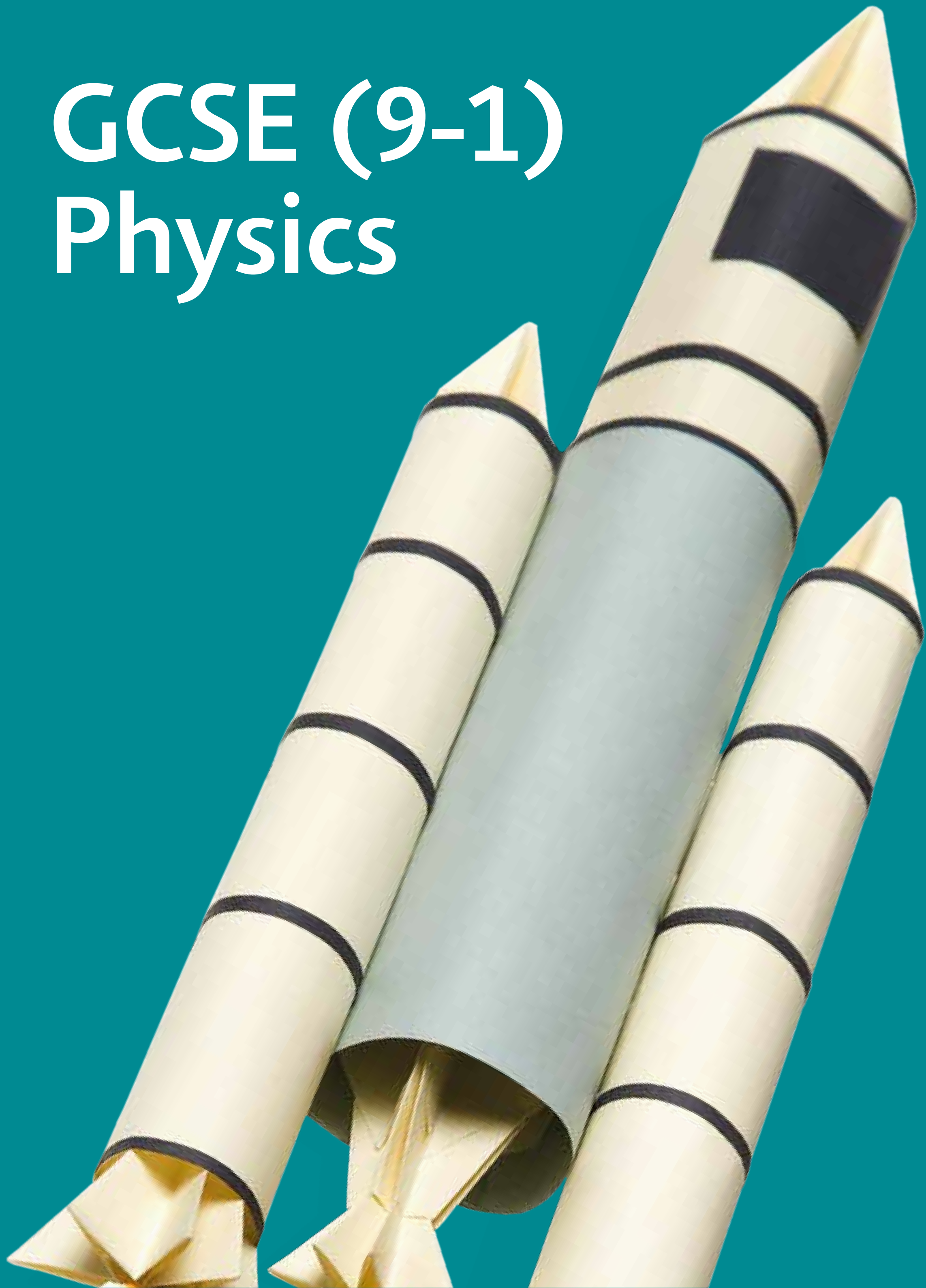
edexcel

GCSE (9-1) Physics



Sample Assessment Materials

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

First teaching from September 2016

First certification from June 2018

Issue 1

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Contents

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Introduction

The Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Physics is designed for use in schools and colleges. It is part of a suite of GCSE qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

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General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Subject specific marking guidance

Symbols, terms used in the mark scheme

- Round brackets ( ): words inside round brackets are to aid understanding of the marking point but are not required to award the point
- Curly brackets { }: indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
- Oblique /: words or phrases separated by an oblique are alternatives to each other and either answer should receive full credit.
- ecf: indicates error carried forward which means that a wrong answer given in an early part of a question is used correctly to a later part of a question.

You will not see 'owtte' (or words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific.

The Additional Guidance column is used for extra guidance to clarify any points in the mark scheme. It may be used to indicate:

- what will not be accepted for that marking point in which case the phrase 'do not accept' will be alongside the relevant marking point
- it might have examples of possible acceptable answers which will be adjacent to that marking point

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Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9–1)

Centre Number	Candidate Number

Physics

Paper 1

Foundation Tier

Sample Assessment Material for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference
1PH0/1F

You must have:
Calculator, ruler, protractor

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 5 0 0 4 9 A 0 1 2 8

PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) Figure 1 shows a solar-powered charger for a mobile phone.

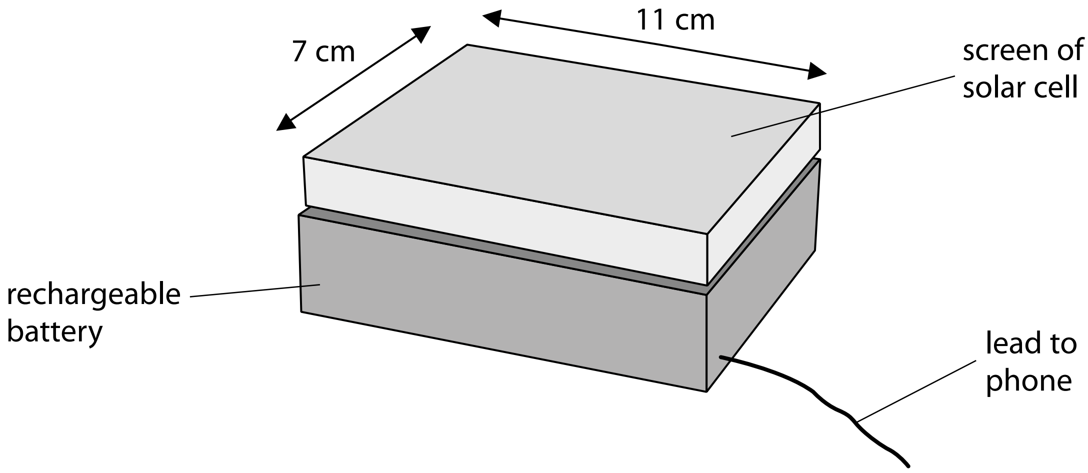

Figure 1

The screen of the solar cell takes in energy from the Sun.

(i) State how energy gets from the Sun to the screen.

(1)

....

....

(ii) State how energy is stored in the charger.

(1)

....

....

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(iii) Each second, 0.12 J of energy from the Sun reaches 1 cm^2 of the screen.

Calculate the total amount of energy reaching the whole screen in 1 second.

(3)

energy = ... J

(b) Mobile phones emit microwaves.

Microwave ovens emit microwaves.

Explain why a mobile phone does not have the same heating effect as a microwave oven.

(2)

....

....

....

....

(Total for Question 1 = 7 marks)

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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)

....

....

....

....

(b) Figure 2 shows a water wave.

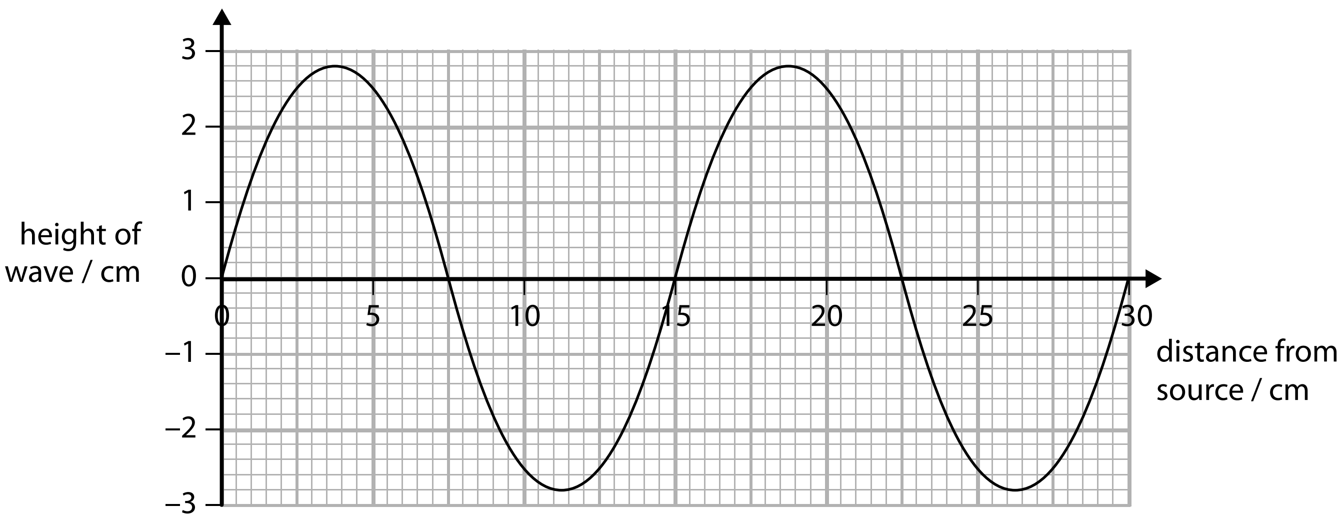

Figure 2

(i) What is the amplitude of this wave?

(1)

☒ **A** 2.8 cm

☒ **B** 5.6 cm

☒ **C** 7.5 cm

☒ **D** 15 cm

(ii) What is the wavelength of this wave?

(1)

☒ **A** 2.8 cm

☒ **B** 7.5 cm

☒ **C** 15 cm

☒ **D** 30 cm

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(c) Water waves are transverse waves.

(i) Give **one** other example of a transverse wave.

(1)

....

(ii) Give **one** example of a longitudinal wave.

(1)

....

(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)

speed = ... m/s

(Total for Question 2 = 9 marks)

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3 (a) Figure 3 shows the structure of an oxygen-14 atom.

(i) Complete the four labels on Figure 3.

(4)

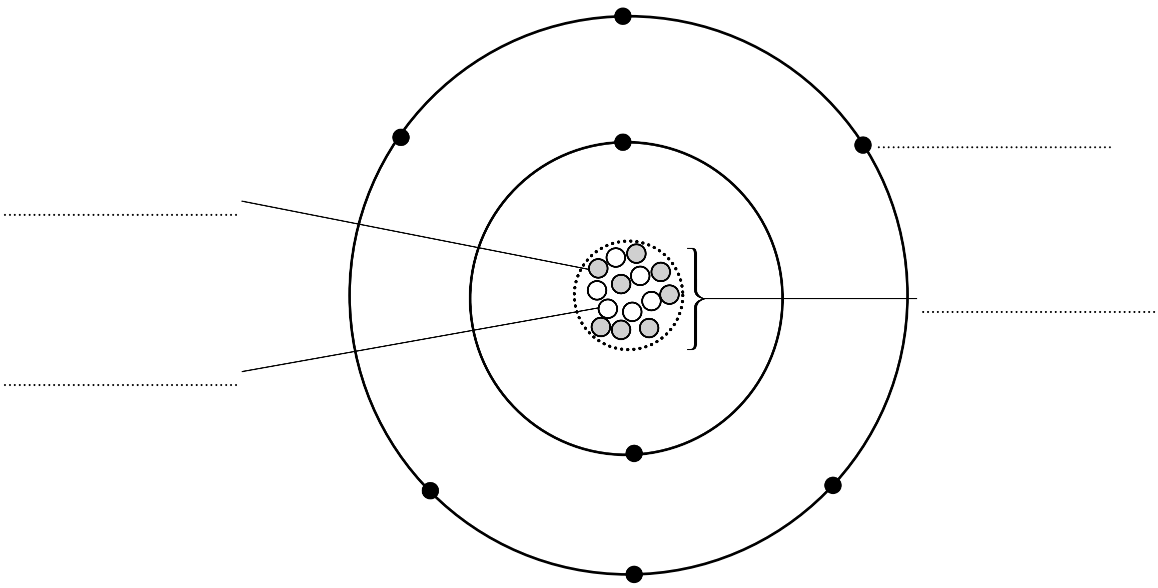

Figure 3

(ii) Which of these particles has a negative charge?

(1)

☒ **A** alpha particle

☒ **B** electron

☒ **C** neutron

☒ **D** nucleus

(iii) State the overall charge of the oxygen-14 atom.

(1)

....

....

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(b) A teacher uses a Geiger-Müller tube and a counter to measure background radiation.

The reading on the counter tube is 34 counts per minute.

(i) The teacher puts a source of beta radiation 15 cm in front of the same Geiger-Müller tube.

The reading on the counter tube is now 468 counts per minute.

Calculate how much radiation detected by the Geiger-Müller tube comes from the source of beta radiation.

(1)

.... counts per minute

(ii) The teacher puts a thick sheet of aluminium between the source of beta radiation and the Geiger-Müller tube.

Estimate the reading on the counter tube.

(1)

.... counts per minute

(iii) Give a reason why the answer to (ii) is only an estimate.

(1)

....

....

(Total for Question 3 = 9 marks)

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4 A student investigates how light behaves as it leaves a clear plastic block.

Figure 4 shows some of her equipment and the path of a ray of light through the block.

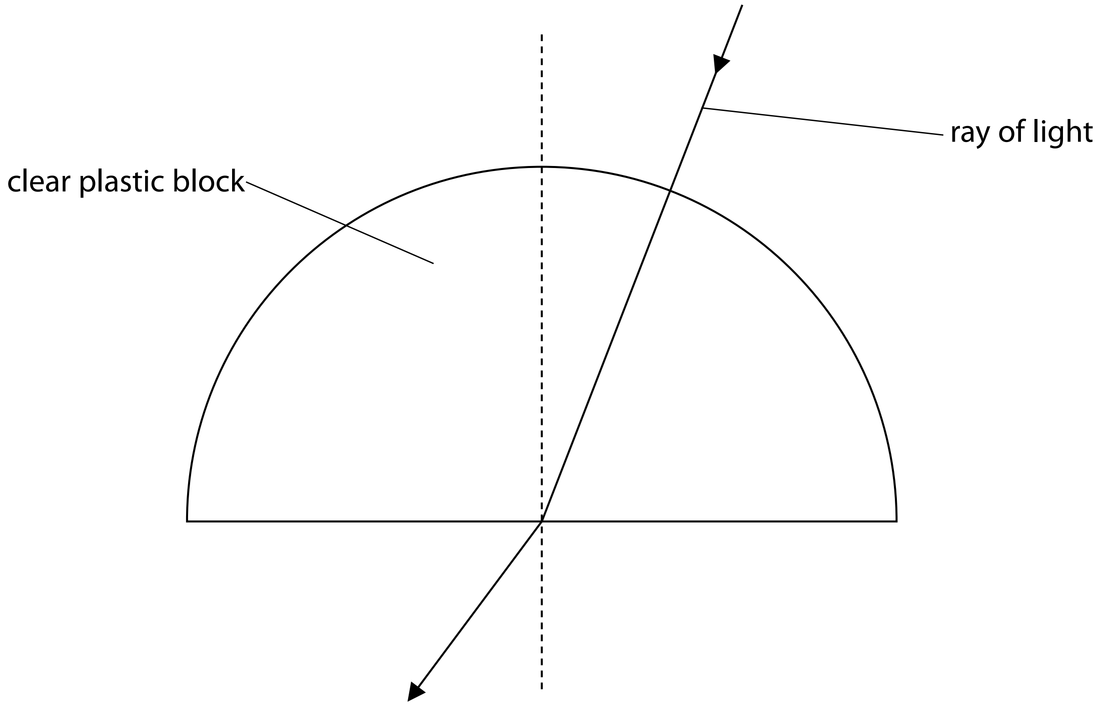

Figure 4

(a) Describe how the student can make sure the light does not change direction as it enters the block.

(2)

....

....

....

....

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(b) She varies the angle of incidence inside the block and records the angle of refraction.

Figure 5 shows her results.

angle of incidence (°)	angle of refraction (°)
5	7
15	22
30	46
40	69
42	76

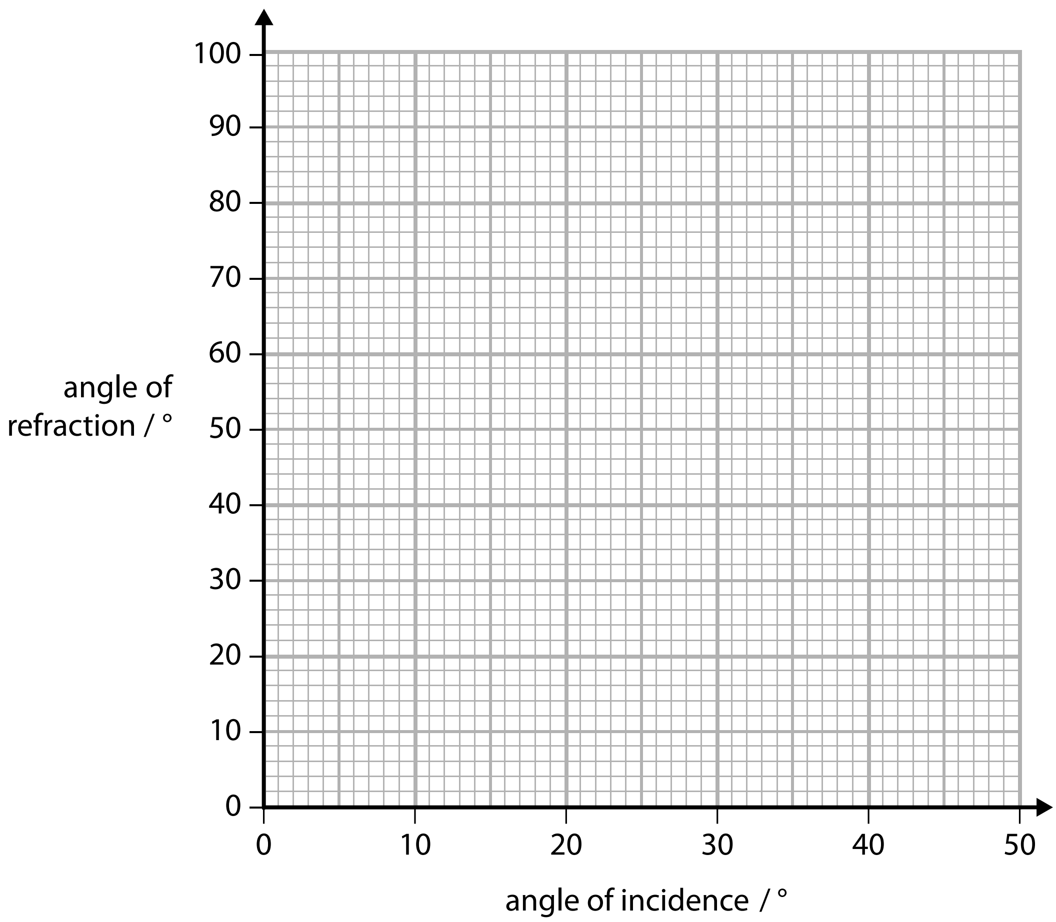
Figure 5

(i) Plot the points on the grid below.

(2)

(ii) Draw the best fit smooth curve through the points.

(1)



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(iii) Estimate the angle of incidence which gives an angle of refraction of 90°.

(2)

angle of incidence = ...

(c) Describe what happens to the ray of light when the angle of incidence is increased beyond the critical angle.

(2)

....

....

....

....

(Total for Question 4 = 9 marks)

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5 (a) A car driver sees a rabbit on the road.

The driver makes an emergency stop after he sees the rabbit.

Figure 6 shows the speed of the car from the time the driver sees the rabbit until the car stops.

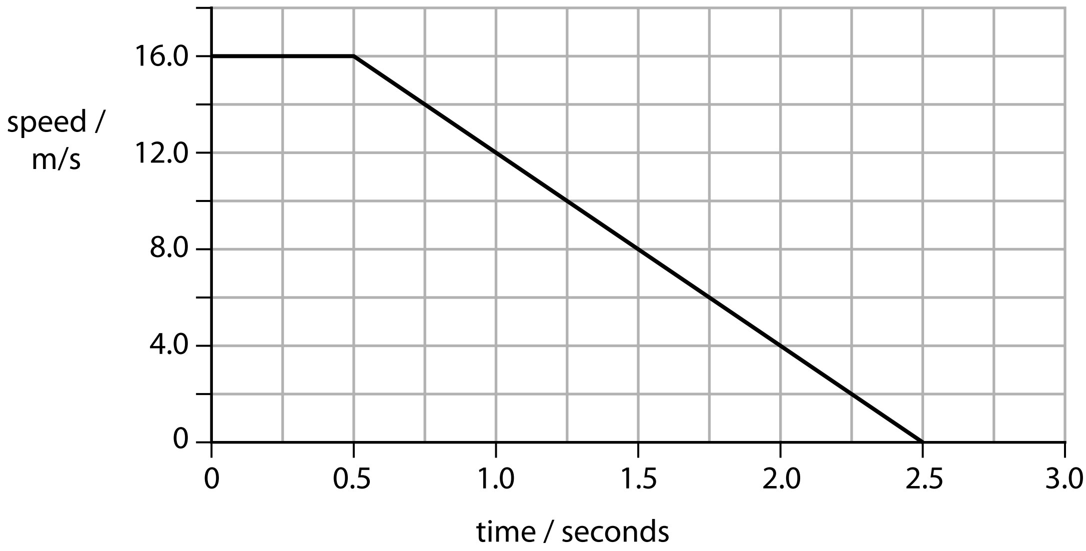

Figure 6

(i) The distance travelled by the car from the time the driver first sees the rabbit to when car starts to slow down is the

(1)

☒ **A** average distance

☒ **B** braking distance

☒ **C** stopping distance

☒ **D** thinking distance

(ii) Calculate the distance that the car travels in the first 0.5 seconds.

(3)

distance = ... m

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(iii) Which equation relates acceleration to change in velocity and time?

(1)

☒ **A** $a = \dfrac{(v - u)}{t}$

☒ **B** $a = \dfrac{t}{(v - u)}$

☒ **C** $a = t(v - u)$

☒ **D** $a = v - \dfrac{u}{t}$

(iv) Calculate the deceleration of the car.

(3)

deceleration = ... m/s^2

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(b) Two students, Alice and Bob, carry out an experiment to measure the speed of cars.

Alice paces out the distance between two lamp posts.

She records:

'*Distance between lamp posts = 20 paces*'

Bob starts to count when a car passes the first lamp post. He stops counting when he thinks it has passed the second lamp post.

He records:

'My estimate for the time taken for the car to pass between the two lamp posts = 3'

Give **three** ways the students could improve their experimental procedure.

(3)

1 ....

....

2 ....

....

3 ....

....

(Total for Question 5 = 11 marks)

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6 (a) A student investigates how the surface of an object affects the radiation it emits.

Figure 7 shows the equipment he uses.

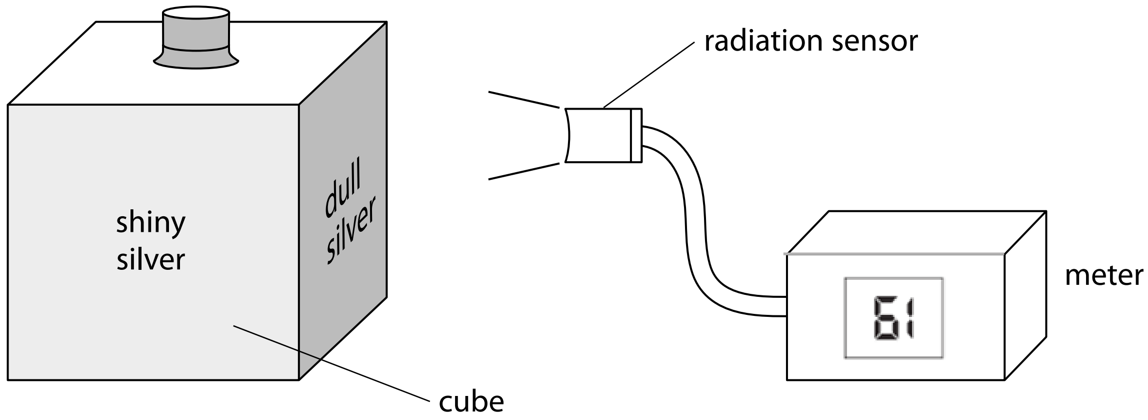

Figure 7

The cube has four different surfaces.

He fills the cube with boiling water so that the temperature of each surface is the same.

He uses the radiation sensor to measure the radiation emitted from each surface.

(i) His readings are shown.

Draw a line from each surface colour to its correct meter reading.
One has been done for you.

(2)

surface colour	meter reading
shiny black	87
dull black	61
dull silver	70
shiny silver	47

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(ii) The temperature of each surface is the same.

Give a reason why the radiation sensor gives a different reading for each surface.

(1)

....

....

(b) (i) What do all waves in the electromagnetic spectrum have in common?

(1)

☒ **A** the same frequency in a vacuum

☒ **B** the same speed in a vacuum

☒ **C** the same colour in a vacuum

☒ **D** the same amplitude in a vacuum

(ii) Blue light has a wavelength of 470 nm and a frequency of 6.30×10^{14} Hz

Calculate the velocity of blue light.

(2)

velocity = ... m/s

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(c) All objects emit electromagnetic radiation.

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

Figure 8 shows this variation for an object at two different temperatures.

The visible region of the electromagnetic spectrum is also shown.

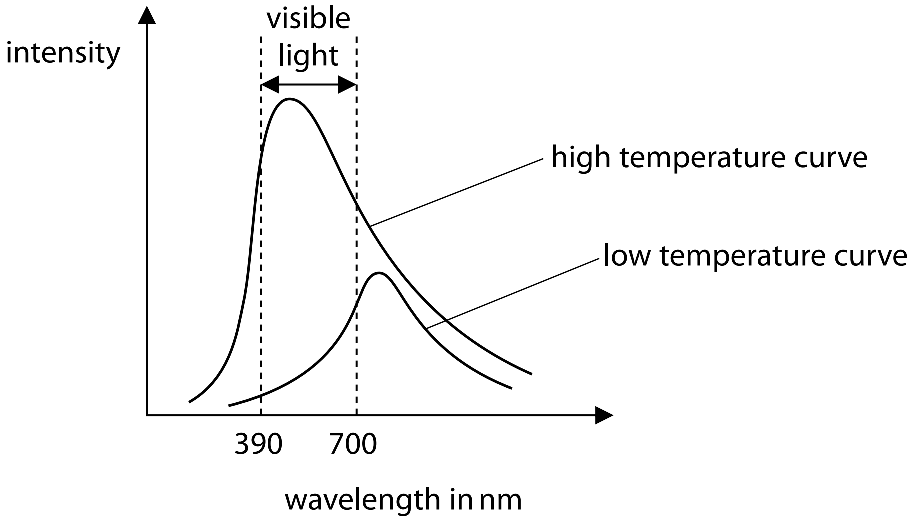

Figure 8

(i) In which part of the electromagnetic spectrum is the peak of the low temperature curve?

(1)

☐ **A** gamma

☐ **B** infrared

☐ **C** radio

☐ **D** ultra violet

(ii) Describe how intensity of the emitted radiation changes with temperature.

(2)

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(Total for Question 6 = 9 marks)

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7 (a) Scientists no longer accept the geocentric model of the universe but it was the accepted theory for hundreds of years.

Explain why the evidence available at the time supported the geocentric model.

(3)

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(b) The Big Bang theory and the Steady State theory are two theories about the origin of the universe.

The discovery of CMB led scientists to accept only one of the theories.

Explain why redshift supports both theories but CMB supports only one of them.

(3)

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(c) (i) A star with a mass very much larger than the Sun

(1)

☒ **A** has a longer main sequence than the Sun and ends as a white dwarf

☒ **B** has a longer main sequence than the Sun and ends as a black hole

☒ **C** has a shorter main sequence than the Sun and ends as a white dwarf

☒ **D** has a shorter main sequence than the Sun and ends as a black hole

(ii) Which row has two correct statements about black holes?

(1)

		the gravitational field of a black hole	**a black hole is formed when**
☒	**A**	allows only electromagnetic radiation to escape	a nebula collapses
☒	**B**	allows nothing to escape	a very large star collapses
☒	**C**	allows nothing to escape	a nebula collapses
☒	**D**	allows only electromagnetic radiation to escape	a very large star collapses

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(d) Figure 9 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.

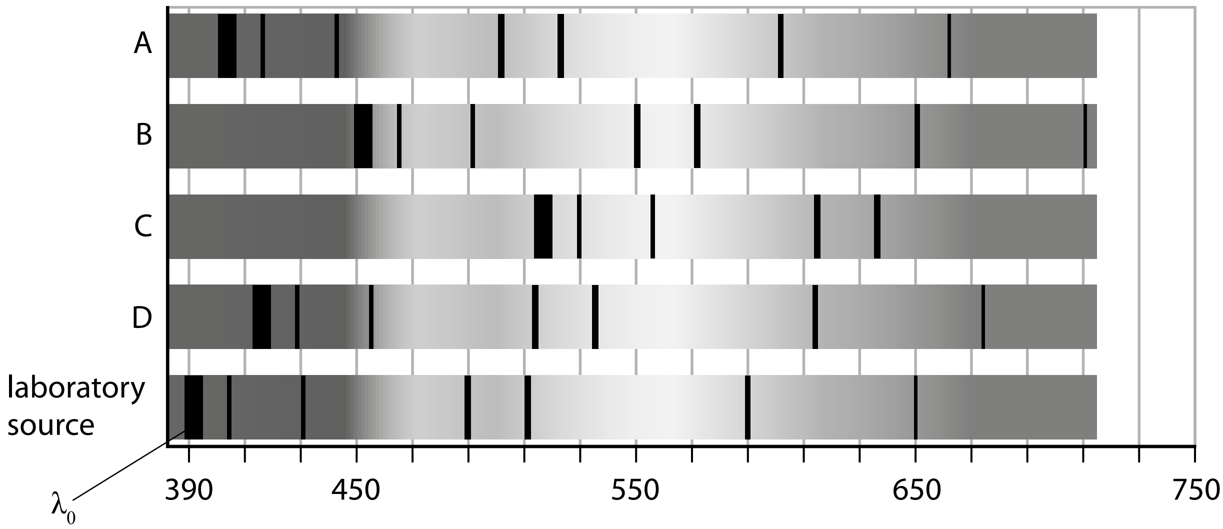

Figure 9

Explain, using Figure 9, which galaxy is furthest away from us.

(3)

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(Total for Question 7 = 11 marks)

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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.

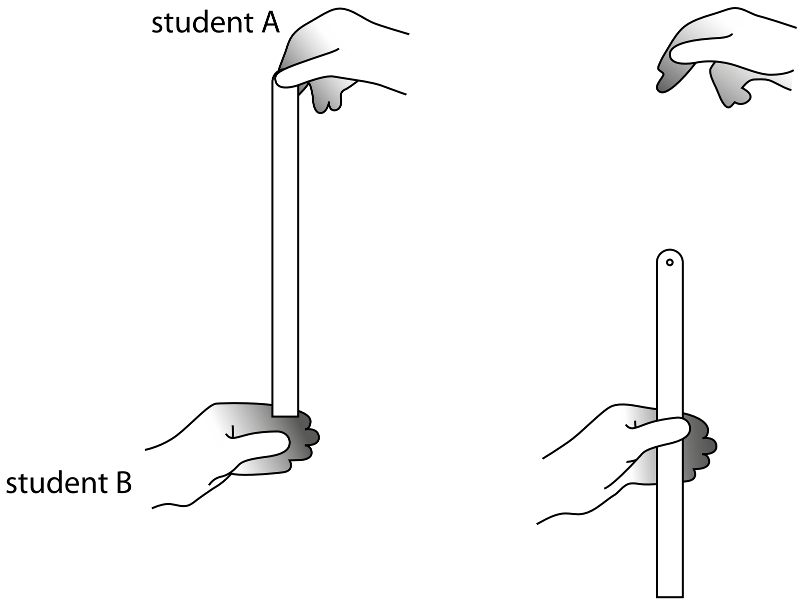

Figure 10

(a) Give a reason why it is better to have the 0 cm mark at the bottom of the ruler rather than at the top.

(1)

....

....

(b) Give a reason why two students are needed for this investigation.

(1)

....

....

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(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)

distance = ... cm

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

Use the equation

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

(2)

average time = ... s

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

(2)

....

....

....

....

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

(2)

1 ....

....

2 ....

....

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

(2)

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(Total for Question 8 = 12 marks)

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9 A car accelerates at a constant rate of $1.83\,m/s^2$ 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)

mass = ... kg

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

Calculate the speed of the car after 16 s.

(3)

speed = ... m/s

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

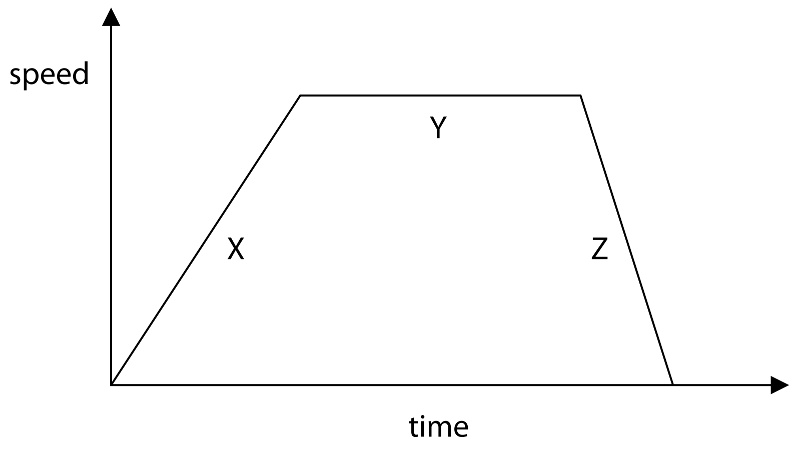

Figure 12

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)

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(Total for Question 9 = 12 marks)

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10 (a) Americium-241 is a radioactive isotope that emits alpha particles.

Americium-241 is used in smoke alarms.

Give a reason why it is safe to use americium-241 in smoke alarms.

(1)

....

....

(b) Iodine-131 is a radioactive isotope with a half-life of 8 days.

The activity of a sample of iodine-131 is 480 Bq.

Calculate the activity of the sample after 16 days.

(2)

activity = ... Bq

(c) A student uses 59 dice to model radioactive decay.

He starts by rolling all the dice at the same time.

He removes all the dice that show a six.

He then rolls the remaining dice.

The student repeats this process five more times.

State **two** improvements the student could make to his model of radioactive decay.

(2)

1 ....

....

2 ....

....

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*(d) Radioactive isotopes can be used to investigate cancer and other illnesses.

The thyroid gland in the neck absorbs most of the iodine that our bodies need.

A person can become ill if their thyroid absorbs too little iodine.

Explain how a radioactive isotope with suitable properties may be used to investigate the uptake of iodine by this gland.

(6)

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(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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Equations

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance $v^2 - u^2 = 2 \times a \times x$
energy transferred = current × potential difference × time $E = I \times V \times t$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil $V_p \times I_p = V_s \times I_s$
change in thermal energy = mass × specific heat capacity × change in temperature $\Delta Q = m \times c \times \Delta\theta$
thermal energy for a change of state = mass × specific latent heat $Q = m \times L$
$P_1 V_1 = P_2 V_2$ to calculate pressure or volume for gases of fixed mass at constant temperature
energy transferred in stretching = 0.5 × spring constant × (extension)^2 $E = ½ \times k \times x^2$

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Paper 1 Foundation

Question number	Answer	Mark
1(a)(i)	(Carried by) electromagnetic wave	**(1)**

Question number	Answer	Mark
1(a)(ii)	As chemical energy in the battery	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iii)	Calculation of area (1) 7 × 11 Substitution (1) 77 × 0.12 Answer (1) 9.2 (J)	77 ecf area award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Additional guidance	Mark
1(b)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the heating effect for the oven and the phone depends on their power (1) • and since the power of an oven is much greater than the power of a phone, the oven produces a greater heating effect (1)	allow not the same wavelength/microwaves cover a range in wavelengths	**(2)**

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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)**

Question number	Answer	Mark
2(b)(i)	A	**(1)**

Question number	Answer	Mark
2(b)(ii)	C	**(1)**

Question number	Answer	Additional guidance	Mark
2(c)(i)	electromagnetic wave	allow any named e.m. wave/seismic S wave	**(1)**

Question number	Answer	Additional guidance	Mark
2(c)(ii)	sound wave	allow ultrasound/infrasound/ seismic P wave	**(1)**

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)**

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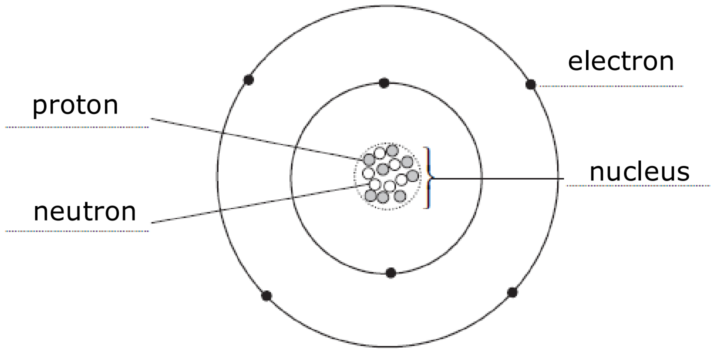
Question number	Answer	Mark
3(a)(i)	One mark for each correct label (4)  	**(4)**

Question number	Answer	Mark
3(a)(ii)	B	**(1)**

Question number	Answer	Mark
3(a)(iii)	zero/0/no charge	**(1)**

Question number	Answer	Mark
3(b)(i)	434	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	34	allow 29 to 39	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(iii)	Radioactive decay is a random process	allow because background count changes every time	**(1)**

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Question number	Answer	Additional guidance	Mark
4(a)	An answer that combines the following points of understanding to provide a logical description: • shine the light along a radius (1) • by marking it on the paper before putting the block down (1)	allow shine the ray at the centre of the straight edge before putting the block down	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(i)	all points correctly plotted to +/− half a square (2)	4 points plotted correctly (i.e. one error) (1)	**(2)**

Question number	Answer	Mark
4(b)(ii)	smooth curve through at least 3 of the points (1)	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)(iii)	• continues line as far as 90° (1) • estimate between 43° and 47° (1)	award full marks for correct numerical answer without working	**(2)**

Question number	Answer	Mark
4(c)	An answer that provides a description by making reference to: • (all) light reflected (1) • back inside block (1)	**(2)**

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Question number	Answer	Mark
5(a)(i)	D	**(1)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	16.0 (m/s) read from graph (1) Substitution (1) (distance travelled =) 16×0.5 Answer (1) 8.0 (m) (1)	award full marks for correct numerical answer without working ecf for substitution and answer using wrong speed value	**(3)**

Question number	Answer	Mark
5(a)(iii)	A	**(1)**

Question number	Answer	Additional guidance	Mark
5(a)(iv)	Obtain readings from graph (1) Substitution (1) $\frac{16}{2.0}$ Answer (1) 8.0 (m/s^2)	award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)	Any three improvements from: • suitable instrument to measure distance (1) • using a greater distance (to reduce effect of reaction times) (1) • suitable instrument to measure time (1) • use of one student at the {first/second} lamp post to signal when to {start/stop} timing (1)	allow tape measure, trundle wheel allow stop watch/clock or timing app. on phone	**(3)**

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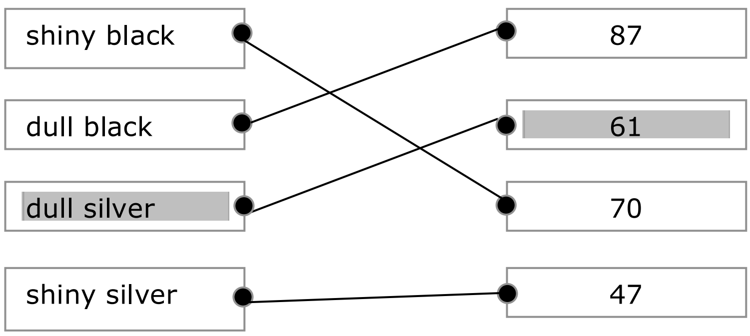
	• two of three sets of students taking readings for the same car (1)		

Question number	Answer	Mark
6(a)(i)	All three correct (2) One or two correct (1) 	**(2)**

Question number	Answer	Additional guidance	Mark
6(a)(ii)	Different surfaces emit (thermal) radiation at different rates	allow reference to surfaces in question	**(1)**

Question number	Answer	Mark
6(b)(i)	B	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	substitution and unit conversion (1) $470 \times 10^{-9} \times 6.30 \times 10^{14}$ answer (1) 2.96×10^{8} (m/s)	award full marks for correct numerical answer without working ecf unit conversion	**(2)**

Question number	Answer	Mark
6(c)(i)	B	**(1)**

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Question number	Answer	Mark
6(c)(ii)	An answer that combines points of interpretation/evaluation to provide a logical description: • as temperature increases, intensity increases (1) • as temperature increases, maximum intensity occurs at a shorter wavelength (1)	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • at the time, there was only naked eye evidence (1) • which indicated Sun/Moon/planets appear to move across the sky (1) • in the same direction, same motion each day (1)	allow valid alternatives, e.g. references to comets	**(3)**

Question number	Answer	Additional guidance	Mark
7(b)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • both theories predict an expanding universe and the Big Bang theory also predicts that the universe had a beginning (1) • the red shift theory indicates that the universe is expanding so supports both theories (1) • whereas CMB also indicates that the universe had a beginning, so supports Big Bang theory (1)	provided evidence that the steady state theory was incorrect	**(3)**

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Question number	Answer	Mark
7(c)(i)	B	**(1)**

Question number	Answer	Mark
7(c)(ii)	B	**(1)**

Question number	Answer	Mark
7(d)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • galaxy C is furthest away (1) • because it has the greatest red shift (1) • and therefore it has the greatest speed (1)	**(3)**

Question number	Answer	Mark
8(a)	Idea of a direct reading (without calculation)	**(1)**

Question number	Answer	
8(b)	If student B drops the ruler, they are not really measuring their own reaction time as they know when ruler has been dropped	**(1)**

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)**

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Question number	Answer	Additional guidance	Mark
8(c)(ii)	Rearrangement (1) $t = \sqrt{\dfrac{\text{distance}}{500}}$ 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)**

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)**

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

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)**

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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)**

Question number	Answer	Additional guidance	Mark
9(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)**

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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)

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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)

Question number	Answer	Additional guidance	Mark
10(a)	alpha cannot penetrate casing	alpha only travel a few cm in air	**(1)**

Question number	Answer	Mark
10(b)	• evidence of division of activity by 2 (1) • 120 (Bq) (1)	**(2)**

Question number	Answer	Mark
10(c)	• increase number of starting dice (1) • do more rolls (1)	**(2)**

Question number	Indicative content	Mark

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***10(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. **AO2 (6 marks)** • use a radioactive isotope of iodine as this is taken up by the gland • isotope given by injection or orally • gland is in the neck, so cannot use an alpha emitter as alpha will not exit through the skin • use beta or gamma emitter • isotope has to have a short enough half-life to minimise exposure to radiation but long enough for the reading to be taken • allow time for isotope to reach gland • use Geiger-Müller tube and counter to determine count rate of isotope in gland • compare with normal count rate to determine whether uptake of iodine is normal		**(6)**

Level	**Mark**	**Descriptor**
	0	No awardable content.
1	1–2	• 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) • Lines of reasoning are unsupported or unclear. (AO2)
2	3–4	• 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) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
3	5–6	• 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 the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

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Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9 - 1)

Centre Number	Candidate Number

Physics

Paper 2

Foundation Tier

Sample Assessment Material for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference
1PH0/2F

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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PEARSON

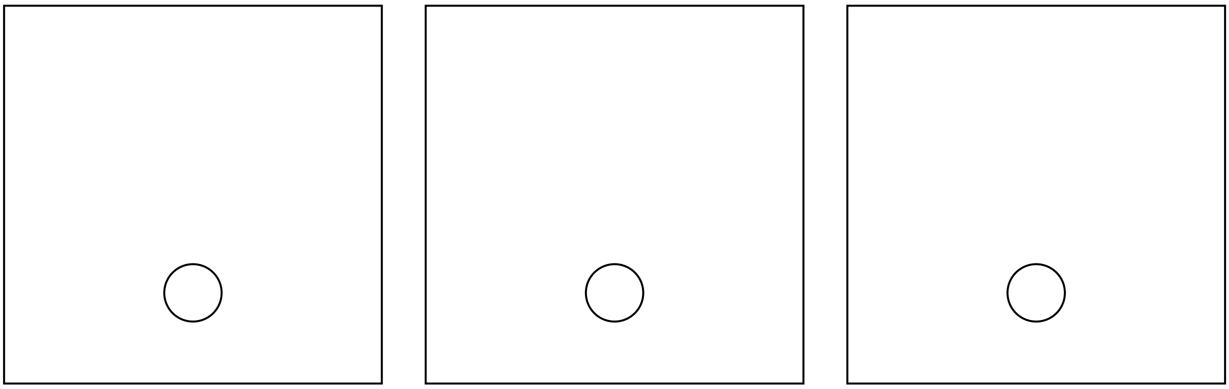
Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒ .
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) (i) Complete each box in Figure 1 to show how particles are arranged in a solid, liquid and gas.

One particle in each box has been drawn for you.

(3)



solid liquid gas

Figure 1

(ii) Which row of the table is correct for water compared to steam?

(1)

		the density of water is	the water molecules are
☐	**A**	bigger	smaller
☐	**B**	smaller	bigger
☐	**C**	bigger	closer together
☐	**D**	smaller	further apart

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(b) A student investigates the density of a copper block and the density of a small stone, as shown in Figure 2.

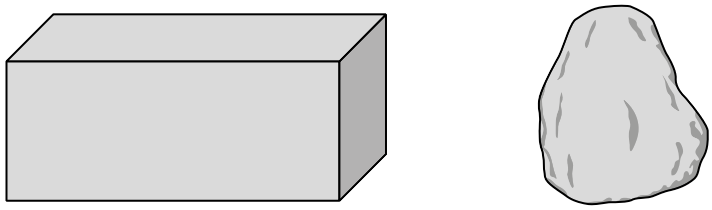

Figure 2

(i) The student calculates the volume of the block as 13 cm^3.

She finds that the mass of the block is 100 g.

Calculate the density of the block.

Use the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(2)

density = ... g/cm^3

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(ii) The student found the volume of the copper block by multiplying the area of its base by its height.

The small stone does not have straight sides.

Describe how the student could measure the volume of the small stone.
You may use a diagram if it helps your answer.

(3)

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(Total for Question 1 = 9 marks)

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2 (a) Figure 3 shows a coil of wire called a solenoid.

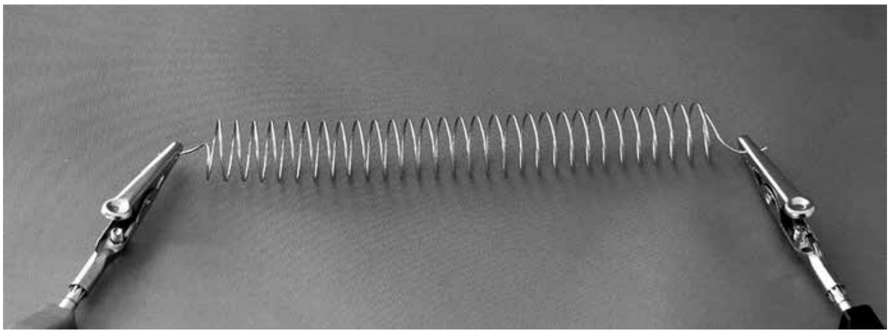

Figure 3

Figure 4 gives information about the magnetic field of a solenoid.

description of the magnetic field	part of magnetic field	
	inside the coil	**outside the coil**
strong	✓	✗
weak	✗	✓
uniform	✓	✗
non-uniform	✗	✓

Figure 4

(i) Draw lines on Figure 5 to show the shape of the magnetic field **inside** the solenoid.

Use information from Figure 4.

(1)

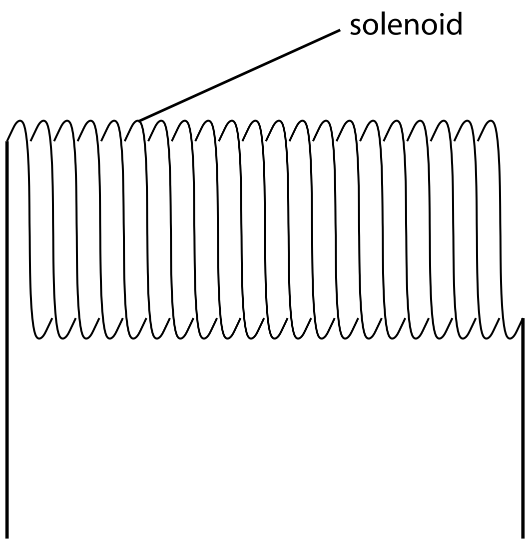

Figure 5

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(ii) Describe how a student can determine the shape of the magnetic field around the solenoid.

(2)

....

....

....

....

(b) A student investigates the magnetic properties of three rods. Each rod is made of one of the following materials:

- soft iron
- steel
- wood

The student places each rod in a solenoid that is connected to a direct current power supply.

The power supply is switched on for a short time.

The student tests the magnetic strength of each rod by seeing how many paper clips it can pick up as shown in Figure 6.

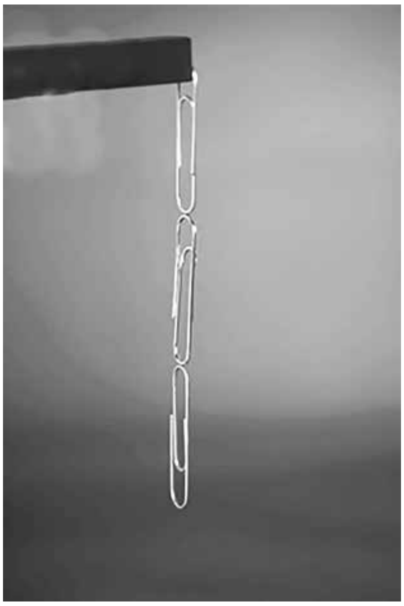

Figure 6

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The student's results are shown in Figure 7.

	number of paper clips picked up by rod			
rod	**before rod is placed in solenoid**	**when there is current in solenoid**	**1 minute after current is switched off**	**10 minutes after current is switched off**
A	0	0	0	0
B	0	6	1	0
C	0	8	7	7

Figure 7

Complete the table below to show which material (soft iron, steel or wood) each rod is made from, with the reason why.

Part of the table has been done for you.

Use information from Figure 7.

(3)

rod	material	reason
A		It is not magnetic because it does not pick up paper clips whether there is a current or not.
B		
C		

(Total for Question 2 = 6 marks)

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3 An electric heater is used to heat some water.

Figure 8 shows the experimental setup used.

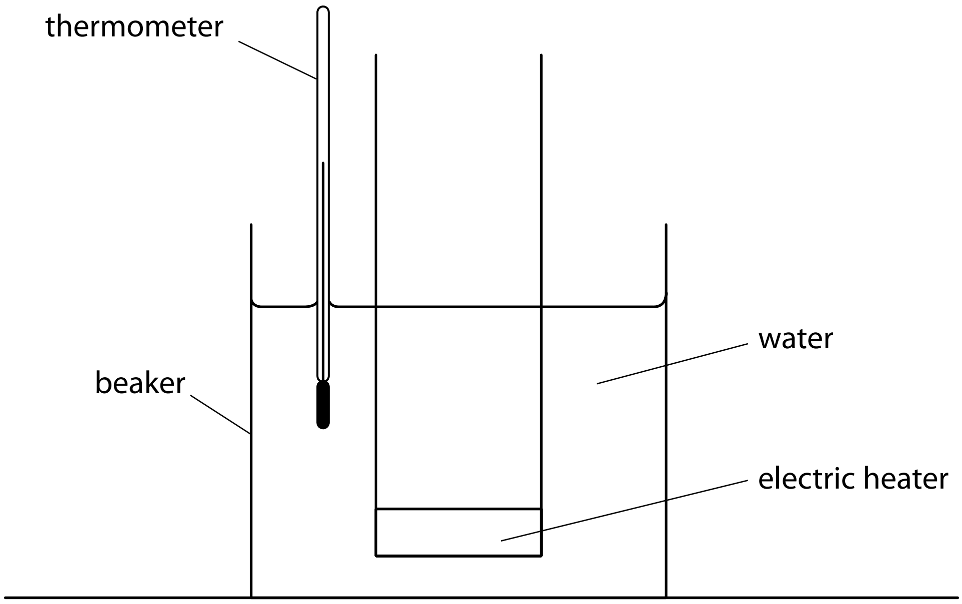

Figure 8

(a) Figure 9 shows the energy transferred by the electric heater in 1 second.

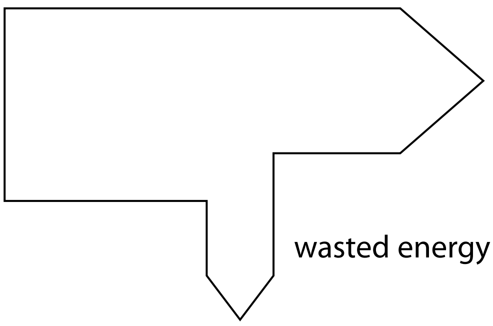

Figure 9

(i) How much energy is wasted each second?

(1)

☒ **A** 12 J

☒ **B** 38 J

☒ **C** 50 J

☒ **D** 88 J

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(ii) Describe what happens to the wasted energy.

(2)

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(b) Explain **one** way the experiment can be improved to reduce the amount of wasted energy.

(2)

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(c) The initial mass of the water in the beaker is 0.72 kg.

The electric heater is switched on for some time and the water boils.

The mass of the water after the heater is switched off is 0.60 kg.

The thermal energy transferred to the water while it boils is 270 000 J.

Use an equation from the formula sheet to calculate the specific latent heat of the water.

(3)

specific latent heat = ... J/kg °C

(Total for Question 3 = 8 marks)

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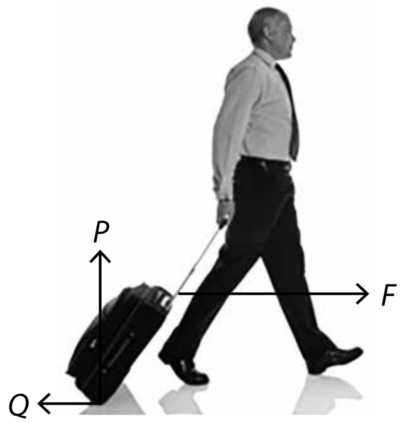
4 A man pulls a suitcase with a horizontal force, *F*, as shown in Figure 10.

Two other forces acting on the suitcase are labelled *P* and *Q*.



Not to scale

Figure 10

(a) (i) Which of these gives the correct names for the forces *P* and *Q*?

(1)

	name of	
	force *P*	**force *Q***
☒ **A**	upthrust	reaction
☒ **B**	reaction	friction
☒ **C**	reaction	reaction
☒ **D**	friction	upthrust

(ii) Draw an arrow on the diagram to represent the weight of the suitcase.

(1)

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(b) The man pulls the suitcase for 80 m along a horizontal path.

The mass of the man and the suitcase is 85 kg.

The man does 1200 J of work on the suitcase as he pulls the suitcase along.

He walks with an average velocity of 1.5 m/s.

(i) Calculate the kinetic energy of the man and the suitcase.

(2)

kinetic energy = ... J

(ii) Calculate the horizontal force, *F*, that the man exerts on the suitcase.

Use the equation:

work done = force $\times$ distance moved in the direction of the force

(2)

force = ... N

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(c) The man runs up a set of stairs carrying his suitcase.

Explain whether he does more total work if he walks up the same stairs instead of running.

(2)

....

....

....

....

(d) The man lifts his suitcase.

The increase in gravitational potential energy of the suitcase is 264 J.

The mass of the suitcase is 12 kg.

Calculate the vertical height the suitcase is raised.

(gravitational field strength, g = 10 N/kg)

Use the equation:

change in gravitational potential energy = mass $\times$ g $\times$ change in vertical height

(2)

height raised = ... m

(Total for Question 4 = 10 marks)

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5 The efficiency of an electric motor is investigated as shown in Figure 11.

The motor lifts a mass at a constant speed.

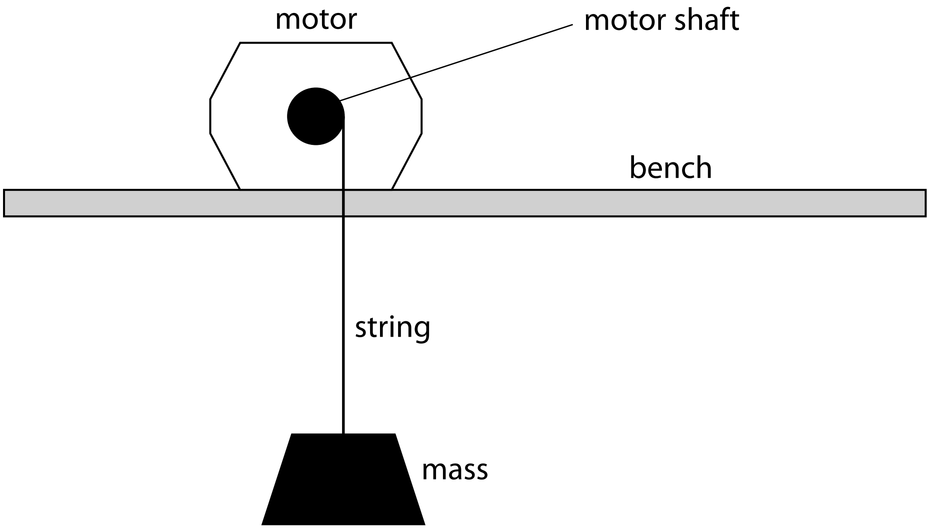

Figure 11

The results are shown in Figure 12.

current in motor	1.9 A
voltage across motor	10.0 V
time taken to lift mass	9.0 s

Figure 12

(a) (i) Which of these changes would improve the results?

(1)

☐ **A** Repeating the investigation with different masses

☐ **B** Repeating the readings and calculating averages

☐ **C** Using a motor that works with a higher voltage

☐ **D** Using a shorter piece of string to lift the mass

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(ii) Which of these best shows the energy stores as the mass is lifted?

(1)

		kinetic energy of the mass	potential energy of the mass
☒	**A**	constant	increasing
☒	**B**	constant	decreasing
☒	**C**	decreasing	increasing
☒	**D**	decreasing	decreasing

(b) (i) Show that the total energy supplied to the motor in the 9 s is about 170 J.

(2)

(ii) During the 9 s the efficiency of the motor is 70%.

Calculate the amount of useful energy transferred in the 9 s.

Use the equation

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy supplied}}$$

(3)

useful energy = ... J

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(c) Which row of the table is correct for the resistance of the motor?

(1)

	resistance of motor =	resistance of motor =
☒ **A**	$I \div V$	$I^2 \div P$
☒ **B**	$V \div I$	$P \div I^2$
☒ **C**	$V \div I$	$P \times I^2$
☒ **D**	$I \times V$	$P \div I^2$

(d) When the motor lifts the mass, the coil in the motor becomes warm.

Explain why the coil becomes warm.

(3)

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(Total for Question 5 = 11 marks)

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6 (a) Figure 13 shows a tank for holding water.

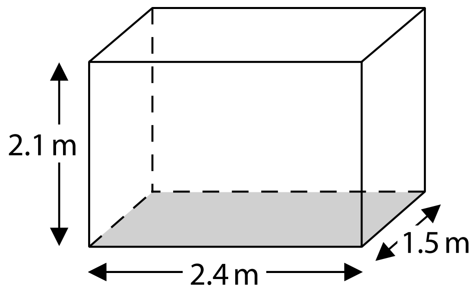

Figure 13

The tank has sides of 2.4 m, 2.1 m and 1.5 m.

The pressure at the bottom of the tank is 12 kPa.

(i) State the equation relating pressure, force and area.

(1)

(ii) Calculate the weight of water in the tank.

(4)

weight = ... N

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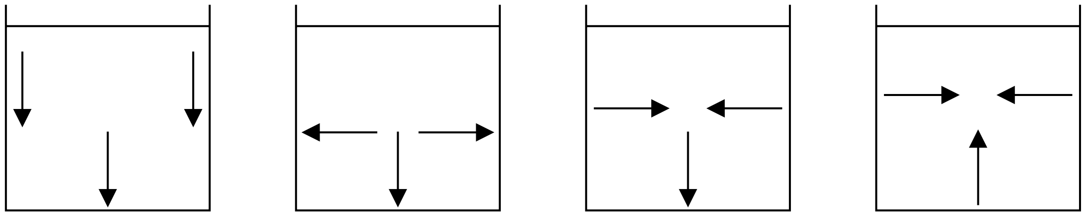
(iii) Which diagram shows the direction of the forces from the water on the inside of the tank?

(1)



☐ **A** ☐ **B** ☐ **C** ☐ **D**

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(b) A student makes the following hypothesis:

'*When I increase the pressure on a fixed mass of gas, the volume of the gas decreases.*'

She has the equipment shown in Figure 14.

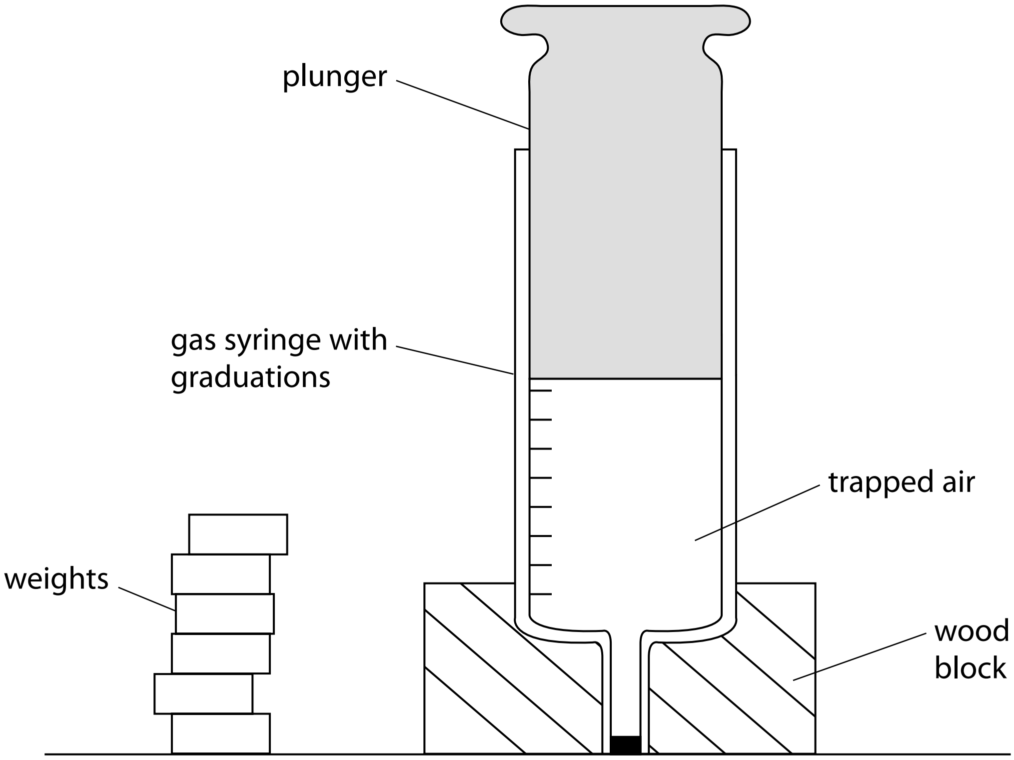

Figure 14

She measures the area of the plunger.

Devise a plan to test her hypothesis.

(4)

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(Total for Question 6 = 10 marks)

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7 (a) Balloon **P** hangs from an insulating thread.

A teacher gives the balloon a positive electric charge, as shown in Figure 15.

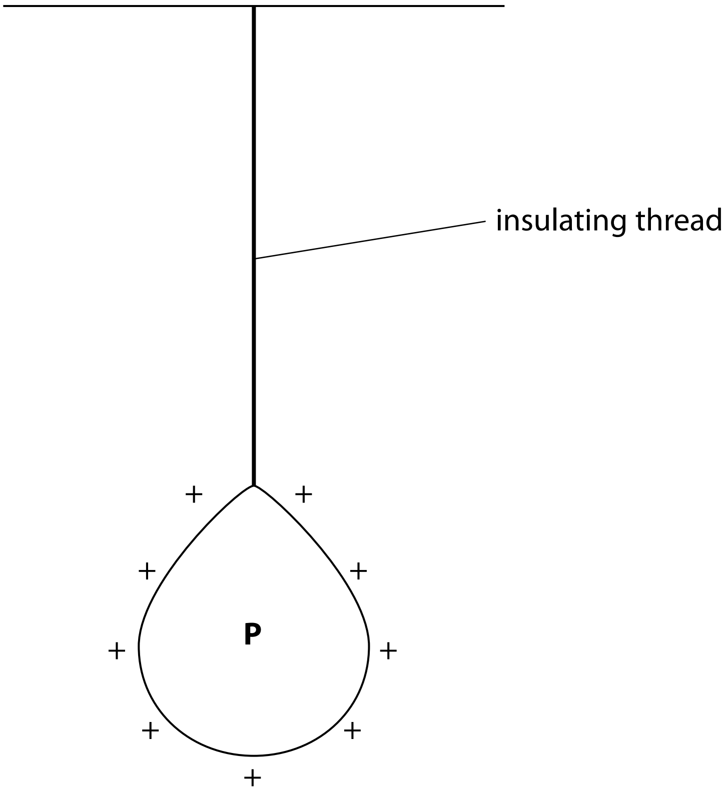

Figure 15

(i) When the balloon is charged like this, it has

(1)

☒ **A** gained electrons

☒ **B** lost electrons

☒ **C** gained protons

☒ **D** lost protons

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(ii) Two more balloons, **Q** and **R**, are charged and placed either side of balloon **P**.

The balloons move to the positions shown in Figure 16.

Add the charges on balloons **Q** and **R** in Figure 16.

(2)

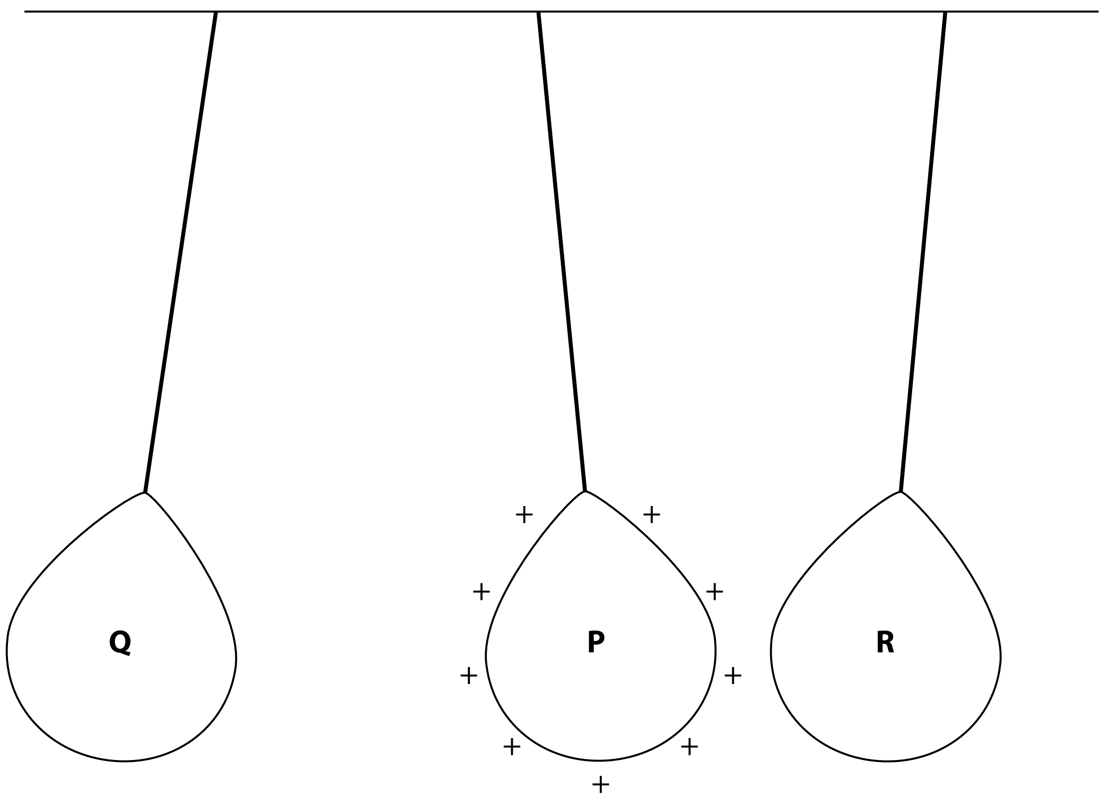

Figure 16

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(b) Figure 17 shows an airport worker refuelling an aircraft.

(Source: © Stanisław Tokarski/123RF)

Figure 17

(i) As fuel moves through the pipe, it becomes positively charged.

Explain how the worker can prevent a build-up of charge when pumping fuel into the aircraft.

(3)

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(ii) Explain how an aircraft can become electrically charged as it flies through the air.

(2)

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(c) 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)

time = ... s

(Total for Question 7 = 11 marks)

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8 A student investigates how the resistance of a thermistor varies with temperature.

(a) The student uses the equipment shown in Figure 18 to measure the temperature of the thermistor.

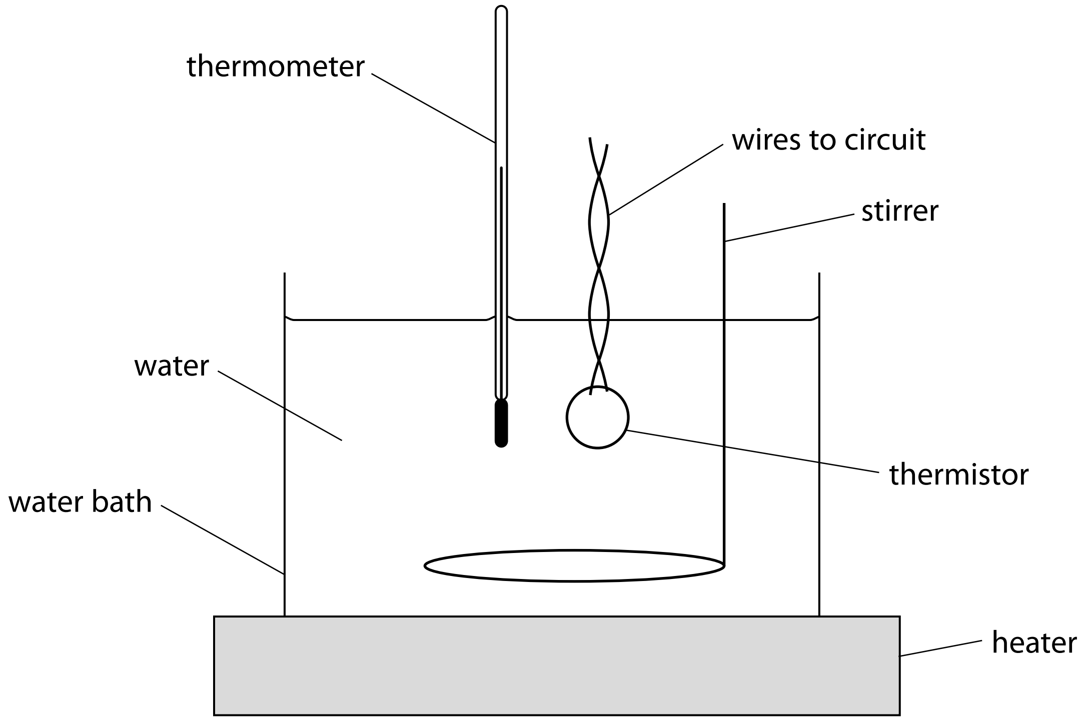

Figure 18

(i) Give **one** reason for using a water bath.

(1)

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....

(ii) The equipment shown in Figure 18 is for investigations in the temperature range from 20 °C to 100 °C.

State **one** way the student could develop this experimental procedure to investigate temperatures outside this range.

(1)

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(b) The student takes measurements for two other components, **A** and **B**.

The results for both these components are shown in Figure 19.

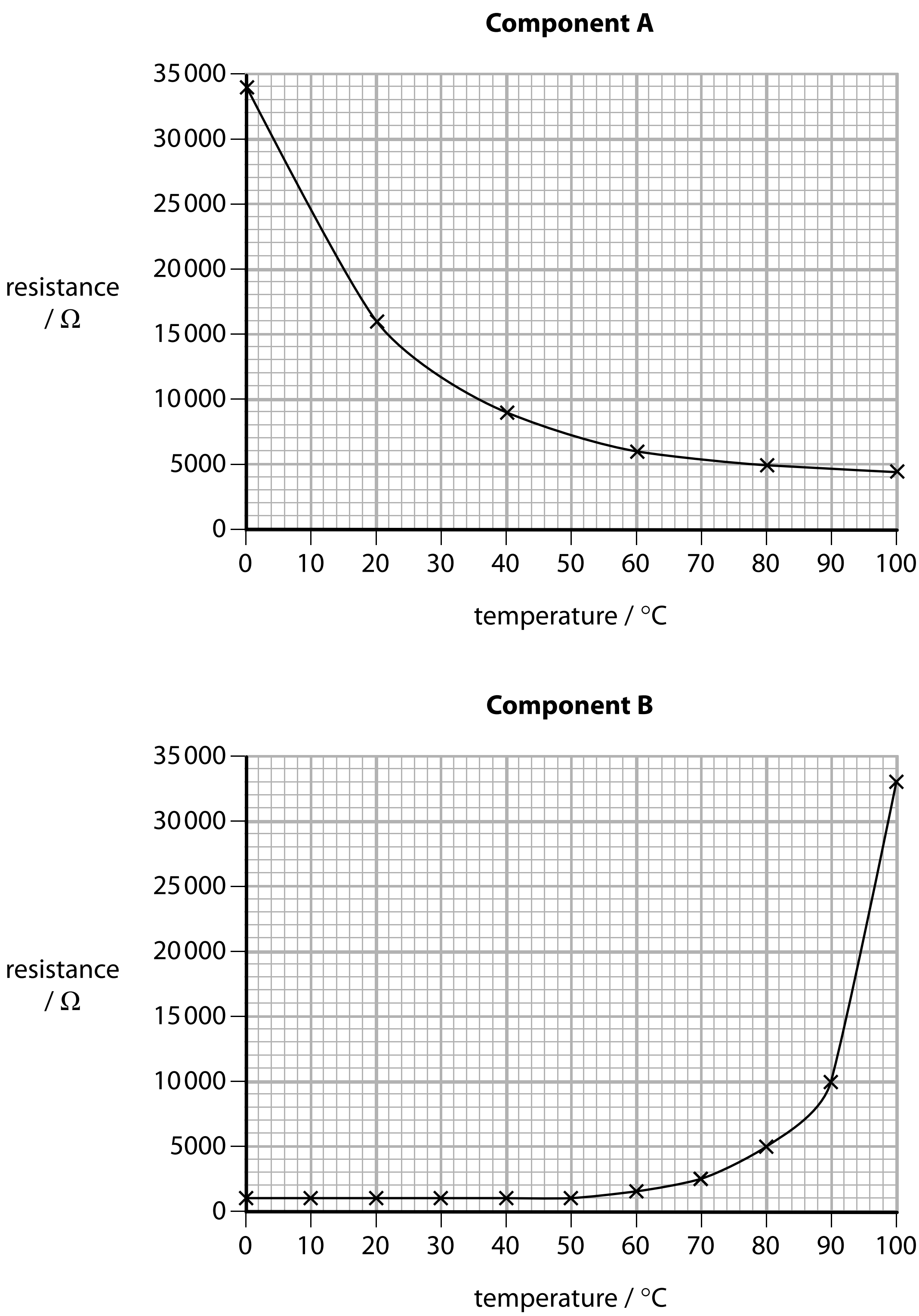

Figure 19

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Compare and contrast how the resistances of component **A** and component **B** vary with temperature.

(3)

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*(c) Describe how the student should carry out an experiment to determine the specific heat capacity of water.

(6)

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(Total for Question 8 = 11 marks)

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9 A student uses a digital calliper to measure the length of a spring, as shown in Figure 20.

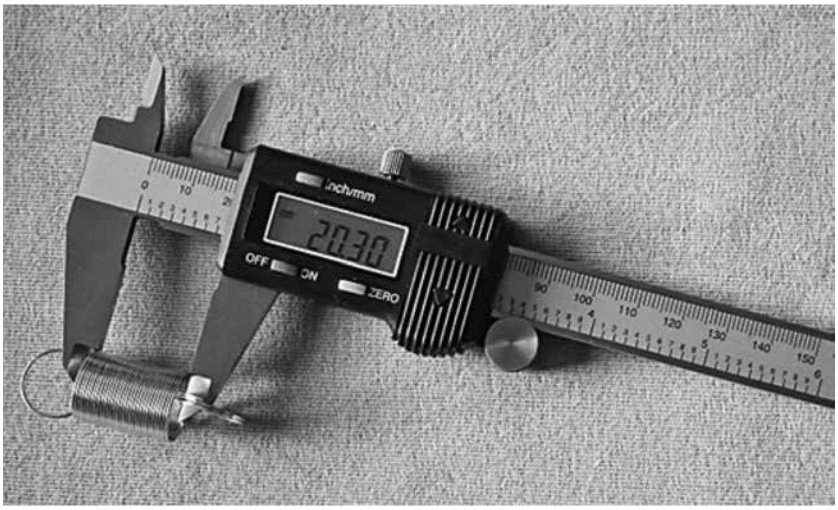

Figure 20

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 21.

Figure 21

(a) Calculate the average length of the spring.

(2)

average length = ... mm

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(b) The student investigates the stretching of a spring with the equipment shown in Figure 22.

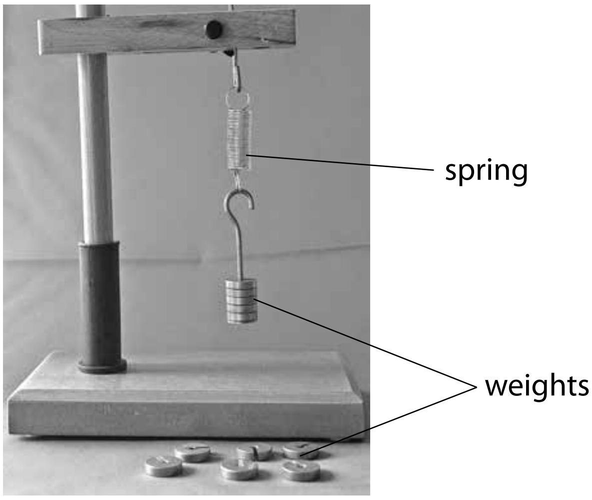

Figure 22

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

The results are shown in Figure 23.

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 23

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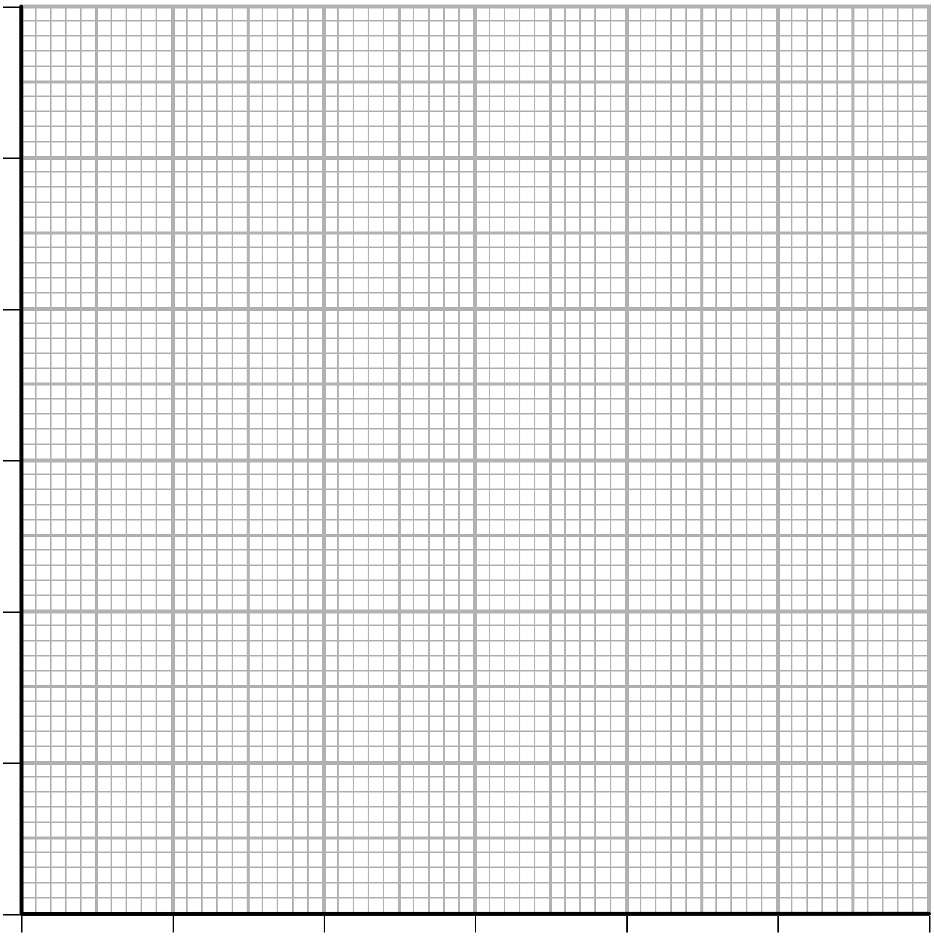
(i) Draw a graph for the readings, using the grid shown.

(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)

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(c) The student extends the investigation by finding information about the stretching of wires.

The student finds the graph shown in Figure 24 for the stretching of a wire.

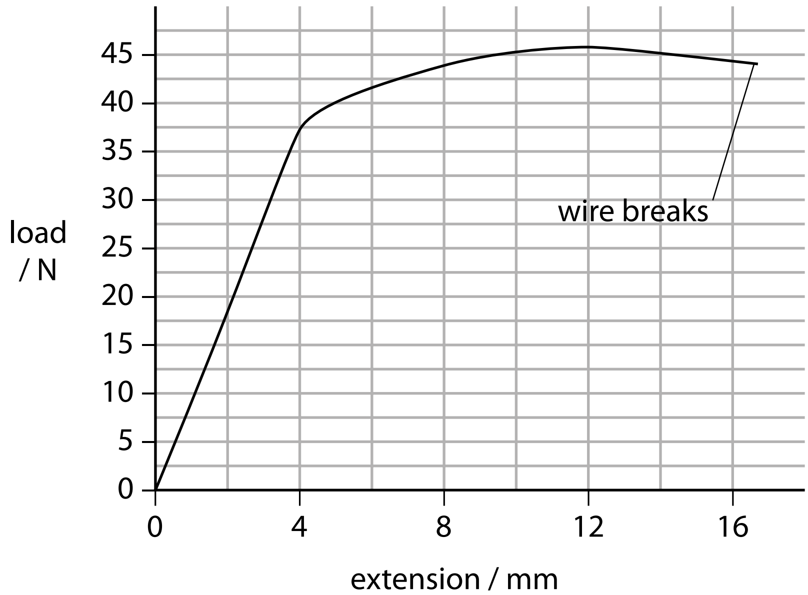

Figure 24

Describe the non-linear stretching of the wire shown in Figure 24.

(3)

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(Total for Question 9 = 11 marks)

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10 A scuba diver is on a sandy beach.

She checks her compressed air cylinders before a dive.
She has two identical steel cylinders, A and B.
Each cylinder contains the same amount of compressed air.

Figure 25 shows the diver's cylinders.

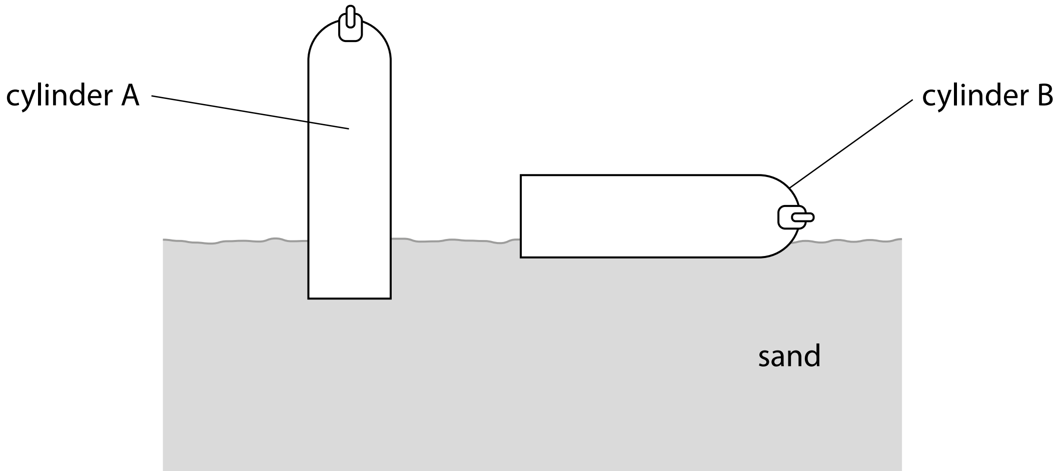

Figure 25

(a) Explain why cylinder A sinks further into the sand than cylinder B.

Use ideas about pressure, force and area in your answer.

(4)

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(b) When underwater, the diver tries to move a large stone block.

The diver uses a long iron bar and a pivot, as shown in Figure 26.

When pushing down with a force of 120 N, the block is balanced.

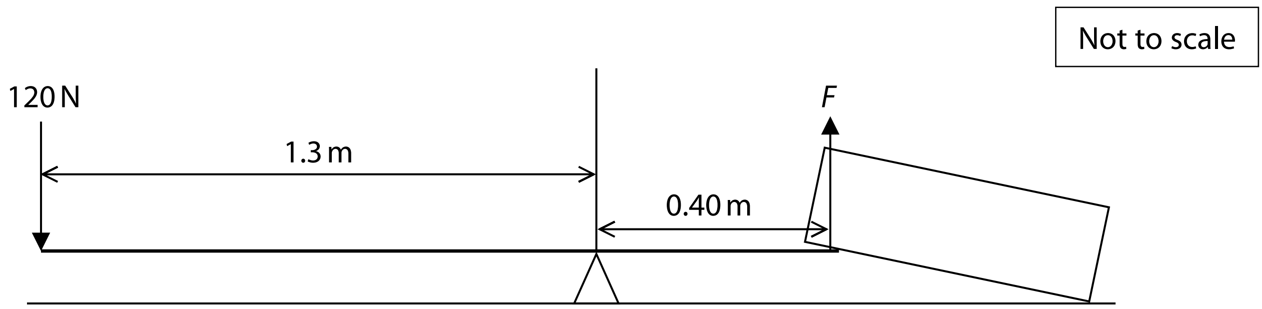

Figure 26

Calculate the size of the force, F, of the bar on the block.

(3)

force = ... N

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*(c) When the diver is swimming under water, she breathes out bubbles of gas, as shown in Figure 27.

(Source: © mihtiander/123RF)

Figure 27

The bubbles of gas rise to the surface.
The temperature of the gas does not change.

Explain what happens to a bubble as it rises to the surface.
Your answer should refer to gas equations, kinetic theory and particles.

(6)

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

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Equations

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance $v^2 - u^2 = 2 \times a \times x$
energy transferred = current × potential difference × time $E = I \times V \times t$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil $V_p \times I_p = V_s \times I_s$
change in thermal energy = mass × specific heat capacity × change in temperature $\Delta Q = m \times c \times \Delta\theta$
thermal energy for a change of state = mass × specific latent heat $Q = m \times L$
$P_1 V_1 = P_2 V_2$ to calculate pressure or volume for gases of fixed mass at constant temperature
energy transferred in stretching = 0.5 × spring constant × (extension)^2 $E = ½ \times k \times x^2$

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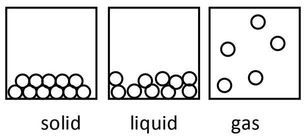
Paper 2 Foundation

Question number	Answer	Additional guidance	Mark
1(a)(i)	In the solid box: regular arrangement and particles touching (1) In the liquid box: irregular arrangement and most particles touching (1) In the gas box: random and spaced (compared to liquid) (1)	ignore variation in particle size ignore arrows/lines indicating movement allow solid and liquid arrangements that do not fill the box 	**(3)**

Question number	Answer	Mark
1(a)(ii)	C	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)(i)	substitution (1) 100 ÷ 13 answer (1) 7.7 (g/cm^3)	award full marks for correct numerical answer without working allow 7.692 (g/cm^3)	**(2)**

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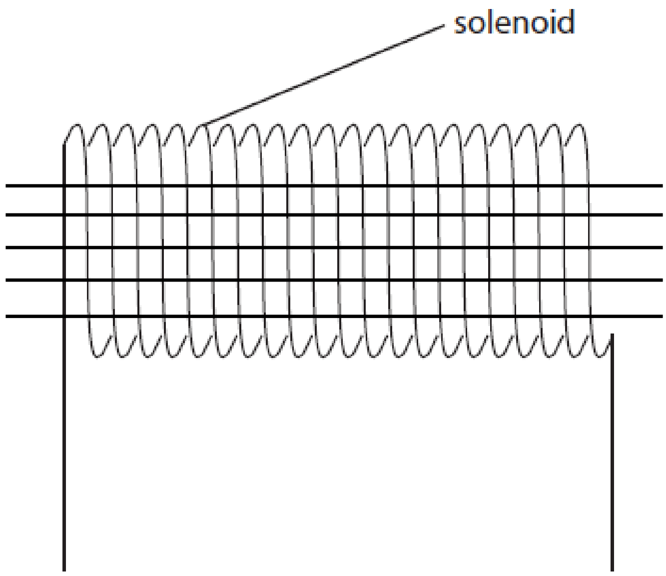
Question number	Answer	Additional guidance	Mark
1(b)(ii)	An answer that provides a description by making reference to: • part fill a measuring cylinder with water and record the starting volume (1) • completely immerse the stone in the water and record the final volume of water and stone (1) • volume of stone = final volume − initial volume (1)	accept valid alternative methods, e.g. fill a displacement can until some water overflows/flows out of spout completely immerse the stone in the displacement can and collect the displaced water in a measuring cylinder volume of water displaced = volume of stone	**(3)**

Question number	Answer	Additional guidance	Mark
2(a)(i)	magnetic lines of force closely packed AND (almost) parallel (1)	ignore any arrows as direction of field is not required ignore any lines outside the coil  	**(1)**

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Question number	Answer	Additional guidance	Mark
2(a)(ii)	An answer that combines the following points of understanding to provide a logical description: • plotting compass placed on card near wire and pencil mark made near N pole of compass (1) • move compass so S pole is above pencil mark and keep repeating this until arrive at starting point (1)	allow sprinkle iron filings on card tap card to allow filings to align with field	**(2)**

Question number	Answer	Mark
2(b)	All three materials correctly identified (1) (rod A – wood, rod B – soft iron, rod C – steel) One mark for each reason: • rod B only attracts paper clips when there is a current in the coil (1) • rod C attracts paper clips when there is a current in the coil and for some time after (1)	**(3)**

Question number	Answer	Mark
3(a)(i)	A	**(1)**

Question number	Answer	Additional guidance	Mark
3(a)(ii)	An answer that provides a description by making reference to: • thermal/heat energy (1) • dissipated in/transferred to air/surroundings (1)	allow heat 'lost' to surroundings	**(2)**

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Question number	Answer	Additional guidance	Mark
3(b)	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): • place the beaker on an insulator (1) • so this (material) will reduce rate of energy transfer (1) or • wrap the beaker in an insulator (1) • so this (material) will reduce the rate of energy transfer (1) or • reduce the surface areas of the water (1) • to give less evaporation (1)	allow named insulator, e.g. cork mat put a lid on the beaker/make the beaker taller and narrower	**(2)**

Question number	Answer	Additional guidance	Mark
3(c)	rearrangement (1) $(l =) \dfrac{\Delta Q}{\Delta m}$ substitution (1) $l = \dfrac{270\,000}{0.12}$ answer (1) 2 250 000 (J/kg °C)	award full marks for correct numerical answer without working 2250 (J/kg °C) gains 2 marks as power of 10 error	**(3)**

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Question number	Answer	Mark
4(a)(i)	B	**(1)**

Question number	Answer	Mark
4(a)(ii)	vertical arrow, acting downward through the suitcase	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)(i)	substitution (1) $(KE =)\ \frac{1}{2} \times 85 \times 1.5^2$ answer (1) 96 (J)	award full marks for correct numerical answer without working allow 95.625 (J)	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	rearrange (1) force = work done ÷ distance answer (1) (force) = 15 (N)	accept rearrangement with values subst., i.e. (force) = 1200 ÷ 80 award full marks for correct numerical answer without working	**(2)**

Question number	Answer	Additional guidance	Mark
4(c)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the work done is the same for walking and running (1) • because work done depends on force and distance only, not time (1)	allow energy for work done because work done ÷ time is power	**(2)**

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Question number	Answer	Additional guidance	Mark
4(d)	rearrangement (1) (height) = change in GPE ÷ (mass × g) answer (1) 2.2 (m)	accept rearrangement with values, i.e. (h) = 264 ÷ (12 × 10) or = 264 ÷ 120 award full marks for correct numerical answer without working	**(2)**

Question number	Answer	Mark
5(a)(i)	B	**(1)**

Question number	Answer	Mark
5(a)(ii)	A	**(1)**

Question number	Answer	Mark
5(b)(i)	substitution into correct equation (1) = 1.9 × 10.0 × 9.0 answer (1) 171 (J) (which is about 170 J) Answer must be shown to 3 significant figures	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	rearrangement (1) (useful energy transferred) = efficiency × total energy supplied substitution (1) = (70 × 170)÷100 answer (1) 119 (J)	award full marks for correct numerical answer without working accept (useful energy transferred) = 170 × 0.7 OR = 171 × 0.7 accept alternative answer from 171 (J) i.e. 120 (J)	**(3)**

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Question number	Answer	Mark
5(c)	B	(1)

Question number	Answer	Mark
5(d)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • the coil contains wires which have a resistance (1) • and current in the wire is due to movement of electrons through (close-packed) lattice of positive ions (1) • hence collisions between electrons and ions in the lattice transfer energy from electrons to the lattice (causing the temperature of the wires/coil to rise) (1)	(3)

Question number	Answer	Mark
6(a)(i)	pressure = force ÷ area	(1)

Question number	Answer	Additional guidance	Mark
6(a)(ii)	rearrangement (1) (F =) $P \times A$ calculation of area (1) 2.4 × 1.5 = 3.6 substitution (1) (F =)12 000 × 3.6 answer (1) 43 200 (N)	award full marks for correct numerical answer without working maximum 3 marks if kPa not converted to Pa	(4)

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Question number	Answer	Mark
6(a)(iii)	B	**(1)**

Question number	Answer	Mark
6(b)	An answer that combines the following points to provide a plan: • put weights on the plunger to increase the pressure of the trapped air (1) • use scale on syringe to measure the volume of trapped air (1) • calculate the pressure from P = weight added/area of plunger (1) • compare the increase in pressure to the volume of trapped air (1)	**(4)**

Question number	Answer	Mark
7(a)(i)	B	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	• label to indicate that balloon Q has a positive charge (1) • label to indicate that balloon R has a negative charge (1)	accept responses showing appropriate +/− signs or worded label	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – understanding (2 marks): • use of a conductor to connect between aircraft and ground (1) • allowing negative charge to move onto the aircraft (1) • therefore neutralising the positive charge(s) (1)	accept (copper) wire accept earth for ground	**(3)**

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Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • there is friction between aircraft and air (1) • which causes electron transfer between aircraft and air (1)	accept idea of air rubbing against wings ignore "charge" "static" do not allow (for second mark) idea of protons moving	**(2)**

Question number	Answer	Additional guidance	Mark
7(c)	equating energy in both equations (1) E = weight × height = power × time rearrangement (1) time = $\frac{(\text{weight} \times \text{height})}{\text{power}}$ substitution and answer (1) time = $230\,000 \times \frac{4.7}{1600}$ time = 680 (s)	allow answers which round to 680, e.g. 675.6	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	Any one reason from: • the thermistor and the water are at the same temperature (1) • large volume of water gives a steady temperature rise (1)	accept idea that only small part of thermometer would be in contact with a thermistor in air accept difficult to control change in temperature of thermistor when heated in air	**(1)**

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Question number	Answer	Additional guidance	Mark
8(a)(ii)	Any one of the following developments to the procedure: • add ice to increase lower limit of temperature range (1) • use liquid with higher boiling point to increase upper limit of temperature range (1)	accept named liquid with higher boiling point, e.g. oil	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)	A comparison and contrast that must include at least **one** similarity and **one** difference from the following points to a maximum of three marks: Similarities • resistance of both changes with temperature (1) • both graphs show a non-linear relationship (1) • data comparison, e.g. both have the same resistance at 80 °C (1) Differences • resistance of A decreases with temperature but resistance of B increases with temperature (1) • for A, (largest slope/rate of change) is at lower temperature but for B, (largest slope/rate of change) is at higher temperature(s) (1) • for B, resistance is constant below 50 °C but for A resistance is roughly constant above 60 °C (1)	accept (smallest slope/rate of change) for A is at higher temperature but (smallest slope/rate of change) for B is at lower temperature	**(3)**

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Question number	Indicative content	Mark
*8(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. **AO1 (6 marks)** • Use of top pan balance to measure mass • Insulate beaker to reduce heat loss • Ammeter connected in series with heater • Voltmeter connected in parallel with heater • Use of $E = I \times V \times t$ to determine energy supplied to the water • Accept use of joule-meter to measure energy supplied • Use of $\Delta E = m \times c \times \Delta\theta$ to determine the specific heat capacity of the water • Measure p.d. across heater • Use stopwatch to measure time liquid is heating • Measure current in heater • Determine mass of water as mass of (beaker and water) – mass of beaker • Measure temperature before and after heating	**(6)**

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3–4	Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5–6	Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

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

Question number	Answer	Additional guidance	Mark
9(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
9(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)**

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Question number	Answer	Additional guidance	Mark
9(c)	An answer that combines points of interpretation/evaluation to provide a logical description: • above 37.5 N/4 mm there are large increases of extension for small increases in load (1) • the maximum extension of the wire is about 16.5 mm before it breaks (1) • above 12 mm the wire keeps on extending when the load is reduced below 46 N (1)	accept extension is (much) greater for each 1 N increase in load above 37.5 N	**(3)**

Question number	Answer	Mark
10(a)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (3 marks): • the gas cylinders have the same weight (1) • but cylinder A has the smallest area (that is in contact with the ground) (1) • the smaller the area, the greater the pressure (or reference to $P = \frac{F}{a}$) (1) • hence cylinder A exerts a greater pressure on the ground (1)	**(4)**

Question number	Answer	Additional guidance	Mark
10(b)	rearrangement (1) force up = (force down × distance of force down from pivot)/distance of force up from pivot substitution into correct equation (1) $F = \frac{120 \times 1.3}{0.40}$ answer (1) 390 (N)	award full marks for correct numerical answer without working	**(3)**

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Question number	Indicative content	Mark
*10(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 (6 marks)** • The bubbles get bigger • Molecules of gas in constant motion • Molecules widely spaced and moving randomly • Molecules impact on surface of bubble/liquid molecules • Average of impacts produces gas pressure • Pressure is due to rate at which gas particles collide with liquid molecules/bubble surface • Liquid pressure decreases as bubble rises • $P_1V_1 = P_2V_2$ • If pressure decreases, volume of bubble will increase/volume of bubble must increase to give a decrease in pressure • As volume increases, rate at which particles collide with surface of bubble decreases	**(6)**

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	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) Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	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) Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	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 the question. (AO2) Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

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Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9–1)

Centre Number | Candidate Number

Physics
Paper 1

Higher Tier

Sample Assessment Material for first teaching September 2016
Time: 1 hour 45 minutes

Paper Reference
1PH0/1H

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 There are many different types of waves.

(a) Waves on the surface of water are transverse waves.

Sound waves are longitudinal waves.

Describe the difference between transverse waves and longitudinal waves.

(2)

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(b) Figure 1 shows a ripple tank.

This is used to study the behaviour of water waves.

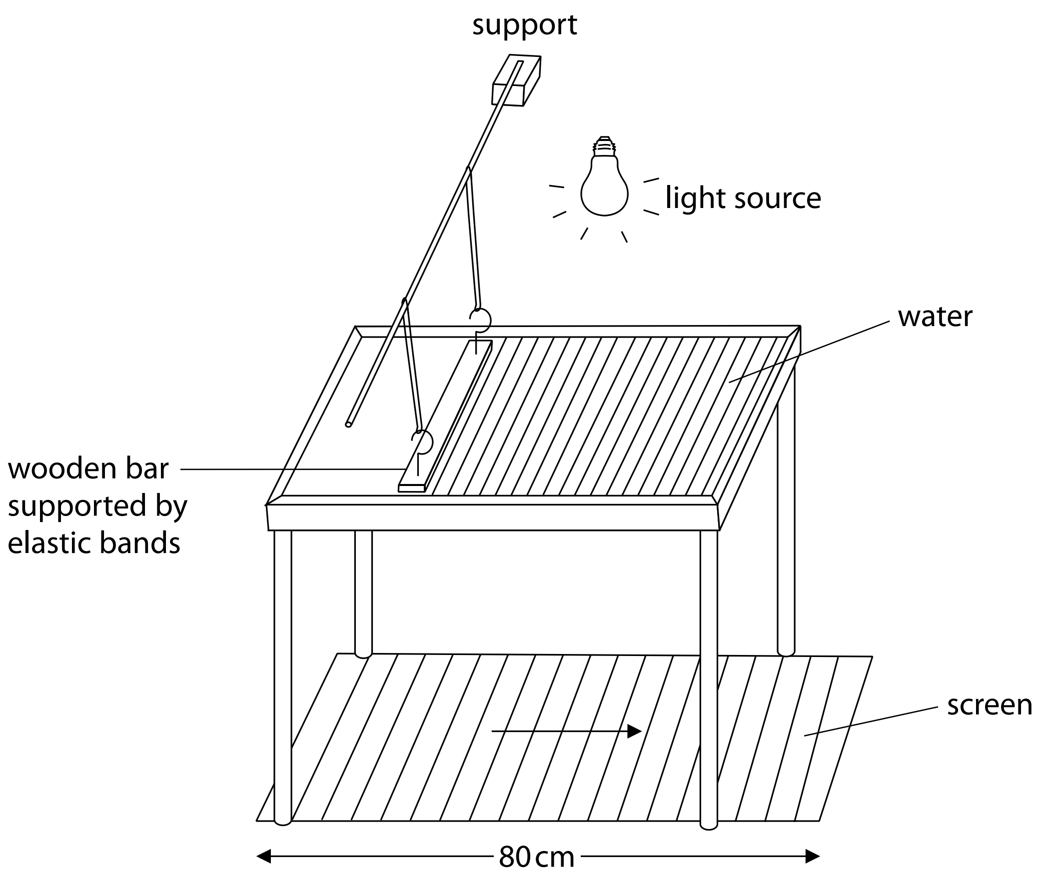

Figure 1

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Water waves are produced in the tank.

The shadow of the waves is projected onto the screen below the tank.

The waves appear to move in the direction of the arrow.

(i) Describe how to determine the frequency of the waves.

(2)

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(ii) The screen is 80 cm long.

What is the approximate wavelength of the waves as seen on the screen?

(1)

☒ **A** 4 cm

☒ **B** 8 cm

☒ **C** 40 cm

☒ **D** 80 cm

(iii) A student uses the image to estimate the speed of the water wave as 75 cm/s.

Which of these is a reason why the estimate is not correct?

(1)

☒ **A** the student used a ruler without mm markings

☒ **B** the light was not bright enough

☒ **C** the student's measurement was inaccurate

☒ **D** the wave seen on the screen is magnified

(Total for Question 1 = 6 marks)

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2 (a) Scientists no longer accept the geocentric model of the universe but it was the accepted theory for hundreds of years.

Explain why the evidence available at the time supported the geocentric model.

(3)

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(b) The Big Bang theory and the Steady State theory are two theories about the origin of the universe.

The discovery of CMB led scientists to accept only one of the theories.

Explain why red shift supports both theories but CMB supports only one of them.

(3)

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(c) (i) A star with a mass very much larger than the Sun

(1)

☒ **A** has a longer main sequence than the Sun and ends as a white dwarf

☒ **B** has a longer main sequence than the Sun and ends as a black hole

☒ **C** has a shorter main sequence than the Sun and ends as a white dwarf

☒ **D** has a shorter main sequence than the Sun and ends as a black hole

(ii) Which row has two correct statements about black holes?

(1)

	the gravitational field of a black hole	**a black hole is formed when**
☒ **A**	allows only electromagnetic radiation to escape	a nebula collapses
☒ **B**	allows nothing to escape	a very large star collapses
☒ **C**	allows nothing to escape	a nebula collapses
☒ **D**	allows only electromagnetic radiation to escape	a very large star collapses

(Total for Question 2 = 8 marks)

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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.

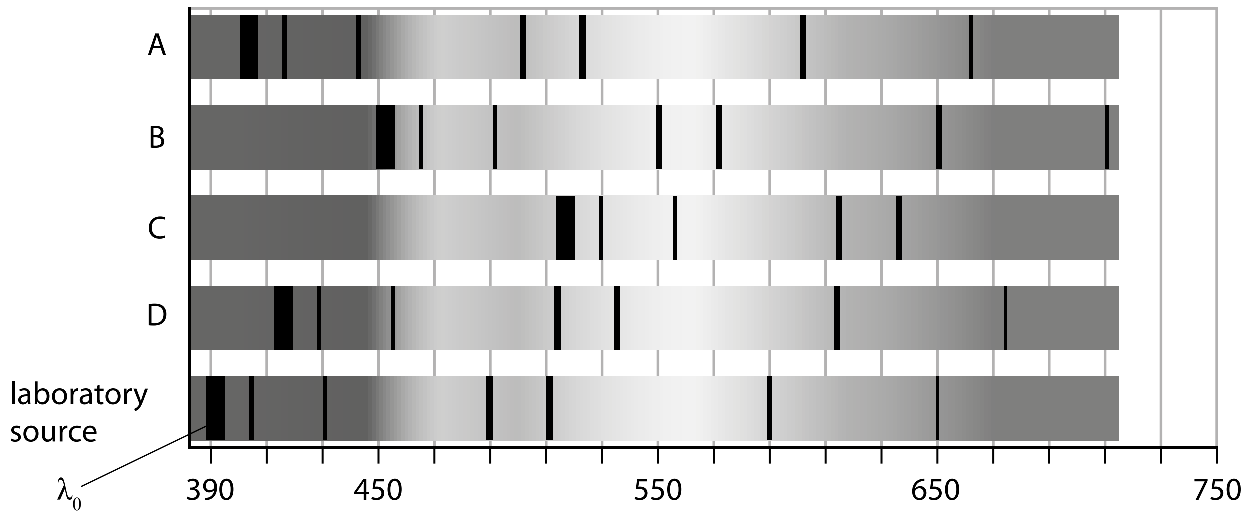

Figure 2

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

(3)

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(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)

$\Delta\lambda$ = ... 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 = ... m/s

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(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 ....

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2 ....

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(Total for Question 3 = 8 marks)

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4 Figure 4 shows two students investigating their 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.

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

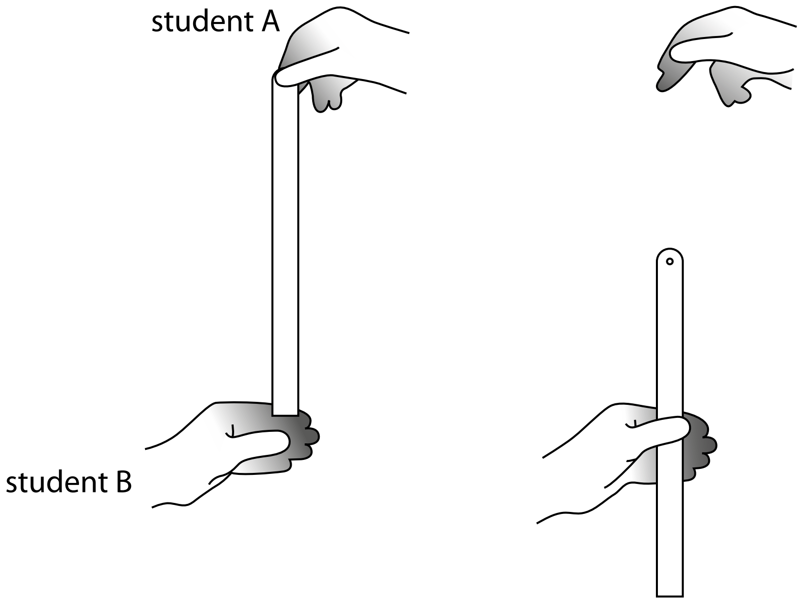

Figure 4

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

Figure 5 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 5

(i) Calculate the average distance dropped for the right hand.

Give your answer correct to 2 significant figures.

(2)

distance = ... cm

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

Use the equation

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

(2)

average time = ... s

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

(2)

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

(2)

1 ....

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2 ....

....

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

(2)

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(Total for Question 4 = 10 marks)

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5 (a) A car accelerates at a constant rate of $1.83\,m/s^2$ 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)

mass = ... kg

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

Calculate the speed of the car after 16 s.

(3)

speed = ... m/s

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(c) The car starts on another journey.

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

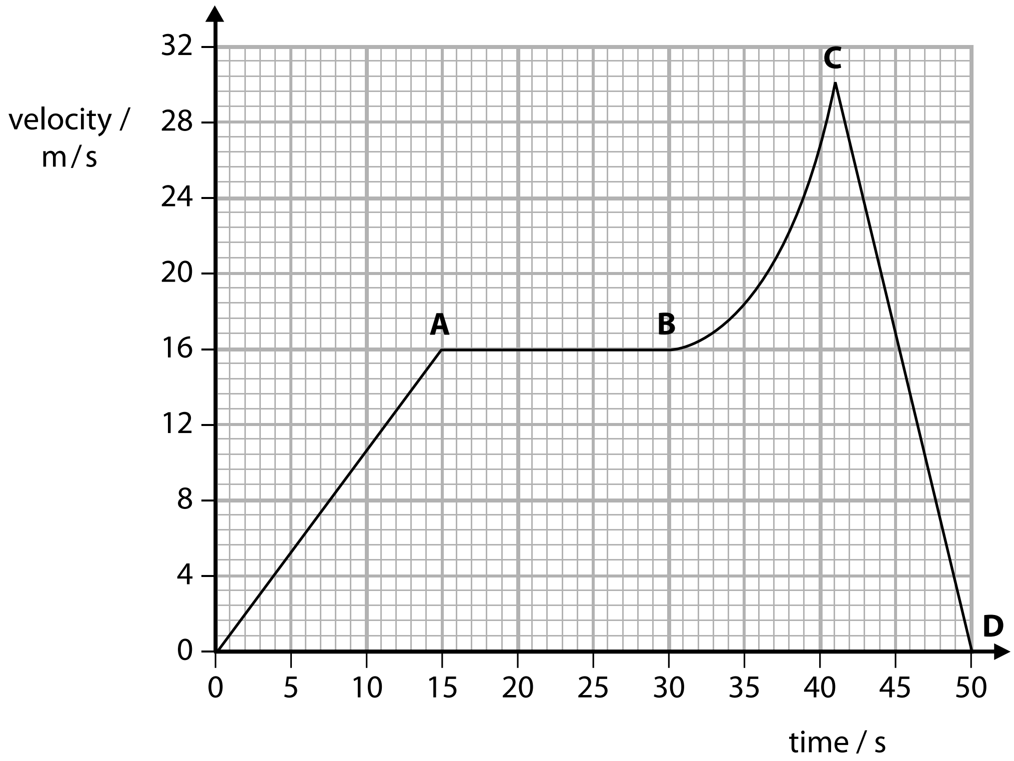

Figure 6

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)

(Total for Question 5 = 10 marks)

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6 Figure 7 shows the nuclei of four atoms.

$^{234}_{92}U$	$^{235}_{92}U$	$^{238}_{94}Pu$	$^{238}_{95}Am$
uranium-234	uranium-235	plutonium-238	americium-238

Figure 7

(a) Which two nuclei have the same number of neutrons?

(1)

☒ **A** plutonium-238 and uranium-235

☒ **B** uranium-235 and americium-238

☒ **C** uranium-234 and americium-238

☒ **D** americium-238 and plutonium-238

(b) (i) State what is meant by the term 'half-life'.

(1)

....

....

(ii) Plutonium-238 is used in spacecraft to provide heat to power generators.

One of these generators contains 925 g of plutonium-238 when it is manufactured.

One gram of plutonium-238 has a power density of 0.54 W/g.

Plutonium-238 has a half-life of 87.7 years.

Calculate the average energy released per second by the generator after 263 years.

(4)

average energy released per second = ... (J)

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(c) The nucleus of americium-238 can absorb an electron.

When this happens, one of the protons in the nucleus becomes a neutron, as shown in Figure 8.

$$ {}^{1}_{1}p + {}^{0}_{-1}e \longrightarrow {}^{1}_{0}n $$

Figure 8

(i) Describe how absorbing an electron affects the proton number and the nucleon number of a nucleus.

(2)

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....

(ii) Deduce which nucleus is formed when americium-238 absorbs an electron.

(1)

☒ **A** uranium-234

☒ **B** uranium-235

☒ **C** plutonium-238

☒ **D** americium-238

(Total for Question 6 = 9 marks)

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7 A student investigates how the average speed of the trolley varies with starting height.

Figure 9 shows the trolley and runway.

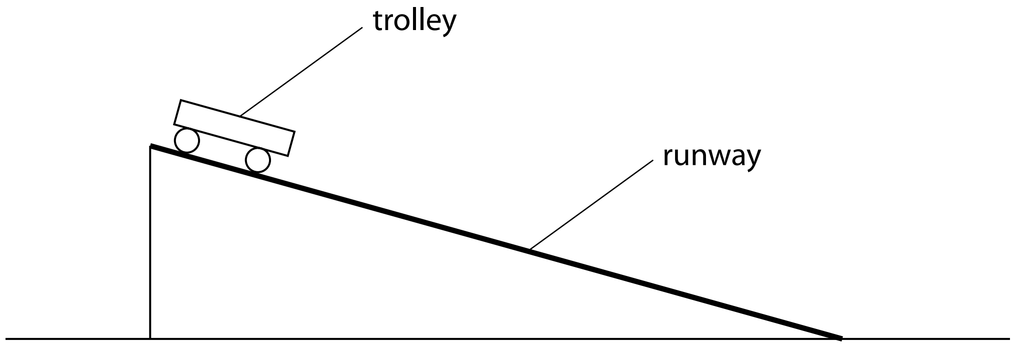

Figure 9

(a) Describe how the student can determine the average speed of the trolley.

(4)

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(b) Figure 10 shows his results.

starting height / m	v / ms^{-1}
0.01	0.22
0.02	0.31
0.04	0.44
0.09	0.66
0.12	0.77
0.14	0.83
0.18	0.94

Figure 10

Figure 11 shows the student's graph.

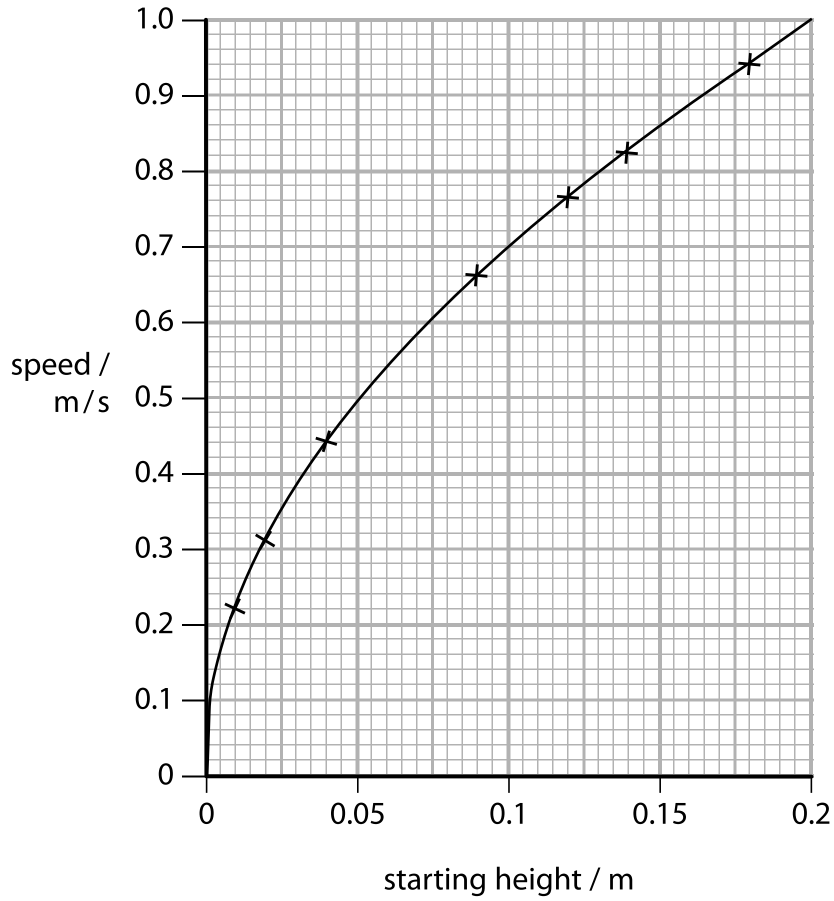

Figure 11

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(i) The trolley has a mass of 650 g.

Calculate the average kinetic energy of the trolley which had a starting height of 0.075 m.

(2)

average kinetic energy= .... J

(ii) Determine the gradient of the graph when the height is 0.1 m.

(2)

gradient = ...

(iii) Describe how the speed of the trolley varies with the changes in height made by the student between 0.04 m and 0.12 m.

(2)

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(c) The student wants to change his experiment to investigate how different surfaces of the runway affect the speed of the trolley down the slope.

Devise an experiment that would allow him to investigate the effect of different surfaces on the average speed of the trolley.

(3)

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(Total for Question 7 = 13 marks)

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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.

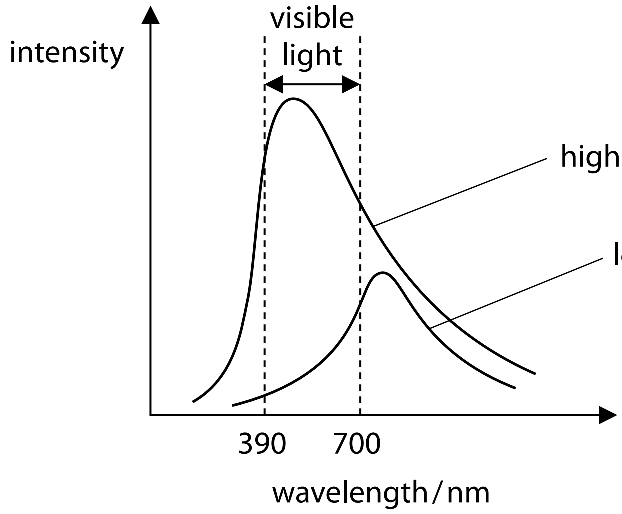

Figure 12

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

(4)

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(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)

count rate = ... counts per minute *(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)

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(Total for Question 8 = 13 marks)

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9 (a) Explain what happens to the wavelength of light when it passes from air into glass.

(2)

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*(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.

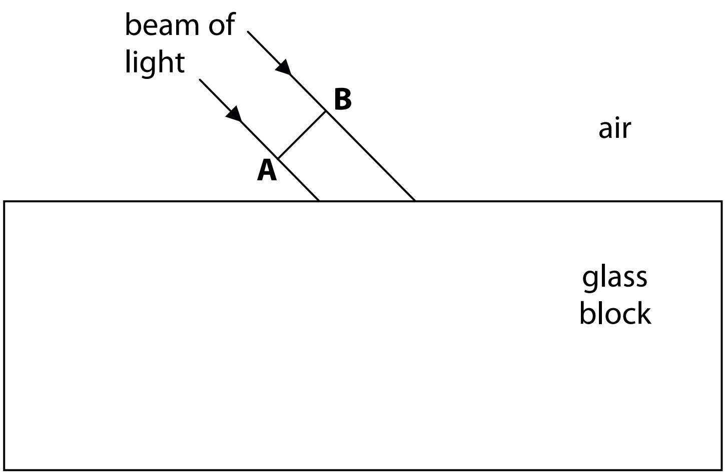

Figure 13

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

(6)

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(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)

frequency = ... Hz

(Total for Question 9 = 12 marks)

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10 In a nuclear reactor, a chain reaction is produced and controlled.

(a) (i) Uranium-235 is the isotope used in many nuclear reactors.

Explain how the fission of uranium-235 can lead to a chain reaction.

(4)

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(ii) Nuclei of beryllium-9 do not absorb neutrons.

Instead, nuclei of beryllium-9 absorb alpha particles and emit neutrons.

Give a reason why a chain reaction can result from the emission of neutrons by uranium nuclei but not by beryllium nuclei.

(1)

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(b) Explain what happen inside a nuclear reactor if neutron speeds are not controlled.

(3)

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(c) Describe how the energy released in the chain reaction in a nuclear reactor is used to drive a turbine in a nuclear power station.

(3)

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(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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Equations

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance

$v^2 - u^2 = 2 \times a \times x$

force = change in momentum ÷ time

$F = \dfrac{(mv - mu)}{t}$

energy transferred = current × potential difference × time

$E = I \times V \times t$

force on a conductor at right angles to a magnetic field carrying a current = magnetic flux density × current × length

$F = B \times I \times l$

$\dfrac{\textit{voltage across primary coil}}{\textit{voltage across secondary coil}} = \dfrac{\textit{number of turns in primary coil}}{\textit{number of turns in secondary coil}}$

$\dfrac{V_p}{V_s} = \dfrac{V_p}{N_s}$

potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil

$V_p \times I_p = V_s \times I_s$

change in thermal energy = mass × specific heat capacity × change in temperature

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

thermal energy for a change of state = mass × specific latent heat

$Q = m \times L$

$P_1 V_1 = P_2 V_2$

to calculate pressure or volume for gases of fixed mass at constant temperature

energy transferred in stretching = 0.5 × spring constant × (extension)^2

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

pressure due to a column of liquid = height of column × density of liquid × gravitational field strength

$P = h \times \rho \times g$

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Paper 1 Higher

Question number	Answer	Mark
1(a)	An answer that provides a description by making reference to: • transverse waves have oscillations perpendicular to direction of travel of the wave (1) • whereas longitudinal waves have oscillations in the same direction as the direction of travel of the wave (1)	**(2)**

Question number	Answer	Mark
1(b)(i)	An answer that combines the following points of understanding to provide a logical description: • take time T for waves to pass a fixed point (1) • and frequency = $\frac{\text{number of waves}}{\text{time taken}}$ (1)	**(2)**

Question number	Answer	Mark
1(b)(ii)	A	**(1)**

Question number	Answer	Mark
1(b)(iii)	D	**(1)**

Question number	Answer	Additional guidance	Mark
2(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • at the time, there was only naked-eye evidence (1) • which indicated Sun/Moon/planets appear to move across the sky (1) • in the same direction, same motion each day (1)	allow valid alternatives, e.g. references to comets	**(3)**

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Question number	Answer	Additional guidance	Mark
2(b)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • both theories predict an expanding universe and the Big Bang theory also predicts that the universe had a beginning (1) • the red shift theory indicates that the universe is expanding so supports both theories (1) • whereas CMB also indicates that the universe had a beginning, so supports Big Bang theory (1)	provided evidence that the Steady State theory was incorrect	**(3)**

Question number	Answer	Mark
2(c)(i)	B	**(1)**

Question number	Answer	Mark
2(c)(ii)	B	**(1)**

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)**

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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) $v = \dfrac{(3\times10^{8})\times(20\times10^{-9})}{(390\times10^{-9})}$ 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)**

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Question number	Answer	Additional guidance	Mark
4(a)(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
4(a)(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)**

Question number	Answer	Additional guidance	Mark
4(b)	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)**

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

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Question number	Answer	Additional guidance	Mark
4(d)	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)

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)

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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)**

Question number	Answer	Mark
6(a)	B	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	The time taken for the activity of a radioactive nuclide to halve (1)	accept for nuclide: isotope sample	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	Determines number of half-lives and rounds (1) 263/87.7 = 3 Determines that 3 half-lives is 1/2 × 1/2 × 1/2 = 1/8 (1) Determines mass of Pu-238 after 3 half-lives (1) 925/8 = 115.625 (g) Determines average energy released per second (1) 115.625 × 0.54 = 62.4 (J)	allow repeated division by 2 allow ecf from step 2 for 1 mark (mass of Pu-238 after1 half-life 925/2 = 462.5 (g)) allow ecf from 1 half-life or from step 3	**(4)**

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Question number	Answer	Mark
6(c)(i)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • proton number/atomic number decreases by 1 (1) • nucleon number/mass number remains unchanged (as p and n have same mass and mass of electron is (assumed) negligible) (1)	**(2)**

Question number	Answer	Mark
6(c)(ii)	C	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)	An answer that combines the following points of understanding to provide a logical description: • measurement of time between(or at) two positions using suitable timing equipment (1) • measurement of suitable distance along the runway with metre rule (1) • measurement of vertical height to starting position (1) • repeats AND averages AND use of a correct equation (1)	allow stopwatch, light gates minimum is 0.5 m metal tape measure average speed = distance/time OR average speed = (speed at A − speed at B)/2	**(4)**

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Question number	Answer	Additional guidance	Mark
7(b)(i)	Substitution of correct data from graph and mass conversion (1) $0.5 \times 0.65 \times (0.61)^2$ Answer (1) 0.12 (J)	maximum of 1 mark if mass in g used allow tolerance of ±0.2 for speed	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	• Tangent to the graph at $h = 0.1$ (1) • Answer in the region 3.5 to 3.6	either seen on graph or suitable pairs of values of Δv and Δh	**(2)**

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Question number	Answer	Mark
7(b)(iii)	An answer that combines points of interpretation/evaluation to provide a logical description: • for each change in height, as the height increases the speed of the trolley increases • the greatest change in speed is between the change in height from 0.04 m to 0.9 m	**(2)**

Question number	Answer	Additional guidance	Mark
7(c)	An answer that combines the following points to provide a logical description of the plan/method/experiment: • identifies control variables (1) • uses at least 3 different surfaces (1) • calculates average speed for each surface and repeats (1)	constant height, constant slope, constant starting points and same length of surface	**(3)**

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)**

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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)**

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)**

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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)

Question number	Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark): • the wavelength decreases because wavelength is the ratio of wave velocity to frequency (1) • and the wave velocity reduces at the boundary but the frequency remains the same (1)	allow the same number of waves per second arrive at the boundary as leave it for no change in frequency at the boundary	**(2)**

Question number	Indicative content	Mark
9(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. **AO1 (6 marks)** • point A reaches the glass block before point B • A moves into the glass block and slows down • as light travels more slowly in glass than in air • B is still in air so is travelling faster than A • this causes part of the wavefront to change direction/refract • by the time B reaches the block it will have travelled further than A • therefore, the whole wavefront changes direction/refracts towards the normal • at the other face, A exits first so the process is reversed • the wavefront changes direction again so it is parallel to its original direction/refracts away from the normal	**(6)**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
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) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

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Question number	Answer	Additional guidance	Mark
9(c)	Substitution into $v = \frac{s}{t}$ to find v (1) $v = \frac{1.5\times10^{11}}{500}$ Substitution into $v = f \times \lambda$ and unit conversion (1) $v = \frac{1.5\times10^{11}}{500} = f \times 670 \times 10^{-9}$ Transposition (1) Rearrangement (1) $f = \frac{\left(1.50\times10^{11}\right)}{500\times\left(670\times10^{-9}\right)}$ Answer (1) 4.5×10^{14} (Hz)	*s* is distance award full marks for correct numerical answer without working maximum 3 marks if λ in nm 4.4776×10^{14} (Hz)	**(4)**

Question number	Answer	Additional guidance	Mark
10(a)(i)	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – knowledge (3 marks): • causes 2 or 3 neutrons to be released (1) • (and) one or more of these (released) neutrons are absorbed by other (U) nuclei (1) • which cause further fission of U nuclei (1) • and release further neutrons that can be absorbed, causing a chain reaction (1)	ignore U nucleus 'splits up'/eq	**(4)**

Question number	Answer	Mark
10(a)(ii)	Idea that to get a chain reaction the particle that impacts the nucleus must be the same as the one released (1)	**(1)**

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Question number	Answer	Additional guidance	Mark
10(b)	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – knowledge (2 marks): • reaction will slow down (1) • because there are fewer fissions (1) • because fission more likely with slow neutrons (1)	allow reactor shuts down/eq fission requires slow neutrons thermal neutrons for slow neutrons	**(3)**

Question number	Answer	Mark
10(c)	An answer that combines the following points of understanding to provide a logical description: • the reactor is surrounded by a coolant (1) • the thermal energy release from the chain reaction heats the coolant (1) • the hot coolant is used to generate steam which is used to drive the turbine (1)	**(3)**

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Write your name here

Surname	Other names

Centre Number					Candidate Number			

Pearson Edexcel
Level 1/Level 2 GCSE (9 - 1)

Physics

Paper 2

Higher Tier

Sample Assessment Material for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference
1PH0/2H

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Figure 1 shows part of a roller coaster ride seen from the side.

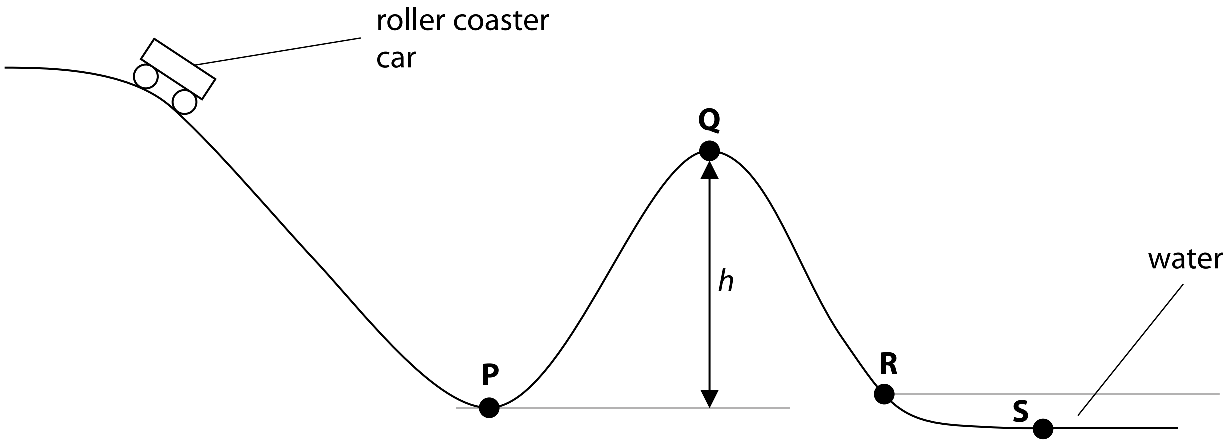

Figure 1

(a) The roller coaster car rolls down towards **P**. The car has mass, m kg and velocity v m/s.

Which of these is the correct equation for calculating the kinetic energy of the car?

(1)

☐ **A** $KE = mv$

☐ **B** $KE = mv^2$

☐ **C** $KE = \frac{1}{2}mv^2$

☐ **D** $KE = 2mv^2$

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(b) The mass of the car is 580 kg.

The car gains 39 000 J of gravitational potential energy as it climbs from **P** to **Q**.

(i) State the equation relating change in gravitational potential energy, mass, gravitational field strength and change in vertical height.

(1)

(ii) Calculate the height h, shown in Figure 1.

(gravitational field strength, g = 10 N/kg)

(3)

h = ... m

(c) The car enters a pool of water at **R**. It slows down and stops at **S**.

Describe how the total energy of the system is conserved as the car travels between **R** and **S**.

(2)

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(Total for Question 1 = 7 marks)

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2 (a) Figure 2 shows a tank for holding water.

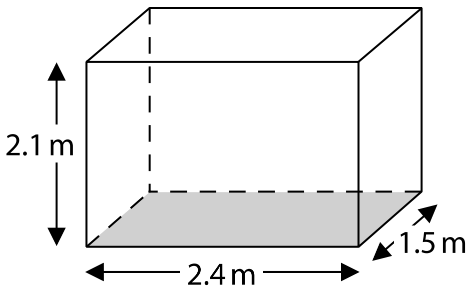

Figure 2

The tank has sides of 2.4 m, 2.1 m and 1.5 m.

The pressure at the bottom of the tank is 12 kPa.

(i) State the equation relating pressure, force and area.

(1)

(ii) Calculate the weight of water in the tank.

(4)

weight = ... N

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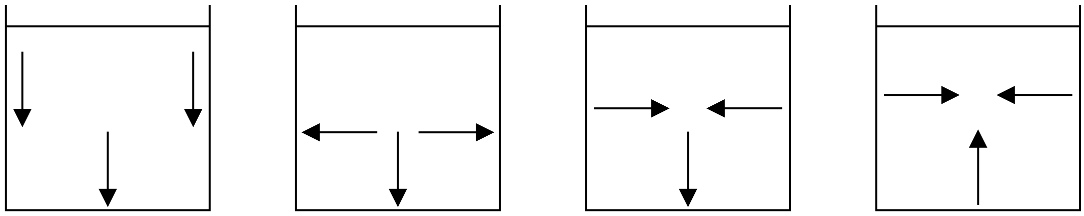
(iii) Which diagram shows the direction of the forces from the water on the inside of the tank?

(1)



☒ **A** ☒ **B** ☒ **C** ☒ **D**

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

Each container contains a liquid, as shown.

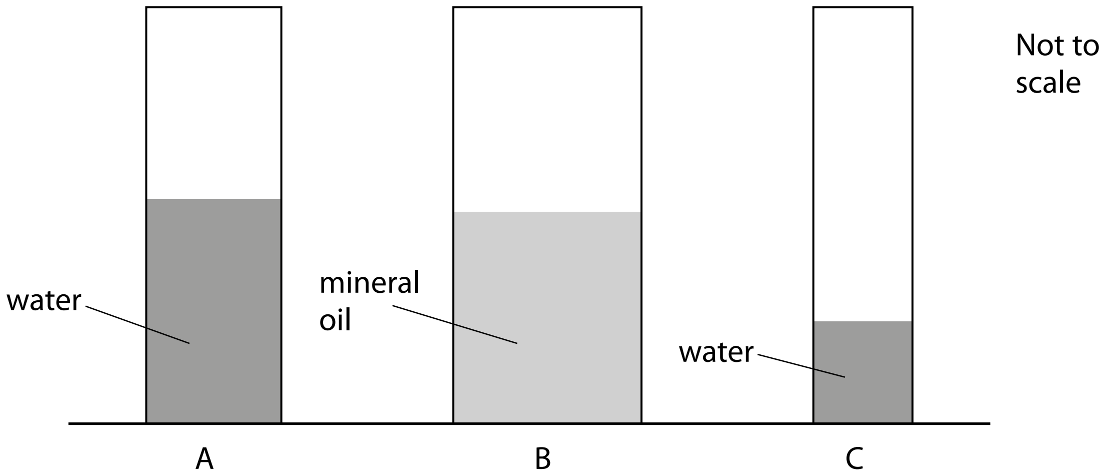


Figure 3

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

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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)

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(Total for Question 2 = 9 marks)

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3 A student investigates how the resistance of a thermistor varies with temperature.

(a) The student sets up the circuit shown in Figure 5 to measure current and voltage.

He finds that it does not work.

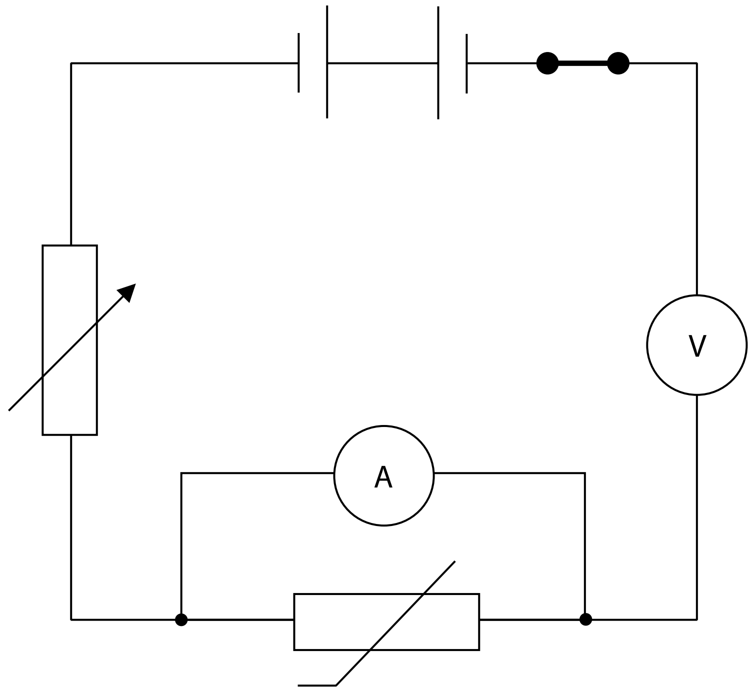

Figure 5

Give **three** modifications the student should make to the circuit so that the circuit works correctly.

(3)

1 ....

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2 ....

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3 ....

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(b) The student uses the equipment shown in Figure 6 to measure the temperature of the thermistor.

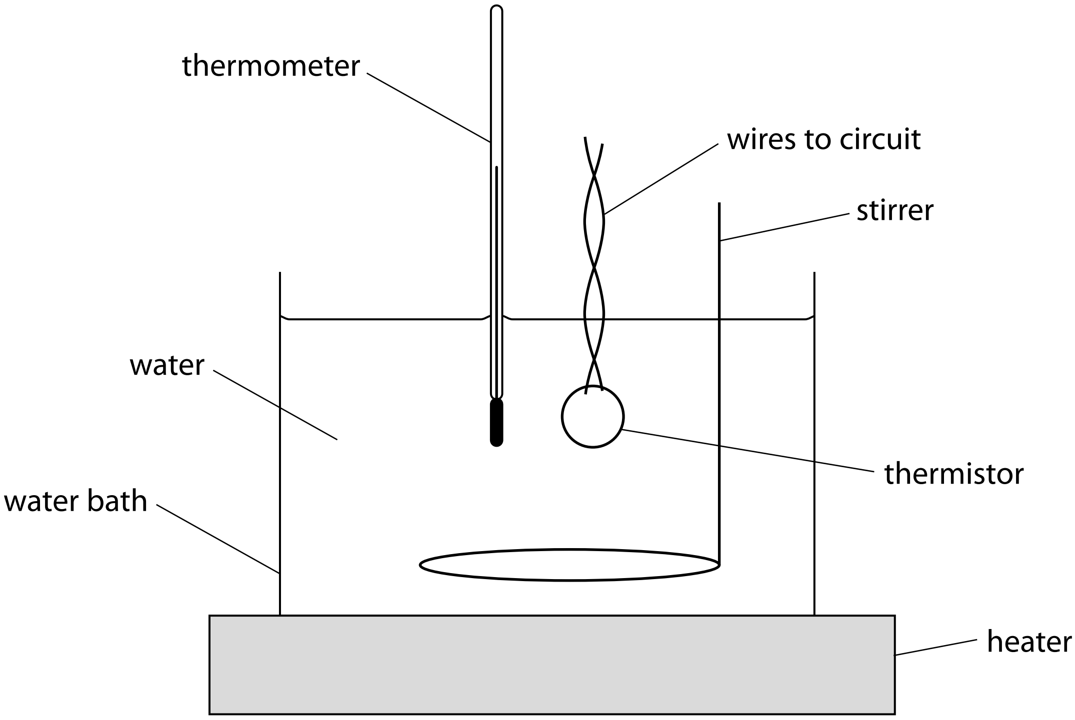

Figure 6

(i) Give **one** reason for using the water bath.

(1)

....

....

(ii) The equipment shown in Figure 6 is for investigations in the temperature range from 20 °C to 100 °C.

State **one** way the student could develop this experimental procedure to investigate temperatures outside this range.

(1)

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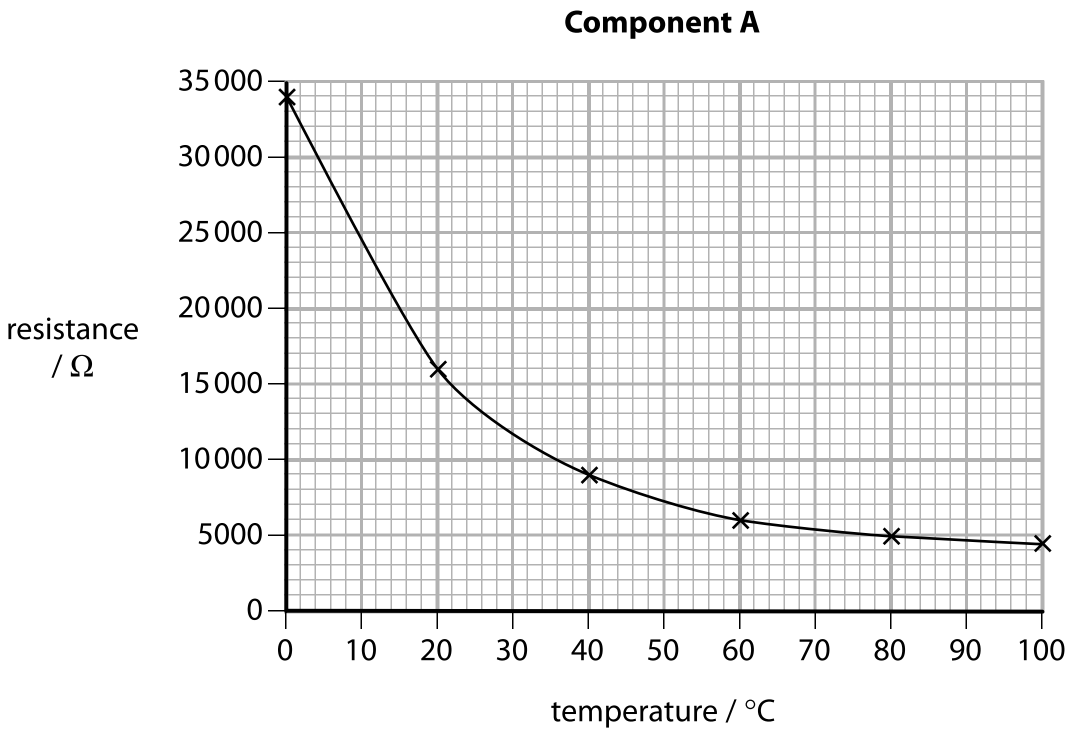
(c) The student takes measurements for two other components, **A** and **B**.

The results for both these components are shown in Figure 7.



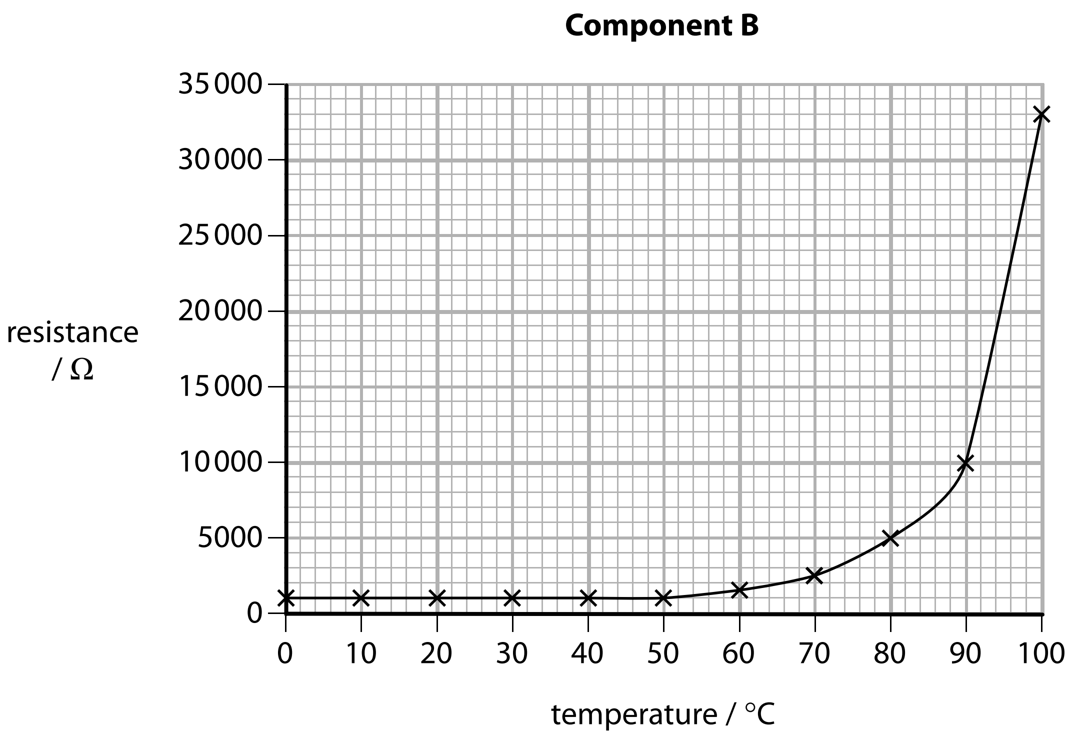


Figure 7

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(i) Compare and contrast how the resistances of component **A** and component **B** vary with temperature.

(3)

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(ii) Component **A** is connected to a 12 V supply.

Which of these is the current in component **A** when the temperature is 80 °C?

(1)

☒ **A** $I = 12 \times 5000$

☒ **B** $I = \dfrac{12}{5000}$

☒ **C** $I = \dfrac{12^2}{5000}$

☒ **D** $I = \sqrt{\left(\dfrac{12}{5000}\right)}$

(Total for Question 3 = 9 marks)

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4 (a) Figure 8 shows an airport worker refuelling an aircraft.

(Source: © Stanisław Tokarski/123RF)

Figure 8

(i) Pumping fuel into an aircraft can be dangerous.

The worker connects an earth wire to the aircraft before pumping fuel.

Give **one** reason why earthing reduces the risk of fire.

(1)

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(ii) Explain how an aircraft can become electrically charged as it flies through the air.

(2)

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(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)

time = ... s

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(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)

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(Total for Question 4 = 8 marks)

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

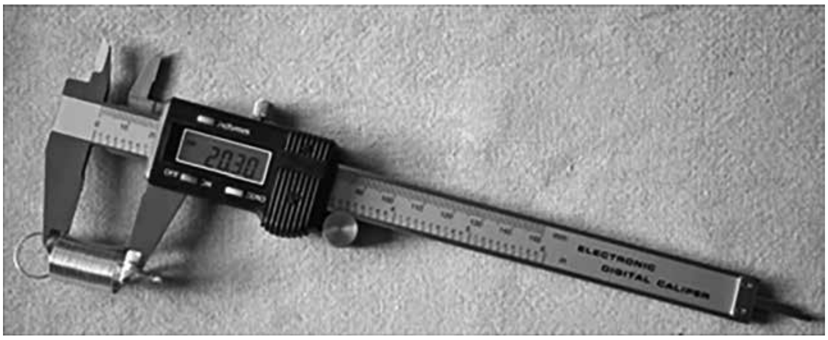

Figure 10

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)

average length = ... mm

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

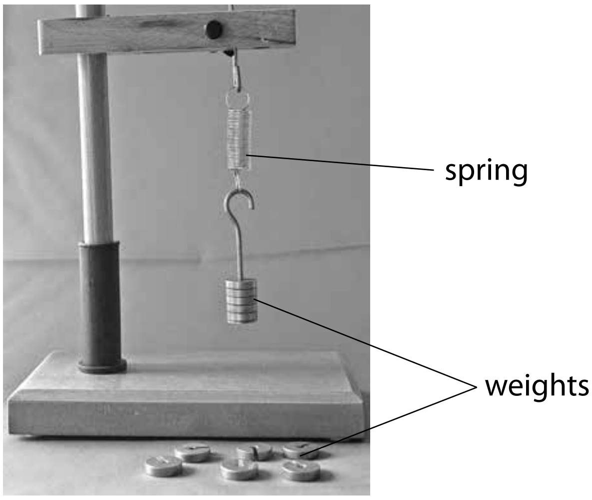

Figure 12

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

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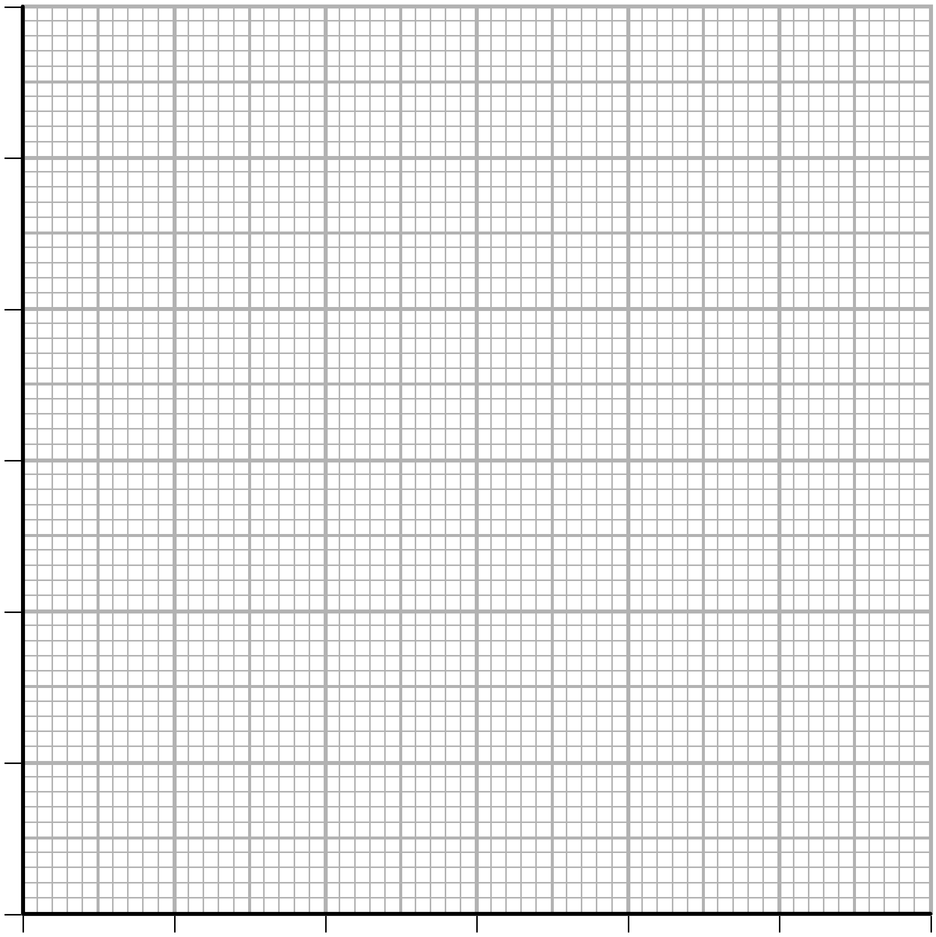
(i) Draw a graph for the readings, using the grid shown.

(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)

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(c) The student extends the investigation by finding information about the stretching of wires.

The student finds the graph shown in Figure 14 for the stretching of a wire.

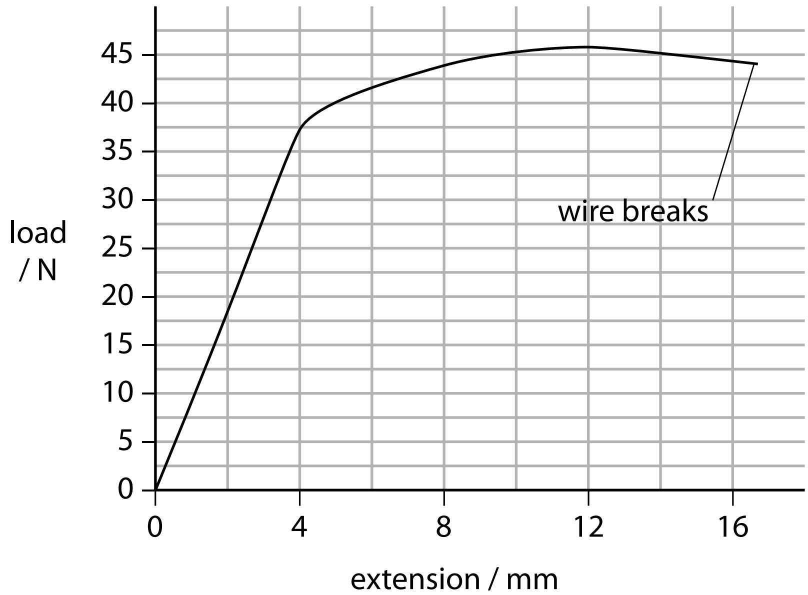

Figure 14

Describe the non-linear stretching of the wire shown in Figure 14.

(3)

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(Total for Question 5 = 11 marks)

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6 Wooden trucks on a toy railway have permanent magnets that hold the train together.

The magnets are arranged so that an N-pole touches an S-pole between each truck, as shown in Figure 15.

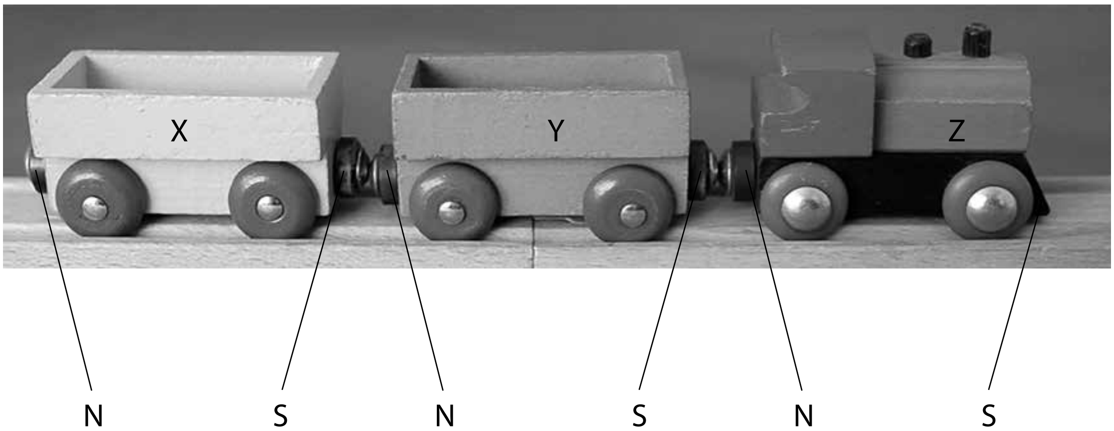

Figure 15

(a) Truck Y is removed from the train, turned through 180° and is then replaced between truck X and Z.

How does this affect the train?

(1)

- ☒ **A** Y attracts both X and Z as before
- ☒ **B** Y still attracts X but now repels Z
- ☒ **C** Y still attracts Z but now repels X
- ☒ **D** Y now repels both X and Z

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(b) The structure of a truck, seen from above, is shown in Figure 16.

The permanent magnets cause a magnetic field both inside and outside the truck.

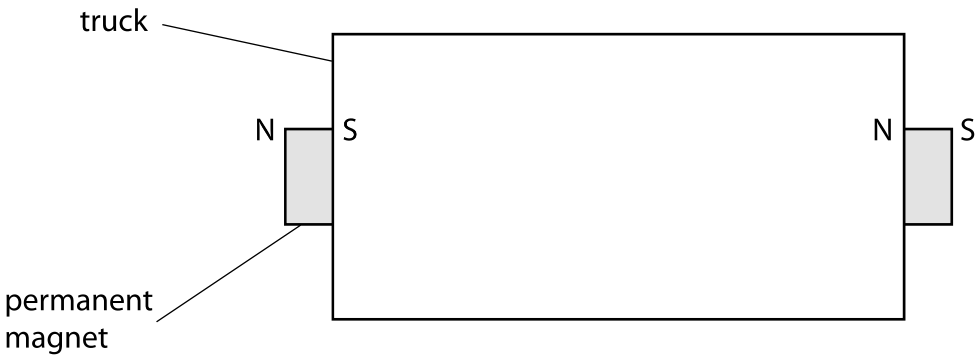
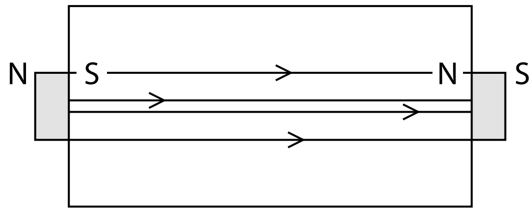


Figure 16

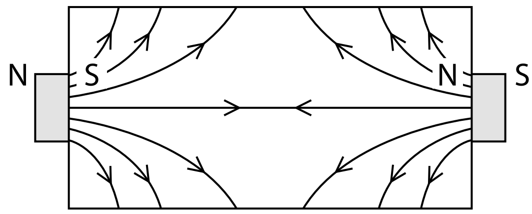
Which of these correctly shows the field inside the truck?

(1)

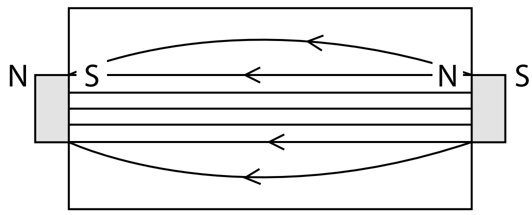
☒ **A**



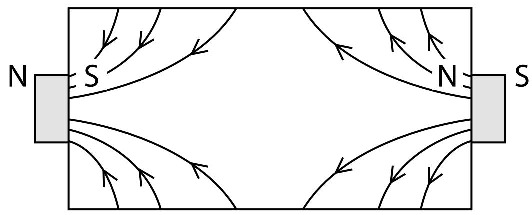
☒ **B**



☒ **C**



☒ **D**



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(c) A student investigates the forces between the trucks in the toy railway.

She places another truck, **W**, next to truck **X**.

She pulls truck **Z** in the direction shown by the arrow.

The whole train travels at a constant speed as shown in Figure 17.

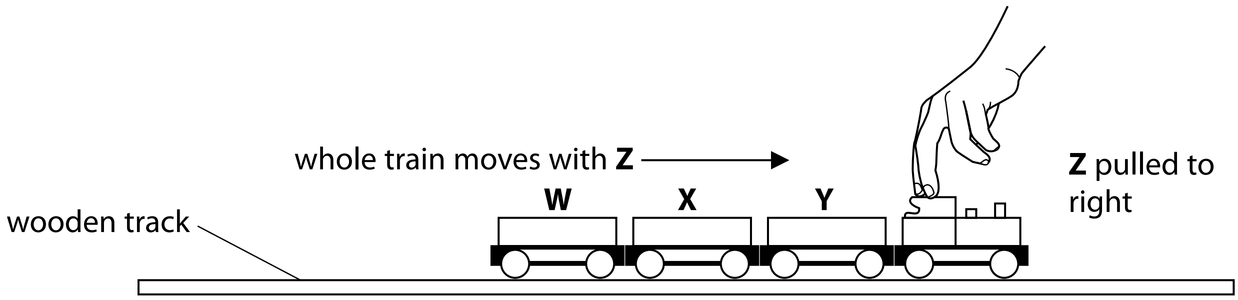

Figure 17

The student repeats this method of adding trucks and pulling the train each time.

When there are seven trucks in total, the train comes apart between **Y** and **Z** when tested as shown in Figure 18.

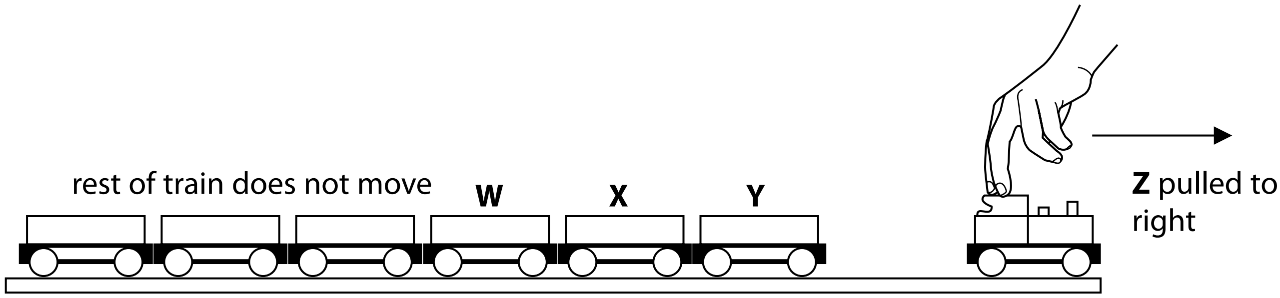

Figure 18

(i) Explain why the train acts in this way by considering the forces involved.

(2)

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(ii) Devise an experiment to investigate the horizontal force needed to separate the trucks from the engine.

(3)

(iii) Explain why a larger force is needed to separate the trucks from the engine if the force is applied at an angle to the horizontal.

(2)

(Total for Question 6 = 9 marks)

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7 (a) A straight piece of wire is 0.713 m long.

It is placed at right angles to a uniform magnetic field of 0.47 T.

The force on the wire is 0.089 N.

Calculate the current in the wire.

Use an equation from the formula sheet. Give your answer to an appropriate number of significant figures.

(2)

current = ... A

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(b) A student investigates the relationship between the magnetic flux density and the electromagnetic force on a current-carrying wire.

The student has the equipment shown in Figure 19.

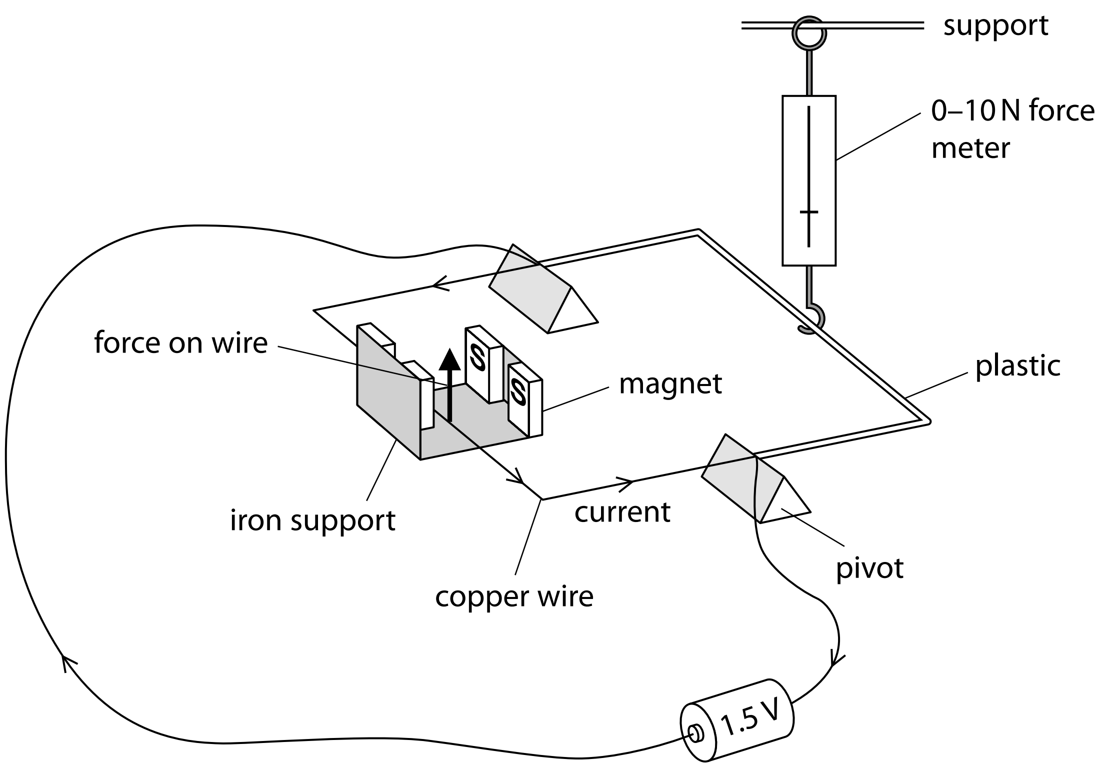

Figure 19

The student varies the number of magnets and measures the force on the wire using the force meter.

The results are shown in Figure 20.

number of pairs of magnets	reading on force meter (N)
1	0.0
2	0.0
3	0.1

Figure 20

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The student decides that his equipment is not sufficiently sensitive.

Give **three** ways the student should develop his investigation to improve the quality of his results.

(3)

1 ....

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2 ....

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3 ....

....

(c) Figures 21 and 22 show different voltages that can be applied across a wire.

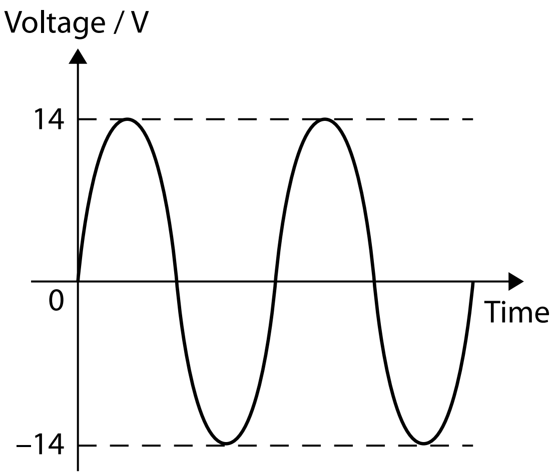

Figure 21

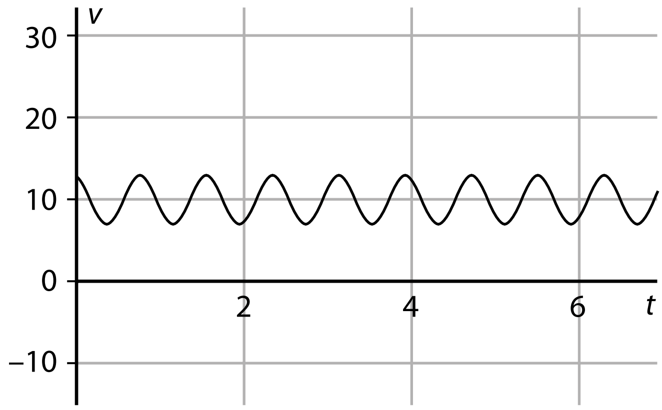

Figure 22

Explain which of the voltages in Figures 21 and 22 cause an a.c. current in the wire.

(2)

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(d) A power transmission wire hangs so that it is at right angles to the Earth's magnetic field.

Although this magnetic field is constant, the cable experiences a changing force.

Explain why the force experienced by the cable changes.

(4)

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(Total for Question 7 = 11 marks)

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8 Figure 23 shows an electric car connected to a battery charger.

(Source: © Danil Roudenko/123RF)

Figure 23

The car has a rechargeable battery to drive its motor.

The rechargeable battery provides a potential difference of 330 V and can store up to 64 MJ.

It takes 8 hours for the battery to receive a full charge.

Assume that the charging process is 100% efficient.

(a) Calculate the total charge that flows while the battery is being charged.

(3)

total charge = ... C

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(b) Calculate the average charging current.

(3)

current = ... A

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*(c) The battery charger shown in Figure 23 is connected to the 230 V a.c. domestic mains supply.

The output voltage of the charger is 335 V and it provides a d.c. charging current. Charging stops if the charging current exceeds 15 A.

Explain how electrical components in the charger can be connected together to give this type of output.

(6)

(Total for Question 8 = 12 marks)

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9 Figure 24 shows a submarine underwater.

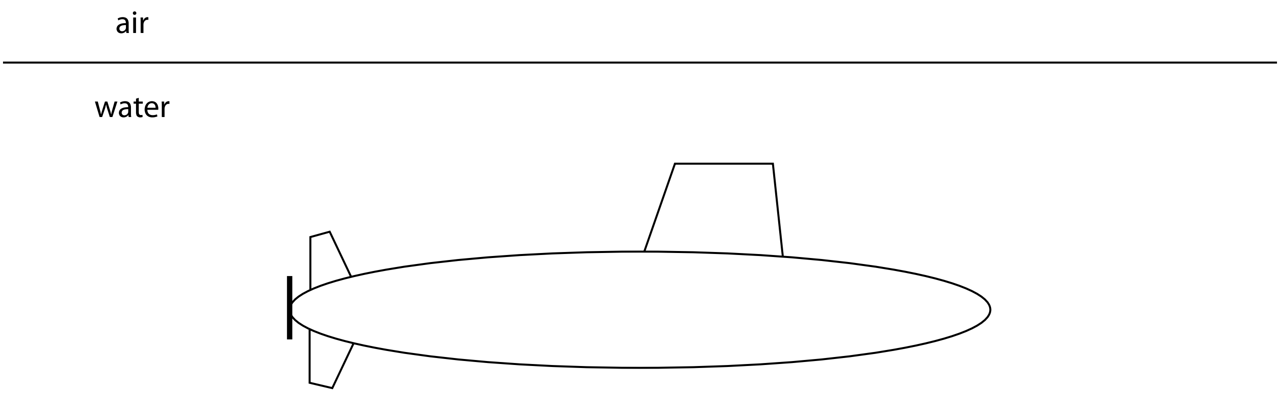

Figure 24

The motor in the submarine turns the gear wheels shown in Figure 25.

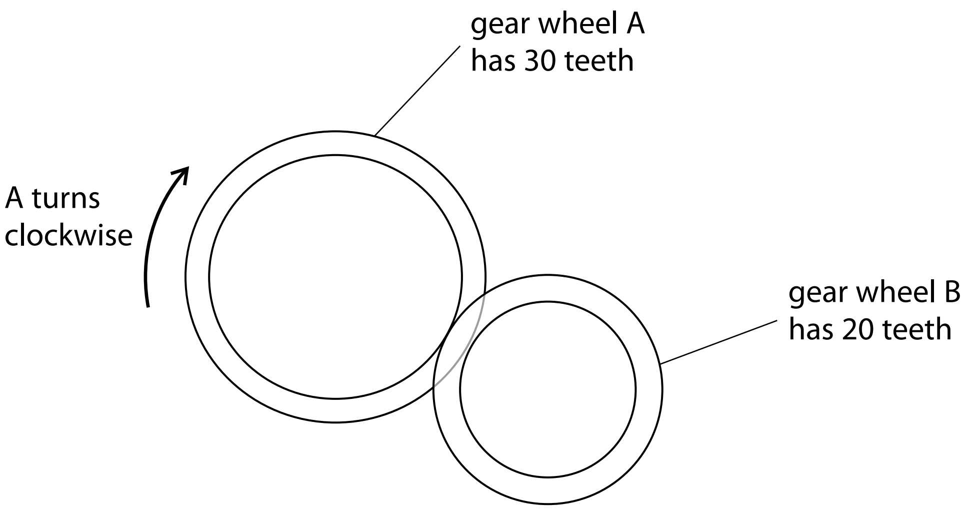

Figure 25

(a) Gear wheel A rotates clockwise through one complete turn.

Which of these is correct for gear wheel B?

(1)

	amount that gear wheel B rotates	direction gear wheel B rotates
☒ **A**	1½ turns	clockwise
☒ **B**	1½ turns	anticlockwise
☒ **C**	⅔ of a turn	clockwise
☒ **D**	⅔ of a turn	anticlockwise

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(b) A bubble of gas escapes from the submarine.

The volume of the bubble is 23.0 cm^3.

The pressure of the gas inside the bubble is 297 kPa.

The bubble rises to the surface without changing temperature.

Calculate the volume of the bubble when it reaches the surface.

Atmospheric pressure = 101 kPa

Use an equation from the formula sheet.

(3)

volume = ... cm^3

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(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)

....

....

....

....

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

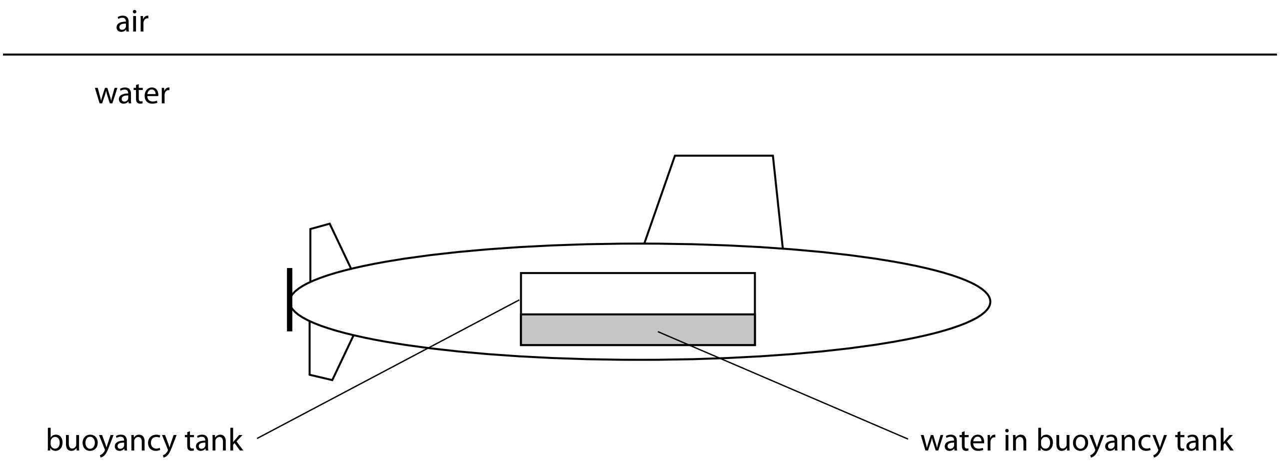

Figure 26

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

(6)

....

....

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(Total for Question 9 = 12 marks)

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10 The espresso machine shown in Figure 27 is an electrical appliance.

(Source: © tanawaty/123RF)

Figure 27

(a) The espresso machine has an electrical heater connected to a 440 V mains supply.

The power of the electrical heater is 3.5 kW.

(i) The rating of a fuse is the current above which it melts.

Which of these is the most suitable fuse for the espresso machine circuit?

(1)

☒ **A** 1 A

☒ **B** 5 A

☒ **C** 10 A

☒ **D** 13 A

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(ii) Before the espresso machine can be used, its heater must raise the temperature of some cold water.

The specific heat capacity of water is 4200 J/kg K.

Show that it takes the heater about 90 s to raise the temperature of 1 kg of water from 18 °C to 95 °C.

Use an equation from the formula sheet.

(3)

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(b) The espresso machine has a steam pipe that can be used to heat milk in a jug, as shown in Figure 28.

(Source: © Wavebreak Media Ltd/123RF)

Figure 28

Steam from the pipe enters the milk, where steam condenses to water.

The steam and hot water heat the milk.

(i) Describe, in terms of energy, how the arrangement and movement of particles in the steam changes as the steam enters the milk, condenses and cools.

(2)

....

....

....

....

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(ii) The specific heat capacity of milk is 3840 J/kg K.

The specific heat capacity of water is 4200 J/kg K.

The specific latent heat of condensation of steam is 2260 kJ/kg.

The temperature of the steam is 100 °C

The mass of steam that condenses is 25 g.

The temperature of the milk rises from 5 °C to 65 °C.

By considering the transfer of energy from the steam to the milk, calculate the mass of milk that is heated by the steam and hot water.

Use equations from the formula sheet.

(4)

mass of milk = ... kg

(iii) Give **two** reasons why the actual mass of steam needed to heat the milk from 5 °C to 65 °C is greater than 25 g.

(2)

1 ....

....

2 ....

....

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

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Equations

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance $v^2 - u^2 = 2 \times a \times x$
force = change in momentum ÷ time $F = \frac{(mv - mu)}{t}$
energy transferred = current × potential difference × time $E = I \times V \times t$
force on a conductor at right angles to a magnetic field carrying a current = magnetic flux density × current × length $F = B \times I \times l$
$\frac{\textit{voltage across primary coil}}{\textit{voltage across secondary coil}} = \frac{\textit{number of turns in primary coil}}{\textit{number of turns in secondary coil}}$ $\frac{V_p}{V_s} = \frac{N_p}{N_s}$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil $V_p \times I_p = V_s \times I_s$
change in thermal energy = mass × specific heat capacity × change in temperature $\Delta Q = m \times c \times \Delta\theta$
thermal energy for a change of state = mass × specific latent heat $Q = m \times L$
$P_1 V_1 = P_2 V_2$ to calculate pressure or volume for gases of fixed mass at constant temperature
energy transferred in stretching = 0.5 × spring constant × (extension)^2 $E = ½ \times k \times x^2$
pressure due to a column of liquid = height of column × density of liquid × gravitational field strength $P = h \times \rho \times g$

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Paper 2 Higher

Question number	Answer	Mark
1(a)	C	(1)

Question number	Answer	Mark
1(b)(i)	change in GPE = mass × gravitational field strength × change in vertical height	(1)

Question number	Answer	Additional guidance	Mark
1(b)(ii)	transformation (1) $h = \Delta E \div mg$ substitution (1) $h = 39\,000 \div (580 \times 10)$ evaluation (1) 6.7 (m)	accept use of $g = 9.81$ accept 6.72 accept 6.85 (from $g = 9.81$)	(3)

Question number	Answer	Additional guidance	Mark
1(c)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • work is done against friction (1) • energy is stored in another specified way (1)	ignore references to friction as energy store acceptable stores are: • KE of water • thermal energy of water • thermal energy of air • (G)PE of water	(2)

Question number	Answer	Mark
2(a)(i)	pressure = force ÷ area	(1)

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Question number	Answer	Additional guidance	Mark
2(a)(ii)	rearrangement (1) (F =) $P \times A$ calculation of area (1) 2.4 × 1.5 = 3.6 substitution (1) (F =) 12 000 × 3.6 answer (1) 43 200 (N)	award full marks for correct numerical answer without working maximum 3 marks if kPa not converted to Pa	**(4)**

Question number	Answer	Mark
2(a)(iii)	B	**(1)**

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)**

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Question number	Answer	Additional guidance	Mark
3(a)	• connect ammeter in series (with thermistor) (1) • connect voltmeter in parallel (with thermistor) (1) • reverse (connections for) one of the cells (1)	allow idea that meters should be swapped for two marks (equivalent to first two points)	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	Any one of the following reasons: • the thermistor and the water are at the same temperature (1) • large volume of water gives a steady temperature rise (1)	accept idea that only small part of thermometer would be in contact with a thermistor in air accept difficult to control change in temperature of thermistor when heated in air	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	Any one of the following developments to the procedure: • add ice to increase lower limit of temperature range (1) • use liquid with higher boiling point to increase upper limit of temperature range (1)	accept named liquid with higher boiling point, e.g. oil	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)(i)	A comparison and contrast that must include at least **one** similarity and **one** difference from the following points to a maximum of three marks: Similarities • resistance of both changes with temperature (1) • both graphs show a non-linear relationship (1) • data comparison, e.g. both have the same resistance at 80°C (1)		**(3)**

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	Differences • resistance of **A** decreases with temperature but resistance of **B** increases with temperature (1) • for **A**, (largest slope/rate of change) is at lower temperature but for **B**, (largest slope/rate of change) is at higher temperature(s) (1) • for **B**, resistance is constant below 50°C but for **A** resistance is roughly constant above 60°C (1)	accept (smallest slope/rate of change) for A is at higher temperature but (smallest slope/rate of change) for B is at lower temperature	

Question number	Answer	Mark
3(c)(ii)	B	**(1)**

Question number	Answer	Mark
4(a)(i)	The earth wire discharges the aircraft to prevent sparking which could ignite the fuel/cause a fire	**(1)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • friction between aircraft and air (1) • causes electron transfer between aircraft and air (1)	accept idea of air rubbing against wings ignore 'charge' and 'static' do not allow (for second mark) idea of protons moving	**(2)**

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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 = $230\,000 \times \frac{4.7}{1600}$ time = 680 (s)	allow answers which round to 680, e.g. 675.6	**(3)**

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)**

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)**

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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)**

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Question number	Answer	Additional guidance	Mark
5(c)	An answer that combines points of interpretation/evaluation to provide a logical description: • above 37.5 N/4 mm there are large increases of extension for small increases in load (1) • the maximum extension of the wire is about 16.5 mm before it breaks (1) • above 12 mm the wire keeps on extending when the load is reduced below 46 N (1)	accept extension is (much) greater for each 1 N increase in load above 37.5 N	**(3)**

Question number	Answer	Mark
6(a)	D	**(1)**

Question number	Answer	Mark
6(b)	C	**(1)**

Question number	Answer	Additional guidance	Mark
6(c)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • frictional forces increase as more trucks are added (1) Plus **one** from: • hence, in order to keep constant speed, the student must increase the force she applies to **Z** (1) • when **Y** and **Z** separate, the frictional forces (to the left) are more than magnetic attraction between **Y** and **Z** (1)		**(2)**

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Question number	Answer	Mark
6(c)(ii)	An answer that combines the following points to provide a plan: • use of a Newton meter used horizontally (1) • record largest force observed (1) • repeat readings several times under same conditions (1)	**(3)**

Question number	Answer	Mark
6(c)(iii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the applied force must be resolved horizontally to determine the force that separates the engine from the trucks • and since the (size of) the resolved force is always less than the (size of) the actual force then a larger force (applied at an angle) is needed to separate the trucks from the engine	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)	substitution into correctly rearranged equation (1) $I = \frac{F}{B} \times l$ $= \frac{0.089}{0.47} \times 0.713$ evaluation to 2 s.f. (1) current = 0.27 (A)	give full marks for correct numerical answer without working	**(2)**

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Question number	Answer	Additional guidance	Mark
7(b)	Any three from: • use a higher current as the force depends on the current (1) • use more/stronger/larger range of magnets (1) • use a force meter with smaller range, e.g. 0.00 to 0.01 (1) • use a longer distance from pivot to increase the moment of the force on the wire (1)	accept voltage for current add variable resistor (in series) with power supply accept use more sensitive force meter	**(3)**

Question number	Answer	Mark
7(c)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • if the voltage changes sign, then the current is changing direction • so in Figure 21 the current is a.c. as the voltage is changing sign and in Figure 22 the current is d.c. as the voltage is always positive	**(2)**

Question number	Answer	Additional guidance	Mark
7(d)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (3 marks): • the transmission wire carries an alternating current (1) • the force is caused by this current which varies in size and direction (1) • the direction of this force depends on the direction of the current so the direction of the force also changes (1) • the magnitude of this force depends on the magnitude of the current so the magnitude of the force also changes (1)	allow responses that link the changes in the force to the interaction of the changing field around the wire with the constant field of the Earth	**(4)**

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Question number	Answer	Additional guidance	Mark
8(a)	Rearrangement of equation (1) $Q = \frac{E}{V}$ Substitution including change of unit (1) 64 MJ = 64 000 000 J $Q = \frac{64\,000\,000}{330}$ Answer and unit (1) Q = 190 000 (C)	allow answers that round to 190 000, e.g. 193 939 if the calculation is worked throughout without changing MJ to J, then maximum of 2 marks unless unit matches quantity	**(3)**

Question number	Answer	Additional guidance	Mark
8(b)	Rearrangement (1) $I = \frac{Q}{t}$ Conversions and substitution (1) 190 (kC) = 190 000 (C) 8 hours = 8 × 3600 (s) = 28 800 (s) $I = \frac{190000}{28800}$ Evaluation (1) = 6.6 (A)	ecf from (a) (6.5972) if 193 939 used then accept 6.7	**(3)**

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Question number	Indicative content	Mark
***8(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. **AO1 (6 marks)** • the sequence of events is voltage change, conversion to direct current, followed by current limiting • the battery is the load in the secondary circuit, not a store of energy for the primary circuit • a transformer is needed to increase (or step up) the voltage • so a diode is needed to change a.c. to d.c. • the charging current can be limited to 15 A using a fuse (or circuit breaker) • a circuit breaker may be preferable to a fuse, since a fuse would need to be replaced after use • the transformer primary coil is connected between the live and neutral in the primary circuit • the diode is connected in the secondary circuit of the transformer • the battery(which is to be charged), diode, fuse and secondary coil should be connected in series in the secondary circuit	**(6)**

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) • Presents an explanation with some structure and coherence. (AO1)
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) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

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Question number	Answer	Mark
9(a)	B	**(1)**

Question number	Answer	Additional guidance	Mark
9(b)	Rearrangement (1) $V_2 = (p_1 \times V_1) \div p_2$ Substitution (1) $V_2 = (297 \times 10^3 \times 23.0) \div (101 \times 10^3)$ Evaluation (1) $V_2 = 67.6\ (\text{cm}^3)$	67.633	**(3)**

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)**

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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)**

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

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		the question. (AO2)

Question number	Answer	Mark
10(a)(i)	C	**(1)**

Question number	Answer	Additional guidance	Mark
10(a)(ii)	Equating the same variable in both equations (1) $\Delta Q = m \times c \times \Delta\theta = P \times t$ Rearrangement (1) $t = \dfrac{(m \times c \times \Delta\theta)}{P}$ Substitution and evaluation (1) $t = \dfrac{(1 \times 4200 \times 77)}{3500}$ = 92 s	allow $\Delta\theta$ seen as 95 − 18 92.4 evaluation must be seen to at least 2 s.f. at some point in the working	**(3)**

Question number	Answer	Additional guidance	Mark
10(b)(i)	An answer that combines the following points of understanding to provide a logical description: • when steam condenses, its molecules move closer together, so the internal energy decreases (1) • when the water from the condensed steam cools, its molecules move more slowly, therefore storing less kinetic energy (1)	allow as water cools, the distance between the particles decreases which increases the intermolecular forces	**(2)**

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Question number	Answer	Additional guidance	Mark
10(b)(ii)	equating the variables in the three equations/principle of conservation of energy (1) $(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w) = (m_m \times c_m \times \Delta\theta_m)$ rearrangement (1) $m_m = \frac{(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w)}{(c_m \times \Delta\theta_m)}$ substitution of correctly calculated quantities (1) $= \left(\frac{\left(\left(\frac{25}{1000}\right) \times 2260000\right) + \left(\left(\frac{25}{1000}\right) \times 4200 \times 35\right)}{3840 \times 60}\right)$ evaluation (1) 0.26 (kg)	allow in words or with suitable alternative subscripts temperature changes and l_w must be correct allow maximum of 3 marks for calculations that omit the energy from cooling of water	**(4)**

Question number	Answer	Mark
10(b)(iii)	Any two of the following reasons: • more steam must condense and transfer the energy that is dissipated to the jug during the process (1) • more steam must condense and transfer the energy that is dissipated to the surroundings during the process (1) • more steam must condense and transfer the energy needed to cause the milk to froth (1) • more steam must condense to replace any steam that might leave the milk without condensing (1)	**(2)**

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