

PHYSICS



EXAM QUESTION PACK

M2 HANDLING DATA

SCORE

/119

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Maths 2: Handling data

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname								
Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

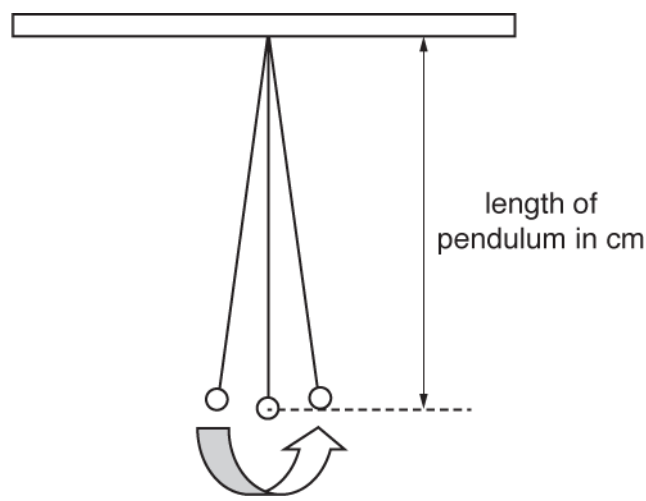
- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **119**.
- The total number of marks may take into account some 'either/or' question choices.

1(a) Helen investigates children’s swings.

She models the swings in the laboratory using weights attached to a string.

This type of swing is called a **pendulum**.

She sets up a pendulum and makes it swing.



Helen uses a pendulum that has a length of 60 cm.

She measures the time it takes the pendulum to complete 10 swings.

She repeats this three times, **A**, **B** and **C**.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
60	16.35		15.65	16.00

The results table is incomplete.

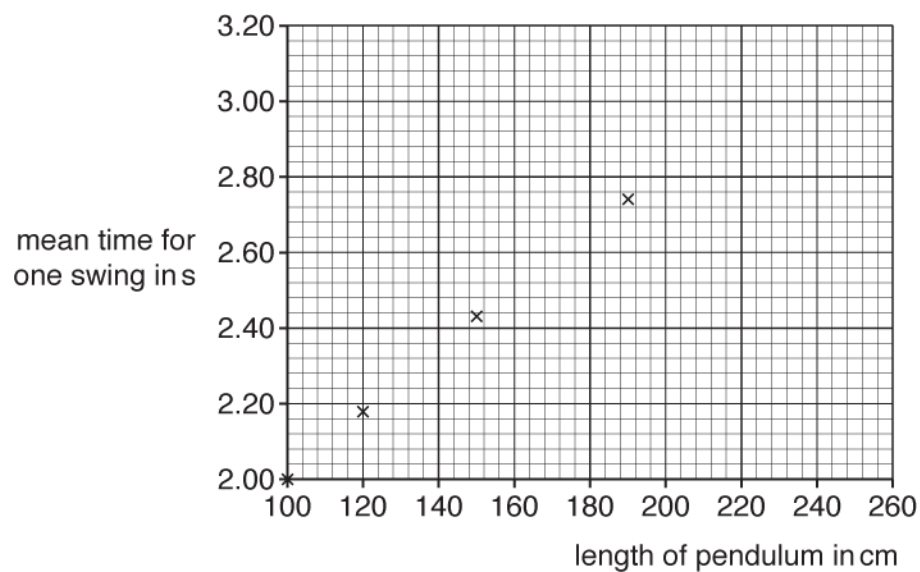
Use the data to calculate the missing value **B**.

answer _____ s [2]

(b) Helen wants to find out about real swings, like those used by children.

She uses longer pendulums and investigates the effect of changing the length.

Look at the graph of Helen's results.



Helen wants to make a pendulum that takes 3 s for one complete swing.

Predict the length of this pendulum.

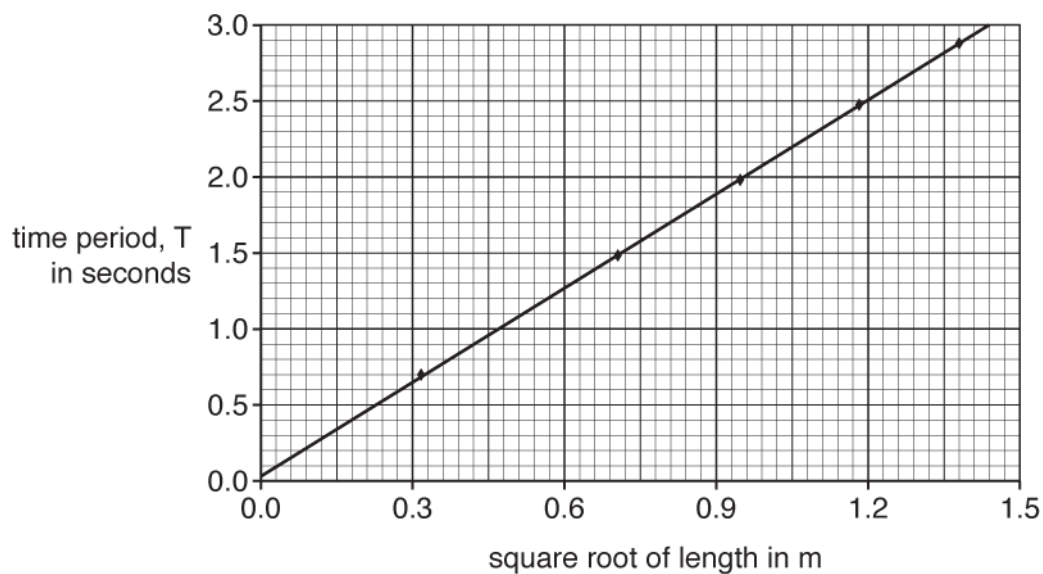
Show your working on the graph.

answer _____ cm [2]

(c) Helen collects more results using a pendulum.

She processes her results.

Look at her graph.



(i) Describe the relationship shown in the graph.

----- [1]

(ii) Helen does some research.

She finds out this information:

- the time it takes for one complete swing is called the time period, T .
- $g = 10 \text{ m/s}^2$ (the acceleration due to gravity)
- L = the length of the pendulum
- $\pi = 3.142$

Helen finds an equation which describes the behaviour of pendulums.

$$T = 2\pi \sqrt{\frac{L}{g}}$$

She wants to find the time period, T for a longer swing.

Calculate the time period for a swing that is 3 m long.

Give your answer to one decimal place.

answer _____ s. [3]

(iii) Helen needs to make a swing with a time period, T , of 1 second.

Calculate the length of a pendulum with a time period of 1 second.

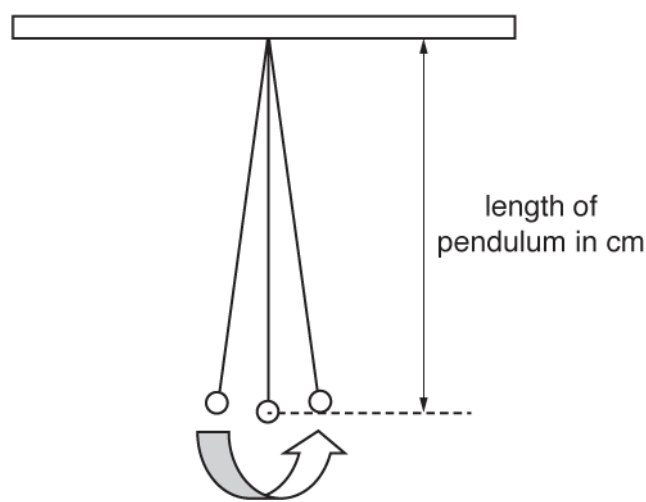
answer _____ m. [2]

2(a) Helen investigates children’s swings.

She models the swings in the laboratory using weights attached to string.

This type of swing is called a **pendulum**.

She sets up a pendulum and makes it swing.



Helen uses a pendulum that has a length of 50 cm.

She measures the time it takes the pendulum to complete 10 swings.

She repeats this three times, **A**, **B** and **C**.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
50	14.62	14.78	14.40	

Calculate the mean (average) time for 10 swings.

answer ----- s [1]

(b) Helen changes the length of the pendulum to 60 cm.

She takes three more measurements and calculates the mean.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
60	16.35		15.65	16.00

The results table is incomplete.

Use the data to calculate the missing value **B**.

answer ----- s [2]

(c) Helen changes the length of the pendulum to 70 cm.

She takes more measurements and calculates the mean.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s				Mean (average) time for one swing in s
	A	B	C	Mean (average)	
70	17.55	17.65	17.32	17.50666	

Use the data to calculate the mean time for one swing.

Give your answer to 2 decimal places.

answer ----- s [2]

(d) Helen wants to find out about real swings, like those used by children.

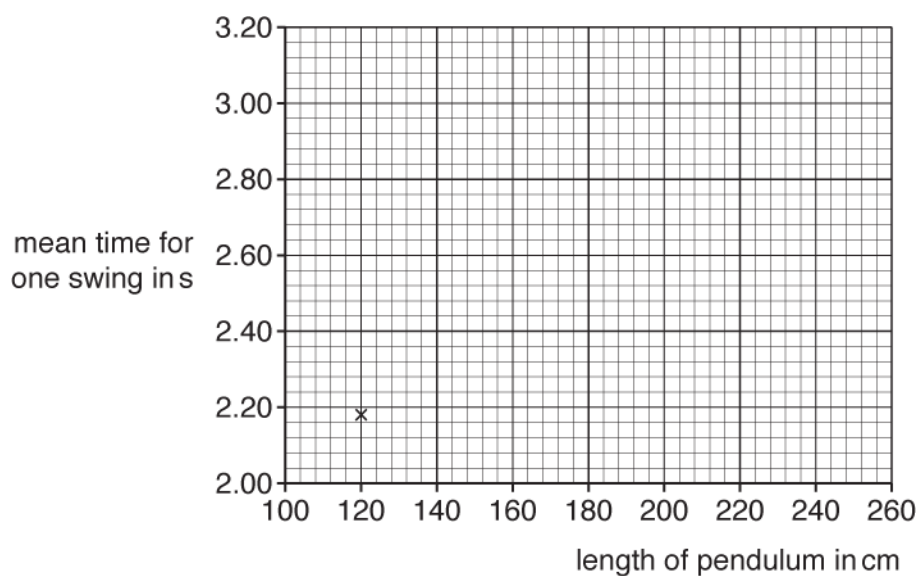
She uses longer pendulums and investigates the effect of changing the length.

Look at the summary of her results.

Length of pendulum in cm	Mean (average) time for one swing in s
100	2.00
120	2.18
150	2.43
190	2.74

- (i) Plot Helen's results onto the graph. One has been plotted for you.

Draw a line of best fit.



[2]

- (ii) Describe the pattern shown by the graph.

[1]

- (iii) Helen wants to make a pendulum that takes 3 s for one complete swing.

Predict the length of this pendulum.

Show your working on the graph.

answer ----- cm [2]

3 A charge of 44 000 C flows through a light bulb. The potential difference is 230 V.

Calculate the energy transferred.

Use the equation: Charge = Energy ÷ Potential difference

Record your answer to 2 significant figures.

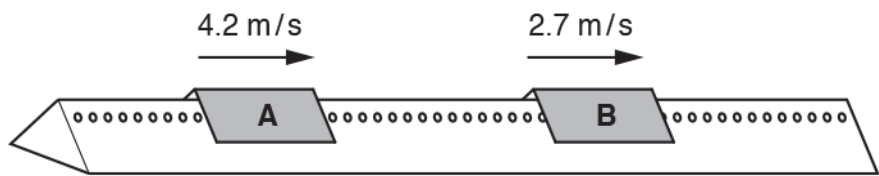
Answer = ... J [4]

4(a) A student investigates collisions of trolleys on a horizontal airtrack.

Write down the **two** quantities involved with motion which are conserved during an elastic collision.

----- [2]

(b) Trolley A has a mass of 2 kg. Trolley B has a mass of 2.5 kg.



(i) Calculate the **momentum** of each trolley.

Trolley A = ... kg m/s
Trolley B = ... kg m/s
[3]

(ii) The two trolleys collide and stick together after the collision. Use your answers to (i) to calculate the **speed** of the combined trolleys after the collision.

Record your answer to 2 significant figures.

Answer = ... m/s [3]

- 5 A student measures the time it takes for a bicycle to stop in an emergency.

She repeats the measurement to get three results.

The average time for her results is 2.72 s.

The first two results are 2.66 s and 2.60 s.

What is the value of her third result?

A 2.63 s

B 2.66 s

C 2.72 s

D 2.90 s

Your answer

[1]

- 6 A scientist uses different drivers to test the stopping distances of the same car.

Look at the results.

Driver	Speed (m/s)	Thinking distance (m)	Braking distance (m)
A	8	6	6
B	16	13	24
C	32	24	96
D	16	12	22
E	8	5	6
F	32	30	120

Driver C travels at 32 m/s on the road and then stops. The car has a mass of 1200 kg.

- (i) Show that the **kinetic energy** stored by the car at 32 m/s is 614 000 J.

[3]

(ii) Describe what happens to the kinetic energy of the car as it brakes and stops.

----- [2]

(iii) The braking distance of the car is 96 m.

Calculate the **braking force** on the car.

Give your answer to 4 significant figures.

Answer = ----- N [3]

- 7 A student experiments with a model parachute and collects some results.

She drops the parachute from a height of 4 m three times and takes three results of the time taken.

The three results are:

3.25 s

3.00 s

3.08 s

What is the mean of the three results?

A 3.00 s

B 3.08 s

C 3.11 s

D 3.25 s

Your answer

[1]

- 8 A student wants to find out which heater produces the largest temperature rise.

Look at the results she collects and the calculations she makes.

Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)
A	18	28	20
B	18	36	16
C	18	44	26
D	18	51	23

Which heater has results that are correctly calculated?

Your answer

[1]

- 9 Fig. 20.1 shows thinking, braking and stopping distances for the same car travelling at different speeds.

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

Calculate the reaction time of the person driving the car.

Answer = _____ s [3]

10

A car has a total weight of 12 000 N. It has four tyres which each have an area of 25 cm² in contact with the road.

Calculate the pressure of the car on the road.

Answer = _____ N/cm²

[3]

11(a) This question is about force, mass and acceleration.

A car starts from rest and accelerates at 3 m/s^2 .

Use the equation: $\text{Acceleration} = \text{Change in velocity} \div \text{Time taken}$

Calculate the **velocity** of the car after 4 s.

Answer = ----- m/s [2]

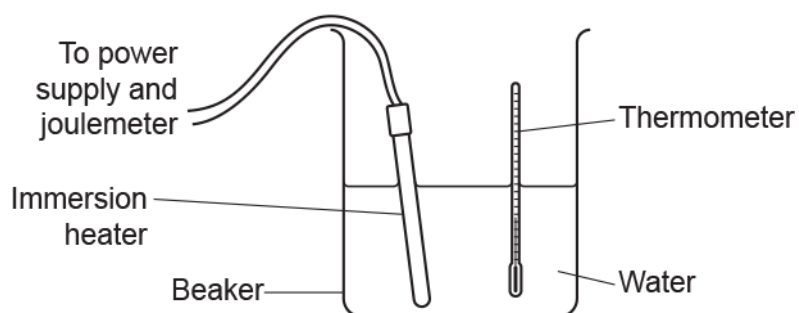
(b) A roller coaster car moves down a slope with an acceleration of 5 m/s^2 .

The force on the roller coaster car is 4000 N.

Calculate the **mass** of the roller coaster car.

Answer = ----- kg [2]

12(a) A student completes an experiment to find the specific heat capacity of water.



He heats up 1 kg of water, using an immersion heater. He measures the temperature rise and calculates the specific heat capacity of the water.

Attempt	Energy supplied (J)	Temperature rise (°C)	Specific heat capacity (J/kg °C)
1	10 000	2	5000
2	21 000	4	5250
3	44 000	8	5500

(i) Calculate the **mean** specific heat capacity.

Answer = ... J/kg °C [1]

(ii) Describe the conclusions that can be drawn from the data.

----- [3]

(b) The actual value for the specific heat capacity of water is 4200 J/kg °C.

(i) Explain why the mean specific heat capacity calculated in (a)(i) is higher than the actual value.

----- [2]

(ii) Write down **two** problems with this experiment **and** suggest how they could be solved.

Use the diagram and results table to help you.

Problem 1 -----

Solution -----

Problem 2 -----

Solution -----

[4]

13(a) A TV has the label below on it.

OCR TV
Voltage: 230 V
Power: 65 W
Frequency: 50 Hz

Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference $\times$ current

Give your answer to 2 significant figures.

Current = ... A [4]

(b) The TV is turned on for 30 minutes.

Calculate the energy transferred by the TV.

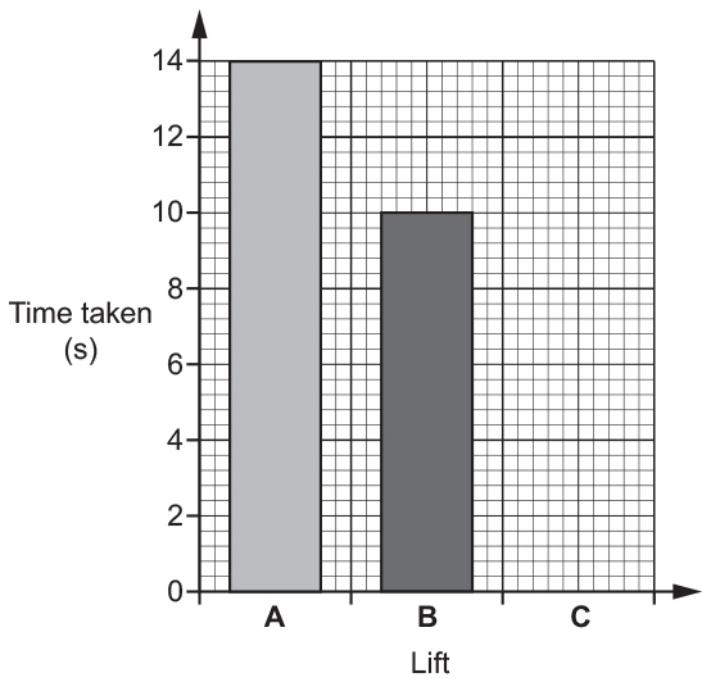
Energy used = ... J [4]

14(a) A tall building needs a lift to move people from one floor to another.

The builder has a choice of three different lifts.

Each lift takes a different amount of time to move between the two floors.

Look at a bar chart of the time taken for each lift.



(i) Lift C takes 12 s to move between the two floors.

Draw a bar for lift C on the bar chart.

[1]

(ii) Calculate the mean time of the three lift journeys.

Mean = ... s [2]

(iii) Explain which lift uses the most power.

----- [2]

(b)

(i) One lift uses 50 000 J for a 12 s journey.

Calculate the power of the lift.

Give your answer to 1 decimal place.

Power = ... W [4]

(ii) When the lift is broken the stairs are used.

Calculate the work done when a 750 N person climbs a distance of 4 m.

Work done = ... J [3]

15(a) A TV has the label below on it.

OCR TV
Voltage: 230 V
Power: 65 W
Frequency: 50 Hz

Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference $\times$ current

Give your answer to 2 significant figures.

Current = ... A [4]

(b) The TV is turned on for 30 minutes.

Calculate the energy transferred by the TV.

Energy used = ... J [4]

16 Ripples are made on the surface of the water. The ripples can be used to model waves.

Student A and student B drop stones into a pond.

(i) Student A measures the frequency and wavelength of the water ripples. Table 17.1 shows his results:

Frequency (Hz) of ripples	0.6
Wavelength (m) of ripples	0.1

Table 17.1

Calculate the wave speed of the ripples.

Use the equation: wave speed = frequency $\times$ wavelength

Wave speed = ...m / s [2]

(ii) Student B measures the same ripples as student A.

She measures:

- The distance one ripple travels.
- The time it takes the ripple to travel this distance.

Table 17.2 shows student B's results:

Distance ripple travels (m)	2.40
Time taken (s)	30.0

Table 17.2

Name the equipment student **B** uses to measure the distance and time.

Distance

Time

[2]

(iii) Use results in **Table 17.2** to calculate the wave speed of the ripples.

Wave speed = ...m / s [1]

(iv) Student **A** and student **B** obtained different answers for the wave speed of the ripples.

Suggest why.

.....
.....
..... [1]

17 A student sets up the circuit in Fig. 17.1 to investigate the resistance of a lamp.

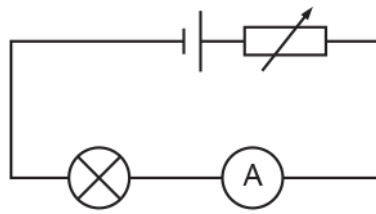


Fig. 17.1

The student plots the results from Table 17.1 on the graph in Fig. 17.2.

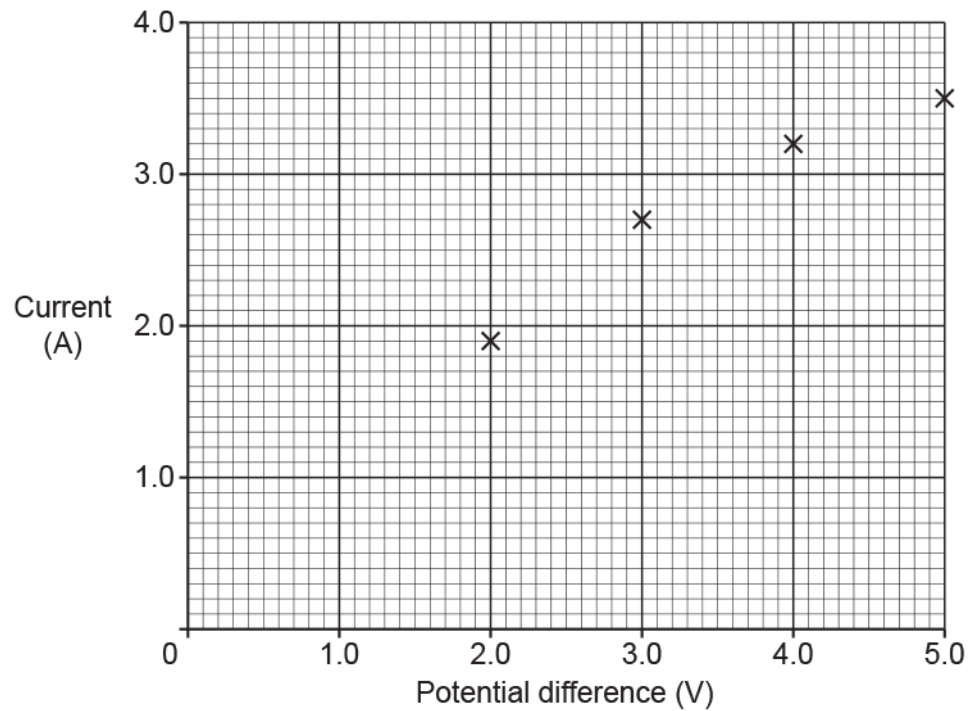


Fig. 17.2

(i) Plot the missing point at 1.0 V on the graph **and** draw a line of best fit.

[2]

(ii) Describe the relationship between potential difference and current.

Use data from the graph to support your answer.

[2]

(iii) Explain how you could use the circuit in Fig. 17.1 to investigate the resistance of a fixed resistor instead of a lamp.

[2]

(iv) Explain how and why the graph in Fig. 17.2 would look different for a fixed resistor at a constant temperature.

[2]

18 A student investigates how a spring stretches.

She measures the original length of the spring, adds a 2.0 N weight, and then measures the extended length of the spring.

Look at her data in the table.

Force used	2.0 N
Original length	3.0 cm
Extended length	7.0 cm
Extension	4.0 cm

(i) Calculate the spring constant for the spring.

Use the equation: force = spring constant $\times$ extension

Spring constant = ... N / cm [3]

(ii) Suggest **two** ways that the student could improve and develop their method to find the spring constant.

----- [2]

19(a) A student drops a paper ball from a balcony 4.00 m high. Her friend measures the time taken for the paper ball to reach the ground.

Suggest the equipment used to measure the height of the balcony and the time taken for the paper ball to reach the ground.

Height -----

Time taken -----

[1]

(b) They record their results in a table.

Attempt	1	2	3	4	5
Time taken (s)	1.84	2.08	2.02	2.08	1.98

(i) Use the data in the table to calculate the mean, median and mode of their results.

Mean = ...

Median = ...

Mode = ...

[3]

(ii) The results are not very precise. Explain how you can tell from the data in the table.

----- [1]

(iii) Suggest a possible source of error in the experimental method and how it could be improved.

Source of error -----

Improvement -----

----- [1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		16 / 16.0 / 16.00 (2) If answer incomplete or incorrect then 48 – 15.65 – 16.35 or 48 – 32 scores (1)	2	
	b		220 (cm) (2) If answer is incorrect or incomplete then: Evidence on graph showing a line or curve scores (1)	2	Allow 216 → 224 (2) BUT for a reasonable curve extrapolated allow 216 → 230 (2)
	c	i	Time-period is (directly) proportional to the square root of length / AW (1)	1	Eg. x and y are proportional (1) Eg. 'As square root of length increases in equal steps, the time period increases in equal steps' (1) Allow linear relationship through the origin (1) Allow examples showing this relationship using numbers Ignore merely 'positive correlation'
		ii	3.4 (3) But if answer is incorrect or incomplete then: $6.284 \sqrt{\frac{3}{10}}$ or $2 \times 3.142 \times 0.5477$ scores (2) $2 \times 3.142 \sqrt{\frac{3}{10}}$ scores (1)	3	Allow decimal place error: Eg. 3.441 (2) Allow 34.4 (2) (for candidate who has used 300 cm instead of 3 m) Look for correct substitution AND some correct processing Eg. (π or) $22/7$ for 3.142 Look for the correct substitutions Eg. $2 \times \pi \sqrt{\frac{3}{10}}$ scores (1)

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	0.3 or 0.25 or 0.253..... etc. (2) But if answer is incorrect or incomplete then evidence of correct substitution (in symbols or numbers) scores (1)	2	Eg. $1 = 2 \times 3.14 \times \sqrt{\frac{L}{10}}$ Allow π or 22/7 for 3.142
			Total	10	
2	a		14.60/14.6 (1)	1	
	b		16 / 16.0 / 16.00 (2) If answer incomplete or incorrect then 48 – 15.65 – 16.35 or 48 – 32 scores (1)	2	
	c		1.75 (2) But if answer is incomplete or incorrect then: 1.750666 scores (1)	2	
	d	i	All 4 points plotted accurately (1) Straight line (by inspection) (1)	2	allow tolerance of $\pm \frac{1}{2}$ square
		ii	Increasing length increases time period / AW (1)	1	
		iii	220 (1) Evidence of working on graph scores (1)	2	allow 216 → 224 (1) allow ecf from previous parts allow value sources from table (rather than graph)
			Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
3			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 000 000 (J) award 4 marks Rearrange to energy = charge × potential difference ✓ 44 000 × 230 ✓ 10 120 000 ✓ 10 000 000 (2 sf) (J) ✓ OR Substitute correctly 44 000 (C) = energy ÷ 230 (V) ✓ Rearrange to energy = 44 000 (C) × 230 (V) ✓ = 10 120 000 (J) ✓ = 10 000 000 (2 sf) (J) ✓	4 (AO2.1) (AO2.1) (AO2.1) (AO1.2)	Fourth mark is for correct rounding If answer line has 10 120 000 (J) award 3 marks m.p.2 can include m.p.1 if equation not written m.p.2 can include m.p.1 as above <u>Examiner's Comments</u> There was an erratum with this question to correct the units to joules. The figures in this question were difficult, and many candidates coped well with the large numbers and also the rearrangement of the equation. Some candidates rearranged the equation before substitution and others after. Fewer candidates were able to round 10 120 000 J to two significant figures (e.g. 10 000 000 J).  OCR support Mathematical Skills Handbook http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4	a		momentum ✓ kinetic energy or KE ✓	2 (AO 2 × 1.1)	IGNORE mass conserved If more than two answers mark the first two answers (unless one of them is mass). Eg 'KE, mass, momentum' ✓✓ Eg. PE, KE, momentum ✓ <u>Examiner's Comments</u> Kinetic energy and momentum were the answers here. Full marks (in 10% of cases) were attained by more able candidates only. Just less than a half gained 1 mark only. 'Energy' or 'potential energy' (rather than kinetic energy) was often seen along with mass, velocity.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINES If answers = 8.4 (kgm/s) and 6.75 / 6.8 (kgm/s) award 3 marks 2 × 4.2 2.5 × 2.7 ✓ A: 8.4 (kgm/s) ✓ B: 6.75/6.8 (kgm/s) ✓	3 (AO 1.2) (AO 2.2) (AO 2.2)	8.4 and 6.7 scores ✓✓ (incorrect rounding of one of the values) <u>Examiner's Comments</u> The great majority calculated both values of momentum correctly and gained 3 marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.4 (m/s) award 3 marks $(8.4 + 6.75) \times 4.5 \checkmark$ $3.37 / 3.366666667 \text{ (m)} \checkmark$ 3.4 (rounding to 2 sf) $\checkmark$	3 (AO 2.2) (AO 2.2) (AO 1.2)	ECF for momentum values eg. $(A + B) \div 4.5$ Wrong answer but evidence of correct rounding $\checkmark$ Eg. 6.75 to 6.8 $\checkmark$ <u>Examiner's Comments</u> Just under a half of candidates calculated this correctly to two significant figures. About a third did gain any credit at all and gave attempts of calculations that were incorrect or difficult to follow.
			Total	8	
5			D $\checkmark$	1 (AO1.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6		i	AWARD ALL CANDIDATES 2 MARKS	2 (AO1 × 2.1) (AO1 × 1.2)	<u>Examiner's Comments</u> We have adjusted the mark scheme to allow for a typo within this question.
		ii	KE transferred to thermal energy / heat in brakes / surroundings / AW ✓✓ OR (KE of car) is reduced / transferred ✓ Brakes gain / absorb thermal energy / heat ✓	2 (AO1.1) (AO1.2)	ALLOW surroundings gain thermal energy / heat dissipated to surroundings IGNORE just brakes get hot <u>Examiner's Comments</u> The majority of candidates knew that the kinetic energy store would decrease or be transferred and so were credited with one mark. Fewer candidates gained the second mark as although they referred to heat or thermal energy they did not specify that the energy was transferred to the brakes or surroundings (i.e. into a thermal energy store).
		iii	AWARD ALL CANDIDATES 3 MARKS	3 (AO2 × 2.1) (AO1.2)	
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																				
7			C ✓	1 (AO 2.2)	Examiner's Comments Higher ability candidates added an extra column to the table to calculate the change in temperature. These candidates were also more likely to write down their workings, even for multiple choice questions. See exemplar 1 Exemplar 1 6 A student wants to find out which heater produces the largest temperature rise. Look at the results she collects and the calculations she makes. <table><tr><th>Heater</th><th>Starting temperature (°C)</th><th>Finishing temperature (°C)</th><th>Change in temperature (°C)</th></tr><tr><td>A</td><td>18</td><td>28</td><td>20</td></tr><tr><td>B</td><td>18</td><td>36</td><td>16</td></tr><tr><td>C</td><td>18</td><td>44</td><td>26</td></tr><tr><td>D</td><td>18</td><td>51</td><td>23</td></tr></table> Which heater has results that are correctly calculated? Your answer ☒ C	Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)	A	18	28	20	B	18	36	16	C	18	44	26	D	18	51	23
Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)																						
A	18	28	20																						
B	18	36	16																						
C	18	44	26																						
D	18	51	23																						
			Total	1																					
8			C ✓	1 (AO 2.2)	Examiner's Comments About two-thirds of the candidates got this question correct: the commonest wrong answer here was A, presumably looking at the symmetry in the bottom part of the diagram.																				
			Total	1																					

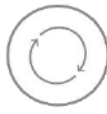
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.75 (s) award 3 marks Recall: (Reaction) time = (Thinking) distance ÷ Speed ✓ 6÷8 or 12÷16 or 24÷32 ✓ = 0.75 (s) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE correct substitutions if NOT rearranged Examiner's Comments 10% of candidates recalled the speed equation and rearrange it as <i>reaction time</i> = <i>thinking distance</i> ÷ <i>speed</i>. The majority of the candidates were unable to interpret the data from the table and very few realised that the reaction time depended on the thinking distance before calculating the answer.
			Total	3	
10			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (N/cm²) award 3 marks Recall: pressure = force ÷ area ✓ 12000 ÷ 100 OR 40000 ÷ 25 ✓ = 120 (N/cm²)	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 12000÷25 for one mark ALLOW for two marks 480 (N/cm²) Examiner's Comments Candidates are advised to start their response to this type of question by writing down the appropriate equation. They should then substitute the numbers from the stem of the question into the equation before they calculate the answer. Making sure to write down each stage of the process. A common error was candidates who had not allowed for the four tyres and gave a final answer of 480 N/cm².
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (m/s) award 2 marks Rearrange formula - 4×3 ✓ 12 (m/s) ✓	2 (AO 2.1) (AO 2.1)	Examiner's Comments Higher ability candidates wrote out in a recognisable form that <i>change in velocity = acceleration × time</i> = $3 \times 4 = 12$ (m/s). A common misconception was to divide the acceleration by time taken (i.e. $3 \times 4 = 0.75$). Candidates should be encouraged to put the numbers into the given equation which will help them to identify if they will need to rearrange the formula.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 800 (kg) award 3 marks Recall: force = mass × acceleration ✓ $4000 \div 5$ ✓ 800 (kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 0.8 for two marks Examiner's Comments Some candidates divided their calculated answer by 1000 so that their answer was actually in tonnes rather than kilograms. Because the equation uses force in N and acceleration in m/s^2 the computed mass will be kilograms. Other candidates divided 4000 by 5^2 perhaps thinking that 5 m/s^2 implied it needed to be squared.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12	a	i	5250 (J/kg°C) ✓	1 (AO1.2)	Examiner's Comments Most candidates (≈ 90%) were able to calculate the mean specific heat capacity efficiently.
		ii	Any three from: specific heat capacity increases with temp rises ✓ specific heat capacity increases with energy supplied ✓ temp rise increases with energy supplied ✓ different amounts of energy were supplied ✓ all of the s.h.cs. are close together (within 5%) / within the range 5000 – 5500 ✓ the experiment was repeated / done 3 times ✓	3 (AO3 × 3.2b)	ALLOW other reasonable observation, e.g. s.h.c. increases with longer heating Examiner's Comments This question expected the candidate to describe the patterns in the tabulated data and to recognise that the table recorded values from three repeats of the experiment with the control variable changed. There were a number of different marking points to allowed candidates to achieve full marks. However, most candidates' answers were too brief and only described one or two possible conclusions.  AfL For this style of question which is assessing AO3 it is important to encourage candidates to write about a minimum of three different conclusions that could be drawn. The space provided is indicative of the expected answer, so in this example describing four “conclusions” briefly (Exemplar 4) would be a better approach than one “conclusion” described in greater detail (Exemplar 3). Exemplar 3 (ii) Describe the conclusions that can be drawn from the data. As the energy supplied increases the specific heat capacity also increases. ✓ [3]

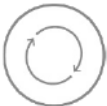
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					Exemplar 4 (iii) Describe the conclusions that can be drawn from the data. As the energy supplied increases, so does the temperature. The specific heat capacity increases by an interval of 256.3 J kg⁻¹ °C⁻¹ after each attempt. Increased temperature and energy supplied causes the specific heat capacity to increase. [3]
	b	i	Any two from: more energy (than expected) heated the water ✓ energy losses must have occurred/not all the energy went into the water ✓ energy transferred to environment /AW ✓	2 (AO2 × 3.2b)	ALLOW heat for energy Examiner's Comments Only a very few candidates answered this question well. These candidates realised that a "higher" calculated value of specific heat capacity meant that more energy had to be transferred to the beaker than was expected. These candidates concluded that much energy had been lost to the environment.
		ii	Any two linked answers from: part of the immersion heater is out of the water ✓ make sure the heater is fully in the water/use a larger/deeper beaker ✓ beaker is not lagged/insulated ✓ lag/insulate the beaker ✓ there is no lid on the beaker ✓ put a lid on the beaker ✓ the temperature rises are quite small ✓ apply more energy to the water ✓ insufficient data ✓ take more readings ✓	4 (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b)	Examiner's Comments Most candidates appeared not to appreciate how the story of the topic being assessed was developed through Q18 and in particular how their answer to Q18(b)(i) should help them in answering Q18(b)(ii). Most candidates offered random comments unrelated to Q18(b)(i). A popular response was the suggestion that a Bunsen burner should be used rather than an electrical immersion heater.
			Total	10	

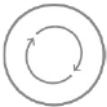
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ $I = P \div V$ ✓ $I = 65 \div 230$ ✓ $I = 0.2826086$ ✓ $I = 0.28$ (A) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf <u>Examiner's Comments</u> Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.2826 before rounding the answer as 0.28 (two significant figures). A number of candidates wrote their answer exactly from the calculator as 0.28 which was not acceptable for two significant figures. Exemplar 1 17 A TV has the label below on it. (a) Calculate the current in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to 2 significant figures. $\text{Current} = \frac{\text{Power}}{\text{Potential difference}}$ $= \frac{65}{230}$ $= 0.2826\dots$ Current = 0.28 A [4] This candidate has clearly rearranged the equation and then substituted the correct numbers from the data box. It is then clear that the candidate has then calculated the correct answer before rounding it correctly to two significant figures.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					The candidate has perhaps helpfully crossed out the frequency as this is not needed for this part. Candidates need to be careful about crossing out quantities as the crossed out quantities might be needed in later parts. Underlining the quantities needed is probably a better method.  AfL For calculations, candidates should show their working. The following steps are useful: 1 Recall equation or select the appropriate equation from the data sheet (if not given in the question) 2 rearrange equation, if necessary 3 substitute the numbers into the equation 4 calculate the answer 5 consider significant figures or decimal places.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks $E = P \times t$ ✓ Unit conversion 30 minutes = 1800 seconds ✓ $E = 65 \times 1800$ ✓ $E = 117000$ (J) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	ALLOW ECF from (a) $E = Q \times V$ or $I \times t \times V$ $E = 0.28 \times 1800 \times 230$ ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) $E = 116000$ (J) ✓ <u>Examiner's Comments</u> Candidates did not always know which equation to use. Many recalled correctly the equation relating energy, power and

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					time but did not always remember that the energy needed to be measured in seconds. Higher ability candidates clearly showed their working including the conversion of 30 minutes to 1800 seconds. Some candidates recalled that $E = Q \times V$ and $Q = I \times t$ or $E = I \times t \times V$ and used the answer from 17(a). This was correct physics and thus gained full credit.  AfL When carrying out calculations, candidates should consider units. Normally time is measured in second. Candidates should be aware of exceptions to the normal units, e.g. when energy transferred is measured in kW h, then the power is measured in kilowatt, kW and time in hour h. Similarly, if a speed is measured in measured in km / h, then the distance should be measured in kilometre, km and the time in hour, h.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a	i	Bar C drawn to the correct height of 12s ✓	1 (AO1.2)	<u>Examiner's Comments</u> Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (s) award 2 marks $14 + 10 + 12 = 36 / (14 + 10 + 12)/3$ without the 36 ✓ $36 \div 3 = 12 \text{ (s)} \checkmark$	2 (AO3.1a) (AO1.2)	ECF from (a)(i) ECF from mp1 above <u>Examiner's Comments</u> Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		iii	Lift B ✓ Takes the least time (power is work done ÷ time taken)/AW ✓	2 (AO3.1b) (AO1.2)	If A chosen and correct explanation (for B) given, award mp2 but not mp1 <u>Examiner's Comments</u> Many candidates identified lift B uses the most power correctly but did not provide an explanation of why it use the most power for the second mark. Some candidates clearly thought the highest bar in the bar chart indicated a greater height reached by the lift and so chose lift A.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4166.7 (W) award 4 marks $P = E \div t$ / power = work done $\div$ time taken ✓ $P = 50000 \div 12$ ✓ $P = 4166.666667$ (W) ✓ $P = 4166.7$ (W) (1dp)✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	ALLOW energy (transferred) $\div$ time taken ALLOW 4166.7 for 2 marks if more dp not given ECF own calculated power to 1 dp <u>Examiner's Comments</u> Part (i): required candidates to round their answer to one decimal place. Many candidates did the calculation well and gained 4/4, or 3/4 with incorrect rounding. Any calculation error in finding the power of the lift could still earn the candidate the last mark if their result was rounded correctly. Part (ii) was done correctly by the majority of candidates. The stem of the question contained some data that they did not need to complete the calculation, which made this a more challenging task than it may appear to be.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3000 (J) award 3 marks ✓ Work done = force $\times$ distance ✓ $W = 750 \times 4$ ✓ $W = 3000$ (J) ✓	3 (AO1.2) (AO2.1) (AO2.1)	
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation $\text{current} = \text{power} \div \text{potential difference}$ / $I = P \div V$ ✓ $I = 65 \div 230$ ✓ $I = 0.2826086$ ✓ $I = 0.28$ (A) ✓	4 (A1.2) (A2.1) (A2.1) (A1.2)	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf <u>Examiner's Comments</u> In their response to this question candidates earned a marks for the correct rearrangement of the given equation, a mark for substitution of the appropriate values, a mark for evaluation, and a mark for expressing the evaluated result to 2 significant figures. Error-carried-forward applied here, as shown in Exemplar 9. The first mark was earned by the power/p.d. quotient; it would have been cleared if they had included a subject to make it into a clear equation). There was no obvious logic to their other workings, but the final expression written is $65/4.5 = 14.4444$ which (expressed to 2 s.f.) is 14, so earned second mark was given. Examiners are expected to mark positively and although the candidate has not set their workings out sensibly the examiner has assumed 65/4.5 and 14 to be the candidate's final decision.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					Exemplar 9 23 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the current in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to 2 significant figures. $\frac{65}{50} = 1.3$ $\frac{65}{230} = 0.28$ Current = 0.28 A [4]
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks $E = P \times t$ ✓ Unit conversion 30 minutes = 1800 seconds ✓ $E = 65 \times 1800$ ✓ $E = 117000$ (J) ✓	4 (A1.2) (A1.2) (A2.1) (A2.1)	ALLOW ECF from (a) $E = Q \times V$ or $I \times t \times V$ $E = 0.28 \times 1800 \times 230$ ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) $E = 116000$ (J) ✓ <u>Examiner's Comments</u> This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.06 (m / s) award 3 marks Speed = 0.6×0.1 ✓ Speed = 0.06 (m / s) ✓	2 (AO2 × 2.1)	
		ii	Distance is measured with a metre-rule OR tape measure ✓ Time is measured with a stop-watch ✓	2 (AO2 × 1.2)	ACCEPT metre-ruler DO NOT ALLOW ruler
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.08 (m / s) award 3 marks Speed = distance ÷ time ✓ = $2.4 \div 30$ ✓ = 0.08 (m / s) ✓	3 (AO1 × 1.2) (AO2 × 2.1)	
		iv	Uncertainty/difficulty in measuring distance ✓ OR Human reaction time in starting/stopping stopwatch ✓	1 (AO3.2a)	ALLOW AW
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17		i	Point 1,1 correctly plotted within $\frac{1}{2}$ small square ✓ Suitable curved line of best-fit drawn ✓	2 (AO2.2 x 2)	Should be within 1 small square of each point. May not be extrapolated to (0,0,)
		ii	Current increases as potential difference increases/AW ✓ Rate of increase reduces/current increases more slowly with potential difference/AW ✓	2 (AO3.1a) (AO3.1a)	IGNORE it is a straight line ALLOW (they are) not proportional / not linear ALLOW resistance increases as current goes up/filament gets hotter
		iii	Change lamp for a (fixed) resistor ✓ Measure current for different potential differences/AW ✓	2 (AO1.2 x 2)	ALLOW repeat the experiment
		iv	Straight line (through the origin)/ current is (directly) proportional to voltage ✓ Resistance is constant./not changing/ fixed✓	2 (AO1.2 x 2)	ALLOW obeys Ohm's Law
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (N/cm) award 3 marks (Spring constant =) force ÷ extension ✓ 2.0 ÷ 4.0 ✓ = 0.5 (N / cm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW 3 marks for 50 N/m Needs algebraic or arithmetic rearrangement for this m.p. Choice of <i>F</i>, <i>ext</i> for wrong data point loses mp2 but can get mp3 for evaluation ecf.
		ii	Any two from: Repeat readings and calculate a mean/average ✓ Use more forces ✓ Plot data on a graph (and use a line of best fit) ✓ Use equipment with a higher resolution✓ Repeat experiment with different equipment (and compare results) ✓	2 (AO3.3b x 2)	
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a		Tape measure / metre rule(r)/stick AND Stop clock/watch✓	1 (AO1.2)	IGNORE just ruler ALLOW light gates
	b	i	Mean = 2(.00) ✓ Median = 2.02 ✓ Mode = 2.08 ✓	3 (AO1.2 x 3)	ALLOW 2.04 for mean (for ignoring 1.84) ALLOW 2.06 for median if 2.04 calculated for the mean
		ii	(They have a) wide spread/range / AW ✓	1 (AO3.2a)	ALLOW (they are) not all close together / don't have a small difference / not similar / AW ALLOW they are too different / have a big gap / not concordant / 0.24 gap IGNORE not consistent
		iii	Improvement must be linked to error Error: Reaction time / difficulty in starting/stopping timer at exact time / AW ✓ Improvement: Video/record the drop (and replay using timings from the recording) / use an electronic timing method / light gates / A/W ✓ OR Error: Not dropping ball from exact height / AW Improvement: Indication of marking the point from where it should be dropped / A/W	2 (AO3.3b) (AO3.3a)	Marks can be awarded for errors/improvements in either section IGNORE difficulty in timing without reason IGNORE human error unless qualified ALLOW use larger distances (so that % error in time is reduced)
			Total	7	