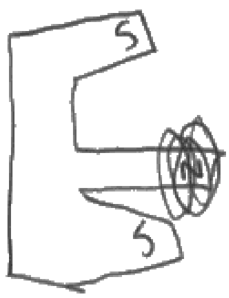
Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V. ↑ pd

Your answer should include ↓ curr

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)



- transformers are able to change the current and therefore potential difference of something to still remain with the same electrical power
- electromagnetic induction is the use of coils of wire around an object to generate a magnet which can be turned on and off
- transformers are used in the national grid to reduce energy loss due to a low potential difference, however remain safe for households to use

ResultsPlus
Examiner Comments

A weak level 1 answer. Insufficient content.

The mention of electromagnetic induction gives the possibility of awarding 1 mark.

Paper Summary

Overall this exam gave ample opportunity for candidates to display their knowledge and understanding at grades 4-9. A mean mark of 62/100 showed this was a relatively high scoring paper, also having good differentiation helping towards the discrimination of grades from this component.

Being able to grasp fundamental ideas is a key in physics. Candidates were found wanting in their appreciation of what 'electric field' and 'the principle of moments' meant. Being able to describe experimental procedures is vital, and has improved over the years. There is still a way to go though, as was evidenced in students' attempts to describe a specific heat capacity of water investigation, where some candidates proposed using Bunsen burners as the heating device alongside joulemeters, which some thought measured energy input.

Candidates have continued to do well with most calculation questions, although many did not cope well with significant figures.

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

· They should make the most of opportunities afforded in laboratories where they become acquainted with practical work from the specification. This concerns both core practicals and the suggested practicals.

· They do need to know S.I. units and what the prefixes stand for. Canndidates also need to have the mathematical skill of being able to round off results of calculations to a given number of significant figures.

· They need more practice on handling powers of ten in their calculations. They should be able to use their calculators with number 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.

· 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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