GCSE

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WJEC GCSE in PHYSICS

APPROVED BY QUALIFICATIONS WALES

SAMPLE ASSESSMENT MATERIALS

Teaching from 2016

This Qualifications Wales regulated qualification is not available to centres in England.

For teaching from 2016
For award from 2018

GCSE PHYSICS

SAMPLE ASSESSMENT MATERIALS

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Contents

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Candidate Name	Centre Number					Candidate Number				
						0				

GCSE

PHYSICS

UNIT 1: ELECTRICITY, ENERGY and WAVES

FOUNDATION TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**7**	
3.	**17**	
4.	**6**	
5.	**9**	
6.	**7**	
7.	**14**	
8.	**6**	
Total	**80**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page
Answer all questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets at the end of each question or part-question.
Question **5(a)** is a quality of extended response (QER) question where your writing skills will be assessed.

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Equations

current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
% efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$	
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
V_1 = voltage across the primary coil V_2 = voltage across the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

SI multipliers

Prefix	Multiplier
m	1×10^{-3}
k	1×10^{3}
M	1×10^{6}

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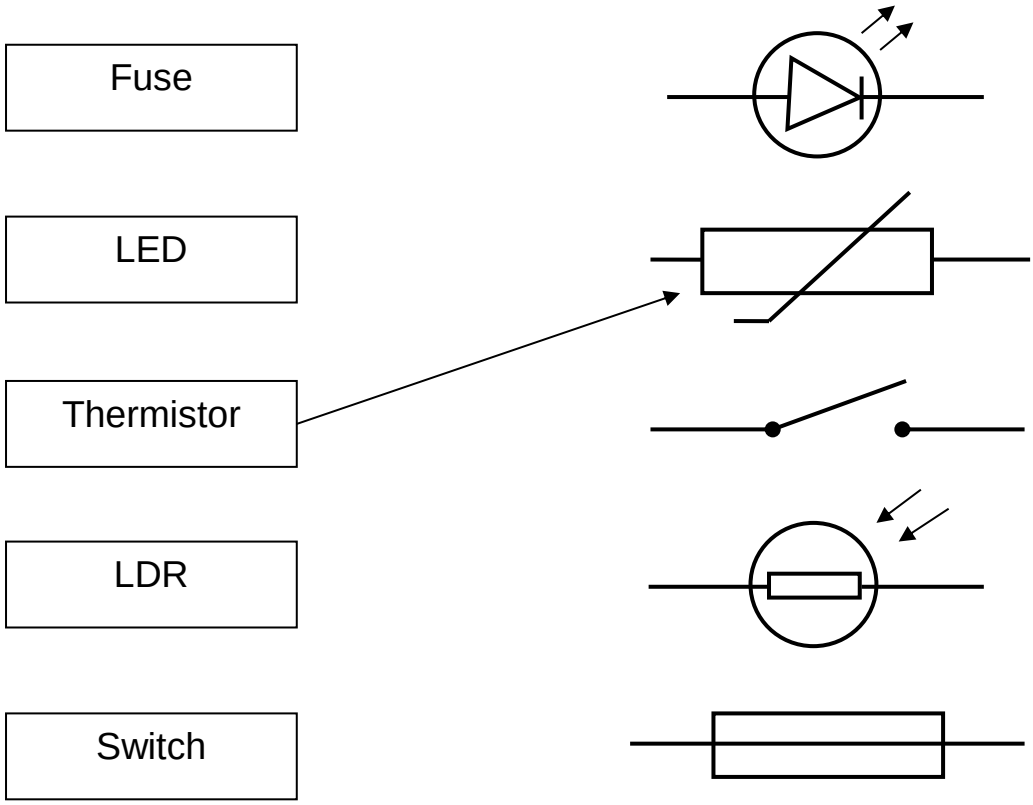
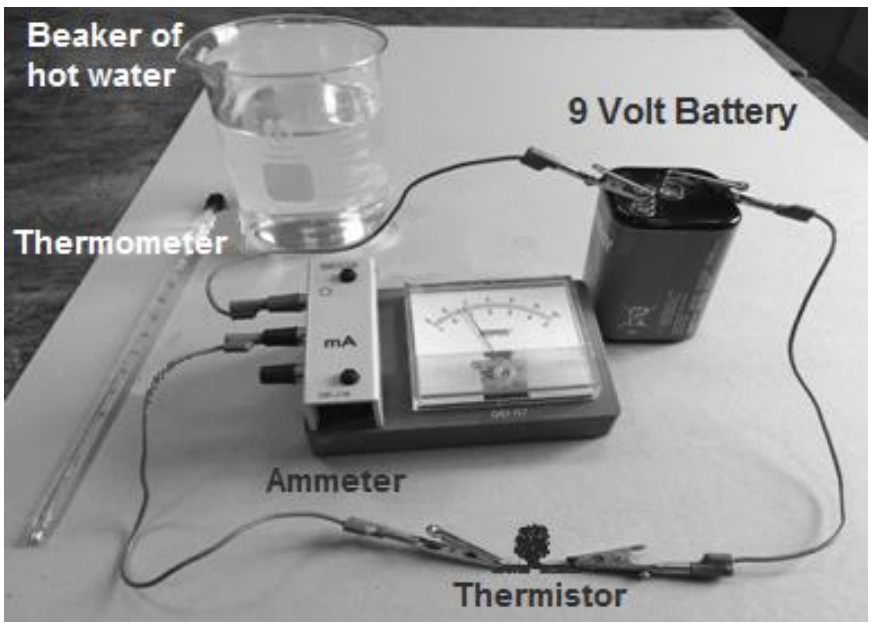
Answer **all** *questions*

1. (a) The boxes on the left show the names of some electrical components. The circuit symbols are shown on the right. They are not in order.
Draw a line from each box on the left to the correct circuit symbol.
One has been completed. [3]



(b) Rhys correctly uses the circuit shown below to investigate the behaviour of a thermistor. He takes a photo of the circuit on his phone. He places the thermistor into a beaker of hot water to start the experiment.



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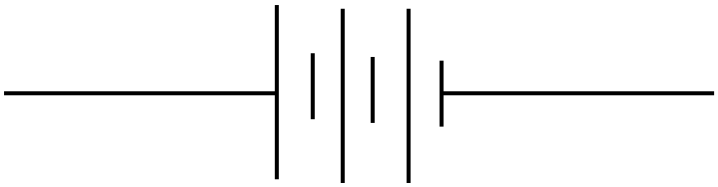
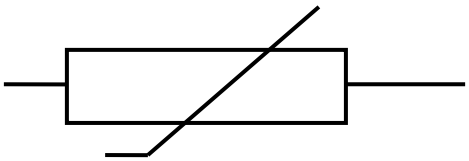
(i) Complete the circuit diagram of the circuit used. [2]

9 V battery





As the hot water cools the reading on the ammeter is recorded in the table below.

Temperature (^{o}C)	**Current (mA)**
100	200
80	140
60	100
40	70
20	50

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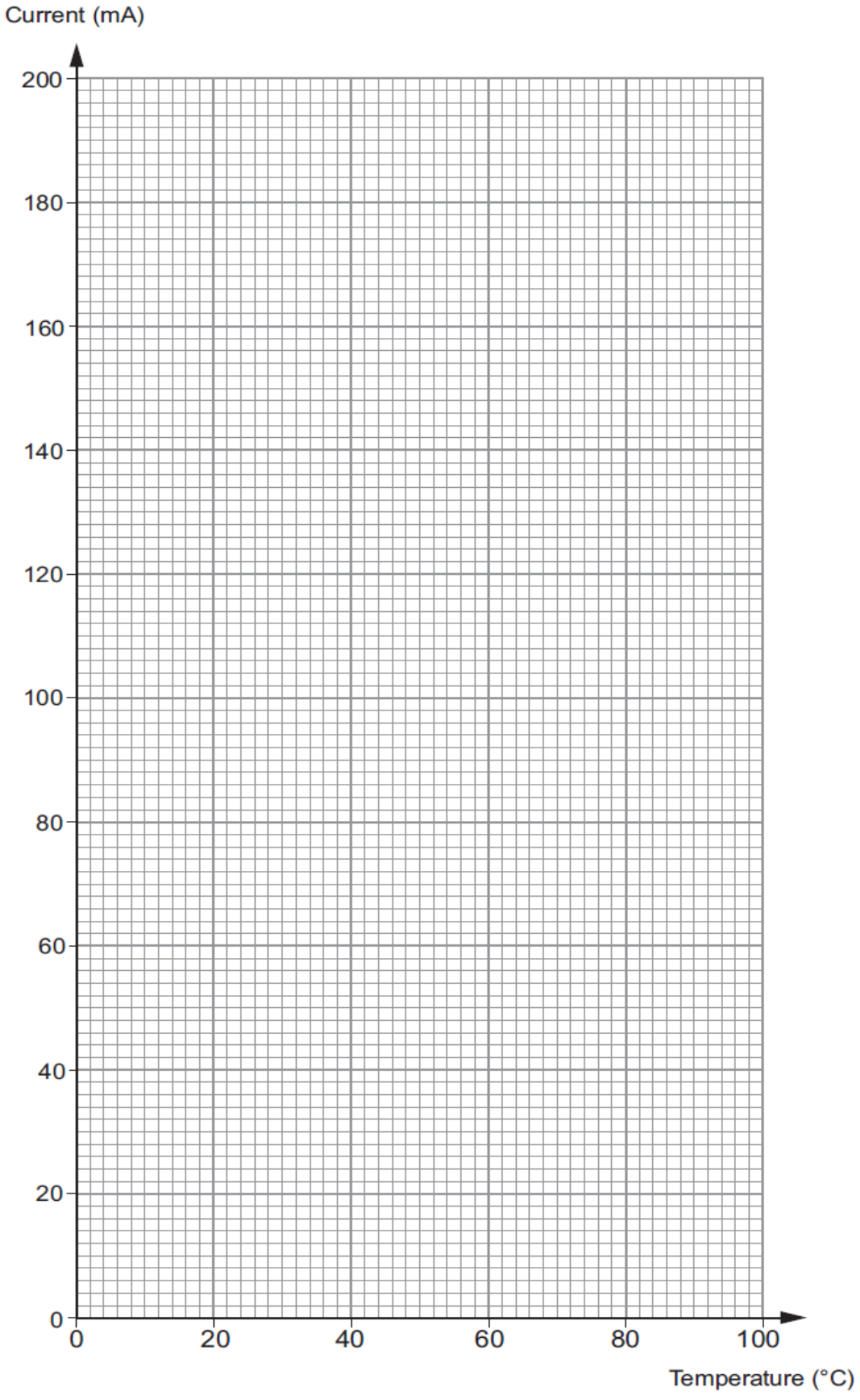
(ii) Plot a graph of the data on the grid below. [3]



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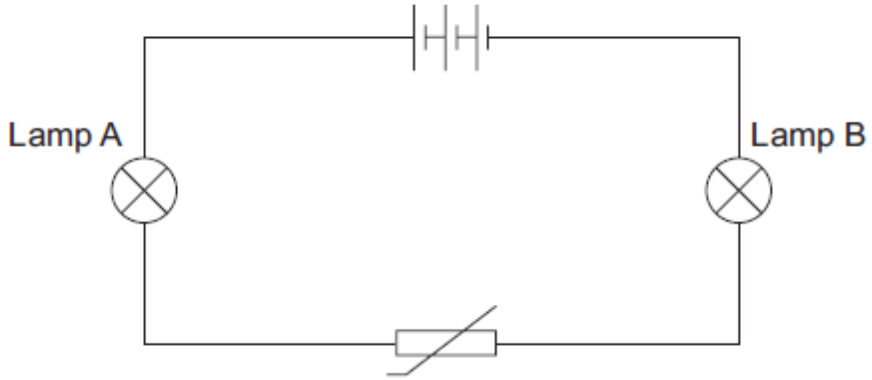
(iii) Describe the relationship between the temperature of the thermistor and the current. [2]

……

……

(c) Rhys sets up the following circuit.



(i) Explain how this circuit can be used to indicate changes in temperature. [2]

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(ii) Lamp B breaks. Explain what happens to lamp A. [2]

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14

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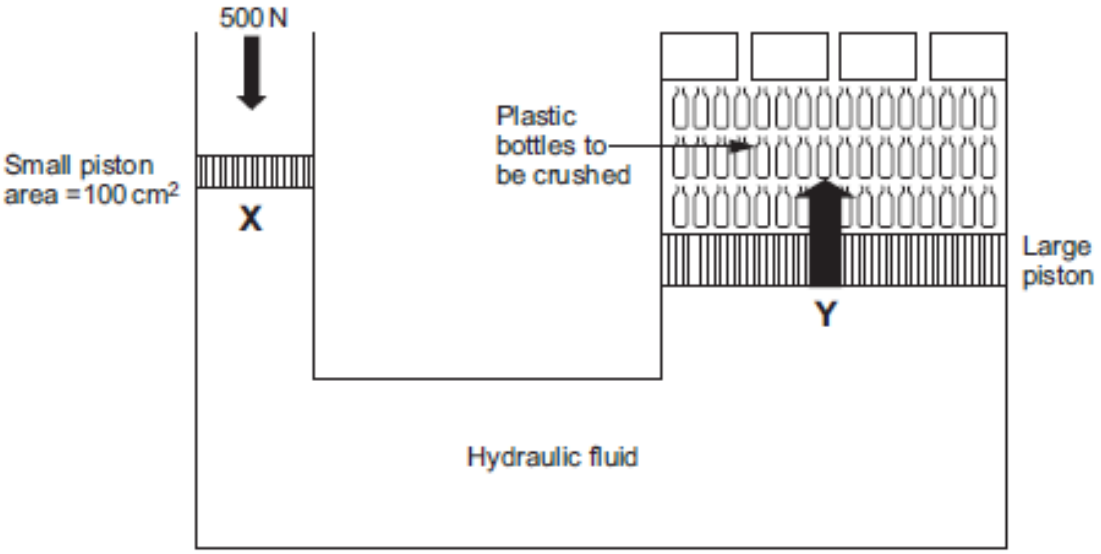
2. In Wales about 725 000 plastic bottles are used each day. Plastic bottles that are collected by local councils need to be transported to recycling plants that are based all around Wales. 250 plastic bottles are crushed into a single small bale. This makes it much easier to transfer them to the recycling factory.

A hydraulic press, as shown in the diagram, can be used. It is designed to exert a large force on the plastic bottles to crush them into a compact single bale. Only a relatively small force needs to be applied at **X** to crush the plastic bottles at **Y**. The pressure applied on the big piston at **Y** will be the same as the pressure exerted at **X**, however the area of the piston at **Y** is 15 times larger than the area of the piston at **X**.



(a) If all of the plastic bottles used each day in Wales are crushed, how many small bales would be produced in **one week**? [2]

number of small bales = ……

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(b) Tick (✓) the box that shows the correct calculation of the pressure exerted by the small piston on the hydraulic fluid at **X**. [1]

$\text{pressure} = \dfrac{\text{force}}{\text{area}} = 500 \times 100 = 50\,000\ \text{N/cm}^2$ ☐

$\text{pressure} = \dfrac{\text{force}}{\text{area}} = \dfrac{500}{100} = 5\ \text{N/cm}^2$ ☐

$\text{pressure} = \dfrac{\text{force}}{\text{area}} = \dfrac{500}{100} = 5\ \text{N/m}^2$ ☐

$\text{pressure} = \dfrac{\text{force}}{\text{area}} = \dfrac{100}{500} = 5\ \text{N/cm}^2$ ☐

(c) Use information from the text and the equation:

force = pressure × area

to calculate the force applied to crush the plastic bottles at **Y**. [2]

force = …… N

(d) The hydraulic press develops a leak. Hydraulic fluid is expensive. A worker at the recycling factory suggests that replacing the hydraulic fluid with air would save money. Explain why the hydraulic press will no longer work if air is used. [2]

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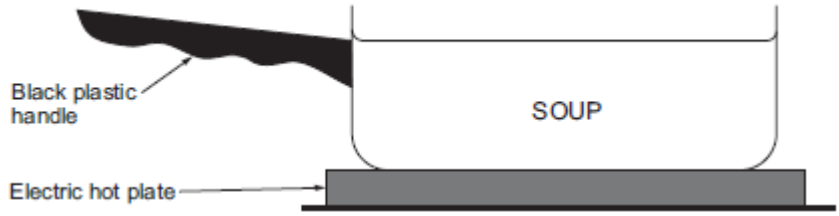
3. The diagram shows a metal pan, containing soup, being heated by an electric hot plate on a cooker.



(a) Complete the following sentences using only the words provided in the box. **Each word can be used once, more than once or not at all.** [4]

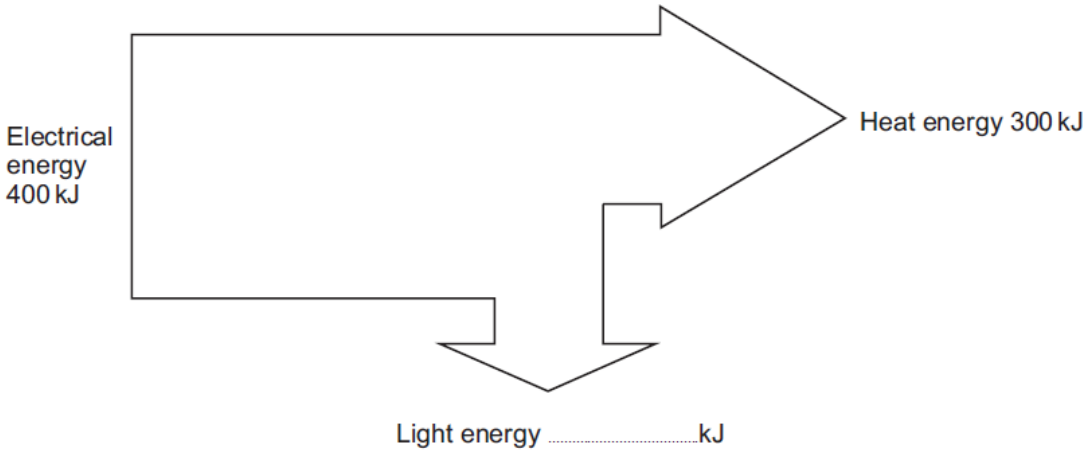
convection **radiation** **conductor** **insulator** **conduction**

(i) The heat is transferred through the base of the metal pan by .....

(ii) All of the soup becomes heated by a …… current that is set up in the liquid.

(iii) The handle is made from plastic as it is a poor …… It is black as it is the best colour at emitting infra-red by ……. when hot.

(b) The Sankey diagram shows the energy transfers taking place when the metal pan is being heated.



(i) **Fill in** the missing value on the diagram. [1]

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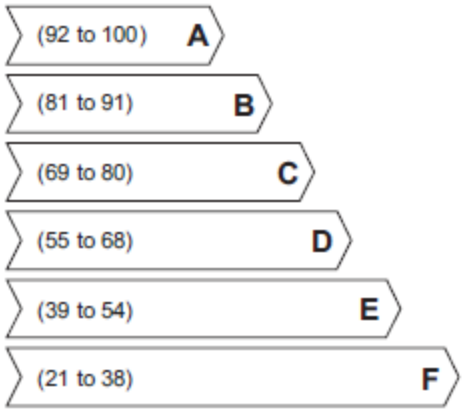
(ii) Use the equation:

$$\% \text{ efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100$$

to calculate the % efficiency of the electric hot plate. [2]

% efficiency = ……

(iii) Manufacturers of electrical appliances use an energy banding code to inform their customers of percentage energy efficiency ratings. A version is shown.



State the energy band for the hotplate of the cooker. [1]

……

(iv) Discuss the importance of buying an appliance which has a high energy efficiency rating, for example a band A appliance. [3]

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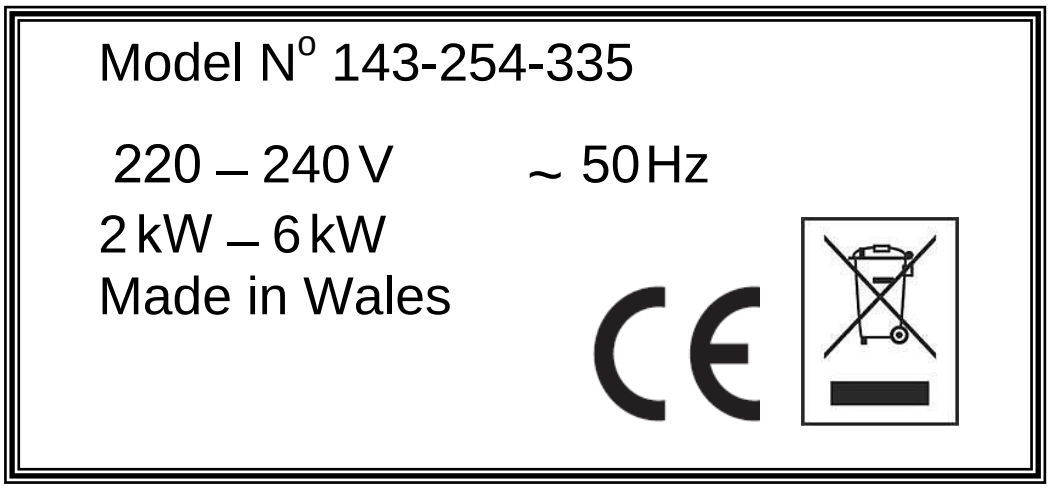
(c) The electric cooker has an information label as shown.



The cooker is being used at maximum power for 3 hours.

(i) Use the equation:

units used (kWh) = power (kW) × time (h)

to calculate the number of units used by the cooker. [1]

number of units used = ……. kWh

(ii) Use the equation:

cost = units used × cost per unit

to calculate the cost, in pence, of using the cooker. One unit (kWh) of electricity costs 15 p. [2]

cost = ……p

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(d) The cooker is connected to a fuse. When the cooker is operating at full power the current is 25 A.
Explain the function of the fuse and select a fuse for the cooker so that it operates safely. You may select from 10 A, 20 A, 25 A or 30 A fuses. [3]

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17

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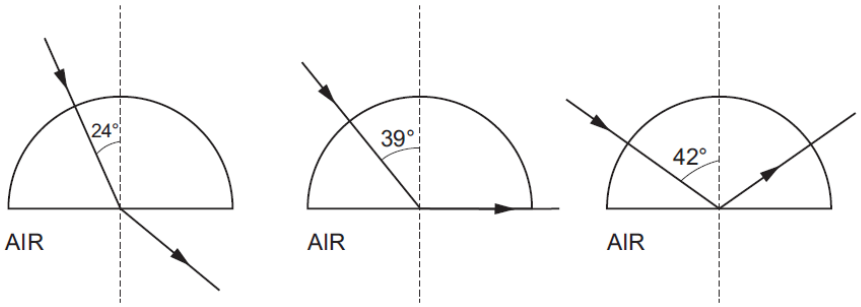
4. The table shows the critical angle for 4 materials as a light beam travels from the material into air.

Material	**Critical angle (degrees)**
diamond	24
glass A	35
glass B	39
perspex	42

A student uses a semi-circular block made from one of the four materials.
Her results are shown below.



(i) Using information from the table and the results explain which material the block is made from. [2]

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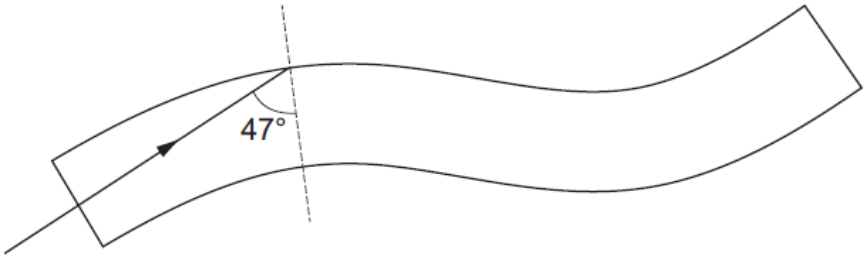
……

(ii) **Complete the diagram** to show how the light ray travels through an optical fibre of an endoscope. [2]



(iii) Medical information about a patient could be obtained with a CT scan. Explain an advantage of using an endoscopic medical examination over a CT scan.[2]

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6

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5. The chart shows the regions of the electromagnetic spectrum (em spectrum).

Radio waves	Micro-waves	Infra-red waves	Visible light	Ultraviolet waves	X-rays	Gamma waves

(a) Describe in terms of their properties why they are all members of this spectrum and explain why they are arranged in the order shown. [6 QER]

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(b) A high exposure to either ultraviolet or infra-red waves can be harmful. State and explain the effects of overexposure to these waves on the human body. [3]

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9

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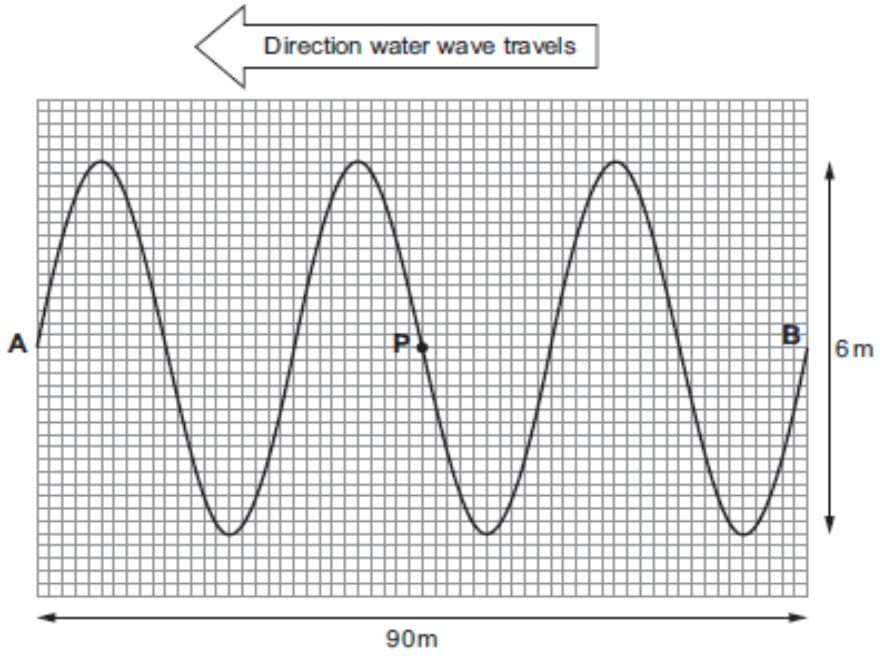
6. The diagram shows some water waves that have been produced following a small earthquake.



(a) (i) How many wavelengths are there between points **A** and **B**? [1]

……

(ii) Calculate the wavelength of the wave. [1]

wavelength = …….…. m

(b) A boat at **P** moves up and down 5 times in 10 seconds.

(i) State the frequency of the water waves. [1]

frequency = …… Hz

(ii) Select and use an equation from page 2 to calculate the speed of the water waves. [3]

speed = ……m/s

(iii) **Draw an arrow** at P to show the direction that the boat moves. [1]

7

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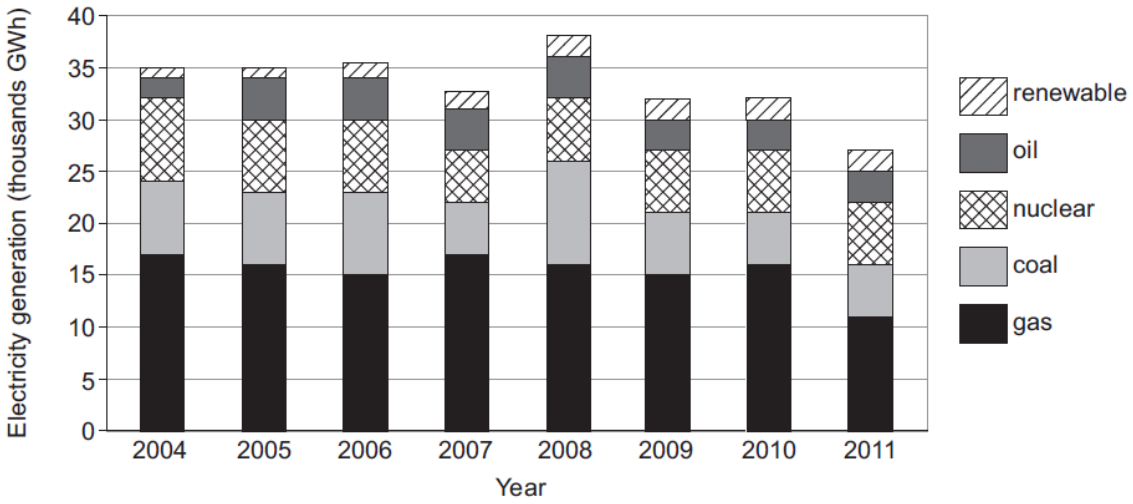
7. Renewable energy is a general term used to describe any source of energy that occurs naturally and is not exhaustible. Developing renewable energy sources for electricity generation is necessary to meet EU and UK Government targets on greenhouse gas emissions and to ensure fuel security. In its 2010 Energy Policy Statement, "*A low carbon revolution",* the Welsh Government set out aspirations totalling 22.5 gigawatts (22.5 GW) of installed capacity from different renewable energy technologies in Wales by 2020/25.

Figure 1: Generation of electricity by energy sources in Wales 2004 -2011



Source: Department of Energy and Climate Change, Welsh Government.

Between 2004 and 2010 the total amount of electricity generated in Wales fluctuated between 32 000 GWh and 38 000 GWh with no consistent trend. In 2011 the total amount of electricity generated in Wales fell to 28 000 GWh.

There are proposals for new power stations to be built in Wales. The most significant is a new nuclear power station at Wylfa B. It has the potential to generate 23 000 GWh each year.

(a) (i) In the article published by the Welsh Government, the 2010 Energy Policy Statement refers to "*A low carbon revolution".* Discuss what this term means for the future of electricity generation in Wales. [2]

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(ii) Use **Figure 1** to identify the trends in the generation of electricity using different energy sources between 2009 and 2011. [2]

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(iii) In 2011 consumers in Wales used 45 000 GWh of electrical energy. Describe how the shortfall between supply and demand was met. [2]

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……

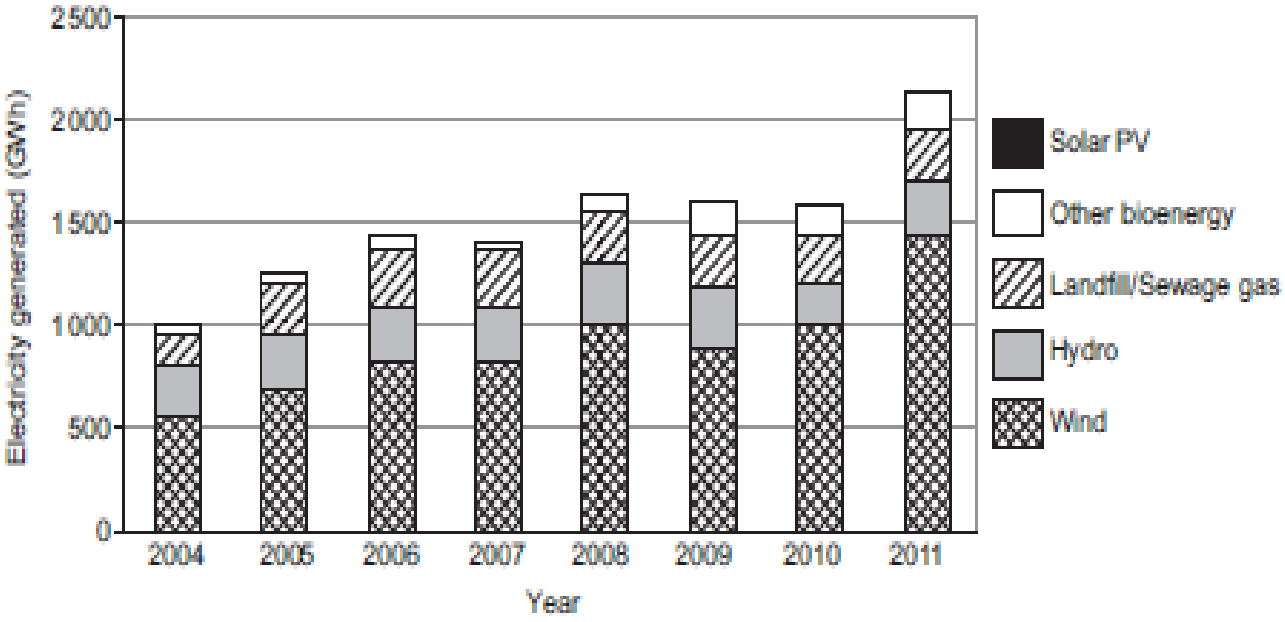
……

(iv) If the new nuclear power station at Wylfa B had been commisioned and used at maximum power in 2011 how much surplus electrical energy would Wales have produced? [2]

electrical energy = ……..GWh

(b) **Figure 2** shows a general upward trend in the amount of electrical energy generated from renewable sources in Wales between 2004 and 2011, reaching a maximum of 2 160 GWh in 2011.

Figure 2: Electricity generated from renewable sources in Wales, 2004 - 2011



(i) State which renewable energy source didn't make a contribution to the electrical energy generated in Wales between 2004 and 2011. [1]

……

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(ii) For the period considered (2004-2011) the total amount of electricity generated from renewables in Wales changes considerably. Explain which renewable energy source was mainly responsible for this change. [2]

……

……

……

(c) Since 2011 considerably more Welsh homes have had PV cells installed. Describe and explain how a bar on the chart of **Figure 2** could look for 2015. [3]

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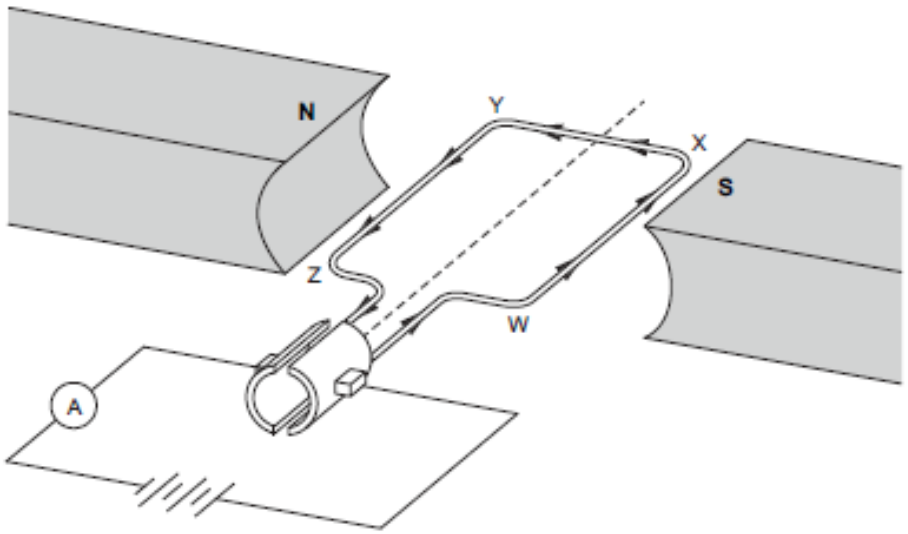
8. The diagram represents a simple electric motor that a pupil investigates in his lesson.



The current in the coil flows from **W** to **Z** as shown on the diagram.

(a) (i) Explain clearly how you would use Flemings left hand rule to determine the direction of the force on the side **YZ**. [3]

……

……

……

……

(ii) State **one** change the student could make so that side **YZ** of the coil moves in the opposite direction. [1]

……

(b) State **two** changes that could be made to make the coil rotate faster. [2]

……..

……..

……..

END OF PAPER

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UNIT 1: ELECTRICITY, ENERGY AND WAVES
FOUNDATION TIER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

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Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

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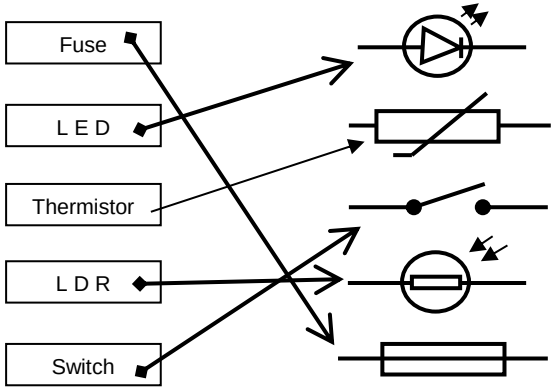
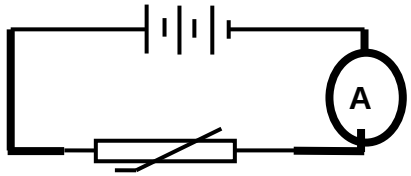
Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			 3 or 4 correct - **3 marks** 2 correct - **2 marks** 1 correct - **1 mark** 0 correct - **0 mark**	3			3		
	(b)	(i)		 Correct ammeter symbol (1) Complete series circuit (1)	2			2		2
		(ii)		All 5 points correctly plotted within ±½ small square division (2) 4 points correctly plotted within ±½ small square division (1) 0-3 points correctly plotted within ±½ small square division (0) Smooth curve of best fit within ± ½ small square division of all points (1) Don't accept thick, double, whispy lines		3		3	3	3

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		Current increase as temperature increases (1) at an increasing rate (1)		2		2		2
	(c)	(i)		Changing the temperature of the thermistor changes its resistance (1) so that the brightness of the bulbs will change (1)			2	2		2
		(ii)		Lamp A is now off (1) because the circuit is broken / incomplete / no charge flows (1)			2	2		2
				Question 1 total	**5**	**5**	**4**	**14**	**3**	**11**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			$\frac{725\,000}{250} = 2\,900$ (1) 2 900 (**ecf**) × 7 = 20 300 (1)			2	2	2	
	(b)			Box 2 - pressure = $\frac{\text{force}}{\text{area}} = \frac{500}{100} = 5\ \text{N/cm}^2$	1			1	1	
	(c)			15 × 100 = 1 500 [cm^2] (1) 5 (**ecf**) × 1 500 = 7 500 [N] (1) **or** Force = 500 × 15 (1) = 7 500 [N] (1)		2		2	2	
	(d)			Gases can be compressed / gas molecules squeezed together when force applied at X (1) The force at Y would be much smaller (1)			2	2		
				Question 2 total	**1**	**2**	**4**	**7**	**5**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i) (ii) (iii)		conduction (1) convection (1) conductor (1) radiation (1)	4			4		
	(b)	(i)		100 [kJ]		1		1	1	
		(ii)		Substitution: $\frac{300}{400} \times 100$ (1) % efficiency = 75 (1)	1	1		2	2	
		(iii)		Band C **or** (69 to 80) (allow **ecf** from (ii))		1		1		
		(iv)		Less energy wasted / more energy usefully converted (1) better for the environment / less impact on environment (1) and will save the user money (1)		3		3		
	(c)	(i)		$6 \times 3 = 18$ [kWh]		1		1	1	
		(ii)		Substitution: 18 (**ecf**) $\times$ 15 (1) Cost = 270 [p] (1)	1	1		2	2	
	(d)			If the current exceeds the fuse rating it melts (1) The circuit is broken (1) [and avoids a potential fire risk] Fuse selected = 30 [A] (1)	1 1	1		3		
				Question 3 total	**8**	**9**	**0**	**17**	**6**	**0**

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Question				Marking details	Marks Available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
4		(i)		Glass B (1) Diagram 2 shows critical angle at 39^{o} / grazing emergence shown (1)			2	2	1	
		(ii)		Two TIR (1) Relatively equal angles of incidence (1)		2		2		
		(iii)		CT scan uses X rays that are ionising (1) which may potentially damage cells (1) (accept opposite argument)	2			2		
				Question 4 total	**2**	**2**	**2**	**6**	**1**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			**Indicative content:** The seven waves are grouped together because they have properties that are identical. The em waves all travel at the same speed (3×10^8 m/s) in a vacuum, they are transverse, they travel in straight lines, they travel through a vacuum and transfer energy. However, they do have different wavelengths, frequency and energy. Their order, from left to right in the diagram, is from long to short wavelength. The frequency and energy of the waves is from low to high. Gamma waves have the highest frequency and energy but the shortest wavelength. The higher the frequency or energy the more ionising the radiation. **5 – 6 marks** Detailed description of the em spectrum that includes both their identical properties and two differences. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.* **3 – 4 marks** A brief description of some identical properties of the em waves and at least one of their differences. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.* **1-2 marks** A basic description of either some of their identical properties or differences. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure*. *The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.*	6			6		

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
				0 marks *No attempt made or no response worthy of credit.*						
	(b)			Ultra-violet may cause cancer / cell damage (1) Infra-red can result in instant burns (1) Ultra-violet waves are higher energy / ionising compared to infra-red (1)	3			3		
				Question 5 total	**9**	**0**	**0**	**9**	**0**	**0**

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Question				Marking details	Marks Available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
6	(a)	(i)		3		1		1		
		(ii)		$\frac{90}{3}$ = 30 [m]		1		1	1	
	(b)	(i)		0.5 [Hz]		1		1	1	
		(ii)		Wave speed = frequency × wavelength (1) Substitution: 0.5 (**ecf**) × 30 (**ecf**) (1) Speed =15 [m/s] (1)	1 1	1		3	3	
		(iii)		Arrow pointing down [at P]			1	1		
				Question 6 total	**2**	**4**	**1**	**7**	**5**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		Less fossil fuels used to generate electricity (1) so less CO_2 produced (1)		2		2		
		(ii)		Reduction in gas used to generate electrical energy (1) The other energy sources remain similar (1)		2		2		
		(iii)		National Grid [connects users to power stations via a network of cables] (1) Electrical energy can be transferred from other parts of UK (1)	2			2		
		(iv)		28 000 + 23 000 = 51 000 [GWh] (1) 51 000 – 45 000 = 6 000 [GWh] (1)		2		2	2	
	(b)	(i)		Solar PV	1			1		
		(ii)		Wind shows a significant increase in 2011 / whereas the other renewable sources are pretty constant between 2004 to 2011 (1) due to more wind farms constructed / windier weather (1)			2	2		
	(c)			Bar will be taller / longer (1) as more electricity generated by renewable sources (1) Wind may continue to follow upward trend but solar PV would increase (1)			3	3	1	
				Question 7 total	**3**	**6**	**5**	**14**	**3**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		Current Z to Y = second finger (1) B field N to S first finger (1) Thumb up for upward force (1)		3		3		3
		(ii)		Reverse battery / swap magnetic poles		1		1		1
	(b)			**Any 2 × (1) from:** Stronger magnets More coils Larger current Iron core added	2			2		2
				Question 8 total	**2**	**4**	**0**	**6**	**0**	**6**

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FOUNDATION TIER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	5	4	14	3	11
2	1	2	4	7	5	0
3	8	9	0	17	6	0
4	2	2	2	6	1	0
5	9	0	0	9	0	0
6	2	4	1	7	5	0
7	3	6	5	14	3	0
8	2	4	0	6	0	6
TOTAL	**32**	**32**	**16**	**80**	**23**	**17**

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Candidate Name	Centre Number					Candidate Number				
						0				

GCSE

PHYSICS

UNIT 1: ELECTRICITY, ENERGY and WAVES

HIGHER TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**6**	
3.	**9**	
4.	**9**	
5.	**13**	
6.	**6**	
7.	**12**	
8.	**11**	
Total	**80**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page
Answer all questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets at the end of each question or part-question.
Question **4(a)** is a quality of extended response (QER) question where your writing skills will be assessed.

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Equations

current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
total resistance in a parallel circuit	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
power = current^2 × resistance	$P = I^2R$
% efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$	
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
	T / K = θ / °C + 273
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
V_1 = voltage across the primary coil V_2 = voltage across the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

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SI multipliers

Prefix	Multiplier
p	1×10^{-12}
n	1×10^{-9}
μ	1×10^{-6}
m	1×10^{-3}

Prefix	Multiplier
k	1×10^{3}
M	1×10^{6}
G	1×10^{9}
T	1×10^{12}

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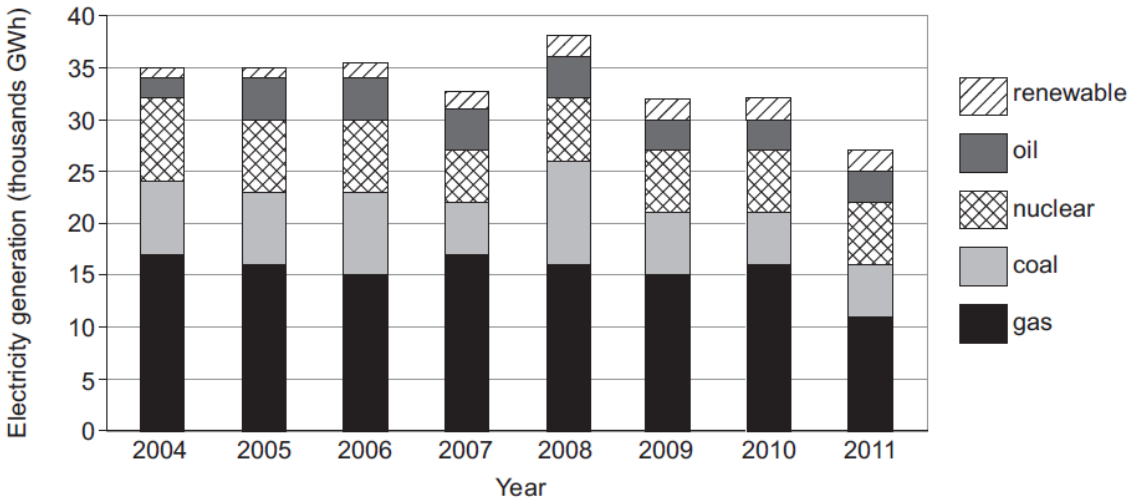
Answer **all** *questions*

1. Renewable energy is a general term used to describe any source of energy that occurs naturally and is not exhaustible. Developing renewable energy sources for electricity generation is necessary to meet EU and UK Government targets on greenhouse gas emissions and to ensure fuel security. In its 2010 Energy Policy Statement, "*A low carbon revolution",* the Welsh Government set out aspirations totalling 22.5 gigawatts (22.5 GW) of installed capacity from different renewable energy technologies in Wales by 2020/25.

Figure 1: Generation of electricity by energy sources in Wales 2004 -2011



Source: Department of Energy and Climate Change, Welsh Government.

Between 2004 and 2010 the total amount of electricity generated in Wales fluctuated between 32 000 GWh and 38 000 GWh with no consistent trend. In 2011 the total amount of electricity generated in Wales fell to 28 000 GWh.

There are proposals for new power stations to be built in Wales. The most significant is a new nuclear power station at Wylfa B. It has the potential to generate 23 000 GWh each year.

(a) (i) In the article published by the Welsh Government, the 2010 Energy Policy Statement refers to "*A low carbon revolution".* Discuss what this term means for the future of electricity generation in Wales. [2]

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(ii) Use **Figure 1** to identify the trends in the generation of electricity using different energy sources between 2009 and 2011. [2]

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(iii) In 2011 consumers in Wales used 45 000 GWh of electrical energy. Describe how the shortfall between supply and demand was met. [2]

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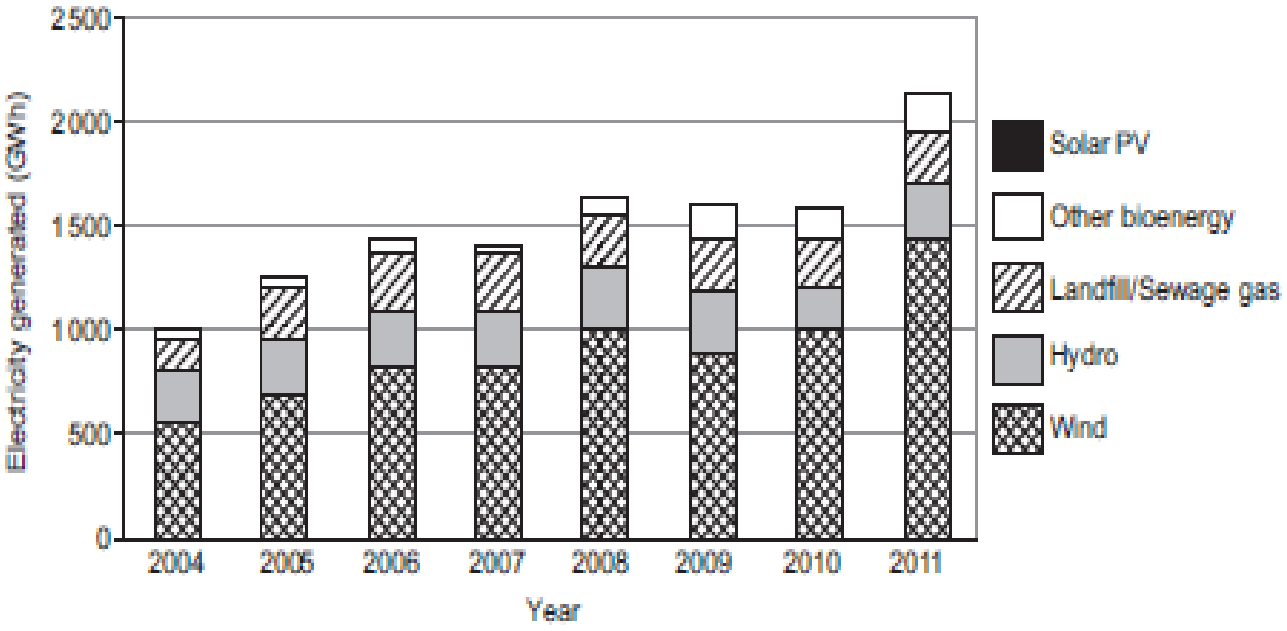
(iv) If the new nuclear power station at Wylfa B had been commisioned and used at maximum power in 2011 how much surplus electrical energy would Wales have produced? [2]

electrical energy = ……..GWh

(b) **Figure 2** shows a general upward trend in the amount of electrical energy generated from renewable sources in Wales between 2004 and 2011, reaching a maximum of 2 160 GWh in 2011.

Figure 2: Electricity generated from renewable sources in Wales, 2004 - 2011



(i) State which renewable energy source didn't make a contribution to the electrical energy generated in Wales between 2004 and 2011. [1]

……

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(ii) For the period considered (2004-2011) the total amount of electricity generated from renewables in Wales changes considerably. Explain which renewable energy source was mainly responsible for this change. [2]

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(c) Since 2011 considerably more Welsh homes have had PV cells installed. Describe and explain how a bar on the chart of **Figure 2** could look for 2015. [3]

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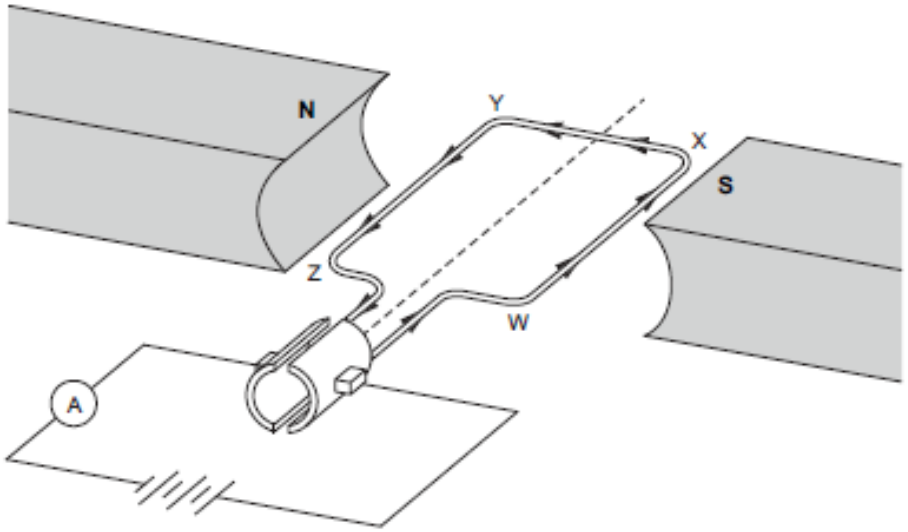
2. The diagram represents a simple electric motor that a pupil investigates in their lesson.



The current in the coil flows from **W** to **Z**. This is shown on the diagram.

(a) (i) Explain clearly how you would use Flemings left hand rule to determine the direction of the force on the side **YZ**. [3]

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(ii) State **one** change the student could make so that side **YZ** of the coil moves in the opposite direction. [1]

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(b) State **two** changes that could be made to make the coil rotate faster. [2]

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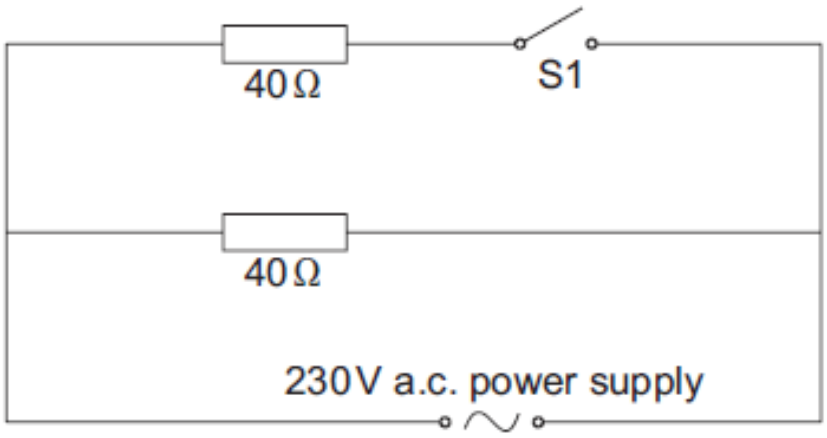
3. The circuit diagram shows a simplified version of the heating circuit used in a hairdryer. The switch (S1) can be closed so that the hairdryer blows hotter air.



Select and use equations from page 2 to answer the following questions.

(a) (i) Calculate the current supplied by the a.c.power supply when **S1 is open**. [3]

current = ……. A

(ii) Calculate the power produced by the resistor when **S1 is open**. [3]

power =…….. W

(b) The company who make the hairdryer state that the amount of heat energy produced each second will double when the switch (S1) is closed. Discuss if their claim is correct. [3]

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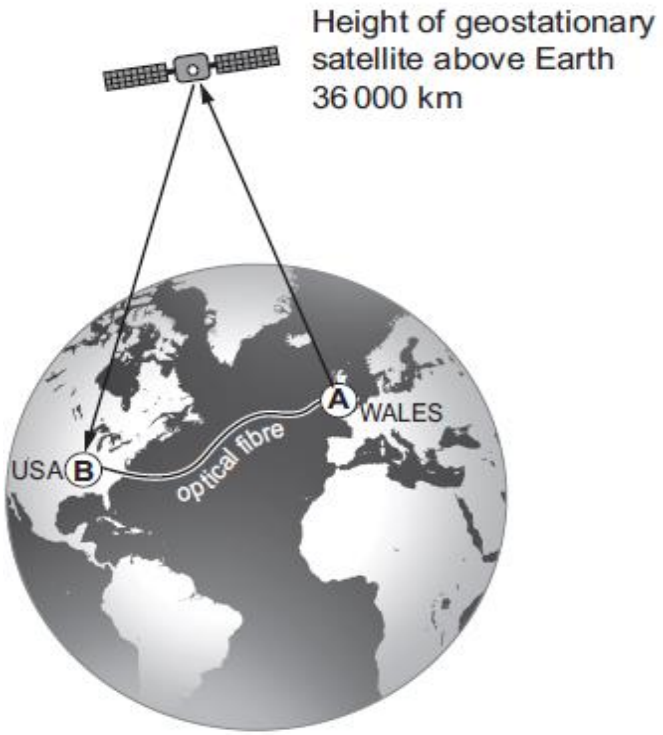
4. An optical fibre between Wales and the USA has a length of 9 000 km. The electromagnetic wave used to send information along the optical fibre travels at ½ the speed of an electromagnetic wave in a vacuum (space).



(a) A top secret and urgent message needs to be sent from the Welsh Government (Wales) to the White House (USA). The two methods available are:

1. via geostationary satellite;
2. via optical fibre.

Compare the two methods, stating any advantages or disadvantages (other than cost) of using them. [6 QER]

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(b) A geostationary satellite is a special type of satellite as it stays directly above the same point on the Earth. State the conditions needed to achieve this. [3]

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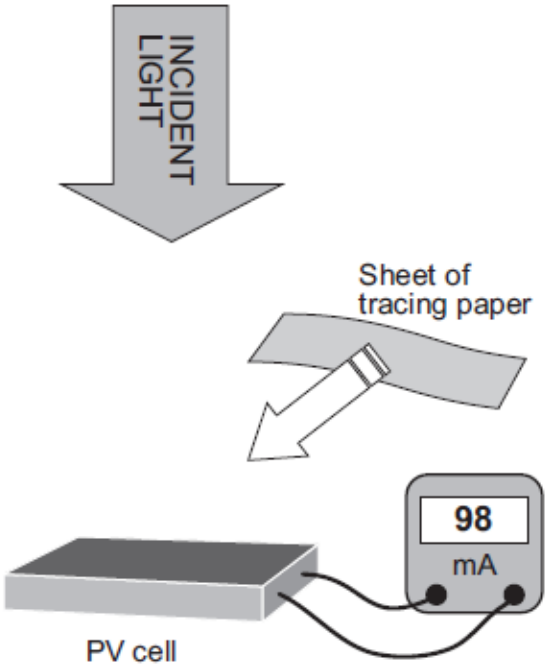
5. Solar cells (PV cells) are used on many houses to generate electrical energy, saving each homeowner money for every kWh of energy produced.

A student makes this prediction to his teacher.
"*I think that thicker clouds will reduce the electrical current generated from a PV cell. The current they produce will be inversely proportional to the thickness of the cloud.*"

The teacher decides to test out this prediction with 6 groups in his class. He decides that tracing paper will be a suitable way to model clouds.



A large sheet of tracing paper is placed over the PV cell.
The current on the milliammeter is recorded.
Extra sheets of tracing paper are then placed over the PV cell. More data are collected.
More sheets of tracing paper model thicker clouds.

Group 1 results

Number of sheets of tracing paper	Trial 1 Current (mA)	Trial 2 Current (mA)	Mean current (mA)
0	100	99	100
1	77	79	78
2	61	60	61
3	50	46	48
5	32	32	32
7	25	19	22
8	18	17	.....

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(a) (i) **Complete the table** opposite for the missing mean current when 8 sheets of tracing paper are covering the PV cell. [1]

(ii) Which pair of readings from the experiment are **least** repeatable? [1]

.....

(iii) To find an uncertainty of a mean value obtained from two pieces of data the following expression can be used:

$$\text{uncertainty} = \frac{\text{trial 1 value} - \text{trial 2 value}}{2}$$

Using data in the table, calculate the uncertainty in the mean for 3 sheets of tracing paper. [1]

uncertainty = …….mA

(iv) The teacher asks the 6 groups to compare their results with each other. Explain the purpose of comparing results with other groups. [2]

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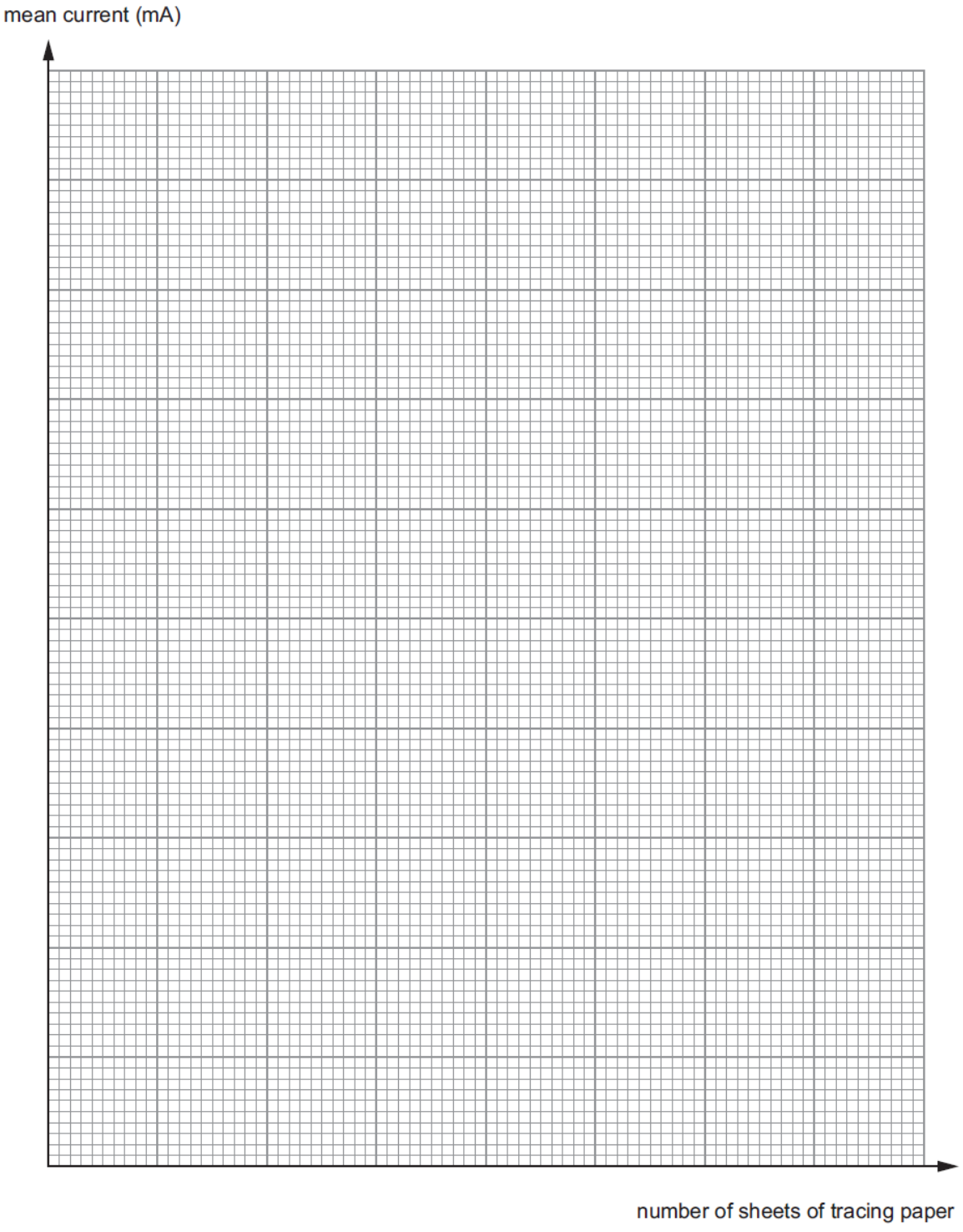
(b) (i) Use the data in the table to plot a graph on the grid below. [3]



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(ii) Using information from **the graph** discuss if the student's prediction is justified. [3]

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(c) Use the findings from this experiment to explain why, in practice, the amount of money saved per day by a homeowner will vary. [2]

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13

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6. Metal aerosol cans contain a gas at high pressure. For safety reasons the can must be able to withstand pressures up to 620 kPa. A pressure greater than this value will cause the can to explode.

A can containing a fixed mass of gas is thrown into a bonfire. It is heated from 27 ^{o}C to 227 ^{o}C.

(a) Using the model of molecular motion explain why the pressure of the gas inside the can will increase when thrown into the bonfire. [2]

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(b) The original pressure (at 27 ^{o}C) of the gas in the can was 280 kPa.
Use an equation from page 2 to determine whether or not the can explodes when thrown into the bonfire. [4]

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7. The information given in the table below states the specific heat capacity of different substances.

Substance	**Specific heat capacity (J/kg ^{o}C)**
water	4 200
oil	2 100
aluminium	880
copper	380

(a) (i) Aluminium has a specific heat capacity of 880 J/kg ^{o}C. Explain what this statement means. [2]

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……

(ii) A 0.75 kg block of aluminium is heated from 20 ^{o}C to 80 ^{o}C. Use an equation from page 2 to calculate the heat energy supplied to the aluminium block. [2]

energy supplied = ……J

(b) The hot aluminium block is now submerged into an insulated beaker of water. The mass of the water in the beaker is 0.50 kg. The final temperature of the water and aluminium block is 30.5 ^{o}C. Calculate the original temperature of the water. [5]

temperature = …… ^{o}C

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(c) Explain which of oil or water is a better coolant in a car radiator. [3]

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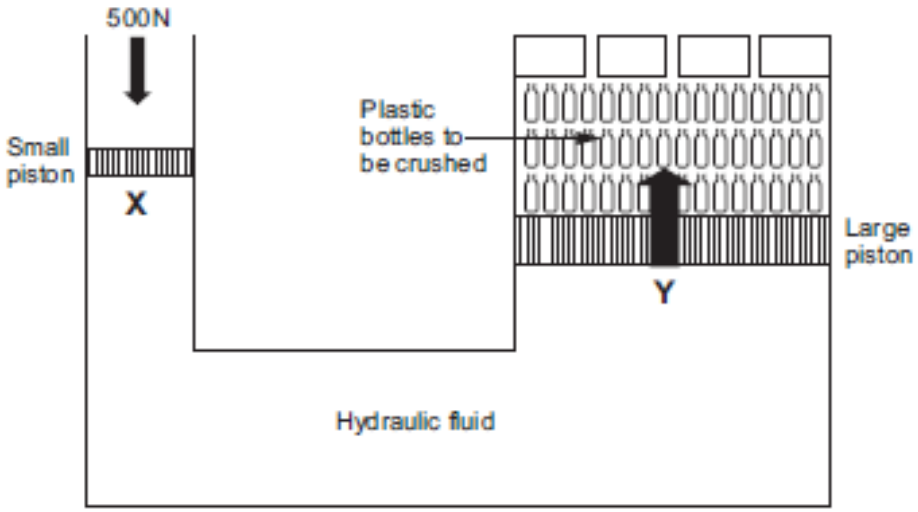
8. In Wales it is reported that 7.25×10^5 plastic bottles are used each day but only 45% of them are recycled. They are collected by local councils and then need to be transported to recycling plants that are based all around Wales. One crushed plastic bottle has a mean volume of 50 cm^3. Many plastic bottles are crushed into a single bale of mass of 190 kg. This makes it much easier to transport the plastic to the recycling factory.

A hydraulic press, as shown in the diagram, can be used. It is designed to exert a large force on the plastic bottles to crush them into a compact single bale. Only a relatively small force needs to be applied at **X** to crush the plastic bottles at **Y**. The pressure applied on the big piston at **Y** will be the same as the pressure exerted at **X**, however the area of the piston at **Y** is **15 times** larger than the area of the piston at **X**.



(a) Plastic has a density of 0.95 g/cm^3. How many bales of plastic bottles are produced in Wales **each week**?

You will need to use an equation from page 2. [6]

number of bales = ……..

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(b) Use information from the text and an equation from page 2 to calculate the force applied to crush the plastic bottles at **Y**. [3]

force = …… N

(c) Explain why air bubbles in the hydraulic liquid make the press less effective at crushing the plastic bottles. [2]

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END OF PAPER

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UNIT 1: ELECTRICITY, ENERGY AND WAVES
HIGHER TIER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

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Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		Less fossil fuels used to generate electricity (1) so less CO_2 produced (1)		2		2		
		(ii)		Reduction in gas used to generate electrical energy (1) The other energy sources remain similar (1)		2		2		
		(iii)		National Grid [connects users to power stations via a network of cables] (1) Electrical energy can be transferred from other parts of UK (1)	2			2		
		(iv)		28 000 + 23 000 = 51 000 [GWh] (1) 51 000 – 45 000 = 6 000 [GWh] (1)		2		2	2	
	(b)	(i)		Solar PV	1			1		
		(ii)		Wind shows a significant increase in 2011 / whereas the other renewable sources are pretty constant between 2004 to 2011 (1) due to more wind farms constructed / windier weather (1)			2	2		
	(c)			Bar will be taller / longer (1) as more electricity generated by renewable sources (1) Wind may continue to follow upward trend but solar PV would increase (1)			3	3	1	
				Question 1 total	**3**	**6**	**5**	**14**	**3**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		Current Z to Y = second finger (1) B field N to S first finger (1) Thumb up for upward force (1)		3		3		3
		(ii)		Reverse battery / swap magnetic poles		1		1		1
	(b)			**Any 2 × (1) from:** Stronger magnets More coils Larger current Iron core added	2			2		2
				Question 2 total	**2**	**4**	**0**	**6**	**0**	**6**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		Selection of: $I = \frac{V}{R}$ (1) Substitution of: $\frac{230}{40}$ (1) Current = 5.75 [A] (1)	1 1	1		3	3	
		(ii)		Selection of: $P = V \times I$ (1) Substitution of: 230 (1) × 5.75 (**ecf**) Power = 1 322.5 [W] (1) **Alternative solution:** Selection of: $P = I^2 \times R$ (1) Substitution of: 5.75^2 (**ecf**) × 40 (1) Power = 1 322.5 [W] (1)	1 1	1		3	3	
	(b)			S1 closed introduces a resistor in parallel that reduces the total resistance (1) [in the circuit / more current flows]. The resistors in parallel are identical so the total resistance will ½ (1) [whilst the current doubles] Their claim is correct as the power doubles because P α I when V = constant (1) **Alternative response:** S1 closed introduces a resistor in parallel that reduces the total resistance (1) [in the circuit / more current flows]. The resistors in parallel are identical so the total resistance will ½ (1) [whilst the current doubles]. Their claim is correct as the power doubles because P α I^2 and P α R (1) when V constant. **Alternative response:** Both in parallel (1) Voltage the same across both, same current as original resistor (1) So double the power as two resistors (1)			3	3		
				Question 3 total	**4**	**2**	**3**	**9**	**6**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			**Indicative content:** Using microwaves for the geostationary satellite means a longer distance to travel but they do travel faster than the infra-red in the shorter optical fibre. The microwaves used travel $\frac{36\,000 \times 2}{9\,000}$ = 8 times the distance compared to the infra-red signal. However, the infra-red signal travels at half the speed. This means that the optical fibre takes a ¼ of the time to transfer information compared to the satellite method. Alternatively it may be said that the satellite has a time delay that is 4 times greater than the optical fibre, which would be a disadvantage. Other advantages of optical fibres include more security and a very low error rate compared to the microwaves used in the satellite transmission. Optical fibres also provide greater data transfer rates (10 Gb/s) compared to satellites (50 Mb/s). **5 – 6 marks** Detailed description of advantages / disadvantages, along with the correct reasoning for time delay. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.* **3 – 4 marks** A brief description of some qualitative advantages / disadvantages, with an attempt to compare time delay. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.* **1-2 marks** A basic description of any qualitative advantages / disadvantages. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. The candidate uses limited scientific terminology and inaccuracies in spelling,*	4	2		6	2	0

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				punctuation and grammar. **0 marks** *No attempt made or no response worthy of credit.*						
	(b)			Orbit above equator (1) [of Earth] Orbit period of 24 hour (1) Orbits in the same direction as Earth spins (1)	3			3		
				Question 4 total	**7**	**2**	**0**	**9**	**2**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		18 not 17.5	1			1	1	1
		(ii)		7 sheets **or** 25 **and** 19	1			1	1	1
		(iii)		$\frac{50-46}{2} = 2$ [mA]	1			1	1	1
		(iv)		To see if data are reproducible (1) so that there is more confidence in the data/findings/conclusion (1)	2			2		2
	(b)	(i)		All 7 points plotted correctly within ±½ small square division (1) Suitable scales (i.e. intervals of 10 mA on the *y*-axis and intervals of 1 on the *x*-axis) (1) Smooth curve of best fit within ± ½ small square division of all points (1) Don't accept thick, double, whispy lines		3		3	3	3
		(ii)		As the sheets of tracing paper increases the current decreases (1) However, doubling the number of sheets of tracing paper on the graph doesn't ½ the current (1) or alternative method so it is not true to say it is inversely proportional (1)			3	3		3
	(c)			Cloud cover varies each day (1) So the amount of energy produced will be variable (1)	2			2		
				Question 5 total	**7**	**3**	**3**	**13**	**6**	**11**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			Molecules gain KE (1) [as temperature increases] so there are more collisions per second on the wall of the can [which means higher pressure] / force increasing for fixed area (1)	2			2		
	(b)			Selection of: $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ (1) Realisation that: $V_1 = V_2$ or by implication (1) $\frac{280 \times 10^3 \cancel{V_1}}{(273+27)} = \frac{p_2 \cancel{V_2}}{(273+227)}$ (1 - for conversion to Kelvin) $p_2 = 5 \times 10^5$ [Pa] so can doesn't explode (1)	1 1	 1 1		4	3	
				Question 6 total	**4**	**2**	**0**	**6**	**3**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		880 J to heat 1 kg (1) By 1 °C (1)	2			2		
		(ii)		$Q = m \times c \times \Delta\theta$ = 0.75 × 880 × 60 (1) Q = 39 600 [J] (1)	1	1		2	2	
	(b)			Aluminium temp change = (80 – 30.5) (1) [= 49.5 °C] Al: 0.75 × 880 × 49.5 **ecf** (1) Water: 0.50 × 4 200 × (30.5 – T_{water}) (1) $\frac{32\,670}{2\,100}$ = 15.6 = (30.5 - T_{water}) (1 - manipulation) T_{water} = 14.9 [°C] (1)	1 1	1 1 1		5	5	
	(c)			Reach same temperature in engine (1) Water has a higher specific heat capacity (1) So absorbs more heat [per given mass] (1)			3	3		
				Question 7 total	**5**	**4**	**3**	**12**	**7**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			Mass (single bottle) = density × volume (1 - manipulation) = 0.95 × 50 = 47.5 [g] (1) Bottles in bale = $\frac{190 \times 10^3}{47.5}$ (1 - conversion) = 4 000 (1) (**ecf**) Number recycled per week = $\frac{45}{100} \times 7.25 \times 10^5 \times 7 = 2.28 \times 10^6$ (1) $\frac{2.28 \times 10^6}{4\,000}$ = 570.9 = 570 bales (1) accept 571 bales **Alternative solution:** $7.25 \times 10^5 \times 0.45$ = number of bottles per day (1) $7.25 \times 10^5 \times 0.45 \times 7$ = number of bottles per week (1) Total volume = $7.25 \times 10^5 \times 0.45 \times 7 \times 50$ (1) Total mass (g) = $7.25 \times 10^5 \times 0.45 \times 7 \times 50 \times 0.95 = 108.48 \times 10^6$ g (1) Number of bales = $\frac{108.48 \times 10^6}{190\,000}$ (1 – conversion kg→ g) Answer = 570.9 = 570 bales (1) accept 571 bales		6		6	6	
	(b)			$\frac{F_X}{A_X} = \frac{F_Y}{A_Y} = p$ (1) $A_Y = 15\ A_X$ (1) $F_Y = 15 \times F_X = 15 \times 500 = 7\,500$ [N] (1)		3		3	3	
	(c)			Air / gas can be compressed (1) so larger force will be needed at X to exert same 7 500 N at Y (1)			2	2		
				Question 8 total	**0**	**9**	**2**	**11**	**9**	**0**

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HIGHER TIER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	3	6	5	14	3	0
2	2	4	0	6	0	6
3	4	2	3	9	6	0
4	7	2	0	9	2	0
5	7	3	3	13	6	11
6	4	2	0	6	3	0
7	5	4	3	12	7	0
8	0	9	2	11	9	0
TOTAL	32	32	16	80	36	17

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Candidate Name	Centre Number					Candidate Number				
						0				

GCSE

PHYSICS

UNIT 2: FORCES, SPACE and RADIOACTIVITY

FOUNDATION TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**9**	
3.	**7**	
4.	**9**	
5.	**13**	
6.	**7**	
7.	**8**	
8.	**9**	
9.	**11**	
Total	**80**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page
Answer all questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets at the end of each question or part-question.
Question **4(b)** is a quality of extended response (QER) question where your writing skills will be assessed.

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Equations

$\text{speed} = \dfrac{\text{distance}}{\text{time}}$	
$\text{acceleration [or deceleration]} = \dfrac{\text{change in velocity}}{\text{time}}$	$a = \dfrac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
force = spring constant × extension	$F = kx$
momentum = mass × velocity	$p = mv$
$\text{force} = \dfrac{\text{change in momentum}}{\text{time}}$	$F = \dfrac{\Delta p}{t}$
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $x = \dfrac{u+v}{2}t$
moment = force × distance	$M = F\,d$

SI multipliers

Prefix	Multiplier
m	1×10^{-3}
k	1×10^{3}
M	1×10^{6}

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Answer **all** *questions*

1. Read the information below.

The first 92 elements in the periodic table occur naturally on the Earth. Other elements have been created by mankind, usually inside nuclear reactors. The atoms of some elements exist in different forms which are called isotopes. Isotopes of the same element all have the same number of protons. However isotopes of different elements may have the same nucleon number, some of which are shown in the table below.

Isotope	**Proton number**	**Nucleon number**
americium (Am)	95	238
uranium (U)	92	238
thorium (Th)	90	238
californium (Ca)	98	238

(a) Read the statements below and tick (✓) the correct statements. [3]

Statement	
Atoms of all of these isotopes have the same number of protons in their nuclei.	
An atom of uranium has 92 neutrons in its nucleus.	
An atom of californium has the greatest number of protons in its nucleus.	
An atom of californium has the smallest number of neutrons in its nucleus	
Uranium is not a naturally occurring element.	
An atom of uranium has 92 protons in its nucleus.	

(b) **Complete the decay equation** of uranium-238 into thorium in the equation below. [2]

$$^{238}_{92}\mathrm{U} \rightarrow {}^{4}_{2}\alpha + {}^{\_}_{\_}\mathrm{Th}$$

(c) **Circle the two** correct isotopes of uranium from the list below. [2]

$$^{232}_{92}\mathrm{U} \quad ^{238}_{89}\mathrm{U} \quad ^{234}_{90}\mathrm{U} \quad ^{235}_{92}\mathrm{U} \quad ^{238}_{91}\mathrm{U}$$

7

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2. The distances between objects in space are mind boggling. Even the distances between planets in our solar system are so enormous that it takes space vehicles from Earth a very long time to get to them, many years in some cases. For example, the space craft called New Voyager that passed Pluto in 2015 was launched from Earth in January 2006 and despite it being the fastest vehicle that has ever been sent from Earth, it took over 9 years to reach Pluto.

Fortunately there is one thing that travels so fast that we can express the vast distances of space in terms of how far it travels in 1 second or even for huge distances, the distance it travels in 1 year. This is of course light. Light travels 300 000 kilometres in 1 second and even at that speed light takes 500 s to travel to us from the Sun. We could say that the Sun is 500 light seconds away. The nearest star to our Sun is about 4 light years away, others are even millions of light years away from us.

Some of the distances used in astronomy are:

1 astronomical unit (AU) is the distance between the Earth and the Sun
1 light second is the distance travelled by light in 1 second = 300 000 km

(a) (i) What is a meant by a light year? [1]

…….

…….

(ii) The sun is 500 light seconds away from Earth.
Use the equation:

distance = speed × time

to calculate this distance in km. [2]

distance = …….km

(iii) The radius of Saturn's orbit is 9 AU. Use your answer to (ii) above to calculate the radius of its orbit in km. [2]

radius = …….km

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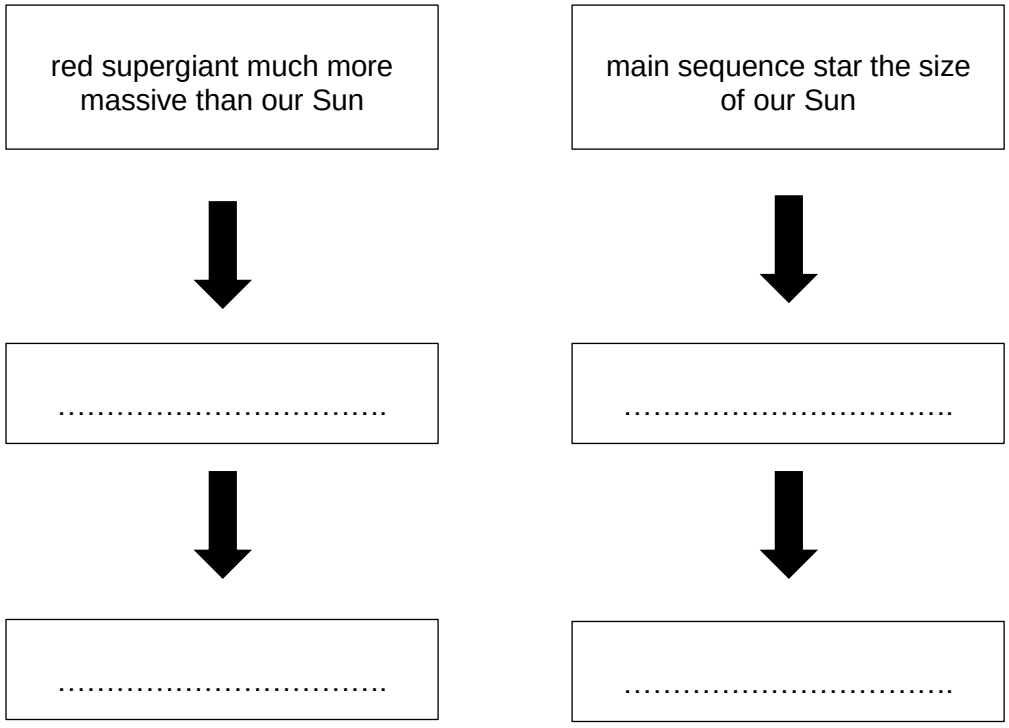
(b) When main sequence stars come to the end of their “lives” they go through stages which depend on their mass.
Choose words or phrases from the box **to complete the diagram** that follows. [4]

red giant	black dwarf	white dwarf	supernova	neutron star



9

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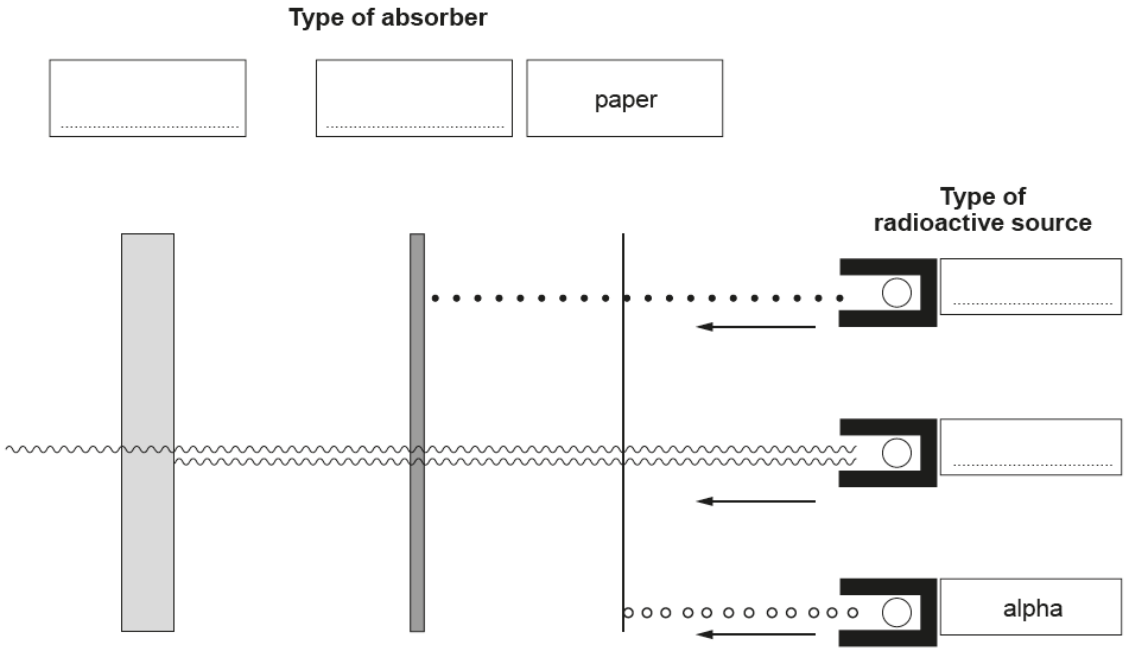
3. (a) The diagram shows the three types of nuclear radiations being absorbed by different materials.
Use the words below to complete the **4** boxes on the diagram. [3]

Beta Gamma Lead Aluminium



(b) The table shows the background count rate (in counts/min) taken in a laboratory at five different times.

	Measurement 1	Measurement 2	Measurement 3	Measurement 4	Measurement 5
Activity (counts/min)	20	22	18	19	21

(i) State why the readings are different. [1]

……

(ii) Calculate the mean activity for the background radiation and convert your answer from counts per minute to counts per second (counts/s). [2]

mean activity = …….. counts/s

(iii) Name one **natural** source of background radiation. [1]

……

7

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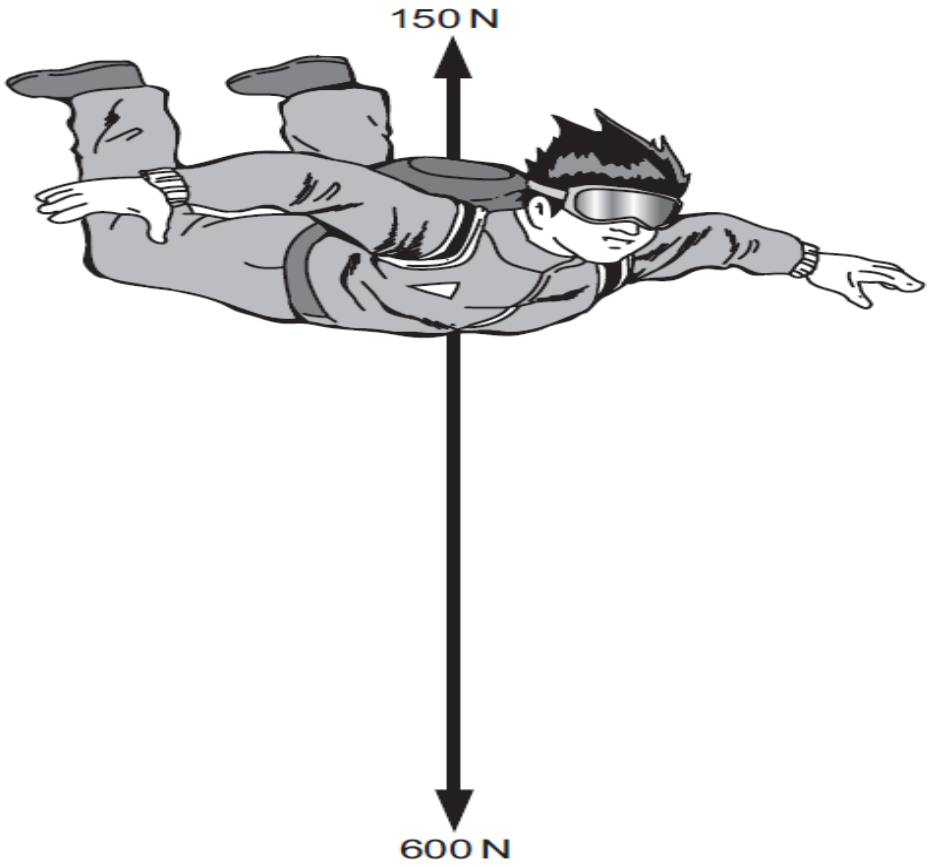
4. A skydiver of mass 60 kg weighs 600 N. The diagram below shows the forces acting on the skydiver **at one point** in her fall.



(a) (i) Calculate the resultant force acting on the skydiver. [1]

resultant force = _____ N

(ii) Use the equation:

$$\text{acceleration} = \frac{\text{resultant force}}{\text{mass}}$$

to calculate the acceleration produced by this resultant force [2]

acceleration = ……. m/s^2

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(b) Describe how the forces acting on the skydiver alter her motion just after jumping from the plane to the point of reaching terminal velocity. [6 QER]

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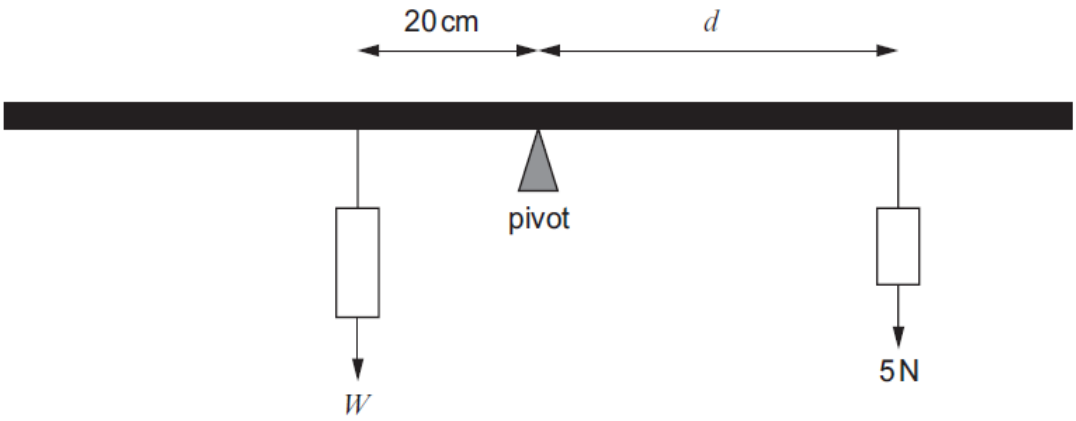
5. See-saws, tower cranes and even simple levers are all things that rely on an understanding of balance and moments in their design. For objects not to topple, the moments must balance. A class of students studying moments carried out the following experiment. They set up a **metre rule** to balance at its mid-point and then placed weights at different distances from the centre to get it to level. One of the weights was kept the same throughout at 5 N but its distance, d, from the pivot (centre of the rule) could be changed. The other balancing weight, W, could be varied but its distance from the pivot was kept constant at 20 cm. This is shown below.



(a) (i) **Complete** the moments equation for the situation shown above. [1]

$$W \times \text{.....} = 5 \times d$$

The results from one group are shown below.

Left side		**Right side**	
W (N)	**Distance (cm)**	**Weight (N)**	***d* (cm)**
3	20.0	5	12.0
4	20.0	5	16.0
5	20.0	5	20.0
8	20.0	5	32.0
10	20.0	5	40.0
12	20.0	5	48.0

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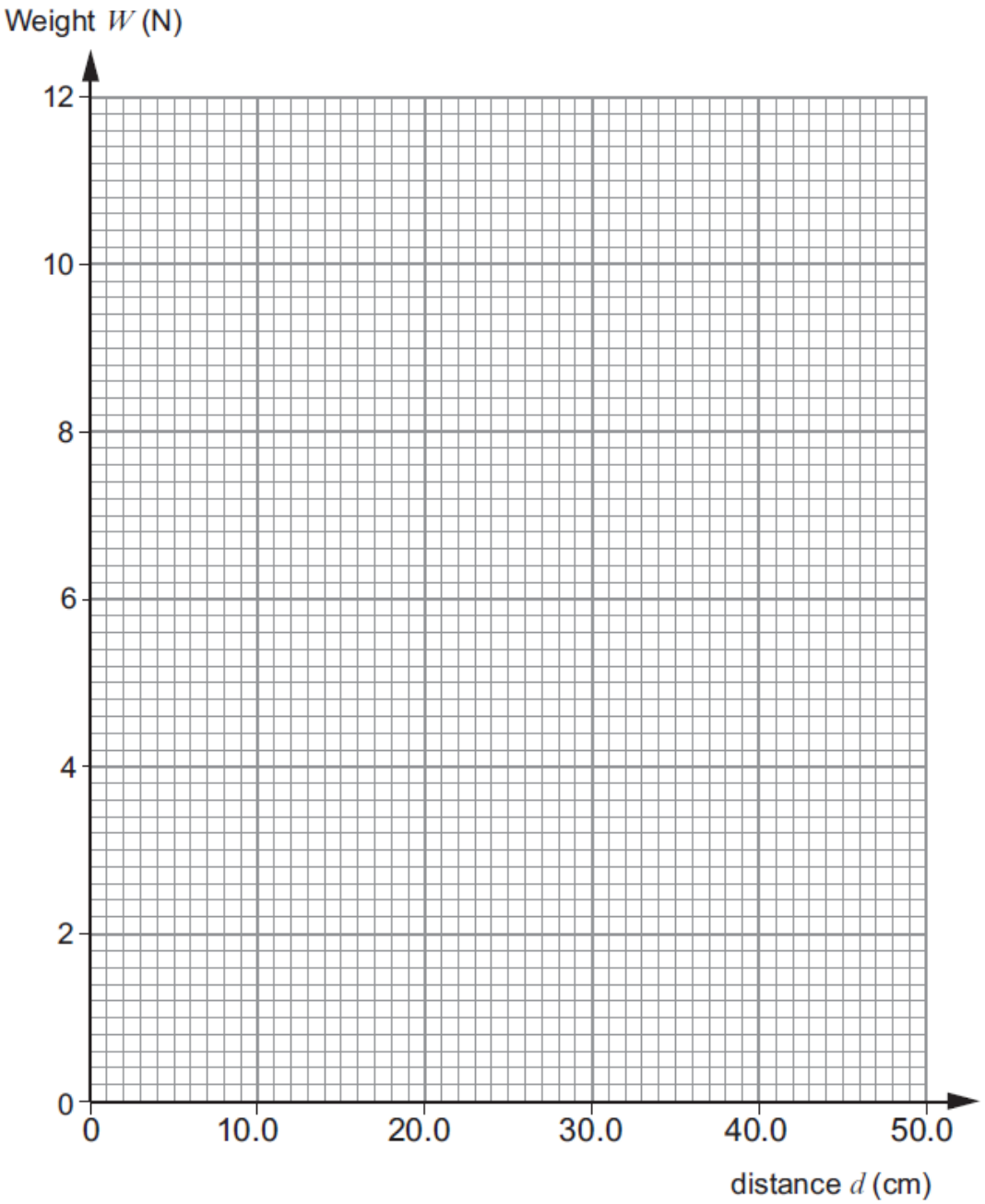
(ii) Plot a graph of the values of W from the left side against values of d from the right side on the grid below . [3]



(iii) Give the value of the weight, W, that would balance at a distance, d, of 10 cm. [1]

force = ... N

(iv) Give the value of d that would balance a weight, W, of 6 N. [1]

d = ... cm

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(v) Describe how the weight, W, changes as the distance, d, changes. [2]

……

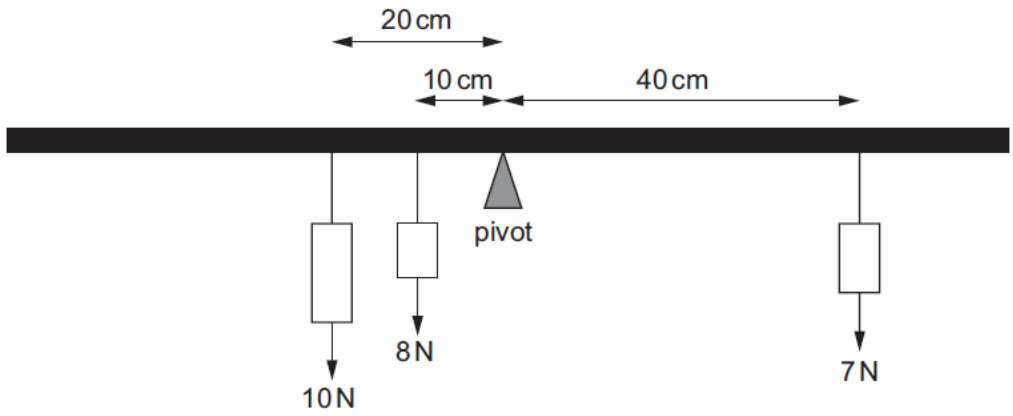
……

(vi) Use your graph to explain whether further readings should have been taken in this experiment. [2]

……

……

(b) The metre rule shown below is supported at its midpoint.
A student suggests that it is balanced. Use the principle of moments to investigate this claim. [3]



……

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13

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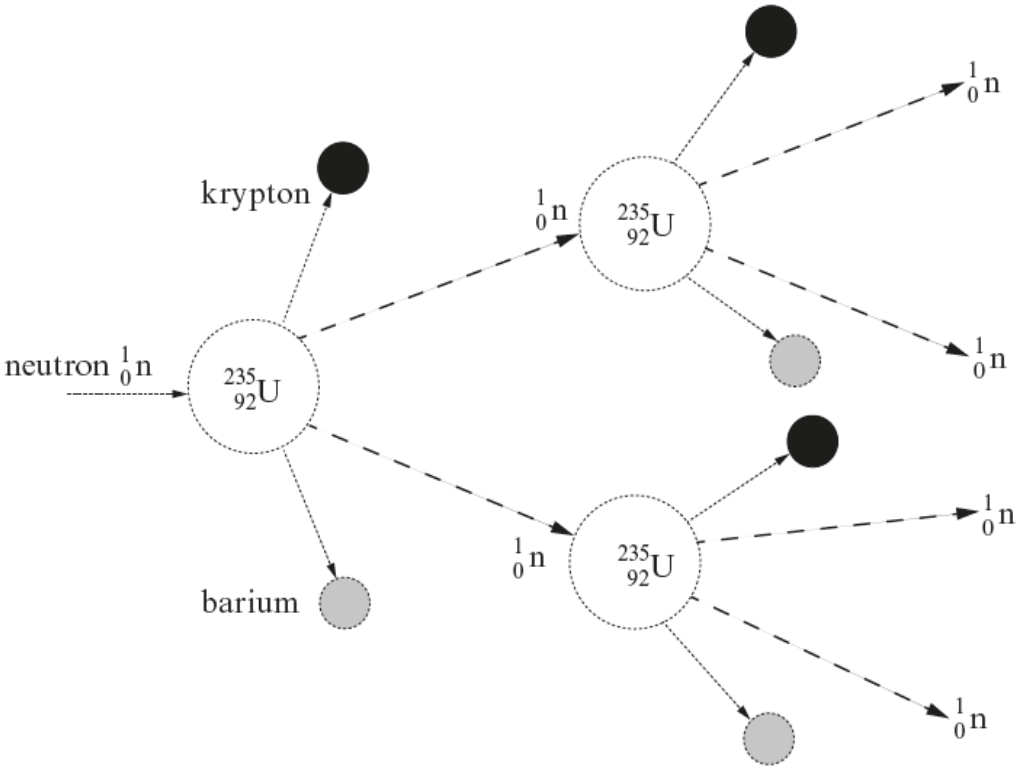
6. (a) Underline the word or phrase in brackets to complete each sentence about nuclear reactors. [3]

(i) The function of the moderator is to (**slow down the neutrons** / **provide channels for the cooling gas** / **speed up the reaction**).

(ii) The function of the control rods is to (**absorb neutrons** / **provide channels for the cooling gas** / **contain the fuel rods**).

(iii) The function of the steel and concrete container is to (**stop a nuclear explosion** / **absorb radiation** / **contain the plasma**).

(b) The following nuclear reaction can take place in a nuclear reactor. Use the diagram to help you answer the questions that follow.



(i) Write down the name of this type of reaction. [1]

……..

(ii) Name **one** waste product of this reaction. [1]

……..

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(c) Give **two** reasons why the safe storage of waste materials from nuclear reactors is controversial. [2]

1. ……

……

2. ……

……

7

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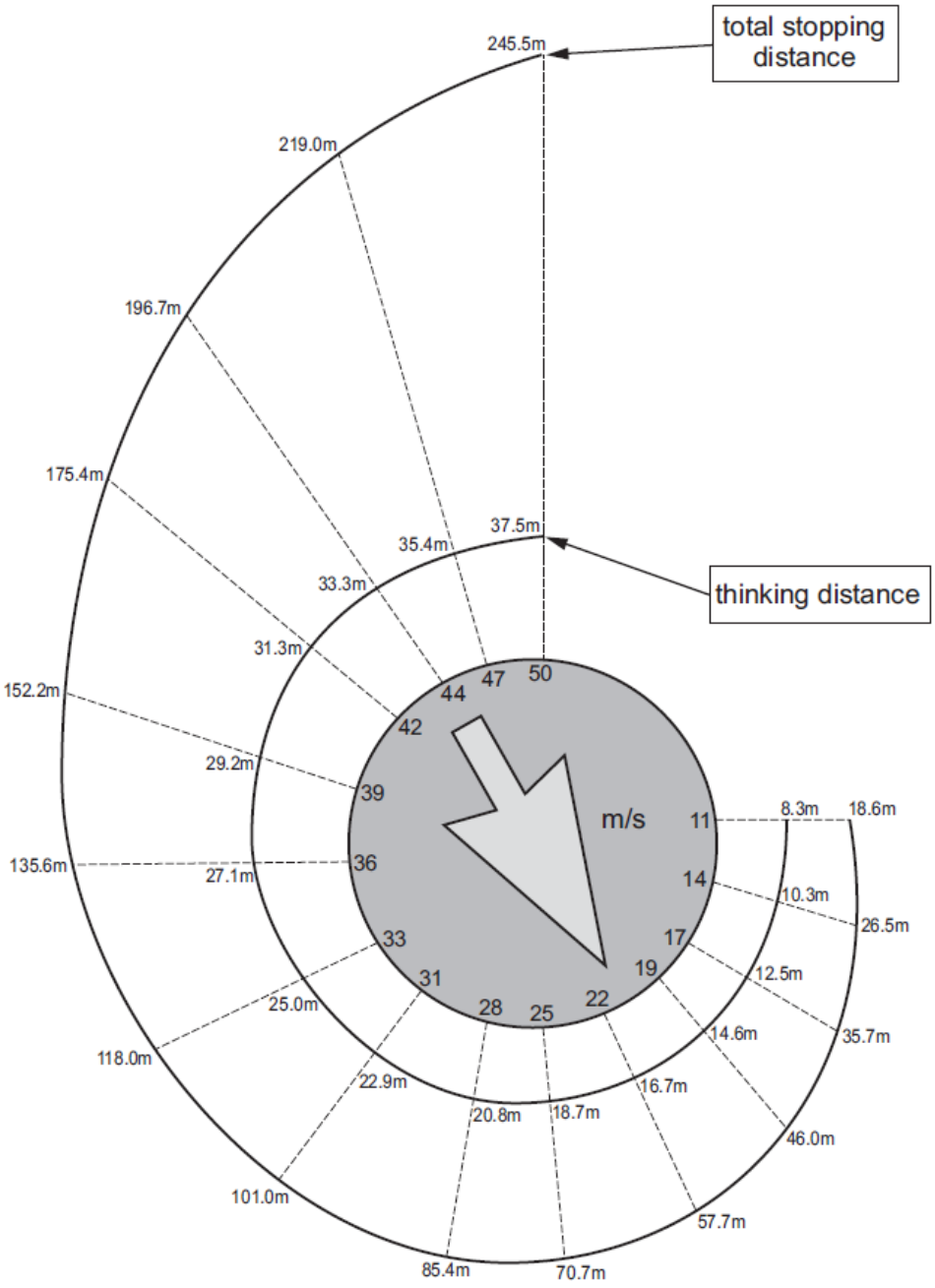
7. The diagram below shows how the thinking distance (m) and total stopping distance (m) for a vehicle on a dry road and with good brakes depends on the vehicle's speed (m/s).



(a) A car driver is travelling along a road when he sees a child step on to the road ahead. The driver's **thinking distance** is 10.3 m at a particular speed.

(i) Use the diagram above to write down the speed of the car. [1]

speed = ……..m/s

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(ii) Use the diagram to write down the total stopping distance for this speed. [1]

stopping distance = …… m

(b) The car now travels at a speed of 25 m/s.

(i) Use the equation:

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

to calculate the **thinking time** for the driver at this speed. [2]

thinking time = …….. s

(ii) Use information from the diagram to calculate **the braking distance** when the car travels at 25 m/s. [2]

braking distance = …….. m

(c) (i) State one factor that would increase the **braking distance**. [1]

……

(ii) **Draw on the diagram** on page 84 a line to show how the **thinking distance** changes for a driver who has been drinking alcohol. [1]

8

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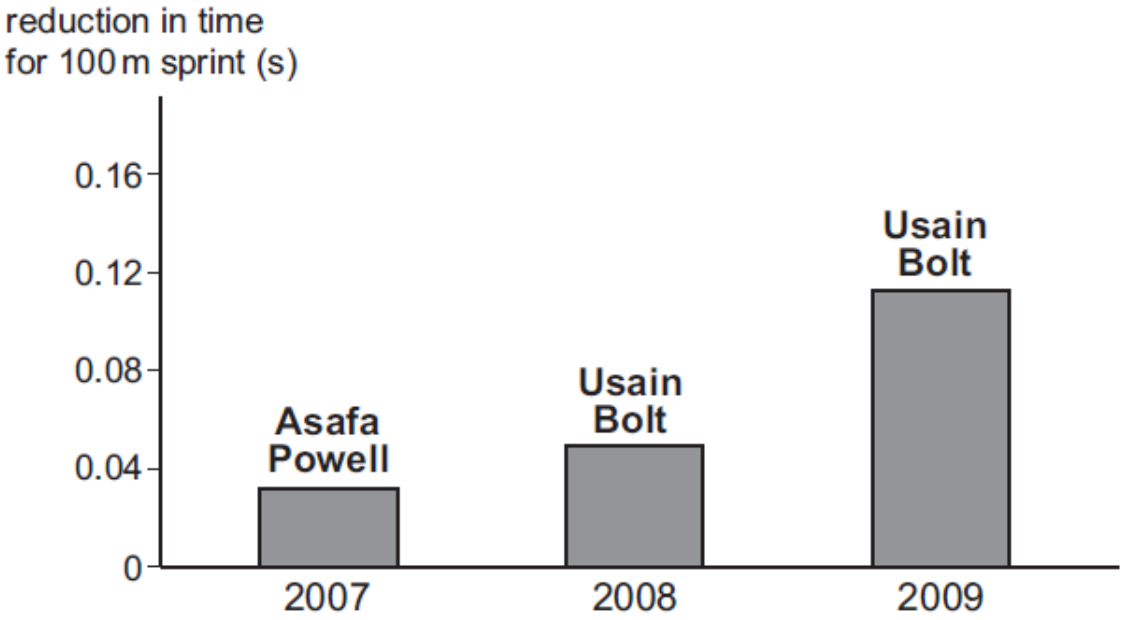
8. Usain Bolt was born in Jamaica in August 1986 and is the fastest man alive. He has run the 100 m in record breaking times as shown in the following chart of world record breakers since 2006.



Though good running form is useful in increasing speed, fast and slow runners have been shown to move their legs at nearly the same rate – it is the force exerted by the leg on the ground that separates fast sprinters from slow. Top short-distance runners exert as much as four times their body weight on the running surface. For this reason, muscle mass in the legs, relative to total body weight, is a key factor in achieving a high speed.

Usain Bolt reached his top speed of 12.4 m/s at 60 m and only maintained it for 20 m in the Berlin world championships' 100 m race.

The following list shows the top times achieved in a 100 m race in the 10 years up to 2015.

Year	Athlete	Time (s)
2005	Asafa Powell	9.77
2006	Asafa Powell	9.77
2007	Asafa Powell	9.74
2008	Usain Bolt	9.69
2009	Usain Bolt	9.58
2010	Tyson Gay	9.78
2011	Usain Bolt	9.76
2012	Usain Bolt	9.63
2013	Usain Bolt	9.77
2014	Justin Gatlin	9.77
2015	Justin Gatlin	9.74

(Source: IAAF)

After the Berlin race of 2009, Bolt made the following statement following his world record time of 9.58 s.

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"When I clocked 9.72 seconds to set the world 100 m record in New York (May 2008), I knew I could do better; when I ran 9.69 to win gold at the Olympics, I knew there was a lot more to come; and now, having run 9.58 in Berlin, I believe I can go even faster."

(a) What is the total time that Usain Bolt has improved on Asafa Powell's world record of 2007? [1]

time = ……. s

(b) Use an equation from page 2 to calculate Usain Bolt's mean speed when he ran his final record time. Give the unit of speed with your answer. [3]

mean speed = ……..
unit = ……....

(c) Explain why top sprinters need to be physically strong. [2]

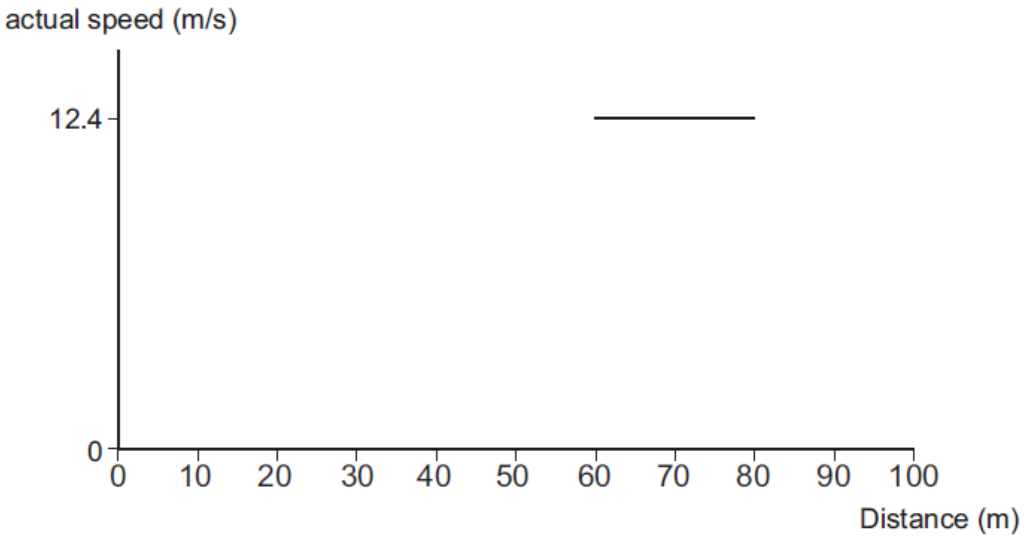
……..

……..

……..

(d) The graph below shows part of the race in which Bolt set the fastest time ever for the 100 m sprint in the Berlin world championships in 2009.

Draw lines before and after the one shown to show how you think his speed would have changed over the 100 m distance. [3]



9

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9. (a) Explain the motion of a cricket ball that is hit high in to the air by a batsman and falls to a fielder. [3]

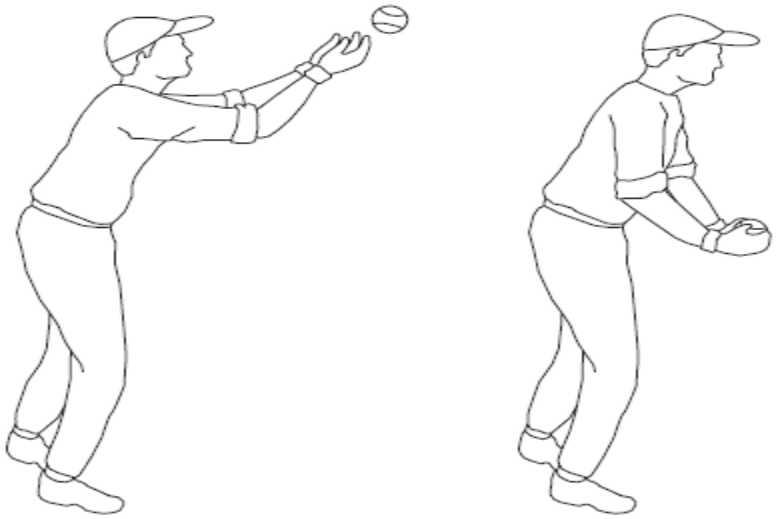
……..

……..

……..

……..

(b) A cricketer catches and stops a ball of mass 0.16 kg which is moving at a speed of 40 m/s.



(i) Use the equation:

momentum = mass × velocity

to calculate the change in momentum of the ball. [2]

momentum change =…… kg m/s

(ii) Use an equation from page 2 to calculate the force applied by the cricketer if the ball is stopped in 0.4 seconds. [2]

force =……. N

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(iii) If the cricketer halves the time taken to stop the ball, state the size of the force. [1]

force = ……. N

(c) Using the ideas involved in this question, state what advice you would give a parachutist when landing and explain the physics behind your answer. [3]

Advice: ……..

…….

Physics behind the advice: ……

…….

11

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UNIT 2: FORCES, SPACE and RADIOACTIVITY
FOUNDATION TIER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

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Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

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<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks Available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>1</td><td>(a)</td><td></td><td></td><td>
<table>
<tr><td>Statement</td><td></td></tr>
<tr><td>Atoms of all of these isotopes have the same number of protons in their nuclei.</td><td></td></tr>
<tr><td>An atom of uranium has 92 neutrons in its nucleus.</td><td></td></tr>
<tr><td>An atom of californium has the greatest number of protons in its nucleus.</td><td>✓</td></tr>
<tr><td>An atom of californium has the smallest number of neutrons in its nucleus.</td><td>✓</td></tr>
<tr><td>Uranium is not a naturally occurring element.</td><td></td></tr>
<tr><td>An atom of uranium has 92 protons in its nucleus.</td><td>✓</td></tr>
</table>
1 mark for each correct answer</td><td></td><td>3</td><td></td><td>3</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td></td><td>234 (1)
90 (1)</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td></td><td>$^{232}_{92}$U (1)

and $^{235}_{92}$U (1)</td><td>2</td><td></td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 1 total</td><td>2</td><td>5</td><td>0</td><td>7</td><td>0</td><td>0</td></tr>
</table>

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		The distance travelled by light in one year	1			1		
		(ii)		Distance = 300 000 × 500 (1) = 15 000 000 [km] (1)	1	1		2	2	
		(iii)		9 × 15 000 000 [km] (1) = 135 000 000 [km] (1)	1	1		2	2	
	(b)			supernova red giant neutron star white dwarf 1 mark for each correct answer in the correct position (4)	4			4		
				Question 2 total	**7**	**2**	**0**	**9**	**4**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			Lead, aluminium, beta, gamma. All four correct – 3 marks 2 or 3 correct - 2 marks 1 correct – 1 mark			3	3		
	(b)	(i)		Radioactive decay is a random process.	1			1		
		(ii)		Mean = 20 (1) $\frac{20}{60}$ = 0.33 [counts/s] (1)		2		2	2	
		(iii)		Rocks / cosmic / radon / food	1			1		
				Question 3 total	**2**	**2**	**3**	**7**	**2**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)		450 [N]		1		1	1	
		(ii)		Substitution: $\frac{450}{60}$ (1) Acceleration = 7.5 [m/s^2] (1)	1	1		2	2	
	(b)			**Indicative content:** Initially, the only force acting on the skydiver is her weight. This makes her accelerate at 10 m/s^2. However, as her speed increases, the air resistance acting upwards on her increases and this reduces the resultant downward force on her. Her downward acceleration thus decreases until she reaches a situation in which her weight and the upward force of air resistance are balanced. She no longer accelerates and travels at a constant speed called her terminal velocity. **5 – 6 marks** Detailed description of the forces involved relating them to her motion without omission. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.* **3 – 4 marks** A description of the forces involved, identifying them by name and relating them in part to changes in her motion. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.* **1-2 marks** A basic description of the forces is given in which one force is identified and some attempt is made to identify changes in motion. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.*	6			6		

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				0 marks *No attempt made or no response worthy of credit.*							
				Question 4 total	**7**	**2**	**0**	**9**	**3**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		$W \times 20 = 5 \times d$	1			1	1	
		(ii)		All 6 points correctly plotted within ±½ small square division (2) 5 points correctly plotted within ±½ small square division (1) 1-4 points correctly plotted within ±½ small square division (0) Correct straight line of best fit within ± ½ small square division of all points (1) Don't accept thick, double, whispy lines		3		3	3	3
		(iii)		2.5 [N]		1		1	1	1
		(iv)		24 [cm]		1		1	1	1
		(v)		As d increases, W increases (1) in proportion / doubling each time d doubles (or similar)(1)		2		2		2
		(vi)		Repeat readings would not have been necessary (1) as all of the results are perfectly along a straight line (1)			2	2		2
	(b)			Anticlockwise moment = $40 \times 7 = 280$ [N cm] (1) Clockwise moment = $(10 \times 20) + (8 \times 10) = 280$ [N cm] (1) Claim is correct because moments are the same (1)			3	3	2	3
				Question 5 total	**1**	**7**	**5**	**13**	**8**	**12**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)		Slow down the neutrons	1			1		
		(ii)		Absorb neutrons	1			1		
		(iii)		Absorb radiation	1			1		
	(b)	(i)		[Nuclear] fission	1			1		
		(ii)		Barium OR krypton	1			1		
	(c)			1. The waste is very radioactive (1) 2. The waste has a long half-life (1)	2			2		
				Question 6 total	**7**	**0**	**0**	**7**	**0**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		14 [m/s]		1		1	1	
		(ii)		26.5 [m]		1		1	1	
	(b)	(i)		Substitution: $\frac{18.7}{25}$ (1) Time = 0.748 [s] (1)	1 1			2	2	
		(ii)		70.7 – 18.7 (1) Distance = 52.0 [m] (1)			2	2	2	
	(c)	(i)		Ice / wet / oil on road / poor brakes / bigger speed / worn tyres	1			1		
		(ii)		Line over-drawn along the inner spiral on the diagram		1		1		
				Question 7 total	**2**	**4**	**2**	**8**	**6**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			0.16 [s]		1		1	1	
	(b)			Selection and substitution: $\frac{100}{9.58}$ (1) Speed = 10.44 (1) Unit = m/s (1)	1 1	1		3	2	
	(c)			They need strong leg muscles / big muscle mass relative to body weight (1) which are needed to exert a large force on the ground (1)		2		2		
	(d)			Continuous line from (0,0) to (60,12.4) (1) Line has decreasing gradient (1) Any line showing small decrease in speed beyond (80,12.4) (1)			3	3	3	
				Question 8 total	**2**	**4**	**3**	**9**	**6**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			The ball decelerates as it rises until it comes to a stop vertically (1) then it accelerates as it falls (1) because gravity pulls down on it (1)		3		3		
	(b)	(i)		Change in momentum = $0.16 \times (0 - 40)$ (1) $= [-]6.4$ [kg m/s] (1)	1	1		2	2	
		(ii)		Selection and substitution: $\frac{6.4}{0.4}$ (1) **ecf** = 16 [N] (1)	1	1		2	2	
		(iii)		32 [N] **ecf**		1		1	1	
	(c)			Bend knees on landing (1) Increases time to stop (1) which decreases the force on legs (1)			3	3		
				Question 9 total	**2**	**6**	**3**	**11**	**5**	**0**

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FOUNDATION TIER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	5	0	7	0	0
2	7	2	0	9	4	0
3	2	2	3	7	2	0
4	7	2	0	9	3	0
5	1	7	5	13	8	12
6	7	0	0	7	0	0
7	2	4	2	8	6	0
8	2	4	3	9	6	0
9	2	6	3	11	5	0
TOTAL	32	32	16	80	34	12

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Candidate Name	Centre Number					Candidate Number				
						0				

GCSE

PHYSICS

UNIT 2: FORCES, SPACE and RADIOACTIVITY

HIGHER TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**11**	
3.	**10**	
4.	**8**	
5.	**6**	
6.	**12**	
7.	**11**	
8.	**11**	
Total	**80**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page
Answer all questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets at the end of each question or part-question.
Question **5** is a quality of extended response (QER) question where your writing skills will be assessed.

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Equations

$\text{speed} = \frac{\text{distance}}{\text{time}}$	
$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
$\text{kinetic energy} = \frac{\text{mass x velocity}^2}{2}$	$\text{KE} = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$\text{PE} = mgh$
force = spring constant × extension	$F = kx$
work done in stretching = area under a force-extension graph	$W = \frac{1}{2}Fx$
momentum = mass × velocity	$p = mv$
$\text{force} = \frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $x = \frac{u+v}{2}t$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$
moment = force × distance	$M = F\,d$

SI multipliers

Prefix	Multiplier
p	1×10^{-12}
n	1×10^{-9}
μ	1×10^{-6}
m	1×10^{-3}

Prefix	Multiplier
k	1×10^{3}
M	1×10^{6}
G	1×10^{9}
T	1×10^{12}

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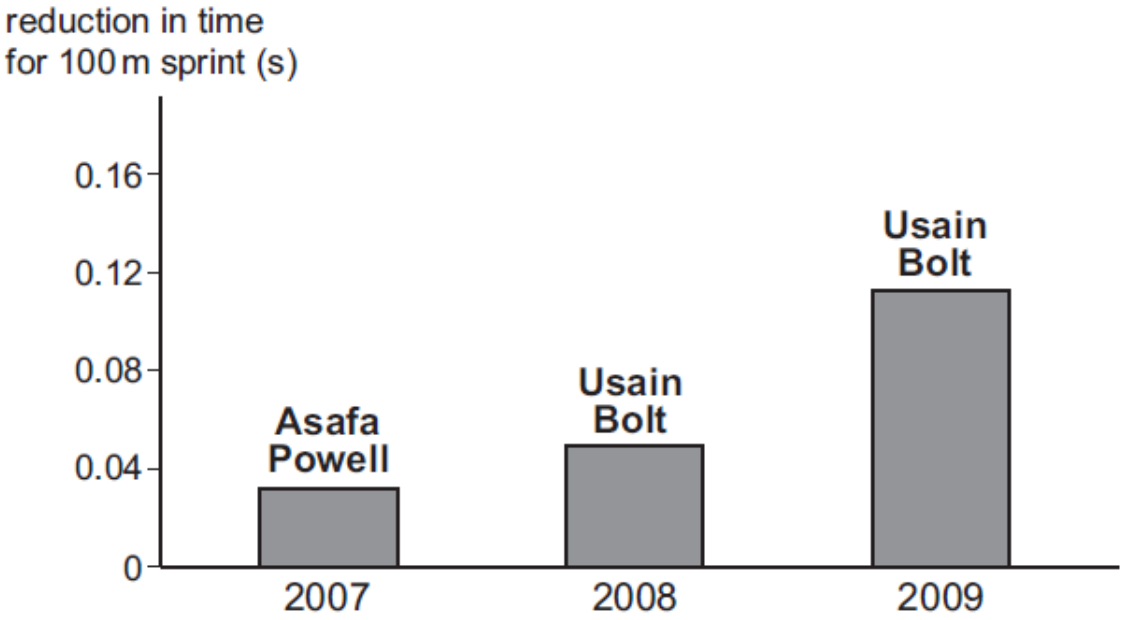
Answer **all** *questions*

1. Usain Bolt was born in Jamaica in August 1986 and is the fastest man alive. He has run the 100 m in record breaking times as shown in the following chart of world record breakers since 2006.



Though good running form is useful in increasing speed, fast and slow runners have been shown to move their legs at nearly the same rate – it is the force exerted by the leg on the ground that separates fast sprinters from slow. Top short-distance runners exert as much as four times their body weight on the running surface. For this reason, muscle mass in the legs, relative to total body weight, is a key factor in achieving a high speed.

Usain Bolt reached his top speed of 12.4 m/s at 60 m and only maintained it for 20 m in the Berlin world championships' 100 m race.

The following list shows the top times achieved in a 100 m race in the 10 years up to 2015.

Year	Athlete	Time (s)
2005	Asafa Powell	9.77
2006	Asafa Powell	9.77
2007	Asafa Powell	9.74
2008	Usain Bolt	9.69
2009	Usain Bolt	9.58
2010	Tyson Gay	9.78
2011	Usain Bolt	9.76
2012	Usain Bolt	9.63
2013	Usain Bolt	9.77
2014	Justin Gatlin	9.77
2015	Justin Gatlin	9.74

(Source: IAAF)

After the Berlin race of 2009, Bolt made the following statement following his world record time of 9.58 s.

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"When I clocked 9.72 seconds to set the world 100 m record in New York (May 2008), I knew I could do better; when I ran 9.69 to win gold at the Olympics, I knew there was a lot more to come; and now, having run 9.58 in Berlin, I believe I can go even faster."

(a) What is the total time that Usain Bolt has improved on Asafa Powell's world record of 2007? [1]

time = ……. s

(b) Use an equation from page 2 to calculate Usain Bolt's mean speed when he ran his final record time. Give the unit of speed with your answer. [3]

mean speed = ……..
unit = ……..

(c) Explain why top sprinters need to be physically strong. [2]

……..

……..

……..

(d) When the gun is fired and the race starts, suggest why top sprinters try to exert as large a backwards force as they are able onto the starting blocks. [2]

……..

……..

……..

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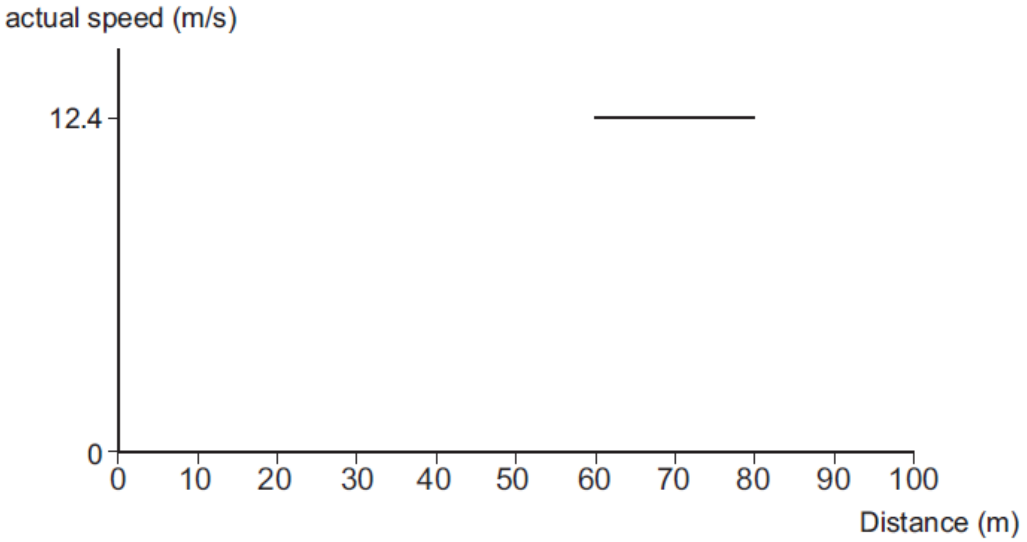
(e) The graph below shows part of the race in which Bolt set the fastest time ever for the 100 m sprint in the Berlin world championships in 2009.

Draw lines before and after the one shown to show how you think his speed would have changed over the 100 m distance. [3]



11

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2. (a) Explain the motion of a cricket ball that is hit high in to the air by a batsman and falls to a fielder. [3]

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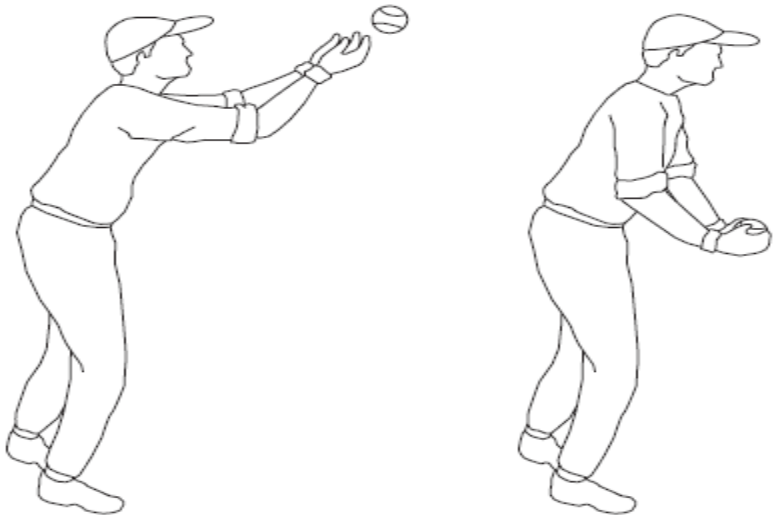
(b) A cricketer catches and stops a ball of mass 0.16 kg which is moving at a speed of 40 m/s.



(i) Use the equation:

momentum = mass × velocity

to calculate the change in momentum of the ball. [2]

momentum change =…… kg m/s

(ii) Use an equation from page 2 to calculate the force applied by the cricketer if the ball is stopped in 0.4 seconds. [2]

force =……. N

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(iii) If the cricketer halves the time taken to stop the ball, state the size of the force. [1]

force = ……. N

(c) Using the ideas involved in this question, state what advice you would give a parachutist when landing and explain the physics behind your answer. [3]

Advice: ……..

…….

Physics behind the advice: ……

…….

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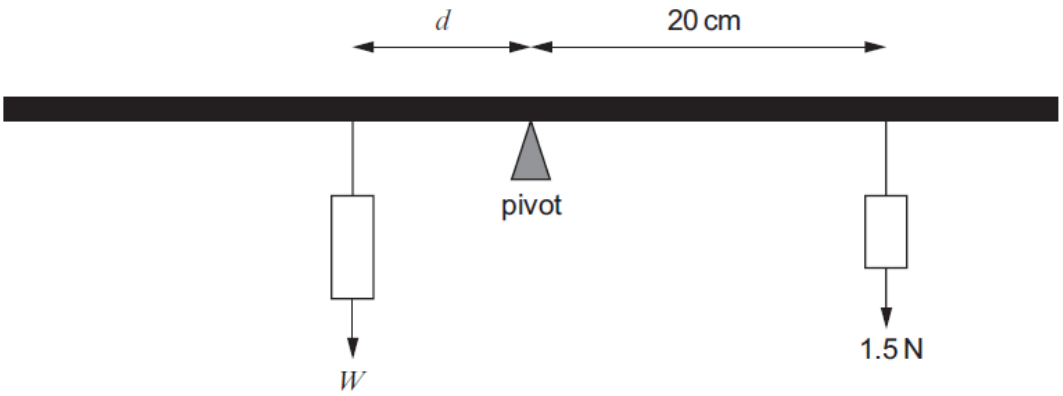
3. See-saws, tower cranes and even simple levers are all things that rely on an understanding of moments in their design. Classes of students the world over study moments to get an understanding of the principles involved. In one such class students carried out the following experiment. They set up a metre ruler to balance at its mid-point and then placed weights at different distances from the centre to get it to balance. One of the weights, W, was changed through the experiment and its distance, d, from the pivot (centre of the ruler) was also changed. The other, balancing weight, of 1.5 N was kept constant and its distance from the pivot was also kept constant at 20 cm. This is shown below.



The results from one group are shown below.

Left side		Right side	
W (N)	Distance d (cm)	Weight (N)	Distance (cm)
4.0	7.5	1.5	20.0
3.0	10.0	1.5	20.0
1.5	20.0	1.5	20.0
1.0	30.0	1.5	20.0
0.75	40.0	1.5	20.0
0.60	50.0	1.5	20.0

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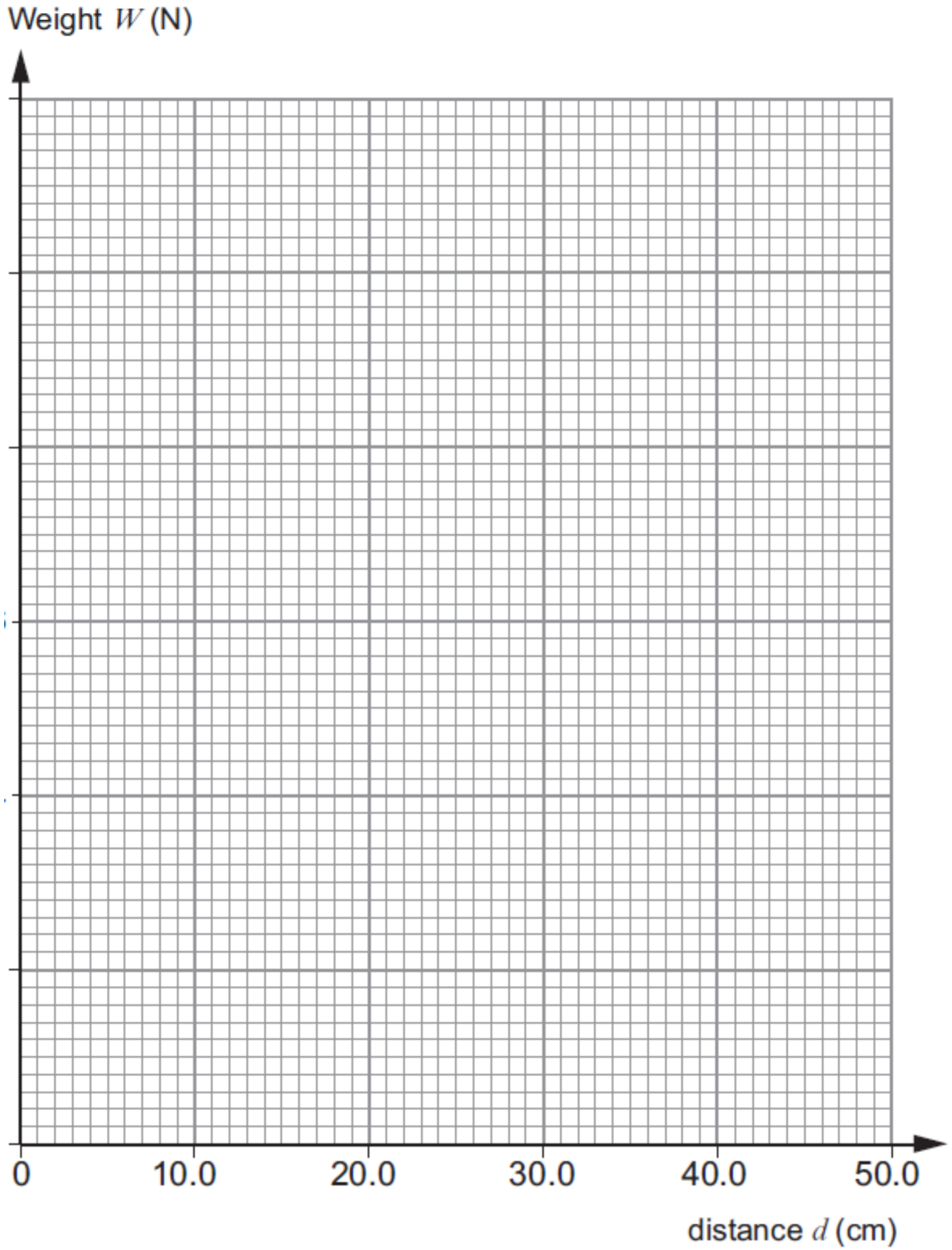
(a) (i) Plot a graph of the values of W against values of d on the grid below. [3]



(ii) Describe how the weight, W, changes as the distance, d, changes. [2]

……

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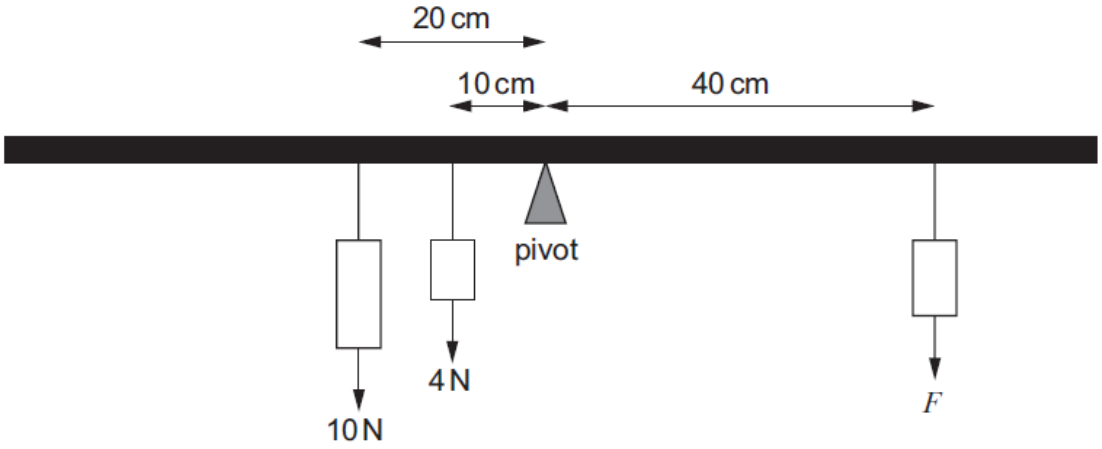
(iii) One student in the group stated that when W was 1.5 N, a change of force by 0.5 N would change the distance by 5.0 cm. Explain whether this statement is true. [2]

……..

……..

……..

(b) Another student predicted that if the value of W was 10 N and they placed a second force of 4 N on the same side at a distance of 10 cm from the pivot, the value of the force F that would be needed on the right hand side at a distance of 40 cm to balance the ruler would be 5 N. Was the student's prediction correct? Explain your answer. [3]



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10

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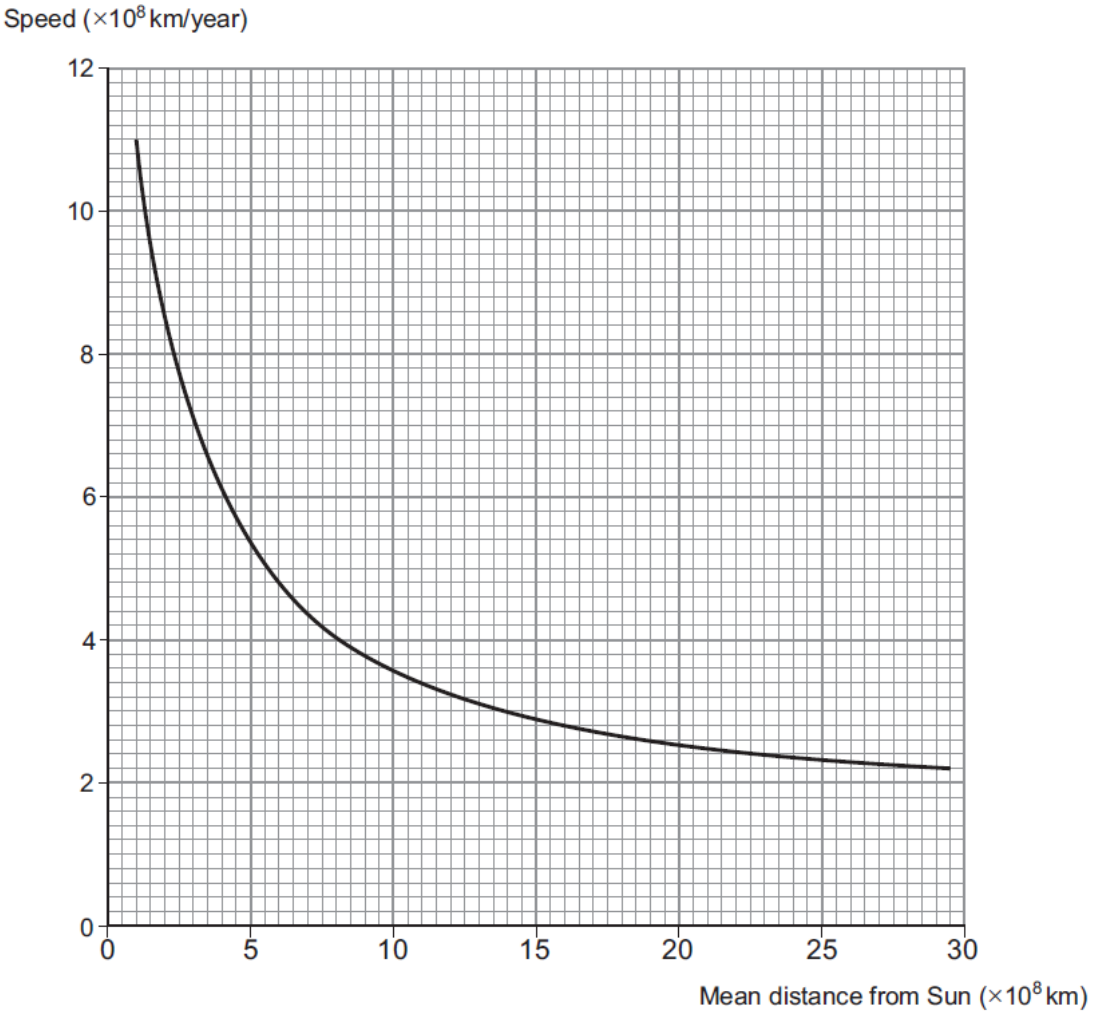
4. Our solar system is made up of 8 planets, each of which may or may not have a moon or moons orbiting them, many asteroids and some dwarf planets. The planets orbit the Sun. For planet Earth the orbit time is one year. The number of years that a planet takes to orbit the Sun depends on its distance from the Sun in the way shown in the table below.
The table gives data on six of the planets in the solar system.

Planet	Mean distance from the Sun ($\times 10^8$ km)	Mean surface temperature (^oC)	Time for one orbit of the Sun (years)
Venus	1.10	480	0.62
Earth	1.50	22	1.00
Mars	2.25	-23	1.88
Jupiter	7.80	-150	11.86
Saturn	14.00	-180	29.46
Uranus	29.00	-210	84.01

The graph shows how the orbital speed of the planets changes with their distance from the Sun.



Use data from the table and graph to answer the following questions.

(a) What is the orbital speed of Saturn? …… km/year [1]

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(b) A dwarf planet, Ceres, is 700 km in diameter and has an orbital speed of 5.8×10^8 km/year. It travels 2.67×10^9 km in making one orbit of the Sun.

(i) Use the graph to find the distance of Ceres from the Sun. [1]

distance = …… km

(ii) Use the equation:

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

to calculate the orbital time of Ceres. [2]

orbital time = …… years

(c) Estimate the mean temperature on Ceres, show your working or explain how you arrived at your answer. [2]

mean temperature = …… ^{o}C

……..

……..

(d) State **two** reasons why Ceres takes longer than Earth to complete one orbit of the Sun. [2]

1. ……

……

2. ……

……

8

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5. Describe the evidence that supports the hot Big Bang model for the origin of the universe. [6 QER]

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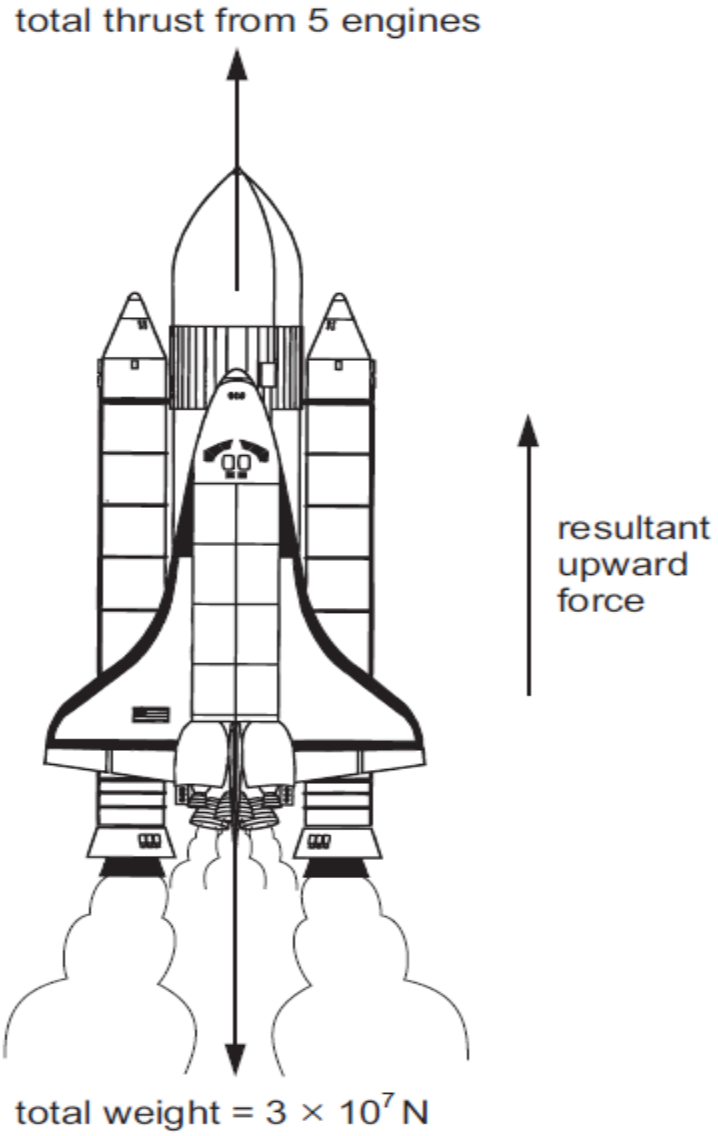
6. The diagram shows a space shuttle just after taking off from its launch pad.



On take-off, America's shuttle used 2 booster engines each providing 12.5 MN of thrust along with the shuttle's 3 engines that each provided 1.8 MN. The shuttle and booster maintain a constant thrust for the first 6 minutes achieving an upward velocity of 27 000 km/h (7 500 m/s) in this time.

(a) Calculate the total thrust of all the engines at take-off. [2]

total thrust = ... MN

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(b) Use an equation from page 2 with your answers above to calculate the initial acceleration at take-off. [g = 10 N/kg] [4]

initial acceleration = ……. m/s^2

(c) Use an equation from page 2 to calculate the mean acceleration over the first 6 minutes. [3]

mean acceleration = ……. m/s^2

(d) During the first six minutes, the rockets produce a constant thrust. Explain why the mean acceleration over the first six minutes is much bigger than the initial acceleration of the rocket. [3]

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12

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7. Isotopes of iodine can be used to study the thyroid gland in the body.
A small amount of the radioactive isotope is injected into a patient and the radiation is detected outside the body. Three isotopes that could be used are $^{123}_{53}\text{I}$, $^{131}_{53}\text{I}$ and $^{132}_{53}\text{I}$. They have half-lives of 13.22 hours, 8 days and 13.2 hours respectively.

(a) Answer the following question in terms of the numbers of particles.
Compare the structures of the **nucle**i of $^{123}_{53}\text{I}$ and $^{131}_{53}\text{I}$. [2]

……..

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(b) The nucleus of $^{131}_{53}\text{I}$ decays into xenon (Xe) by giving out beta (β) and gamma (γ) radiation.

(i) What is beta radiation? [1]

……

(ii) Complete the equation below to show the decay of I-131. [2]

$$^{131}_{53}\text{I} \rightarrow {}^{....}_{54}\text{Xe} + {}^{0}_{....}\beta + \gamma$$

(c) The isotope $^{123}_{53}\text{I}$ decays by gamma emission. Explain why it is better to use $^{123}_{53}\text{I}$ than $^{131}_{53}\text{I}$ as a medical tracer. [2]

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(d) (i) I-131 has a half-life of 8 days. Explain what this statement means. [2]

……

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(ii) Following the nuclear power station disaster in Japan 2011, people living in the area were given non-radioactive iodine 127 ($^{127}_{53}\mathrm{I}$) supplement tablets to reduce their intake of iodine-131 that leaked from the reactor. Calculate the length of time that people had to take the supplement before the activity of iodine-131 reduced to approximately 3% of its original value immediately after the leak. [2]

time = …… days

11

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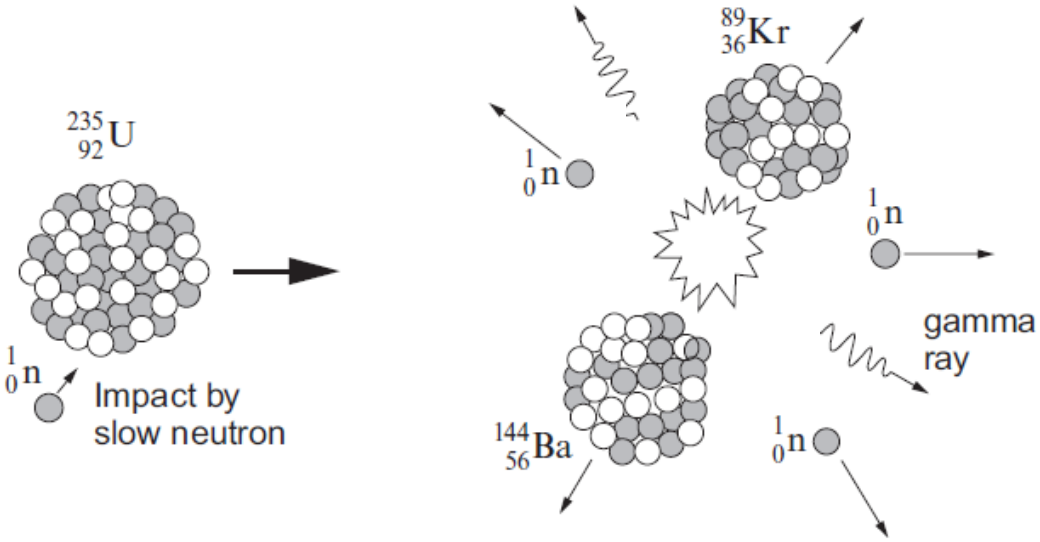
8. The diagram below shows an example of a nuclear fission reaction in which a neutron strikes an atom of $^{235}_{92}U$.



The three neutrons released in the reaction have high energies and move very fast.

(a) State which part of the nuclear reactor core is designed to reduce the neutrons' high energies and explain why the reduction in energy is necessary. [3]

……..

……..

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(b) (i) Only 1 of the 3 neutrons released is needed to maintain a controlled chain reaction. Describe how the others are stopped inside the reactor. [2]

……

……

……

(ii) Describe how the fission reactions inside a nuclear reactor can be shut down completely. [2]

……

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(c) (i) Write a balanced nuclear equation for the reaction shown above. [2]

(ii) If the barium nucleus in the diagram above is released with the same **kinetic energy** as a neutron, explain why the size of its velocity would only be **one twelfth ($\frac{1}{12}$)** of the velocity of a neutron. [2]

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11

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UNIT 2: FORCES, SPACE and RADIOACTIVITY
HIGHER TIER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

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Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			0.16 [s]		1		1	1	
	(b)			Selection and substitution: $\frac{100}{9.58}$ (1) Speed = 10.44 (1) Unit = m/s (1)	1 1	 1		 3	 2	
	(c)			They need strong leg muscles / big muscle mass relative to body weight (1) which are needed to exert a large force on the ground (1)		2		2		
	(d)			To obtain maximum/greatest <u>forward</u> force on the sprinter (1) To give maximum/large [initial] acceleration (1)			2	2		
	(d)			Continuous line from (0,0) to (60,12.4) (1) Line has decreasing gradient (1) Any line showing small decrease in speed beyond (80,12.4) (1)		1 1	 1	 3	 3	
				Question 1 total	**2**	**6**	**3**	**11**	**6**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			The ball decelerates as it rises until it comes to a stop vertically (1) then it accelerates as it falls (1) because gravity pulls down on it (1)		3		3		
	(b)	(i)		Change in momentum = $0.16 \times (0 - 40)$ (1) $= [-]6.4$ [kg m/s] (1)	1	1		2	2	
		(ii)		Selection and substitution: $\frac{6.4}{0.4}$ (1) **ecf** = 16 [N] (1)	1	1		2	2	
		(iii)		32 [N] **ecf**		1		1	1	
	(c)			Bend knees on landing (1) Increases time to stop (1) which decreases the force on legs (1)			3	3		
				Question 2 total	**2**	**6**	**3**	**11**	**5**	**0**

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Question				Marking details	Marks Available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
3	(a)	(i)		Linear scale marked on W axis (intervals of 1 N) (1) All 6 points correctly plotted within ±½ small square division (1) Smooth curve of best fit within ± ½ small square division of all points (1) Don't accept thick, double, whispy lines		3		3	3	3
		(ii)		As the distance increases, W decreases (1) at a decreasing rate (1). A statement of inversely proportional gets 2 marks. A statement of $W \times d$ is constant or is equal to 30 gets 2 marks.		2		2	2	2
		(iii)		The statement is not entirely true (1) If W were increased by 0.5 N then d would decrease by 6.0 cm but if it were decreased by 0.5 N then d would increase by 10.0 cm (1)			2	2		2
	(b)			Clockwise moment = 200 + 40 = 240 [N cm] **and** Anticlockwise moment = $F \times 40$ [N cm] (1) $F = \frac{240}{40}$ = 6 [N] (1) Hence the student's prediction was incorrect (1) **Alternative solution:** 200 + 40 = $F \times 40$ (1), so $F = \frac{240}{40}$ = 6 [N] (1) Hence the student's prediction was incorrect (1) **Alternative solution:** Using the student's prediction, clockwise moment = 40×5 = 200 N cm (1) Total anticlockwise moment = 240 N cm, ruler not balanced (1) Hence student incorrect.			3	3	2	3
				Question 3 total	**0**	**5**	**5**	**10**	**7**	**10**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			3×10^8 [km/year]		1		1	1	
	(b)	(i)		4.5×10^8 [km]		1		1	1	
		(ii)		Substitution: $\frac{2.67 \times 10^9}{5.8 \times 10^8}$ (1) Time = 4.60 [years] (1)	1 1			2	2	
	(c)			Temperature θ in the range - 45 $\leq$ $\theta \leq$ - 100 [^{o}C] (1) Temperature lies somewhere between - 23 and -150 [^{o}C] for Mars and Jupiter (1)	2			2		
	(d)			1. Ceres has a greater distance to travel in one orbit (1) 2. Speed of Ceres is less than that of the Earth / The gravitational attraction of the Sun on Ceres is less than on the Earth (1)	2			2		
				Question 4 total	**5**	**3**	**0**	**8**	**4**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5				**Indicative content:** The evidence consists of two parts: absorption spectra from distant galaxies and the existence of CMBR. Absorption spectra from distant galaxies which consist of coloured light crossed with black lines. The wavelengths of the black lines are shifted to the red end of the spectrum when compared with light from similar sources in the laboratory. The reason for this is that the galaxies are moving away from us. Those that show the biggest red shift are those that are furthest way. This suggests that the universe began its existence at a single point and has expanded outwards ever since. The time taken in traversing the universe to reach us has resulted in those wavelengths being further red shifted due to the expansion of the universe. CMBR on the other hand initially existed as gamma radiation of very small wavelength but an expanding universe has caused the wavelength to increase into the microwave region of the em spectrum. **5 – 6 marks** Description of red shift, detailed implication of cosmological red shift and of CMBR. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.* **3 – 4 marks** A description of red shift or cosmological red shift with some aspects of CMBR. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.* **1-2 marks** A simple description of red shift or cosmological red shift or CMBR. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure*. *The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.*	6			6		

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				0 marks *No attempt made or no response worthy of credit.*							
				Question 5 total	**6**	**0**	**0**	**6**	**0**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			$(2 \times 12.5) + (3 \times 1.8)$ (1) = 30.4 [MN] (1)		2		2	2	
	(b)			Mass of rockets + boosters $= \frac{3 \times 10^7}{10} = 3 \times 10^6$ [kg] (1) Resultant force = $30.4 \times 10^6 - 3 \times 10^7 = 4 \times 10^5$ [N] (1) Acceleration $= \frac{4 \times 10^5}{3 \times 10^6}$ = (1 - sub + manip) = 0.1333 [m/s^2] (1)		4		4	4	
	(c)			$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$ $= \frac{7\,500}{360(1)}$ (1 – substitution) = 20.8 [m/s^2] (1)	1	1 1		3	3	
	(d)			Mass reduces (1) Weight reduces so resultant force increases (1) Acceleration is proportional to resultant force [which increases] and inversely proportional to mass [which decreases] so acceleration increases (1)			3	. 3		
				Question 6 total	**1**	**8**	**3**	**12**	**9**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			The isotope with the larger mass number has 8 (or the greater number / more neutrons (1) They both have the same number of protons. (1)	2			2		
	(b)	(i)		Beta particle is a fast moving electron that is emitted from a nucleus	1			1		
		(ii)		131 (1) and -1 (1)	2			2		
	(c)			The beta radiation emitted by iodine-131 (1) would potentially damage / ionise tissue as it passed through the body (1)	2			2		
	(d)	(i)		It / 8 hours is the time taken for the number of nuclei / mass /activity (1) to reduce by half (1)	2			2		
		(ii)		Calculation of 5 half-lives (1) $5 \times 8 = 40$ [days] (1)		2		2	2	
				Question 7 total	**9**	**2**	**0**	**11**	**2**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			The moderator [usually of graphite or water] slows the neutrons (1). This is necessary to increase the probability of them being captured (1) when in collision with nuclei of the uranium fuel (1)	3			3		
	(b)	(i)		Control rods [usually made of boron steel, silver, indium or cadmium] (1) are lowered into the reactor to absorb surplus neutrons (1)	2			2		
		(ii)		Control rods would be fully dropped (1) into the reactor to absorb <u>all</u> neutrons (1)	2			2		
	(c)	(i)		$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{89}_{36}\mathrm{Kr} + {}^{144}_{56}\mathrm{Ba} + 3{}^{1}_{0}\mathrm{n}$ Symbol equation correct (1) 1 for 3 neutrons on RHS (1)		2		2		
		(ii)		Since $(\frac{1}{2}mv^2)\mathrm{Ba} = (\frac{1}{2}mv^2)\mathrm{n}$ (1) (or by implication) Then $144v^2(\mathrm{Ba}) = 1v^2(\mathrm{n})$ (1) [Hence $v_{\mathrm{Ba}} = \frac{1}{12}v_{\mathrm{n}}$] Accept m_{Ba} = 144 m_{n} for first mark **OR**: accept (for 1 mark) that Ba has a bigger mass, so needs less speed for <u>the same kinetic energy</u> (as the neutron).			2	2	2	
				Question 8 total	**7**	**2**	**2**	**11**	**2**	**0**

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HIGHER TIER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	6	3	11	6	0
2	2	6	3	11	5	0
3	0	5	5	10	7	10
4	5	3	0	8	4	0
5	6	0	0	6	0	0
6	1	8	3	12	9	0
7	9	2	0	11	2	0
8	7	2	2	11	2	0
TOTAL	32	32	16	80	35	10

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GCSE

PHYSICS

UNIT 3: PRACTICAL ASSESSMENT

SAMPLE ASSESSMENT MATERIALS

INSTRUCTIONS TO TEACHERS / EXAMS OFFICERS

Confidential

To be opened on receipt for immediate use by

TEACHERS / EXAMS OFFICERS

This document should be stored securely by the exams officer when not in use by the teacher. Its contents should not be divulged except to those concerned with the preparation of the assessment.

A. General Instructions

1. Each candidate will have to submit the number of tasks indicated in the table below.

Qualification	Number of tasks to be submitted
Biology	1
Chemistry	1
Physics	1
Science (Double Award)	2
Applied Science (Double Award)	2
Applied Science (Single Award)	1

The assessment will need to be completed in the first half of the spring term (i.e. January-February). Each task will be completed in two sessions each of 60 minutes duration.

Each task will have a section A and a section B. Section A and section B will be two separate question papers.

Section A will be completed in session 1 and will involve obtaining results. This will be collected from the candidates at the end of session 1. Section B will be completed in session 2 and will involve the analysis and evaluation of the results. Candidates should be given access to their section A question paper in session 2. **Section B should not be given to candidates until the second session. Both sections should be collected in at the end of session 2.**

2**.** The assessment should be supervised at all times by a member of staff responsible for teaching GCSE Science. Centres may use additional laboratories, provided that a subject teacher is available to supervise all groups at all times.

3. Teachers may open the **"Setting up Instructions"** document at the start of January. **This is for the purpose of ensuring that the apparatus functions well enough for the candidates to complete the task fully. Teachers are encouraged to try out the task, whilst preserving the confidentiality of the assessment.**

4. The question papers for all tasks will be made available to the examinations officer in each centre at the start of January.

5. **Section A**: It is permissible for candidates to work in small groups, of no more than three candidates. Teachers should ensure that each group has adequate working space and that the groups are set a reasonable distance apart. Each group requires uninterrupted access to the allocated apparatus – one set of apparatus per group. This is carried out under a limited level of control, i.e. learners may work with others to obtain results but they must provide their own responses to the questions set. Teacher assistance should not normally be required, but may be given if equipment failure occurs.

6. Once section A is completed, the question paper should be securely stored by the teacher until section B takes place.

7. **Section B**: This is carried out under a high level of control, i.e. learners must work individually. This section is to be completed with no teacher feedback or assistance allowed and under formal supervision. Candidates should have access to their section A question paper, as they need the results obtained in the first session to answer the questions in section B.

8. Candidates should write their answers in the spaces provided on the question paper. Should there be a need for additional space then a standard extension/answer booklet should be provided.

9. If candidates fail to obtain results for section A, it is acceptable for them to be given unformatted teacher results.

10. As soon as both section A and section B have taken place, question papers for each candidate should be attached to each other and then securely stored by the exams officer before they are sent to the examiner by …… at the latest. Teachers should not be given access to the completed question papers after the actual assessments have taken place.

11. The assessment will be externally marked by a WJEC examiner. The name and address of the examiner will be issued to centres by the end of April.

12. Monitoring visits will take place on a random sample of centres to ensure the practical assessment is being administered correctly.

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B. Specific Instructions

Details of the apparatus and materials required for the tasks follow.

If any difficulty is experienced in providing the apparatus, WJEC should be informed as soon as possible.

Contacts:

Subject Officer Helen Francis, 029 2026 5081, helen.francis@wjec.co.uk

Support Officer Lowri Evans, 029 2026 5140, lowri.evans@wjec.co.uk

INVESTIGATING THE EXTENSION OF A SPRING

Apparatus Required

The following apparatus is required for each group:
(each group should consist of no more than three candidates)

- 1 × expendable spring (spring constant 25 N m^{-1}) prestretched prior to use
- 1 × clamp stand and boss
- 1 × 30 cm ruler (resolution ± 1 mm)
- 1 × 100 g mass hanger and 5 × slotted masses

GCSE

PHYSICS

UNIT 3: PRACTICAL ASSESSMENT

SAMPLE ASSESSMENT MATERIALS

INVESTIGATING THE EXTENSION OF A SPRING

SETTING UP INSTRUCTIONS

Confidential

To be opened on …… (date) by TEACHERS

This document should be stored securely by the exams officer when not in use by the teacher. Its contents should not be divulged except to those concerned with the preparation of the assessment.

SECTION A

Introduction

Your task is to investigate the extension of a spring.

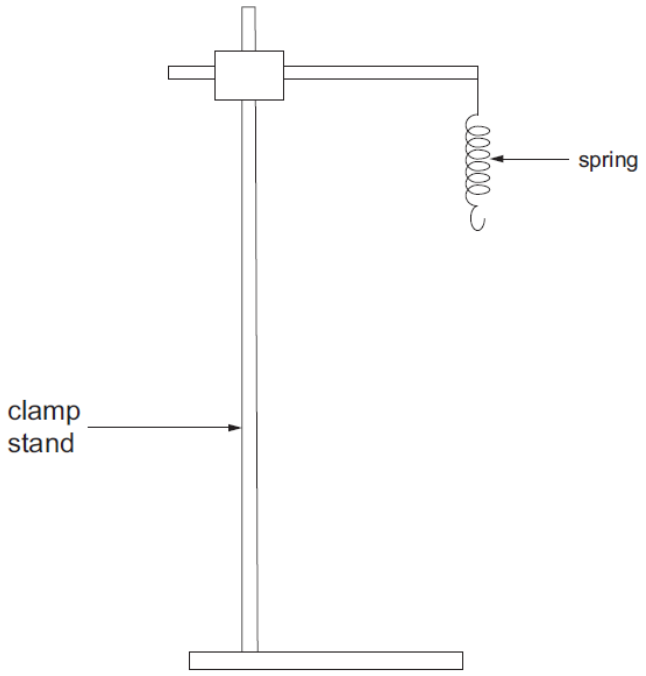
When a load is added to a spring it extends. The extension of a spring is the difference between the unstretched and the stretched length. The apparatus shown below can be used to investigate how the extension of a spring varies with the force stretching it. The force on the spring can be calculated from:

force (N) = mass (kg) × 10

Apparatus

The following apparatus is required for each group:
(each group should consist of no more than three candidates)

- 1 × expendable spring (spring constant 25 N m^{-1}) prestretched prior to use
- 1 × clamp stand and boss
- 1 × 30 cm ruler (resolution ± 1 mm)
- 1 × 100 g mass hanger and 5 × slotted masses



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Method

1. Set up the apparatus as shown in the diagram.

2. Use the ruler to measure the length of the spring.

3. Add a 100 g mass hanger to the spring.

4. Measure the new length of the spring.

5. Calculate the extension.

6. Repeat steps 3 - 5 until all masses have been added.

7. Repeat steps 1 - 6 to gain three sets of results in total.

The remainder of the examination paper is not required for the purpose of checking the setting up of the task.

In order that the work of each candidate may be correctly assessed, information is required about the materials used in the task. Please ensure that the "**Information required from centres**" sheet on page 144 is completed and given to the exams officer to be sent to the examiner with the completed examination papers.

GCSE

PHYSICS

UNIT 3: PRACTICAL ASSESSMENT

SAMPLE ASSESSMENT MATERIALS

INVESTIGATING THE EXTENSION OF A SPRING

INFORMATION REQUIRED FROM CENTRES

Centre Number ……...

(Please detach and send with the completed examination papers to the **examiner.**)

Typical spring constant value:

.....

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Candidate Name	Centre Number					Candidate Number				
						0				

GCSE

SCIENCE (Double Award)

UNIT 3: PRACTICAL ASSESSMENT

SAMPLE ASSESSMENT MATERIALS

INVESTIGATING THE EXTENSION OF A SPRING

SECTION A

(1 hour)

For Examiner's use only		
	Maximum Mark	**Mark Awarded**
Section A	**6**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The total number of marks available for this section of the task is 6.
The number of marks is given in brackets at the end of each question or part question.
This task is in 2 sections, **A** and **B**. You will complete section **A** in one session and section **B** in the next session.

SECTION A

Introduction

Your task is to investigate the extension of a spring.

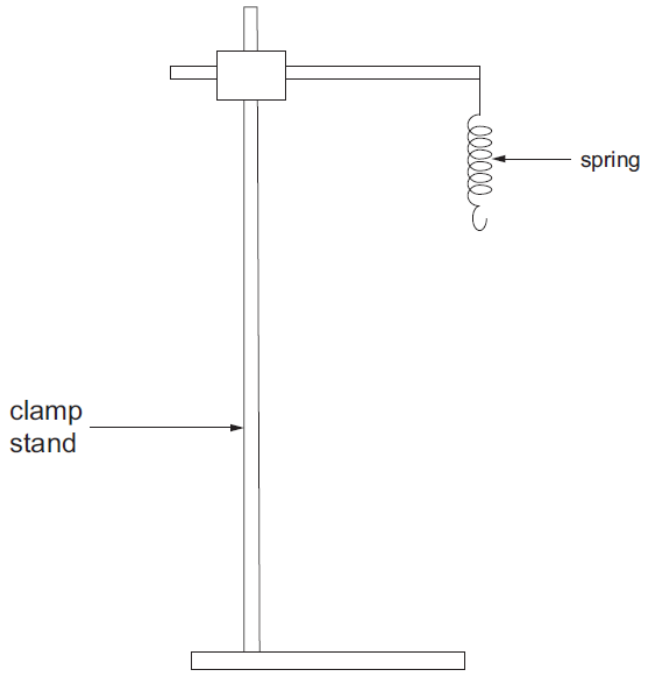
When a load is added to a spring it extends. The extension of a spring is the difference between the unstretched and the stretched length. The apparatus shown below can be used to investigate how the extension of a spring varies with the force stretching it. The force on the spring can be calculated from:

force (N) = mass (kg) × 10

Apparatus

The following apparatus is required for each group:
(each group should consist of no more than three candidates)

- 1 × expendable spring (spring constant 25 N m^{-1}) prestretched prior to use
- 1 × clamp stand and boss
- 1 × 30 cm ruler (resolution ± 1 mm)
- 1 × 100 g mass hanger and 5 × slotted masses



Read the method and answer question 1(a) before carrying out the experiment and recording your results.

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Method

1. Set up the apparatus as shown in the diagram.
2. Use the ruler to measure the length of the spring.
3. Add a 100 g mass hanger to the spring.
4. Measure the new length of the spring.
5. Calculate the extension.
6. Repeat steps 3 - 5 until all masses have been added.
7. Repeat steps 1 - 6 to gain three sets of results in total.

Answer **all** *questions*

1. (a) Make a hypothesis for this experiment. [1]

……

……

You may record raw results in the space below.

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(b) Present your results in a table, including all of your results and the mean extension for each value of the independent variable. [5]

END OF PAPER

Candidate Name	Centre Number					Candidate Number				
						0				

GCSE

PHYSICS

UNIT 3: PRACTICAL ASSESSMENT

SAMPLE ASSESSMENT MATERIALS

INVESTIGATING THE EXTENSION OF A SPRING

SECTION B

(1 hour)

For Examiner's use only		
	Maximum Mark	**Mark Awarded**
Section B	**24**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator and your section **A** exam paper.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The total number of marks available for this section of the task is 24.
The number of marks is given in brackets at the end of each question or part question.
This task is in 2 sections, **A** and **B**. You will have completed section **A** in a previous session.

SECTION B

Answer **all** *questions*

2. (a) (i) Identify the independent and dependent variables in this experiment. [2]

independent variable: ……

dependent variable: ……

(ii) Name **one** variable that must be controlled in this experiment. Give a reason for your answer. [2]

……

……

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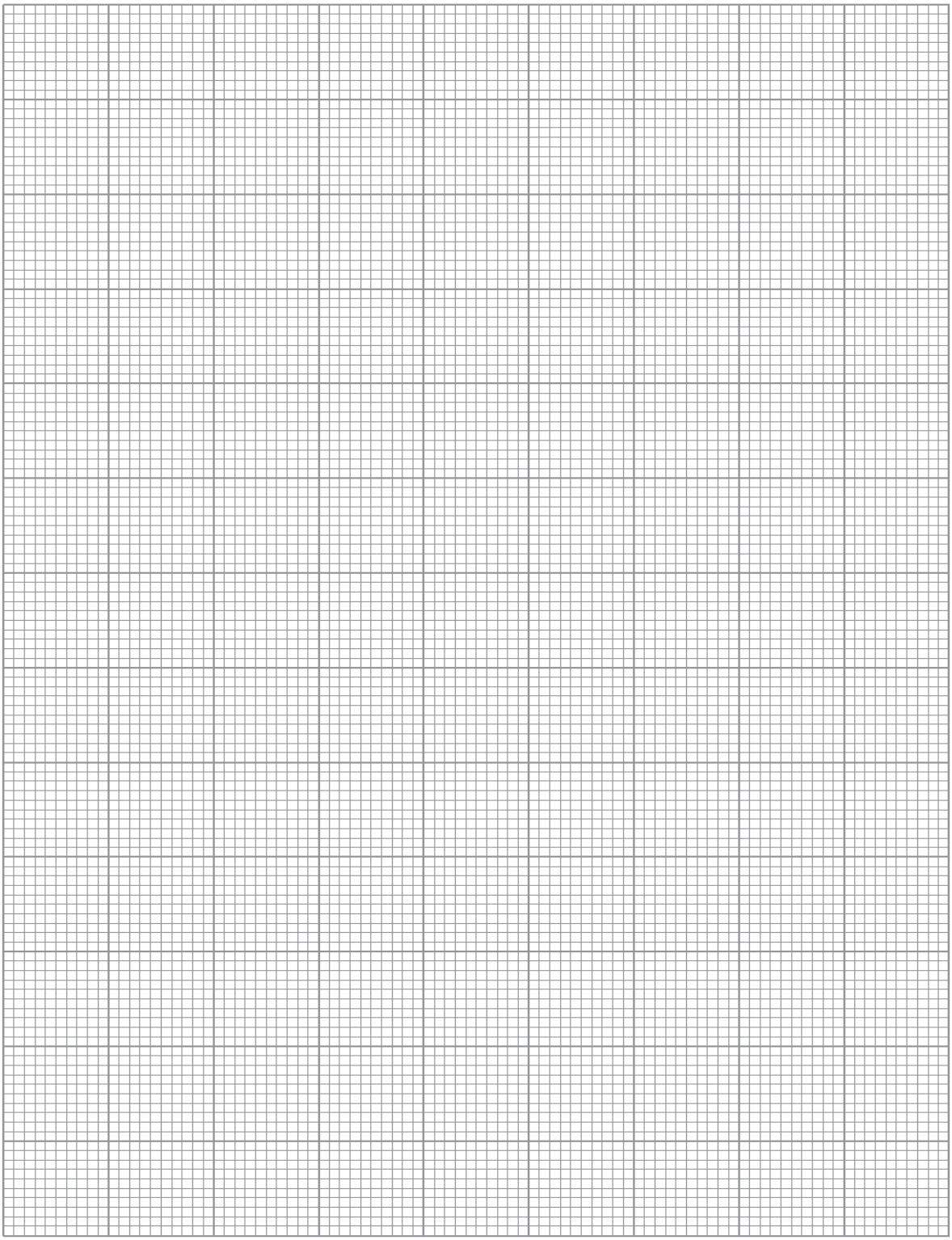
(b) A mass of 100 g provides a force of 1 N to the spring. Use this information and your results from section A to plot a graph of force (vertical axis) against extension (horizontal axis). [5]



(c) It is suggested that the extension is directly proportional to the force. Do your results support this theory? [2]

……

……

(d) The spring constant, k, is given by:

$$k = \frac{\text{force}}{\text{extension}}$$

Use data from your graph to calculate a value for the spring constant. Include a unit with your answer.

[3]

spring constant = ……..

unit = ……..

(e) The experiment is repeated with a spring which is twice as stiff. This means its spring constant is twice as big. Use the equation:

$$\text{force} = k \times \text{extension}$$

to calculate the force required to give an extension of 0.5 m. [3]

force = …….. N

(f) Evaluate the quality of the data you have collected. You should consider accuracy and repeatability in your answer. [3]

……

……

……

……

……

……

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(g) Identify **one** source of inaccuracy in this experiment and state an improvement. [2]

……

……

(h) The experiment was repeated with an elastic band. The results are shown in the table below. Describe how the elastic band behaves differently to an ideal spring for which extension is directly proportional to force. [2]

Force (N)	Extension (mm)
1.0	102
2.0	303
3.0	470
4.0	579
5.0	653
6.0	732
7.0	800
8.0	860

……

……

……

……

24

END OF PAPER

UNIT 3: PRACTICAL ASSESSMENT
INVESTIGATING THE EXTENSION OF A SPRING

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

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SECTION A

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			As mass increases extension increases	1			1		1
	(b)			All data recorded and logically organised (1) Headings - mass/ length/ extension(1) Units – g / mm / mm (1) Accept kg / m Extension calculated correctly (1) Extension means calculated correctly (1)	1 1 1	 1 1		 5	 2	 5
				Section A total	**4**	**2**	**0**	**6**	**2**	**6**

SECTION B

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		Independent variable – mass (1) Dependent variable – extension (1)	2			2		2
		(ii)		Same spring (1) Different springs have different stiffness (1)	1	1		2		2
	(b)			Scales & use of at least ½ of graph paper (1) All plots correctly plotted with ± ½ small square tolerance (2) 1 error (1) >1 error (0) Line of best fit within ± ½ small square division of all points (1) Don't accept thick, double, whispy lines Correct force used (1)	1 1	2 1		5	5	5
	(c)			Yes (no mark) Since straight line (1) through origin (1) **ecf**		2		2		2
	(d)			Matched values taken from graph (1) Substitution (1) Correct answer with consistent unit N/m or N/cm (1)	1	1 1		3	2	3
	(e)			Calculation of k (2 × their value) (1) Substitution (1) Calculation of correct force e.g. consistent units in substitution (1)	1 1	1		3	2	3
	(f)			Correct judgement of repeatability (1) Linked to similarity of repeats (1) Correct description of how accuracy was achieved e.g. avoiding parallax, measuring to nearest mm or reference to scatter about line of best fit (1)			3	3		3
	(g)			Effect of parallax when taking readings(1) Use a pointer / use a set square (1)		1	1	2		2

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(h)			Doubling force does not double extension (1) So not directly proportional (1)			2	2		2
				Section B total	**8**	**10**	**6**	**24**	**9**	**24**