edexcel

Exemplar work with commentary

GCSE (9-1) Physics

Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Physics (1PH0)

GCSE (9–1) Physics Exemplars

Contents

Introduction

This guide has been put together using student responses to our sample assessment materials in GCSE (9-1) Physics. We have grouped the answers according to the overall themes that developed through the marking process, and hope that this will give you more information on key development areas for students studying for this qualification.

The assessment of practical skills covers both knowledge of core practicals, and candidates' ability to apply that knowledge to new contexts, or to apply investigative skills to scenarios presented in the examinations. These scientific enquiry skills are something candidates will need to practice, such as questions which focus on knowledge and understanding of specific methods in practicals and drawing conclusions based on practical work. It is important to note that questions set in a practical context but testing the theoretical knowledge and understanding will not count towards the 15% marks allocated to practical skills. Questions that are assigned to this percentage will be ones where candidates are at an advantage if they have carried out the core practical.

There is a set percentage of maths marks (30%) to be met in these papers. When looking at maths content to be assessed, there are two factors that need to be considered. Firstly, the breadth of maths to be covered (which can be found in Appendix 1 in the specification) and secondly the level of maths as specified by Ofqual. In general, candidates will need to practice answering maths questions in the same way as they do now. Practicing answering these types of questions will help to minimise the minor calculation errors or mistakes that are made. Is it also important to highlight the importance of checking their answers, particularly when reading data from a graph or table, using an equation to substitute given numbers in a question, or giving answers to a set number of significant figures.

The extended open response questions (6 mark questions) test candidates' ability to construct a sustained line of reasoning. Questions assessing this are marked with an asterisk. As these items are more open ended, they are marked using a levels-based mark scheme. Our 2011 qualifications contained 6 mark questions, and candidates generally respond well to them. The general areas to develop and focus on when answering these questions are still focused on ensuring candidates answer the whole question and are able to make links both using information given in the question, and using their own knowledge. They should be able to draw conclusions, and make arguments or analyse information (backed up with their own knowledge) if the question requires it.

The question examples in this guide will give you a range of answers relating to the themes highlighted above to show you the varied answers candidates may give. There are also detailed examiner comments for each answer to explain how the marks have been allocated, and the merits or development points for each answer.

Practical skills

Combined Science (Foundation)

Example 1 - Question 2a

2 (a) A student is standing 600 m from a firework display.

A firework explodes with a loud bang, and a flash of light is seen.

Describe how a student can measure the time it takes for the sound wave from the loud bang to travel 600 m.

(2)

Mark scheme

Question number	Answer	Mark
2(a)	An answer that combines the following points of understanding to provide a logical description: • use a stopwatch (1) • start timing when flash is seen and stop when bang is heard (1)	**(2)**

Student answers

2 (a) A student is standing 600 m from a firework display.

A firework explodes with a loud bang, and a flash of light is seen.

Describe how a student can measure the time it takes for the sound wave from the loud bang to travel 600 m.

(2)

He ~~tot~~ could press a timer when he sees the ~~tig~~ flash and stop the timer when he hears the bang and record the time it takes

Examiner Comments

This response scores both marks, 1 mark for saying what is being measured (the time between seeing the flash and hearing the bang) and 1 mark for saying what it is measured with. 'Timer' is just about acceptable here as a measuring device.

Marks awarded = 2

2 (a) A student is standing 600 m from a firework display.

A firework explodes with a loud bang, and a flash of light is seen.

Describe how a student can measure the time it takes for the sound wave from the loud bang to travel 600 m.

(2)

because light is faster than sound, so the sound will be a few seconds after the flash of light

Examiner Comments

What this student says is true but it is not answering the question so scores no marks.

Marks awarded = 0

Example 2 - Question 8d

8 Figure 10 shows two students investigating reaction times.

Student B supports his left hand on a desk.

Student A holds a ruler so that the bottom end of the ruler is between the finger and thumb of student B.

When student A releases the ruler, student B catches the ruler as quickly as he can with his left hand.

The investigation is repeated with the right hand of student B.

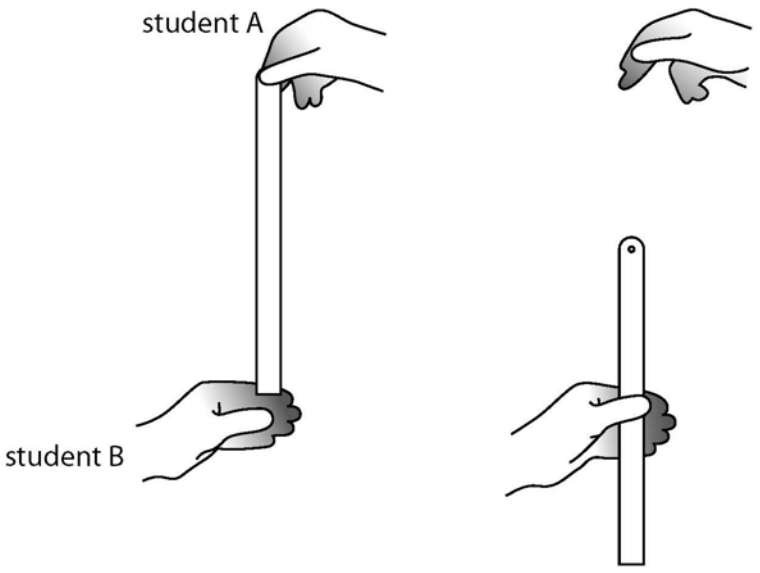


Figure 10

(d) Explain whether any of the readings are anomalous.

(2)

Mark scheme

Question number	Answer	Additional guidance	Mark
8(d)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • 25.5 is an anomalous result (1) • (because) it is much further away from the mean than the other results (1)	ignore 19	(2)

Student answers

(d) Explain whether any of the readings are anomalous.

(2)

On the left hand, trail 2, it is 25.5cm, this is anomalous because it's a big difference compared to the others.

Examiner's comments

Here the anomalous result is correctly identified for the first mark and would have scored the second mark with a bit more detail about 'the difference'.

Mark awarded = 1

Example 3 - Question 8e

8 Figure 10 shows two students investigating reaction times.

Student B supports his left hand on a desk.

Student A holds a ruler so that the bottom end of the ruler is between the finger and thumb of student B.

When student A releases the ruler, student B catches the ruler as quickly as he can with his left hand.

The investigation is repeated with the right hand of student B.

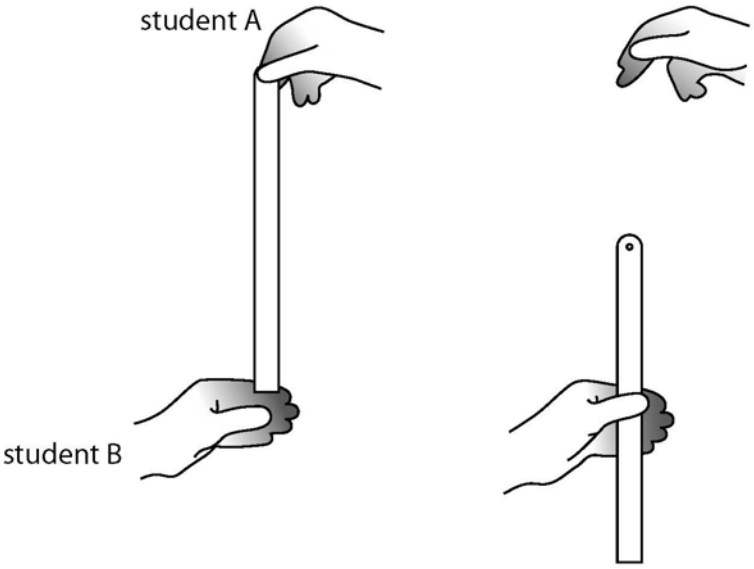


Figure 10

(e) Give **two** ways that the students can improve the quality of their data, other than ignoring anomalous results.

(2)

Mark scheme

Question number	Answer	Mark
8(e)	• Take more readings (1) • Idea that a third student should also measure the reaction time (1)	**(2)**

Student answers

(e) Give **two** ways that the students can improve the quality of their data, other than ignoring anomalous results.

(2)

1 Do more tests e.g 10 instead of just 5.

2 Have a 3rd person to measure accurately.

Examiner's comments

A good response, close to the mark scheme. Scores both marks.

Marks awarded = 2

Example 4 - Question 8f

8 Figure 10 shows two students investigating reaction times.

Student B supports his left hand on a desk.

Student A holds a ruler so that the bottom end of the ruler is between the finger and thumb of student B.

When student A releases the ruler, student B catches the ruler as quickly as he can with his left hand.

The investigation is repeated with the right hand of student B.

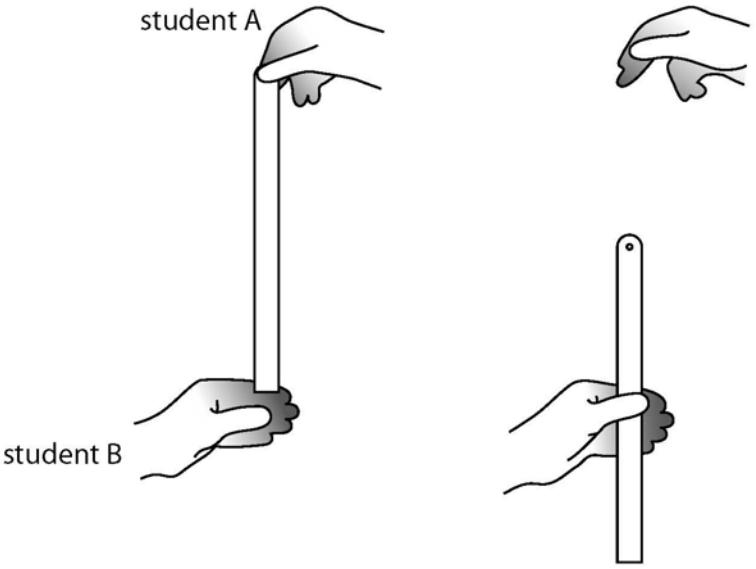


Figure 10

(f) Describe how the students could develop their investigation to investigate how reaction time changes with another variable.

(2)

Mark scheme

Question number	Answer	Additional guidance	Mark
8(f)	An answer that combines the following points to provide a logical description of the plan/method/experiment: • using a larger group of students/large population of students (1) • and measure how their reaction time varies with age/height (1)	allow any suitable variable	(2)

Student answers

(f) Describe how the students could develop their investigation to investigate how reaction time changes with another variable.

(2)

You could do the experment with people of different ages to see how age affects reaction time

Examiner's comments

This has the idea of using a larger group of people and identifies another variable to investigate. Scores both marks.

Marks awarded = 2

(f) Describe how the students could develop their investigation to investigate how reaction time changes with another variable.

(2)

The time of day - if the students are tired, their reaction times will be slower.

Examiner's comments

This identifies a new variable, tiredness, but does not give quite enough detail about how it is to be tested.

Marks awarded = 1

Combined Science (Higher)

Example 1 – Question 5a and b (also Maths)

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

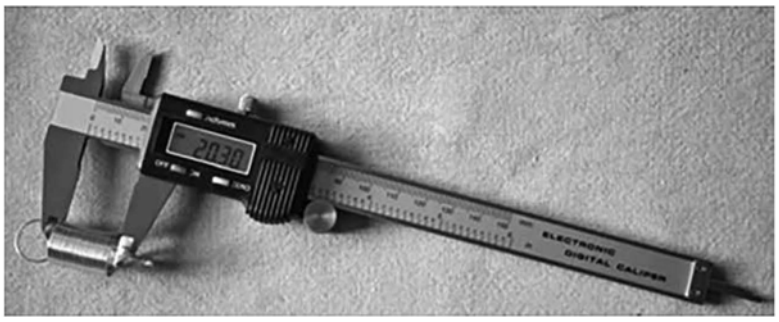


Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

Figure 11

(a) Calculate the average length of the spring.

(2)

(b) The student investigates the stretching of a spring with the equipment shown in Figure 12.

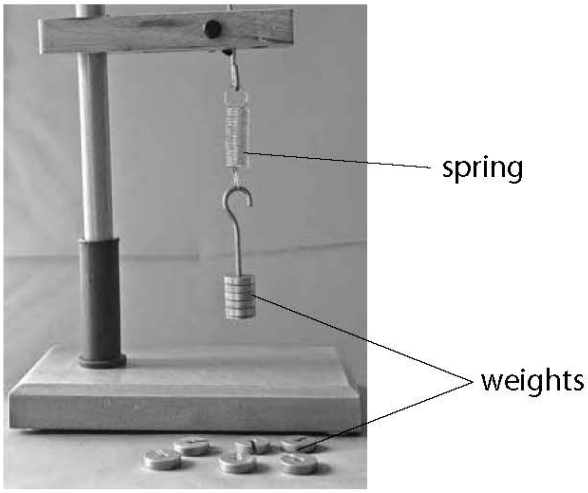


Figure 12

The student investigates the extension of the spring using six different weights.

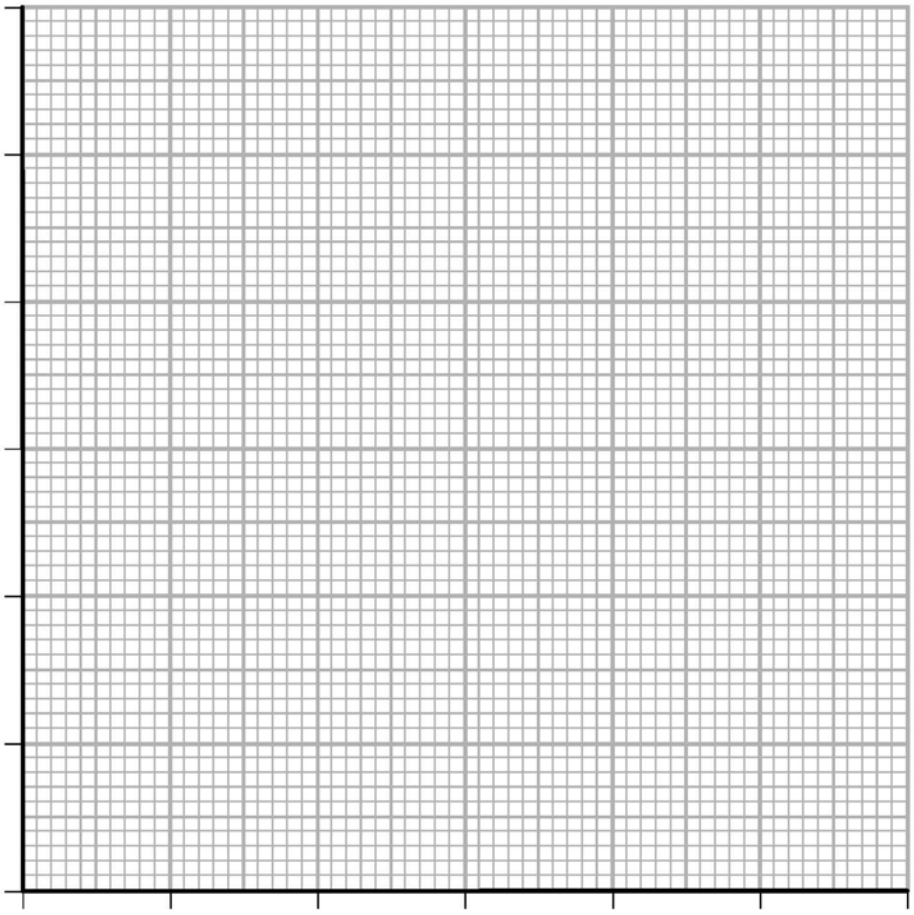
The results are shown in Figure 13.

weight (N)	extension (mm)
0.20	4.0
0.40	8.0
0.60	12.0
0.80	16.0
1.00	20.0
1.20	24.0

Figure 13

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'The extension of the spring is directly proportional to the weight stretching the spring.'

Comment on the student's conclusion.

(3)

Mark scheme

Question number	Answer	Additional guidance	Mark
5(a)	evidence that anomalous reading excluded (1) evaluation (1) average length = 20.31 (mm)	accept 101.57 (÷5) for first mark accept 20.314 (mm)	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	• Axes with linear scales that use more than half of each edge of the grid and labelled with units from table (1) • All points correctly plotted to ± half a square (1) • Single straight line passing through all points and the origin (1)	allow 1 mark if only one plotting error and correct line drawn for points plotted	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	A comment that makes reference to the following points: (using table) • idea that equal increments of force/weight/mass cause equal increments of extension (1) • correct reference to figures in the table (1) OR (using graph) • the graph line is straight (1) • the graph line passes through the origin (1) AND therefore the student's conclusion is correct (1)	last marking point can only be achieved if at least one of the other two marks is awarded	**(3)**

Student answers to (a)

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

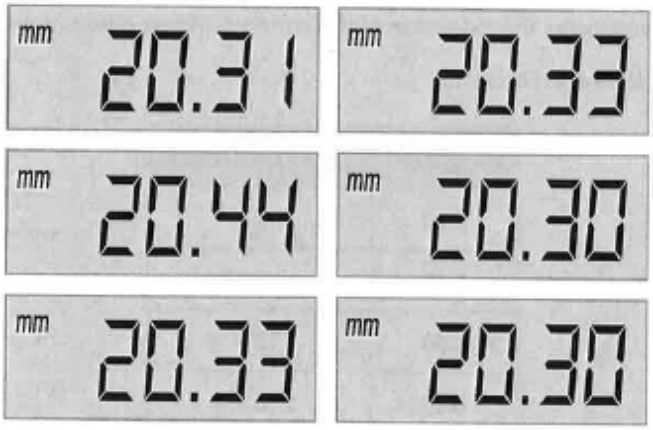


Figure 11

(a) Calculate the average length of the spring.

(2)

20.31
20.33
20.44
20.30
20.33
20.30
122.01

122.01 ÷ 6 = 20.335

average length = 20.335 mm

Examiner's comments

This answer cannot be awarded the first mark as the anomalous result has been included. The evaluation is correct for six readings and gains one mark.

Mark awarded = 1

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

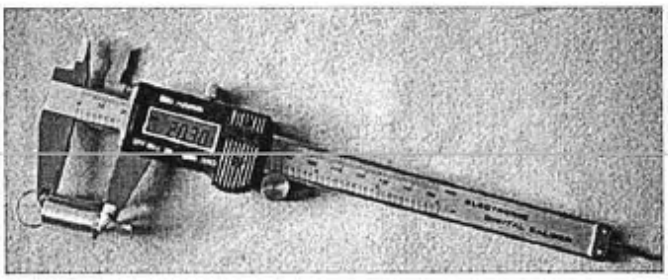


Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

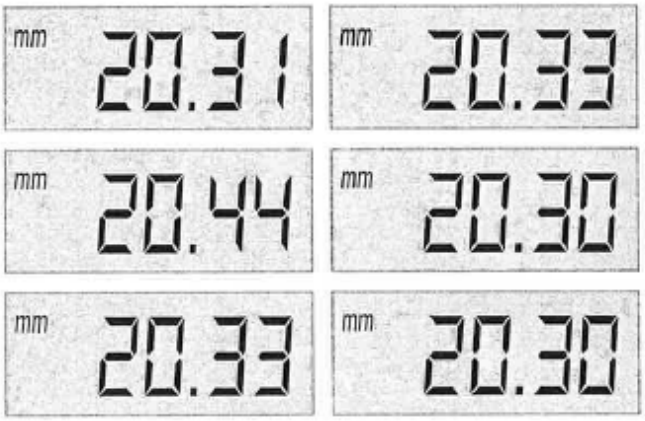


Figure 11

(a) Calculate the average length of the spring.

(2)

$20.31 + 20.33 + 20.30 + 20.33 + 20.30$

$= 101.57 \ (\div 5)$

$= 20.314$

average length = 20.31 mm

Examiner's comments

The working here is clear and the answer deserves full marks.

Marks awarded = 2

Student answers to (b)

(b) The student investigates the stretching of a spring with the equipment shown in Figure 12.

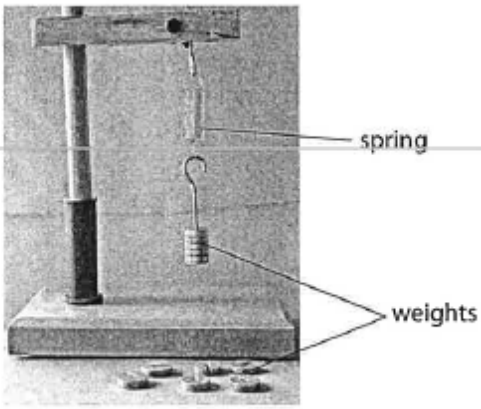


Figure 12

The student investigates the extension of the spring using six different weights.

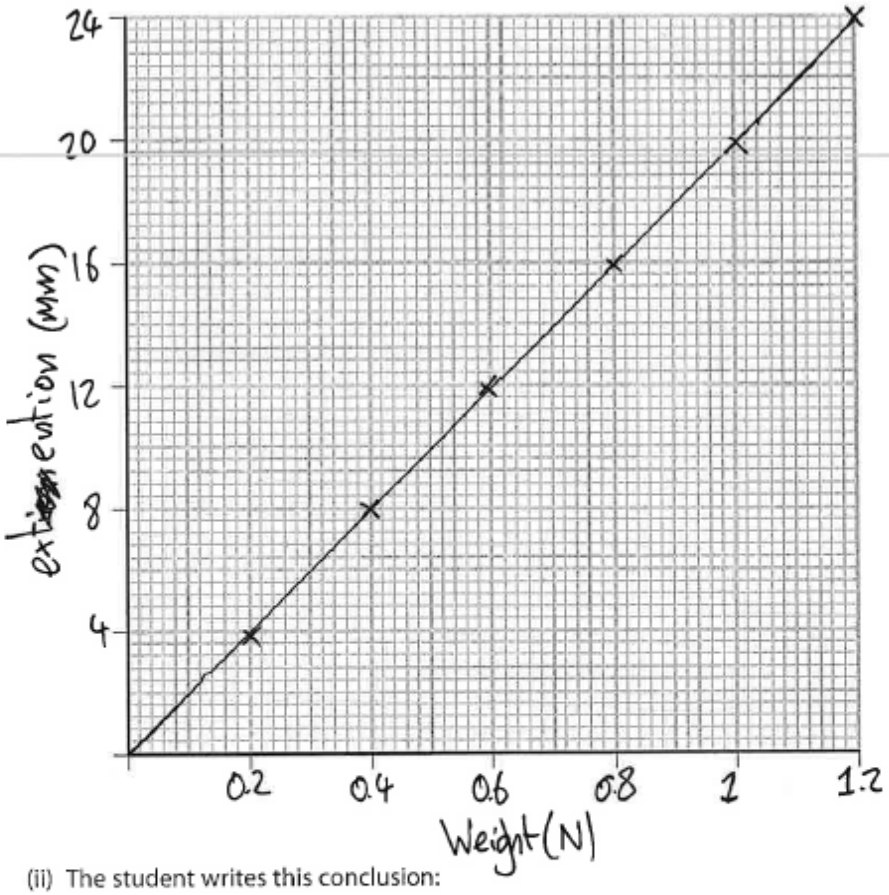
The results are shown in Figure 13.

weight (N)	extension (mm)
0.20	4.0
0.40	8.0
0.60	12.0
0.80	16.0
1.00	20.0
1.20	24.0

Figure 13

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'The extension of the spring is directly proportional to the weight stretching the spring.'

Comment on the student's conclusion.

(3)

He is correct. The extension of the spring increases by the same amount every time when the mass is increased by 0.2N.

Examiner's comments

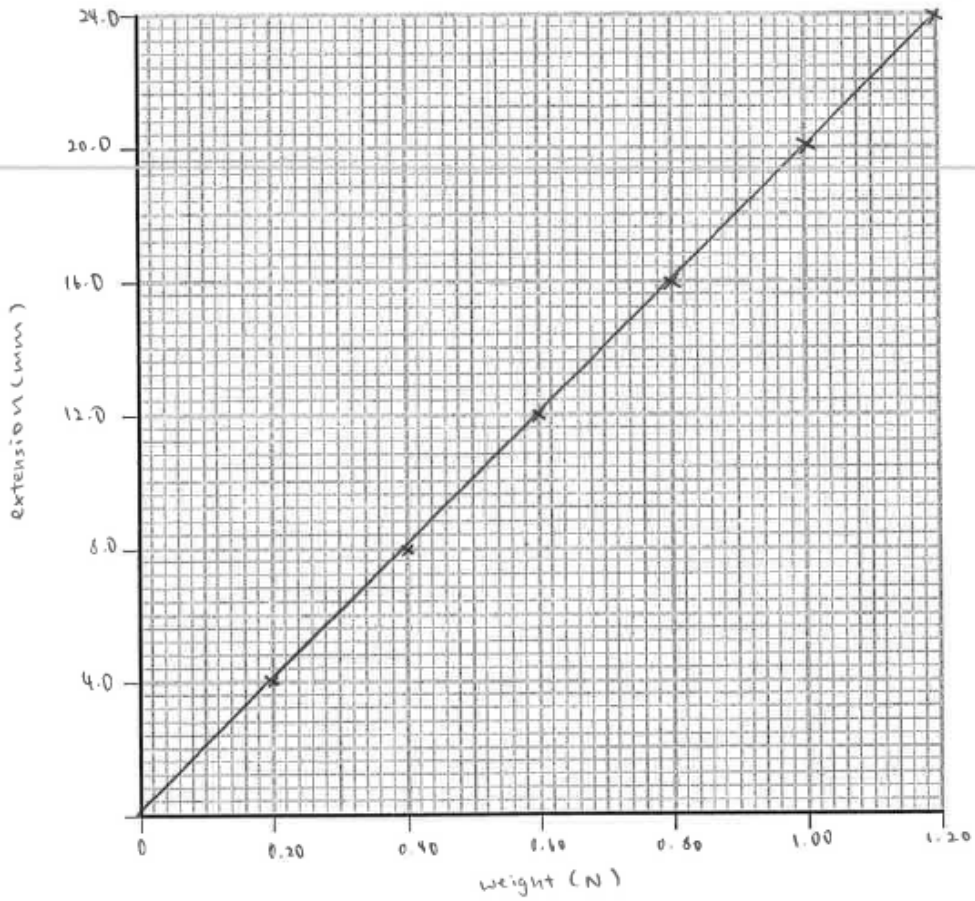
(i) 'Draw a graph' involves drawing the axes (including labels and units) plotting the points and drawing a suitable line. This student has done all that and so scores all 3 marks.

(ii) All 3 marks scored here, using the first alternative in the mark scheme. The '0.2N increase each time' is a good enough reference to the figures in the table to get the second mark.

Marks awarded = 6

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'The extension of the spring is directly proportional to the weight stretching the spring.'

Comment on the student's conclusion.

(3)

The student is correct because it is a straight line through the origin. they are directly proportional.

Examiner Comments

Full marks for part (i) and full marks for part (ii) using the second alternative in the mark scheme.

Marks awarded = 6

Separate Physics (Higher)

Example 1 – Question 9c

(c) A student is interested in the way that submarines are controlled.

She has several regular wooden blocks, a set of weights and a tank of water.
Wood floats in water.

The student plans to immerse the wooden blocks fully in the water and investigate the relationship between the upthrust and the weight of water displaced.

Describe how she should determine **one** of the variables in this investigation.

(2)

Mark scheme

Question number	Answer	Mark
9(c)	An answer that combines the following points to provide a logical description of the plan: EITHER • (determine upthrust) by adding weights until the block of wood is fully immersed and recording the load required (1) • calculate upthrust by adding load and weight of block (1) OR • (determine the weight of water displaced) by using a ruler to measure the dimensions of the block and multiplying them together to find the volume (1) • calculate the weight of water from volume × density × *g* (1)	**(2)**

Student answer

(c) A student is interested in the way that submarines are controlled.

She has several regular wooden blocks, a set of weights and a tank of water.
Wood floats in water.

The student plans to immerse the wooden blocks fully in the water and investigate the relationship between the upthrust and the weight of water displaced.

Describe how she should determine **one** of the variables in this investigation.

(2)

She could record how many weights it takes to add onto the block before it sinks.

Examiner's comments

This answer gains the first marking point for the basic method but cannot gain the second mark as there is no attempt to explain how to use the results obtained.

Marks awarded = 1

Maths skills

Combined Science (Foundation)

Example 1 - Question 2d

(d) An earthquake causes a sea wave.

This sea wave travels 26 400 m in two minutes.

Calculate the speed of the wave.

Use the equation

$$\text{wave speed} = \frac{\text{distance}}{\text{time}}$$

(3)

Mark scheme

Question number	Answer	Additional guidance	Mark
2(d)	two minutes = 120 s (1) substitution (1) 26 400 ÷ 120 answer (1) 220 (m/s)	 ecf unit change award full marks for correct numerical answer without working	 **(3)**

Student answers

(d) An earthquake causes a sea wave.

This sea wave travels 26 400 m in two minutes.

Calculate the speed of the wave.

Use the equation

$$\text{wave speed} = \frac{\text{distance}}{\text{time}}$$

(3)

$$\frac{26400}{2} = 13200$$

speed = 13200 m/s

Examiner's comments

This answer does not show the required unit conversion of minutes to seconds for the time. Error carried forward is allowed leaving the two remaining marks to be awarded.

Marks awarded = 2

(d) An earthquake causes a sea wave.

This sea wave travels 26 400 m in two minutes.

Calculate the speed of the wave.

Use the equation

$$\text{wave speed} = \frac{\text{distance}}{\text{time}}$$

(3)

wave speed = $\frac{26400\ \text{m}}{120\ \text{s}}$

= 220 m/s

speed = ... m/s

Examiner's comments

This answer is set out well and gains full marks

Marks awarded = 3

Example 2 - Question 8c

(c) The students took five results for the left hand and five results for the right hand.

Figure 11 shows their results.

which hand	distance dropped (cm)					
	trial 1	trial 2	trial 3	trial 4	trial 5	average
left	10.1	25.5	18.4	14.6	11.7	14
right	17.5	16.1	19.4	18.6	20.2	.....

Figure 11

(i) Calculate the average distance dropped for the right hand. Give your answer correct to 2 significant figures.

(2)

(ii) Calculate the average time for the left hand.

Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

(2)

Mark scheme

Question number	Answer	Additional guidance	Mark
8(c)(i)	calculating the mean (1) 18.36 rounding to 2 s.f. (1) 18 (cm)	award full marks for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
8(c)(ii)	Rearrangement (1) $t = \sqrt{\frac{\text{distance}}{500}}$ Substitution and answer (1) time = 0.17 (s)	award full marks for correct numerical answer without working allow answers which round to 0.17, e.g. 0.1673	(2)

Student answers

(c) The students took five results for the left hand and five results for the right hand.

Figure 11 shows their results.

which hand	distance dropped (cm)					
	trial 1	trial 2	trial 3	trial 4	trial 5	average
left	10.1	25.5	18.4	14.6	11.7	14
right	17.5	16.1	19.4	18.6	20.2	18

Figure 11

(i) Calculate the average distance dropped for the right hand. Give your answer correct to 2 significant figures.

(2)

17.5
16.1
19.4 +
18.6
20.2
91.8

18.35
5 | 91.830

18.35 = 18

distance = 18 cm

(ii) Calculate the average time for the left hand.

Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

(2)

$0.028 = \frac{14}{500}$

average time = 0.028 s

Examiner's comments

The answer to (i) gains full marks. The calculation is correct and the answer is given to 2 significant figures.

In (ii) this student has not taken the square root and so cannot gain any marks.

Marks awarded = 2

(c) The students took five results for the left hand and five results for the right hand.

Figure 11 shows their results.

which hand	distance dropped (cm)					
	trial 1	trial 2	trial 3	trial 4	trial 5	average
left	10.1	25.5	18.4	14.6	11.7	14
right	17.5	16.1	19.4	18.6	20.2	.....

Figure 11

(i) Calculate the average distance dropped for the right hand. Give your answer correct to 2 significant figures.

(2)

$17.5 + 16.1 + 19.4 + 18.6 + 20.2 = \frac{91.8}{5}$

$= 18.36$

distance = 18.36 cm

(ii) Calculate the average time for the left hand.

Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

(2)

$\text{time}^2 = \frac{14}{500}$

$= \sqrt{0.028}$

$= 0.167$

average time = 0.167 s

Examiner's comments

In (i) the student is only awarded 1 mark for a correct calculation of the mean because the answer is not given correct to 2 significant figures

In part (ii) both marks are awarded for this completely correct answer.

Mark awarded = 3

(ii) Calculate the average time for the left hand.

Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

(2)

time² = 14/500

= 0.028

√0.028 = 0.1673320053

average time = ... s

Examiner's comments

This clearly presented answer is correct and gains the 2 marks.

Marks awarded = 2

Example 3 - Question 9a

9 A car accelerates at a constant rate of 1.83 m/s² along a flat straight road.

(a) The force acting on the car is 1.870 kN.

Calculate the mass of the car.

Give your answer to three significant figures.

(3)

Mark scheme

Question number	Answer	Additional guidance	Mark
9(a)	rearrangement (1) $m = \frac{f}{a}$ substitution and conversion (1) $m = \frac{1870}{1.83}$ answer and rounding to 3 s.f. (1) 1020 (kg)	maximum 2 marks if kN not converted to N award full marks for correct numerical answer without working	**(3)**

Student answers

9 A car accelerates at a constant rate of 1.83 m/s² along a flat straight road.

(a) The force acting on the car is 1.870 kN.

Calculate the mass of the car.

Give your answer to three significant figures.

(3)

$\frac{1.83}{1870} = 0.9786096257$

Examiner's comments

This student does not gain any marks for this incorrect rearrangement of the equation.

Marks awarded = 0

Combined Science (Higher)

Example 1 – Question 5

5 (a) A car accelerates at a constant rate of 1.83 m/s² along a flat straight road.

The force acting on the car is 1.870 kN.

Calculate the mass of the car.

Give your answer to three significant figures.

(3)

(b) The car accelerates from rest for 16 s.

Calculate the speed of the car after 16 s.

(3)

(c) The car starts on another journey.

Figure 6 shows the graph of the car's movement.

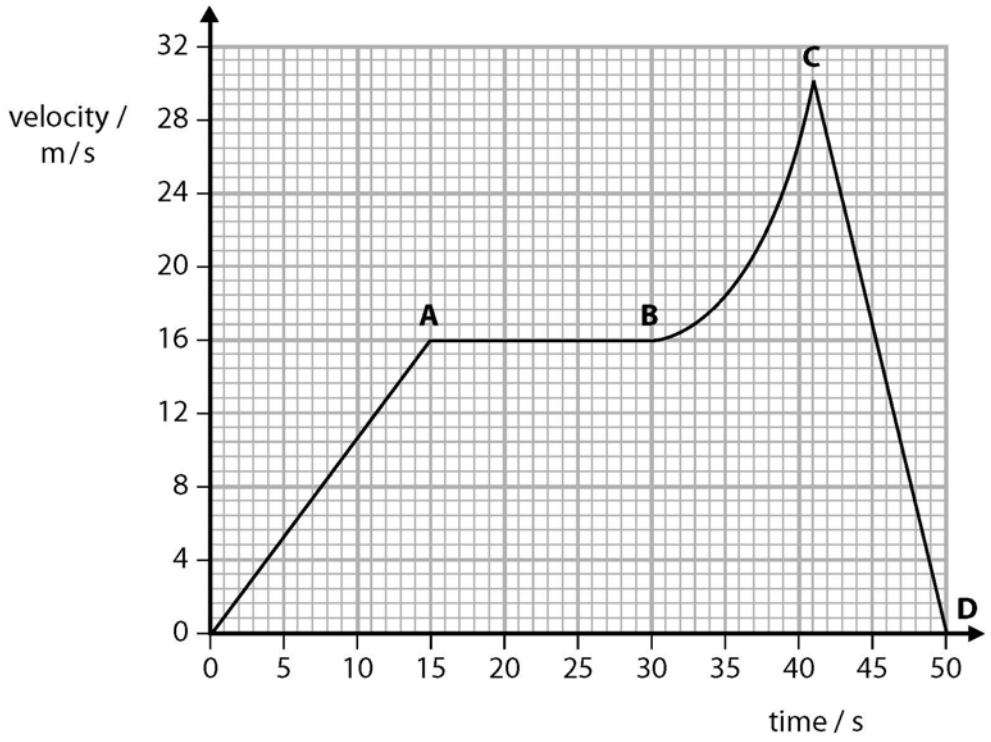


Figure 6

Show that the distance travelled when the car is moving at a constant speed is greater than the distance travelled when the car is slowing down.

(4)

Mark scheme

Question number	Answer	Additional guidance	Mark
5(a)	Rearrangement (1) $m = \frac{f}{a}$ Substitution and conversion (1) $m = \frac{1870}{1.83}$ Answer and rounding to 3 s.f. (1) 1020 (kg)	maximum 2 marks if kN not converted to N award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)	Rearrangement of $\frac{(v-u)}{t} = a$ (1) $v = u + at$ Substitution (1) $v = 0 + 1.83 \times 16$ Answer (1) 29.3 (m/s)	award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
5(c)	Correctly identifies data points from the graph to calculate areas (1) Calculates area under AB (1) 240 m Calculates area under CD (1) 135 m distance travelled at constant speed = 240 m is greater than distance travelled when slowing down = 135 m (1)	**(4)**

Student answers to (a) and (b)

5 (a) A car accelerates at a constant rate of 1.83 m/s² along a flat straight road.

The force acting on the car is 1.870 kN.

Calculate the mass of the car.

Give your answer to three significant figures.

(3)

$F = ma$

$m = \frac{F}{a} = \frac{1870}{1.83} = 1021.8579$

$= 1020$

mass = 1020 kg

(b) The car accelerates from rest for 16 s.

Calculate the speed of the car after 16 s.

(3)

$a = \frac{v-u}{t}$ $\quad v = at + u$

$= (1.83 \times 16) + 0$

$= 29.28$

speed = 29.28 m/s

Examiner's comments

Part (a) is set out well with working clearly shown. Correct answer given to three significant figures. Full marks.

Part (b) is also set out clearly and gains full marks.

Marks awarded = 6

Student answers to (c)

(c) The car starts on another journey.

Figure 6 shows the graph of the car's movement.

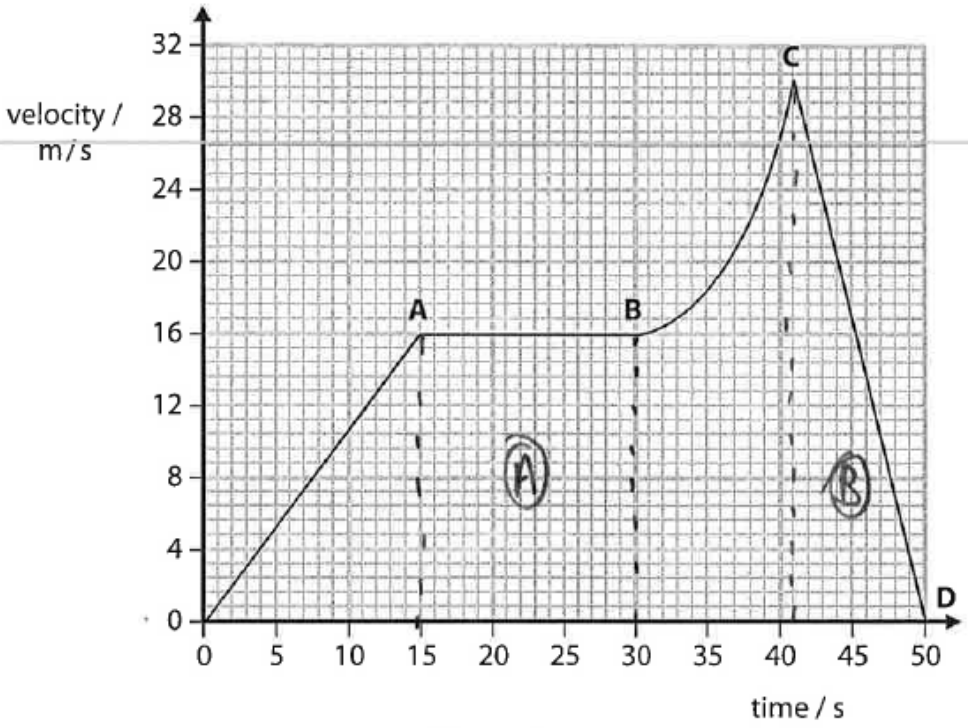


Figure 6

Show that the distance travelled when the car is moving at a constant speed is greater than the distance travelled when the car is slowing down.

(4)

A = 15 x 16
= 240m

B = 9 x 30 / 2
= 135m

240 > 135

Examiner's comments

Part c gains full marks. It is a succinct and fully correct answer.

Marks awarded = 4

(c) The car starts on another journey.

Figure 6 shows the graph of the car's movement.

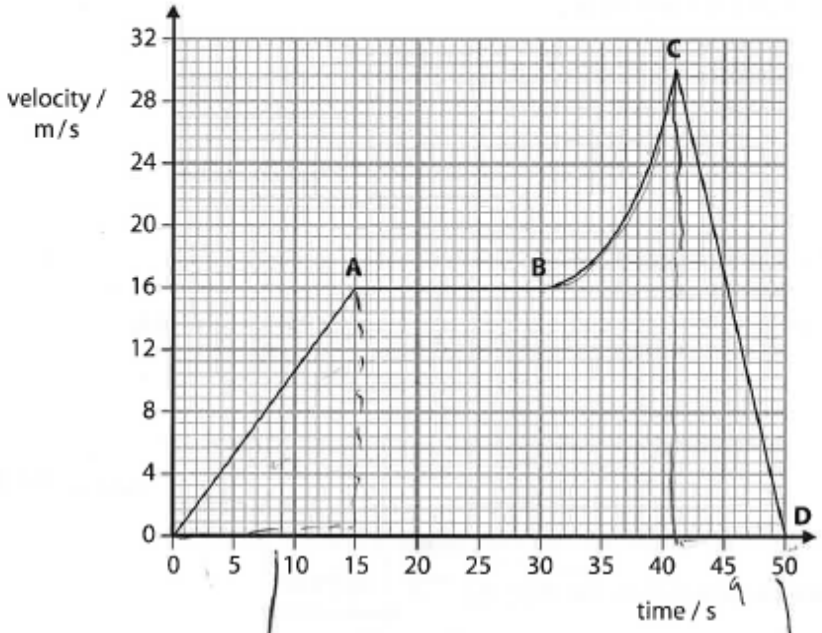


Figure 6

Show that the distance travelled when the car is moving at a constant-speed is greater than the distance travelled when the car is slowing down.

(4)

Distance = Area of triangle

$\frac{15 \times 16}{2} = 120\text{ m}$

↓ constant speed.

$\frac{9 \times 30}{2} = 135\text{ m}$

120m < 135m

Examiner's comments

The points are not correctly identified since the area of constant speed is not included.

This answer cannot make a correct comparison therefore and only one mark is awarded (for the correct working for the area under the graph for section CD).

Marks awarded = 1

Example 2 – Question 5 (also Practical)

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

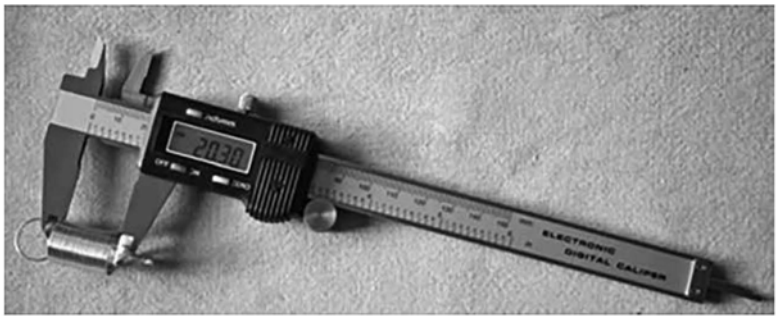


Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

Figure 11

(a) Calculate the average length of the spring.

(2)

(b) The student investigates the stretching of a spring with the equipment shown in Figure 12.

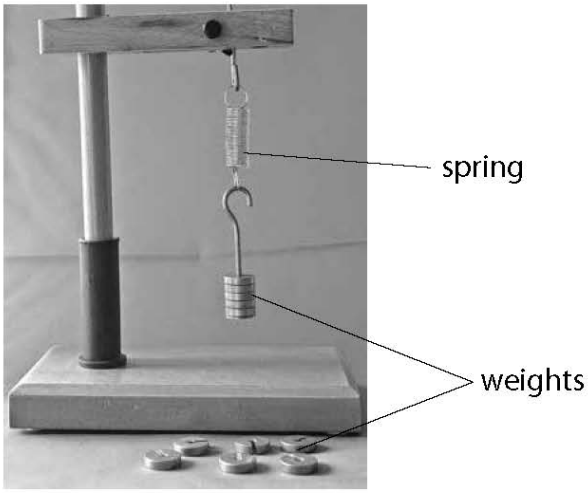


Figure 12

The student investigates the extension of the spring using six different weights.

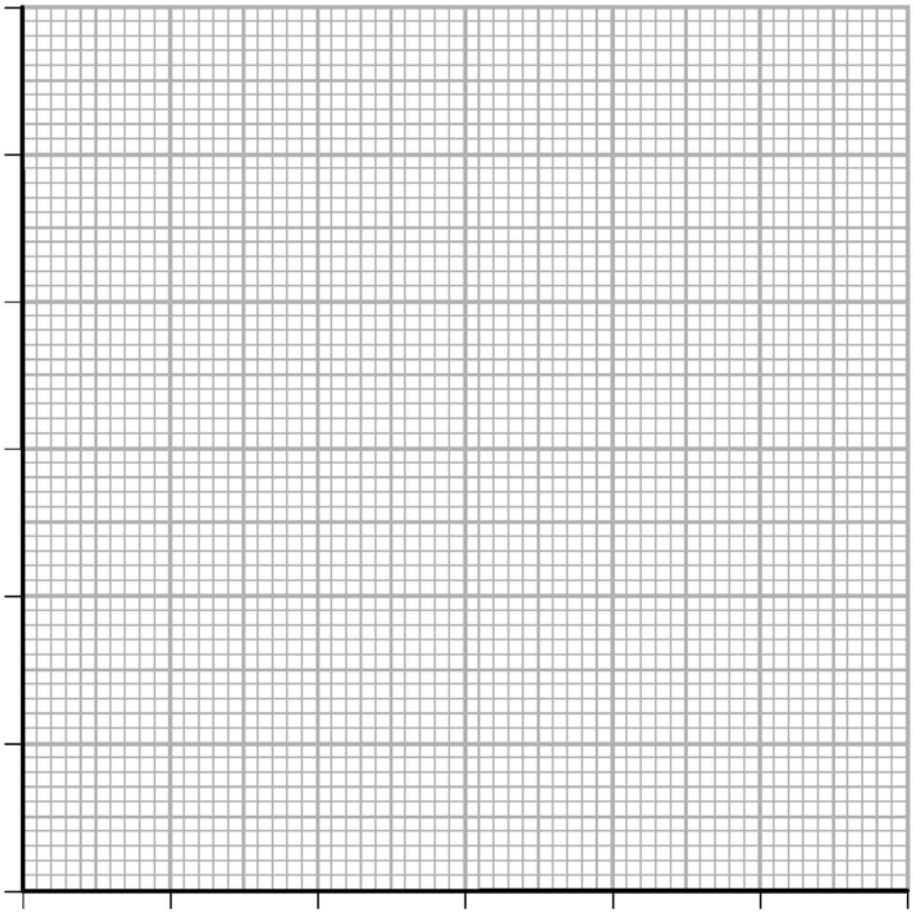
The results are shown in Figure 13.

weight (N)	extension (mm)
0.20	4.0
0.40	8.0
0.60	12.0
0.80	16.0
1.00	20.0
1.20	24.0

Figure 13

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'The extension of the spring is directly proportional to the weight stretching the spring.'

Comment on the student's conclusion.

(3)

Mark scheme

Question number	Answer	Additional guidance	Mark
5(a)	evidence that anomalous reading excluded (1) evaluation (1) average length = 20.31 (mm)	accept 101.57 (÷5) for first mark accept 20.314 (mm)	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	• Axes with linear scales that use more than half of each edge of the grid and labelled with units from table (1) • All points correctly plotted to ± half a square (1) • Single straight line passing through all points and the origin (1)	allow 1 mark if only one plotting error and correct line drawn for points plotted	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	A comment that makes reference to the following points: (using table) • idea that equal increments of force/weight/mass cause equal increments of extension (1) • correct reference to figures in the table (1) OR (using graph) • the graph line is straight (1) • the graph line passes through the origin (1) AND therefore the student's conclusion is correct (1)	last marking point can only be achieved if at least one of the other two marks is awarded	**(3)**

Student answers to (a)

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

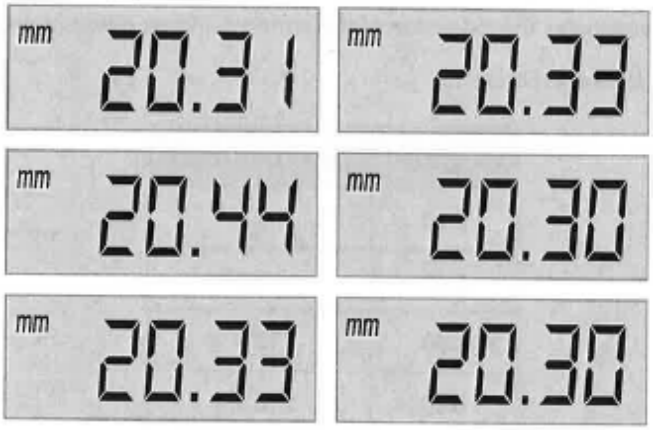


Figure 11

(a) Calculate the average length of the spring.

(2)

20.31
20.33
20.44
20.30
20.33
20.30
122.01

122.01 ÷ 6 = 20.335

average length = 20.335 mm

Examiner's comments

This answer cannot be awarded the first mark as the anomalous result has been included. The evaluation is correct for six readings and gains one mark.

Mark awarded = 1

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

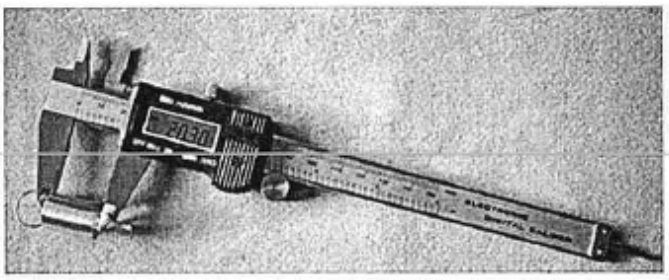


Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

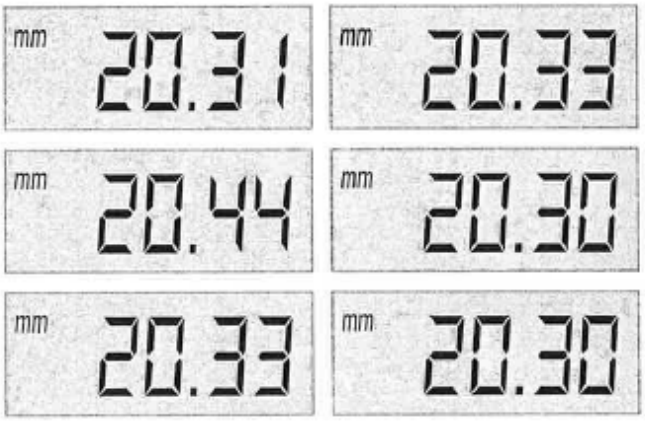


Figure 11

(a) Calculate the average length of the spring.

(2)

20·31 + 20·33 + 20·30 + 20·33 + 20·30

= 101·57 (÷5)

= 20·314

average length = 20·31 mm

Examiner's comments

The working here is clear and the answer deserves full marks.

Marks awarded = 2

Student answers to (b)

(b) The student investigates the stretching of a spring with the equipment shown in Figure 12.

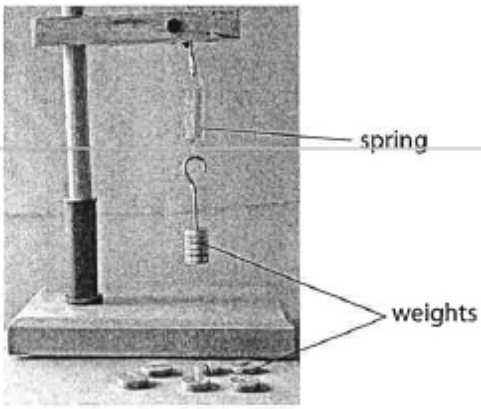


Figure 12

The student investigates the extension of the spring using six different weights.

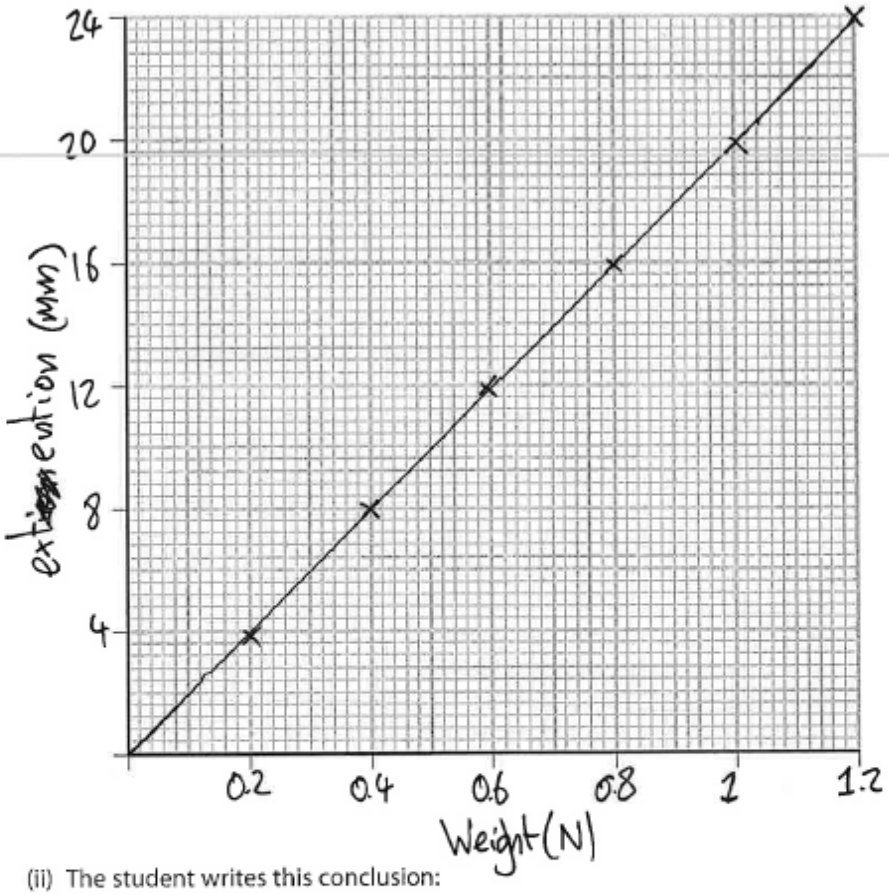
The results are shown in Figure 13.

weight (N)	extension (mm)
0.20	4.0
0.40	8.0
0.60	12.0
0.80	16.0
1.00	20.0
1.20	24.0

Figure 13

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'The extension of the spring is directly proportional to the weight stretching the spring.'

Comment on the student's conclusion.

(3)

He is correct. The extension of the spring increases by the same amount every time when the mass is increased by 0.2N.

Examiner's comments

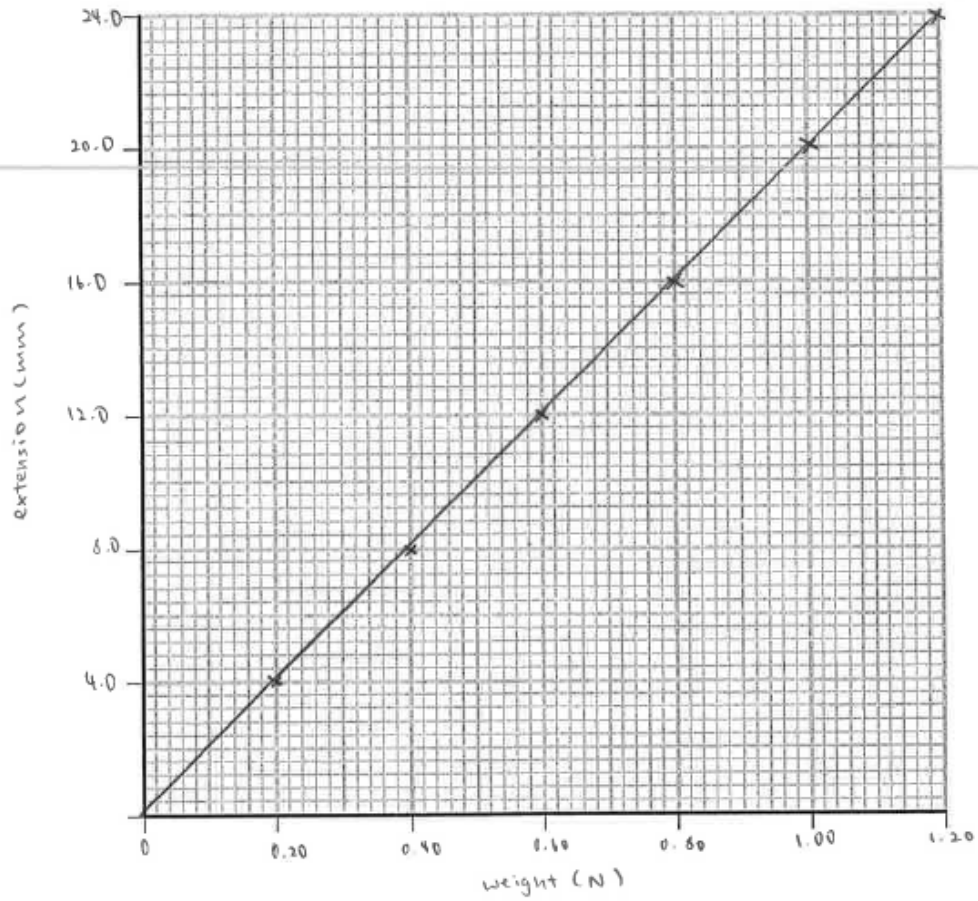
(i) 'Draw a graph' involves drawing the axes (including labels and units) plotting the points and drawing a suitable line. This student has done all that and so scores all 3 marks.

(ii) All 3 marks scored here, using the first alternative in the mark scheme. The '0.2N increase each time' is a good enough reference to the figures in the table to get the second mark.

Marks awarded = 6

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'The extension of the spring is directly proportional to the weight stretching the spring.'

Comment on the student's conclusion.

(3)

The student is correct because it is a straight line through the origin. They are directly proportional.

Examiner Comments

Full marks for part (i) and full marks for part (ii) using the second alternative in the mark scheme.

Marks awarded = 6

Example 3 – Question 9c

(c) The distance between the Earth and the Sun is 1.50×10^{11} m.

Light takes 500 s to travel from the Sun to the Earth.

The wavelength of red light is 670 nm.

Calculate the frequency of red light, using only the data provided.

(4)

Mark scheme

Question number	Answer	Additional guidance	Mark
9(c)	Substitution into $v = \frac{s}{t}$ to find v (1) $v = \frac{1.5 \times 10^{11}}{500}$ Substitution into $v = f \times \lambda$ and unit conversion (1) $v = \frac{1.5 \times 10^{11}}{500} = f \times 670 \times 10^{-9}$ Transposition (1) Rearrangement (1) $f = \frac{\left(1.50 \times 10^{11}\right)}{500 \times \left(670 \times 10^{-9}\right)}$ Answer (1) 4.5 x 10^{14} (Hz)	s is distance award full marks for correct numerical answer without working maximum 3 marks if λ in nm 4.4776 x 10^{14} (Hz)	**(4)**

Student answers

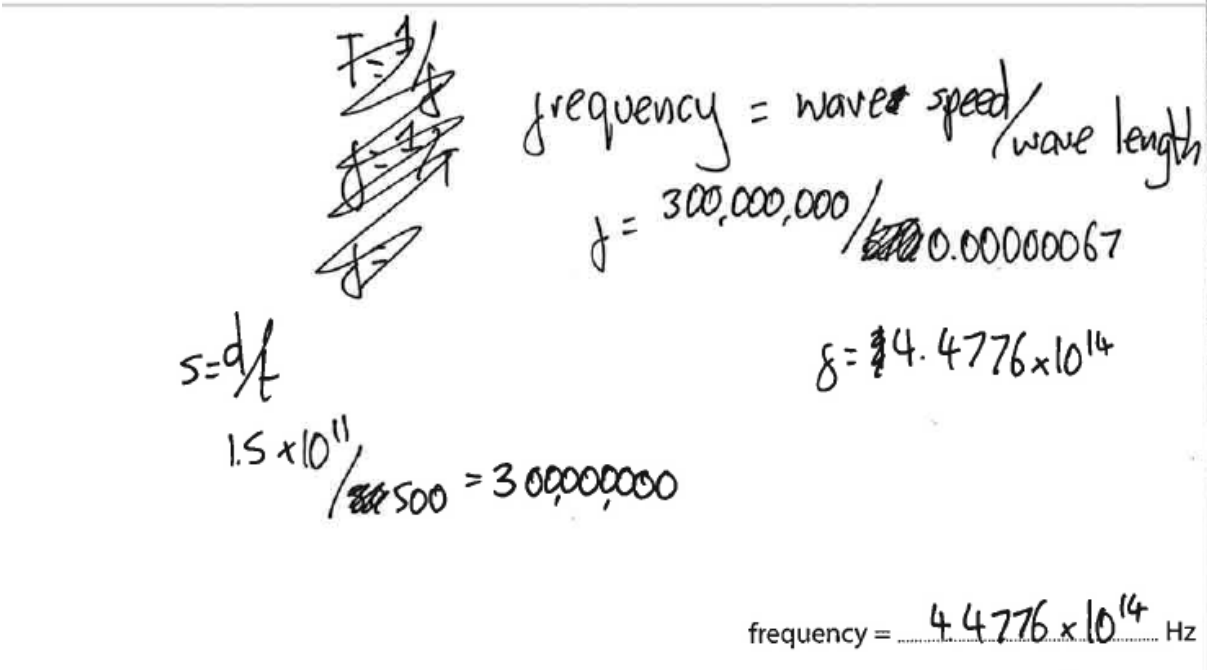
(c) The distance between the Earth and the Sun is 1.50×10^{11} m.

Light takes 500 s to travel from the Sun to the Earth.

The wavelength of red light is 670 nm.

Calculate the frequency of red light, using only the data provided.

(4)



Examiner's comments

A fully correct answer gaining 4 marks. It is well set out.

Marks awarded = 4

Separate Physics (Higher)

Example 1 – Question 4b

(b) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

Mark scheme

Question number	Answer	Additional guidance	Mark
4(b)	Equating energy in both equations (1) E = weight × height = power × time Rearrangement (1) time = $\frac{(\text{weight} \times \text{height})}{\text{power}}$ Substitution and evaluation (1) time = 230 000 × $\frac{4.7}{1600}$ time = 680 (s)	allow answers which round to 680, e.g. 675.6	(3)

Student answers

(b) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

$\frac{230,000 \times 4.7}{1700}$ = 675.625 = ~~635.8823529...~~ = ~~636~~ 676

$\frac{636}{6}$ = 106

= 106 minutes

= 1 hour ~~46~~ minutes to refuel

time = $\frac{676}{6}$ s

$\frac{676}{6}$ = 112.666...

= 113

= 1 hour 53 minutes

Examiner's comments

An example of a fully correct answer gaining full marks.

Marks awarded = 3

(b) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

$E = I \times V \times t$

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

$\frac{230000 \times 4.7}{1600}$

time = 676 s

(3sf)

Examiner's comments

An interesting variation with I × V taken as 1600W. This more unusual answer gains full marks

Marks awarded = 3

Example 2 – Question 8a

8 (a) All objects emit electromagnetic radiation.

The intensity and wavelength of the emitted radiation vary with the temperature of the object.

Figure 12 shows this variation for a filament lamp at two different temperatures.

The visible region of the electromagnetic spectrum is also shown.

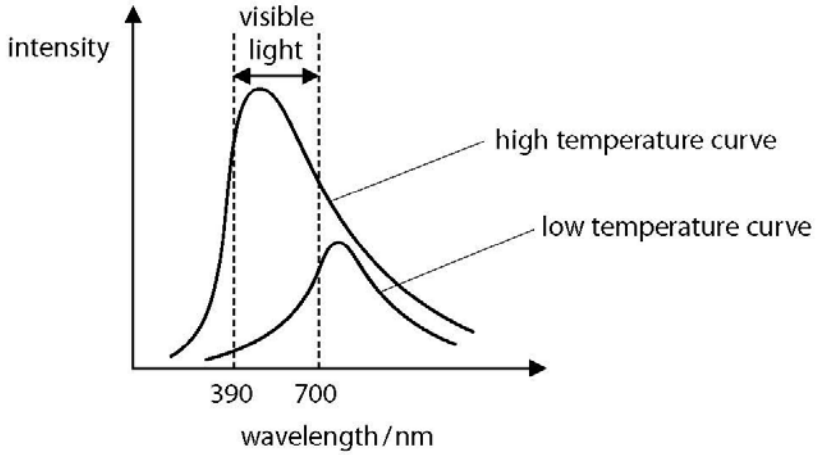


Figure 12

(i) Explain why a filament lamp appears brighter and less red as its temperature increases.

(4)

(ii) The intensity of gamma radiation can be measured using a Geiger-Müller tube and counter.

The count rate recorded by the counter tube depends on how far away the Geiger-Müller tube is from the gamma radiation source.

The equation relating count rate to distance from the source is

$$\text{count rate} = \frac{k}{d^2}$$

where d is the distance from the source and k is a constant.

A Geiger-Müller tube is placed 0.70 m from a source of gamma radiation.
The counter displays a count rate of 85 000 count per minute.

Calculate the count rate recorded when the Geiger-Müller tube is placed 1.3 m away from the same gamma radiation source.

(3)

Mark scheme

Question number	Answer	Mark
8(a)(i)	An explanation that combines identification via a judgement (2 marks) to reach a conclusion via justification/reasoning (2 marks): • intensity of radiation increases with temperature (1) • the distribution of the emitted wavelengths of radiation is affected by temperature (1) • at low temperatures the intensity of radiation emitted is low and the (range of) emitted wavelengths (of radiation) are high so the lamp appears dull red (1) • at higher temperatures the intensity of the radiation is greater and the (range of) emitted wavelengths (of radiation) are low so the lamp appear to be brighter and less red (1)	**(4)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	Substitution and rearrangement to find k (1) $k = 85000 \times 0.70^2$ Substitution to find new count rate (1) count rate = $\frac{85000 \times 0.70^2}{1.3^2}$ Answer (1) 25000 (counts per minute)	41650 24645 (counts per minute)	**(3)**

Student answers

8 (a) All objects emit electromagnetic radiation.

The intensity and wavelength of the emitted radiation vary with the temperature of the object.

Figure 12 shows this variation for a filament lamp at two different temperatures.

The visible region of the electromagnetic spectrum is also shown.

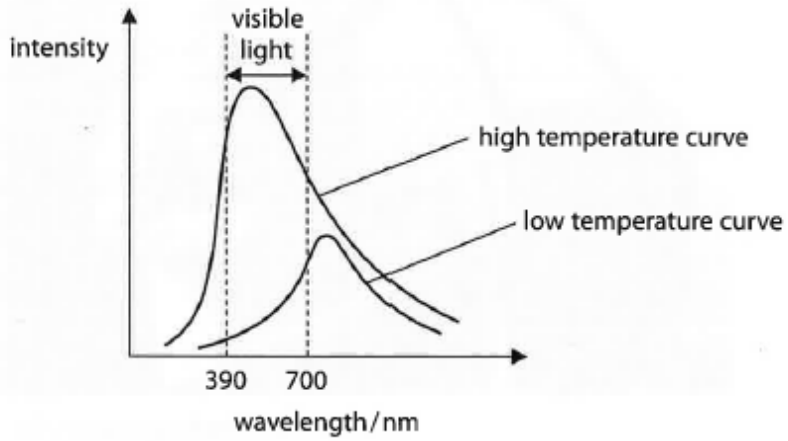


Figure 12

(i) Explain why a filament lamp appears brighter and less red as its temperature increases.

(4)

As the temperature increases, the shorter the wavelength emitted. Red is a longer wavelength within the visible spectrum and so the shorter the wavelength as it gets hotter, the further it goes from red to violet (less red). The light also appears brighter because the higher the temperature, the greater the intensity (within the visible light spectrum). Greater intensity = brighter.

Examiner's comments

The points are made in a different order to the mark scheme but are all here so full marks is given.

Marks awarded = 4

(ii) The intensity of gamma radiation can be measured using a Geiger-Müller tube and counter.

The count rate recorded by the counter tube depends on how far away the Geiger-Müller tube is from the gamma radiation source.

The equation relating count rate to distance from the source is

$$\text{count rate} = \frac{k}{d^2}$$

where d is the distance from the source and k is a constant.

A Geiger-Müller tube is placed 0.70 m from a source of gamma radiation.
The counter displays a count rate of 85 000 count per minute.

Calculate the count rate recorded when the Geiger-Müller tube is placed 1.3 m away from the same gamma radiation source.

(3)

$k = 85000 \times 0.70$
$= 59500$

$CR = \frac{59500}{1.3}$

$= 45769.23$

count rate = 45769.2 counts per minute

Examiner's comments

No marks can be awarded here because the student has not started with distance squared.

Marks awarded = 0

Extended open response

Combined Science (Foundation)

Example 1 - Question 9c

*(c) Figure 12 is a speed-time graph for a different car moving on a horizontal road.

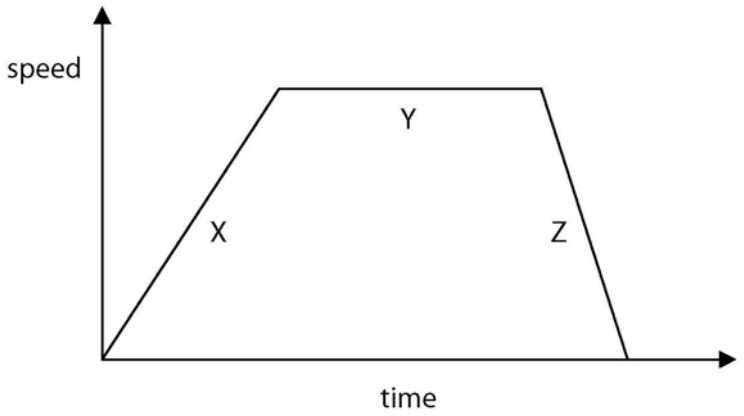


Figure 12

Describe the energy transfers taking place during the movement of the car.

You should refer to energy stores as well as transfers between energy stores for all three sections of the graph.

(6)

Mark scheme

Question number	Indicative content	Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2** • fuel forms a store of chemical (potential) energy • chemical energy is transferred to kinetic energy and thermal energy when the car moves • kinetic energy transferred to thermal energy as the car slows down **AO3** • during X, kinetic energy increases as the car's speed increases/car accelerates and the increase in kinetic energy is provided by the chemical energy store • during all three sections, work is done against frictional forces in the moving parts of the car and against the drag from the air • during Y, kinetic energy stays constant when the car moves at constant speed but energy is still transferred to thermal energy • during Z, kinetic energy decreases as the car slows down	**(6)**

Level	Mark	Descriptor
	0	No awardable content.
1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The description attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The description is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)

3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The description is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Student answers

*(c) Figure 12 is a speed-time graph for a different car moving on a horizontal road.

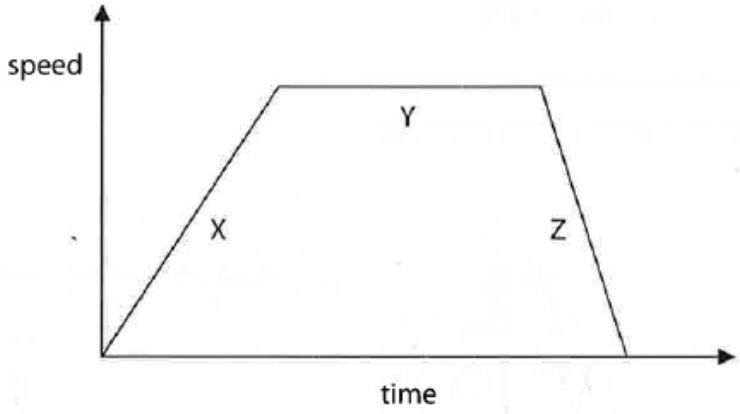


Figure 12

Describe the energy transfers taking place during the movement of the car.

You should refer to energy stores as well as transfers between energy stores for all three sections of the graph.

(6)

During X ~~he is~~ the car is moving by going ~~fast.~~ At a constant speed. Then the car rests ~~&~~ at Y, until at Z it is at a faster speed then X but is still at a constant speed.

Examiner's comments

This student has interpreted the graph as a distance-time graph instead of a speed-time graph. This illustrates the importance of checking the axes of graphs when asked to do any kind of analysis. No reference has been made to the energy involved at the various stages. There is no awardable content here so 0 marks.

Marks awarded = 0

*(c) Figure 12 is a speed-time graph for a different car moving on a horizontal road.

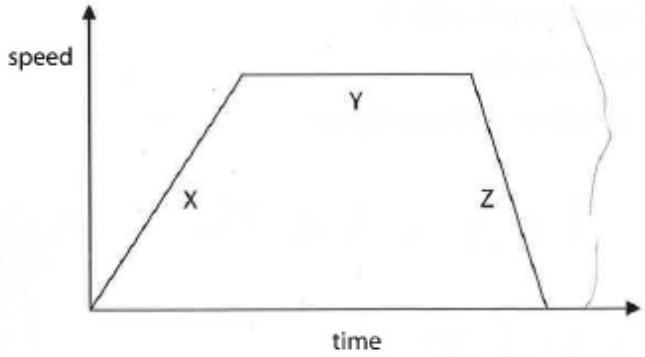


Figure 12

Describe the energy transfers taking place during the movement of the car.

You should refer to energy stores as well as transfers between energy stores for all three sections of the graph.

(6)

the most amount of energy needed would be for section x because accelerating takes the most energy, y you are going at a steady speed the same for a while thats why people do not turn their cars off to restart in a short amount of time, it uses too much energy.

(Total for Question 9 = 12 marks)

Examiner's comments

There is a limited attempt at interpreting the graph in that section X is correctly identified as the section where the car is accelerating. Even though energy is mentioned, there is no reference made to the ideas of the source of the energy or the transfers involved. This is level 1, scoring 2 marks.

Marks awarded = 2

*(c) Figure 12 is a speed-time graph for a different car moving on a horizontal road.

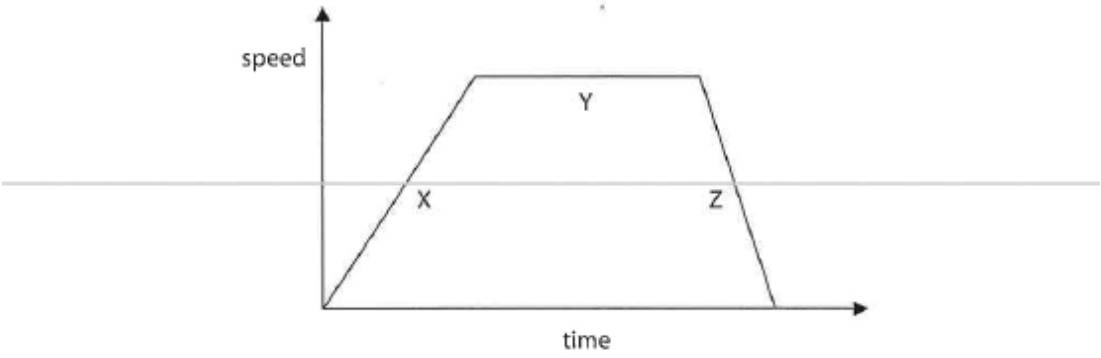


Figure 12

Describe the energy transfers taking place during the movement of the car.

You should refer to energy stores as well as transfers between energy stores for all three sections of the graph.

(6)

At X, the car is accelarating at a constant rate, as the energy of the car which is moving it is greater than any of the other sorces acting against the car such as air resistance and drag. At Y, the car has stopped accelarating and the car is travelling at a constant speed. The kinetic energy the car has is now levelling out with the opposing forces (such as drag) and therefore the car is neither accelarating or decelarating. At Z, the car is slowing down and eventually stops. The car is probably stopped by the car braking - the cars kinetic energy is counteracted by friction.

Examiner's comments

This response has a full analysis of a velocity-time graph but confuses energy and forces. It applies some knowledge of velocity to the analysis by correctly using the term acceleration. The analysis of the graph puts it into level 2 but it needed some correct application of knowledge about energy. It is, therefore, level 2 but only 3 marks.

Marks awarded = 3

*(c) Figure 12 is a speed-time graph for a different car moving on a horizontal road.

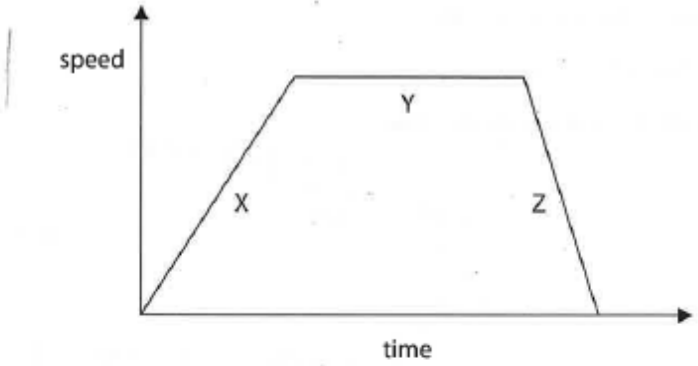


Figure 12

Describe the energy transfers taking place during the movement of the car.

You should refer to energy stores as well as transfers between energy stores for all three sections of the graph.

(6)

From X to Y the car is accelerating and the beginning energy is chemical energy, causing kinetic energy to take place- meaning the wasted energy to be heat. From Y to Z is at a constant speed and it is still chemical energy causing kinetic energy causing the wasted heat to be heat energy. From Z is a deceleration which is kinetic energy causing sound energy meaning the wasted energy to be heat.

Examiner's comments

This response interprets the whole of the graph correctly and links this to the ideas of the energy sources and transfers involved, even though the words 'store' and 'transfers' are not used. There is also no mention of the fuel being the source of the chemical energy.

Mark awarded = 5

Combined Science (Higher)

Example 1 – Question 9b

*(b) Figure 13 shows a beam of red light approaching one side of a rectangular glass block.

The beam of light will pass through the block and leave through the opposite side.

AB is a wavefront.

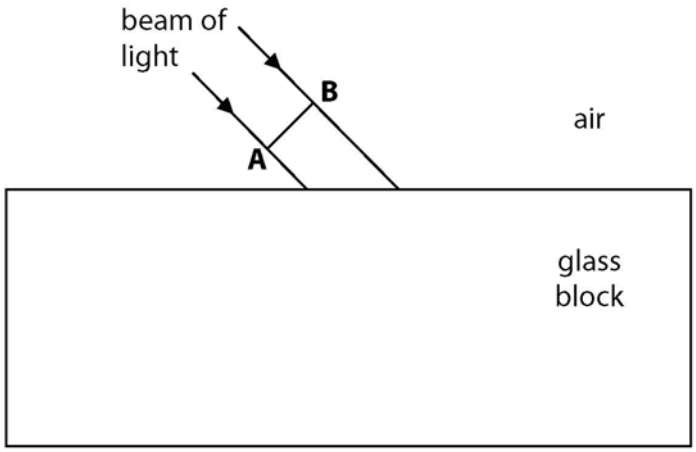


Figure 13

Discuss the path of the wavefront **AB** as it enters and leaves the glass block.

(6)

Mark scheme

Question number	Answer	Additional guidance	Mark
9(c)	Substitution into $v = \frac{s}{t}$ to find v (1) $v = \frac{1.5 \times 10^{11}}{500}$ Substitution into $v = f \times \lambda$ and unit conversion (1) $v = \frac{1.5 \times 10^{11}}{500} = f \times 670 \times 10^{-9}$ Transposition (1) Rearrangement (1) $f = \frac{(1.50 \times 10^{11})}{500 \times (670 \times 10^{-9})}$ Answer (1) 4.5 x 10^{14} (Hz)	s is distance award full marks for correct numerical answer without working maximum 3 marks if λ in nm 4.4776 x 10^{14} (Hz)	**(4)**

Student answers

*(b) Figure 13 shows a beam of red light approaching one side of a rectangular glass block.

The beam of light will pass through the block and leave through the opposite side.

AB is a wavefront.

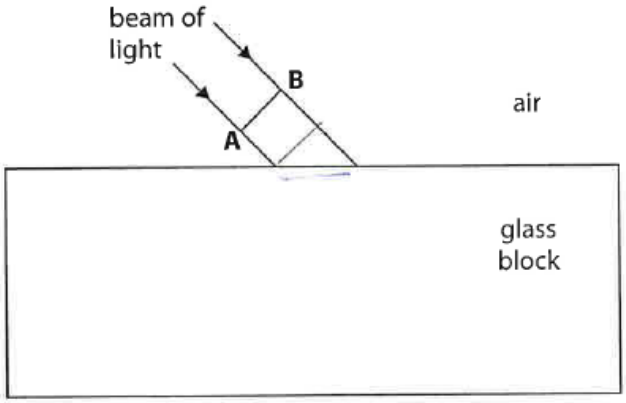


Figure 13

Discuss the path of the wavefront **AB** as it enters and leaves the glass block.

(6)

Point A hits the glass before point B, and is slowed down first. B carries on at the faster speed until it hits the glass, causing the light to bend towards the normal. The wavefront AB should continue, but at a lesser angle from the normal, until it reaches the glass-air boundary at the other side of the glass block. Point A should hit the boundary before point B, and leave the glass, entering the air, first, and as it is travelling for longer in a less dense material, should speed up before point B, causing the light to bend away from the normal as it leaves the glass.

Examiner's comments

This response demonstrates accurate and relevant physics understanding throughout. It describes what happens to the beam. It shows understanding that this is due to a decrease in speed as the beam enters the block and an increase in speed as the beam leaves the block and also why these changes in speed cause the changes in direction. It has a well-developed structure which is clear, coherent and logical.

This is level 3.

Marks awarded = 6

*(b) Figure 13 shows a beam of red light approaching one side of a rectangular glass block.

The beam of light will pass through the block and leave through the opposite side.

AB is a wavefront.

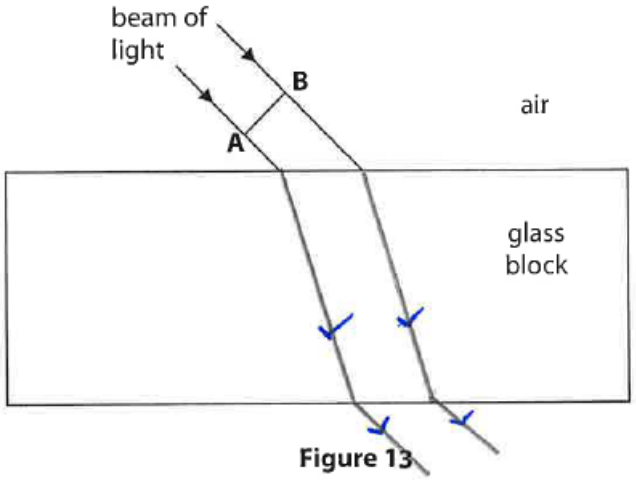


Figure 13

Discuss the path of the wavefront **AB** as it enters and leaves the glass block.

(6)

as the beam of light hits the glass block it will slow down and bend towards the normal. When it moves through the glass it will stay at a slower speed. When it then enters the air it will again bend at the same angle as the angle when it hit the glass block increasing in speed and moving away from the bend.

Examiner's comments

This response demonstrates accurate and relevant physics understanding but is not fully developed. It describes what happens to the beam. It shows understanding that this is due to a decrease in speed as the beam enters the block and an increase in speed as the beam leaves the block but does not discuss why this change in speed causes a change in direction. It has a structure which is clear, coherent and logical.

This is level 2.

Marks awarded = 4

*(b) Figure 13 shows a beam of red light approaching one side of a rectangular glass block.

The beam of light will pass through the block and leave through the opposite side.

AB is a wavefront.

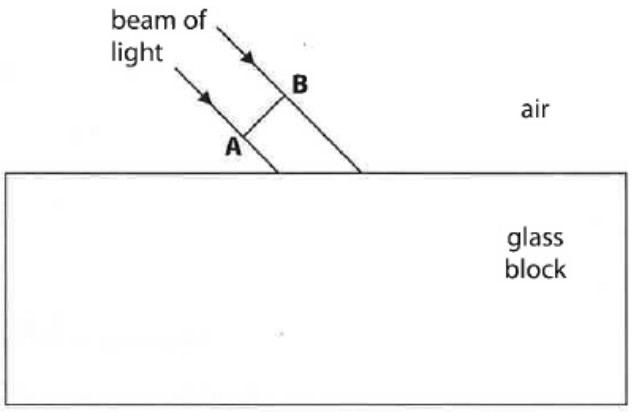


Figure 13

Discuss the path of the wavefront **AB** as it enters and leaves the glass block.

(6)

The beam of light goes from a less dense to a more dense medium. The light bends towards the normal. This is because the speed of light in the glass block increases because there are more particles to vibrate. As the light leaves the glass block, it refracts away from the normal. This is because its speed decreases as there are less particles to vibrate. The wavelength of light gets longer.

Examiner's comments

This response demonstrates elements of physics understanding, some of which is inaccurate. It describes what happens to the beam. and knows that this is due to a change in speed but has the wrong change in speed. It does not discuss why this change in speed causes a change in direction. It has some structure and coherence.

This is level 1.

Marks awarded = 2

Separate Physics (Higher)

Example 1 – Question 8b

*(b) Sulfates and black soot are particles formed by industrial processes.

Some of these particles are found in the atmosphere over the Arctic Ocean.

The sulfates stay in the atmosphere and reflect (scatter) sunlight.

The black soot falls onto the Arctic ice.

Discuss how a reduction in these industrial processes is likely to affect the temperature of the atmosphere.

(6)

Mark scheme

Question number	Indicative content	Mark
*8(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 (6 marks)** • the soot could make the ice black • black ice will absorb more IR radiation than white ice • black ice might cause an increase in the temperature of the Earth because absorption of IR radiation (can) cause an increase in temperature • reduction in soot might reduce warming because the ice will not be as black/will be more white • shiny sulfates (are good at) reflecting/scattering IR radiation which means less heat absorbed • sulfates scatter the IR and this reduces the amount of IR radiation falling on the Earth • sulfates might cause a decrease in the temperature of the Earth • reduction in sulfates might increase warming	**(6)**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The discussion attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The discussion is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The discussion is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Student answers

*(b) Sulfates and black soot are particles formed by industrial processes.

Some of these particles are found in the atmosphere over the Arctic Ocean.

The sulfates stay in the atmosphere and reflect (scatter) sunlight.

The black soot falls onto the Arctic ice.

Discuss how a reduction in these industrial processes is likely to affect the temperature of the atmosphere.

(6)

With less Sulfates in the atmosphere, the sunlight will not be scattered but focussed its heat directly onto earth. This increases the intensity of the sunlight and the heat therefore the atmosphere temperature will increase. Black soot on the ice makes the surface absorb the Sun better than the white ice, however it also radiates a lot of heat back into the atmosphere. Less black soot means the white ice will reflect more sunlight back into the atmosphere, increasing its temperature

Examiner's comments

The discussion is well supported throughout by linkage and application of knowledge and understanding about how the nature of a surface affects the amount of thermal energy radiated and absorbed in the context of this question. The lines of reasoning are mostly supported by the application of relevant evidence. What prevents this achieving full marks is the reasoning that sunlight reflected from the white ice will cause an increase in temperature.

This is level 3.

Marks awarded = 5

*(b) Sulfates and black soot are particles formed by industrial processes.

Some of these particles are found in the atmosphere over the Arctic Ocean.

The sulfates stay in the atmosphere and reflect (scatter) sunlight.

The black soot falls onto the Arctic ice.

Discuss how a reduction in these industrial processes is likely to affect the temperature of the atmosphere.

(6)

As the industrial process decrease decreases the temperature will also decrease. As the black soot is far more heat / light absorbant than the Arctic ice, so more thermal energy is absorbed heating up the atmosphere whereas if there was less black soot more the light would be reflected back to space from the sun and heat would be lost.

Sulphates acts as a green house gas as they contain the heat / light by scattering it so it can't exit the atmosphere into space, so thermal energy is contained, if the industrial process decreases, this would decrease, more light would escape, temp ↓.

Examiner's comments

The discussion is mostly supported throughout by linkage and application of knowledge and understanding about how the nature of a surface affects the amount of thermal energy radiated and absorbed in the context of this question. The lines of reasoning are mostly supported by the application of relevant evidence. The discussion about the effects of soot are good but he discussion about the effects of sulfates is not correct.

This is level 2.

Marks awarded = 4

*(b) Sulfates and black soot are particles formed by industrial processes.

Some of these particles are found in the atmosphere over the Arctic Ocean.

The sulfates stay in the atmosphere and reflect (scatter) sunlight.

The black soot falls onto the Arctic ice.

Discuss how a reduction in these industrial processes is likely to affect the temperature of the atmosphere.

(6)

The effect of the soot is very dangerous for the earth because for the earth to keep a constant and suitable temperature it needs to radiate the same amount of energy that is absorbed. If parts of the atmosphe are not covered in the soot then the earth will begin to warm due to the fact that more sunlight is reaching the earths surface. This is because the earth will be absorbing more light energy allowing the atmosphere to warm. This could be bad as it will result is faster global warming which could melt polar ice caps killing polar bears.

Examiner's comments

The discussion attempts to link and apply knowledge and understanding about how the nature of a surface affects the amount of thermal energy radiated and absorbed in the context of this question but the attempts are flawed. The lines of reasoning are unclear. It starts off well by stating that the Earth needs to radiate the same amount of energy it absorbs if it is to maintain a constant temperature but disintegrates after that.

This is level 1.

Marks awarded = 2

Example 2 – Question 9d

*(d) Figure 26 shows the submarine stationary and submerged at a depth of 10 m.

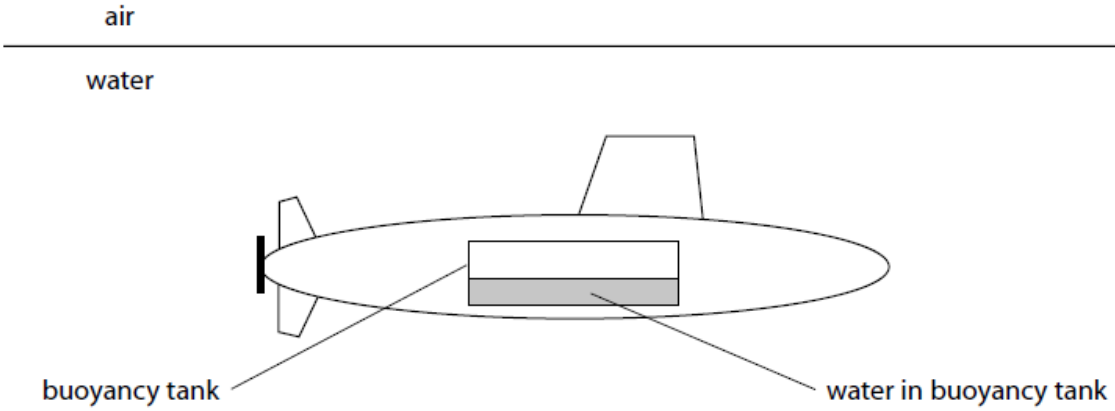


Figure 26

Explain how pumping water into and out of the buoyancy tank affects the depth of the submarine below the surface.

(6)

Mark scheme

Question number	Indicative content	Mark
*9(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks)** • upthrust is the force on the submarine in the water (submerged) in a fluid • upthrust on the submarine and its weight act in opposite directions • upthrust is equal to the weight of water displaced by the submarine • the difference in pressures on the upper and lower surfaces of the submarine causes the upthrust **AO2 (3 marks)** • the volume of the submarine is fixed so the upthrust on the submarine is constant • increasing/decreasing volume of water in tanks increases/ decreases weight of submarine but does not affect upthrust • if weight increases to become greater than upthrust there is a resultant downward force on the submarine so the submarine sinks • if weight decreases to become less than upthrust there is a resultant upward force on the submarine so the submarine rises	**(6)**

Extended open response

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of

Student answers

*(d) Figure 26 shows the submarine stationary and submerged at a depth of 10 m.

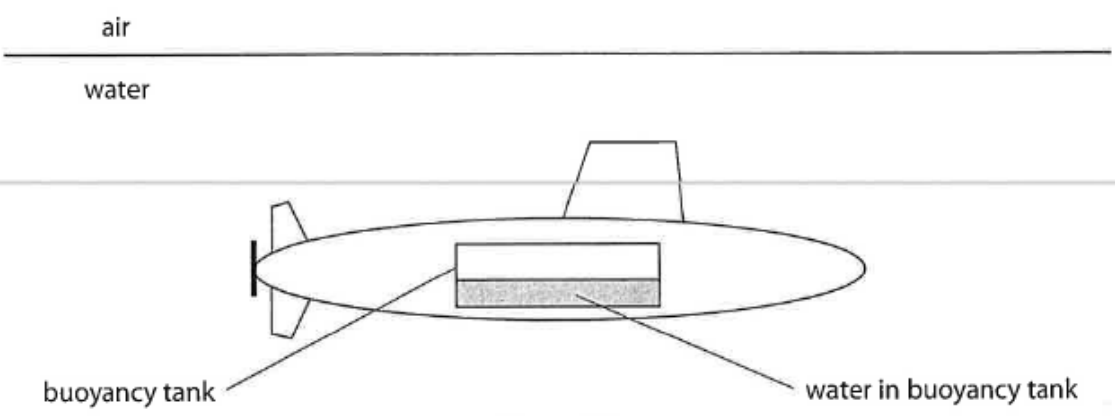


Figure 26

Explain how pumping water into and out of the buoyancy tank affects the depth of the submarine below the surface.

(6)

Pumping water into the buoyancy tank increases the pressure of the gas inside it, as there is less volume for them to take up. As pressure = force ÷ area, and the area on which the force is exerted remains the same, an increased pressure means an increased force. This means the submarine has a higher weight and so may sink deeper until the pressure acting on it is equal to the pressure inside the tank. Pumping water out of the tank reverses the process, causing the submarine to rise in the water, becoming stationary once again at a decreased depth.

Examiner's comments

This student knows that pumping water into the submarine increase the weight and causes it to sink. The explanation given as to why the weight increases is flawed and no mention is made of the part upthrust plays in this situation.

This is level 1.

Mark scheme = 2

*(d) Figure 26 shows the submarine stationary and submerged at a depth of 10 m.

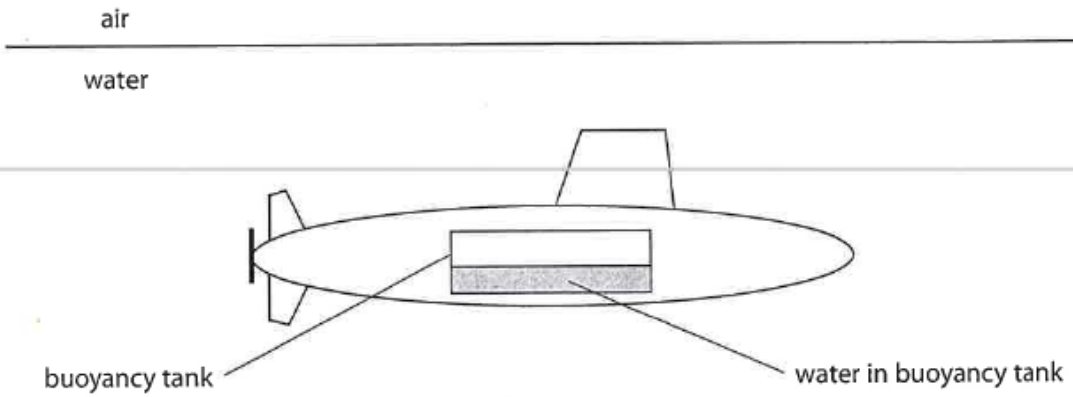


Figure 26

Explain how pumping water into and out of the buoyancy tank affects the depth of the submarine below the surface.

(6)

Pumping water in to the buoyancy tank increases the depth of the submarine. This is because water is denser than air, so more water in the buoyancy tank should have a greater mass than just air, and so the weight of the should be increased, so that the force of the submarine's weight acting downwards is greater than the upthrust acting upwards, causing the submarine to go deeper and accelerate downwards in the water.

Pumping water out of the buoyancy tank decreases the depth of the submarine. This is because air is less dense than water, so having less water in the buoyancy tank should have a less greater mass than just air, and so the weight of the submarine should decrease, so that the force of the submarine's weight acting downwards is less than the upthrust acting upwards, causing the submarine to go upwards and to rise and accelerate

Examiner's comments

This student knows that pumping water into the submarine increase the weight and causes it to sink. The explanation given as to why the weight increases and why this causes the submarine to sink is an accurate application of physics knowledge and understanding to this situation. What is missing here is an explanation of what upthrust is and why it remains constant in this situation.

This is level 2.

Marks awarded = 4

Other examples

Combined Science (Higher)

Example 1 – Question 5c: Application of knowledge and understanding

(c) The car starts on another journey.

Figure 6 shows the graph of the car's movement.

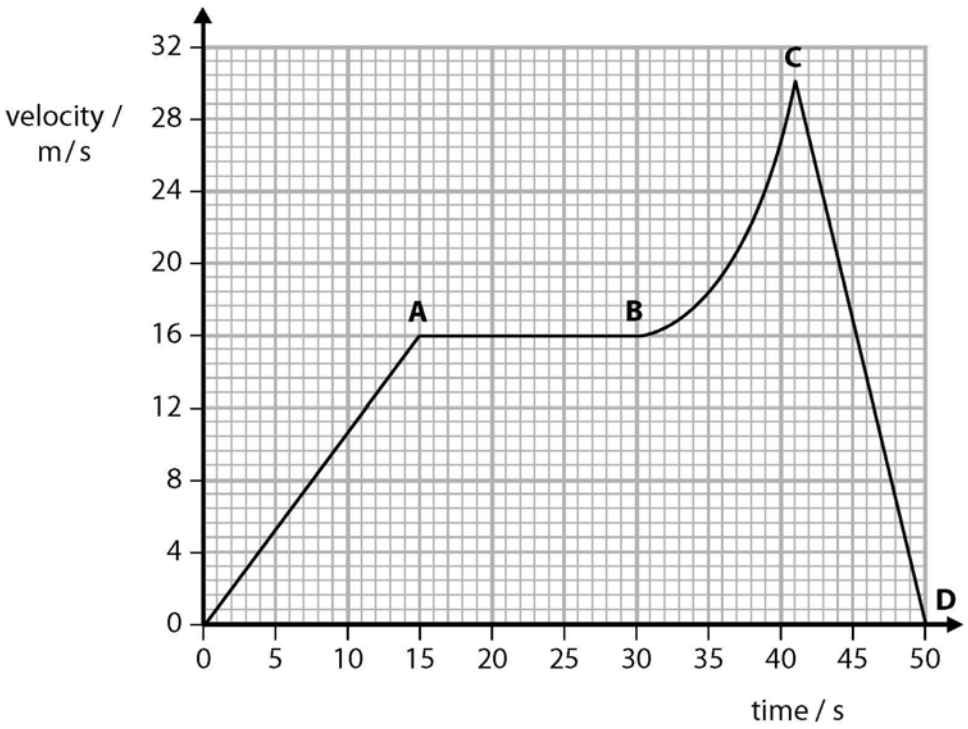


Figure 6

Show that the distance travelled when the car is moving at a constant speed is greater than the distance travelled when the car is slowing down.

(4)

Mark scheme

Question number	Answer	Mark
5(c)	Correctly identifies data points from the graph to calculate areas (1) Calculates area under AB (1) 240 m Calculates area under CD (1) 135 m distance travelled at constant speed = 240 m is greater than distance travelled when slowing down = 135 m (1)	**(4)**

Student answers

(c) The car starts on another journey.

Figure 6 shows the graph of the car's movement.

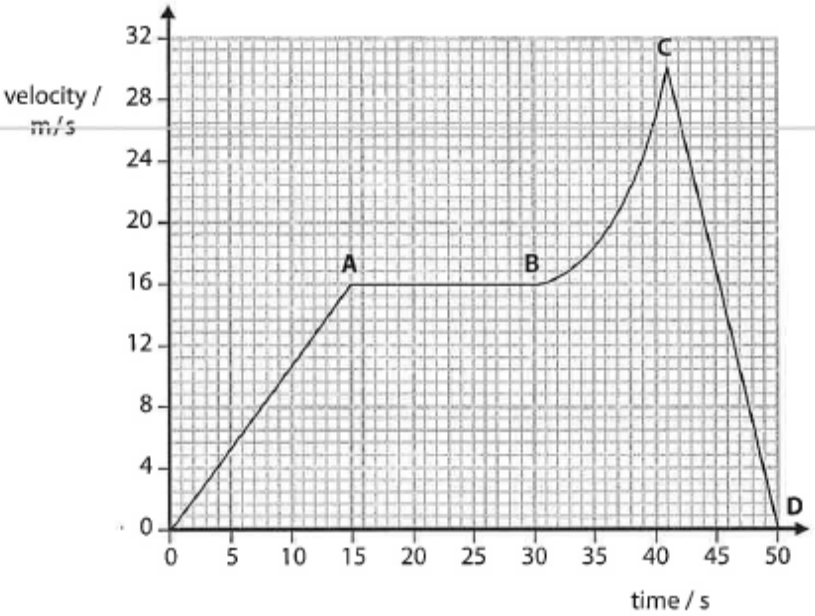


Figure 6

Show that the distance travelled when the car is moving at a constant speed is greater than the distance travelled when the car is slowing down.

(4)

Distance = area under graph

constant speed = 15 x 16 = 240m

slowing down = ½ x 9 x 30

= 135m

240m > 135m ∴ distance travelled at constant speed is greats.

Examiner's comments

The required points are well made in this answer which gains full marks.

Marks awarded = 4

Separate Physics (Higher)

Example 1 – Question 3: Application of knowledge and understanding

3 (a) Figure 2 shows some lines in the absorption spectra from four different galaxies (A, B, C, and D) and from a laboratory source.

All the spectra are aligned and to the same scale.

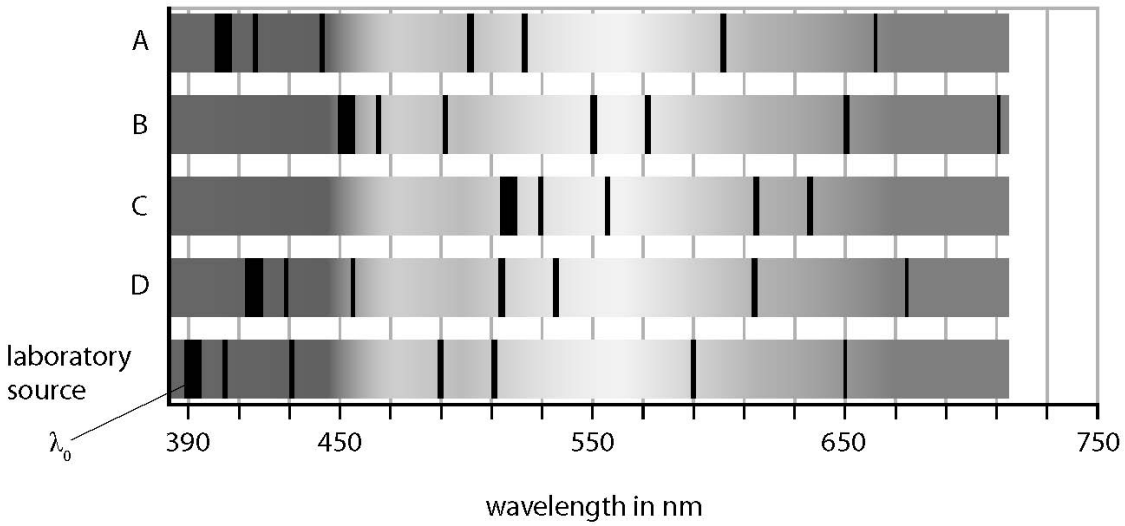


Figure 2

(i) Explain, using Figure 2, which galaxy is furthest away from us.

(3)

(ii) In Figure 2, the reference wavelength, λ_0, is shown at 390 nm.

Estimate the change in the reference wavelength, $\Delta\lambda$, for the light from galaxy D.

(1)

(iii) Calculate the speed, v, of galaxy D.

Use the equation

$$v = c\frac{\Delta\lambda}{\lambda_0}$$

[c = speed of light = 3×10^8 m/s]

(2)

(b) Figure 3 shows a photograph of galaxy D.

This photograph was taken by a student at his home.

(Source: Paul Curtis)

Figure 3

State **two** ways that the student can improve the observational techniques so that the quality of the image is improved.

(2)

Mark scheme

Question number	Answer	Mark
3(a)(i)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • galaxy C has the greatest red shift (1) • so this galaxy has the greatest speed (1) • since the galaxy with the greatest speed will be furthest away, then galaxy C is at the furthest distance(1)	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)(ii)	20 (nm)	Allow answers in the range 19 to 25	**(1)**

Question number	Answer	Additional guidance	Mark
3(a)(iii)	Substitution (1) $v = \frac{(3\times10^{8})\times(20\times10^{-9})}{(390\times10^{-9})}$ Answer (1) = 15 400 000 (m/s)	allow ecf from (c)(i) power of 10 error = max 1 accept 15 384 615 (m/s) award full marks for correct numerical answer without working	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)	Any **two** from the following improvements: • use wider aperture telescope/camera (1) • better quality objective lens (1) • use longer exposure time while telescope is locked onto star (1) • move telescope to better seeing conditions, e.g. dry desert, higher up a mountain, dark skies (1)	allow improvements from photography, e.g. use longer exposure time use a satellite telescope ignore use pc to adjust the sharpness of the image	**(2)**

Student answers

3 (a) Figure 2 shows some lines in the absorption spectra from four different galaxies (A, B, C, and D) and from a laboratory source.

All the spectra are aligned and to the same scale.

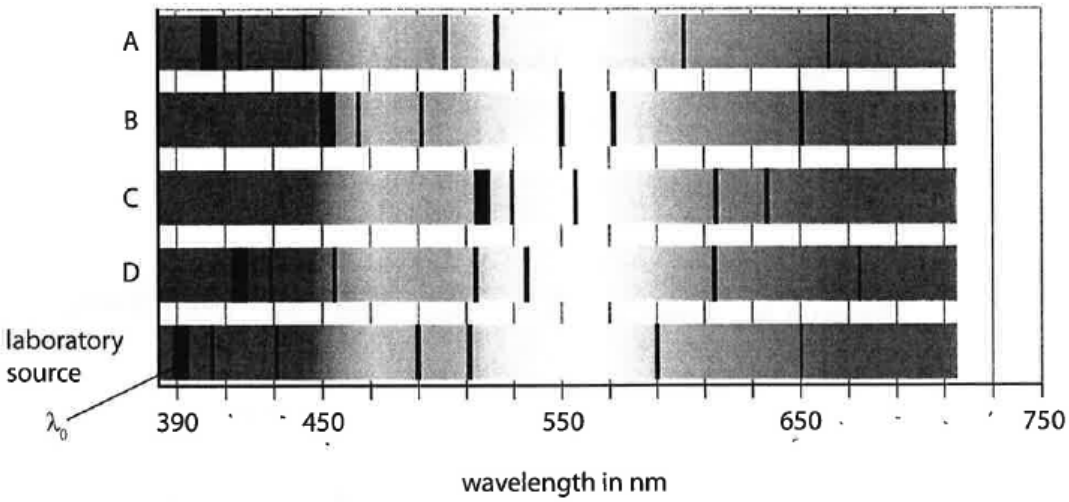


Figure 2

(i) Explain, using Figure 2, which galaxy is furthest away from us.

(3)

Galaxy C is the Furthest away from us because it shows the most red shift, the gaps in the spectrums are shifted the furthest to the red end. Galaxies which show the most red shift move faster in a different direction meaning that they are further away.

Examiner's comments

This answer is a more unusual one which does not give the points in the order given in the mark scheme. Nevertheless, the points are all there so full marks are awarded.
Marks awarded = 3

(ii) In Figure 2, the reference wavelength, λ_0, is shown at 390 nm.

Estimate the change in the reference wavelength, $\Delta\lambda$, for the light from galaxy D.

(1)

$\Delta\lambda =$ 60 nm

(iii) Calculate the speed, *v*, of galaxy D.

Use the equation

$$v = c\frac{\Delta\lambda}{\lambda_0}$$

[c = speed of light = 3×10^8 m/s]

(2)

$v = 3 \times 10^8 \left(\frac{60}{390}\right)$

$v = 46153846$

$v =$ 46153846 m/s

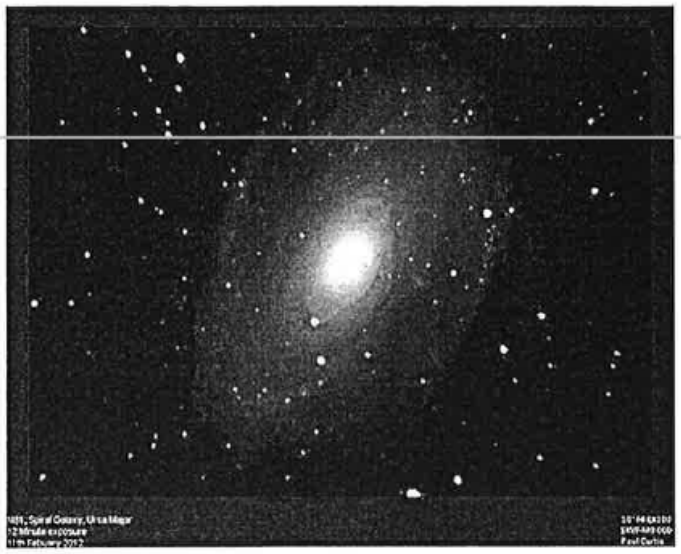
Examiner's comments

The answer given in part (ii) is incorrect but an error carried forward is allowed giving full marks in part (iii)

Marks awarded = 2

(b) Figure 3 shows a photograph of galaxy D.

This photograph was taken by a student at his home.



(Source: Paul Curtis)

Figure 3

State **two** ways that the student can improve the observational techniques so that the quality of the image is improved.

(2)

1 Use a telescope with a larger mirror

2 Go to the altitude where there is less cloud between you and the galaxies.

Examiner's comments

Answer (1) is equivalent to the first marking point 'use wider aperture' and answer (2) is equivalent to the fourth marking point of 'better seeing conditions so two marks are awarded.

Marks awarded = 2

Example 2 – Question 4c: Application of knowledge and understanding

(c) Figure 9 shows an electrostatic method for spray-painting a car door.

The car door has a negative charge.

The droplets of paint receive a positive charge as they leave the spray gun.

(Source: © Jens Brüggemann/123RF)

Figure 9

Explain how charging the door helps the paint to form an even coating on both sides of the door.

You should use ideas of forces and fields in your answer.

(2)

Mark scheme

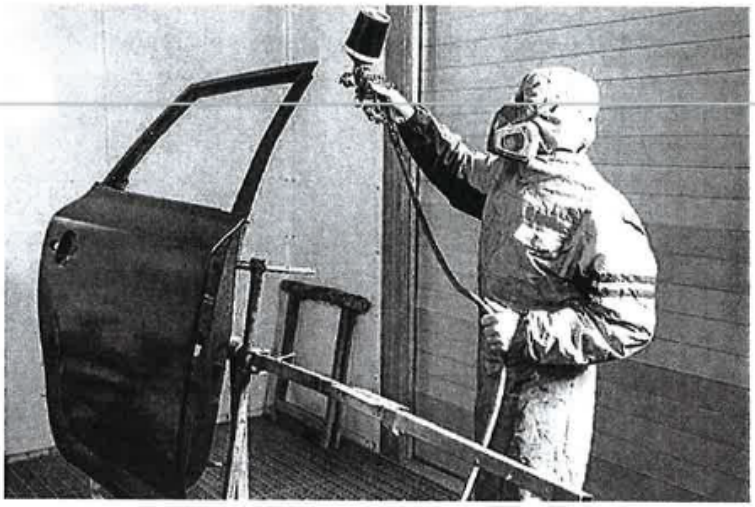
Question number	Answer	Mark
4(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • (negatively charged) door attracts (positively charged) paint (droplets) (1) Plus any **one** of the following: • therefore (positively charged) paint (droplets) follow lines of force and coat both sides of the car door (1) • since electric field (or lines of force) directed towards the (car) door, then positive paint will move to the door (1) • as electric field (or lines of force) touches all parts of the (car) door hence the positive paint will coat all parts of the door (1)	**(2)**

Student answers

(c) Figure 9 shows an electrostatic method for spray-painting a car door.

The car door has a negative charge.

The droplets of paint receive a positive charge as they leave the spray gun.



(Source: © Jens Brüggemann/123RF)

Figure 9

Explain how charging the door helps the paint to form an even coating on both sides of the door.

You should use ideas of forces and fields in your answer.

(2)

The droplets of paint are positive and so are attracted to the negatie charged door. As it is attracted it will repel other droplets away from each other and therefore create and even coating being spread out.

Examiner's comments

This answer clearly gains the first marking point in the scheme for applying knowledge of forces between opposite charges. Although fields are not mentioned in the second sentence it is a good explanation using forces of repulsion for the second mark.

Marks awarded = 2

Explain how charging the door helps the paint to form an even coating on both sides of the door.

You should use ideas of forces and fields in your answer.

(2)

The opposite charges attract causing the paint to evenly coat the door and so aspect as the door will be left uncoated as the paint will be attracted to the negatively charged unpainted areas of the car,

(Total for Question 4 = 8 marks)

Examiner's comments

Contrast this answer with the last one (above) to see that the answers can gain full marks in different ways.

Marks awarded = 2

Example 3 – Question 2b: Application of knowledge and understanding (new content)

(b) Figure 3 shows three containers A, B, and C.

Each container contains a liquid, as shown.

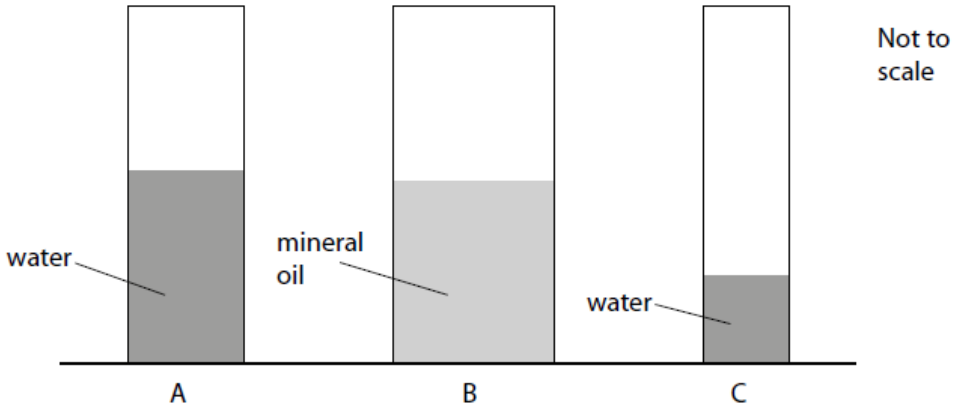


Figure 3

Figure 4 gives some data about the liquids and containers.

container	area of base (cm^2)	name of liquid	density of liquid (g/cm^3)	depth of liquid in container (cm)
A	16	water	1.00	50.00
B	32	mineral oil	0.91	50.00
C	12	water	1.00	25.00

Figure 4

Mark scheme

Question number	Answer	Additional guidance	Mark
2(b)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • pressure in A is the highest and pressure in C is the lowest (pressure in B is between them) (1) • pressure depends on depth of liquid (so) can compare A and C because same liquid (hence) pressure in A is twice that of C (1) • pressure depends on density of liquid (so) can compare A and B since same depth hence pressure in A greater than pressure in B (1)	allow a mathematical approach, i.e. calculating all three pressures from the relevant data	(3)

Student answers

Explain which container has the highest pressure at the bottom, and which container has the lowest.

Use information from Figure 3 and Figure 4.

(3)

vol = area x depth. Vol (A) = 800 cm^3, (B) = 1600cm^3, (C) = 300cm^3

mass = density x vol. Mass (A) = 800g, (B) = 1456g, (C) = 300g

weight = mg (when g = 10). Weight (A) = 8000N, (B) = 14560N, (C) = 3000N

pressure = force ÷ area. Pressure (A) = 500 Pa, (B) = 455Pa, (C) = 250 Pa

Container A has the highest pressure at the bottom

Container C has the lowest

Examiner's comments

This answer gains full marks. It is not the same as the answer in the mark scheme but is a perfectly valid mathematical way of reaching a correct conclusion. The additions to the table, together with the working and explanation given, lead to very clear and thorough answer.

Marks awarded = 3

Explain which container has the highest pressure at the bottom, and which container has the lowest.

Use information from Figure 3 and Figure 4.

(3)

A = $D = \frac{M}{V}$ = $m = DV$ = 1·00 x 50 x 16 = 800 $P = \frac{F}{A}$ = 8000N / 10 = 800 Pa

B = m = 32 x 0·91 x 50 = 1456g

$P = F/A$ = 1456N / 32 = 455 Pa

C = M = 12 x 1 x 25 = 300

$P = F/A$ = 3000N / 12 = 250 Pa

A most C least

(Total for Question 2 = 9 marks)

Examiner's comments

This answer shows an alternative mathematical approach set out in clear steps and also gaining full marks

Marks awarded = 3

Explain which container has the highest pressure at the bottom, and which container has the lowest.

Use information from Figure 3 and Figure 4.

(3)

Container A has the greatest pressure as the pressure is 3.125 (50÷16=3.125). Container C however has the lowest pressure ÷ 25÷16 = 1.5625

Examiner's comments

Unfortunately, this answer only gives the pressure in two of the three containers and therefore prevents a valid conclusion being drawn. Only one mark can be awarded.

Marks awarded = 1