OCR
Oxford Cambridge and RSA

Accredited

GCSE (9–1) Physics B (Twenty First Century Science)

H

J259/03 Breadth in physics (Higher Tier)

Sample Question Paper

Date – Morning/Afternoon

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (in mm)
- the Data Sheet

You may use:
- a scientific or graphical calculator

First name	
Last name	
Centre number	
Candidate number	

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

Answer **all** the questions.

1 **(a)** **(i)** Define density.

……

…… **[1]**

(ii) A volume of air measuring 3.0 m^3 has a mass of 3.9 kg.

Calculate its density.

……..kg/m^3 **[2]**

(b) Georgina does an experiment to test the hypothesis '*the reason why a solid floats or sinks in a liquid depends upon both the density of the solid and the density of the liquid'.*

She was given blocks of rubber and wood and bottles of maple syrup and baby oil.

Material	**Density (g/cm^3)**
Rubber	1.52
Wood	0.85
Maple Syrup	1.37
Baby Oil	0.80

Material	**Floats in Maple Syrup**	**Floats in Baby Oil**
Rubber	No	No
Wood	Yes	No

Georgina concludes that the density of both the solid and the liquid affects whether it floats or sinks.

Use the data to justify Georgina's conclusion.

……

……

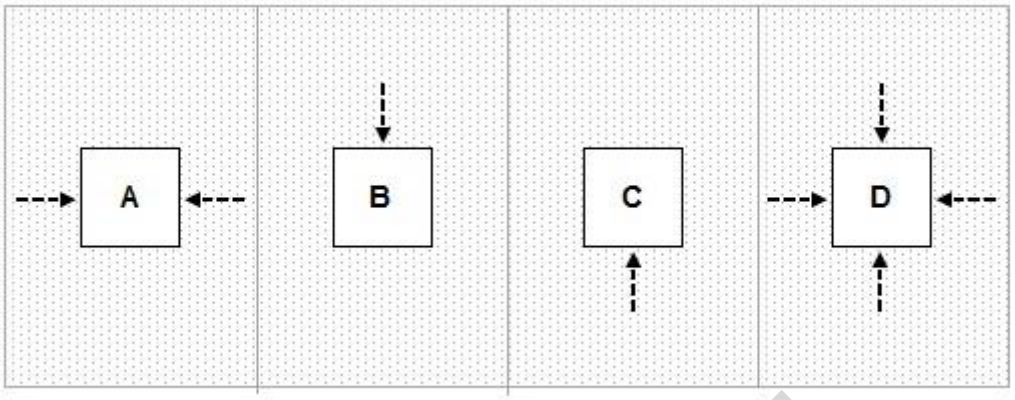
……

……

…… **[2]**

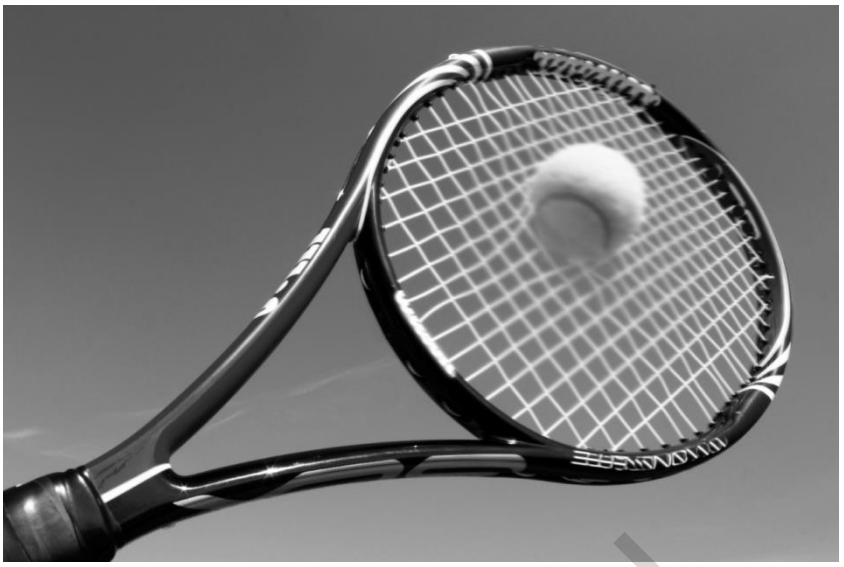
(c) A solid block is immersed in a liquid.

Which **one** of the diagrams **A**, **B**, **C** or **D**, best shows the **direction** of all the force(s) on the solid caused by the liquid pressure?



…….. **[1]**

2 This is a picture of a tennis ball being hit.



(a) The racket exerts an average force of 1000 N on the tennis ball.

Complete the following table to show whether each statement about the average force exerted by the tennis ball on the racket is **true** or **false**.

Put ticks (✓) in the correct boxes.

	True	**False**
It is a vector quantity		
The average force acts in the same direction as the ball is moving		
The average force equals 1000 N		
The average force depends upon the weight of the ball		

[2]

(b) The tennis ball has a mass of 0.06 kg.

Calculate the momentum of the ball (in kg m/s) as soon as it leaves the racket at 50 m/s.

……..kg m/s **[3]**

(c) Calculate the weight in Newtons of the tennis ball. Gravitational field strength = 10N/kg.

……N **[3]**

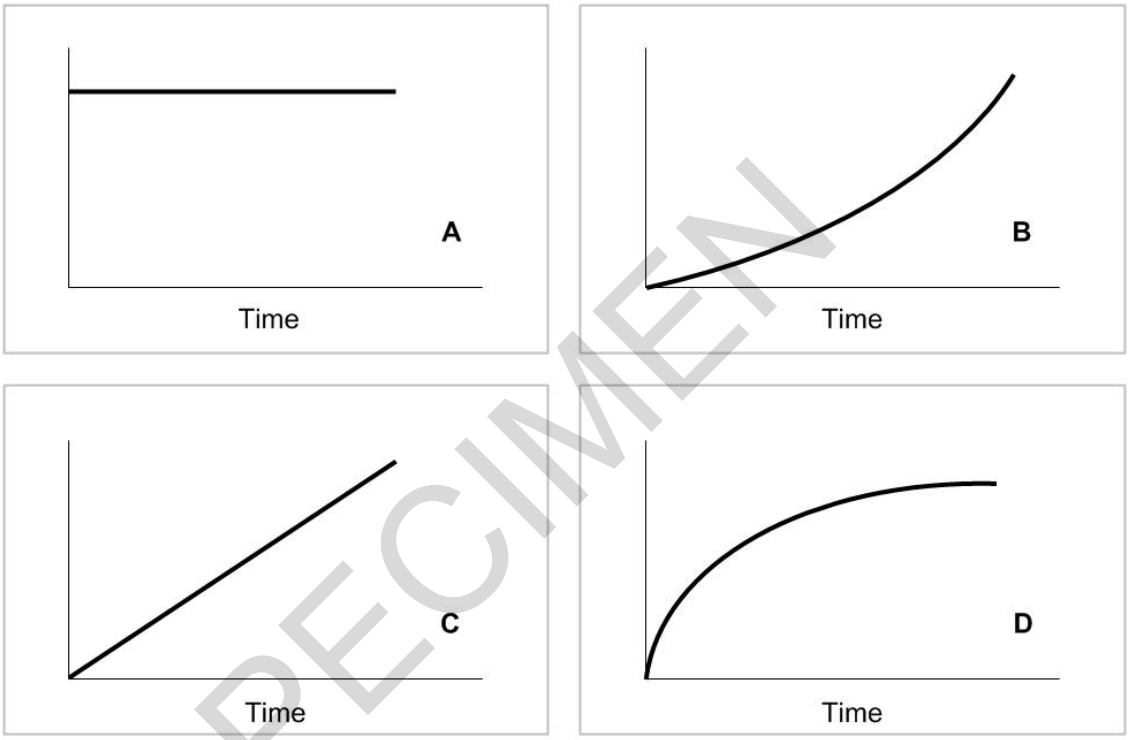
3 **(a)** A coin is dropped to the floor.

(i) Which of the graphs below **A, B, C** or **D**, represents the distance time graph of the coin dropping?

…….. **[1]**

(ii) Which of the graphs below **A, B, C** or **D,** represents the speed time graph of the coin dropping?

…….. **[1]**



(b) The coin falls through a distance of 150 cm in a time of 0.8 seconds.

Calculate the average speed at which the coin falls.

……m/s **[3]**

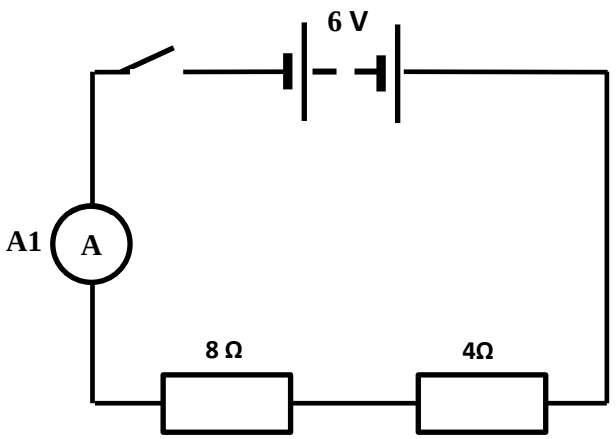
(c) Explain the difference between vectors and scalars as it applies to velocity and speed.

……

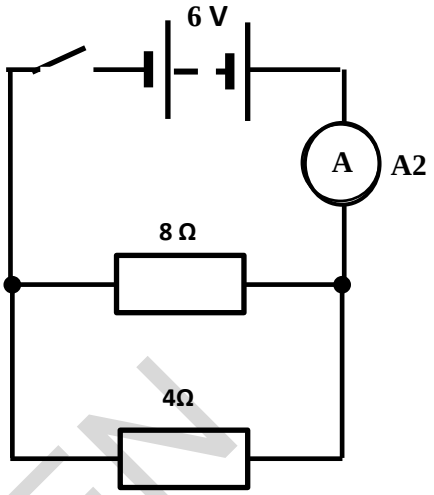
……

…….. **[3]**

4 Lydia is comparing series and parallel circuits in a class practical.



Circuit A



Circuit B

(a) Lydia decides to check the battery voltage in the circuits.
Using the correct circuit symbol add a meter to circuit **A** to show how she could do this.

[1]

(b) Lydia switches on both circuits.

Put a tick (✓) in the box next to the correct answer.

The reading on $\mathbf{A_1}$ is less than the reading on $\mathbf{A_2}$.	☐
The total resistance in circuit B is 6 Ω.	☐
The p.d. across the 8 Ω is the same in both circuits.	☐
The p.d. across A2 is very large	☐

[1]

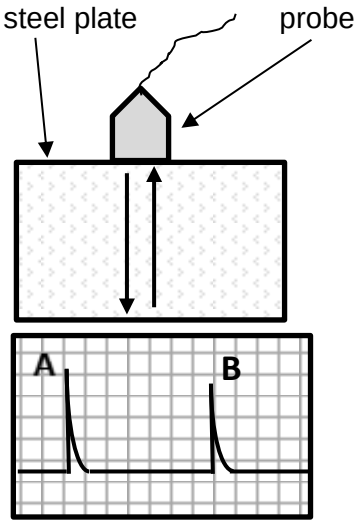
(c) Lydia replaces the 4 Ω resistor with a 6 Ω resistor in each circuit.
Complete the following table to show whether each statement is now true for the two circuits.

Put ticks (✓) in the correct boxes.

Statement	**True for circuit A**	**True for circuit B**	**True for both**
The current from the battery decreases			
Each unit of charge does less work on the 8 Ω resistor			
The current in the 8 Ω resistor does not change			

[3]

5 Ultrasonic testing is a technique widely used in industry to detect defects or flaws in many materials including metals and plastics.



The probe sends out a sound wave into a sample of steel plate.

There are two signals displayed. One from the outgoing pulse (**A**) and the second due to the echo from the bottom surface (**B**).

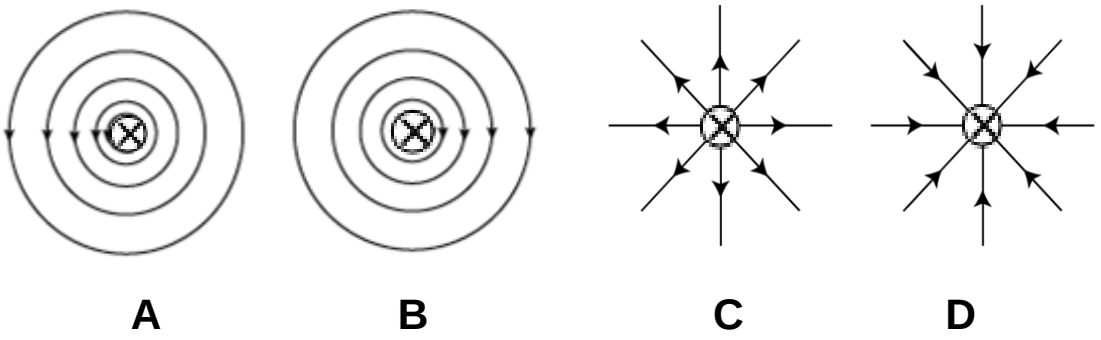
The frequency of a sound wave is 100 kHz.

Calculate the wavelength of these waves given that their speed is 330 m/s?

……..m **[4]**

6 This question is about the magnetic effect of an electric current.

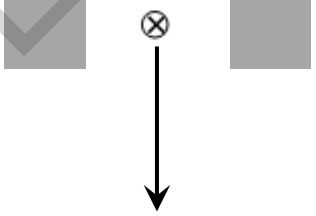
(a) **(i)** Which **one** of the diagrams correctly shows the magnetic field caused by a wire conducting an electric current (electric current flowing **into the paper**)?



…….. **[1]**

A wire is placed between the north and south poles of a permanent magnet and at right angles to the magnetic field.

The current is switched on (electric current flowing **into the paper**). This creates a force on the wire in the direction shown.



Direction of force

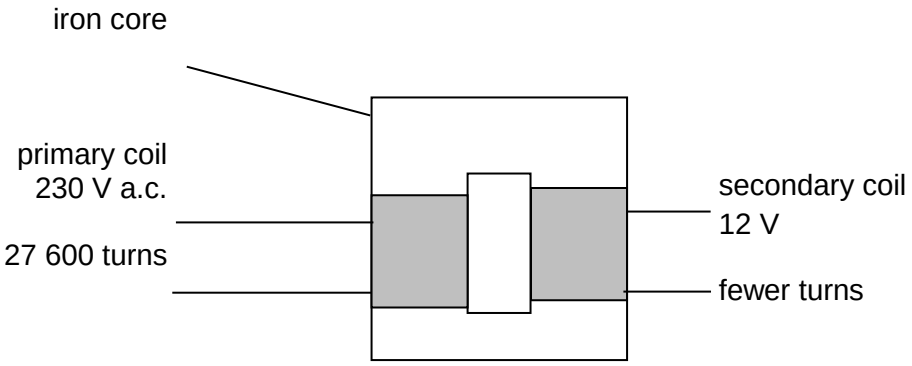
(ii) Complete the diagram by labelling the North and South poles of the permanent magnet **and** sketching the resulting magnetic field between the poles. **[2]**

(iii) The current in the wire in (ii) is 0.2 A, and the magnetic flux density is 0.036 T.

Calculate the length of wire inside the magnetic field if the force experienced is 5.4×10^{-4} N.

……..m **[3]**

(b) This is a diagram of a simple transformer.



The secondary coil produces an output of 12V.

Calculate the number of turns needed on the secondary coil.

number of turns = …… **[2]**

(c) A National Grid transformer in a sub-station converts 30 000 V into 230 V to power a town of 12 000 inhabitants. The transformer is 99% efficient.

Using appropriate estimates, discuss the energy consequences **for the transformer sub-station** if the efficiency is less than 100%.

……

……

……

…….. **[2]**

7 Two students are investigating springs and forces.

They begin by comparing **three** different springs.

They measured how much each spring stretched for a range of different weights attached.

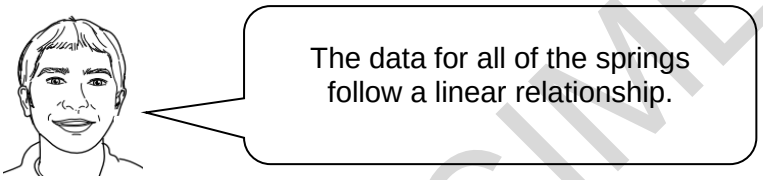
Here are their results:

SPRING A	
Force (N)	Extension (cm)
0.0	0.0
1.0	0.7
2.0	1.4
3.0	2.1
4.0	2.8
5.0	3.5

SPRING B	
Force (N)	Extension (cm)
0.0	0.0
1.0	0.6
2.0	1.0
3.0	1.6
4.0	2.4
5.0	3.8

SPRING C	
Force (N)	Extension (cm)
0.0	0.0
1.0	1.6
2.0	3.2
3.0	4.8
4.0	6.4
5.0	8.0

(a) One of the students makes a comment about the data.



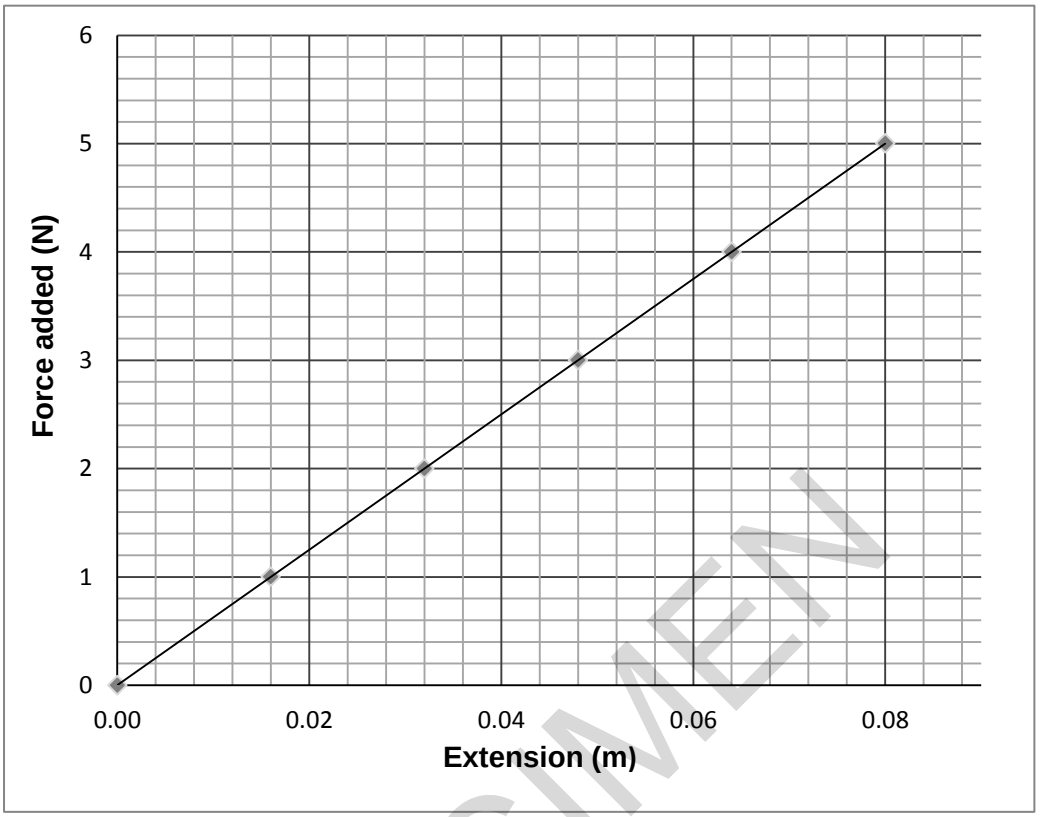
Is this student correct?
Use your understanding of what is meant by a linear relationship to help explain your answer.

……..

……..

…….... **[2]**

They then plotted a graph of the data for **spring C**. (Note that the extension of the spring is in metres).



(b) Use the graph to calculate the amount of work done (in joules) in stretching the spring over the first 8 cm (0.08 m).

……..J

[2]

(c) When a rubber band is pulled, it stretches quite easily to start with and then becomes stiffer. Sketch a curve on the graph above to show this behaviour.

[1]

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TURN OVER FOR THE NEXT QUESTION

8 This question is about changing ideas about our Universe.

(a) In 1917 scientists suggested that the Universe was not changing in size.

Explain the effect that gravity would have in a Universe that is not changing in size.

……..……..

……..…... **[1]**

(b) About this time, Edwin Hubble noticed **red- shifts** in the light from the galaxies.
This provided evidence that galaxies were moving away from each other at high speeds.

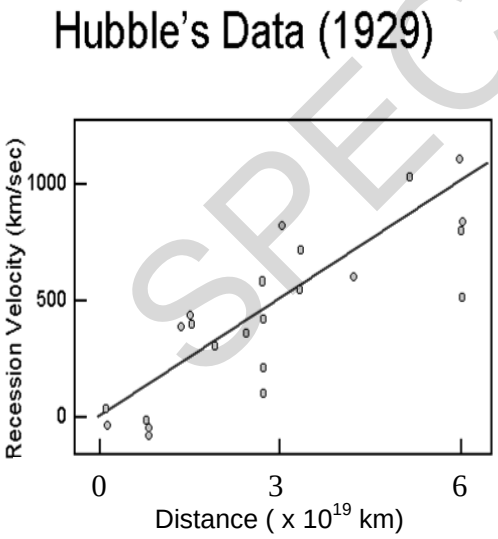
(i) Explain what is meant by red- shift and how this shows that galaxies are receding.

……..

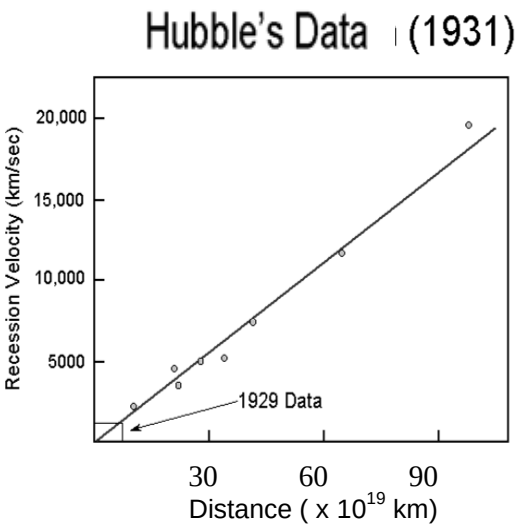
……..

……... **[2]**

The graphs show how the speed that galaxies are moving away from us is linked to their distance from us.



Hubble's original data
(galaxies up to 6 x 10^{19} km away)



Later graph
(galaxies up to 100 x 10^{19} km away)

(ii) Describe the trend shown in the graphs on page 14 and explain how the data provides evidence which leads to the 'Big Bang' model of the Universe.

……..

……..

……..

……..

……..

…….. **[3]**

(iii) From graphs such as those on page 14, astronomers can work out how old the Universe is.

Assuming that the speeds of the galaxies have remained reasonably constant over time, explain how the data can be used to calculate the age of the Universe.

……..

……..

……..

…….. **[2]**

(iv) Suggest **two** reasons why present day estimations over the age of the Universe are more trustworthy than Hubble's initial values.

……..

……..

……..

…….. **[2]**

9 **(a)** Nuclear medicine uses radioactive isotopes as tracers and to help diagnose and treat different types of cancer.

Here are some details about four radioactive isotopes of iodine.

Isotope	Radiation emitted	Half-life
Iodine - 123	gamma	13 hours
Iodine - 128	beta	25 minutes
Iodine - 129	Beta and gamma	15.7 million years
Iodine - 131	Beta and gamma	8 days

(i) Iodine - 123 is widely used as a **tracer**. Explain why it is the most suitable out of the four listed in terms of the radiation that it emits and its half-life.

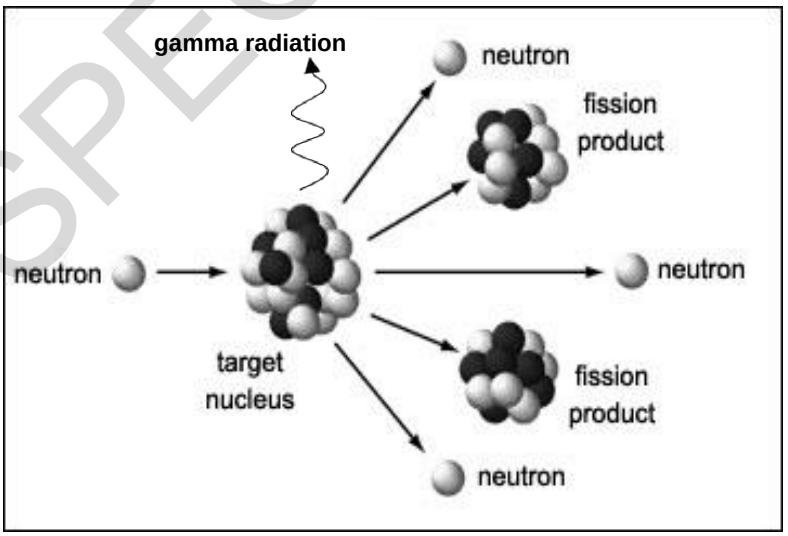
……..

……..

…….. **[2]**

(ii) Both iodine-129 and iodine-131 are produced by the fission of uranium atoms during the operation of nuclear reactors.

Here is a diagram of a fission reaction.



How is the energy released in this reaction carried away from the target nucleus after fission?

……..

……..

…….. **[2]**

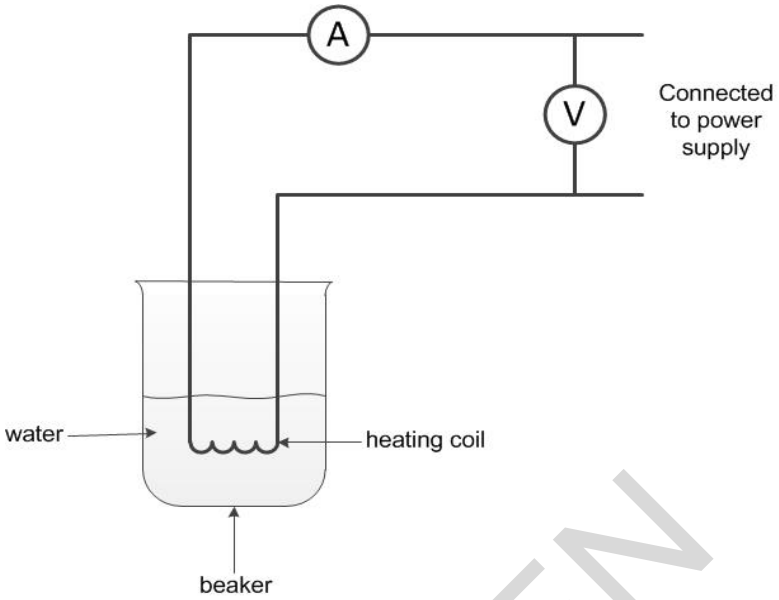
(b) Describe the process of Nuclear **Fusion**.

……

……

…….. **[2]**

10 Richard uses the equipment below to calculate the specific heat capacity of water.



(a) **(i)** State **one** safety issue Richard needs to consider in a risk assessment and explain what they can do to prevent this risk.

……..

……. **[2]**

(ii) He calculates the change in thermal energy to be 12 900 J.

Calculate the specific heat capacity of water if the mass of water is 0.1 kg and the temperature change is 30°C.

……..J/kg°C **[3]**

(iii) State and explain how he could improve the experiment to get a more accurate result.

……

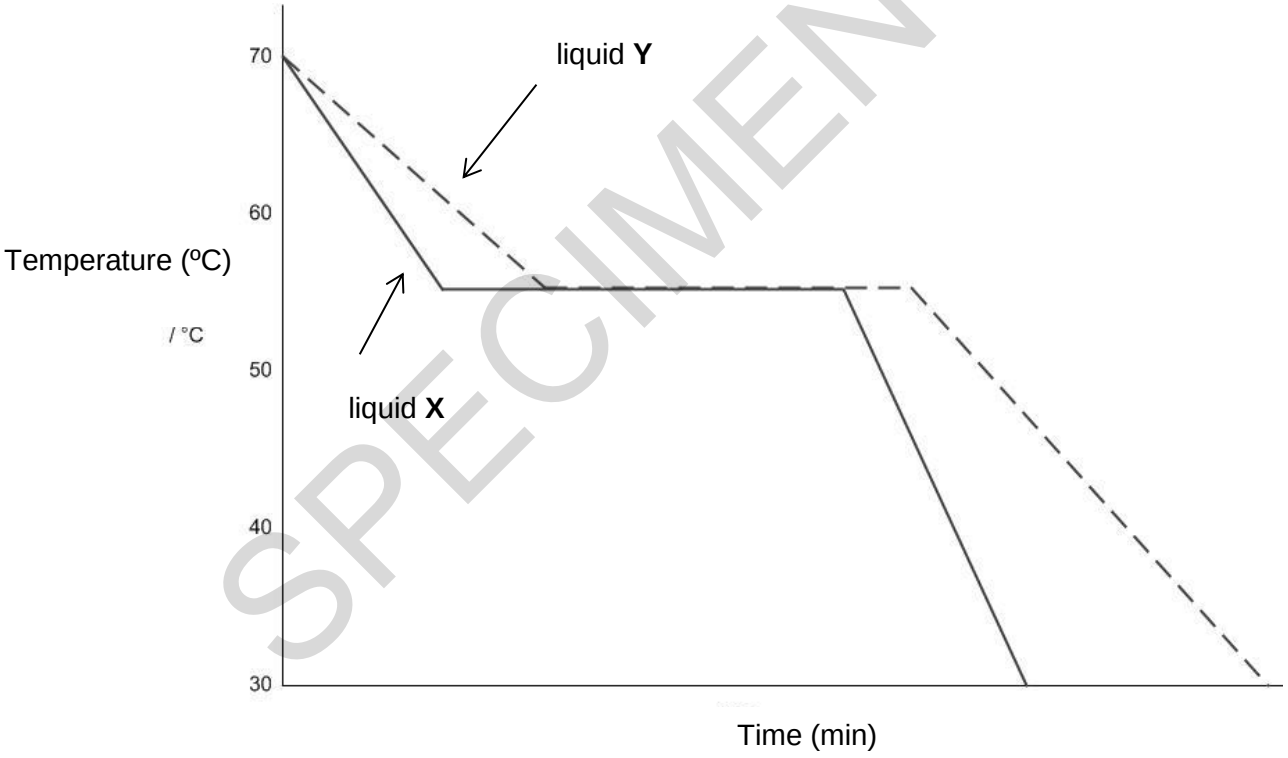
……

…… **[2]**

(b) Richard then does another experiment. He fills two beakers with equal masses of liquids **X** and **Y,** at the same temperature.

The temperatures of the liquids are monitored throughout the experiment.

The variation with time of the temperature of the liquids is shown below.



Use the graph to compare what happens to liquids **X** and **Y** at 55 °C. Suggest what is happening to the liquids at this temperature.

……

……

[3]

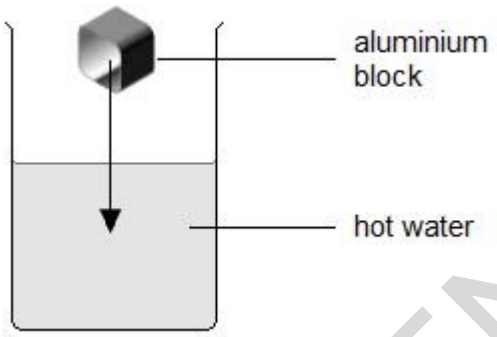
……

(c) Richard argues that liquids **X** and **Y** are the same substance.
State what evidence there is to support this?

……

…… **[1]**

(d) A beaker contains hot water. Richard wants to calculate the thermal energy lost by the hot water when he puts a cold aluminium block into it.



What information will he need to make this calculation?

……

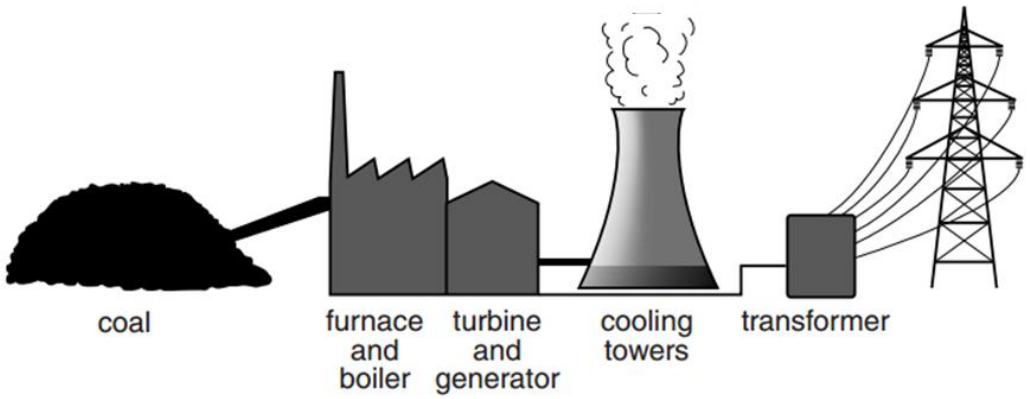
……

……

……

…… **[3]**

11 **(a)** In a coal burning power station large amounts of heat energy are needed to convert water to steam.



(i) Name an energy resource which does **not** need a furnace or boiler, as it can drive the turbine directly when generating electricity.

…… **[1]**

(ii) Write down **one** advantage and **one** disadvantage this method of generating electricity has over a coal burning power station.

……

……

……

…… **[2]**

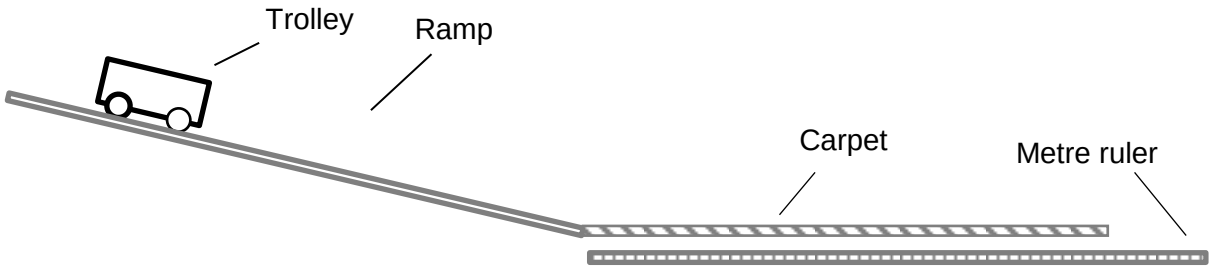
(b) Some coal-burning power stations can provide some of their waste energy to heat local houses and industries. However, the efficiency of these Combined Heat and Power stations is reduced from a typical coal-burning power station.

Select **one** answer below to give a location where this would be useful.

Town A: small population far from power station	
Town B: large population close to power station	
Town C: large population far from power station	
Town D: small population close to power station	

[1]

12 A group of students are designing an experiment to investigate the relationship between stopping distance and speed.



The apparatus

The trolley has a mass of 200 g and is placed on a gently sloping ramp.

Thick carpet is used to slow down the trolley.

The metre ruler is needed to measure the stopping distance.

(a) How could the student calculate the 'top speed' of the trolley at the bottom of the ramp, just before it reaches the carpet?
Name the apparatus and how it should be used.

……

……

……

…… **[3]**

The procedure

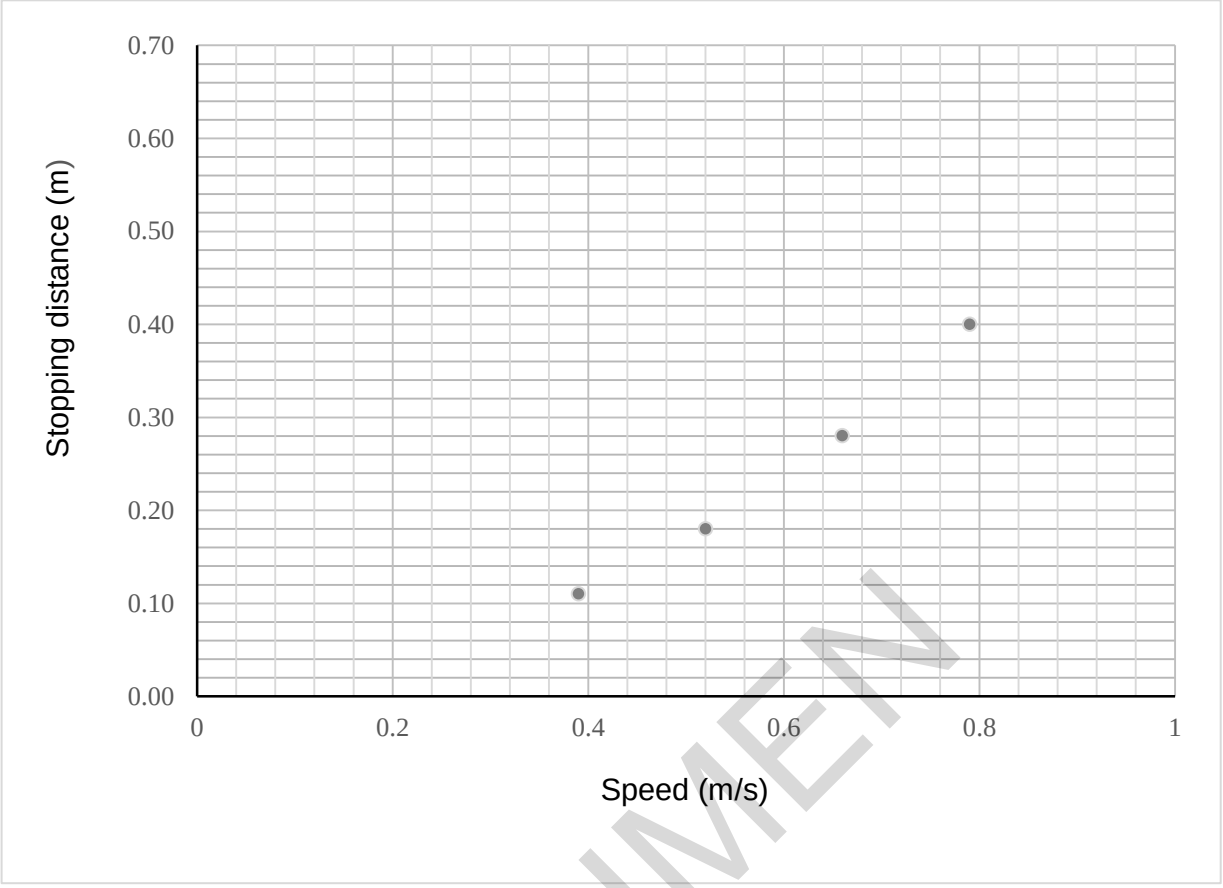
The trolley is released and allowed to run freely down the slope.

The distance it takes for the trolley to come to rest is measured.

The experiment is repeated by releasing the trolley from different positions up the ramp in order to change the 'top speed'.

The results

Speed (m/s)	Stopping distance (m)
0.52	0.18
0.39	0.11
0.66	0.28
0.79	0.40
0.82	0.44
0.94	0.62



(b) Complete the plotting of the points on the grid above and draw a smooth curve of best fit. **[2]**

(c) Describe the pattern shown on the graph.

……

……

…… **[2]**

(d) Describe and explain how the stopping distances graph would differ if the trolley had an 800g mass placed on top of it.

……

……

……

…… **[3]**

END OF QUESTION PAPER

OCR
Oxford Cambridge and RSA

…day June 20XX – Morning/Afternoon
GCSE (9–1) Physics B (Twenty First Century Science)
J259/03 Breadth in physics (Higher Tier)

SPECIMEN MARK SCHEME

Duration: 1 hour 45 minutes

MAXIMUM MARK 90

This document consists of 20 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

The breakdown of Assessment Objectives for GCSE (9-1) in Physics B:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>Density = mass ÷ volume ✓</td><td>1</td><td>1.1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>FIRST CHECK THE ANSWER ON ANSWER LINE.
If answer = 1.3 (kgm/s) award 2 marks

3.9 ÷ 3.0 ✓

=1.3 (kg/m^3) ✓</td><td>2</td><td>2.1</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>She is correct:
Density of solid > Density of liquid → Solid sinks ORA; ✓

Quotes data from the table in support of claim ✓</td><td>2</td><td>1.1

3.2b</td><td>No mark for just stating Georgina is correct</td></tr>
<tr><td></td><td>(c)</td><td></td><td>D ✓</td><td>1</td><td>1.1</td><td></td></tr>
<tr><td>2</td><td>(a)</td><td></td><td><table><tr><th></th><th>True</th><th>False</th></tr><tr><td>It is a vector quantity</td><td>✓</td><td></td></tr><tr><td>The force acts in the same direction as the ball…..</td><td></td><td>✓</td></tr><tr><td>The force equals 1000 N</td><td>✓</td><td></td></tr><tr><td>The force depends upon the weight of the ball</td><td></td><td>✓</td></tr></table></td><td>2</td><td>2.2</td><td>4 correct = 2 marks
2 or 3 correct = 1 mark
1 or 0 correct = 0 marks</td></tr>
<tr><td></td><td>(b)</td><td></td><td>FIRST CHECK THE ANSWER ON ANSWER LINE.
If answer = 3.0 (kgm/s) award 3 marks

Recall: Momentum = mass x velocity ✓

= 0.06 x 50 ✓

= 3.0 (kgm/s) ✓</td><td>3</td><td>

1.1

2.1

2.1</td><td>Correct substitution gains first 2 marks (if equation is missing)</td></tr>
<tr><td></td><td>(c)</td><td></td><td>FIRST CHECK THE ANSWER ON ANSWER LINE.
If answer = 0.6 (N) award 3 marks

Recall: Weight (N) = mass (kg) x gravitational field strength (N/kg) ✓

=0.06 kg x 10 N/kg ✓</td><td>3</td><td>

1.1

2.1</td><td>Correct substitution gains first 2 marks (if equation is missing)</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
			= 0.6 (N) ✓		2.1	

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	B ✓	1	3.2a	
		(ii)	C ✓	1	3.2a	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE.** **If answer = 1.88(m/s) award 3 marks** Recall speed = distance ÷ time ✓ Converts cm into m = 150cm = 1.5m ✓ 1.5 m ÷ 0.8 s = 1.88 (m/s) ✓	3 1.1 2.1 2.1		
	(c)		The speed of an object does not give indication of a direction ✓ The velocity of an object at a given moment is its speed, together with an indication of its direction. ✓ Velocity is a vector and speed is a scalar ✓	3	1.1	

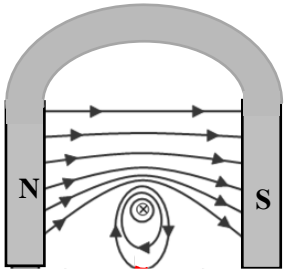
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td>(V) connected in parallel with battery in circuit A ✓</td><td>1</td><td>2.2</td><td>Correct symbol needed and across battery ONLY ALLOW if correctly drawn in circuit A</td></tr>
<tr><td></td><td>(b)</td><td></td><td>The reading on A_1 is less than the reading on A_2. ✓</td><td>1</td><td>2.1</td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td>
<table>
<tr><th>Statement</th><th>True for circuit A</th><th>True for circuit B</th><th>True for both</th></tr>
<tr><td>The current from ……</td><td></td><td></td><td>✓</td></tr>
<tr><td>Each unit of charge does ……</td><td>✓</td><td></td><td></td></tr>
<tr><td>The current in the 8……</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>3</td><td>1.1
2.1
2.1</td><td>One mark for each correct row</td></tr>
<tr><td>5</td><td>(a)</td><td></td><td>FIRST CHECK THE ANSWER ON ANSWER LINE.
If answer = 3.3 x 10^{-3} (m) award 4 marks

Recall and apply v = f x λ ✓

Rearrange to get λ = v ÷ f ✓

Convert kHz to Hz 100 kHz = 100000 Hz ✓

330 m/s ÷ 100000 Hz = 3.3 x 10^{-3} (m) ✓</td><td>4</td><td>1.1
1.1
2.1
2.1</td><td></td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	B ✓	1	2.1	
		(ii)	N and S pole correctly labelled; ✓ Magnetic field pattern correct direction between poles **and** over the top of the wire ✓  	2	2.1	
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE.** **If answer = 7.5 x 10^{-2} (m) award 3 marks** Select F=BIL Rearrange to get L = F ÷ (BI) ✓ 5.4 x 10^{-4} N ÷ (0.036 x 0.2) ✓ 7.5 x 10^{-2} (m) ✓	3	 1.1 2.1 2.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE.** **If answer = 1 440 (turns) award 2 marks** $\frac{230}{27600} = \frac{12}{X}$ ✓ **OR** $\frac{230 \times 12}{27600}$ / **AW** ✓ 1 440 (turns) ✓	2	1.2 2.1	

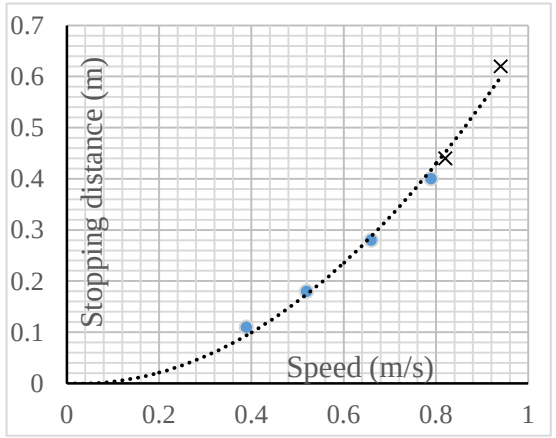
Question			Answer	Marks	AO element	Guidance
	(c)		Energy dissipated in transformer will result in heat up of substation. If not removed it will result in a meltdown. ✓ Large amount of energy justified by estimate e.g. 1 to 5kW per person. Typical output current at 230V of 200 - 10 000 A ✓	2	2.1	
7	(a)		(The student is incorrect / partly correct) Springs A **and** C follow a linear relationship / spring B does not follow a linear relationship; ✓ In a linear relationship the extension increases in equal amounts (as the force does) / the graph is a straight line from the origin ✓	2	3.1a	Marks are for the **explanation**
	(b)		Area under graph OR 0.5 x 5 x 0.08 ; ✓ 0.2 (J) ✓	2	2.2	
	(c)		Curve line drawn starting 0,0 parabola-like curve with increasing gradient.	1	2.2	

Question			Answer	Marks	AO element	Guidance
8	(a)		Gravity would cause the universe to contract / collapse ✓	1	2.1	**ALLOW** galaxies would move towards each other
	(b)	(i)	Light (from distant galaxies) is shifted towards the red end of the spectrum ✓ Wavelengths are increased / frequencies are decreased ✓	2	1.1	**DO NOT ALLOW** 'light is redder'
		(ii)	Further galaxies are moving away faster; ✓ Space (or universe) is expanding; ✓ **Any one from:** Universe was much smaller in the past ✓ Universe may have started from a single point ✓	3	1.1 1.1 2.1	**ALLOW** the relationship is proportional
		(iii)	Read distance and speed data from graph ✓ Calculate time = distance ÷ speed ✓	2	3.1a 2.1	
		(iv)	**Any two from:** More observations/more precise measurements have been made; ✓ Telescopes / technology has improved; ✓ Observations can be made from outside the earth's atmosphere / radiations other than visible light can be observed. ✓	2	1.2 1.1	

Question			Answer	Marks	AO element	Guidance
9	(a)	(i)	Gamma radiation penetrates tissue, so can be detected outside the body / Beta radiation is absorbed in the body and cause more damage to cells; ✓ Isotope needs to have a short half-life to reduce the length of time of exposure to the radiation ✓	2	1.1 3.2a	
		(ii)	<u>Kinetic energy</u> of the particles / fission products (and neutrons); ✓ Gamma / ionising radiation ✓	2	1.1	**IGNORE** K.E. of neutrons 'Radiation' is insufficient
	(b)		Hydrogen nuclei can fuse into helium nuclei ✓ Releasing energy ✓	2	1.1	

Question			Answer	Marks	AO element	Guidance
10	(a)	(i)	Risk from burning from hot water/heating element ✓ Prevent risk by using care when around hot water/putting lid on the beaker/putting heating element in the water before turning it on and waiting for it to cool before removing it. ✓	2	2.2 3.3a	**ALLOW** any other sensible risk and linked precaution
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE.** **If the answer = 4300 (J/kg°C) award 3 marks.** Select: E = m x c x θ Rearrange to get θ = E ÷ m x c ✓ = 12 900 J ÷ (0.1kg x 30°C) ✓ =4300 (J/kg°C)✓	3	1.1 2.1 2.1	
		(iii)	Any reference to insulation/lagging ✓ Reduce heat transfer to surroundings✓	2	3.3b	
	(b)		They stay at 55 °C for the same amount of time ✓ X (solidifies) before Y ✓ At 55 °C both X and Y solidify / freeze ✓	3	3.1b 3.2b 3.2b	
	(c)		Same temperature for solidification/freezing ✓	1	3.2b	
	(d)		Specific heat capacity (of water) ✓ Mass of hot water ✓ Temperature change ✓	3	3 x 1.2	**ALLOW** initial and final temperatures

Question			Answer	Marks	AO element	Guidance
11	(a)	(i)	Wind / tidal / wave / HEP ✓	1	1.1	**DO NOT ALLOW** 'solar'
		(ii)	Any suitable advantage relating to d(i) – renewable/sustainable/no greenhouse gases during power generation/no emissions that cause acid rain. ✓ Any suitable disadvantage ✓ e.g. damage to habitats	2	1.1	**DO NOT ALLOW** 'cleaner'
	(b)		Town D ✓	1	3.1a	

Question			Answer	Marks	AO element	Guidance
12	(a)		Light gate / electronic timer / data logger; ✓ Measures the time for trolley to travel a (known) distance ✓ Use speed = distance ÷ time ✓	3	1.2	
	(b)		 Last two points both plotted correctly; ✓ Smooth curve drawn going through (0.0) ✓	2	1.2	
	(c)		As the speed of the trolley increases, the stopping distance increases; ✓ The stopping distance increases more quickly at higher speeds ✓	2	1.2	**ALLOW** 'the braking force is proportional to speed' for 1 mark
	(d)		(More gpe to start with i.e.) more ke when reaching carpet ✓ The resistive force of the carpet would be unchanged ✓ The stopping distance would be greater at each speed ✓	3	1.2	**ALLOW** wrong answer to force but must be consistent. **ALLOW** attempts to quantify

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