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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2016

J250/05 Summer 2024 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 5 series overview

J250/05 is the first of the two Foundation physics papers for the GCSE (9–1) Gateway Science Combined Science A. Question 16 is the overlap question with the Higher tier paper J250/11.

J250/05 covers the topics:

- P1 Matter
- P2 Forces
- P3 Electricity and Matter
- CS7 Practical Skills

The vast majority of candidates completed all questions in the examination within the allotted time. To do well on this paper, candidates needed to able to use the Equation Sheet to identify the correct equations, manipulate these equations and be comfortable applying their knowledge and understanding to both familiar and unfamiliar contexts and practical science activities.

It was pleasing to see many candidates showing their calculations in numerical questions both in Section A and Section B.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• identified and applied or manipulated equations • demonstrated knowledge of scientific procedures (e.g. finding the power of a student, measuring specific latent heat) • analysed and interpreted distance-time graphs to calculate average speed.	• found it difficult to rearrange equations correctly • did not always read questions carefully and missed out parts • lacked the necessary knowledge about velocity-time graphs and resultant forces to respond in depth to the Level of Response question.

Section A overview

Section A consists of ten multiple choice questions, concentrating on Assessment Objectives 1 and 2 (AO1 and AO2).

Nearly all candidates attempted all of the questions.

Candidates need to be aware that when they write their response in the answer box, if they do not clearly write the letter, especially when writing 'B' or 'D', no credit will be given. If a candidate changes their mind about a response, they need to cross out their initial answer and write their final response next to the answer box.

It was pleasing to see some candidates also wrote down their calculations for the numerical multiple choice questions, especially if the equation needed to be rearranged in order to work out the final answer.

Questions 2 and 4, which required candidates to substitute values directly into a given equation, were answered correctly by the majority of candidates.

Question 8, which required candidates to determine the resultant force acting on an object and relate this to the motion of the object, was also understood well.

Assessment for learning

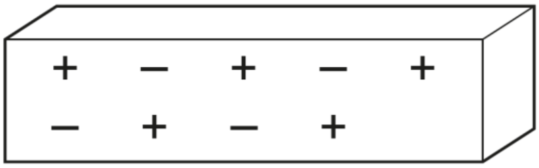
Candidates who did well on this section did the following:

- underlined keywords
- wrote 'equation triangles' and/or calculations next to numerical questions
- worked through the distractors methodically, e.g. by eliminating those they believed to be the most obviously incorrect responses
- wrote the letters clearly, especially to distinguish between B and D.

Question 1

1 Objects can be charged by rubbing them with a cloth.

The diagram shows a plastic rod which has become charged.



Which statement correctly describes the plastic rod?

A The rod has an overall negative charge.

B The rod has an overall positive charge.

C The rod has gained neutrons.

D The rod has gained protons.

Your answer ☐ **[1]**

Many candidates observed that the plastic rod had more positive charges than negative charges. However, a common incorrect response of D suggests that candidates lack understanding about which particles can move.

Misconception

A common misconception was that protons can be gained when an object becomes charged.

Question 3

3 Which two instruments are used to measure the **density** of a rectangular glass block?

A A measuring cylinder and a ruler

B A protractor and a ruler

C A protractor and an electronic balance

D A ruler and an electronic balance

Your answer ☐ **[1]**

More than half of candidates correctly identified the two instruments used to measure the density of a rectangular glass block. However, many candidates did not recognise that an instrument was needed to measure the mass as well as the volume of the object, and therefore incorrectly chose option A.

Assessment for learning

Candidates could benefit from short activities, such as a card sort, where they match measuring instruments to the different quantities that they measure.

Question 5

5 An object of mass 2.0 kg accelerates. The force acting on the object is 5.0 N.

Calculate the acceleration of the object.

Use the equation: force = mass × acceleration

A $0.4\,m/s^2$

B $2.5\,m/s^2$

C $3.0\,m/s^2$

D $10.0\,m/s^2$

Your answer ☐ **[1]**

This question required candidates to rearrange the equation provided in order to calculate the acceleration of the object. The 'equation triangle' proved to be a very useful tool as candidates who wrote this down next to the question tended to gain credit. However, approximately half of candidates appeared to struggle with rearranging the equation and chose option A (dividing mass by force) or option D (multiplying mass by force).

Exemplar 1

A $0.4\,m/s^2$

B $2.5\,m/s^2$

C $3.0\,m/s^2$

D $10.0\,m/s^2$

$\frac{F}{m \times A}$

Your answer B

The use of the 'equation triangle' has proved a useful tool in enabling the candidate to rearrange the equation correctly and choose the correct option.

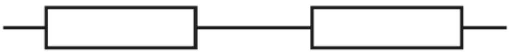
Question 7

7 The resistors shown in **A**, **B**, **C** and **D** are identical.

Which arrangement has the **smallest** resistance?

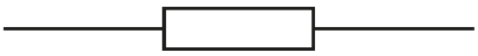
A

B



C

D



Your answer **[1]**

The majority of candidates found this question about net resistance very challenging. Most candidates appeared to know that the net resistance of resistors in series increases as the number of resistors increases but did not recall that the net resistance of resistors in parallel decreases

The most common incorrect response was the single resistor – option D.

Misconception

? A very common misconception was that the net resistance of resistors in parallel also increases with the number of resistors.

Question 9

9 Which row describes the difference between a vector quantity and a scalar quantity?

	Has magnitude	**Has direction**
A	scalar only	vector only
B	vector and scalar	vector only
C	vector and scalar	scalar only
D	vector only	vector and scalar

Your answer ☐ **[1]**

The majority of candidates appeared to struggle to apply their knowledge of scalar quantities and vector quantities to how the information was presented in the table. Candidates who wrote down the definition of each quantity next to the question were more likely to choose the correct option.

Question 10

10 Different scientists have contributed to the model of the atom.

What is the order of each scientist's contribution from the oldest to the newest?

Oldest ⟶ Newest

A Bohr, Rutherford, Thomson

B Rutherford, Bohr, Thomson

C Thomson, Bohr, Rutherford

D Thomson, Rutherford, Bohr

Your answer ☐ **[1]**

This question about the model of the atom proved to be challenging to the majority of candidates.

Some candidates were able to recall the order of the scientist's contributions by learning a mnemonic for their names, or they found it helpful to learn just the first letters of the scientist's names in order, e.g. TRB.

Section B overview

Section B consisted of short, one mark questions as well as questions requiring longer responses and a Level of Response question. It covered all of the assessment objectives, and many questions needed candidates to use mathematical skills.

The majority of candidates attempted most questions which is good examination technique. It is also good technique to show calculations in numerical questions, not just the final response, as this can help compensatory marks to be given if the final response is incorrect.

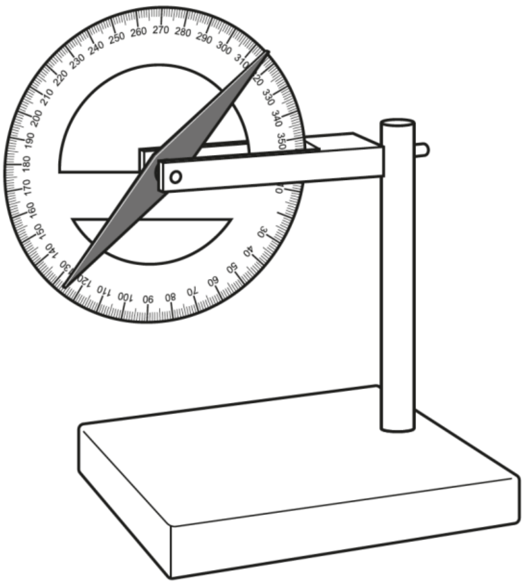
Key areas for improvement in future series include rearranging equations, describing methods for practical activities and working scientifically skills.

Question 11 (a) (i) and (ii)

11 This question is about magnetic fields.

(a) **Fig. 11.1** shows a diagram of a measuring instrument.

Fig. 11.1



(i) Name this measuring instrument.

.... **[1]**

Question 11 (a) (ii)

(ii) What information does the instrument in **Fig. 11.1** give us about the core of the Earth?

....

.... **[1]**

In Question 11 (a) the majority of candidates did not recognise the measuring instrument shown in Fig. 11.1 or that the instrument can be used to provide evidence that the Earth's core is magnetic. Many incorrect responses to (a) (ii) only referred back to the stem of the question, e.g. 'it is a magnetic field', or suggested it gave us information about the strength of the Earth's magnetic field.

Assessment for learning

Candidates could benefit from short activities where they are provided with pictures of different measuring instruments which they have to name.

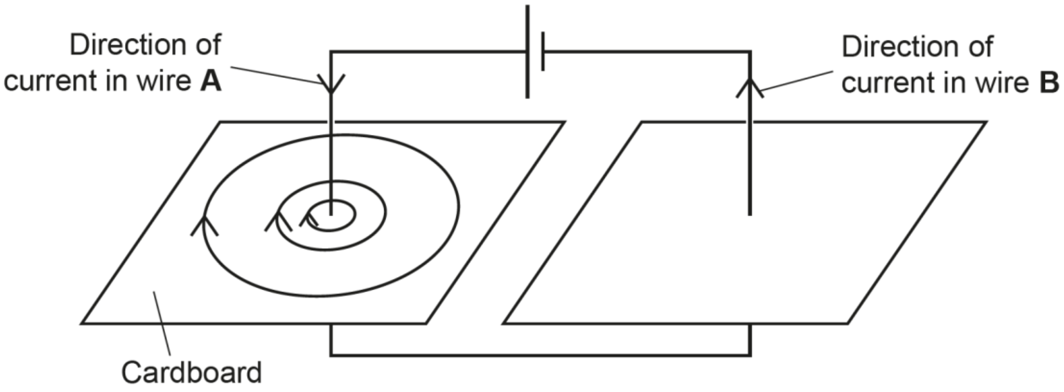
Question 11 (b) (i) and (ii)

(b) **Fig. 11.2** shows a diagram of an electrical circuit containing two straight wires, **A** and **B**.

Each wire passes through a piece of cardboard.

The magnetic field is shown around wire **A**.

Fig. 11.2



(i) Describe how you can use iron filings to show the shape of the magnetic field pattern around wire **B**.

....

.... **[2]**

Question 11 (b) (ii)

(ii) Draw the shape and direction of the magnetic field pattern around wire **B** on **Fig. 11.2**. **[3]**

Some candidates did not seem familiar with the use of iron filings to show the shape of a magnetic field and did not do much more than repeat the question in their response to (b) (i).

Question 11 (b) (ii) discriminated well between the lowest achieving and highest achieving candidates. It was good to see that students were familiar with the shape of the magnetic field around a current-carrying wire and many candidates were also able to determine that the direction of the magnetic field around wire **B** was anticlockwise.

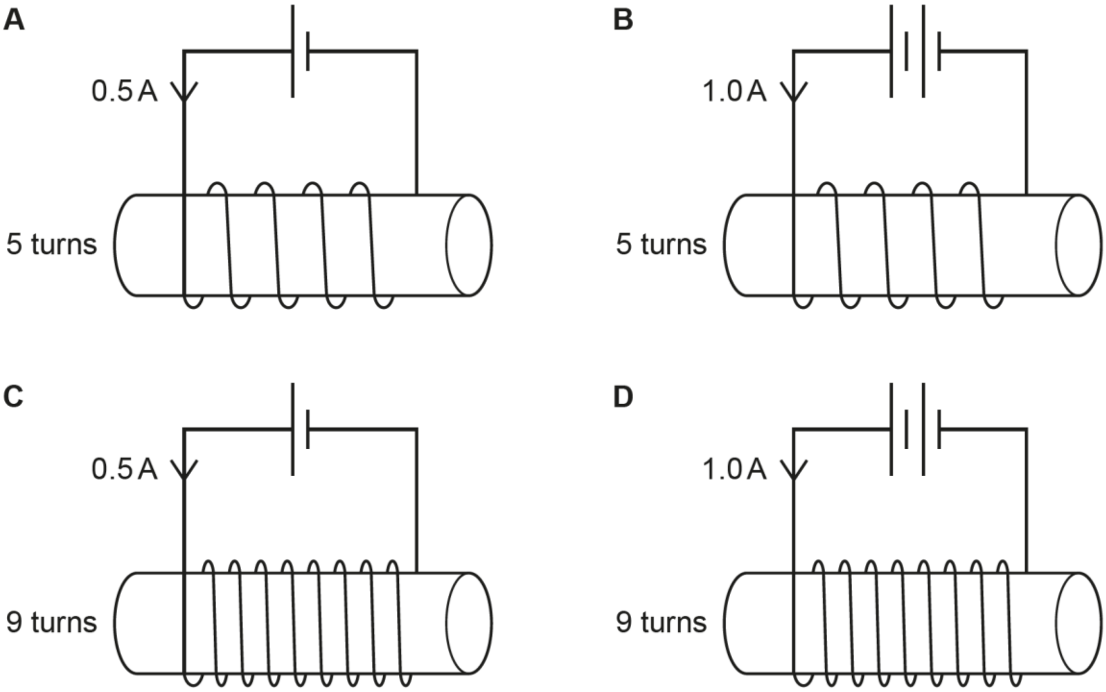
Some candidates lost marks because of untidy sketching of the concentric circles which meant that it was not clear if the circles became further apart with distance from the wire.

Question 11 (c)

(c) Solenoids can be used to produce magnetic fields.

Fig. 11.3 shows the current and the number of turns of wire in four different solenoids **A**, **B**, **C** and **D**.

Fig. 11.3



The solenoids are all made of the same material using wires of equal thickness.

Which solenoid has the strongest magnetic field?

Give a reason for your answer.

Solenoid ....

Reason ....

....

....

[2]

Most candidates correctly identified solenoid D. Although many candidates appeared to know the reason for choosing solenoid D, they did not gain the second mark. Instead of explaining that it was the *highest* current and *greatest* number of turns that meant solenoid D had the strongest magnetic field, many responses were not comparative and stated that solenoid D had the strongest magnetic field because it had a current of 1.0 A and 9 turns.

Candidates should also be aware that describing a current as 'stronger' will not gain credit.

Question 12 (a) (i), (ii), (iii)

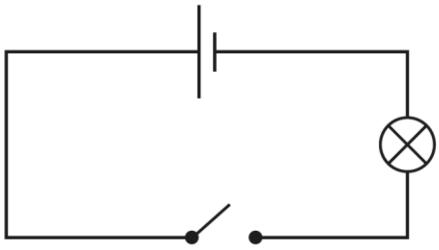
12 This question is about how electrical circuits work.

(a) A student builds three different electrical circuits.

Explain why the lamp does **not** light in each circuit.

(i) **Fig. 12.1** shows the first circuit.

Fig. 12.1

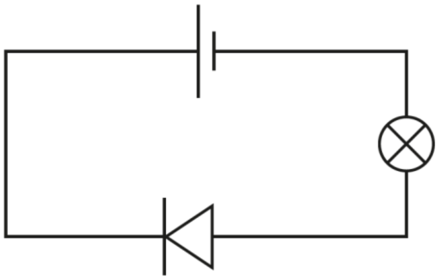


The lamp does **not** light because ....

.... **[1]**

(ii) **Fig. 12.2** shows the second circuit.

Fig. 12.2



The lamp does **not** light because ....

.... **[1]**

(iii) **Fig. 12.3** shows the third circuit.

Fig. 12.3

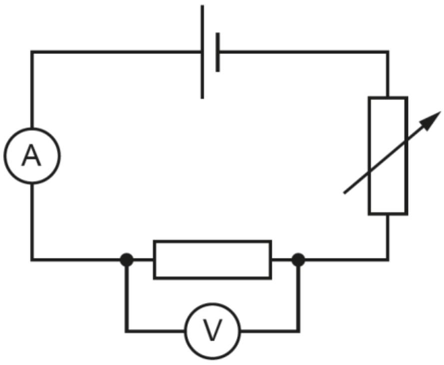
The lamp does **not** light because ....

.... **[1]**

Question 12 (b) (i)

(b) The student uses the meters in the circuit in **Fig. 12.4** to determine the resistance of a resistor.

Fig. 12.4



(i) Draw lines to connect each meter name with:

- the way the meter is connected and
- the quantity it measures.

Meter name	**The way the meter is connected**	**The quantity it measures**
		Potential difference
Ammeter	In parallel	Resistance
Voltmeter	In series	Current

[2]

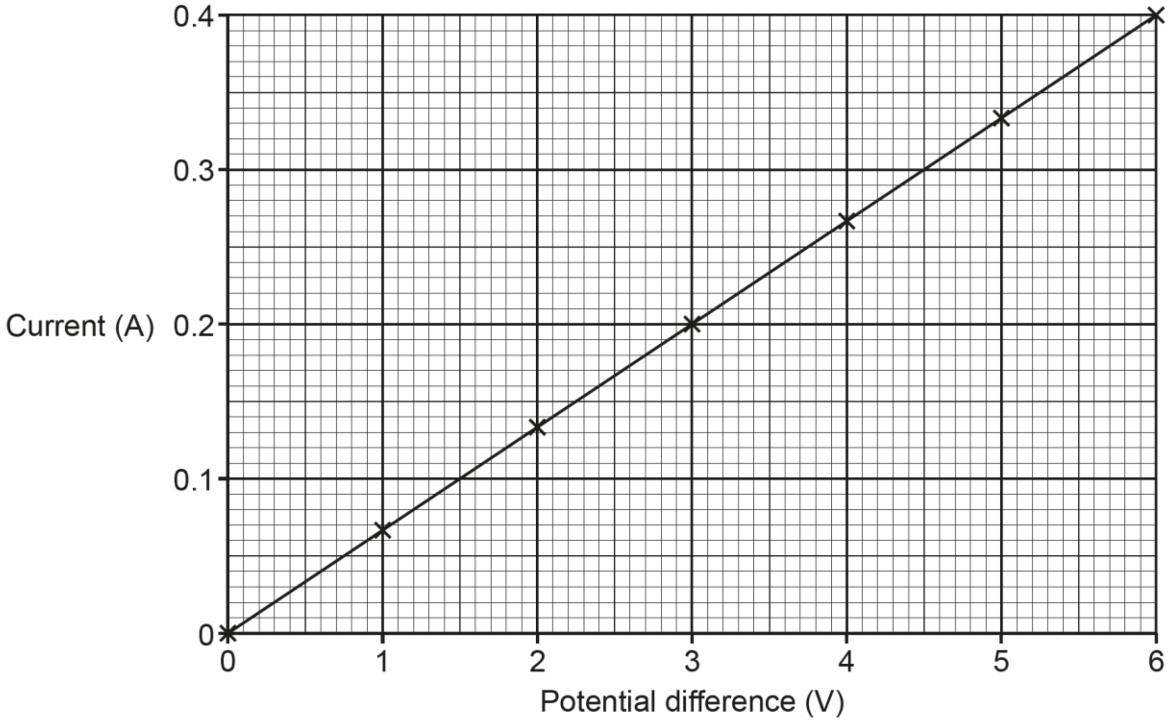
It was good to see that candidates had a very good understanding of simple electrical circuits in Question 12 (a) and 12 (b) (i). Most candidates, however, could not recall the name of the diode in (a) (ii), often naming other components instead and so did not gain credit. Although most candidates knew the way each meter in (b) (i) was connected, only the higher achieving candidates could also link the meter to the quantity it measures.

Assessment for learning

Candidates could benefit from a short activity where they match the name of an electrical component with its circuit symbol and a description of how it behaves in an electrical circuit.

Question 12 (b) (ii), (iii) and (iv)

(ii) The student uses the circuit to take several readings of current and potential difference.
The graph shows the student's results.



Complete the sentence about the graph to explain the relationship between potential difference and current.
Use words from the list.

decreases	**increases**	**stays the same**

As the potential difference increases, the current .... **[1]**

(iii) The ratio of potential difference : current at 3 V is 15 : 1.

Calculate the ratio of potential difference : current at 6 V.
Use the graph.

Ratio = ... **[1]**

(iv) Complete the sentence about the graph.
Use a word from the list.

elastic	**linear**	**non-linear**	**plastic**

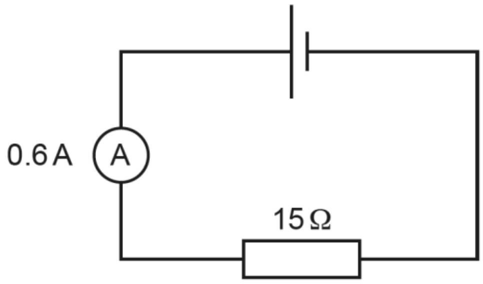
The graph of current against potential difference for the resistor is .... **[1]**

Candidates demonstrated a very good understanding of straight-line graphs and the relationship shown between potential difference and current.

Question 12 (b) (iii) was well attempted, but candidates struggled to express their response as the correct ratio.

Question 12 (c)

(c) This diagram shows a cell connected in series with a resistor.



Calculate the potential difference of the cell in the diagram.

Use the equation: potential difference = current × resistance

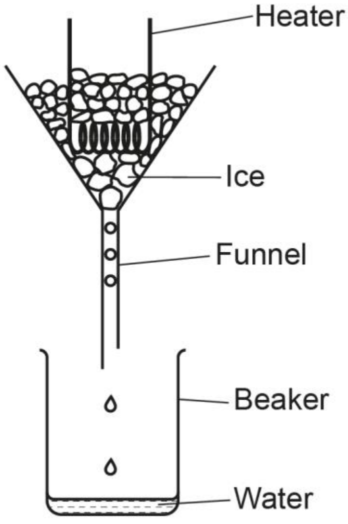
Potential difference = ... V **[2]**

Nearly all candidates were confident with substituting the values for current and resistance into the equation given to calculate the potential difference of the cell.

Question 13 (a)

13 A teacher wants to measure the specific latent heat of ice.

The diagram shows the equipment the teacher uses.



(a) Which statement describes how to get accurate results?

Tick (✓) **one** box.

Add some ice to the beaker. ☐

Use the heater for a very short time. ☐

Wrap insulation around the funnel. ☐

Wrap insulation around the heater. ☐

[1]

Type your commentary here

Question 13 (b)

(b) Here are some steps in the method for this experiment. The steps are **not** in the correct order.

Write numbers in the boxes next to each step to show the correct order.
One is already done for you.

Measure the mass of the beaker.	**1**
Measure the mass of the beaker and water.	
Turn off the heater and stop timing.	
Turn on the heater and start timing.	

[1]

Many candidates had the correct idea that insulation could affect accuracy, but a significant number of these candidates mistakenly thought that insulating the heater itself would improve the accuracy of the results.

Assessment for learning

Candidates often struggle to suggest how to improve the accuracy of an experiment. They could therefore benefit from being asked to consider sources of inaccuracy and how the accuracy could be improved each time they watch a demonstration or carry out an experiment.

Question 13 (c), (d) and (e)

(c) In one set of results 0.006 kg of ice melts.

Calculate the weight of the ice that melts.

Gravitational field strength = 10 N / kg

Use the equation: gravitational force = mass × gravitational field strength

Weight of ice = ... N **[2]**

(d) The heater is turned on for 150 seconds.

The power of the heater is 15 W.

Calculate the energy transferred by the heater.

Use the equation: energy transferred = power × time

Energy transferred = ... J **[2]**

(e) In another set of results 0.015 kg of ice melts.

The energy transferred by the heater is 5010 J.

Calculate the specific latent heat of ice.

Use the Equation Sheet.

Specific latent heat of ice = ... J / kg **[3]**

The majority of candidates were confident with substituting the values into the straightforward equations given in Questions 13 (c) and 13 (d) and gained full credit.

Question 13 (e) required candidates to select the correct equation from the Equation Sheet and to rearrange it. Although candidates often selected the correct equation from the Equation Sheet, often they could not rearrange it correctly and mostly multiplied energy by the mass instead of dividing energy by the mass, so no credit was gained.

Assessment for learning

Candidates often find rearranging equations correctly very challenging. The 'equation triangle' is a very useful tool, especially for candidates who struggle with algebraic rearrangement.

It would be beneficial for such candidates to practise:

- placing each term of an equation into the correct section of the 'equation triangle'
- using the 'equation triangle' to rearrange both familiar and unfamiliar equations.

Question 14*

14* A crane lifts a block straight upwards. **Fig. 14.1** shows the forces acting on the block.
The size of these forces may change during its journey.

Fig. 14.1

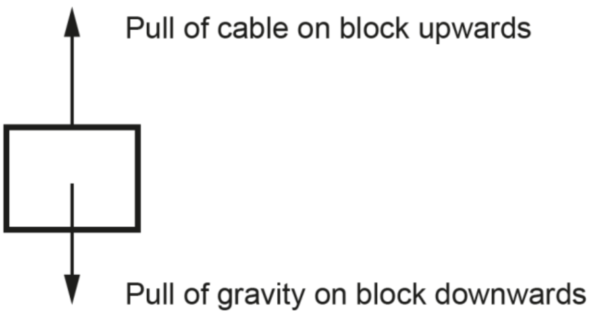
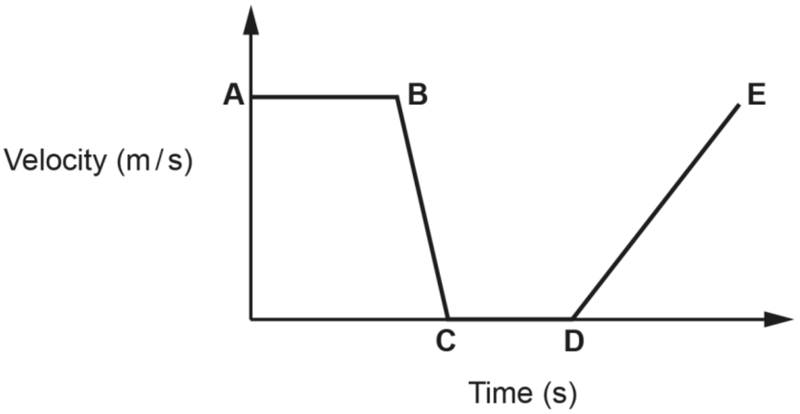


Fig. 14.2 shows the velocity-time graph for the block during a part of its journey.

Fig. 14.2



Use **Fig. 14.1** and **Fig. 14.2** to:

- Describe how the velocity of the block changes from point **A** to point **E**.
- Describe how the resultant force on the block changes from point **A** to point **E**.

....

....

....

....

....

.... **[6]**

The Level of Response question was of standard demand and assessed AO2 and AO3. It required candidates to interpret the graph in Fig. 14.2 to describe how the velocity of the block changed from point **A** to point **E**. Candidates were also asked to describe how the resultant force on the block changed from point **A** to point **E** using Fig. 14.1 and Fig. 14.2.

The question proved challenging to most candidates with few gaining more than three marks and a significant number of candidates not gaining any credit.

Most candidates gave at least a basic explanation of how the velocity of the block changed but very few gave any creditworthy description of the resultant force on the block.

Candidates who gave a detailed description of the velocity in each section of the graph, but no description of the resultant force, were able to score a maximum of Level 2, three marks. Poor quality of communication and lack of clarity about which section of the graph the candidates were referring to, often prevented candidates from gaining higher marks.

The majority of candidates had a very poor understanding of the forces acting on the block. There were few references to balanced and unbalanced forces and references to resultant forces were mostly incorrect.

Misconception

Common misconceptions included:

- the pull of gravity increased when the velocity of the block increased and decreased when the velocity decreased
- the resultant force acting on the block increased when the velocity of the block increased and decreased when the velocity decreased.

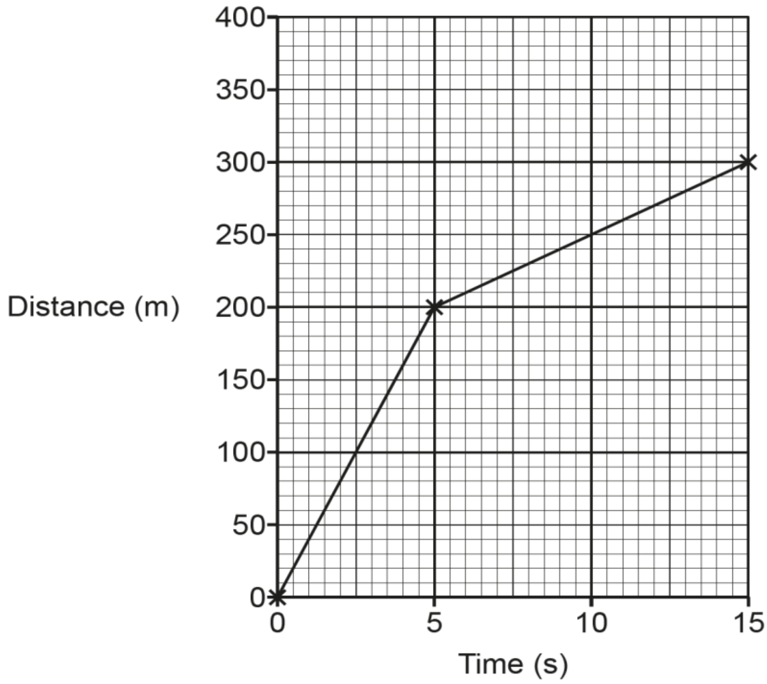
Exemplar 2

In Fig. 14.2 the block is moving at a constant speed A to B. Then massivly slows down B to C, a big decreace. Then C to D it stays still and then there is a big inceace from D to E. The resultant force first decreaces then it increaces.

This response was given Level 2, three marks. The candidate has included a detailed description of the velocity of the block in each section of the graph but there are no creditworthy statements about the resultant force on the block. To progress to four marks, or to Level 3, the candidate would need to discuss the idea of balanced/unbalanced forces on the block or compare the size of the pull of gravity on the block with the pull of the cable on the block.

Question 15

15 The distance-time graph shows the journey of a car.



Calculate the average speed of the car.

Use the graph **and** the equation: distance travelled = speed × time

Average speed = ... m / s **[4]**

This question required candidates to read values off the graph and to rearrange the equation provided to calculate the average speed of the car.

The majority of candidates gained at least one mark, either from identifying the value of 300 m for distance and 15 s for time, or from rearranging the equation provided to make average speed the subject. This highlights the importance of writing down workings and not just the final response in order to gain compensatory marks.

Common errors included:

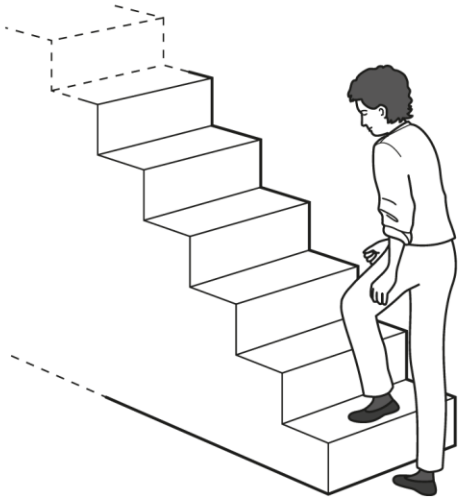
- incorrectly rearranging the equation to find average speed, e.g. average speed = 300 x 15 instead of average speed = 300 ÷ 15
- calculating the speeds of the car between 0 - 5 s and between 5 - 15 s and then averaging these two speeds.

Assessment for learning

Candidates could benefit from writing down calculations rather than only their final response so that compensatory marks may be given.

Question 16 (a)

16 Two students do an experiment to measure their power by walking up steps.



(a) This is the data from student **P**:

- Weight = 600 N
- Number of steps = 250
- Height of each step = 0.20 m

Calculate the work done by student **P**.

Work done = ... J **[3]**

Question 16 was an overlap question with the Higher Tier paper and therefore of standard demand. It assessed candidates' understanding and application of work done and power as well as working scientifically skills.

The majority of candidates scored at least one mark in 16 (a) for selecting the correct equation from the Equation Sheet. However, a significant number of candidates made the common error of not multiplying the height of each step by the number of steps in order to work out the distance moved by student **P**. By showing their working, candidates were still able to gain compensatory marks.

Another common error was to multiply weight by the number of steps. This meant that there was no distance used in the equation so did not gain any credit.

Question 16 (b)

(b) This is the data from student **Q**:

- Work done = 36 000 J
- Time taken = 240 s

Calculate the power of student **Q**.

Use the equation: power = $\frac{\text{work done}}{\text{time}}$

Give your answer in kW.

Power = ... kW **[3]**

Most candidates scored at least two marks for a simple substitution into the equation proved. However, candidates struggled to give their answer in kilowatts and it was generally only the higher achieving candidates who gained full credit by correctly converting their answer for power in watts into kilowatts. Most candidates either did not attempt to convert their answer into kilowatts or did not convert it correctly.

Assessment for learning

Candidates could benefit from practising how to:

- use unit prefixes
- convert from one unit to another.

Question 16 (c)

(c) Describe how the students carry out this experiment. Include any equipment they use.

....

....

....

....

....

.... **[3]**

Most candidates made a good attempt at this question and appeared familiar with the practical activity. The question discriminated well between the lower achieving and higher achieving candidates. However, poor quality of communication, not always reading the question carefully enough and not answering each part of the question resulted in few candidates gaining full credit.

Common errors included:

- not mentioning the equipment used
- measuring mass instead of weight
- not being explicit as to what they were measuring, e.g. 'measure the step' instead of 'measure height of step'.

Assessment for learning

Candidates could benefit from underlining key words and phrases in a question so that they are less likely to forget to answer part of the question when writing their response.

Candidates could also benefit from short starter or plenary activities where they are provided with a practical activity and asked to write a short method, including a list of the equipment and what the equipment measures.

Question 16 (d) (i) and (ii)

(d) Student **P** carries out the experiment five more times and calculates their power.

Here are student **P**'s results.

	Try 1	Try 2	Try 3	Try 4	Try 5
Power (W)	120	121	122	121	123

(i) How can student **P**'s results be described?

Tick **one** (✓) box in each row.

	Yes	No
Precise		
Repeatable		

[1]

(ii) Explain your answer to **(d)(i)**.

....

....

.... **[2]**

Candidates demonstrated poor understanding of the terms precise and repeatable. The term precise was understood slightly better by the higher achieving candidates and some of these candidates could explain why student **P**'s results were precise in (d) (ii).

Some candidates stated that the results were close together in (d) (ii) but did not link this to precision and so did not gain credit.

Misconception

A common misconception was that repeatable results simply meant that the student had repeated the measurements.

Assessment for learning

The terms precise, accurate, repeatable and reproducible are never well known or understood by candidates.

Candidates could therefore benefit from being asked questions about these terms each time they watch a demonstration or carry out an experiment.

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