WJEC GCSE PHYSICS

PHYSICS



EXAM QUESTION PACK

UNIT P1 FOUNDATION TIER 4463 PAPERS

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

S16-4463-01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

A.M. MONDAY, 20 June 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**4**	
2.	**11**	
3.	**8**	
4.	**7**	
5.	**6**	
6.	**10**	
7.	**14**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **7***(d)*.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
% efficiency = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\frac{1}{1\,000}$
k	10^{3}	1 000
M	10^{6}	1 000 000

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Answer **all** *questions.*

1. An absorption spectrum from a star is a pattern of black lines on a coloured background.



The boxes in the left column list four features of the spectrum.
The boxes in the right column list the causes of these features.

(i) **Draw a line** from each feature to its correct cause on the right. [3]

Feature	Cause
A single black line	Due to wavelengths of visible light emitted by the star
The black lines move towards the red end of the spectrum	Due to the gas elements in the star
Pattern of black lines	Due to cosmological red shift
Coloured background	Due to one wavelength of light being absorbed

(ii) Name the theory that is supported by cosmological red shift. [1]

.....

4

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2. The diagram shows apparatus that was used to investigate transformers.



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The same input coil was used throughout the investigation.

Different output coils (**A**, **B**, **C** and **D**) were used.

The results are shown below.

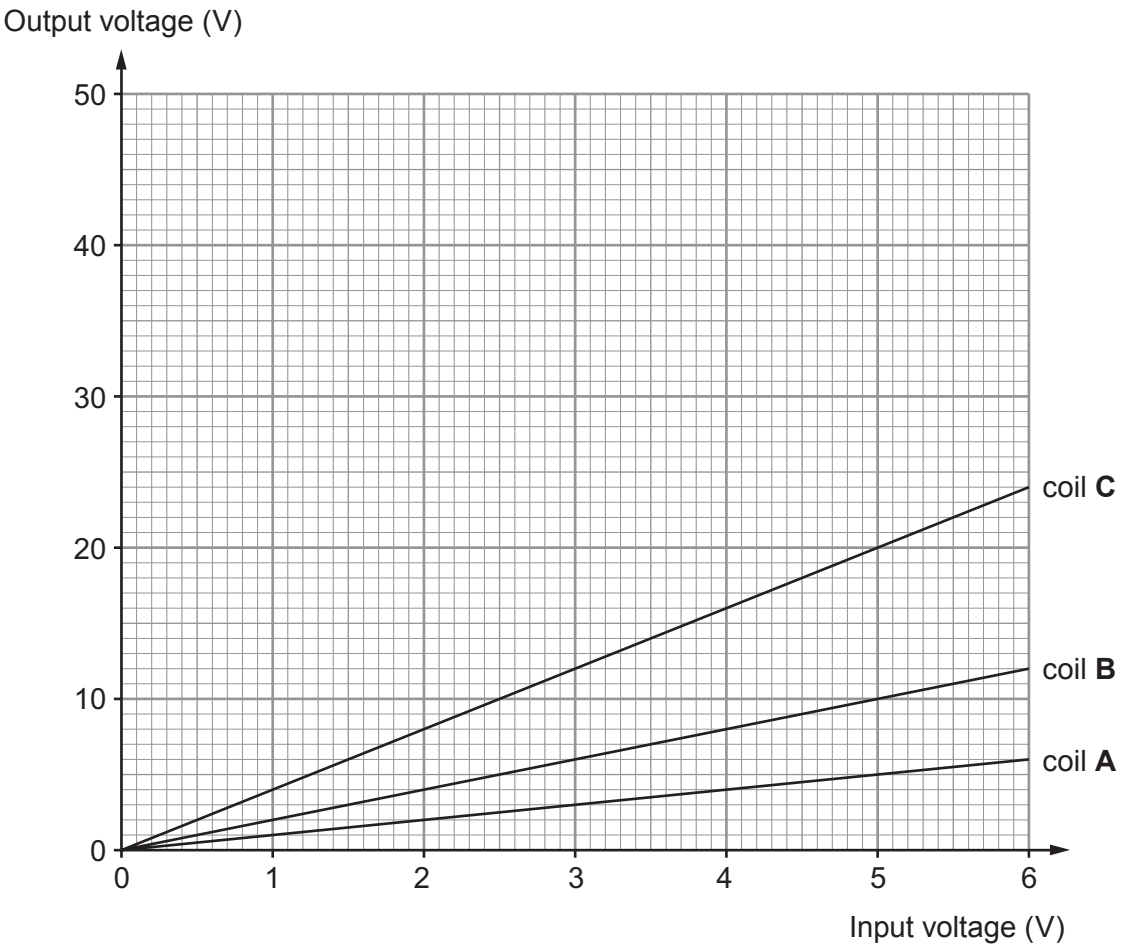
	Output voltage (V) from			
Input voltage (V) to coil	coil **A**	coil **B**	coil **C**	coil **D**
1	1	2	4	8
2	2	4	8	16
.....	4	8	16	32
5	5	10	.....	40
6	6	12	24	48

(a) (i) **Complete** the table. [2]

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Some of the results have been plotted on the grid below.



(ii) Use the information in the table **to plot a graph** for coil **D**. [3]

(iii) Describe the relationship between the input voltage and the output voltage for coil **B**. [2]

.....

.....

(iv) Select the output coil which would be used to operate a 12 V lamp at normal brightness from a 3 V input voltage.

..... [1]

(v) Which of the output coils does not step-up the voltage? ..... [1]

(b) Explain the use of step-down transformers in the National Grid. [2]

.....

.....

.....

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Turn over.

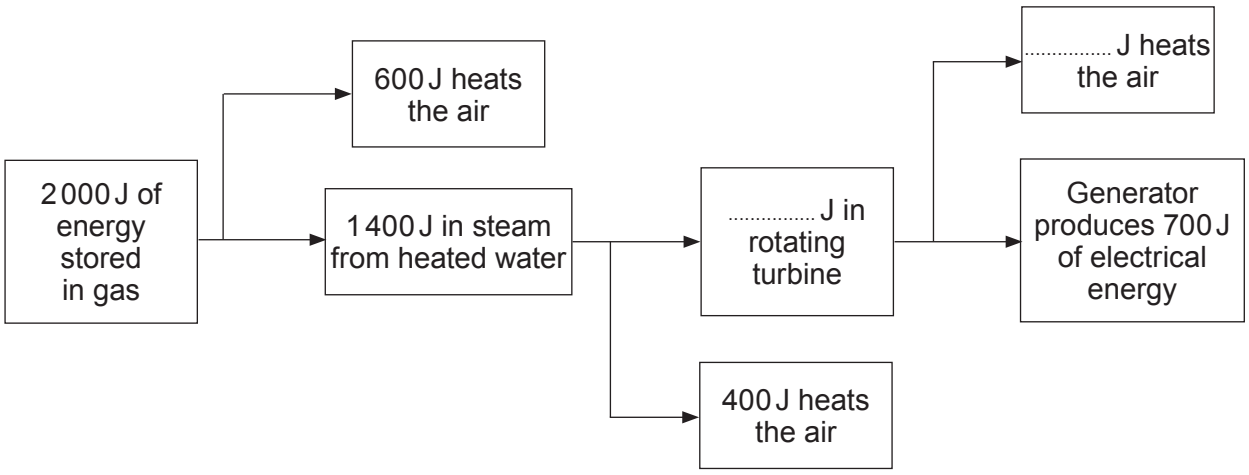
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3. Some power companies produce electricity by using gas.
Not all the energy stored in the gas is converted into electrical energy.

(a) The diagram below shows the energy flow in the process of producing electricity from gas.



(i) **Complete the flow diagram** above. [2]

(ii) State the amount of useful energy output from an input of 2 000 J. ..... J [1]

(iii) Use an equation from page 2 to calculate the % efficiency of producing electricity from gas. [2]

% efficiency = ...

(iv) Find the percentage of energy wasted in the process. [1]

% wasted energy = ...

(b) Give **two** reasons why power companies should look for other methods of producing electricity instead of using gas. [2]

1. .....

.....

2. .....

.....

8

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4. The diagram shows an earthquake's shock wave that was detected under the Indian Ocean.



4463 010007

(a) (i) Write down the maximum amplitude of the shock wave. [1]

maximum amplitude = ... units

(ii) How many complete waves are shown? ..... [1]

(b) The frequency of the shock wave is 40 Hz and its wavelength is 120 m.

(i) State what a frequency of 40 Hz means. [1]

.....

(ii) Use an equation from page 2 to calculate the wave speed of the shock wave. [2]

wave speed = ... m/s

(c) The shock wave caused a tsunami which travelled 150 000 m in 750 s. Use an equation from page 2 to calculate its speed. [2]

speed = ... m/s

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5. *(a)* The table below lists **most** of the regions of the electromagnetic spectrum.

Tick (✓) the boxes next to the regions that are ionising radiations. [2]

Region	Ionising radiation
radio waves	
microwaves	
infra-red	
visible	
ultraviolet	
X-rays	

(b) Three other types of ionising radiation are **alpha**, **beta** and **gamma** radiation.

(i) Which of these is the most penetrating radiation? ..... [1]

(ii) Which of these is the least ionising radiation? ..... [1]

(c) Nuclear waste emits ionising radiations.

State **two** reasons why the storage of nuclear waste is difficult. [2]

1. .....

2. .....

6

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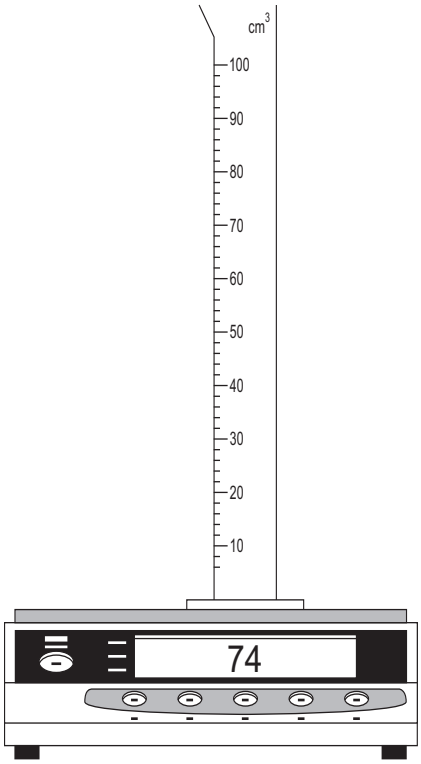
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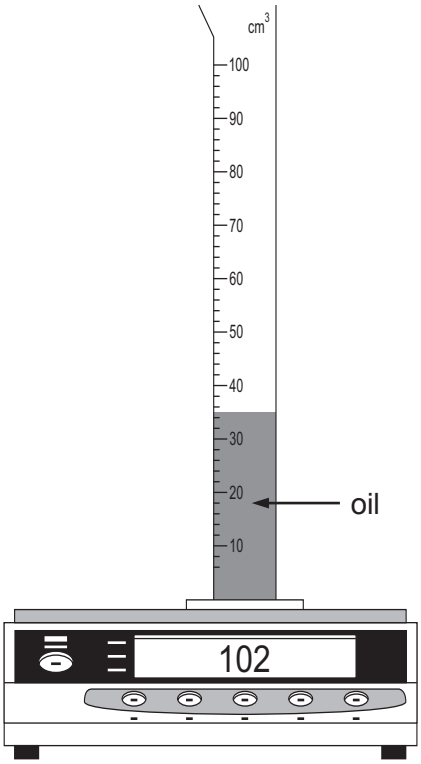
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6. A pupil wants to compare the densities of oil and water. Oil floats on water.
She uses a **measuring cylinder that has a mass of 74 g** and an electronic balance that measures to the nearest gram (g).

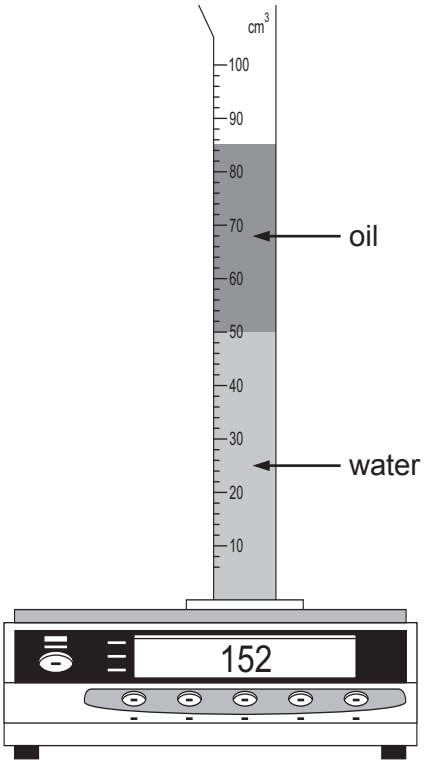
She places the empty measuring cylinder on to the balance.



She places the measuring cylinder containing some oil on to the balance.



Some water was then added to the cylinder.

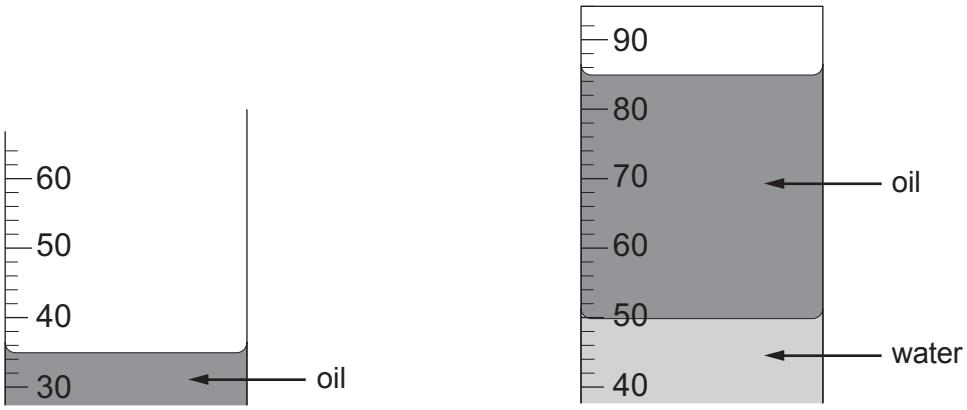


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The liquid levels in the measuring cylinder are shown below.



(a) (i) Use the diagrams **to complete the table** below. [3]

	Volume (cm^3)	Mass (g)
oil	35	.....
water	.....	.....

(ii) Use the data above and an equation from page 2 to calculate the density of oil and give its unit in this experiment. [3]

density of oil = ...

unit = ...

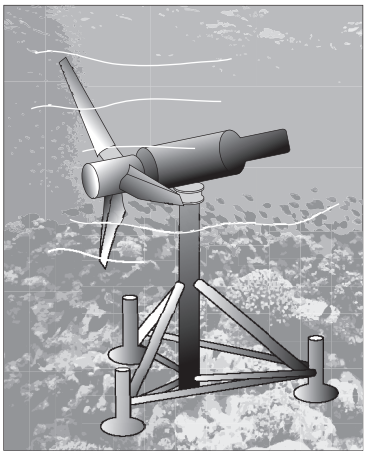
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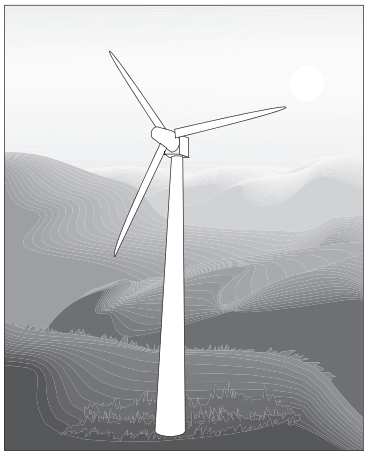
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(b) Electrical energy can be generated from wind and from moving water. The density of air is 1.3 kg/m^3 and the density of water is 1 000 kg/m^3.



TIDAL WATER TURBINE



WIND TURBINE

(i) Give two **advantages** of producing electricity by using tidal water turbines compared to wind turbines sited on land. [2]

.....

.....

.....

.....

(ii) Give two **disadvantages** of producing electricity by using tidal water turbines compared to wind turbines sited on land. [2]

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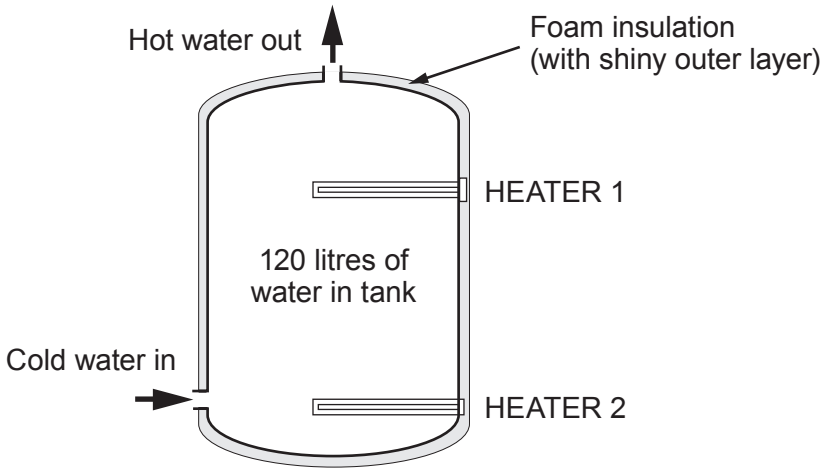
TURN OVER FOR THE LAST QUESTION.

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7. A hot water tank that is covered in foam insulation contains a total of 120 litres of water. It has two electric heaters, either of which may be used to heat water to the same final temperature. Heater **1** is used during the day and heater **2** is used during the night. A simplified diagram is shown below.



(a) Explain why heater **1** does not heat all of the water in the tank. [2]

.....

.....

(b) (i) Explain why foam is used to cover the hot water tank to reduce heat loss. [2]

.....

.....

.....

(ii) State how the shiny outer surface of the foam reduces heat loss. [2]

.....

.....

.....

(c) Explain how the foam covering benefits the environment. [2]

.....

.....

.....

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(d) The following table gives information about heating water by either of the two heaters.

	Electric heater **1**	Electric heater **2**
Volume of water that is heated by the heater (litres)	40	120
Time to heat this volume of water (hours)	0.5	3
Power (kW)	4	2
Cost per unit (p)	16	5

A householder has to decide which heater (**1** or **2**) to use. She will need to use 30 litres of hot water.
Use data from the table and equations from page 2 to compare the two methods of heating in terms of: [6 QWC]

- the number of units used to heat the water;
- the cost of electricity used;
- the impact on the environment;
- advice that should be given to the householder.

Assume the water in the tank is initially cold.

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MORE SPACE OVER THE PAGE IF REQUIRED

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14

END OF PAPER

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GCSE MARKING SCHEME

SUMMER 2016

SCIENCE - PHYSICS P1
4463/01/02

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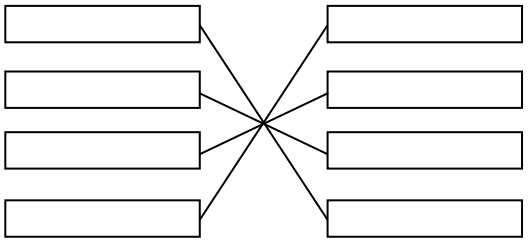
INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
1			i		3	4 correct → 3 marks 3 correct→ 2 marks 1 or 2 correct → 1 mark 0 correct → 0 marks 			2 lines from any feature to any cause.
			ii		1	Big Bang			
		Total			**4**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
2		(a)	i		2	4 (1) 20 (1)			
			ii		3	Plots ± ½ small square division (2) -1 mark for each incorrect plot to a maximum of 2 Straight line through origin – no tolerance (1)	**ecf** for the input voltage value "4" for plotting treated as an anomalous point when drawing line If all points are misplotted can award **ecf** for line mark		Thick, whispy, double, wobbly lines
			iii		2	Input voltage increases so does output (1) It doubles (1) Award 1 mark for - [Directly] proportional to each other	Positive correlation = 1 mark When the input voltage increases by 1 the output voltage increases by 2 = 2 marks Output = 2 × input (award 2 marks)		Linear unless qualified
			iv		1	C			
			v		1	A			
		(b)			2	Decreases voltage (1) To make it safe[r] (1) **The 2nd mark needs to be linked to the 1st mark**	For safety reasons Less dangerous Step down voltage	References to energy and power Increases the current	Decreases the electricity
		Total			**11**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		(a)	i		2	1 000 [J] in rotating turbine (1) 300 [J] heats the air (1) **ecf on 1st answer - 700**			Negative answer
			ii		1	700 [J]			
			iii		2	Subs: $\frac{700}{2\,000}$ (1) **no ecf from (ii)** Ans = 35 (1)	0.35 (1)		
			iv		1	65 **ecf** Accept 65 even if answer to (iii) is incorrect	0.65		
		(b)			2	[Burning gas adds to] - greenhouse emissions / global warming [effect] / release of CO_2 (1) Limited resource / non-renewable / finite source (1)		Reference to cost Not very efficient Gas is a fossil fuel Reference to pollution	Acid rain
		Total			**8**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)	i		1	6 [units]	-6		
			ii		1	8			
		(b)	i		1	[40] cycles / vibrations / oscillations per second	[40] waves/s or vibrations/s		Hz/s
			ii		2	Subs: 40×120 (1) Ans = 4 800 [m/s] (1)			
		(c)			2	Subs: $\frac{150\,000}{750}$ (1) Ans = 200 [m/s] (1)			
		Total			**7**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)			2	Ticks by ultraviolet (1) and X-rays (1) Deduct 1 mark for each extra tick to a maximum of 2 marks			
		(b)	i		1	Gamma			
			ii		1	Gamma			
		(c)			2	Reference to containment (1) Long term storage (1)	Long half-life / long time to decay / thousands of years to decay (1) Deep underground (1)	Security Monitoring Cost Leaks Highly penetrating	Highly radioactive / emits radiation / hundreds of (or many) years to decay / lasts for a long time / decompose
		Total			**6**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
6	**1**	(a)	(i)		3	<table><tr><td></td><td>Volume (cm^3)</td><td>Mass (g)</td></tr><tr><td>oil</td><td>35</td><td>28 (1)</td></tr><tr><td>water</td><td>50 (1)</td><td>50 (1)</td></tr></table>			
			(ii)		3	Density of oil = $\frac{28(ecf)}{35}$ (1) = 0.8 (1) Correct unit of $\underline{g/cm^3}$ given (1)	If 102 used then answer is 2.9[1] = award 2 marks **ecf** Accept kg/m^3 if mass and volume have been converted correctly		g/ml answer rounded to whole number
		(b)	(i)		2	ADVANTAGES: smaller than wind turbines / have a bigger power output or energy output / water is denser than air (1) [more] reliable output / water is always flowing (1)	Always a tide / not always wind	Reference to cost / visual or noise pollution / takes up less space / less needed	
			(ii)		2	DISADVANTAGES: danger to <u>sea animals</u> or shipping or sea lanes (1) [more] difficult / expensive to maintain / erect / build (1)	Ships could damage turbine Damage underwater habitats Problems for sea life	Could rust Barnacle build up is a problem Damage to sea bed Sea life or fish damaging the turbine	
		Total			**10**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
7	**2**	(a)			2	Only water above it is heated (1) Because hot water rises or is less dense / due to convection (1) **The 2nd mark must be linked to the 1st mark.**	Water below the heater can't get hot = 1st mark	Hot water expands / particles move further apart	Heat rises Hot air rises
		(b)	(i)		2	Foam / air is a [good] insulator or poor conductor (1) Because it has <u>trapped</u> air inside it (1) **The 2nd mark must be linked to the 1st mark.**	Pockets of air Reduces convection currents <u>outside</u> (1) because the outer temperature is lower (1)		Harder for heat to travel through air Air holes
			(ii)		2	Shiny surfaces are <u>poor emitters</u> (1) of <u>heat radiation</u> (1)	Infra-red instead of heat radiation Poor radiator of heat = 2 marks Reflect infra-red radiation back in (1)		Reflects heat back in
		(c)			2	Less electricity used / fewer power stations will be needed (1) which means less fuel (or a named fuel) is used or mined / less pollution (in any terms) is emitted from the power stations (1) **The 2nd mark must be linked to the 1st mark.**		The atmosphere heats up less	Reference to the ozone layer
		(d)			6	**Indicative content:** **Heater 1**: $4 \times 0.5 = 2$ [kWh] Cost = $2 \times 16 = 32$ p **Heater 2:** $2 \times 3 = 6$ [kWh] Cost = $6 \times 5 = 30$ p Heater 1 is 2 p more expensive than heater 2. **Heater 1:** $E = Pt = 2$ [kWh] **Heater 2:** $E = Pt = 6$ [kWh] Heater 2 uses up to 3 times more energy than heater 1 there is a 4 kWh difference. This will have an impact on the environment as more natural energy resources will be used up, more pollution/is produced which increases the greenhouse effect.			More water used up.

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
						5-6 marks **See indicative content – correct calculation for both heaters and a full comparison made** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** **Calculation of units used and costs for both, comparison between the two made with advice to householder – all 3 attempted or 2 done well** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** **Calculation of units used for both or one correct or some commentary provided** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total			**14**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	3	(a)	(i)		3	All points correctly plotted ± ½ small square division (2) -1 mark for each incorrect plot to a maximum of 2 Smooth curve through the points (1)			A series of straight lines, fuzzy or thick lines
			(ii)		1	2 [minutes]			
			(iii)		1	5 [^{o}C]			
		(b)	(i)		2	Points correctly plotted with coordinates (0,35), (2,20) and (4,10) ± ½ small square division (1) Smooth curve through the correct points within ± ½ small square division (1)	<u>If no points plotted allow curve</u> from (0,35) to (4,10) award 1 mark only		Smooth curve through incorrect points
			(ii)		3	A greater temperature (1) difference [between the can and its surroundings] (1) results in more heat loss per second or per unit time (1) **For 3 marks to be awarded, the 1st and 2nd marks must be linked to the 3rd mark.**			Greater heat
		(c)			4	8 μm chosen (1) used as 8×10^{-6} m (1-conv), $f = \frac{3 \times 10^{8}}{8 \times 10^{-6}}$ (1- manip and sub) $f = 3.75 \times 10^{13}$ [Hz] (1- ans) **Powers of 10 slip on λ deduct 1 mark**	Using 10 μm gives an answer of 3×10^{13} Hz award 3 marks (only one error has been made) Using 9 μm gives an answer 3.33×10^{13} Hz award 2 marks		Wavelengths of 18 μm and 2 μm no marks Any other wavelength chosen no marks
		Total			**14**				

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Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT	Sub-section							
	4	(a)			2	Responds to changes in demand / copes with power station failures (1) by bringing reserve or backup stations [online] (1)		Peak times	
		(b)			3	$\frac{2 \times 10^8}{400\,000} = 500$ [A] (1 – manip. & subs.), (1-conversion from 400 kV to 400 000) (1- ans) **Alternative:** Input current calculated = 4 000 [A] (1) Voltage ratio is 1:8 **and** current ratio is 8:1 (1) so = 500 [A] (1)	Incompatible units to give an answer of 5×10^n gets 2 marks		
		(c)			3	Transmission at 50 kV would produce a greater current [through the grid] (1) resulting in a bigger power/heat/energy loss [in the cables] (1) The energy wasted in the two transformers is less than the energy that would be wasted from operating at a lower voltage with no transformers (1) **All three marks can only be awarded if the 3rd mark is linked to the first two marks.**	Converse argument		Prevent heat loss
		Total			**8**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	(a)	(i)		1	[2 000 – 400] = 1 600 [cpm]			
			(ii)		1	Gamma	γ		
		(b)	(i)		1	0 [cpm]	zero / none		
			(ii)		2	**Can gain credit even if (b)(i) is non-zero.** Beta can't pass through aluminium (1) And aluminium does not alter the count rate compared to paper / so count rate would have dropped if beta was present (1) **The 2nd mark must be linked to the 1st mark.**	If beta was present, the count rate would have dropped beyond aluminium = 2 marks		
		(c)			1	Background radiation has already been taken away or is not included			
		Total			**6**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6	(i)			1	4×10^9 years / 4 billion years			Light years
		(ii)			1	0.2×10^{-7} [m] or 2×10^{-8} [m]			
		(iii)			6	**Indicative content:** The chemical composition of stars in galaxies can be found by studying the absorption lines in their spectra. There are more lines in the spectrum from the distant galaxy which suggests that it contains more than just hydrogen because each black line represents a wavelength that is absorbed by additional elements. Light from the distant galaxy shows that the lines in its spectrum are red shifted when compared with those of laboratory hydrogen, that is, the lines have moved to the red end of the spectrum and their wavelengths have increased. This red shift shows that the separation this galaxy is from us is increasing. (Candidates who go on to discuss the expansion of the Universe, the existence of CMBR and the Big Bang theory should be penalised). **5-6 marks** **See indicative content – composition and distance both covered** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.			

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
						3-4 marks – either composition or distance covered well or attempt made at both The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks – attempt made at either composition or distance** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total			**8**				

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

W16-4463-01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

A.M. THURSDAY, 14 January 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**7**	
3.	**8**	
4.	**10**	
5.	**8**	
6.	**11**	
7.	**6**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may 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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **7**.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
% efficiency = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\frac{1}{1000}$
k	10^{3}	1000
M	10^{6}	1000000

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Answer **all** *questions.*

1. The three types of nuclear radiations are alpha (α), beta (β) and gamma (γ). [3]

(a) (i) Name the radiation that is the most easily blocked. .....

(ii) Name the radiation that most easily passes through the skin. .....

(iii) Name the one radiation that is a wave. .....

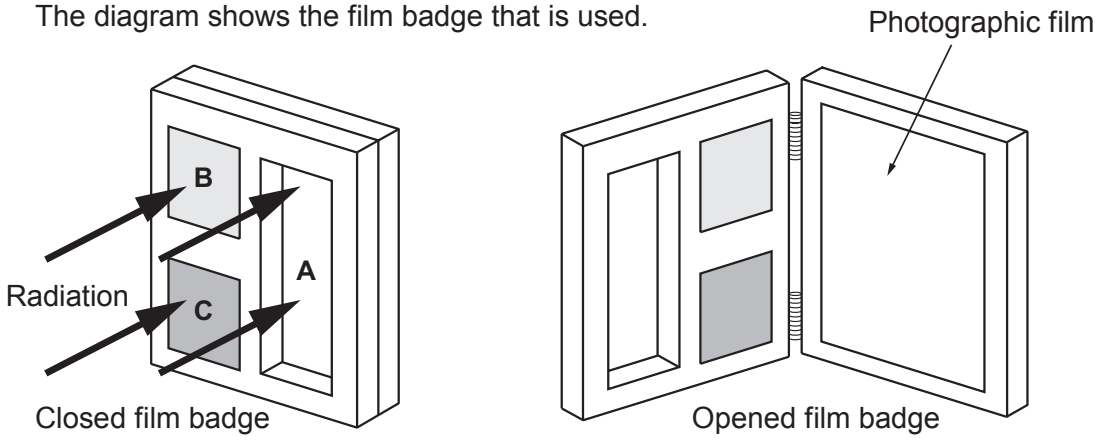
(b) Nuclear power station workers wear a film badge to monitor their exposure to the different types of nuclear radiation. Explain why this is important. [2]

.....

.....

.....

(c) The diagram shows the film badge that is used.



Window A has no absorber.
Window B has a paper absorber.
Window C has an aluminium absorber.

(i) Name a radiation that could penetrate (pass through) window **C**. .....

(ii) Name a radiation that could pass through window **B**. .....

(iii) Name a radiation that could **only** pass through window **A**. .....
[3]

(d) One worker wears a film badge underneath his clothing. [2]

(i) State which window's results would be affected. .....

(ii) Give a reason for your answer.

.....

.....

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Turn over.

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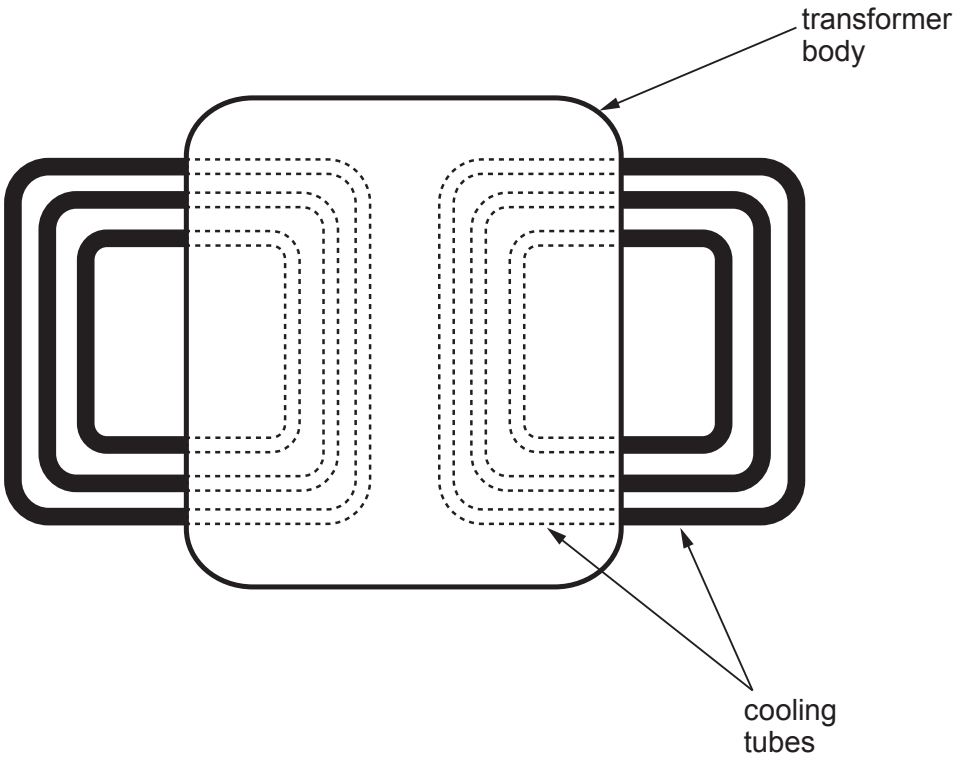
2. *(a)* Complete the following sentences about the National Grid by underlining the correct phrase in each bracket. [3]

(i) An advantage of the National Grid is to **[stop power stations breaking down / get electricity to consumers faster / keep electricity available if some power stations fail]**.

(ii) Step-up transformers are used to **[get the electricity to consumers faster / reduce energy losses in the cables / increase the current in the cables]**.

(iii) Step-down transformers are used to **[make the voltage smaller / reduce energy losses in the cables / reduce the power]**.

(b) Large transformers get hot when they are working. They are cooled by pumping cool oil through them. The oil becomes hot and is pumped to the outside cooling tubes.



(i) Describe why the cooling tubes are painted dull black. [2]

.....

.....

(ii) If the pump in the tubes breaks down convection then happens. Explain where the hottest oil would be found in the tubes. [2]

.....

.....

.....

7

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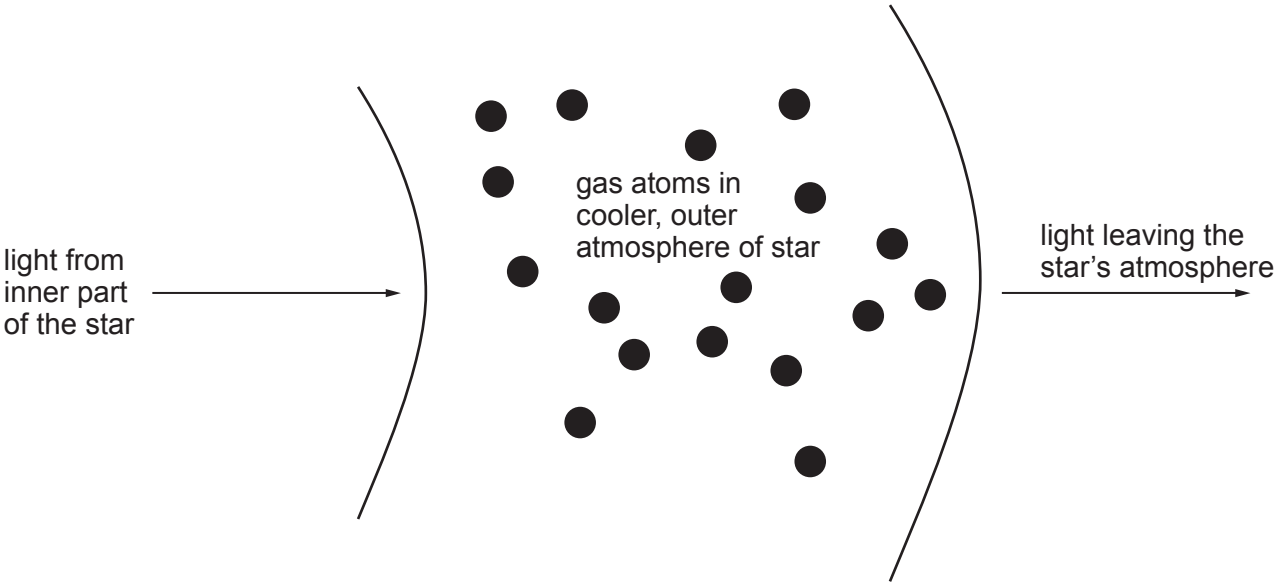
Examiner only

3. The diagram shows gas atoms in the cooler, outer atmosphere of a star in a galaxy that is 20 million light years away.

(a) Write down the time taken for light to get to us from the star. [1]

.....

(b) The diagram shows light from the inner part of the star passing through its outer atmosphere. Some of the wavelengths are absorbed.



The diagrams below show three spectra.

Diagram A

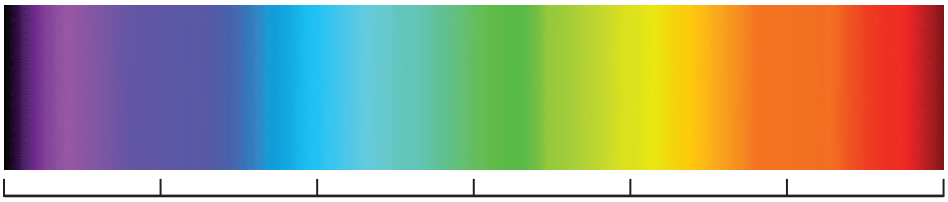


Diagram B



Diagram C



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Put a tick (✓) in the correct column below to show which is the correct diagram for each statement. [2]

	Diagram A	Diagram B	Diagram C
Light leaving the star's atmosphere			
Light from inner part of the star			

(c) The spectrum below is from another star in the same galaxy.



Explain how the lines show that the stars are different. [2]

.....

.....

.....

(d) Lines in spectra from distant galaxies are shifted towards the red end of the spectrum.

(i) State what has happened to the **wavelengths** of those lines. [1]

.....

(ii) The lines in spectra from some other galaxies are further red shifted. State what this tells us about those galaxies. [1]

.....

(e) Cosmological red shift supports the Big Bang theory. Name one other piece of evidence that supports this theory. [1]

.....

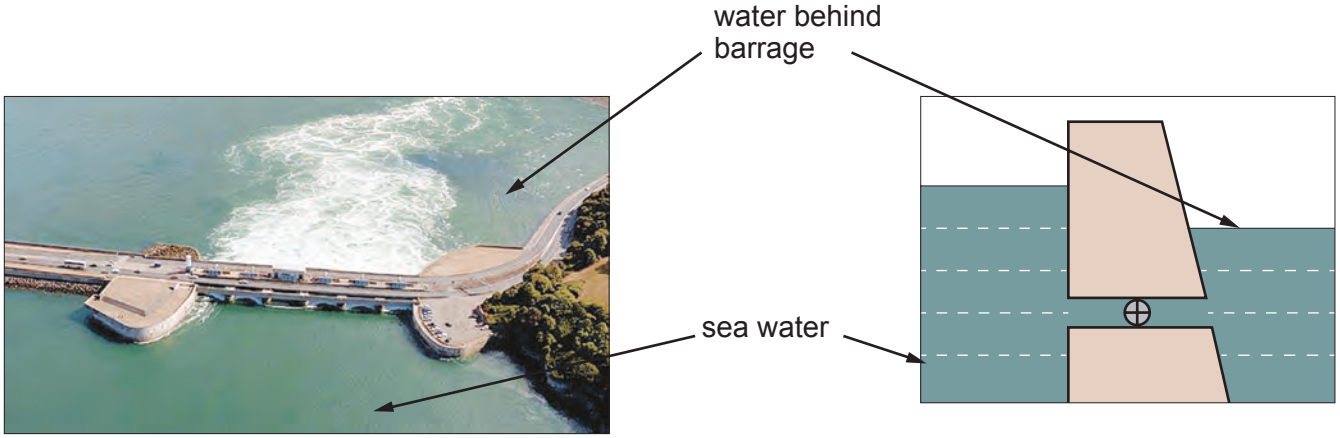
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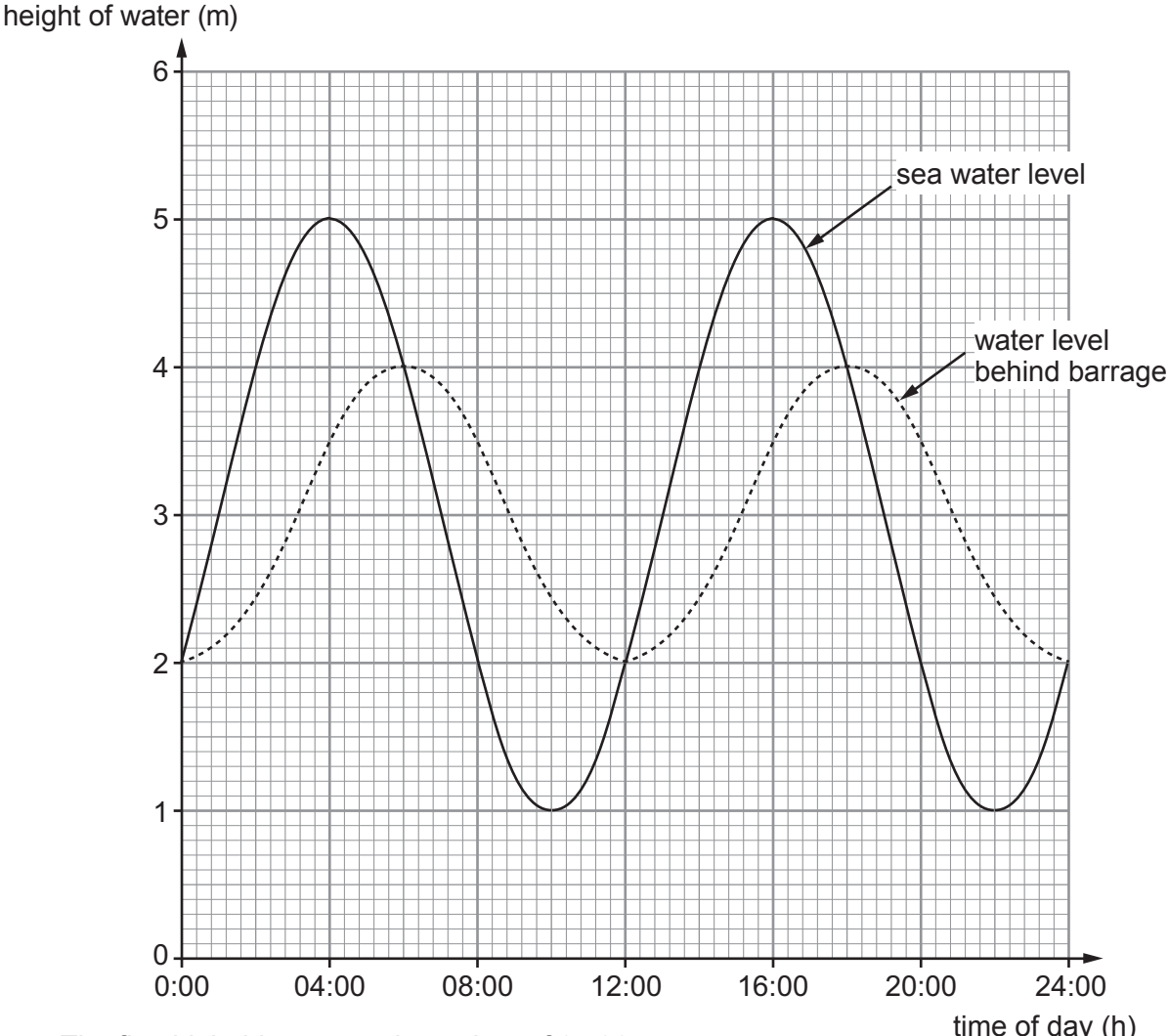
4463 010007

4. The first modern tidal power station was built in 1966 at La Rance in France.

Water flows into the barrage when the sea is at a higher level than the water behind the barrage. The water flows out again when the sea level is lower than the water behind the barrage.



One day in June 2015, the sea water levels each side of the barrage changed in the way shown by the lines on the graph below.



The first high tide occurred at a time of 04:00.

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(a) Use the information from the graph opposite to answer the following questions. [5]

(i) Write down the height of the sea water at high tide. height = ... m

(ii) At what time is the **second high tide** of the day? time= .....

(iii) Write down the time taken to go from one high tide to the next.

time = ... hours

(iv) Write down one time when both water levels are the same.

time = ...

(v) Write down one time when no power is being generated.

time = ...

(b) The table below gives information about a turbine in the barrage at La Rance.

	Power (MW)
Maximum power output	10
Mean power output	2.6
Maximum power input	16

Use the equation:

$$\% \text{ efficiency} = \frac{\text{maximum power output}}{\text{maximum power input}} \times 100$$

to calculate the % efficiency of the turbine at maximum power output. [2]

% efficiency = ...

(c) (i) State **two** advantages to the environment of generating electricity in this way. [2]

.....

.....

(ii) State **one** disadvantage to the environment of generating electricity in this way. [1]

.....

.....

10

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5. *(a)* The diagram shows the different regions of the electromagnetic (em) spectrum.

gamma radiation

X-rays

.....

visible light

infra-red

.....

radio waves

(i) **Fill in the gaps** above. [2]

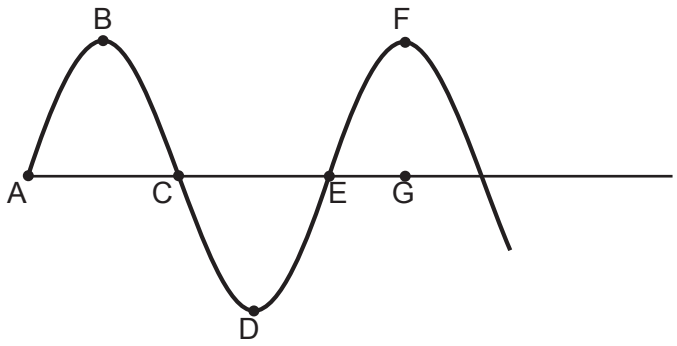
(ii) Complete the sentences below by underlining the correct phrase in each bracket. [3]

Visible light travels **[faster than / at the same speed as / slower than]** radio waves.

The frequency of visible light is **[higher than / the same as / lower than]** the frequency of X-rays.

The wavelength of visible light is **[longer than / the same as / shorter than]** the wavelength of radio waves.

(b) (i) Use letters on the diagram **to complete the sentences** that follow. [2]



The distance between point ..... and point ..... is equal to one wavelength.

The distance between point ..... and point ..... is equal to the amplitude.

(ii) **Draw a new wave** with a smaller amplitude on the diagram above. [1]

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6. A kettle is connected to an energy meter that measures units used in kWh to **1 decimal place**. The energy meter **is not** reset to zero at the start.

4	4	5	·	2	kWh	Start meter reading
4	6	3	·	9	kWh	Meter reading after 1 week

(a) What does the abbreviation kWh stand for? ..... [1]

(b) (i) Calculate the number of units used by the kettle during the week. [1]

units used = ... kWh

(ii) During the week the kettle is used for a total of 8.5 hours.
Use the equation:

$$\text{power (kW)} = \frac{\text{units used (kWh)}}{\text{time (h)}}$$

to calculate the power of the kettle **in watts**. [3]

..... W

(iii) Each unit (kWh) of electricity costs 20 p. Use an equation from page 2 to calculate the cost **in pounds** of using the kettle for the week. [2]

£ .....

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(c) A smaller kettle for use in a caravan has a power rating that is a quarter ($\frac{1}{4}$) of the original kettle but it is used for **double** the amount of time. How much would it cost to use this kettle instead? [2]

cost = ...

(d) The European Union is considering banning high powered kettles. Explain whether banning high powered kettles will help reduce our energy use. (It takes 0.1 kWh to boil 1 kg of water.) [2]

.....

.....

.....

11

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7. **Compare** the use of different types of electromagnetic (em) radiation in long distance communication between the UK and USA by optical fibres and satellites. [6 QWC]

Include in your answer:

- the types of em radiation used;
- a comparison of time delay, using the information below and the equation: $\text{time} = \frac{\text{distance}}{\text{speed}}$;

Length of optic cable between UK and USA	7 200 km
Height of geosynchronous satellite above Earth	36 000 km
Speed of em waves in glass	200 000 km/s
Speed of em waves in space	300 000 km/s

- any other advantages or disadvantages of either method.

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END OF PAPER

6

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GCSE MARKING SCHEME

JANUARY 2016

SCIENCE – Physics 1
4463/01/02

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INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

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Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT	Sub-section							
1		*(a)*	i		1	Alpha	α		
			ii		1	Gamma	γ		
			iii		1	Gamma	γ		
		(b)			2	To <u>measure the</u> [dose of] <u>radiation</u> received (1) **Either × 1 mark:** • because [too much] nuclear radiation is dangerous / harmful to living <u>cells</u> / mutates <u>cells</u> / damage DNA • so they are removed from the workplace / limit exposure / limit the dose received	Accept "they ionise cells, or they kill cells" or "they cause cancer / radiation poisoning" or "so they know if the area they are in is safe" for the second mark	Some radiations can harm you	Type of radiation received for the 1st mark Cause illness for the 2nd mark
		(c)	i		1	Gamma	γ		More than one type identified
			ii		1	Beta or gamma	β, γ		More than one type identified
			iii		1	Alpha	α		More than one type identified
		(d)			2	Window A (1) because <u>alpha</u> is stopped by <u>cloth / material</u> (1)	β and γ can pass through cloth		Blocked by paper Or no absorber present
		Total			**10**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
2		*(a)*	i		1	Keep electricity available if some power stations fail			More than one answer underlined
			ii		1	Reduce energy losses in the cables			More than one answer underlined
			iii		1	Make the voltage smaller			More than one answer underlined
		(b)	i		2	They are <u>good emitters</u> (1) of heat [radiation] / so the tubes cool quicker (1)	The heat (1) is <u>radiated</u> <u>well</u> (1) They give off radiation well = 1 mark A good radiator = 1 mark		Good emitters and absorbers unless qualified Allows radiation to happen
			ii		2	Near the top of the tubes / hot liquids rise (1) because hot liquids are less <u>dense</u> (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Hot liquid floats on top of cooler liquid = 1 mark		Hot air rises
		Total			**7**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
3		*(a)*			1	20 million years	20 million y		20 million light years
		(b)			2	Tick in column B – top row (1) Tick in column A – bottom row (1)			More than one tick in a row
		(c)			2	The lines are in different places / wavelengths / more lines (1) so it shows that [different] gases / elements [are present in their atmospheres] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Gases have got lines = 1 mark Gases have got different lines = 2 marks Different gas atoms		Different atoms
		(d)	i		1	[The wavelengths have] increased	Got bigger or longer		Expanded Stretched Widened Moved to the red end
			ii		1	[The galaxies] are further away	Moving away faster		They are getting further away from us / far away / further apart
		(e)			1	Cosmic microwave background radiation (or CMBR)			
		Total			**8**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
4		*(a)*	i		1	5 [m]			
			ii		1	16:00	16 or 4pm		
			iii		1	12 [hours]			
			iv		1	Any of: 0:00 (or midnight), 06:00, 12:00, 18:00 (or 6pm), 24:00 (or midnight)	0,6,12,18,24		
			v		1	Any of: 0:00 (or midnight), 06:00, 12:00, 18:00 (or 6pm), 24:00 (or midnight)	0,6,12,18,24		
		(b)			2	$\frac{10}{16}$ (1) = 62.5 (1-ans)	If no workings shown 0.62[5] or 0.63 = 1 mark 63 = 2 marks 62 = 1 mark		
		(c)	i		2	**Any 2 × (1) from:** • No CO_2 / SO_2 / no polluting gases released / no pollution / no waste products • Renewable [source of energy] • No fossil fuels used up • No radioactive waste			CO_2 and SO_2 for two separate marks
			ii		1	Disturbs habitats, large area of land needed, danger to fish / wildlife			Effect on wildlife without qualification Reference to visual pollution
		Total			**10**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5	**1**	*(a)*	i		2	Ultraviolet (1) Microwave (1)	UV		
			ii		3	At the same speed as (1) Lower than (1) Shorter than (1)			More than one answer underlined
		(b)	i		2	BF or AE (1) FG (1)			
			ii		1	**FOUNDATION TIER only** A wave of at least <u>one complete cycle</u> drawn with every crest and trough with smaller amplitude than the one shown – irrespective of any wavelength drawn			
		Total **FT** **HT**			**7** **8**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
6	**2**	*(a)*			1	Kilowatthour	kilowattshour		Kilowatt per hour
		(b)	i		1	463.9 – 445.2 = 18.7 [kWh]			19
			ii		3	$\frac{18.7\text{(ecf)}}{8.5}$ (1) = 2.2 (1) = 2 200 [W] (1) **ecf** from 2.2	19 as an ecf If no workings shown 2.2 on answer line = 2 marks		
			iii		2	18.7(**ecf**) × 20 p = 374 (1) = [£]3.74 (1) **Alternative:** [18.7 **(ecf)** ×] 0.2 (1 - conversion) = [£]3.74 (1)	If no workings shown 374 on answer line = 1 mark		£3.74 p
		(c)			2	Quarter of the power: $\left(\frac{2.2}{4}\right)$ (**ecf** from (b)(ii)) shown **or** × 2 time (8.5 × 2) shown (1) £1.87 / 187 p (1) **ecf** from (b)(iii) N.B. If no workings shown answer should be half of answer to (b)(iii)	[£]$\frac{3.74}{4}$ (i.e. 93.5 p) **or** [£]3.74 × 2 (£7.48) **or** $\frac{18.7}{2}$ ok for first mark		£1.87 p
		(d)			2	[Lower power kettle] will need to be switched on for longer (1) so same electricity used / need to supply the same energy (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Reverse argument for the first mark		
		Total			**11**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
7	**3**				6	**Indicative content:** Microwaves carry information via geosynchronous satellites. Infra-red or visible light send information through optical fibres. The signal travels a shorter distance by optical fibres but at a slower speed. Calculations of the time delay: 0.036 s for optical fibre, 0.24 s for each satellite. Therefore the delay is less by optical fibre. Signals sent by optical fibre do not suffer from interference. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	The speed is 2/3 but the distance is 1/10.	Cost	
		Total			**6**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4	*(a)*			2	To <u>measure the</u> [dose of] <u>radiation</u> received (1) **Either × 1 mark:** • because [too much] nuclear radiation is dangerous / harmful to living <u>cells</u> / mutates <u>cells</u> / damage DNA • so they are removed from the workplace / limit exposure / limit the dose received	Accept "they ionise cells, or they kill cells" or "they cause cancer / radiation poisoning" or "so they know if the area they are in is safe" for the second mark	Some radiations can harm you	Type of radiation received for the 1st mark Cause illness for the 2nd mark
		(b)	i		2	Black, Black, Not black (1) all correct Black, Black, Black (1) all correct			Any other colours
			ii		2	The <u>clothing</u> will absorb the <u>alpha</u> radiation (1) so it will not be recorded on the film / a false reading will be obtained (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**			
		(c)	i		3	Scale on x-axis from 0 – 5.0 present with intervals of 1.0 **and** scale on y-axis from 0 – 90.0 present with intervals of 10.0 (1) All points plotted within ± ½ small square division (1) Smooth curve of best fit from x = 0 to 2.5 ± ½ small square division on each point (1)	If scale transposed or incorrect don't award the scale mark but if correct the plots and curve marks can be awarded (2.0, 19.0) plot is likely not to lie on the curve of best fit		Thick, wobbly, disjointed, wispy curves
			ii		2	The count rate decreases as the thickness of aluminium increases (1) The count rate decreases at a bigger rate at start <u>and</u> eventually reaches zero (1)			Gradient is less steep
			iii		2	3.5 mm indicated (1) 3.3 [× 10^{-13} J] (1) (± 0.1)			
		Total			**13**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
	5		i		3	By studying absorption lines (1) which are caused by gas atoms (1) **Either × 1 mark**: • absorbing [light] at specific wavelengths • which are characteristic of an element **The 3rd mark can only be awarded if it is linked to the 2nd mark.**			
			ii		2	**Any 2 × (1) from:** • Wavelengths of absorption lines are increased / red shift • All are moving away • Further ones are moving faster	The red shift is greater for even more distant galaxies = 2 marks		
			iii		2	CMBR is a remnant of [radiation from the origin of the Universe] / high energy waves / gamma rays (1) which has 'stretched' as the Universe has expanded (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**		Red shift	
		Total			**7**				

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Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT	Sub-section							
	6	*(a)*	i		3	Substitution: $1000 = \frac{\text{mass}}{700}$ (1) manipulation and answer = 700 000 / 7×10^5 (1) $\times$ 24 = 16 800 000 [kg] or 1.68×10^7 [kg](1) **Alternative:** $700 \times 24 = 16\,800$ (1) mass = density $\times$ volume (1 – manipulation) $16\,800 \times 1\,000 = 1.68 \times 10^7$ [kg](1)	16.8 M[kg]		
			ii		3	matching pair of units (1) $\frac{1 \times 10^7}{3.5 \times 10^3} = 2\,857$ [A] (1) $\times$ 24 = 68 571[.4 A] (1) **Alternative:** 10 [$\times 10^6$] $\times$ 24 = 240 [MW] [2.4×10^8] (1) matching pair of units (1) $\frac{2.4 \times 10^8}{3.5 \times 10^3} = 68\,571$[.4 A] (1)	If no workings shown: 2 857 [A] = 2 marks 68 571 [A] = 3 marks If matching units are not used award a max of 2 marks – answer will be 68 571 $\times 10^n$		
			iii		2	$\frac{10}{16}$ (1) = 62.5 (1-ans)	If no workings shown 0.62[5] or 0.63 = 1 mark 63 = 2 marks 62 = 1 mark		
		(b)			2	Tidal [flow] is not constant / volume [per second] changes (1) Which causes the <u>power input</u> to the turbines to vary / <u>power input</u> is proportional to the volume [per second] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**			The tide comes in twice a day / rises and falls

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Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT	Sub-section							
		(c)			6	**Indicative content:** The large amount of concrete required/construction traffic will lead to large quantities of CO_2 being produced contributing to global warming. Very expensive to build. The barrage will change the tides/water level leading to a loss of habitat/disruption to wildlife. The barrage will affect water flow leading to silting of the river causing navigation problems for ships. The barrage would act as a barrier for fish affecting their migration. The barrage will not need a fuel supply to operate so running costs will be low and no waste will be produced. No greenhouse gases will be produced. Tidal power is a reliable and renewable source of energy. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.	Peak times – max flow could be in the middle of the night		

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
						1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total			**16**				

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

S15-4463-01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

A.M. MONDAY, 15 June 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**12**	
3.	**7**	
4.	**5**	
5.	**13**	
6.	**11**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **6***(d)*.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
% efficiency = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\frac{1}{1\,000}$
k	10^{3}	1 000
M	10^{6}	1 000 000

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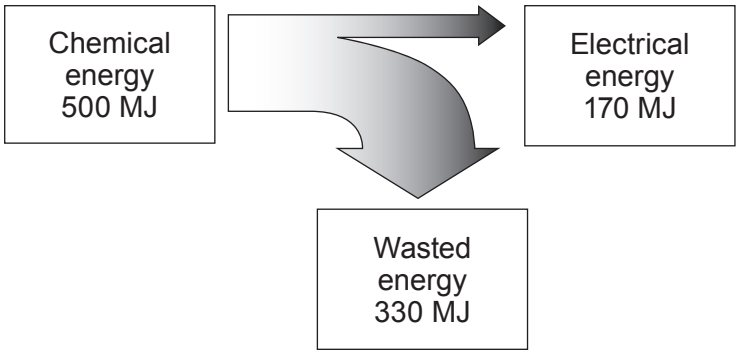
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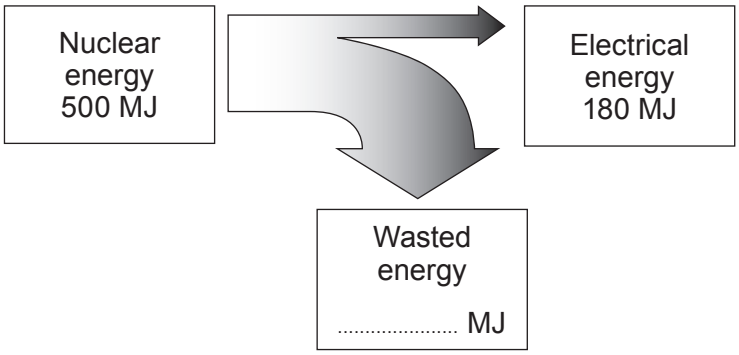
Answer **all** *questions.*

1. The three diagrams below show the overall energy transfers in three different types of thermal power stations.

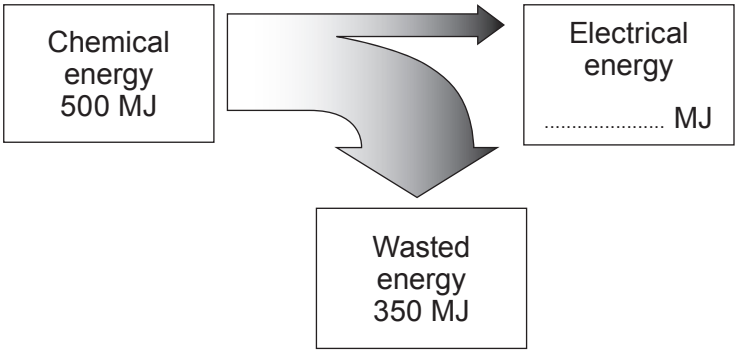
A. Oil power station



B. Nuclear power station



C. Coal power station



(a) **Complete the diagrams** above to show the missing energy values. [2]

(b) Use information from the above diagrams to answer the questions below.

(i) Which type of energy is the input energy in an oil power station? [1]

.....

(ii) Which type of energy is the useful output energy in each power station? [1]

.....

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(c) (i) Name the type of power station with the biggest wasted energy. [1]

.....

(ii) Explain how this energy may be wasted. [2]

.....

.....

.....

(d) Use an equation from page 2 to calculate the % efficiency of the oil power station. [2]

% efficiency = ...

(e) Waste products from power stations can affect the environment.

Complete the table below to describe the **environmental problems** caused by each waste product. [3]

Type of power station	Waste product	Environmental problem
oil	carbon dioxide	....
nuclear	radioactive material	....
coal	sulfur dioxide	....

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12

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2. *(a)* The diagram shows an incomplete electromagnetic (em) spectrum.

(i) Choose words or phrases from the box to fill in the gaps in the em spectrum below. [3]

Sound waves	Microwaves	Ultraviolet waves	Gamma rays

.....	X-rays	.....	Visible light	Infra-red	.....	Radio waves

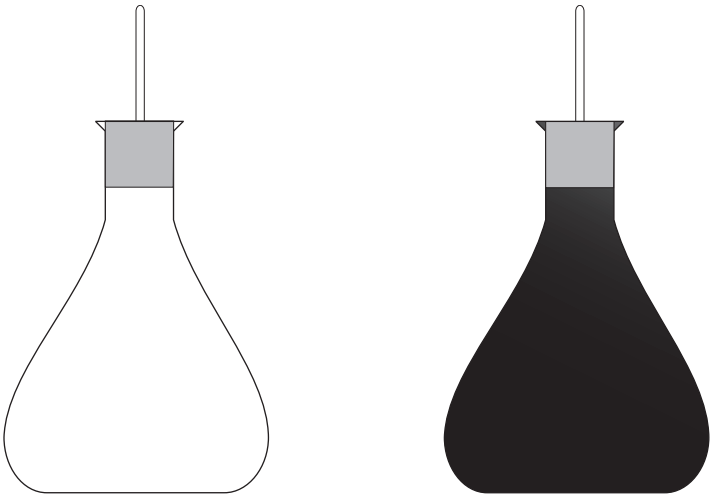
(ii) Underline the correct term in each bracket below. [3]

Infra-red waves travel **[faster than / slower than / at the same speed as]** radio waves in space.

Infra-red waves have wavelengths **[longer than / shorter than / the same as]** radio waves.

Infra-red waves have frequencies **[lower than / higher than / the same as]** X-rays.

(b) An experiment was set up to investigate the cooling of water in two flasks. One flask was painted shiny white. The other was painted matt black.



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(i) The starting temperature of the hot water poured into both flasks was 80 °C.

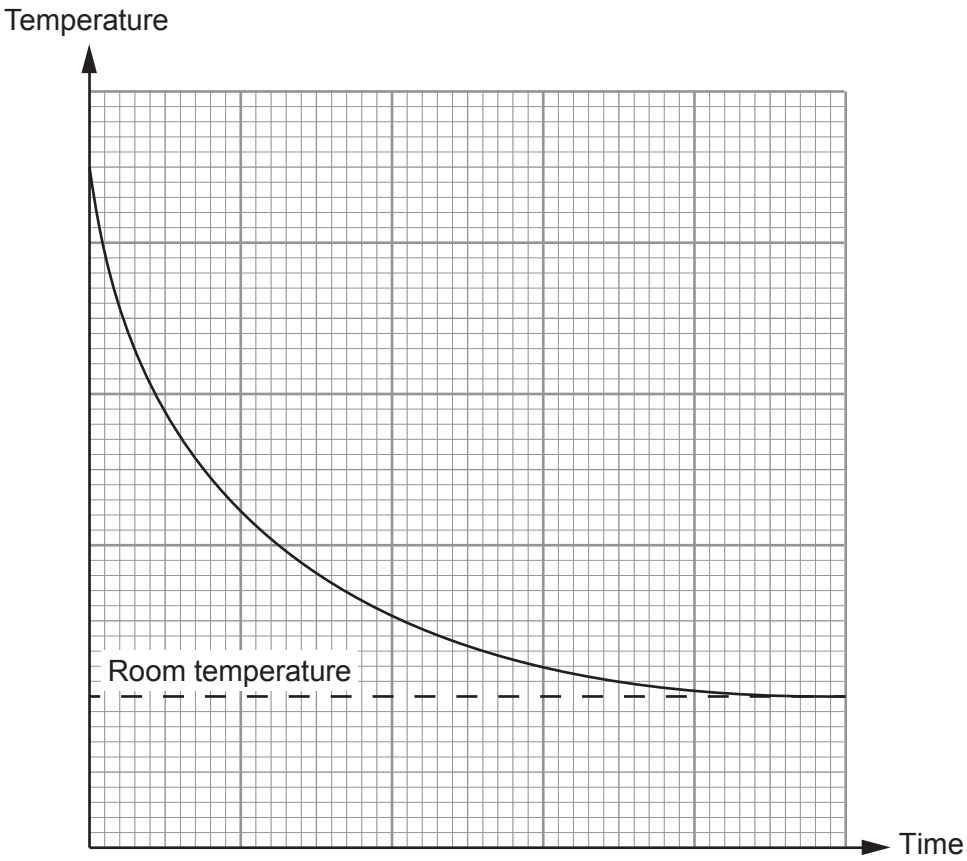
Explain what other quantity had to be kept the same in both flasks to make the experiment fair. [2]

.....

.....

.....

(ii) The graph below shows how the temperature of water in the white flask changed until it reached room temperature.



I. **Add a line to the graph** to show the cooling curve for water in the black flask. [2]

II. Explain the difference between the two cooling curves. [2]

.....

.....

.....

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3. Solar panels are fitted to a house.

(a) They save money for the householder in two ways:

- they reduce the number of units of electricity bought from the National Grid, saving 16 p per unit;
- in addition, the government pays the householder a feed-in tariff of 14 p for every unit of electricity generated.

(i) What is the householder's **total** saving for each unit used from the solar panels? [1]

..... p

(ii) Each year the householder uses 4 000 units of electricity generated by the solar panels. Calculate the total saving in a year using the equation: [2]

$$\text{total saving in a year} = \text{total saving per unit} \times \text{number of units}$$

saving = ...

(iii) The solar panels produce electricity for 2 000 hours each year.

Calculate the mean power output of the solar panels using the equation: [2]

$$\text{power (kW)} = \frac{\text{units used}}{\text{time (h)}}$$

power = ... kW

(b) It is estimated that fitting solar panels reduces CO_2 emissions by 0.5 kg for every unit of electricity produced. Calculate how much CO_2 will be saved by this household each year. [2]

CO_2 savings = ... kg

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4. *(a)* Some common distance units used in astronomy are:

- 1 light year = the distance that light travels in one year;
- 1 parsec (pc) = 3.3 light years;
- 1 kiloparsec (kpc) = 1 000 parsecs = 3 300 light years;
- 1 astronomical unit (AU) = the distance between the Earth and the Sun = 150 million km.

Use the information above to answer the following questions.

(i) How many years does it take light to travel 1 parsec? [1]

..... years

(ii) Our galaxy is about 30 kpc in diameter. What is its diameter in light years? [1]

diameter = ... light years

(iii) The distance between the Sun and Neptune is 30 AU. What is this distance in million km? [1]

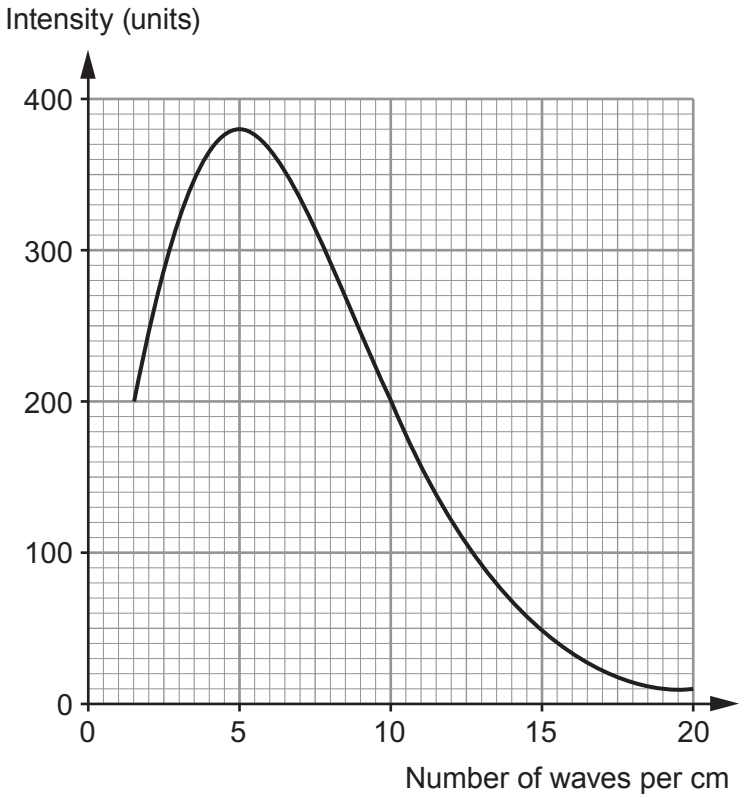
distance = ... million km

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(b) Cosmic Microwave Background Radiation (CMBR) fills the entire universe. The spectrum of the CMBR is shown on the graph below.



Use the graph to answer the following questions.

(i) State the intensity of the most intense microwaves detected. [1]

..... units

(ii) State the number of waves per cm for the most intense microwaves. [1]

number of waves per cm = ...

5

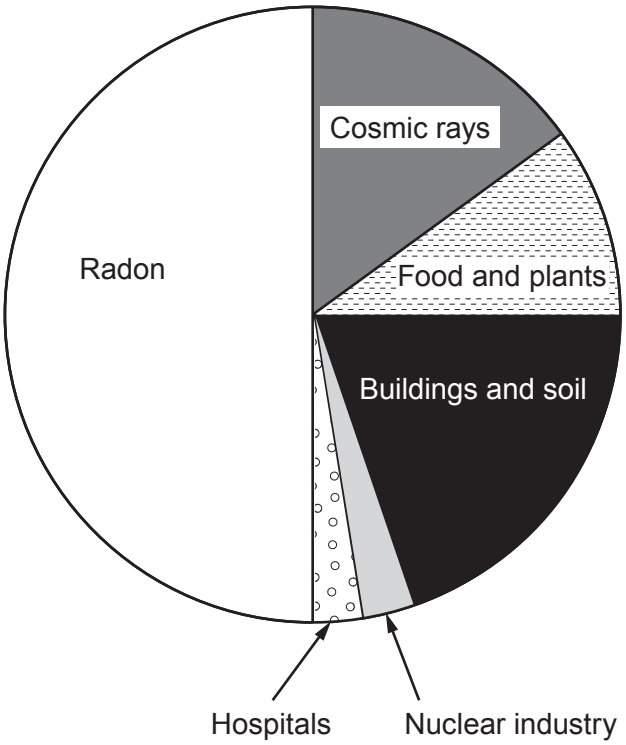
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5. The sources of background radiation in a part of the U.K. are shown in the pie chart below.



(a) A single reading of the total background radiation showed 20 counts taken in a minute.

(i) Calculate the total number of counts per minute (cpm) from cosmic rays and food and plants **together**. [2]

..... cpm

(ii) Describe how a more reliable value of the total background radiation could have been found. [2]

.....

.....

.....

(iii) Give the name of **one** source of background radiation that depends largely on the rocks in the area in which the measurement is taken. [1]

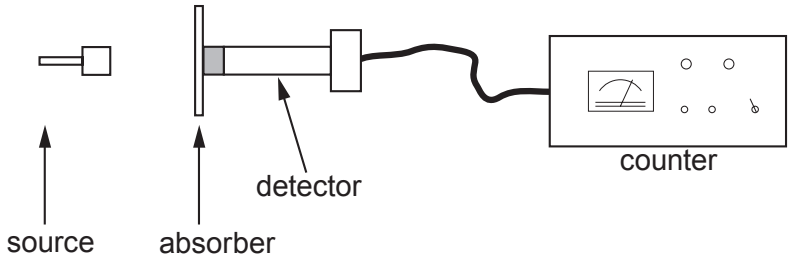
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(b) A radiation detector is connected to a counter in a classroom. Absorbers were placed directly in front of the detector in an attempt to find which radiation was being given off by the radioactive source americium-241.



The following results were obtained.
The figures **include** the mean background radiation count of 20 cpm.

Absorber	Reading obtained (counts per minute)
none	350
thin card	20
3 mm of aluminium	21
20 mm lead	1

Use the information in the table above and your knowledge of radioactivity to answer the following questions.

(i) Calculate the mean number of counts per minute emitted by the americium-241. [2]

..... cpm

(ii) Explain which **type** of radiation is given off by the source. [2]

.....

.....

.....

(iii) Give a reason why pupils in the class did not need to be shielded from the source's radiation. [1]

.....

(iv) Explain how the data shows that background radiation is mainly gamma. [2]

.....

.....

.....

(v) State why the count rates measured beyond the aluminium are different from the mean background count. [1]

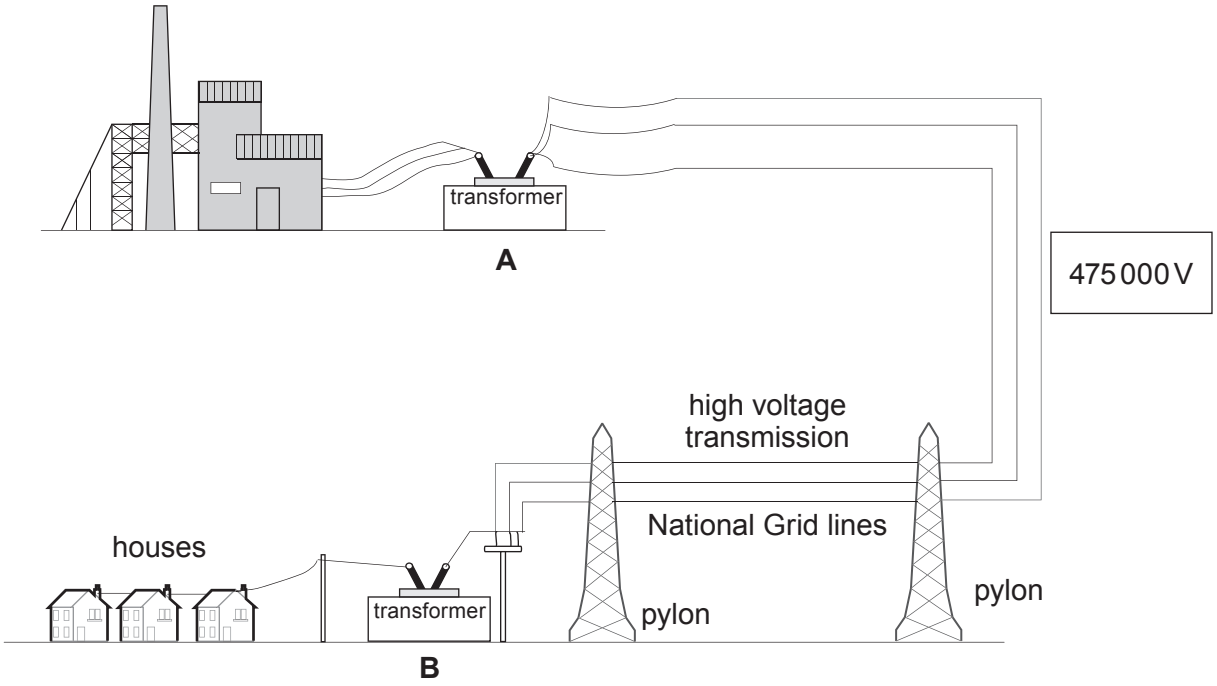
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6. A diagram of the National Grid is shown below.



(a) Explain how transformer **A** makes the National Grid more efficient. [2]

.....

.....

.....

(b) Transformer **A** supplies 950 MW to the National Grid at 475 000 V.
Write down the input power to the National Grid in watts. [1]

power = ... W

(c) Explain the purpose of transformer **B**. [2]

.....

.....

.....

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(d) Discuss how the National Grid maintains a reliable supply of electricity to consumers. [6 QWC]

Include in your answer:

- how the demand for electricity changes through the day;
- which types of power stations generate electricity continuously;
- why hydroelectric power stations are so useful to the National Grid.

11

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2015

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2015 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

		Page
Physics 1	Foundation Tier	1
	Higher Tier	7
Physics 2	Foundation Tier	14
	Higher Tier	22
Physics 3	Foundation Tier	29
	Higher Tier	36

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Physics 1 – Summer 2015
Foundation Tier

Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
1		(a)			2	320 [MJ] (1) 150 [MJ] (1)			
		(b)	(i)		1	chemical [energy]			
			(ii)		1	electrical [energy]	electricity		
		(c)	(i)		1	coal	C		
			(ii)		2	Wasted as heat (thermal) energy (1) Since turbines, pipes etc become hot / water cools (1) **Alternative:** Wasted as sound energy (1) Because of the noise [released by the machines] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Cooling towers/chimney/ Transformers / friction in moving parts Steam	Other types of named energies References to CO_2	Friction only Smoke
		(d)			2	$\text{efficiency} = \frac{\text{useful power transfer}}{\text{total power input}} \times 100$ $\text{efficiency} = \frac{170}{500} \times 100$ Selection of 170 anywhere (1) Efficiency = 34 (1)	Answer alone gains both marks $\frac{500}{170} = 34$ gets 1 mark only Answer only of 0.34 gets 1 mark		170 on the answer line
		(e)			3	**Oil:** causes [increased] greenhouse effect / global warming / climate change (1) **Nuclear:** must be stored safely for a long time / problems linked to storage or leaks (1) **Coal:** causes acid rain (1)		Global warming when referring to problems with SO_2	Leaves nuclear waste / ozone layer / harmful to humans or wildlife
		Total Mark			12				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		(a)	(i)		3	Gamma [rays] , Ultraviolet [waves] / UV , Micro[waves] 3 × (1)			
			(ii)		3	At the same speed as (1) Shorter than (1) Lower than (1)			
		(b)	(i)		2	Volume (1) As different volumes will cool at different rates (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Amount / mass / same level of water		Quantity
			(ii)	I	2	**Curve always** below given line starting from somewhere above room temperature starting on the *y*-axis (1) **Levelling** sooner at room temperature (1)		Line not at same starting point	Any lines to the right
				II	2	Line for black flask is steeper / black flask cooled quicker (1) Because black surfaces are better / good emitters [of IR] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.** **No ecf from the previous part**	Accept converse argument about white		Don't cool at the same rate because they're different colours
		Total Mark			12				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		(a)	(i)		1	30 [p]			
			(ii)		2	30 × 4 000 **ecf** (1) 120 000 p (1) **Alternative:** 0.3 × 4 000 **ecf** (1) £1 200 (1)	120 000 **or** 1 200 – no workings shown award 1 mark only £1 200 p award 1 mark only		
			(iii)		2	$\frac{4\,000}{2\,000}$ (1) 2 [kW] (1)			$\frac{2\,000}{4\,000} = 2$
		(b)			2	4 000 × 0.5 (1) 2 000 [kg] (1)			
		Total Mark			7				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)	(i)		1	3.3 [years]			3.3 light years
			(ii)		1	99 000 [light years]			
			(iii)		1	4 500 [million km]			
		(b)	(i)		1	380 [units]			
			(ii)		1	5 [number of waves per cm]			
		Total Mark			5				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)	(i)		2	One quarter / 25% (1) × 20 = 5 [cpm] (1)	Alternative routes to get an answer of 5		
			(ii)		2	Repeat the test / counts per minute / take more readings (1) and find the mean (1) **OR** count / reading / measure over longer period of time (1) and divide by that number of minutes (1)			
			(iii)		1	Radon **OR** buildings / soil	Ground / earth		Named rocks / uranium
		(b)	(i)		2	350 – 20 (1 - for subtraction of 20 from any value) = 330 [cpm] (1)			
			(ii)		2	Alpha (1) Because the reading is reduced [to background level] by thin card / can't penetrate thin card (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	**Alternative for the 2nd mark:** If it was beta or gamma the reading wouldn't be reduced by thin card		Alpha with beta or gamma Alpha absorbed by card and gamma absorbed by lead
			(iii)		1	Range of alpha is only a few [about 30] cm in air / can't penetrate the skin or clothes / not very penetrating	Short range in air can't reach them		Only harmful inside the body
			(iv)		2	Aluminium has no effect on the count rate (1) because only gamma passes through aluminium / beta can't pass through aluminium (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	There's still a [small] count rate [beyond lead] (1) only gamma goes through lead (1)	Reference to alpha	
			(v)		1	Background count varies over time / random			
		Total Mark			13				

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
6		(a)			2	Increases or steps up the voltage / reduces the current (1) to reduce energy / heat losses [in the cables] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**		Improves efficiency (given)	Reduces the power No heat loss
		(b)			1	950 000 000 [W]	950×10^6		950 MW
		(c)			2	Reduce the voltage (1) to a safer value [for use in the home] / because high voltages are more dangerous (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Step-down the voltage	Increase the current	
		(d)			6	**Indicative content:** Some types of power station continue working for 24 hours a day and for 365 days a year. These include nuclear, coal and oil powered stations which take a long time to shut down and to start up again. Through the day, however, demand changes, the demand being small at night while most of the population is sleeping but during the daytime there are peaks of demand, notably at breakfast time and again in early evening. To meet this demand some power stations are needed which can be brought on stream at very short notice. This is where hydroelectric power stations are very useful because they can start up within seconds by just opening a valve to let the water flow. They, along with reserve oil and gas powered stations can also be used to maintain supply during maintenance or breakdown times of other stations. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total Mark			11				

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Physics 1 – Summer 2015
Higher Tier

Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT	Sub-section							
	1	(a)	(i)		2	One quarter / 25% (1) × 20 = 5 [cpm] (1)	Alternative routes to get an answer of 5		
			(ii)		2	Repeat the test / counts per minute / take more readings (1) and find the mean (1) **OR** count / reading / measure over longer period of time (1) and divide by that number of minutes (1)			
			(iii)		1	Radon **OR** buildings / soil	Ground / earth		Named rocks / uranium
		(b)	(i)		2	350 – 20 (1 - for subtraction of 20 from any value) = 330 [cpm] (1)			
			(ii)		2	Alpha (1) Because the reading is reduced [to background level] by thin card / can't penetrate thin card (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	**Alternative for the 2nd mark:** If it was beta or gamma the reading wouldn't be reduced by thin card		Alpha with beta or gamma Alpha absorbed by card and gamma absorbed by lead
			(iii)		1	Range of alpha is only a few [about 30] cm in air / can't penetrate the skin or clothes / not very penetrating	Short range in air can't reach them		Only harmful inside the body
			(iv)		2	Aluminium has no effect on the count rate (1) because only gamma passes through aluminium / beta can't pass through aluminium (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	There's still a [small] count rate [beyond lead] (1) only gamma goes through lead (1)	Reference to alpha	
			(v)		1	Background count varies over time / random			
		Total Mark			13				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	2	(a)			2	Increases or steps up the voltage / reduces the current (1) to reduce energy / heat losses [in the cables] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**		Improves efficiency (given)	Reduces the power No heat loss
		(b)	(i)		1	950 000 000 [W]	950×10^6		950 MW
			(ii)		2	$I = \frac{P}{V}$ $I = \frac{950\,000\,000}{475\,000}$ (manip & subst- 1) **ecf** from (b)(i) I = 2 000 [A] (1) **Alternative:** Calculations with matching units e.g. mega or kilo	An answer of 2×10^n [A] other than 2×10^3 award 1 mark only unless **ecf** rule applies		$\frac{475\,000}{950\,000\,000}$ = 2 [A]
		(c)			2	Reduce the voltage (1) to a safer value [for use in the home] / because high voltages are more dangerous (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Step-down the voltage	Increase the current	
		(d)			6	**Indicative content:** Some types of power station continue working for 24 hours a day and for 365 days a year. These include nuclear, coal and oil powered stations which take a long time to shut down and to start up again. Through the day, however, demand changes, the demand being small at night while most of the population is sleeping but during the daytime there are peaks of demand, notably at breakfast time and again in early evening. To meet this demand some power stations are needed which can be brought on stream at very short notice. This is where hydroelectric power stations are very useful because they can start up within seconds by just opening a valve to let the water flow. They, along with reserve oil and gas powered stations can also be used to maintain supply during maintenance or breakdown times of other stations. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology			

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	2	(d)				**3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total Mark			13				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	3	(a)	(i)		1	20 [J/m^2]			
			(ii)		4	20% × 700 (1 - for use of 700) = 140 [W/m^2] (1) 1 000(conversion-1) ÷ 140 **ecf** = 7.14 (ans-1) [m^2] **Alternative solution:** 20% × 1 400 (1 - for use of 1 400) = 280 [W/m^2] (1) 1 000(conversion-1) ÷ 280 **ecf** = 3.57 (ans-1) [m^2] Incorrect rounding loses answer mark.	1 000 [J/s] (1) So need 5 000 [J/s] (1) Area = $\frac{5\,000}{700}$ (1) Area = 7.14 (ans-1) [m^2]		
		(b)			3	Radiation [IR / visible] from the Sun is absorbed by the surface of the Earth (1) The ground [gets heated and] emits radiation [IR] with an <u>increased wavelength</u> (1) which is absorbed by / trapped in the atmosphere (1)		Other em regions referred to	Different wavelength Blocked by the atmosphere Bounces back
		Total Mark			8				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4	(a)	(i)		3	Scale on x-axis from 0 – 4.0 present with intervals of 0.5 **and** scale on y-axis from 0 – 6.0 present with intervals of 1.0 (1) Points plotted within ± ½ small square division (1) don't penalise for point (0,0) not being present Smooth curve of best fit from origin ± 1 small square division on each point (1)	If scale transposed or incorrect don't award the scale mark but if correct the plots and curve marks can be awarded		Thick, wobbly, disjointed, wispy curves
			(ii)		2	As the depth increases the wave speed increases (1) At a decreasing rate (1) No **ecf** from graph	Positive correlation (for the 1st mark) Slower rate	Non-linear	For a straight line graph they are proportional Answer for incorrect wave speed
		(b)	(i)		3	5.3 (1) = $f \times 8.1$ (1) f = 0.65 [Hz](1) N.B. **Speed value must be taken from candidate's graph** N.B. If speed is: 5.0 then f = 0.617 [Hz] 5.1 then f = 0.630 [Hz] 5.2 then f = 0.642 [Hz] 5.4 then f = 0.666 [Hz] 5.5 then f = 0.679 [Hz]			
			(ii)		2	Waves have decreasing wavelength [from A to B] (1) because speed decreases [but f remains constant] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**		Any reference to amplitude change	
		Total Mark			10				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	(a)			2	Time $= \frac{3\,900}{3}$ (1) = 1 300 $\frac{1300}{52}$ **(ecf)** = 25 [hours](1) **Alternative solution:** Time = $= \frac{3\,900}{52}$ (1) = 75 $\frac{75}{3}$ **(ecf)** = 25 [hours](1)			
		(b)	(i)		4	3 900 × 30 p (1) =117 000 p (1) conversion to [£]1170 (1) $\frac{7\,500}{1170}$ **(ecf)** = 6.41 [years] (1) Incorrect rounding loses answer mark. **Accept alternative routes**	If 16 p used, time = 12.02 [years] award 3 marks If 14 p used, time = 13.74 [years] award 3 marks		
			(ii)		2	Money saved <u>each year</u> would increase (1) reducing the pay-back time (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**			
		(c)			2	Units saved = 3 900 × 25 = 97 500 (1) CO_2 saving = 97 500 **(ecf)** × 0.5 = 48 750 [kg] (1)			25 × 0.5
		Total Mark			10				

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6	(a)			6	**Indicative content:** Absorption spectra from distant galaxies 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 black lines from more distant galaxies are more red shifted due to the expansion of space itself. This suggests that the Universe began its existence at a single point and has expended outwards ever since. 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** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total Mark			6				

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

W15-4463-01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

P.M. THURSDAY, 15 January 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**3**	
2.	**4**	
3.	**7**	
4.	**8**	
5.	**6**	
6.	**8**	
7.	**8**	
8.	**16**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may 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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **8***(c)*.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
% efficiency = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\frac{1}{1\,000}$
k	10^{3}	1 000
M	10^{6}	1 000 000

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Answer **all** *questions.*

1. The boxes on the left show the names of objects in the Universe.
The boxes on the right show the time taken for light to travel from these objects to Earth. They are not in order.
Draw a line from each box on the left to the correct box on the right. [3]

Objects in the Universe	**Time taken for light to travel to Earth**
The Sun	1.3 seconds
Alpha Centauri (a star in the Milky Way)	Over 2 million years
The Andromeda Galaxy	4.5 years
The Moon	500 seconds

3

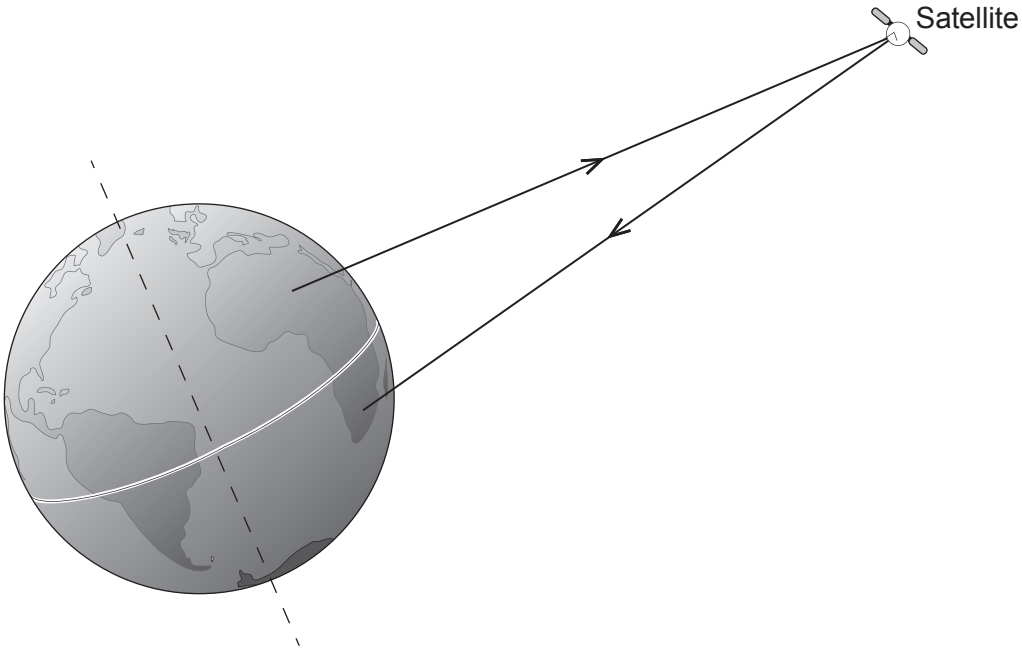
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2. A geosynchronous (geostationary) satellite orbits high above the Earth. Geosynchronous satellites are used for relaying television programmes to our homes. It takes **0.24 s** for a signal to get to the satellite from Earth.



(a) Put ticks (✓) in **three** boxes below next to the correct statements about this satellite. [3]

It stays above the same point on the Earth at all times. ☐

It relays radio waves. ☐

It orbits the Earth once in 365 days. ☐

It orbits the Sun once in 1 day. ☐

It relays microwave signals. ☐

It orbits above the equator. ☐

(b) State why a signal sent from a television studio by satellite takes **0.48 s** to reach your house. [1]

.....

.....

4

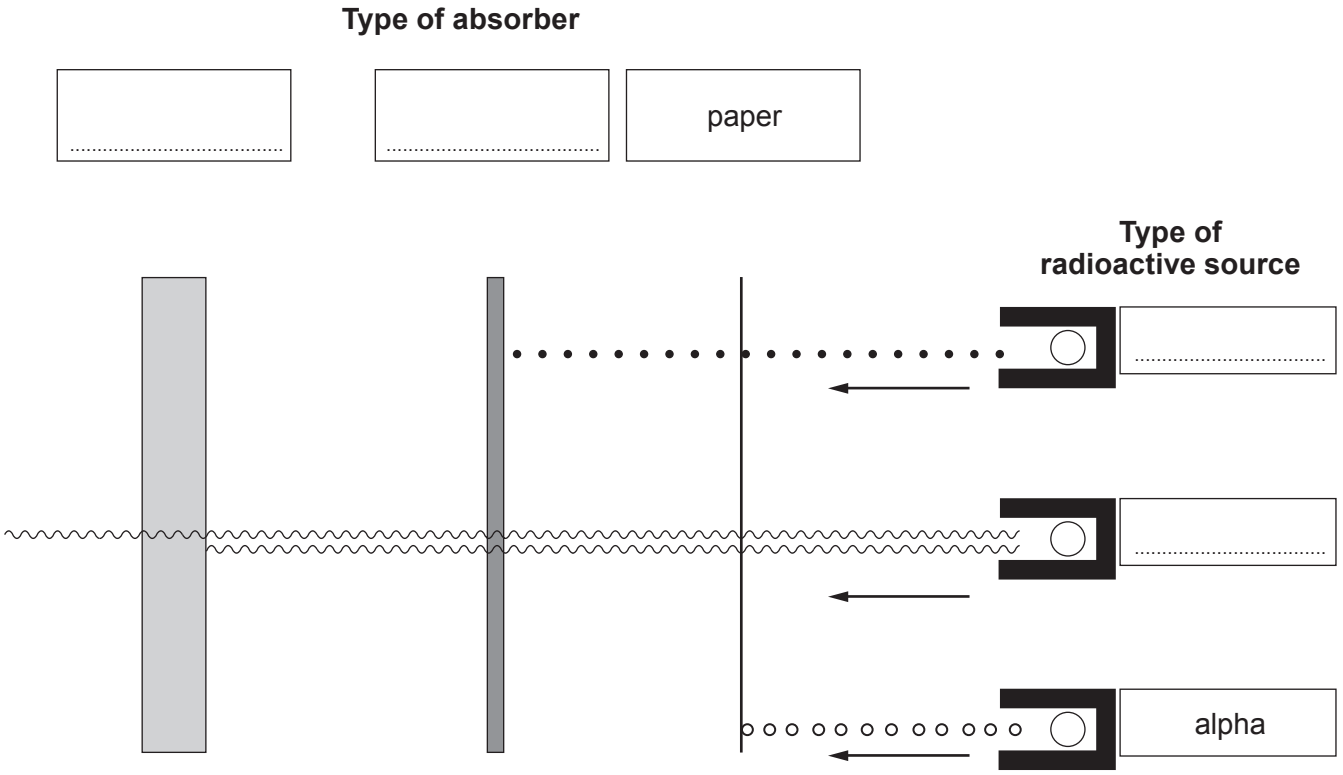
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3. *(a)* The diagram shows three types of nuclear radiations being absorbed by different materials. Use the words below to complete the boxes on the diagram. [3]

beta **gamma** **lead** **aluminium**



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(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)	30	32	28	29	31

(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 (count/s). [2]

mean activity = ... counts/s

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

.....

7

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4. The table gives some information about three electrical appliances.

Appliance	Power input (W)	Power wasted (W)	Useful power output (W)	Efficiency (%)
television	200	120	80	
security light	1 000	.....	300	30
microwave oven	.....	350	350	50

(a) **Complete the table** for the security light and microwave oven. [2]

(b) (i) Write the name of the unit shown by the letter W in the table. [1]

.....

(ii) Use an equation from page 2 to calculate the efficiency of the **television**. [2]

efficiency = ... %

(c) The security light is switched on for 4 hours.

(i) Use an equation from page 2 to calculate the number of units (kWh) used. [2]

units used = ... kWh

(ii) Use an equation from page 2 to calculate the cost of using the security light if electricity costs 15 p per unit. [1]

cost = ... p

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5. The table gives some information about a nuclear power station and a wind turbine.

	How they compare	
	wind turbine	a nuclear power station
expected lifetime (years)	20	60
mean power output (MW)	2	2000
land area needed (km^2)	0.7	4.5
cost to commission (£)	3 million	4000 million
waste produced	none	radioactive waste
lifetime carbon footprint (g of CO_2/kWh)	4.6	5

Use data from the table to answer the following questions.

(a) (i) Calculate the number of wind turbines that would be needed to produce the same power as one nuclear power station. [1]

number of wind turbines = ...

(ii) Calculate the land area needed by a wind farm in order to produce the same power as one nuclear power station. [2]

area = ... km^2

(iii) How many wind turbines would need to be built every 60 years to provide the same power as one nuclear power station? [2]

number of wind turbines = ...

(b) State **one** advantage of producing electricity by nuclear power compared with wind turbines. [1]

.....

.....

.....

6

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6. In an answer to an examination question, one candidate wrote the following description of the National Grid. It earned no marks.

"The National Grid is *a system of pylons* that sends electricity from *transformers to factories.*"

(a) State how **this** answer can be improved by changing the words in italics. [3]

system of pylons

.....

transformers

.....

to factories

.....

(b) Transformers are used in the National Grid. Step-up transformers reduce the current.

(i) Give a reason why they are called step-up transformers. [1]

.....

(ii) State the reason for reducing the current. [1]

.....

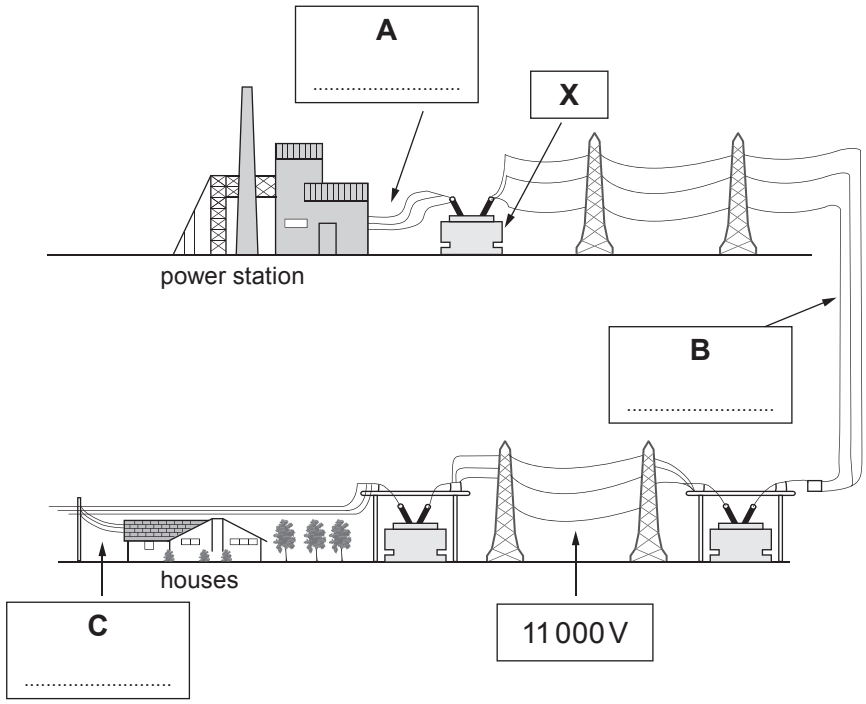
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(c) The diagram shows part of the National Grid.
Voltages used in the grid are 230 V, 50 000 V and 132 000 V.

(i) Write the voltages at **A**, **B** and **C**. [2]



(ii) Name the object labelled **X** on the diagram. [1]

.....

8

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7. A hospital radiology department displays information about the dose a patient receives from different types of X-rays.

Type of X-ray	Received dose in units	Equivalent days of background radiation
Knee	1	1.5
Chest	2	3
Skull	10	15
Spine	100	150
Hip	30	45
Pelvis	100	150
Abdomen	150	225

(a) Explain why X-rays are a risk to the patient. [2]

.....

.....

.....

(b) Use information in the table to explain which type of X-ray is the most dangerous for the patient. [2]

.....

.....

.....

(c) A patient is told that he has received a total radiation dose of 140 units from X-rays.

(i) Calculate how many chest X-rays this dose is equivalent to. [2]

number of chest X-rays = ...

(ii) The mean background radiation a person receives is 43 200 counts each day. Calculate the counts of radiation received by the patient from this number of chest X-rays. [2]

counts received = ...

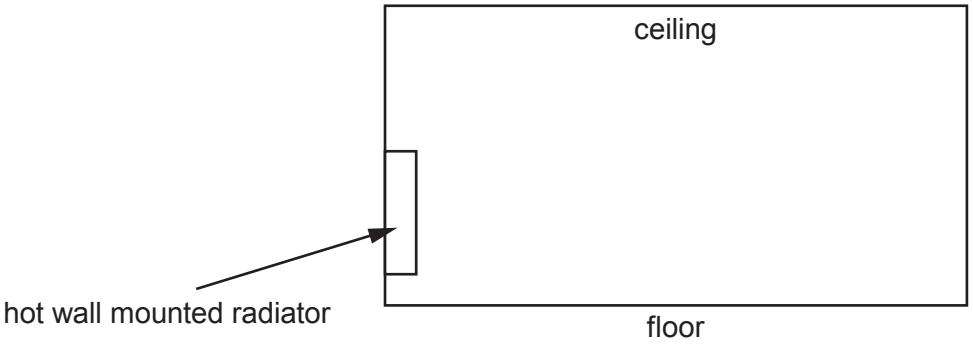
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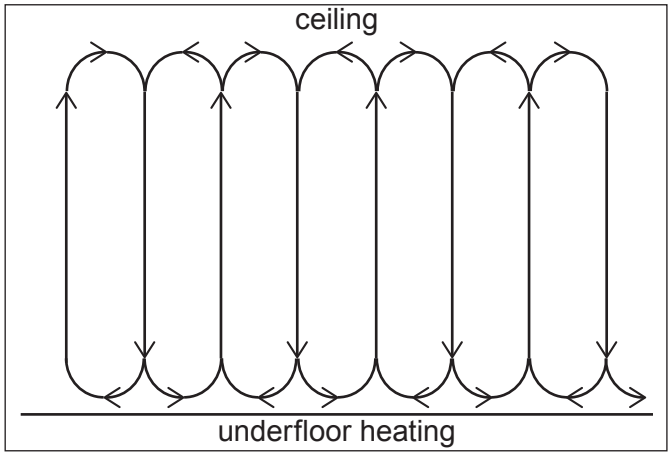
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8. *(a)* (i) Complete the diagram below by adding arrows to show how air in a room is heated by convection. [2]



(ii) The diagram below shows air movement in a room with underfloor heating. All of the floor is heated with a grid of wires. They get hot when an electric current flows through them.



Explain why underfloor heating is more effective at heating the air in the room than the single wall mounted radiator. [2]

.....

.....

.....

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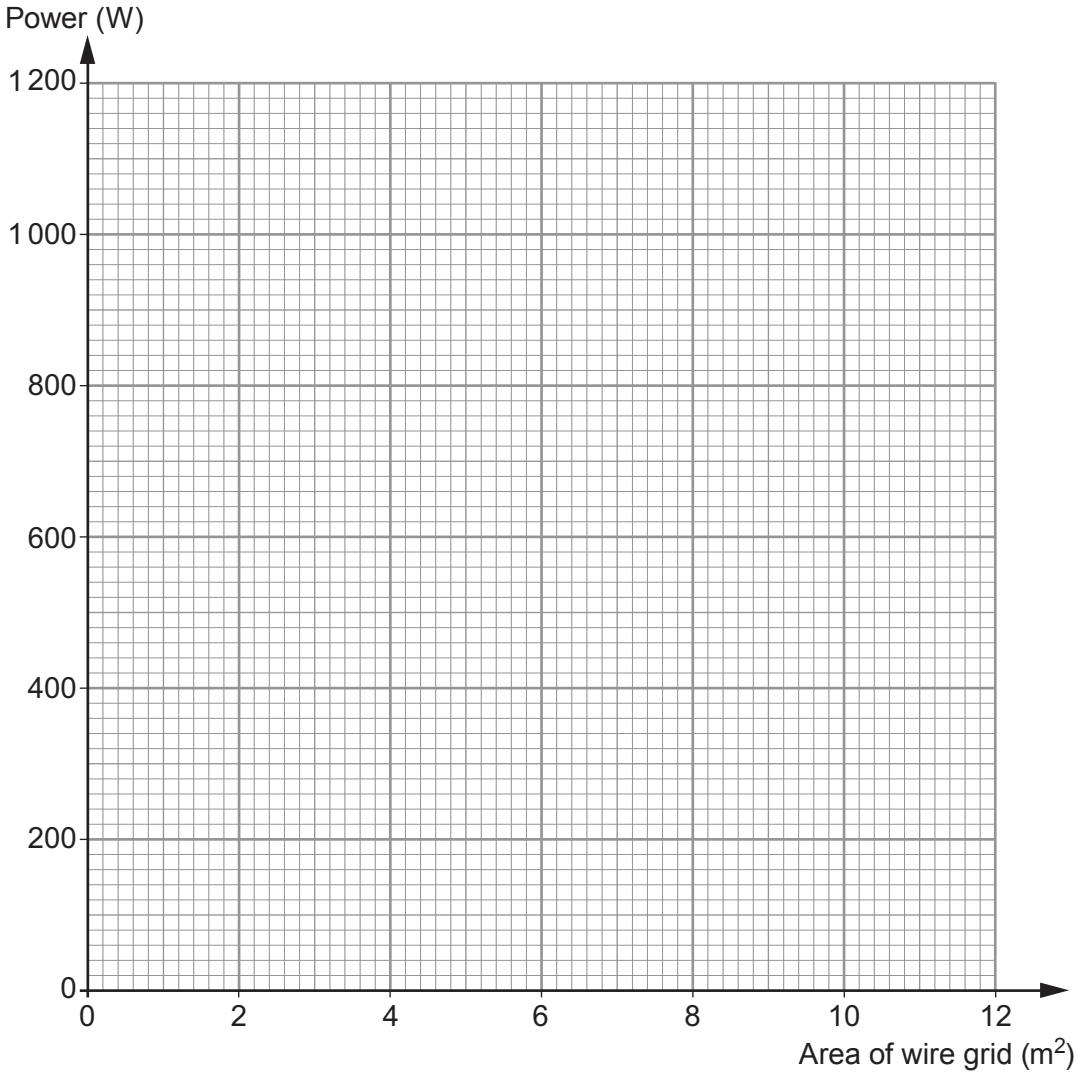
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(b) The power produced by the wire grid depends on its area as shown in the table below.

Area of wire grid (m^2)	Power from wire grid (W)
0.0	0
1.0	150
2.0	300
4.0	600
6.0	900
8.0	1200

(i) Plot the data on the grid below and draw a suitable line. [3]



(ii) Describe the relationship between the power and the area of the wire grid. [2]

.....

.....

(iii) Use the data to find the power produced by a grid of area 12 m^2. ..... W [1]

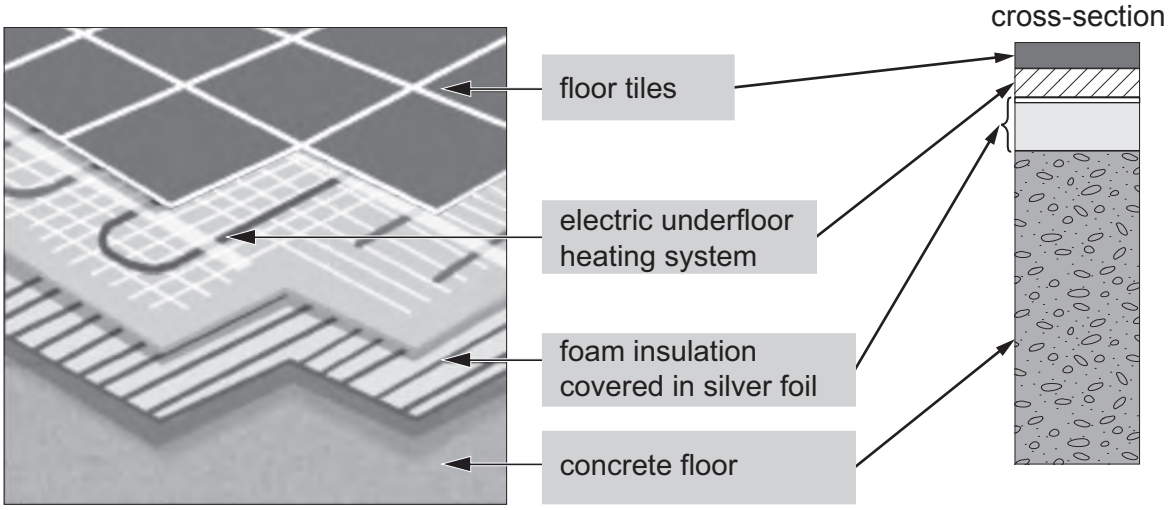
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(c) The diagrams show how the underfloor heating system is laid under tiles.



Explain how features in the diagrams above improve the effectiveness of heating the room. [6 QWC]

Include in your answer:

- why some of the heat transfers through the concrete floor;
- how this heat loss is reduced.

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE- PHYSICS

JANUARY 2015

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2015 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

	Page
Physics 1 (Foundation Tier)	1
Physics 1 (Higher Tier)	6
Physics 2 (Foundation Tier)	11
Physics 2 (Higher Tier)	15

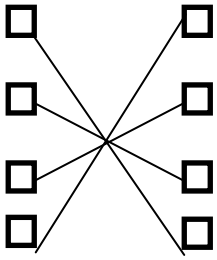
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GCSE Science - Physics 1 Mark Scheme

January 2015

FOUNDATION TIER

Question			Marking details	Marks
1			 All four correct – 3 marks 2 or 3 correct - 2 marks 1 correct – 1 mark **AWARD a MAXIMUM OF 3 marks** **Question total**	3 **[3]**
2.	(a)		Ticks in boxes 1, 5 and 6 (3) 1 mark penalty for any extra tick.	3
	(b)		Has to travel back / distance travelled by the signal is double the height of the satellite above the earth. **Don't accept** travel further / take longer / double the time **Question total**	1 **[4]**
3.	(a)		lead, aluminium, beta, gamma. **Accept** symbols β and γ All four correct – 3 marks 2 or 3 correct - 2 marks 1 correct – 1 mark **AWARD a MAXIMUM OF 3 marks**	3
	(b)	(i)	[Radioactive decay is] a random (haphazard or unpredictable) [process] **Don't accept** taken at different times / not the same	1
		(ii)	mean = $\frac{30(1)}{60}$ (1)= [0.5 counts/s] **Award 1 mark** for 30 wherever it appears (if nothing else shown) **Award 1 mark** for division by 60 **Award 2 marks** for an answer only of 0.5 [counts/s]	2

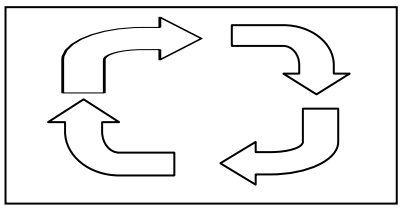
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Question			Marking details	Marks
		(iii)	rocks / cosmic / radon / food / Sun / buildings **Accept** soil / ground / correctly named rocks e.g. granite Don't accept Earth / air / named foods **Question total**	1 **[7]**
4.	(a)		700 [security light] (1), 700 [microwave] (1)	2
	(b)	(i)	Watt[s] **Accept** wat	1
		(ii)	$\%\ \text{efficiency} = \frac{80}{200}(1 - \text{subs})[\text{x } 100] = 40(1)$ **Award 1 mark** for an answer of 0.4	2
	(c)	(i)	Units = 1 × 4 (1) = 4 (1) **Award 1 mark** for an answer only of 4 000 (i.e. no workings shown). Don't award any marks for an answer only of 40 or 400.	2
		(ii)	cost = 4 (**ecf**) × 15 = 60 Mark is for the answer **Accept** £0.60 **Don't accept** £0.60 p **Question total**	1 **[8]**
5.	(a)	(i)	1 000	1
		(ii)	1 000(**ecf**) × 0.7 (1 – subs) = 700 [km^2] (1-answer)	2
		(iii)	$\frac{60}{20}(1)\text{x } 1000(\textbf{ecf}) = 3\ 000[1 - \text{answer}]$ Answer of 3 **award 1 mark**	2
	(b)		Wind doesn't always blow / nuclear runs all of the time / takes less ground space / fewer habitats destroyed / total commissioning cost is less / longer lifetime. **Accept** more reliable / bigger power [output] / bigger energy [output] / more electricity. **Question total**	1 **[6]**
6.	(a)		[A system of] **cables/wires** (1) **Accept** power lines from **power stations** (1) to **consumers/users** (1) (**accept** 2 named consumers e.g. schools, hospitals, factories, houses)	3
	(b)	(i)	They step up (increase) the voltage **Don't accept** increase the voltage and power / decrease the current	1

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Question			Marking details	Marks
		(ii)	To reduce energy losses / heat losses / to improve efficiency / prevent overheating **Don't accept** any reference to stopping energy / heat losses	1
	(c)	(i)	50 000 at A, 132 000 at B, 230 at C 2 marks for all 3, 1 mark for 1 or 2 correct. **AWARD a MAXIMUM OF 2 marks**	2
		(ii)	Step-up transformer	1
			Question total	**[8]**
7.	(a)		Can cause cancer / deform babies (1) because they ionise **or** damage **or** mutate **or** kill cells / ionising (1) **The 2nd mark must be linked to the 1st mark.**	2
	(b)		Abdomen [X –ray] (1) because it causes the largest received dose / highest dose or units / most days of radiation [given to the patient] (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** just a reference to 225	2
	(c)	(i)	$\frac{140}{2}$ (1 - subs) = 70 (1)	2
		(ii)	210 days (1)(**ecf**) 3 × answer to (i)) × 43 200 = 9 072 000 [counts] (1) **Award 1 mark** for [70 (**ecf**) × 43 200] = 3 024 000 **Award 1 mark** for [3 × 43 200] = 129 600	2
			Question total	**[8]**
8.	(a)	(i)	Circulation of air from the radiator inside the room (1) arrows in clockwise direction (1) 	2
		(ii)	Air heated all along floor /air heated over bigger area (1) so rises at all points (everywhere) / more convection currents (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** heat rises or air in the room heats up faster	2

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Question			Marking details	Marks
	(b)	(i)	Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2. No penalty for missing origin plot. Straight line (1) (ruler must be used) line must be extended back towards origin	3
		(ii)	**Award 2 marks** for: They're proportional **OR** As the area doubles the power doubles **OR** As the area increases the power increases at a constant rate **OR** Power = area $\times$ 150 **Award 1 mark** for: As the area increases so does the power **OR** Power α wire gird	2
		(iii)	1 800 [W]	1
	(c)		**Indicative content:** Conduction and radiation will take place in all directions from the hot wire grid. The wire grid is at a higher temperature than the bottom surface of the concrete floor. This temperature difference causes energy to flow down through the floor. The foam insulation reduces heat transfer through the concrete by conduction. The silver foil reduces heat loss because it reflects radiant heat back up into the room. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.	6

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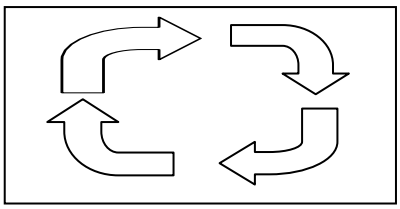
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Question			Marking details	Marks
			1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	**[16]**
			FOUNDATION TIER PAPER TOTAL	**[60]**

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HIGHER TIER

Question			Marking details	Marks
1.	(a)		Can cause cancer / deform babies (1) because they ionise **or** damage **or** mutate **or** kill cells / ionising (1) **The 2nd mark must be linked to the 1st mark.**	2
	(b)		Abdomen [X –ray] (1) because it causes the largest received dose / highest dose or units / most days of radiation [given to the patient] (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** just a reference to 225	2
	(c)	(i)	$\frac{140}{2}$ (1 - subs) = 70 (1)	2
		(ii)	210 days (1)(**ecf**) 3 × answer to (i)) × 43 200 = 9 072 000 [counts] (1) **Award 1 mark** for [70 (**ecf**) × 43 200] = 3 024 000 **Award 1 mark** for [3 × 43 200] = 129 600	2
			Question total	**[8]**
2.	(a)	(i)	Circulation of air from the radiator inside the room (1) arrows in clockwise direction (1) 	2
		(ii)	Air heated all along floor /air heated over bigger area (1) so rises at all points (everywhere) / more convection currents (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** heat rises or air in the room heats up faster	2
	(b)	(i)	Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2. No penalty for missing origin plot. Straight line (1) (ruler must be used) line must be extended back towards origin	3

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Question			Marking details	Marks
		(ii)	**Award 2 marks** for: They're proportional **OR** As the area doubles the power doubles **OR** As the area increases the power increases at a constant rate **OR** Power = area $\times$ 150 **Award 1 mark** for: As the area increases so does the power **OR** Power α wire gird	2
		(iii)	1 800 [W]	1
	(c)		**Indicative content:** Conduction and radiation will take place in all directions from the hot wire grid. The wire grid is at a higher temperature than the bottom surface of the concrete floor. This temperature difference causes energy to flow down through the floor. The foam insulation reduces heat transfer through the concrete by conduction. The silver foil reduces heat loss because it reflects radiant heat back up into the room. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
			Question total	**[16]**

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Question			Marking details	Marks
3.		(i)	Electricity is transmitted at high (increases the) voltages (1) to reduce the current (1). This reduces energy losses due to heat (1). **Either the 2nd mark must be linked to the 1st mark or the 3rd mark must be linked to the 2nd mark.** If reference to power increasing is made the maximum mark that can be awarded is 2. **Don't accept** any reference to stopping energy losses	3
		(ii)	$3950 \text{x} \left(\frac{92}{100} \right)$ (1 - substitution) = 3 634 [MW] (1)	2
		(iii)	**EITHER**: 230 × 80 = 18 400 [W] (1) Then pair of values with consistent units e.g $\frac{3634}{0.0184}$ or $\frac{3634000}{18.4}$ or $\frac{3634000000}{18400}$ (1) = 197 500 (1) (allow **ecf** from (ii) and on 18 400) **OR**: current = $\frac{3634000000(1)}{230(1)}$, $\frac{15800000}{80}$ = 197 500 (1) N.B. mark after 230 moves to after the 2nd division **Award 2 marks** for an answer of 214 674 **Question total**	3 **[8]**
4.		(i)	2.22 × 10^6 years **Don't accept** light years	1
		(ii)	Atoms of gas (1) absorb light (1) at certain wavelengths / frequencies / colours **accept** re-emitted in all directions (1) **Either the 2nd mark must be linked to the 1st mark or the 3rd mark must be linked to the 2nd mark.**	3
		(iii)	Red shift measurements show that galaxies are continuing to move apart / away (1) CMBR originated from waves / gamma rays (produced at the birth of the Universe) which have stretched (1) **Don't accept** reference to any other em wave **which** means the Universe (space) is expanding / does not look the same over time (1) **Don't accept** started from the same point **Either the 3rd mark must be linked to the 1st mark or the 2nd mark.** **Question total**	3 **[7]**

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Question			Marking details	Marks
5.		(i)	Conversion of 1.5 GHz to 1.5×10^9 or 3×10^8 to 0.3 Gm/s (1) Substitution & manipulation (1) Answer = 0.2 [m] (1) **Award 2 marks** for answer of 2×10^8 [m] Any other answer of 2×10^n can be awarded a maximum of 2 marks if clear workings shown.	3
		(ii)	Conversion of 35 km to 35 000 m (1) Substitution & manipulation (1) Answer = 1.17×10^{-4} [s] (1) **Accept** 1.2×10^{-4} [s] **Don't accept** 1.16×10^{-4} [s] **Award 2 marks** for answer of 1.17×10^{-7} [s] **Award 1 mark** for answer of 1.16×10^{-7} [s] Any other answer of 1.17×10^{-n} can be awarded a maximum of 2 marks if clear workings shown. **Question total**	3 **[6]**
6.	(a)		It provides power (electricity) to consumers / users (1) (**accept** 2 named consumers e.g. schools, hospitals, factories, houses) and maintains a reliable supply / is capable of responding to fluctuating demand / caters for a power station breakdown (1) **Don't accept** reference to efficiency	2
	(b)	(i)	Energy = $P \times t = \frac{5400(1)}{60(1)} \times 0.95$ (1) = 85.5 [MWh] **Award 2 marks** for an answer of 5 130 [MWh] **Award 2 marks** for an answer of 90	3
		(ii)	**EITHER:** 85.5 MWh **(ecf)** = 85 500 kWh (1) Cost = 85 500 × [£]0.05 (1) = [£]4 275(1) $\frac{650000}{4275}$ = 152 [weeks] (1) **OR:** 85.5 MWh **(ecf)** = 85 500 kWh (1) Cost = 85 500 × 5 [p] = 427 500 [p] (1) 65 000 000 (1) ÷ 427 500 = 152 [weeks] (1) **OR:** (650 000 ÷ 0.05) (1) = 13 000 000 [kWh] (1) 13 000 000 ÷ 85 500(1-conversion) = 152 [weeks] (1) **Accept** an answer of 153 [weeks] if correct workings shown	4

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Question			Marking details	Marks
	(c)		**Indicative content:** The number of wind turbines required to meet the demand is $\frac{40000}{0.95}$ = 42 106. This compares with 16 nuclear power stations. The area of land or sea required for this number of turbines would be extremely large. Is there sufficient area available? Wind turbines can only operate between certain wind speeds. They will not produce a consistent power supply. However, wind turbines do not use any fuel so will not produce any waste. Running wind turbines will not produce greenhouse gases so will not contribute to global warming or acid rain. Some people consider wind turbines to be a source of visual and noise pollution. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[15]**
			HIGHER TIER PAPER TOTAL	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

A.M. MONDAY, 16 June 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**4**	
3.	**6**	
4.	**11**	
5.	**10**	
6.	**12**	
7.	**12**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may 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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **7***(a)*(i).

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
% efficiency = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\frac{1}{1000}$
k	10^{3}	1000
M	10^{6}	1000000

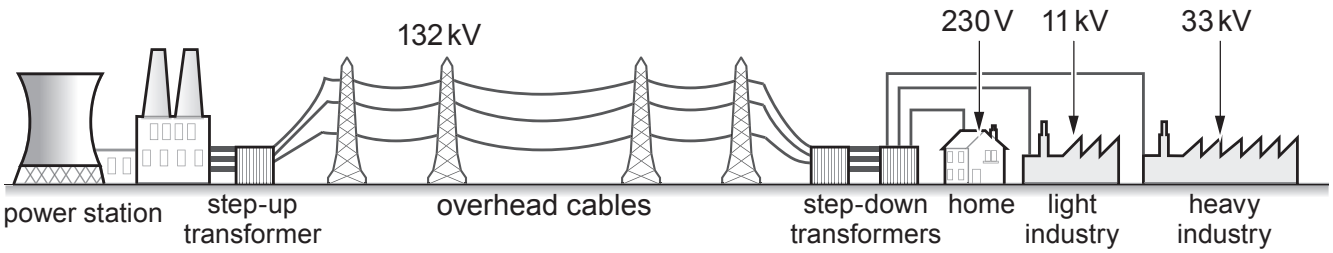
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Answer **all** *questions.*

1. The diagram below shows part of the National Grid.



(a) Use the information in the diagram to answer the following questions.

(i) Name the part where the voltages are highest. [1]

.....

(ii) Name the part that makes the voltage safer for users in homes. [1]

.....

(iii) Name the part that reduces current. [1]

.....

(b) State **two** advantages of joining power stations together in the National Grid. [2]

1. .....

2. .....

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5

Turn over.

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2. Infra-red, radio waves and microwaves are types of electromagnetic radiation used in long distance communication.

(i) Complete the table below by selecting from **infra-red, radio waves** or **microwaves**. [3]

Method of communication	Type of radiation used
Optical fibre signals	.....
Satellite communication	.....
Signals from mobile phone masts	.....

(ii) Which of the three types of radiation given above has the longest wavelength? [1]

.....

4

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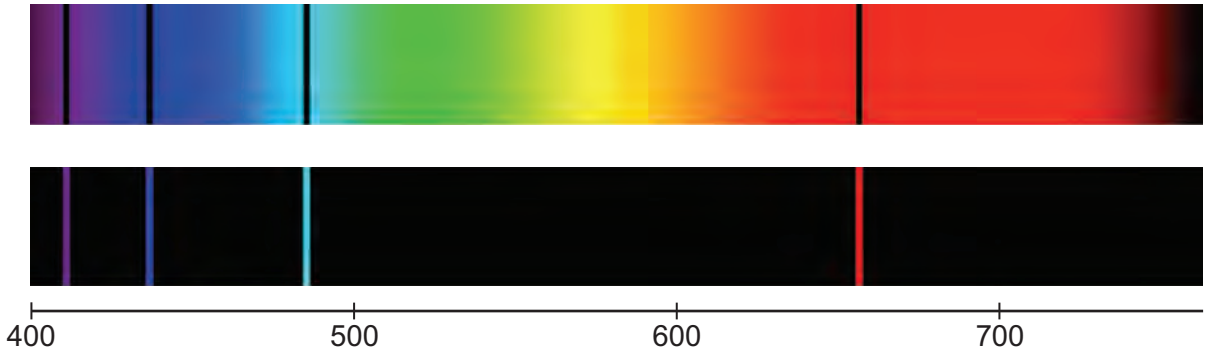
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3. *(a)* The diagram below shows two **spectra** produced by hydrogen gas.
The **top** spectrum is produced when **white** light is passed through hydrogen.
The **bottom** spectrum is produced by glowing hydrogen.



(i) State **two** ways in which they are similar. [2]

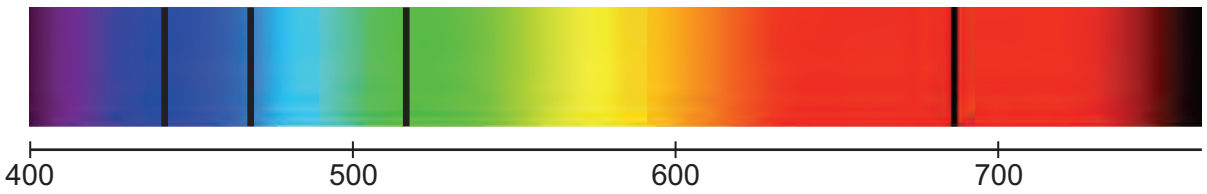
1. .....

2. .....

(ii) State **one** way in which they are different. [1]

.....

(b) The hydrogen spectrum below is from a distant star.



(i) How is it different from the top hydrogen spectrum in *(a)*? [1]

.....

(ii) What does this tell you about the star? [1]

.....

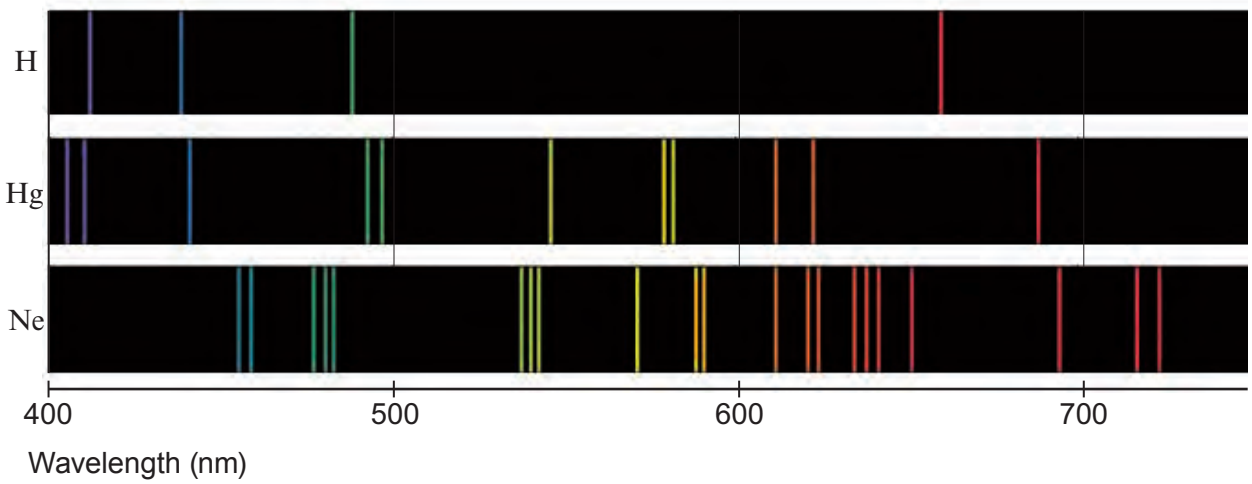
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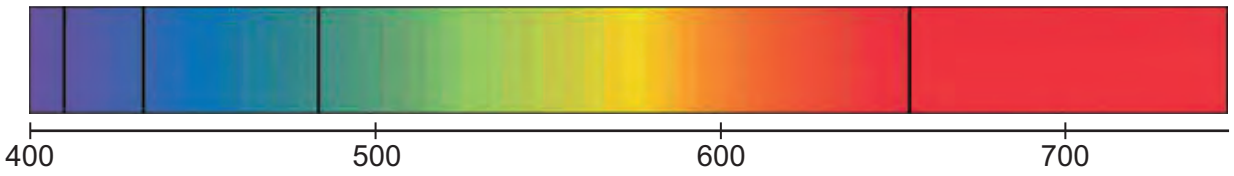
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(c) The first three spectra below are the emission spectra of glowing gases of hydrogen (H), mercury (Hg), and neon (Ne). The bottom spectrum is the absorption spectrum from a nearby gas cloud.

Emission spectra



Absorption spectrum from gas cloud



How can you tell the gas cloud does not contain any neon or mercury vapour? [1]

.....

.....

6

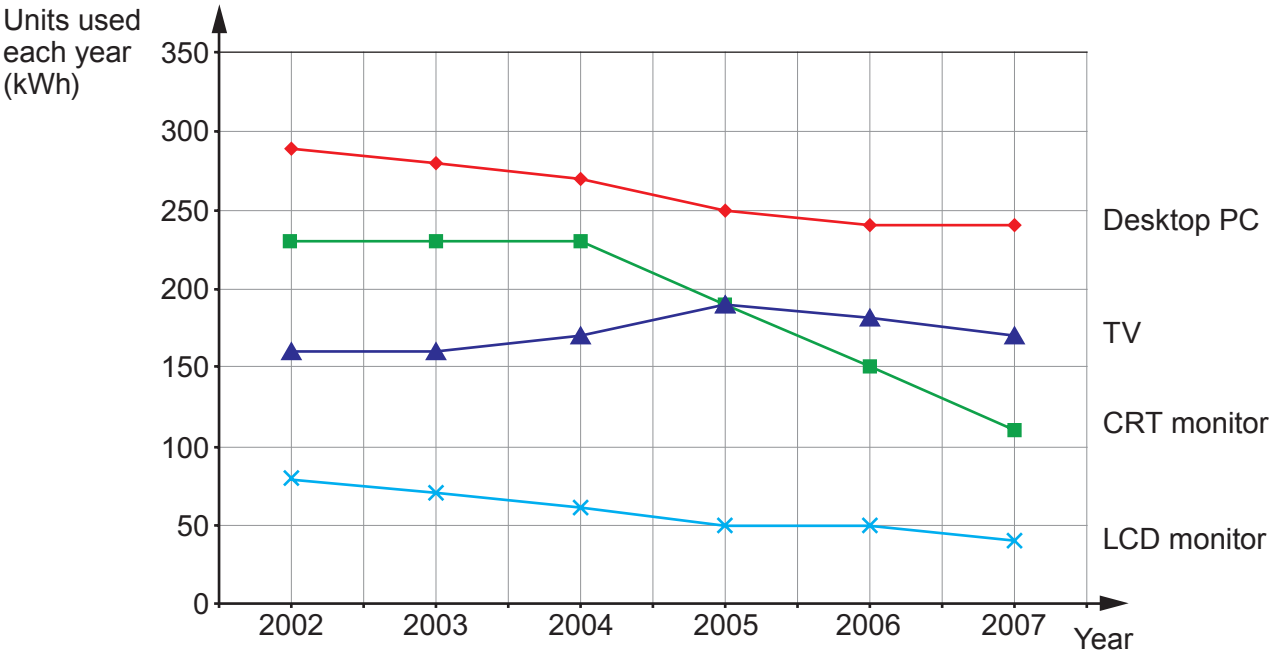
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4. *(a)* The graph shows the number of units of electricity (kWh) used each year by four different electrical items bought new in each of the years 2002 to 2007.



Use information from the graph above to answer the following questions.

(i) State which item uses the most energy every year. ..... [1]

(ii) In which year do the CRT monitor and TV use the same number of units? [1]

.....

(iii) In 2005 which item costs 5 times as much to run as the LCD monitor? [1]

.....

(iv) Explain which item has the greatest improvement in its efficiency between 2002 and 2007. [2]

.....

.....

.....

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(b) Use the information in the table to answer the questions that follow.

Type of monitor	CRT monitor 	LCD monitor 
Electrical power input (W)	90	30
Useful power output (W)	18	20

(i) Use an equation from page 2 to calculate the efficiency of the CRT monitor. [2]

efficiency = ... %

(ii) How many joules of energy does the CRT monitor waste each second? [1]

..... J

(iii) The CRT monitor has a power of 90 W and costs £4.50 to run.

(I) Calculate the cost of using the LCD monitor for the same amount of time. [2]

cost = £ .....

(II) How much would be saved by using the LCD monitor instead of the CRT monitor for this time? [1]

saving = £ .....

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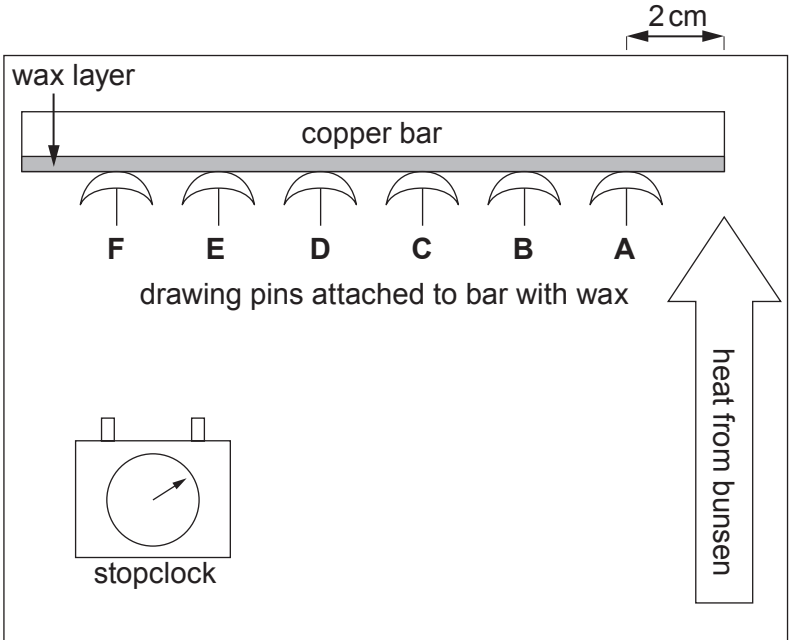
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5. An experiment to investigate heat transfer along a copper bar is set up as shown in the diagram.



Wax melts at 70°C

Diameter of copper bar = 1 cm

Length of copper bar = 14 cm

Mass of each drawing pin = 1 g

Distance between each pin = 2 cm

Bunsen burner blue flame used.

The stopclock reads to the nearest second.

A Bunsen burner heats the copper bar at one end.
The time that each drawing pin drops off the bar is recorded and a graph is plotted.

(a) Use some of the following words to complete the sentences below.
Each word may be used **once**, **more than once** or **not at all**.

conduction	convection	radiation	hot	cold

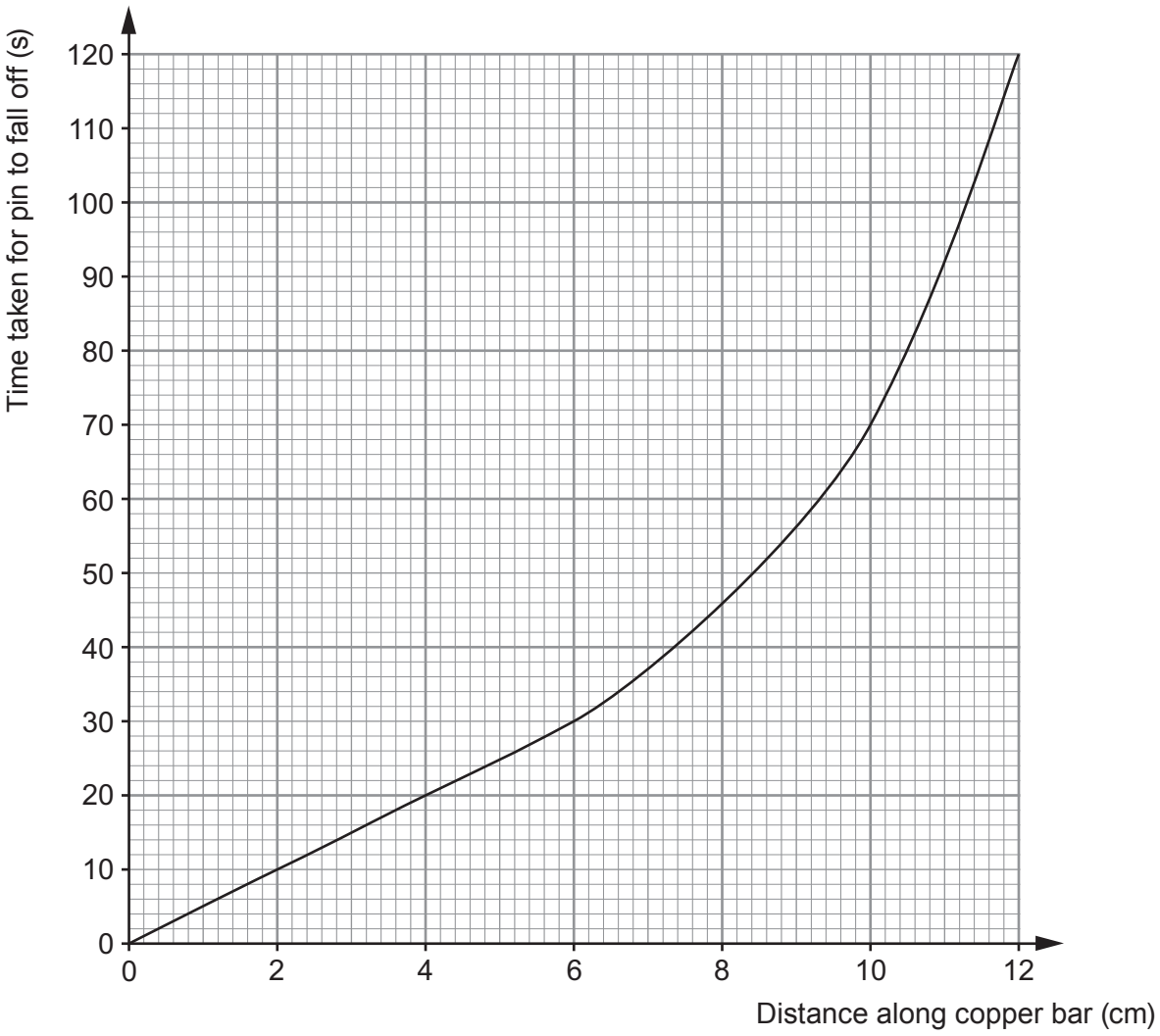
The heat energy passes along the copper bar by ..... causing the wax to melt. The bar gives out energy in all directions by ..... . Energy moves from the ..... end to the ..... end of the bar. [3]

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(b) The graph is shown below.



(i) Use the graph to complete the table of results. Some results have already been completed. [2]

Distance along copper bar (cm)	0	2	4	6	8	10	12
Time taken for pin to fall off (s)	0	10	20	30	.....	.....	120

(ii) How long did it take drawing pin **C** to fall from the copper bar? ..... s [1]

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(c) (i) The experiment is repeated with a steel bar. State **two** ways of making the experiment fair. [2]

1. .....

2. .....

(ii) Use the information below to explain why the results would be different if this steel bar was used instead. [2]

Rate of conduction along copper bar = 212 units

Rate of conduction along steel bar = 26 units

.....

.....

.....

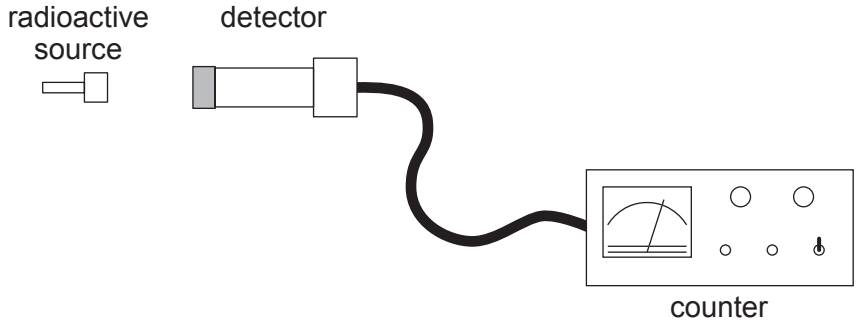
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6. Many radioactive sources emit more than one kind of radiation. The apparatus below can be used to identify the radiations that a source gives out. Different absorbers are placed in turn between the source and detector and the reading on the counter is taken.



An experiment produced the following results. **All figures have been corrected for background radiation**.

Absorber placed between detector and source	Count rate (counts per minute)
No absorber	5000
Thin card	5000
3 mm thickness of aluminium	4000
10 mm thickness of lead	500

(a) (i) Name **one** radiation that is **not** given out by this source. [1]

.....

(ii) How much of the original radiation is absorbed by the aluminium? [1]

..... counts per minute

(iii) How much of the original count rate was produced by beta radiation? [1]

..... counts per minute

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(b) When gamma radiation passes through lead from a different source, the counts per minute depend on the thickness of lead between the source and the counter in the way shown in the table.

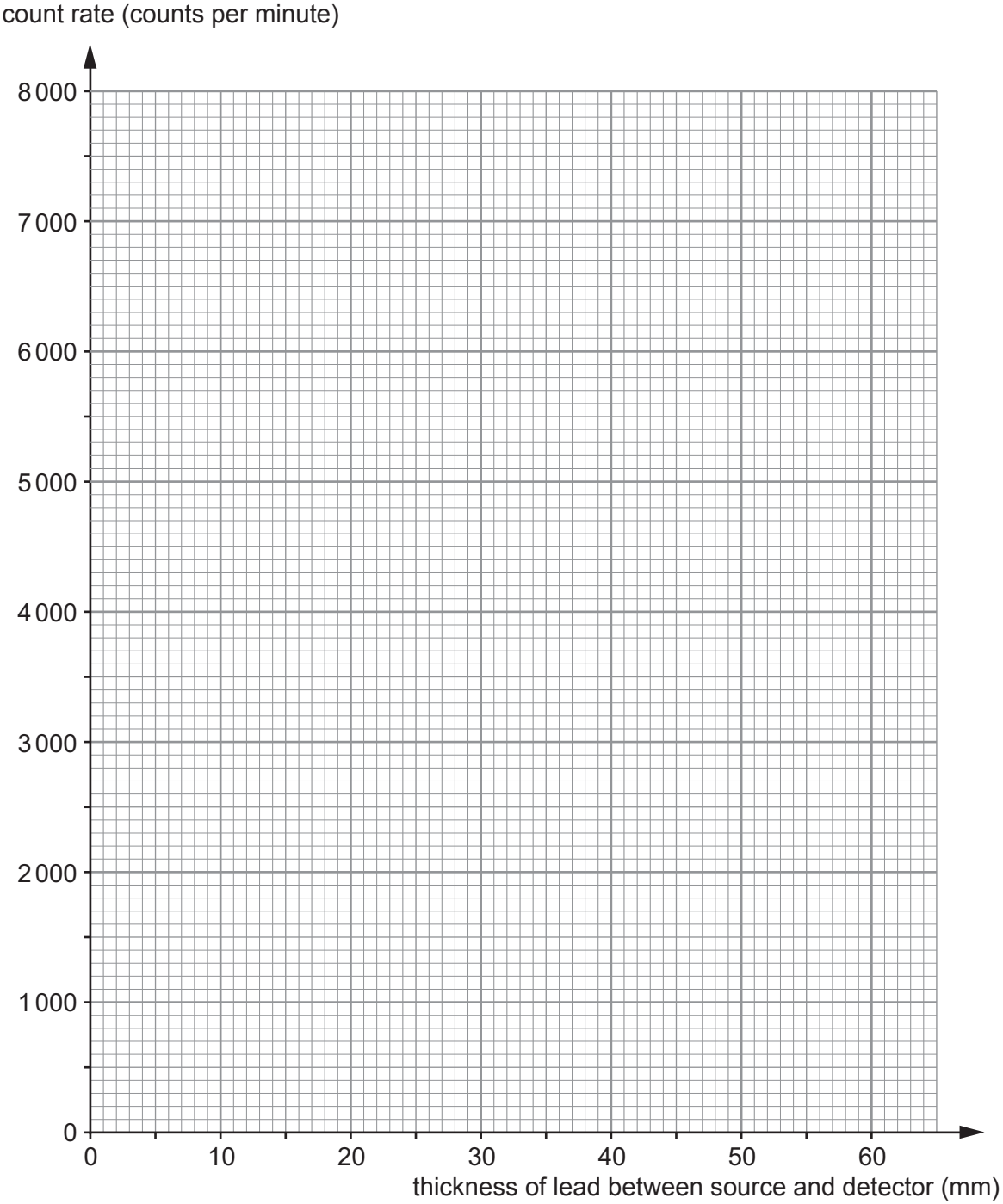
Thickness of lead between source and detector (mm)	Count rate (counts per minute)
0	8000
10	4000
30	1000
40	500
50	250

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(i) Plot the data on the grid below and draw a suitable line. [3]



(ii) Use the graph to describe the relationship between the count rate and the thickness of lead. [2]

.....

.....

.....

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(iii) The count rate for a 10 mm thickness of lead is 4 000 counts per minute.

(I) What **fraction** of this would be detected for a 30 mm thickness of lead? [2]

fraction = ...

(II) What count rate would be detected for a 60 mm thickness of lead? [1]

count rate = ... counts per minute

State how you arrived at your answer. [1]

.....

.....

12

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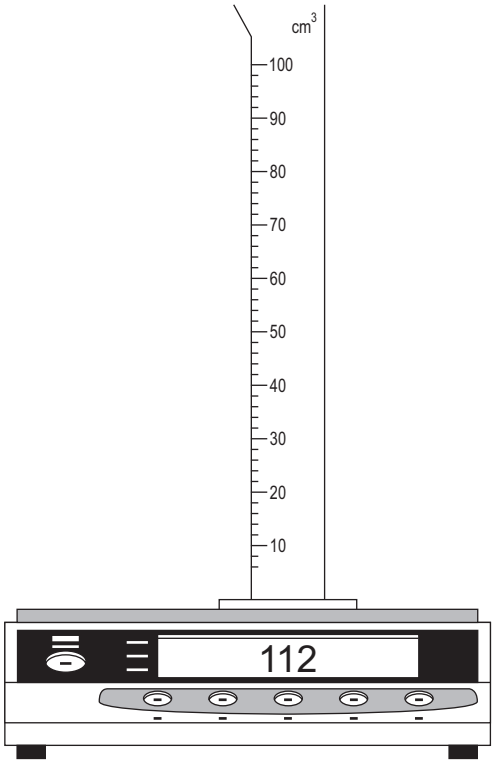
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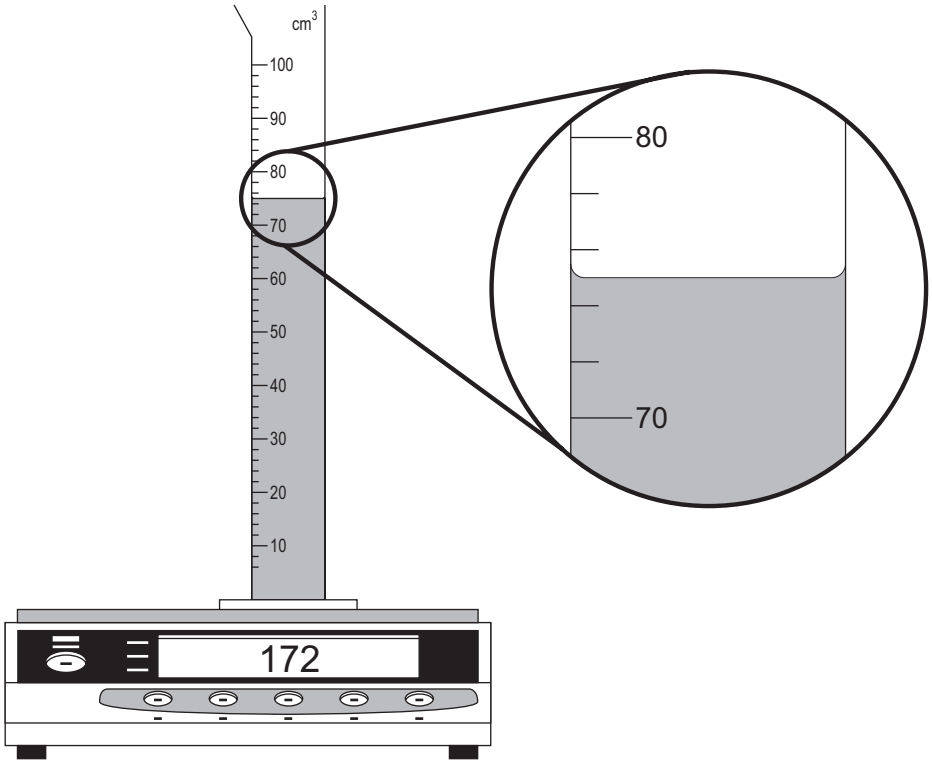
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7. *(a)* A pupil wants to find the density of an oil. She uses a chemical balance which measures to the nearest gram (g). She places an empty measuring cylinder on to the balance.



She pours some oil into the cylinder. The level of oil in the measuring cylinder is shown.



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(i) Use this data to find the density of oil.

- Use an equation from page 2.
- Show all your workings.
- Explain each stage in your calculation. [6 QWC]

(ii) State **two** ways in which the density of the oil could be found to a greater accuracy. [2]

1. .....

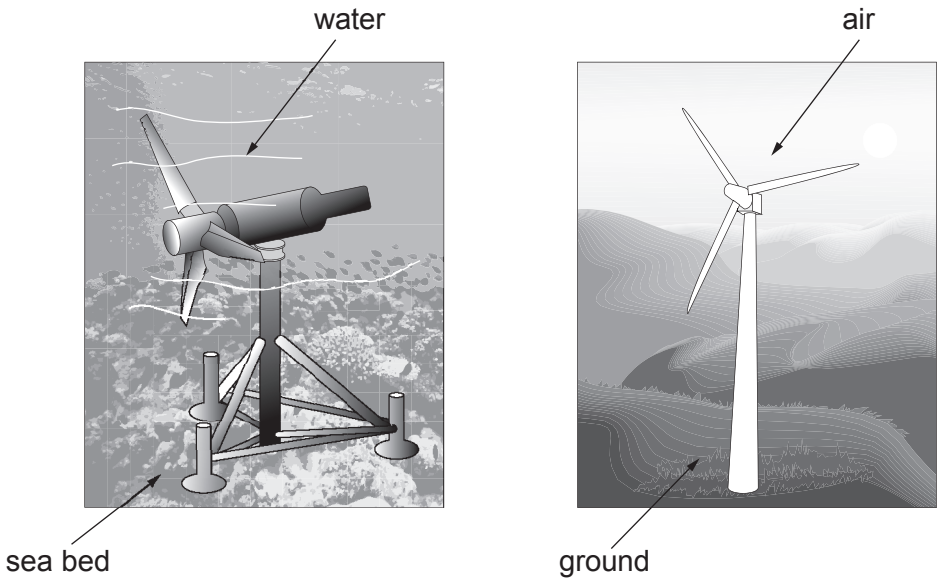
2. .....

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(b)



tidal water turbine wind turbine

The table below shows differences between tidal water turbines and wind turbines.

	Tidal water turbine	Wind turbine
Speed of water or wind (m/s)	5	15
Density of water or air (kg/m^3)	1 000	1
Length of blade (m)	10	35
Area swept out by blade (m^2)	314	3 850
Power output at this speed (MW)	2.9	1.5

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(i) Use information from the table opposite to answer the following questions.

(I) Calculate the difference in power output between the two types of turbine.[1]

power = ...

unit = ...

(II) State **one** reason why water turbines have a bigger power output than wind turbines. [1]

.....

.....

(ii) Other than having a larger power output, explain **one** advantage that tidal water turbines have over wind turbines. [2]

.....

.....

.....

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2014

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2014 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

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GCSE Science - Physics 1

Marking Scheme - Summer 2014

FOUNDATION TIER

Question				Marking details	Marks
1.	(a)	(i)		[Overhead] cables **Don't accept** National Grid	1
		(ii)		Step-down [transformer]	1
		(iii)		Step-up [transformer]	1
	(b)			**Any 2 ×(1) from:** • [More] reliable - **Don't accept** more efficient • [In case a power station breaks down for] back up • Can react to a changing demand **Don't accept** a better electricity supply **or** more power **or** gives electricity when needed.	2
				Question total	**[5]**
2.		(i)		Infra-red (1) Micro[waves] (1) Micro[waves] (1)	3
		(ii)		Radio [waves]	1
				Question total	**[4]**
3.	(a)	(i)		Same number <u>of lines</u> / four <u>lines</u> (1) <u>Lines</u> at same wavelength / <u>lines</u> at same place (1) **Don't accept** same colours **Award 1 mark** for they're both black on the right hand side	2
		(ii)		One has bright/coloured **or** dark [background] / One has black lines **or** coloured lines / colours missing in top spectrum are on the bottom spectrum. **Don't accept** colours in reverse **or** different colours	1
	(b)	(i)		<u>Lines</u> have moved to red end **or** wavelength of <u>lines</u> is increased **or** <u>lines</u> have different wavelengths **or** <u>lines</u> are red shifted **or** <u>lines</u> shifted to the right / <u>lines</u> are in different positions	1
		(ii)		<u>Moving away</u> don't accept further away	1
	(c)			No <u>matching lines</u> crossing spectrum [from neon or mercury] / because it <u>only</u> has lines for hydrogen / it only has four <u>lines</u> / it is the hydrogen spectrum. **Treat as neutral** any reference to not enough lines or double lines.	1
				Question total	**[6]**

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Question				Marking details	Marks
4.	(a)	(i)		Desktop / PC	1
		(ii)		2005	1
		(iii)		Desktop / PC	1
		(iv)		CRT [monitor] (1) **Don't accept** the green line because biggest drop [in units used or energy consumed (1) **To award both marks both statements must be linked.**	2
	(b)	(i)		% efficiency = useful energy transfer / total energy input × 100 $= \frac{18}{90} \times 100 = 20[\%]$ (1) for substitution (1) answer Correct answer only gets 2 marks **Award 1 mark** for 0.2	2
		(ii)		72 [J]	1
		(iii)	(I)	Division by 3 (1) [£]1.50 (1)	2
			(II)	[£]3.00 (**ecf for £4.50 – answer in (b)(iii)(I))** If answer in (b)(iii)(I) is bigger than £4.50 a negative answer is required.	1
				Question total	**[11]**
5.	(a)			Conduction (1) radiation (1) hot **and** cold (1) [both in correct order for mark] [**NOT** right to left]	3
	(b)	(i)		46 (1) 70 (1)	2
		(ii)		30 [s]	1
	(c)	(i)		**Any 2 ×(1) from:** • Same diameter **or** same thickness • Identical drawing pins **or** same mass of drawing pins • Same flame **or** same flame temperature **or** same starting temperature • Same type of wax **or** same amount of wax • Same distance between pins (**NOT** same length / same temperature only / same number of pins)	2
		(ii)		Steel is a poorer conductor / rate of conduction in steel is lower / so heat travels through it slower (1) so time before pins drop off would be longer (1) **To award both marks both statements must be linked.**	2
				Question total	**[10]**

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Question				Marking details	Marks
6.	(a)	(i)		Alpha / α / helium nucleus	1
		(ii)		1 000 [counts per minute]	1
		(iii)		1 000 [counts per minute]	1
	(b)	(i)		Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2 Smooth curve between 10 and 50 mm allow ± ½ small square division (1) **Don't allow** wispy, wobbly, thick, double lines	3
		(ii)		As the thickness increases, the counts per minute (count rate) decreases (1) in smaller and smaller intervals / at a decreasing rate (1) **Treat as neutral:** in a non-linear way **or** gradient decreases as the thickness increases **ecf** from graph **Award 2 marks for:** every 10 mm the count rate halves	2
		(iii)	(I)	1 000 (1) but not on answer line ¼ expressed in any terms **or** 0.25 (1) **Accept** 25%	2
			(II)	125 (1) [counts per minute] The count rate halves every 10 mm (1) **Accept** is a quarter of the 40 mm value **or** half the 50 mm value **Or** extrapolated graph (1) value between 50 – 200 (1)	2
				Question total	**[12]**
7.	(a)	(i)		**Indicative content:** Mass of measuring cylinder (from the first diagram)= 112 g Mass of measuring cylinder + liquid (from the second diagram)= 172 g Volume of liquid (from the third diagram) = 75 cm^3 Mass of liquid = 60 g $\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{60}{75} = 0.8\ \text{g/cm}^3$ **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.	6

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Question				Marking details	Marks
				1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	
		(ii)		**Any 2 ×(1) from:** • Better resolution / more precise / smaller increments / smaller divisions on balance / cylinder • Use a cylinder that measures to the nearest ml • Use a balance that measures to 1 decimal place • Take measurements at eye level • Bigger volume (amount) of liquid • Use a pipette **or** burette **or** volumetric flask **or** syringe • Take repeat readings with different volumes of oil	2
	(b)	(i)	(I)	1.4 MW **(unit with answer** for the mark)	1
			(II)	Density is bigger **accept** density of air is smaller	1
		(ii)		Water flow / tides (**NOT** waves) is more constant / more regular / more reliable (1) so the power output is more constant (1) **Alternative:** Water turbines are below the water / out of sight (1) so visual / noise pollution is less (1) **Alternative:** Water turbines are smaller (1) so cheaper to build / can be sited more densely / sited in shallow water / less harmful to wildlife (1) **To award both marks both statements must be linked.**	2
				Question total	**[12]**
				Foundation tier paper total	**[60]**

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GCSE Science - Physics 1

Marking Scheme - Summer 2014

HIGHER TIER

Question				Marking details	Marks
1.	(a)	(i)		Alpha / α / helium nucleus	1
		(ii)		1 000 [counts per minute]	1
		(iii)		1 000 [counts per minute]	1
	(b)	(i)		Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2 Smooth curve between 10 and 50 mm allow ± ½ small square division (1) **Don't allow** wispy, wobbly, thick, double lines	3
		(ii)		As the thickness increases, the counts per minute (count rate) decreases (1) in smaller and smaller intervals / at a decreasing rate (1) **Treat as neutral:** in a non-linear way **or** gradient decreases as the thickness increases **ecf** from graph **Award 2 marks for:** every 10 mm the count rate halves	2
		(iii)	(I)	1 000 (1) but not on answer line ¼ expressed in any terms **or** 0.25 (1) **Accept** 25%	2
			(II)	125 (1) [counts per minute] The count rate halves every 10 mm (1) **Accept** is a quarter of the 40 mm value **or** half the 50 mm value **Or** extrapolated graph (1) value between 50 – 200 (1)	2
				Question total	**[12]**
2.	(a)	(i)		**Indicative content:** Mass of measuring cylinder (from the first diagram)= 112 g Mass of measuring cylinder + liquid(from the second diagram)= 172 g Volume of liquid (from the third diagram) = 75 cm^3 Mass of liquid = 60 g $\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{60}{75} = 0.8\ \text{g/cm}^3$ **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.	6

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Question				Marking details	Marks
				3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	
		(ii)		**Any 2 ×(1) from:** • Better resolution / more precise / smaller increments / smaller divisions on balance / cylinder • Use a cylinder that measures to the nearest ml • Use a balance that measures to 1 decimal place • Take measurements at eye level • Bigger volume (amount) of liquid • Use a pipette **or** burette **or** volumetric flask **or** syringe • Take repeat readings with different volumes of oil	2
	(b)	(i)	(I)	1.4 MW (**unit with answer** for the mark)	1
			(II)	Density is bigger **accept** density of air is smaller	1
		(ii)		Water flow / tides (**NOT** waves) is more constant / more regular / more reliable (1) <u>so</u> the power output is more constant (1) **Alternative:** Water turbines are below the water / out of sight (1) <u>so</u> visual / noise pollution is less (1) **Alternative:** Water turbines are <u>smaller</u> (1) <u>so</u> cheaper to build / can be sited more densely / sited in shallow water / less harmful to wildlife (1) **To award both marks both statements must be linked.**	2
				Question total	**[12]**

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Question				Marking details	Marks
3.	(a)			Units used = 1.5 ((1) for conversion) ×(8 × 14) **or** 112 (1) = [168] Cost = units used × cost per unit 2 520 = 168 **(ecf)** × cost per unit Cost per unit = $\frac{2520}{168}$ ((1) substitution and manipulation) = 15 [p] ((1) for answer) Answer of £15 p loses the answer mark N.B.1. Failure to convert 1 500 W to 1.5 kW loses conversion mark and gives an answer of 0.015 p – **Award 3 marks** N.B.2. Failure to convert £25.20 to 2 520 p gives an answer of 0.15 p - **Award 3 marks** N.B.3. Failure to include 8 or 14 loses 2nd mark only and gives an answer of 1.875 p (accept 1.88 or 1.9) and 1.071 p (accept 1.1) respectively. **Award up to the 3 other marks** N.B.4. Failure to include 1.5 gives an answer of 112 units and a cost of 22.5 p – **Award 3 marks** N.B.5. Failure to convert to 1.5 kW and failure to convert to 2 520 p gives an answer of 0.00015 p – **Award 2 marks**	4
	(b)			$E = P \times t$ = 1 500 × 14 × 8 **or** 168 000 (1) 60 × 60 **or** 3 600 (1) [= 604 800 000 J] N.B. Award **1 mark** only for: 28 800, 50 400, 403 200, 5.4×10^6, 43.2×10^6, 75.6×10^6, 5.4×10^3, 43.2×10^3, 75.6×10^3	2
				Question total	**[6]**

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Question				Marking details	Marks
4.	(a)	(i)		Output power = 99% × 2 ×10^9 = 1.98 × 10^9 [W]	1
		(ii)		Input Voltage = $\frac{P}{I} = \frac{2x10^9}{4x10^4}$ (1) for substitution 5 × 10^4 [V] (1) Output voltage = 8 × (5 × 10^4) **(ecf)** = 4 × 10^5 [V] (1) Output current = $\frac{1.98x10^9}{4x10^5}$ **(ecf on both values)** = 4.95 × 10^3 [A] (1) for answer **Alternative:** **Award 2 marks for:** Output current = Input current ÷8 = 5 × 10^3 [A] **Then award another 2 marks for**: 5 × 10^3 × 99% = 4.95 × 10^3 [A]	4
	(b)			[Step-up] transformer reduces the current **or** makes the current low[er] / increases the voltage **or** makes the voltage high[er] (1) to reduce energy / heat losses [in the cables] / increase efficiency (1). **To award both marks both statements must be linked.** [Step-down] transformers reduce the voltage (1) to a safe[r] level (1). **To award both marks both statements must be linked.**	4
				Question total	**[9]**

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Question				Marking details	Marks
5.	(a)	(i)		Straight line / as one increases the other increases at a steady rate / goes up in equal steps (1) through the origin (1). **Award 2 marks for** doubling the velocity doubles the distance.	2
		(ii)		Age of universe will be bigger (1). [Value of constant will decrease] meaning the gradient is lower (1). **To award both marks both statements must be linked.**	2
	(b)			4×10^8 (1) $\times 9.5 \times 10^{12} = 3.8 \times 10^{21}$ [km] (1) If 10^8 is omitted **award 1 mark for** answer of 3.8×10^{13}	2
	(c)			Wavelength = (669.4 – 13.1) nm = 656.3 nm (1) $= 656.3 \times 10^{-9}$ m (1) for conversion $c = f\lambda$ so $f = \frac{c}{\lambda}$ (1) for manipulation $= \frac{3x10^8}{656.3x10^{-9}}$ (1) for substitution $= 4.571 \times 10^{14}$ [Hz] (1) N.B.1. If nm is not converted to m then: $\lambda = 656.3$(1) and $f = \frac{c}{\lambda}$ (1- manipulation) = $\frac{3x10^8}{656.3}$ (1-substitution) $= 4.571 \times 10^5$ [Hz] (1) **so award 4 marks.** N.B.2. If 13.1 is <u>added</u> then: $\lambda = 682.5$ nm(no mark) $= 682.5 \times 10^{-9}$ m (1-conversion) and then $f = \frac{c}{\lambda}$ (1- manipulation) = $\frac{3x10^8}{682.5x10^{-9}}$ (1-substitution) $= 4.396 \times 10^{14}$ [Hz] (1) (must apply correct rounding if done) **so award 4 marks.** N.B.3. <u>If no attempt to use 13.1</u> then: $\lambda = 669.4$ nm(no mark) $= 669.4 \times 10^{-9}$ m (1-conversion) and then $f = \frac{c}{\lambda}$ (1- manipulation) = $\frac{3x10^8}{669.4x10^{-9}}$ (1-substitution) $= 4.482 \times 10^{14}$[Hz] **so award 3 marks.**	5

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Question				Marking details	Marks
	(d)	(i)		Gamma [rays] / short wavelength radiation (1) have stretched / increased wavelength / reduced frequency [over time as the Universe expanded] (1) **To award both marks both statements must be linked.**	2
		(ii)		**Any 2 ×(1) from:** • Because their wavelengths will get longer / waves stretched • Because frequencies decrease • Lower energy of waves **To award both marks both statements must be linked.**	2
				Question total	**[15]**
6.				**Indicative content:** A geostationary / geosynchronous satellite orbits the Earth in 24 hours – the same time as the rotation period of the Earth. It therefore stays above the same point on the Earth so that ground satellite dishes do not have to be moved. A minimum of three satellites are needed to relay messages around the world. They relay only microwaves which carry TV, telephone and other signals. Signals can also be relayed along optical fibres which transfer via coded infra-red signals and radio waves can be reflected off the atmosphere. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[6]**
				Higher tier paper total	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

P.M. THURSDAY, 16 January 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**7**	
3.	**8**	
4.	**10**	
5.	**6**	
6.	**12**	
7.	**12**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may 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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **7***(c)*.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
% efficiency = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\frac{1}{1000}$
k	10^{3}	1000
M	10^{6}	1000000

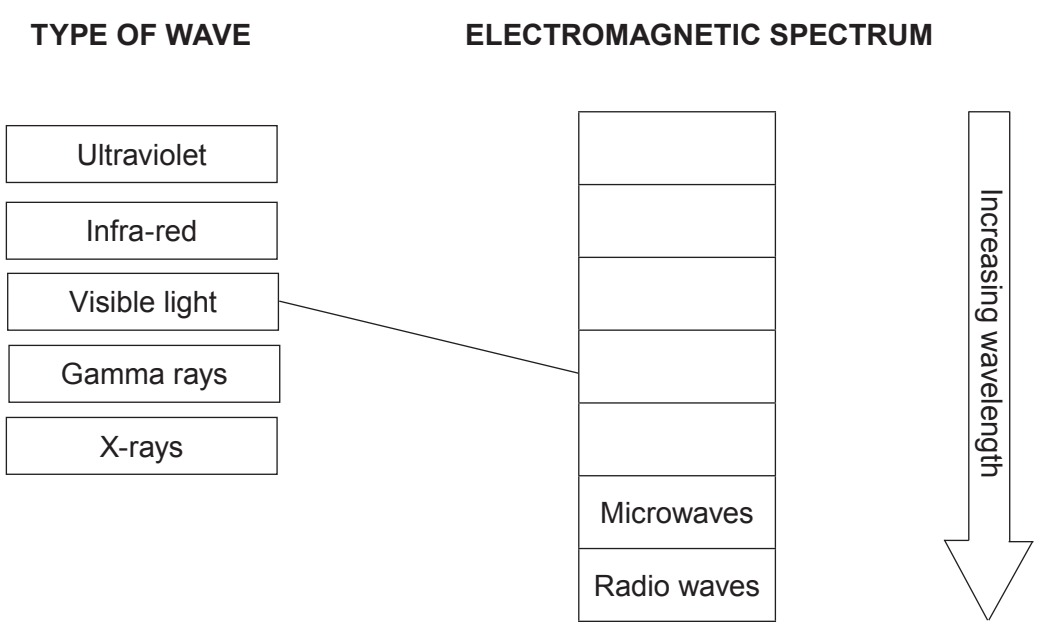
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Examiner only

Answer **all** *questions.*

1. *(a)* Draw a line from each type of wave on the left to show its correct position in the electromagnetic (em) spectrum.
Draw 4 lines only. One has been done for you. [3]



(b) (i) Microwave radiation is an em wave in the wavelength range 0.1 cm to 30 cm.
State **one** possible wavelength for a radio wave. [1]

Wavelength ..... cm

(ii) State **one** property that is the same for radio waves and microwaves. [1]

.....

5

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2. *(a)* In a laboratory, a radiation detector was placed in front of a radioactive source. The readings were carefully taken every minute and are shown below.

Time (mins)	1	2	3	4	5
Detector reading (counts)	34	36	40	31	34

(i) Put a tick (✓) alongside the **one** correct reason below for the readings not being the same every minute. [1]

Detector was probably not working properly.	
Radioactive decay is random.	
The source was faulty.	
The times were not carefully measured.	
The detector was moved nearer the source in the 5 minutes.	

(ii) Calculate the mean number of counts every minute. [2]

Mean counts = ...

(iii) State how the method used above could be changed to find the count rate of the background radiation in the laboratory. [1]

.....

.....

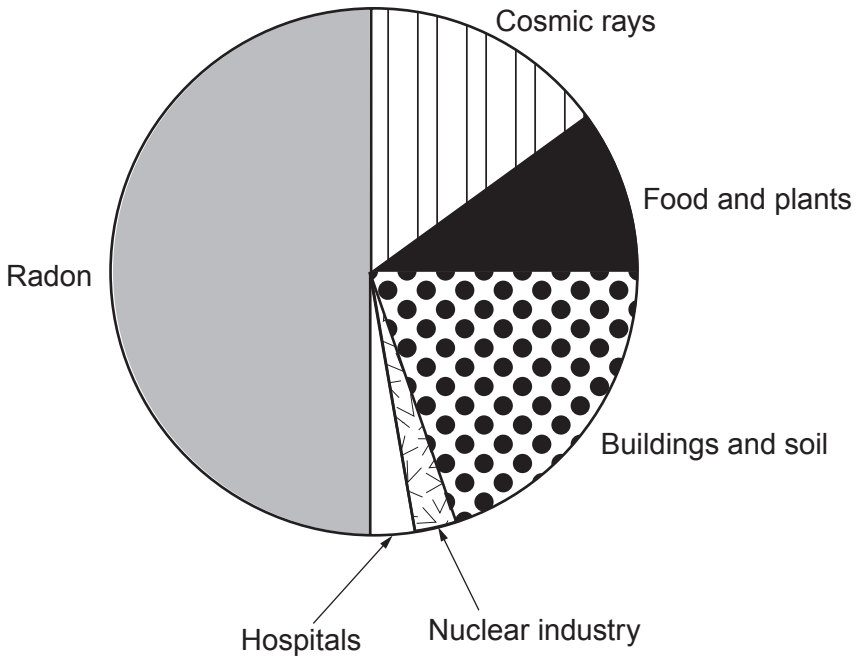
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(b) The sources of background radiation are shown in the pie chart below.

Sources of background radiation



(i) Use the information in the pie chart to answer the questions that follow.

(I) Name the background source that gives the same percentage as hospitals. [1]

.....

(II) State the percentage of background radiation that comes from radon. [1]

..... %

(ii) State the reason why the amount of radon varies across the country. [1]

.....

7

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Turn over.

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3. The following label is attached to the back of a microwave oven that also contains an electric grill.

230 V	~	50 Hz
Microwave power		1.2 kW
Grill power		1.8 kW

(a) Use the information on the label to complete the following statement. [3]

The mains electricity supply in the home is ..... volts which has a frequency of ..... . The power of the grill is ..... watts.

(b) Name the **two** types of electromagnetic waves that the oven uses to cook food. [2]

..... and .....

(c) The grill and microwave are used continuously to cook a small joint of meat.

(i) Write down the total power used to cook the meat. [1]

Total power = ... kW

(ii) The cooking time is 0.5 hours. Use the equation:

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

to calculate the number of units used to cook the meat. [1]

Units used = ... kWh

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(iii) Given that a unit of electricity costs 14 p, use the equation:

$$\text{cost} = \text{units used} \times \text{cost per unit}$$

to calculate the cost of cooking the meat. [1]

Cost = ... p

8

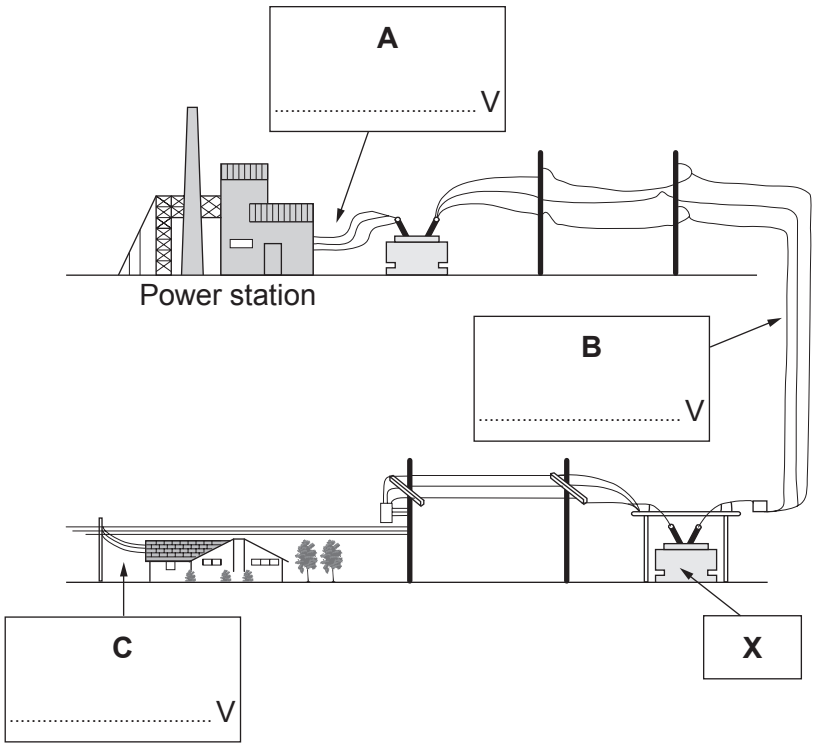
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Turn over.

Examiner only

4. The diagram shows an electricity transmission network that connects power stations to users.



(a) (i) Give the name of this electricity distribution system. [1]

.....

(ii) Voltages used in the distribution of electricity are 400 000 V, 50 000 V and 230 V. Write the correct values **in the boxes A, B** and **C** on the diagram. [2]

(iii) Name the device that is labelled **X** on the diagram. [1]

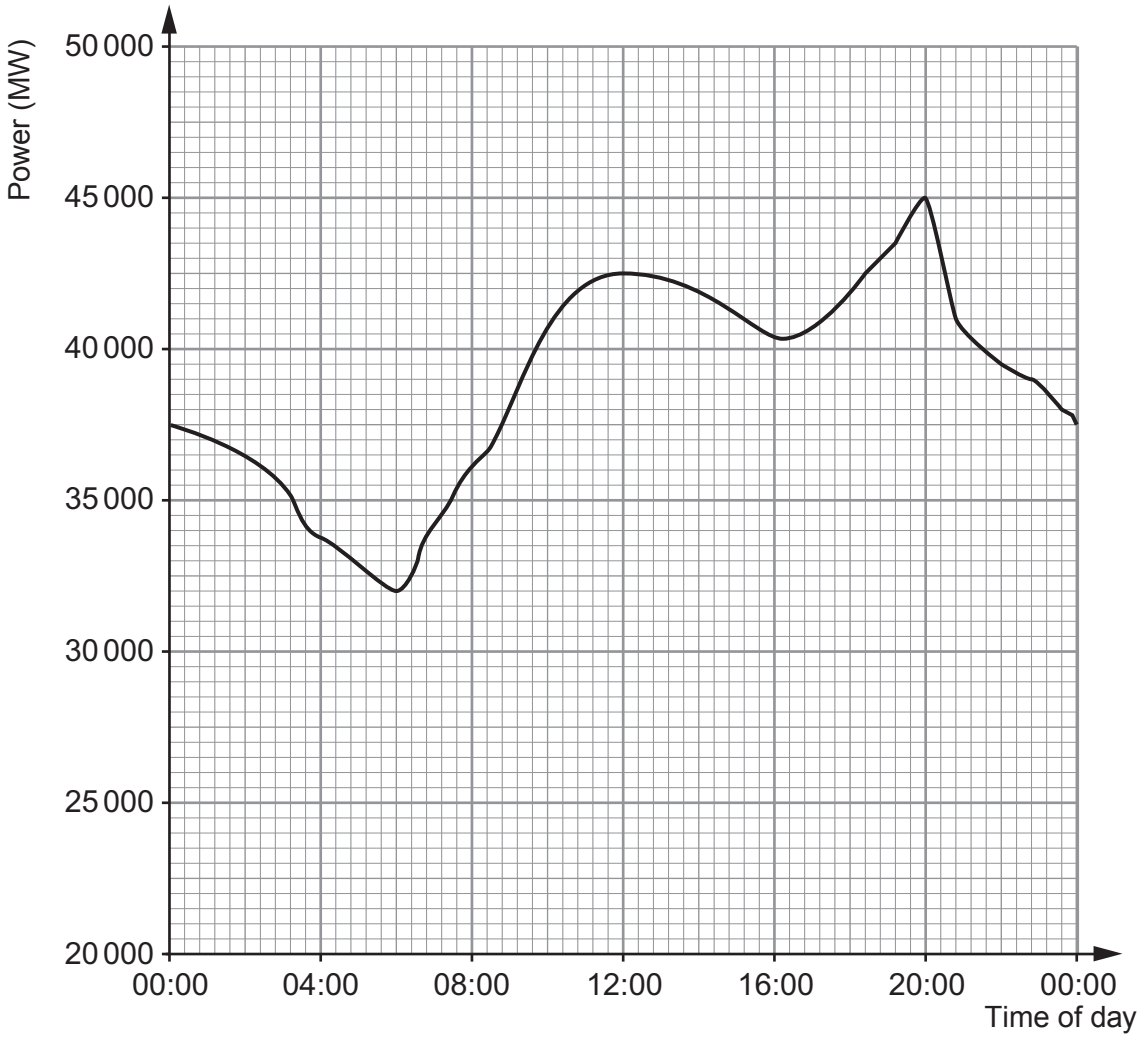
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Examiner only

(b) In Britain, the demand for electricity in a day changes in the way shown on the graph below.



(i) At what time was the demand for electricity smallest? ..... [1]

(ii) Write down the maximum power used in Britain during the day.

..... MW [1]

(iii) In the early hours of the morning, demand for electricity is low. Name **one** type of power station that is not supplying electricity to the distribution system at this time.

..... [1]

(iv) At 20:00, Britain transferred **in** 400 MW of electricity from Ireland, 1 000 MW from France and 1 000 MW from the Netherlands to cope with demand. Calculate how much electrical power was being produced in Britain at this time. Give the correct unit. [3]

Power = ... Unit = ...

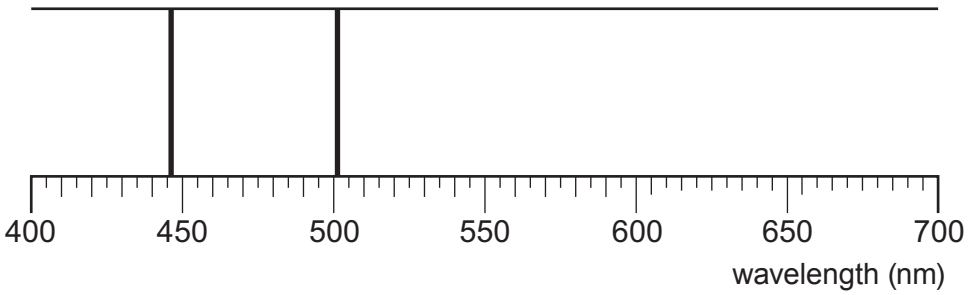
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Examiner only

5. The diagram shows two of the dark lines in the spectrum from the Sun.



(i) Use the information in the table below to put a tick (✓) alongside the element that produced this pair of dark lines. [1]

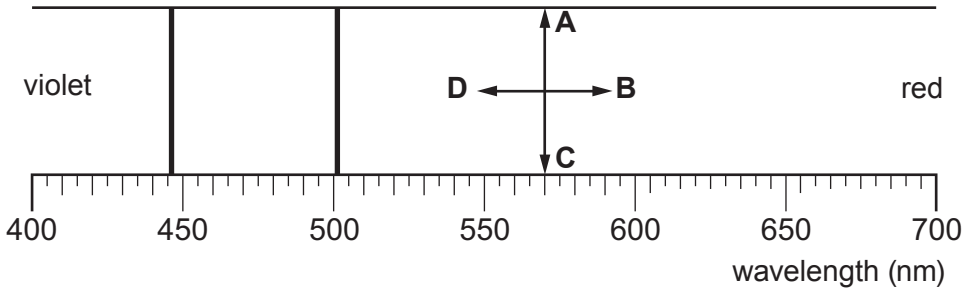
Element	Some wavelengths in the spectrum (nm)		Gas used to make the spectrum (Tick ✓)
Iron	431	527	
Hydrogen	410	486	
Helium	447	502	
Sodium	590	591	

(ii) Underline the word or phrase in the bracket to correctly complete the following sentence. [1]

The two dark lines are due to light being
(**absorbed** / **reflected** / **not absorbed** / **combined**) by the atoms.

(iii) These two dark lines show up in the spectrum of light from distant galaxies, but their positions are different. Write down one of the letters **A, B, C** or **D** which shows the direction that the lines would move in the diagram below.

..... [1]



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(iv) State **why** these lines have moved in the direction you have chosen. [1]

.....

.....

.....

(v) State what this evidence from distant galaxies tells us about the Universe. [1]

.....

(vi) Name the event that the evidence suggests created our Universe. [1]

.....

6

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Turn over.

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6. There is an increasing demand for electricity but the reserves of fossil fuels are decreasing.

(a) A way to meet increasing demand for electricity is to build nuclear power stations.

(i) Give **two** reasons to support building more nuclear power stations than other types in the future. [2]

1. .....

2. .....

(ii) Nuclear waste is a problem that must be dealt with. One possible solution would be to bury the waste deep underground. State **one** disadvantage of burying nuclear waste. [1]

.....

(b) Electricity can also be generated using bio-fuels such as woodchip and straw. Plants for bio-fuels use carbon dioxide from the air as they grow. Explain why burning bio-fuels is more environmentally friendly than burning fossil fuels. [2]

.....

.....

.....

(c) The table below shows typical crop yields and the energy content of some bio-fuels.

Crop	Crop yield in a year from each km^2 of land (tonnes)	Energy content (units/tonne)
poplar	8	18
willow	10	20
grass	5	16

(i) Which crop would be the worst choice for using as a bio-fuel? ..... [1]

Give **two** reasons for your answer. [2]

1. .....

2. .....

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(ii) A 10 MW power station needs 50 000 tonnes of willow crop a year.

I. Calculate the area of land needed to grow this amount of willow crop. [1]

Area ..... km^2

II. Calculate the energy content of 50 000 tonnes of willow crop. [1]

Energy content = ... units

(iii) An area of 2 km^2 of land is needed to produce 10 MW using wind turbines. Explain why this method of generating electricity is more environmentally friendly than using bio-fuels. [2]

.....

.....

.....

12

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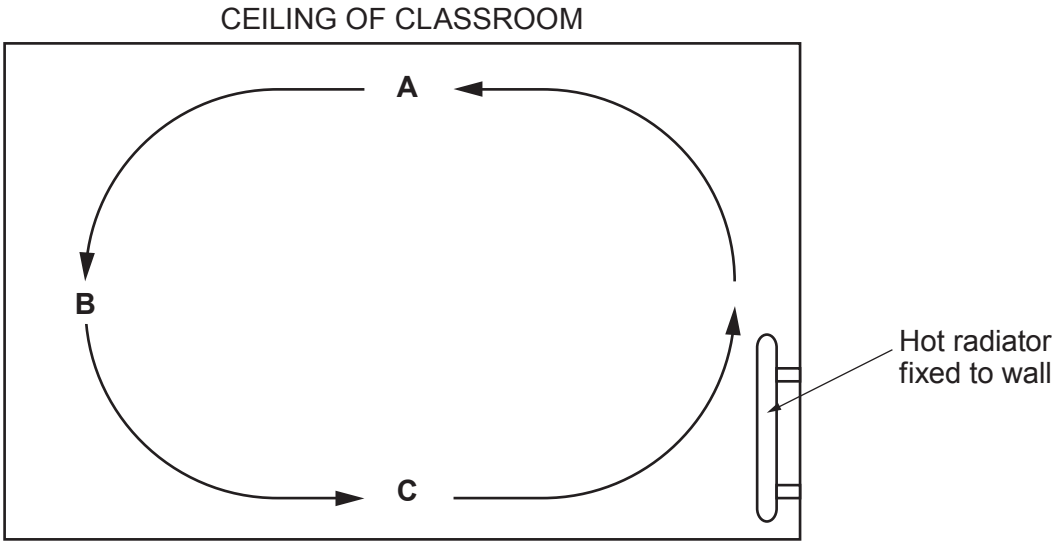
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7. *(a)* A classroom has a volume of 80 m^3 and contains 104 kg of air. Use an equation from page 2 to calculate the density of the air in the room and state the unit. [3]

Density = ...

Unit .....

(b) The classroom is now heated by a radiator. This sets up a convection current in the air as shown in the diagram below.



(i) At which point **A, B** or **C** is the air in the classroom the hottest? ..... [1]

(ii) At which point **A, B** or **C** is the air in the classroom least dense? ..... [1]

(iii) Give a reason for your answer to *(b)*(ii). [1]

.....

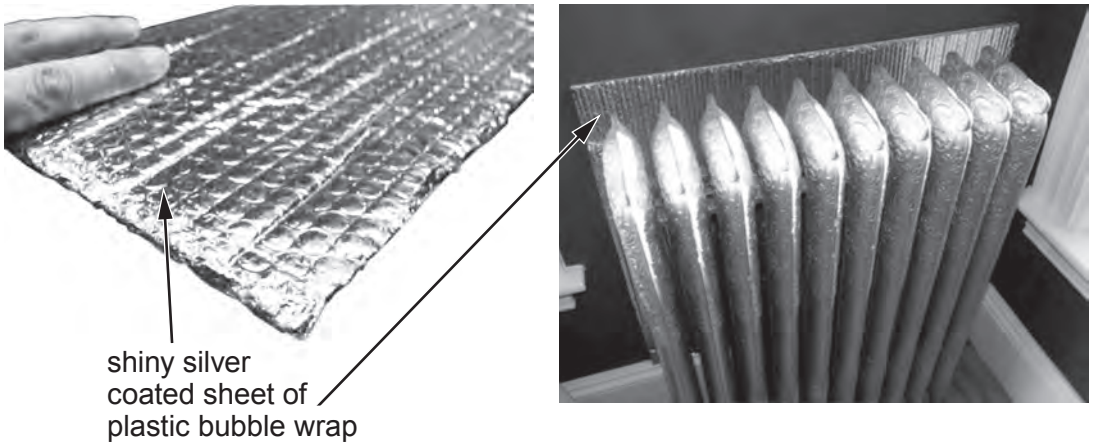
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(c) A shiny silver coated sheet of plastic bubble wrap is placed on the wall behind the radiator. Explain how this can reduce heat loss from the classroom by conduction, convection and radiation. [6 QWC]



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12

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

JANUARY 2014

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2014 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

	Page
P1 - 4463 (01/02)	1
P2 - 4473 (01/02)	10

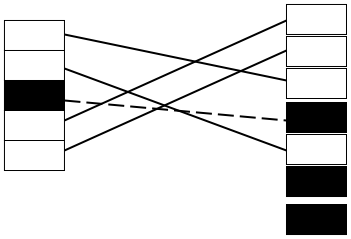
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GCSE Science - Physics 1 Mark Scheme

January 2014

FOUNDATION TIER

Question				Marking details	Marks
1.	(a)			 4 lines joined or words correct = 3 marks. 2 or 3 lines or words correct = 2 marks. 1 line or word correct = 1 mark. 0 lines or words correct = 0 mark. Deduct 1 mark for each additional line.	3
	(b)	(i)		Bigger than 30 / accept bigger than 0.3 m (provided cm deleted) / alternatives.	1
		(ii)		Travel through vacuum/travel in straight lines/same speed [in a vacuum] / transverse/[they both] carry energy /[they both] carry information / reflect / refract	1
				Question total	**[5]**
2.	(a)	(i)		Radioactive decay is random (more than one tick don't award the mark)	1
		(ii)		Dividing by 5 **or** total of 175 (1) mean = 35(1) (Answer alone gets both marks) (174/5 = 35 award 1 mark only)	2
		(iii)		Take the readings with no source (must be implied source is removed rather than distance increased)	1
	(b)	(i)	(I)	Nuclear industry	1
			(II)	50[%]	1
		(ii)		Different areas have different rocks in the ground / some areas have more uranium than others / more or less granite in the ground	1
				Question total	**[7]**

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Question				Marking details	Marks
3.	(a)			230 (1), 50 [Hz] (1), 1 800 (accept 1.8 with kilo or k)(1)	3
	(b)			Microwave (1), infra-red (1) Don't accept microwave power or micro	2
	(c)	(i)		3.0 [kW] (Accept 3 000 only if the k is deleted in kW)	1
		(ii)		Units = (3.0 (**ecf from (i)**) x 0.5) = 1.5 [kWh] Mark for the answer	1
		(iii)		Cost = (1.5 (**ecf from (ii)**) x 14 p) = 21 [p] Mark for the answer Do not credit £ 21 p or £0.21 p	1
				Question total	**[8]**
4.	(a)	(i)		National Grid	1
		(ii)		A - 50 000 [V], B - 400 000 [V], C – 230 [V] [2 marks for all 3 correct, 1 mark for 1 or 2 correct]	2
		(iii)		Step-down transformer	1
	(b)	(i)		06:00 (Accept 6 am)	1
		(ii)		45 000 [MW]	1
		(iii)		[pumped storage] hydroelectric - accept solar	1
		(iv)		45 000 **or** 2 400 (1) 42 600 (1) (Answer alone gets 2 marks) Unit – MW (1) Can be written alongside power value. Don't accept mW.	3
				Question total	**[10]**
5.		(i)		Helium indicated as correct (in any manner) (more than one tick don't award the mark)	1
		(ii)		Absorbed	1
		(iii)		B on answer line or selected on diagram	1
		(iv)		Galaxies are moving away from us / moving apart **or** the Universe is expanding. Don't accept red shifted.	1
		(v)		It is expanding / started at one point	1
		(vi)		Big Bang	1
				Question total	**[6]**

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Question				Marking details	Marks
6.	(a)	(i)		Any 2 x (1) from: • produces a lot of energy <u>for a small mass</u> of fuel or is a concentrated energy source (accept amount for mass) • it is reliable or it can generate all of the time • produces no pollutant <u>gases</u> / doesn't contribute to global warming (accept named gas or greenhouse gases) (do not accept no pollution) • produces only a small volume of (solid) waste (accept amount for volume) • less dependence on fossil fuels / conserves fossil fuels • provides energy security	2
		(ii)		Any (1) from: • [radioactive waste] may <u>leak</u> [into the ground / environment] (don't accept radiation leaking) • geological changes (accept earthquakes etc.) • radioactive material may get into the food chain • [over time if location not correctly recorded] it may be excavated Do **not** accept answers in terms of property prices or damages the environment or cost or terrorism.	1
	(b)			Does not add to / cause global warming or greenhouse effect (1) because carbon dioxide released during burning = carbon dioxide used during growing/overall add no carbon dioxide to the environment (1) (Accept they are carbon neutral <u>or</u> they <u>just</u> release CO_2 <u>back</u> into the air) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(c)	(i)		Grass (1) low<u>est</u> crop yield (accept <u>only</u> 5 tonnes ... (1) low<u>est</u> energy content (accept <u>only</u> 16 .....(1)	3
		(ii)	(I)	$\frac{50000}{10} = 5\,000\,[km^2]$ Mark for the answer	1
			(II)	50 000 x 20 = 1 000 000 [units] Mark for the answer	1
		(iii)		Less land / space used (1) so less destruction of habitats / so more land available for food production (1) (Don't credit references to CO_2 or SO_2.) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[12]**

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Question				Marking details	Marks
7.	(a)			$\rho = \frac{104}{80}$ (1) = 1.3 (1) kg/m^3 (1) **Alternative:** $\rho = \frac{104000}{80000000}$ (1) = 0.0013 (1) g/cm^3 (1)	3
	(b)	(i)		A	1
		(ii)		A	1
		(iii)		Because <u>hot</u> air rises / expands (don't accept heat rises or least dense)	1
	(c)			**Indicative content** The silver sheet reflects infra-red radiation back into the radiator and reflects heat back into the room. The ridged panels / bubble wrap trap insulating pockets of air between the radiator and the wall, reducing heat lost through the wall by conduction. Plastic is also an insulator. The outside air temperature of the wall will be reduced by both factors above, so convection will be reduced. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[12]**
				FOUNDATION TIER PAPER TOTAL	**[60]**

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HIGHER TIER

Question				Marking details	Marks
1.	(a)	(i)		Any 2 x (1) from: • produces a lot of energy <u>for a small mass</u> of fuel or is a concentrated energy source (accept amount for mass) • it is reliable or it can generate all of the time • produces no pollutant <u>gases</u> / doesn't contribute to global warming (accept named gas or greenhouse gases) (do not accept no pollution) • produces only a small volume of (solid) waste (accept amount for volume) • less dependence on fossil fuels / conserves fossil fuels • provides energy security	2
		(ii)		Any (1) from: • [radioactive waste] may <u>leak</u> [into the ground / environment] (don't accept radiation leaking) • geological changes (accept earthquakes etc.) • radioactive material may get into the food chain • [over time if location not correctly recorded] it may be excavated Do **not** accept answers in terms of property prices or damages the environment or cost or terrorism.	1
	(b)			Does not add to / cause global warming or greenhouse effect (1) because carbon dioxide released during burning = carbon dioxide used during growing / overall add no carbon dioxide to the environment (1) (Accept they are carbon neutral <u>or</u> they <u>just</u> release CO_2 <u>back</u> into the air) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(c)	(i)		Grass (1) low<u>est</u> crop yield (accept <u>only</u> 5 tonnes .... (1) low<u>est</u> energy content (accept <u>only</u> 16 .....) (1)	3
		(ii)	(I)	$\frac{50000}{10} = 5\,000\,[km^2]$ Mark for the answer	1
			(II)	50 000 x 20 = 1 000 000 [units] Mark for the answer	1
		(iii)		Less land / space used (1) so less destruction of habitats / so more land available for food production (1) (Don't credit references to CO_2 or SO_2.) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[12]**

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Question				Marking details	Marks
2.	(a)			$\rho = \frac{104}{80}$ (1) = 1.3 (1) kg/m^3 (1) **Alternative:** $\rho = \frac{104000}{80000000}$ (1) = 0.0013 (1) g/cm^3 (1)	3
	(b)	(i)		A	1
		(ii)		A	1
		(iii)		Because <u>hot</u> air rises / expands (don't accept heat rises or least dense)	1
	(c)			**Indicative content** The silver sheet reflects infra-red radiation back into the radiator and reflects heat back into the room. The ridged panels / bubble wrap trap insulating pockets of air between the radiator and the wall, reducing heat lost through the wall by conduction. Plastic is also an insulator. The outside air temperature of the wall will be reduced by both factors above, so convection will be reduced. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
				Question total	**[12]**

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Question				Marking details	Marks
3.	(a)			1.3 [seconds]	1
	(b)	(i)		Scales on both axes more than ½ of the grid used (1). All Points correct (no tolerance allowed) (1) best fit curved line drawn passing through (0,0) (1) allow **ecf.** Don't accept double lines / whispy / disjointed / wobbly lines.	3
		(ii)		Wave speed increases (1) at a decreasing rate (don't accept non-linearly) (1) allow **ecf** from graph	2
		(iii)		65 ± 1 [cm/s] allow **ecf** from graph	1
	(c)			Any row of data used. E.g. Distance = 30 x 3.0 = 90 [cm] (1) Tray length = $\frac{90}{4}$ (1) for dividing by 4, allow **ecf** for 90 = 22.5 [cm] (1) ± 0.1cm (allow **ecf** if depth 3.0 cm data used) For 90 [cm] on answer line award 1 mark.	3
				Question total	**[10]**
4.		(i)		total power input = 44 000 MW (1) useful power output = 0.9 x 44 000 **(ecf)** MW (1) = 39 600 [MW] (1) Award 2 marks for 37 582 [MW]	3
		(ii)		step-up transformer / high voltage (1) so decrease / lower / less current **or** less power / heat / energy loss [in cables] (1) (treat small current as neutral) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
		(iii)		Correct power of 996 MW used (1) Division of power by voltage with matching units (1) A division by 8 appearing anywhere (1) Award 2 marks for $\frac{996}{0.27}$ = 3 689 [A] Award 1 mark for $\frac{996}{270}$ = 3.689 [A]	3
				Question total	**[8]**

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Question				Marking details	Marks
5.				X is iodine – 131 (1) Reasoning: count rate only reduced by lead / so must be gamma emitter (1) Y is silver – 110 (1) Reasoning: count rate reduced by aluminium and lead / so must be beta and gamma emitter (1) Z is radium – 226 (1) Reasoning: count rate reduced by paper and lead / so must be alpha and gamma emitter (1) **AWARD A MAXIMUM OF 5 MARKS ONLY** **Question total**	5 **[5]**
6.	(a)	(i)		X-rays & ultraviolet 1 mark each – correctly positioned	2
		(ii)		<table><tr><th>Region of em spectrum</th><th>Wavelength range (m)</th></tr><tr><td>Gamma rays</td><td><1×10^{-11}</td></tr><tr><td>X rays</td><td>1×10^{-11} to 1×10^{-9}</td></tr><tr><td>Ultraviolet</td><td>1×10^{-9} to 4×10^{-7}</td></tr><tr><td>Visible light</td><td>4×10^{-7} to 7×10^{-7}</td></tr></table> shortest wavelength inserted alongside gamma rays (1) correct sequence for the remaining 3 (1)	2
	(b)			Use of 1×10^{-9} (1) subs & manip (1) ans 3×10^{17} [Hz] (1) If answer of 7.5×10^{14} [Hz] award 2 marks **Question total**	3 **[7]**

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Question				Marking details	Marks
7.				**Indicative content:** They are spectra of light crossed by dark lines. They can tell us the composition of the star/galaxy gas cloud because different elements will absorb light at different wavelengths to produce each dark line. They can also tell us how far away the galaxy is from us, and the further away from us the faster the galaxy moves because the further the dark lines are red shifted. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[6]**
				HIGHER TIER PAPER TOTAL	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/01

SCIENCE A/PHYSICS

PHYSICS 1
FOUNDATION TIER

A.M. TUESDAY, 18 June 2013

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**6**	
3.	**6**	
4.	**9**	
5.	**8**	
6.	**12**	
7.	**12**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may 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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **7***(b)*.

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Equations

$\text{density} = \dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
$\%\ \text{efficiency} = \dfrac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
$\text{speed} = \dfrac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier	
m	10^{-3}	$\dfrac{1}{1\,000}$
k	10^{3}	1 000
M	10^{6}	1 000 000

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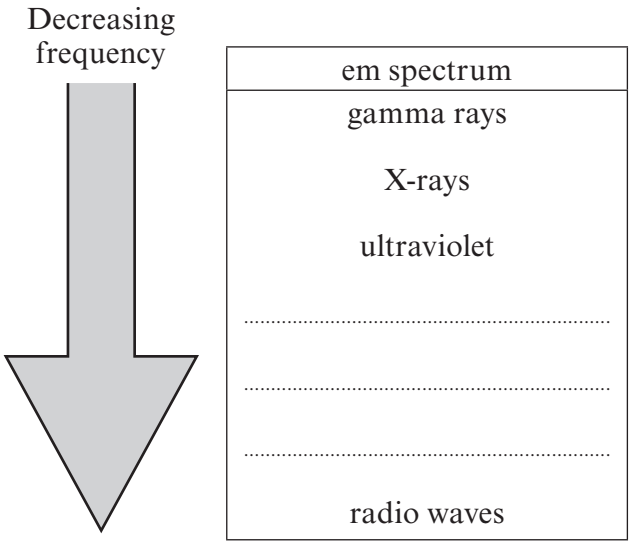
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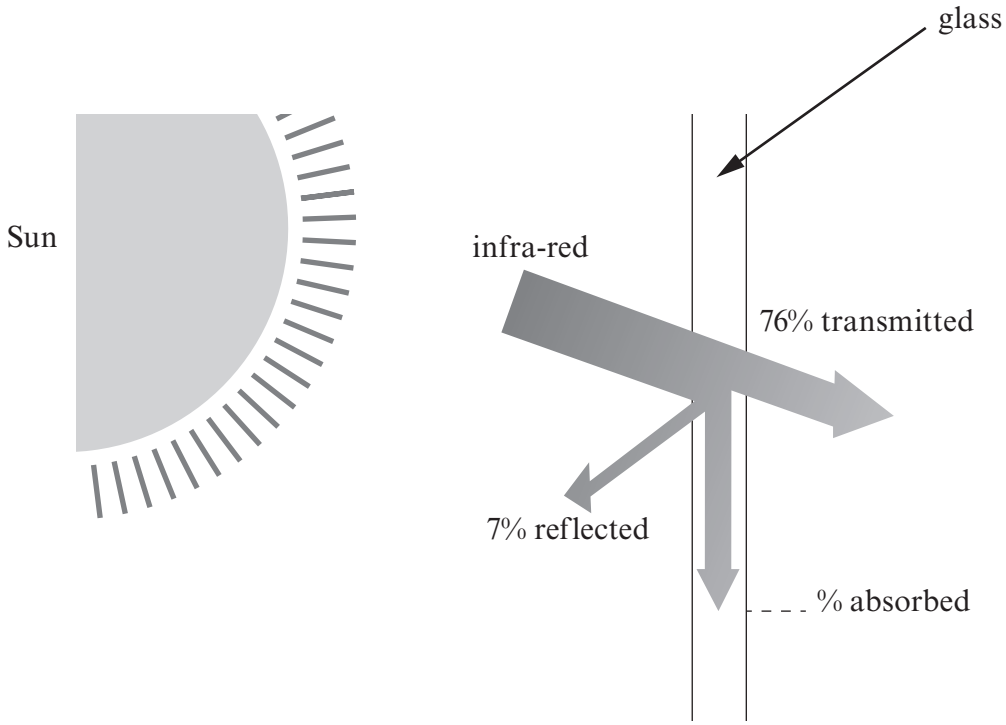
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Answer **all** *questions.*

1. *(a)* **Microwaves, visible light** and **infra-red** are types of electromagnetic waves used in communication.
Complete the list below to show their position in the electromagnetic (em) spectrum. [2]



(b) Microwaves and visible light easily pass through glass. **Infra-red** radiation is reflected, absorbed and transmitted by glass as shown in the diagram below.



(i) What percentage of infra-red is absorbed by the glass in the diagram? [1]

..... %

(ii) What effect does the absorbed infra-red have on the temperature of the glass? [1]

.....

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(c) Tick (✓) the boxes next to the **three** correct statements about infra-red. [3]

Black surfaces are poor emitters of infra-red	
Black surfaces are poor reflectors of infra-red	
Shiny silver surfaces are good reflectors of infra-red	
Shiny silver surfaces are poor emitters of infra-red	
Shiny silver surfaces are good absorbers of infra-red	

7

2. The table shows the powers of three different kettles.

Kettle	Power (W)	Power (kW)
X	1 000	1.0
Y	2 200	.....
Z	1 600	1.6

(a) **Complete** the table. [1]

(b) In one week, each kettle is used for a total of 30 minutes.

(i) Which kettle, **X**, **Y** or **Z** is cheapest to use? ..... [1]

(ii) The energies transferred by the kettles during this time are:

1 800 000 J 2 880 000 J 3 960 000 J

Underline the correct energy transfer for kettle **Y**. [1]

(iii) Use an equation from page 2 to calculate the units used (kWh) by kettle **Z** in one week. [2]

units used = ... kWh

(iv) Use an equation from page 2 to calculate the cost of using kettle **Z** for one week if one unit of electricity costs 15 p. [1]

cost = ... p

6

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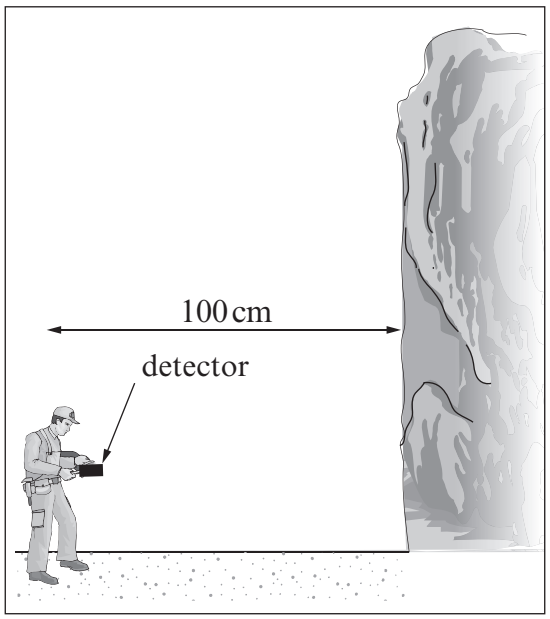
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3. The count rate from a radioactive quarry wall is measured at different distances.



The results are shown in the table below. (Background radiation has been taken away from the results.)

Distance between quarry wall and detector (cm)	Counts in one minute
5	105
20	100
40	96
60	93
80	89
100	0

(i) The quarry wall only emits one type of radiation. State whether it is alpha, beta or gamma. [1]

.....

(ii) Give **two** reasons for your answer. [2]

1. .....

2. .....

(iii) Suggest **two** ways in which the strength of evidence from the experiment could be improved. [2]

1. .....

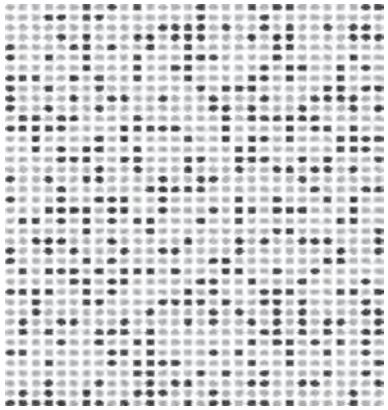
2. .....

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(iv) The grey spots in the diagram below show undecayed nuclei in the radioactive quarry wall. The black spots are nuclei that have decayed.



Give a reason why it is **not** possible to predict which nucleus will decay next. [1]

.....

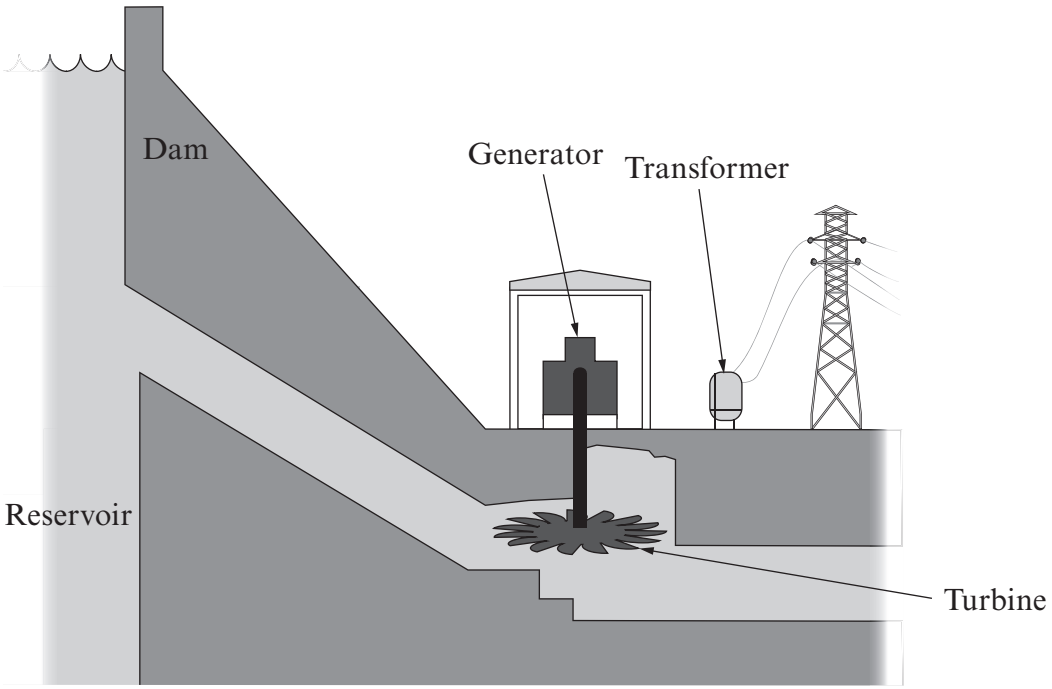
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4. The diagram shows a hydroelectric power station.



(a) The volume of water that flows past the turbine every second is 25 m^3.

(i) The density of water is 1 000 kg/m^3.

Use the equation:

mass = density × volume

to calculate the mass of water flowing past the turbine every second. [1]

mass = ... kg

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(ii) Every 1 kg of water loses 120 J of energy as it flows down the pipe to the turbine. Calculate the **total energy lost** every second by this falling water. [2]

energy = ... J

(b) The generator provides 2 MW of power to the transformer. The output power of the transformer is 1.8 MW.
Use an equation from page 2 to calculate the % efficiency of the transformer. [2]

% efficiency = ...

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(c) Explain how hydroelectric power stations help to keep a reliable supply of electricity to the National Grid. [2]

.....

.....

(d) (i) Give a reason why electrical power is transmitted (sent) at high voltages across the National Grid. [1]

.....

(ii) Give a reason why electrical power is supplied at low voltages to consumers. [1]

.....

9

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5. *(a)* The distances to stars and solar system planets are very large. Astronomers make their lives easier by using a number of different units.

1 light year = distance travelled by light in one year
1 AU = distance between the Earth and Sun
(1 AU = 8.3 light minutes)

(i) The centre of our galaxy is 30 thousand light years away. How long does light take to travel to us from the centre of the galaxy? [1]

..... years

(ii) How long does light take to travel from the Sun to Earth? [1]

..... minutes

(iii) Light takes 13 hours to travel from Pluto to Earth. What is the **distance** between these planets? [1]

..... hours

(iv) Mercury is 0.4 AU from the Sun. Venus is further than Mercury from the Sun but not as far as Earth. Estimate the distance between the Sun and Venus. [1]

..... AU

(b) The spectrum of light from the Sun is crossed with dark lines.



Complete the sentences below by **underlining** the correct word(s) in brackets. [2]

(i) The dark lines are caused by atoms of gas (**reflecting** / **absorbing** / **transmitting**) light.

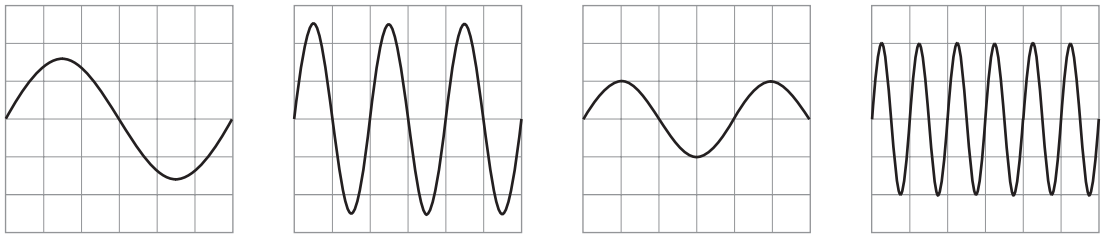
(ii) The dark lines in the spectrum from a distant galaxy moving away from us would be (**blue shifted** / **red shifted** / **green shifted**).

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(c) Four wave patterns of light from a star are shown below. Each pattern is produced in the same time interval.



A **B** **C** **D**

(i) Which wave pattern has the lowest frequency? ..... [1]

(ii) Which wave pattern has the largest amplitude? ..... [1]

8

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6. Electricity is generated using many different sources.

(a) The table below shows the pollutant gases produced by burning fossil fuels to generate electricity.

Fossil fuel	Pollutant (unit)			
	Carbon monoxide	Carbon dioxide	Sulfur dioxide	Nitrous oxide
Coal	90	94 600	765	292
Oil	16	77 400	1 350	195
Gas	15	56 100	1	93

Use information in the table above to answer the following questions.

(i) Explain which fossil fuel will have the least impact on global warming. [2]

.....

.....

(ii) Explain which fossil fuel will cause the least acid rain. [2]

.....

.....

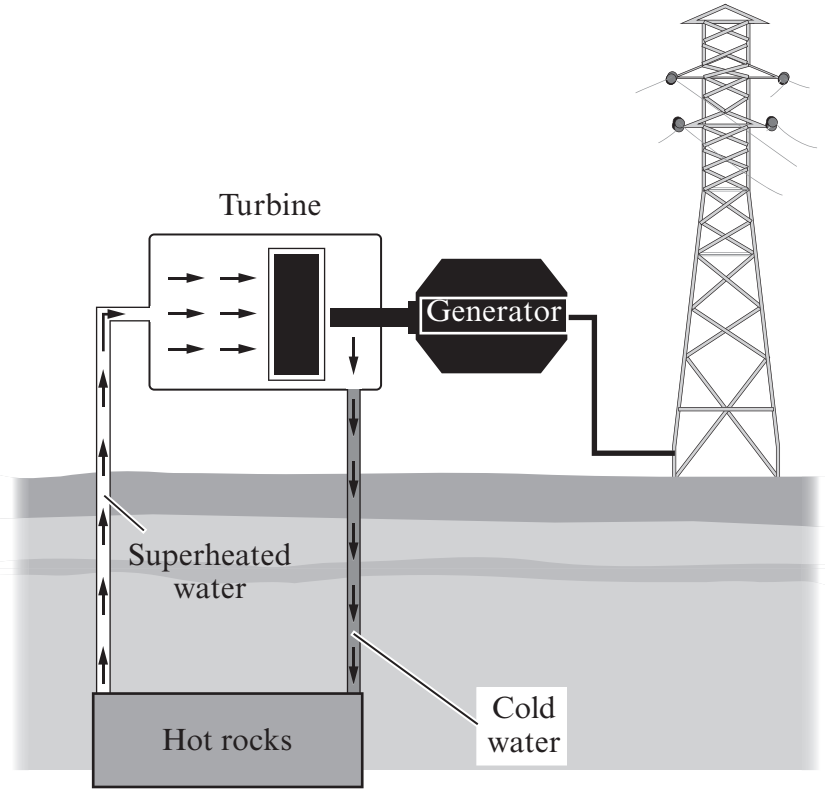
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(b) Plans have been revealed for what will be the first geothermal power station to be built in the UK. A 3 MW geothermal power station will be built at the Eden Project in Cornwall.

Cold water will be pumped down to hot rocks where its temperature will reach 150 °C. The superheated water will then be pumped back up, turn to steam, and turn turbines at ground level where electricity will be generated.



(i) This power station is similar to fossil fuel power stations because both types have turbines and generators. State **one** *other* way they are similar. [1]

.....

(ii) Give **one** advantage of geothermal power compared with solar power. [1]

.....

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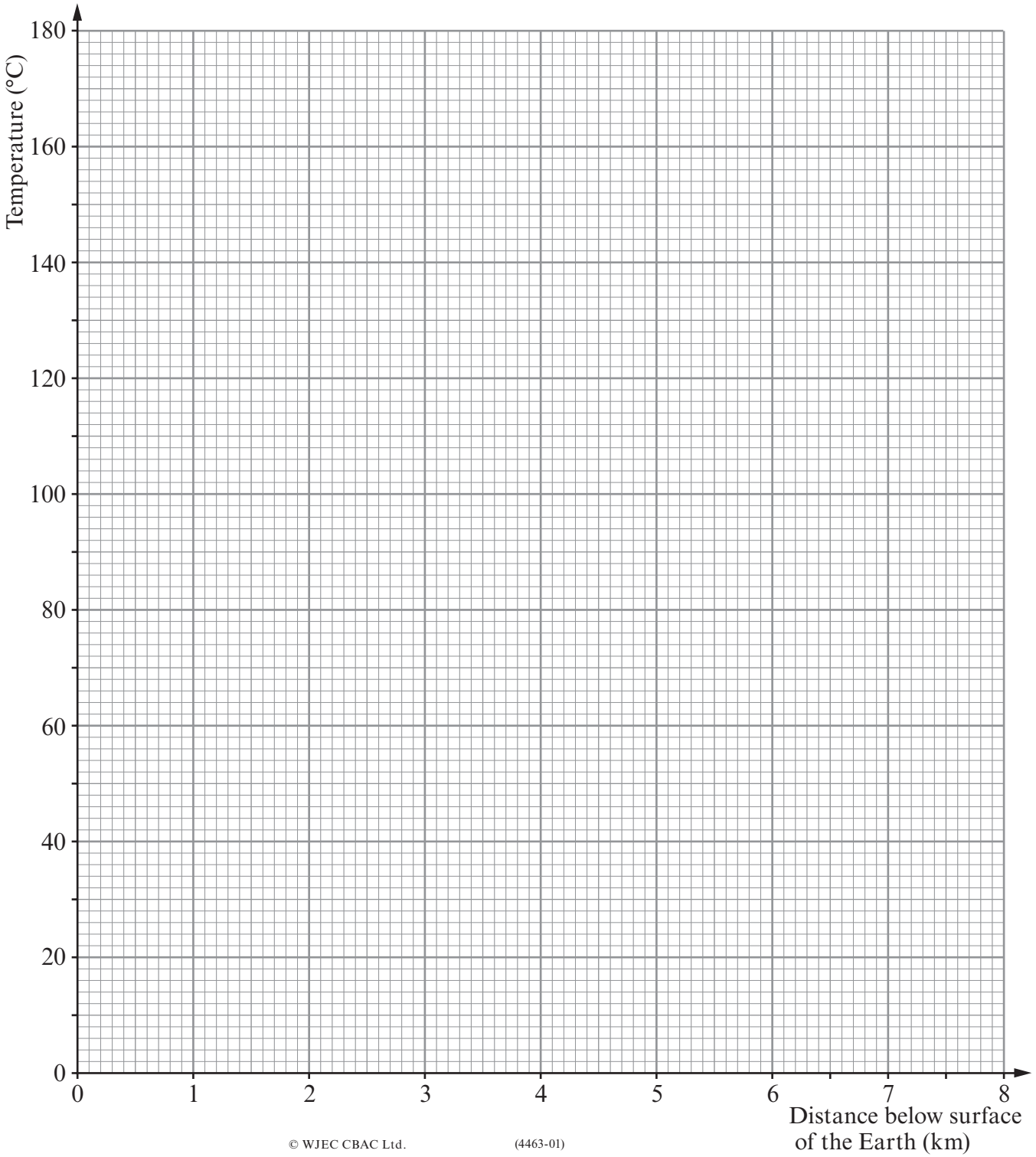
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(c) The table below shows the temperature at different distances below the surface of the Earth.

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Distance below surface of the Earth (km)	Temperature (°C)
1	40
2	60
4	100
6	140
8	180

(i) **Plot the data** on the grid below and draw a suitable line. [3]



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(ii) Use the graph to find the distance water will have to be pumped down to reach 150 °C. [1]

distance = ... km

(d) This power station will provide 2.4 MW (2 400 000 W) for supplying homes. Calculate how many homes this power station could supply. Assume each home uses 2 000 W of power. [2]

number of homes = ...

12

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7. A semi-detached house is poorly insulated.
The owner has £3 200 available to spend on improving the insulation.
Information on each type of insulation is shown in the table below.

Part of house	Insulated or not	Heat energy lost per second (W)	Cost of insulation (£)	Payback time (years)	Expected annual saving (£)
LOFT	No insulation	4 200			
	Fibre glass laid on floor of loft	1 500	800	.....	200
CAVITY WALL	No insulation	3 000			
	Insulated with foam	1 300	1 200	10	120
DOORS	Wood	1 200			
	PVCu	1 000	1 200	60	.....
WINDOWS	Single glazed	1 500			
	Double glazed	1 200	2 400	96	25

(a) Complete the spaces in the last **two** columns of the table. [2]

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(b) Use information from the table opposite to advise the owner on how best to spend all the £3 200 on insulation. **[6 QWC]**

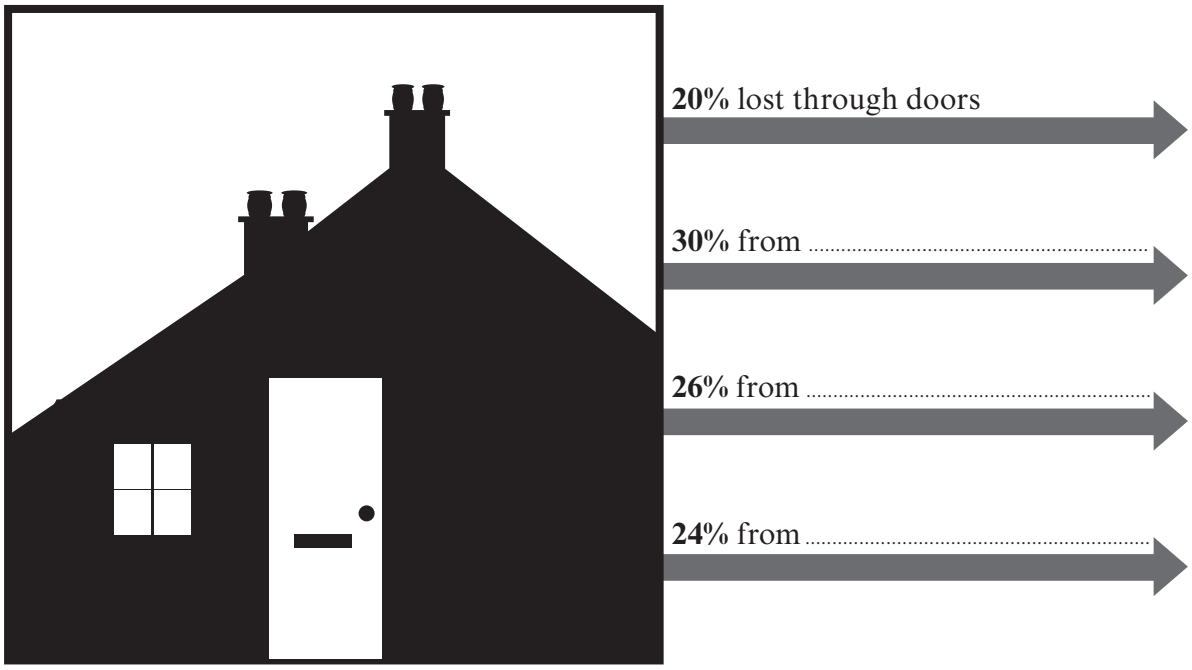
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(c) The diagram shows the percentages of energy lost from the house if it is **fully insulated**. Label the arrows to show which part of the house each percentage comes from. *One has been done for you.* You should refer to the table on page 16. [2]



(d) Explain how convection currents are set up in a cavity wall with no insulation. [2]

.....

.....

.....

12

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2013

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2013 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

	Page
Physics 1 - Foundation Tier	1
Physics 1 - Higher Tier	5
Physics 2 - Foundation Tier	9
Physics 2 - Higher Tier	13
Physics 3 - Foundation Tier	17
Physics 3 - Higher Tier	20

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GCSE SCIENCE - PHYSICS 1

FOUNDATION TIER

Question			Marking details	Marks
1.	(a)		visible light – infrared - microwaves all correct – 2 marks 1 or 2 correct – 1 mark	2
	(b)	(i)	17[%] (accept 100-83)	1
		(ii)	increases / heats up / rises (accept – very hot / gets hot / warms it up)	1
	(c)		ticks in boxes 2, 3 & 4 (3x(1) – each additional tick over 3 loses a mark)	3
			Question total	**[7]**
2.	(a)		2.2 [kW]	1
	(b)	(i)	X	1
		(ii)	3 960 000 J	1
		(iii)	use of 1.6 (1) conversion of 30 min to 0.5 h and multiply (1) Answer 0.8 [kWh] scores (2) Answer 48 – 1 mark (1.6 x 30 – uses the correct power) 0.5 / 1.1 / 500 / 1 100 / 800 – 1 mark (has converted time correctly) (1.6 ÷ 0.5) = 1 mark only	2
		(iv)	0.8 (**ecf**) x 15 = 12 [p] mark is for the answer. Don't accept £0.12 p	1
			Question total	**[6]**
3.		(i)	beta	1
		(ii)	Any 2 x (1): - alpha would not penetrate through [that much] air - gamma would not be absorbed by [that much] air - beta blocked by that much air answer **must** refer to penetration through **air** or implied through air e.g. alpha would not get that far	2
		(iii)	Any 2 x (1): repeat [the experiment] (accept more results) measure [counts] over a longer period of time take readings at smaller distance intervals start taking readings at 0 (accept increase the range) use a different part of the quarry wall Don't accept: more people do the experiment / better detectors	2
		(iv)	[decay is] random / no pattern / decay at different times / decay is disorganised. (Do not accept unpredictable.)	1
			Question total	**[6]**

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Question			Marking details	Marks
4.	(a)	(i)	1 000 x 25 = 25 000 [kg] mark is for the answer on answer line	1
		(ii)	25 000 (**ecf**) x 120 (1) = 3 000 000 [J] (1)	2
	(b)		$\frac{1.8}{2}$ x 100 (1) = 90[%] (1) Answer 0.9 – 1 mark	2
	(c)		back up or quick start (1) when demand increases e.g. at breakfast time / break in a sporting event / another power station has broken down (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(d)	(i)	reduce energy or heat losses / increase efficiency (do not accept just reduce the current or there is no heat loss)	1
		(ii)	[low voltages are] saf**er** / high voltages are dangerous / for safety	1
			Question total	**[9]**
5.	(a)	(i)	30 thousand [years]	1
		(ii)	8.3 [minutes] (ignore reference to light if written)	1
		(iii)	13 [light hours]	1
		(iv)	accept > 0.4 [AU] and <1 [AU]	1
	(b)	(i)	absorbing (1)	2
		(ii)	red shifted (1)	
	(c)	(i)	A	1
		(ii)	B	1
			Question total	**[8]**

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Question			Marking details	Marks
6.	(a)	(i)	Gas (1) because it produces <u>smallest amount / less carbon dioxide or carbon monoxide</u> (1) accept converse argument. **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
		(ii)	Gas (1) because it produces <u>smallest amount / less sulfur dioxide or nitrous oxide</u> (1) (e.g. accept because sulphur dioxide is 1). Accept converse argument. **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(b)	(i)	heats water / produces steam (accept they use cold water)	1
		(ii)	operates 24 hours a day (accept not always sunny / rocks are always hot / produces electricity in the night / [more] reliable)	1
	(c)	(i)	plots (2) ± ½ small square division (ignore any other points that are plotted) -1 mark for each incorrect plot up to a max of 2 straight line (1) (ignore any line before the 1st point). Don't accept double lines / whispy / disjointed / wobbly lines or the line missing points.	3
		(ii)	6.5 ± 0.05 [km] **ecf** value must be taken from their graph	1
	(d)		$\frac{2400000}{2000}$ (1) = 1 200 (1)	2
			Question total	**[12]**

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Question			Marking details	Marks
7.	(a)		4 (1), 20 (1)	2
	(b)		Indicative content: The advantages of insulating the loft are of primary importance. The money spent is the least, it is recouped in the shortest time and gives the greatest gain in energy loss reduction (2 700 W), this accounts for £800 of the spending money. The cavity wall insulation is of second priority with an outlay of £1200, a payback time of just 10 years and the next greatest energy saving of 1 700 W. The remaining money of £1200 is better spent on replacing their doors because of the smaller payback time. The doors have a payback time of 60 years but save only 200 W in total. [The total spend is £3 200 with an annual saving of £340 giving a payback time of 9.4 years.] **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
	(c)		loft / roof, cavity / wall, windows [2 marks for all correct, 1 mark for 1 or 2 parts correct]	2
	(d)		[Inner] wall / house heats the air (1) which becomes less dense / rises (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.** **Question total**	2 **[12]**
			Foundation tier paper total	**[60]**

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HIGHER TIER

Question			Marking details	Marks
1.	(a)	(i)	Gas (1) because it produces <u>smallest amount / less carbon dioxide or carbon monoxide</u> (1) accept converse argument. **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
		(ii)	Gas (1) because it produces <u>smallest amount / less sulfur dioxide or nitrous oxide</u> (1) (e.g. accept because sulphur dioxide is 1). Accept converse argument. **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(b)	(i)	heats water / produces steam (accept they use cold water)	1
		(ii)	operates 24 hours a day (accept not always sunny / rocks are always hot / produces electricity in the night / [more] reliable)	1
	(c)	(i)	plots (2) ± ½ small square division (ignore any other points that are plotted). -1 mark for each incorrect plot up to a max of 2 straight line (1) (ignore any line before the 1st point). Don't accept double lines / whispy / disjointed / wobbly lines or the line missing points.	3
		(ii)	6.5 ± 0.05 [km] **ecf** value must be taken from their graph	1
	(d)		$\frac{2400000}{2000}$ (1) = 1 200 (1)	2
			Question total	**[12]**
2.	(a)		4 (1), 20 (1)	2
	(b)		Indicative content: The advantages of insulating the loft are of primary importance. The money spent is the least, it is recouped in the shortest time and gives the greatest gain in energy loss reduction (2 700 W), this accounts for £800 of the spending money. The cavity wall insulation is of second priority with an outlay of £1200, a payback time of just 10 years and the next greatest energy saving of 1 700 W. The remaining money of £1200 is better spent on replacing their doors because of the smaller payback time. The doors have a payback time of 60 years but save only 200 W in total. [The total spend is £3 200 with an annual saving of £340 giving a payback time of 9.4 years.] **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.	6

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Question			Marking details	Marks
			3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	
	(c)		loft / roof, cavity / wall, windows [2 marks for all correct, 1 mark for 1 or 2 parts correct]	2
	(d)		[Inner] wall / house heats the air (1) which becomes less dense / rises (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(e)		Reduced temperature difference between inside and outside (1) results in less money (spent and) saved / less energy used on heating (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(f)		Units saved = $\frac{12000}{15}$ [or $\frac{120}{0.15}$]= 800 (1 conv+substitution, 1 ans) Time = $\frac{800}{1.7}$ (1) **ecf** for 800= [470.588 hours] Answer of 470.588 / 470.59/470.6/471/470 – award 3 marks 470.58/470.5/ 0.47– award 2 marks 4.7 – award 1 mark 0.0047 – award 0 marks **Question total**	3 **[17]**
3.	(a)		Alpha and beta completely stopped by any thickness (1), gamma intensity reduced (1) by an amount that depends on the thickness of the concrete (1) {NB1 for "alpha, beta, gamma all stopped give 1 mark only} {NB2 for "gamma stopped if the concrete is thick enough" 1 mark}	3
	(b)	(i)	e.g. stored underground / vitrification / in tanks of deep water / lead lined or concrete containers / at sea. Don't accept put into space.	1
		(ii)	suitable advantage such as safe from terrorism/secure/away from living things (1) suitable disadvantage such as may get into water supply / containers leak in time / difficult to monitor / earthquakes (1) Don't accept reference to cost or time. (Accept unrelated answer to part (i))	2
			Question total	**[6]**

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Question			Marking details	Marks
4.	(a)	(i)	A network of [power] cables/ wires (1) that connect power stations to consumers / homes / schools / factories.(1)	2
		(ii)	low**er** current (1) to **reduce** energy / heat losses or to improve efficiency (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(b)	(i)	step-down because output voltage is smaller / input voltage higher / reduces voltage **or** less turns on output coil / more turns on input coil / turns reduced. (Accept it supplies homes / schools / industry.)	1
		(ii)	[power = voltage x current] $I = \frac{10000000}{400000}$ (1 sub/manip, 1 conv) {for $\frac{10}{400}$ with answer = 1 mark, but with any compatible conversion gets both marks e.g. $\frac{10000}{400}$ – 2 marks} = 25[A] (1 ans)	3
		(iii)	$99 = \frac{\text{power output}}{10\text{x}10^6} \times 100$ $\text{power output} = \frac{99}{100}\text{x } 10\text{x}10^6 = 9.9\text{x}10^6$ W or 9.9 MW (1sub, 1 manip, 1 ans **with correct unit**)	3
			Question total	**[11]**
5.	(a)		*….stays above the same point on the Earth* (1) *…..and orbits the Earth in 24 hours / same time / same rate as Earth spins [once]*. (1) Don't accept orbits the Earth at the same speed	2
	(b)	(i)	2(1) x 0.2 (1) = [0.4 V] On the answer line: If 0.4 only award 2 marks / 0.2 award 1 mark / 2 or 0.8 award 0 marks	2
		(ii)	signal has to travel twice as far [as 36 million km] / up and down	1
		(iii)	[single cycle of] smaller amplitude (1) starting at 0.24 ± 0.02 on horizontal axis (1) Ignore the wavelength or number of cycles.	2
			Question total	**[7]**

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Question			Marking details	Marks
6.	(a)		the <u>distance/ how far</u> light travels in **<u>4 years</u>**	1
	(b)		Indicative content: Light coming from the centre of stars is absorbed by the gases in their atmospheres / interstellar gases and re-emitted in all directions. Their frequency / wavelength gives information about the gases present and the fact that they are red shifted gives information about their distance away and the speed at which they are moving away – by the application of Hubble's measurements and law. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[7]**
			Higher tier paper total	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

New GCSE

4463/01

SCIENCE A
FOUNDATION TIER
PHYSICS 1

P.M. THURSDAY, 17 January 2013

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**2**	
2.	**3**	
3.	**3**	
4.	**6**	
5.	**3**	
6.	**8**	
7.	**9**	
8.	**7**	
9.	**6**	
10.	**13**	
Total	**60**	

4463 010001

ADDITIONAL MATERIALS

In addition to this paper you may 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.
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.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **10***(a)*.

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Equations

$\text{density} = \dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
energy transfer = power × time	$E = Pt$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
$\%\ \text{efficiency} = \dfrac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$	
wave speed = wavelength × frequency	$c = \lambda f$
$\text{speed} = \dfrac{\text{distance}}{\text{time}}$	

SI multipliers

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

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Answer **all** *questions.*

1. The Big Bang theory of the origin of the Universe was built up based on some of the following facts.

Tick (✓) only **two** boxes alongside the facts that helped to set up this theory. [2]

Light from distant galaxies is red shifted. ☐

Our Sun is one of billions of stars in the Milky Way galaxy. ☐

Scientists have discovered that stars are made from gases. ☐

Scientists have detected Cosmic Microwave Background Radiation (CMBR). ☐

There are billions of galaxies in the Universe. ☐

2

4463 010003

2. The boxes in the left column show four energy sources.
Draw a single line from each energy source to the correct statement on the right. [3]

Coal	An energy source used in power stations that have high decommissioning costs.
Nuclear fuel	An energy source that is burned in power stations.
The Sun	An energy source that drives turbines directly.
Wind	An energy source that supplies solar panels.

3

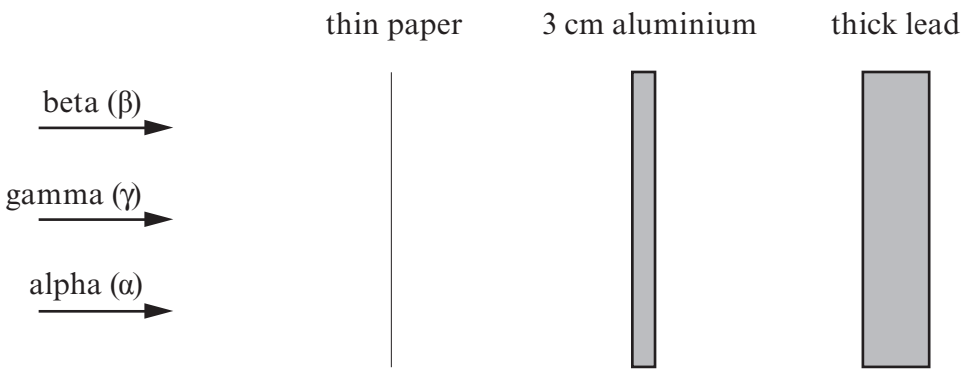
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3. The diagram shows three types of radiation, alpha (α), beta (β) and gamma (γ).



Continue each arrow to show how far **each type** of radiation travels before it gets absorbed. [3]

3

4.

Earth	Universe	Milky Way	Sun	Solar system

(a) Write the objects named above in order of **increasing size**. [4]

....

Smallest **Largest**

(b) Which **one** of the above objects is a galaxy? ..... [1]

(c) State what is meant by a 'light year'. [1]

.....

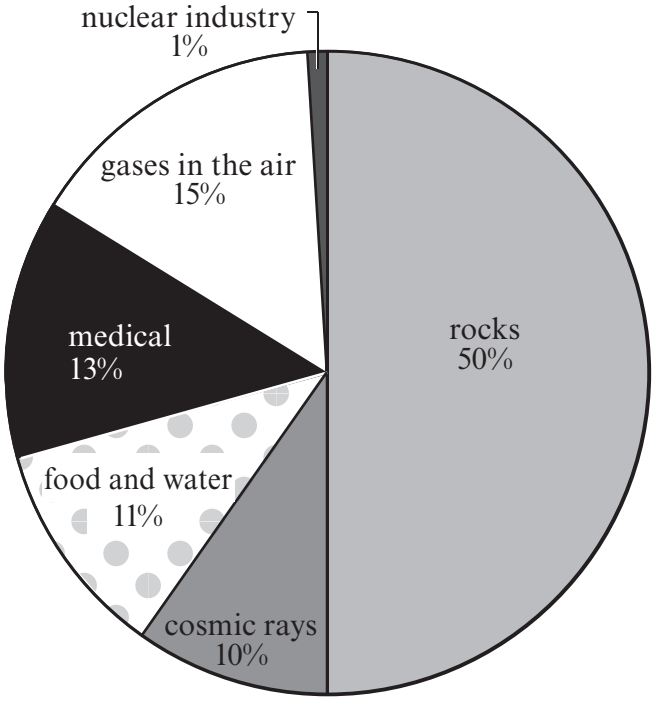
6

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5. Background radiation is all around us. The pie chart shows the main sources of this radiation in one area of the U.K.



(a) Name a radioactive gas that is released from the ground. ..... [1]

(b) The background count rate in the area concerned was 30 counts per minute (cpm). Calculate the count rate due to rocks alone. [1]

Count rate = ... cpm

(c) The government is considering doubling the number of nuclear power stations in the country. State why this would not significantly change the pie chart. [1]

.....

.....

3

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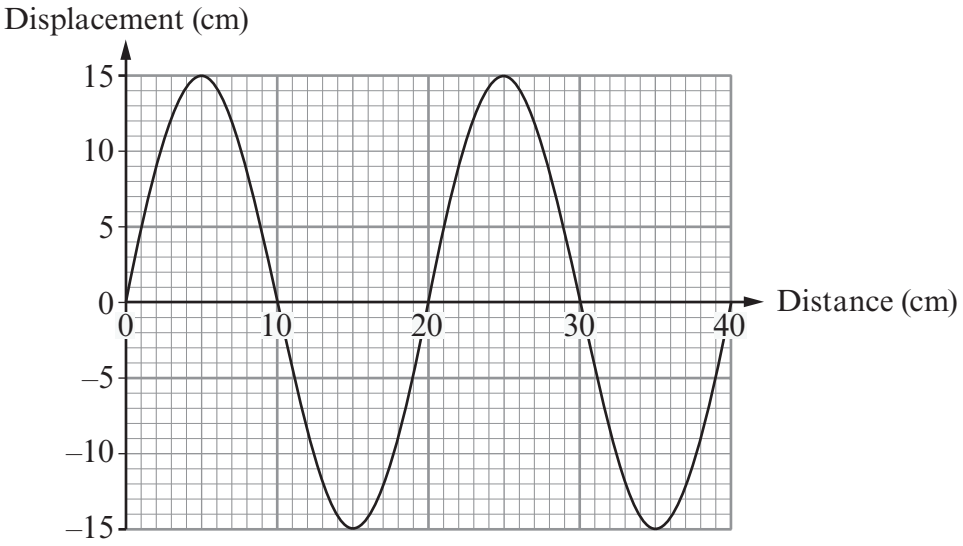
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6. Waves are shown on the grid below.



(a) Write down the amplitude of the waves. ..... cm [1]

(b) Write down the wavelength of the waves. ..... cm [1]

(c) If 10 waves are produced in 5 seconds, calculate their frequency. [2]

frequency = ... Hz

(d) Use the equation:

wave speed = wavelength × frequency

to calculate the speed of the waves and state the unit. [3]

wave speed = ...

unit = ...

(e) **Underline** the correct statement in the bracket below.

If the wave amplitude was doubled the speed of the waves would (double / stay the same / halve). [1]

8

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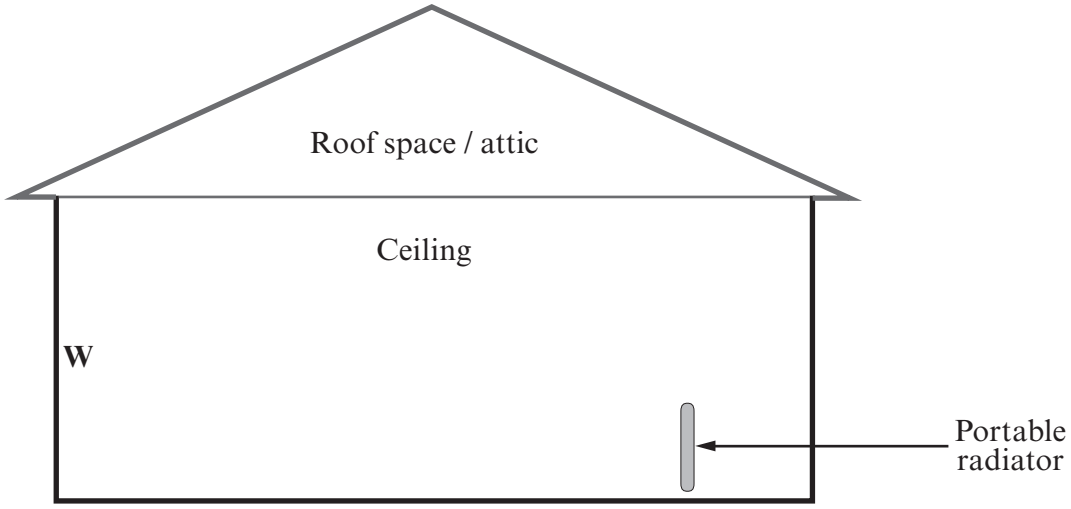
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7. A family moves into a bungalow where all the walls and ceiling are damp. They decide to dry it out using a portable oil-filled radiator that is placed in the position shown below.



(a) Heat transfer by conduction, convection or radiation is responsible for the following effects. **Circle** the correct word in each case.

(i) The wall near to the radiator dries before the wall **W** due to [1]

Conduction Convection Radiation

(ii) Heat energy, from the hot oil in the radiator, passes **through the metal** to the air outside due to [1]

Conduction Convection Radiation

(b) Explain how a convection current arises, which dries the ceiling quickly. [2]

.....

.....

.....

.....

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(c) The following table gives information about heat losses from a bungalow without insulation.

Part of the bungalow	Percentage of heat lost without insulation	Cost of insulation (£)	Saving per year (£)
Roof	50%	600	200
Walls	25%	1 000	150
Floor	5%	2 300	40
Doors and windows	.....	3 500	100

(i) Complete the table to show the percentage of heat lost through the doors and windows. [1]

(ii) Explain why insulating the attic would be the most cost-effective method of reducing heat loss. [2]

.....

.....

(iii) State how heat is lost through the ceiling **and then** the attic space when the attic is not insulated. [2]

.....

.....

9

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8. The following table gives information about 4 metals that may be used in overhead cables in the National Grid.

Metal	Strength of cable (units)	Ability to conduct electricity (units)	Density (kg/m^3)
Copper	250	600	8 950
Steel	800 to 2 000	10	7 900
Aluminium	220	35	2 700
Lead	10	5	11 300



(a) Use only the information in the table above to answer the following questions.

(i) Give **one** reason why copper is usually the best metal to use for electrical wires.[1]

.....

(ii) Name the metal that would be most unsuitable for overhead cables. [1]

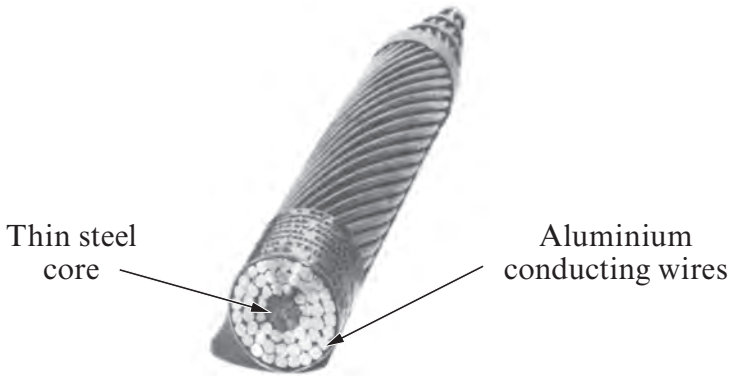
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(iii) Explain why actual overhead cables are made from a thin steel core surrounded by aluminium conducting wires. [3]



.....

.....

.....

.....

.....

(b) The aluminium used in a 100 m length of cable has a volume of 0.12 m^3. Use the equation

mass = density × volume

and information from the table on the opposite page to calculate the mass of aluminium in this cable. [2]

mass = ... kg

7

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9. Read the following passage.

Its official now! Radiation from your mobile phone may be killing you.

(Freely adapted from an article from EMRstop.org)

Source: DNA India

Professor Kumar, of Bombay University has done extensive research on mobile phone radiation and its effects.

The major health hazards of non-ionising radiation from mobile phones and masts are given below.

Excessive use of mobile phones can cause cancer. Use of mobile phones for more than 30 minutes per day for 10 years increases the risk of brain cancer.

There is a 400% increase in the risk of brain cancer among teenagers using mobile phones. The younger the child, the deeper the penetration of electromagnetic radiation because the skull is thinner.

Mobile phone radiation causes irreversible damage to male fertility. Studies have found a 30% lower sperm count in intensive male users of mobile phones.

People who often use mobile phones can suffer damage to their vision. Mobile phones that work at 900 and 1 800 MHz have outputs of 0.25 W and 0.125 W respectively and increase the temperature within the eye by 0.1 °C.

Exposure to electromagnetic waves can cause sleep disorders.

(a) Use information in the passage to answer the following questions.

(i) Give **one** frequency at which mobile phones operate. ..... [1]

(ii) It is suggested that the output power is directly proportional to the frequency of mobile phones.
Use evidence from the passage to show whether or not this is correct. [2]

.....

.....

.....

.....

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(iii) Explain what needs to be done for the claims in the passage to be accepted by the wider scientific community. [2]

.....

.....

.....

(b) Name the region of the electromagnetic spectrum used by mobile phones to communicate with their masts. [1]

.....

6

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10. The table below gives information about generating electricity from wind and nuclear power.

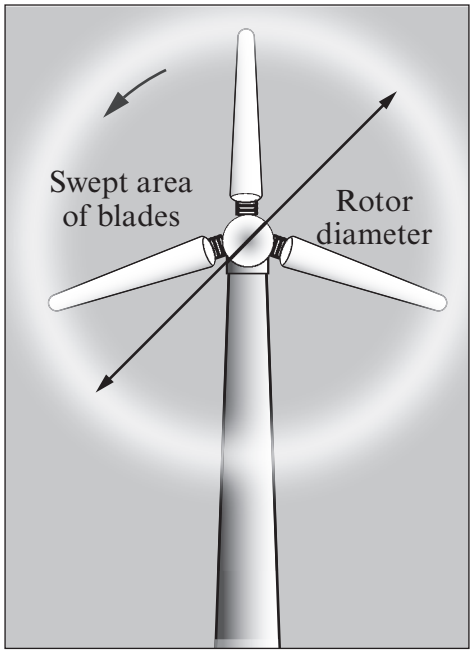
How they compare		
	A wind turbine	A nuclear power station
Overall cost of generating electricity (p/kWh)	5.6	2.8
Maximum power output (MW)	2	3 600
Lifetime (years)	15	45
Waste produced	None	Radioactive waste
Lifetime carbon footprint (g of CO_2/kWh)	4.64/5.25 (onshore/offshore)	5
Commissioning cost (£ million)	3	4 000

(a) Use your knowledge and information from the table to **compare** the **cost-effectiveness** and **environmental** impact of the two methods of generating electricity. [6 QWC]

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(b) The maximum power output from a wind turbine depends on the rotor diameter as shown in the table.



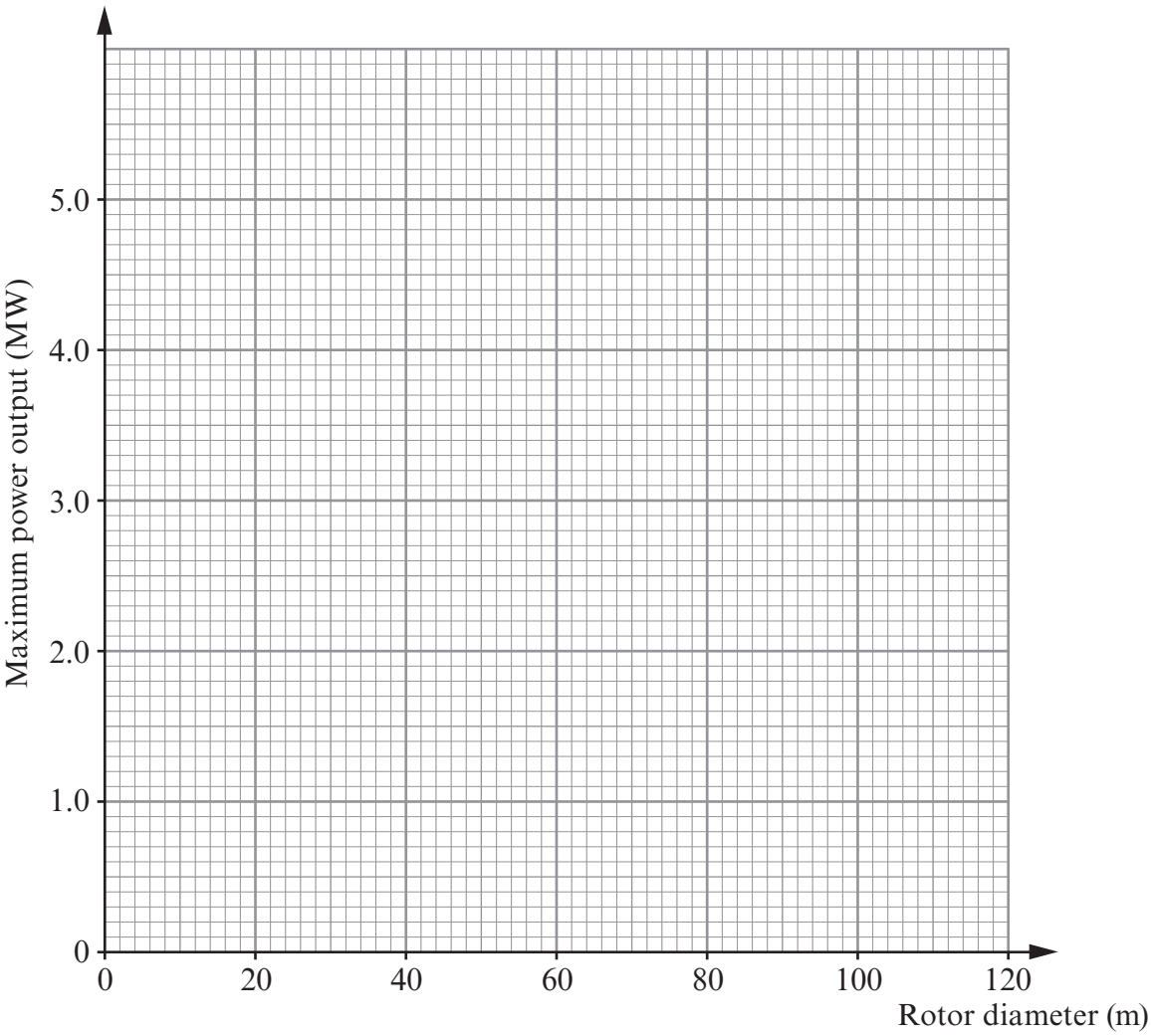
Rotor diameter (m)	Maximum power output (MW)
40	0.5
60	1.1
80	2.0
90	3.0
110	4.5

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(i) Plot the data on the grid below and draw a suitable line. [3]



(ii) Describe the relationship between rotor diameter and maximum power output. [2]

.....

.....

.....

(c) Use an equation from page 2 to calculate the efficiency of the wind turbine when the useful power transfer is 3.0 MW and the input power is 5.0 MW. [2]

efficiency = ... %

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE - PHYSICS (NEW)

JANUARY 2013

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2013 examination in GCSE SCIENCE - PHYSICS (NEW). They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

Unit	Page
PHYSICS 1 - FOUNDATION TIER	1
PHYSICS 1 - HIGHER TIER	4
PHYSICS 2 - FOUNDATION TIER	7
PHYSICS 2 - HIGHER TIER	12

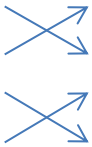
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GCSE Science - Physics 1 Mark Scheme

January 2013

FOUNDATION TIER

Question			Marking details	Mark
1.			1st and 4th boxes ticked. **Question total**	2 **[2]**
2.			 Any 1 correct - 1 mark Any 2 correct – 2 marks Any 3 or all four correct – 3 marks **Question total**	3 **[3]**
3.			Beta stopped at aluminium (1) Gamma stopped at lead or passes through the lead (1) Alpha stopped at thin paper (1) **Question total**	3 **[3]**
4.	(a) (b) (c)		Earth, Sun, Solar system. Milky Way, Universe. All in correct positions – 4 marks, 4 correct- 2 marks, 3 correct – 2 marks, 2 correct – 1 mark Milky Way It is a <u>distance</u> (travelled by light in 1 year) **Question total**	 4 1 1 **[6]**
5.	(a) (b) (c)		Radon 15 [cpm] Nuclear industry accounts for <u>only</u> 1% / a <u>very</u> small part **Question total**	1 1 1 **[3]**
6.	(a) (b) (c) (d) (e)		15 [cm] 20 [cm] $f = \frac{10}{5}$ (1) = 2 [Hz] (1) wave speed = 20 (ecf) x 2 (ecf) (1 – substitution) = 40(1) Unit cm/s (1) stay the same **Question total**	1 1 2 3 1 **[8]**

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Question			Marking details	Mark
7.	(a)	(i)	radiation	1
		(ii)	conduction	1
	(b)		Warm air is less dense than cold air (1) so it rises (1)	2
	(c)	(i)	20[%]	1
		(ii)	The cost [of insulation] is the <u>least</u> of all (accept "<u>just</u> £600")(1) and the annual saving is the <u>greatest</u> (accept "<u>shortest</u> payback time") (1)	2
		(iii)	conducted through the ceiling (1) then convected through the attic space(1).	2
			Question total	**[9]**
8.	(a)	(i)	best ability to conduct electricity	1
		(ii)	Lead	1
		(iii)	Steel provides the strength (up to 2 000 units) (1), aluminium is used for its low density (1) meaning the wires aren't too heavy (1)	3
	(b)		mass = 2 700 x 0.12 (1 substitution) = 324 [kg] (1)	2
			Question total	**[7]**
9.	(a)	(i)	900 or 1 800 <u>MHz</u> (1) (value + unit for the mark)	1
		(ii)	The bigger the frequency, the <u>smaller</u> the output power (1) whereas to be proportional, as one increases, the other would increase.(1) OR EQUIVALENT	2
		(iii)	more research (1) by <u>other</u> scientists (1)	2
	(b)		microwaves	1
			Question total	**[6]**
10.	(a)		Indicative content: Cost of generating electricity using nuclear energy is cheaper than wind. To generate the same power output requires 1 800 turbines for every nuclear power station which would cost £5 400 million compared with £4 000 million. Also during the lifetime of a nuclear power station, wind turbines would need to be replaced 3 times. There is no waste produced by wind but with nuclear power there is radioactive waste to dispose of which adds cost and has an impact on the environment due to radiation hazards. Onshore wind power would produce less of a greenhouse effect than nuclear but offshore wind would produce more.	6

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Question			Marking details	Mark
			5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	
	(b)	(i)	plots (1) x2 smooth curve or best fit straight line (1)	3
		(ii)	As rotor diameter increases so does the maximum power output (1) but the increase is non-uniform / at an increasing rate / non-linear / not proportional (1)	2
	(c)		Efficiency = $\frac{3}{5}$ x 100 (1 substitution) = 60[%] (1)	2
			Question total	**[13]**
			Foundation paper total	**[60]**

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HIGHER TIER

Question			Marking details	Mark
1.	(a)	(i)	best ability to conduct electricity	1
		(ii)	Lead	1
		(iii)	Steel provides the strength (up to 2 000 units) (1), aluminium is used for its low density (1) meaning the wires aren't too heavy (1)	3
	(b)		mass = 2 700 x 0.12 (1 substitution) = 324 [kg] (1)	2
			Question total	**[7]**
2.	(a)	(i)	900 or 1 800 MHz (1) (value + unit for the mark)	1
		(ii)	The bigger the frequency, the smaller the output power (1) whereas to be proportional, as one increases, the other would increase.(1) OR EQUIVALENT	2
		(iii)	more research (1) by other scientists (1)	2
	(b)		microwaves	1
			Question total	**[6]**
3.	(a)		A network (1) of power stations/substations/power lines (1)	2
	(b)	(i)	To reduce voltage (1) to safe levels (1)	2
		(ii)	Convert 0.46 MW to 460 000 W (1), subs, (1), rearrange $\frac{460000}{230}$ = 2 000 [A] (1)	3
			Question total	**[7]**
4.	(a)		Indicative content: Cost of generating electricity using nuclear energy is cheaper than wind. To generate the same power output requires 1 800 turbines for every nuclear power station which would cost £5 400 million compared with £4 000 million. Also during the lifetime of a nuclear power station, wind turbines would need to be replaced 3 times. There is no waste produced by wind but with nuclear power there is radioactive waste to dispose of which adds cost and has an impact on the environment due to radiation hazards. Onshore wind power would produce less of a greenhouse effect than nuclear but offshore wind would produce more.	6

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Question			Marking details	Mark
			5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	
	(b)	(i)	plots (1) x2 smooth curve or best fit straight line (1)	3
		(ii)	As rotor diameter increases so does the maximum power output (1) but the increase is non-uniform / at an increasing rate / non-linear / not proportional (1)	2
	(c)		use of 3 MW (1), subs into equation (1), rearrange to give $\frac{3}{0.6}$ ans = 5 [MW] (1)	3
			Question total	**[14]**
5.	(a)		Helium Y, Iron N, Hydrogen Y, Sodium Y, (all correct 2 marks / 2 or 3 correct 1 mark / 0 or 1 correct 0 marks)	2
	(b)	(i)	Conversion of 410 nm to 410 x 10^{-9} (1) subs (1), rearrange $\frac{3x10^{8}}{410x10^{-9}}$ = 7.3 x 10^{14} [Hz] (1)	3
		(ii)	Convert light year to m – $3x10^{8}$ x $3.2x10^{7}$ (1) = $9.6 x10^{15}$ [m] (1), x 8.6 = $8.26x10^{16}$ [m] (1) (accept $8.3x10^{16}$ but not $8.2x10^{16}$)	3
			Question total	**[8]**

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Question			Marking details	Mark
6.		(i)	Low penetrating power (1) so would not get to tumour (1)	2
		(ii)	Penetration depends on energy (1) and do not have to penetrate the body to get to the tumour (1).	2
		(iii)	They are ionising radiation (1) so destroy/kill the cancer cells (1).	2
			Question total	**[6]**
7.	(a)	(i)	3 100 [J] (1)	1
		(ii)	3.1 [kW] (1)	1
		(iii)	3.1 x 10 = 31 kWh (1) x 13 = <u>403 p</u> (1)	2
	(b)		There would be a greater temperature difference (1) so energy loss per second increases resulting in greater cost of heating (1).	2
			Question total	**[6]**
8.			Indicative content: In **cosmological red shift**, the **wavelength** at which the radiation is *originally* emitted is lengthened as it travels through expanding space. **Cosmological red shift** results from the expansion of space itself and *not* from the motion of an individual body. Compare a **galaxy** formed a long time ago, with a **galaxy** formed more recently. Although each **galaxy** emits the same **wavelength** of the **light**, the **light** from the older **galaxy** has spent longer travelling through the expanding **Universe**, and has therefore experienced a greater 'stretching' (**red shift**). The universe must have originated from a singularity, formed by a Big Bang and has been expanding ever since. 5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. 3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. 1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. 0 marks The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[6]**
			Higher paper total	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

New GCSE

4463/01

SCIENCE A
FOUNDATION TIER
PHYSICS 1

P.M. FRIDAY, 15 June 2012

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**6**	
3.	**5**	
4.	**7**	
5.	**6**	
6.	**12**	
7.	**6**	
8.	**9**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may 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.

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.

You are reminded of the necessity for good English and orderly presentation in your answers.

A list of equations is printed on pages 2 and 3. In calculations you should show all your working.

You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **8***(a)*.

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Equations and Units

Physics 1

$$\text{power} = \frac{\text{energy transfer}}{\text{time}} \qquad P = \frac{E}{t}$$

units used (kWh) = power (kW) × time (h)
cost = units used × cost per unit

$$\%\ \text{efficiency} = \frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$$

$$\text{density} = \frac{\text{mass}}{\text{volume}} \qquad \rho = \frac{m}{V}$$

$$\text{wave speed} = \text{wavelength} \times \text{frequency} \qquad v = \lambda f$$

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

Physics 2

$$\text{power} = \text{voltage} \times \text{current} \qquad P = VI$$

$$\text{current} = \frac{\text{voltage}}{\text{resistance}} \qquad I = \frac{V}{R}$$

$$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}} \qquad a = \frac{\Delta v}{t}$$

acceleration = gradient of a velocity-time graph

$$\text{momentum} = \text{mass} \times \text{velocity} \qquad p = mv$$

$$\text{resultant force} = \text{mass} \times \text{acceleration} \qquad F = ma$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time}} \qquad F = \frac{\Delta p}{t}$$

$$\text{work} = \text{force} \times \text{distance} \qquad W = Fd$$

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Physics 3

$$\text{pressure} = \frac{\text{force}}{\text{area}} \qquad p = \frac{F}{A}$$

$v = u + at$

$x = \frac{1}{2}(u + v)t$

where u = initial velocity, v = final velocity, a = acceleration, t = time, x = displacement

Units

1 kWh = 3.6 MJ
T / K = θ / °C + 273

SI multipliers

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

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

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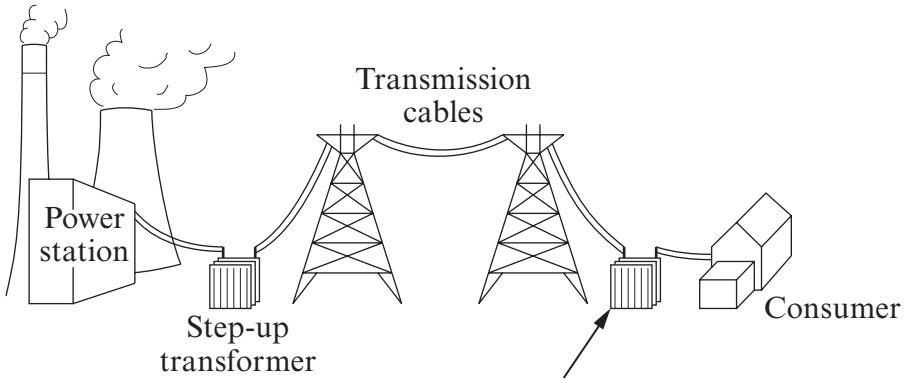
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Answer **all** *questions.*

1. The diagram shows how electricity is distributed from a power station to consumers.



.....

.....

(a) (i) Fill in the missing label on the diagram. [1]

(ii) Place a tick (✓) in the boxes next to the **three** correct statements about the step-up transformer. [3]

It allows the electricity to travel further. ☐

It increases the voltage. ☐

It increases the speed of the electricity through the cables. ☐

It decreases the current. ☐

It reduces energy losses from the cables. ☐

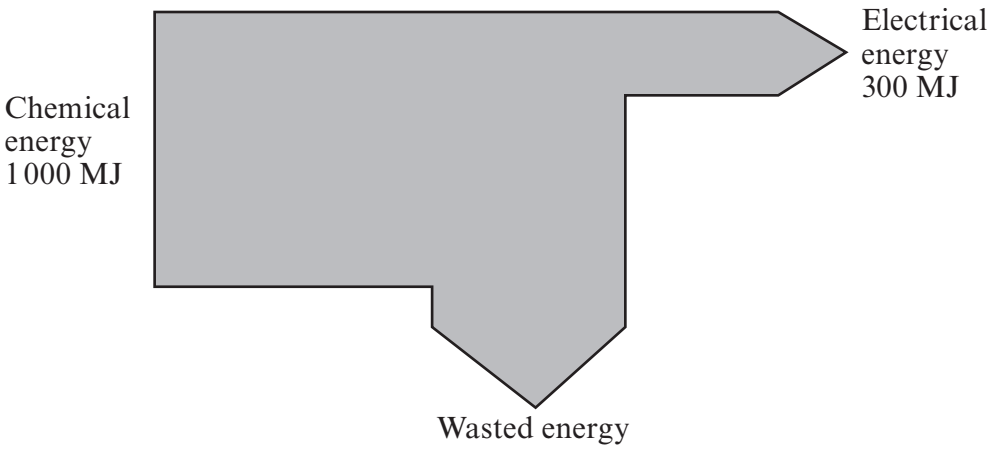
It decreases the voltage. ☐

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(b) The Sankey diagram shows the energy transfers for this power station.



(i) How much energy is wasted? ..... MJ [1]

(ii) What happens to this wasted energy? [1]

.....

(iii) Use an equation from pages 2 and 3 to calculate the efficiency of the power station. [3]

Efficiency = ... %

9

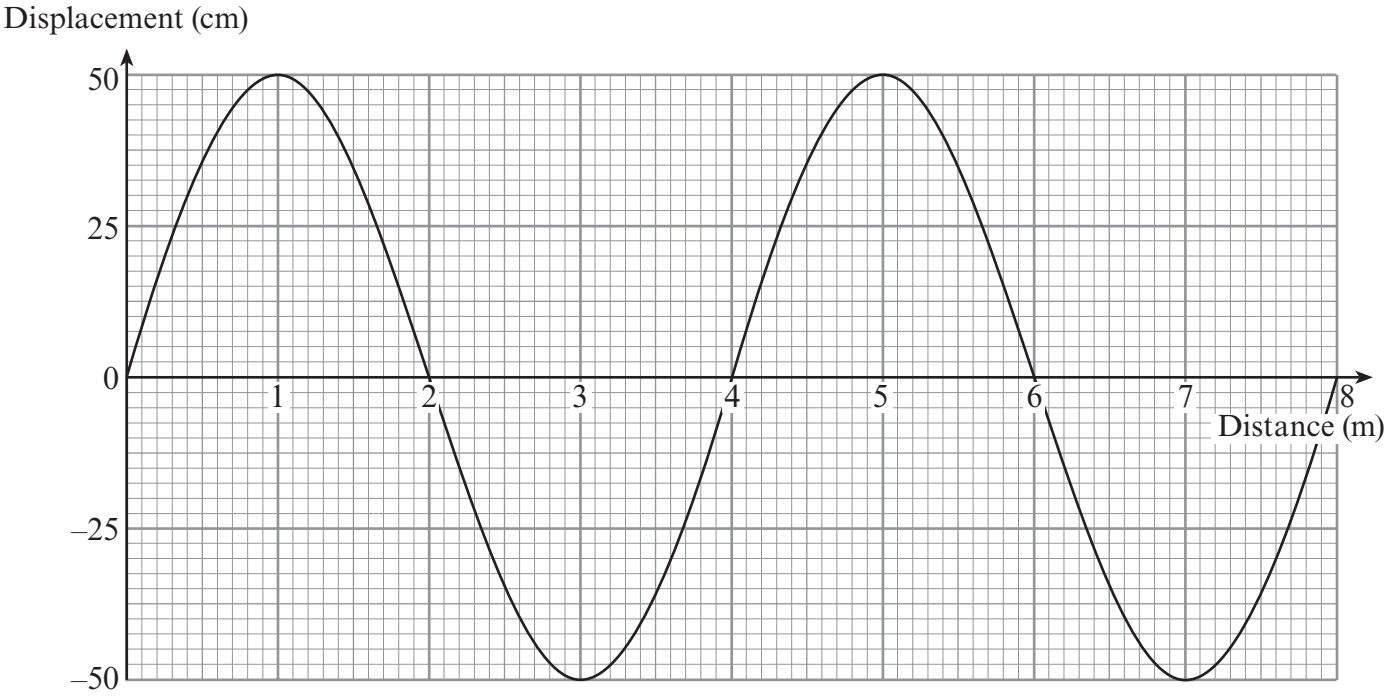
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2. The diagram shows a water wave on the ocean.



(a) (i) Write down the wavelength of the wave. .....m [1]

(ii) Write down the amplitude of the wave. .....cm [1]

(b) If the wave travels with a speed of 2.8 m/s along the surface, use the equation

$$\text{frequency} = \frac{\text{wave speed}}{\text{wavelength}}$$

to calculate the frequency of the wave. [2]

Frequency = ... Hz

(c) Use the equation

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

to calculate the distance travelled by the wave in 100 s. [2]

Distance = ... m

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3. **Radio waves, microwaves, infra-red** and **visible light** are all parts of the electromagnetic spectrum that are used for communication.

(a) State **one** property that they all have in common. [1]

.....

.....

(b) State **one** way in which they are different from one another. [1]

.....

.....

(c) Use the parts of the electromagnetic spectrum named above to complete the following sentences. [3]

Information is sent along optical fibres using ..... .

Satellite dishes on Earth use ..... to communicate with orbiting satellites.

Mobile phones receive ..... signals.

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4. The table shows data about some energy sources used to generate electricity in the UK.

Energy source	% of UK electricity generation	Total commissioning and decommissioning cost (£ million)	Generating cost per unit (p)	Output power (MW)
Coal	30	550	2.8	1 000
Gas	40	400	2.4	1 200
Nuclear	20	1 200	3.2	800
Wind turbine	0.004	2	3.3	2
Hydroelectric	3	400	3.5	80

(a) Use the information in the table to answer the following questions.

(i) Which type of energy source generates the most electricity for the UK? [1]

.....

(ii) Calculate how many wind turbines would be needed to produce the same output power as one nuclear power station. [2]

Number of wind turbines = ...

(iii) Apart from the total commissioning and decommissioning cost, give **two** reasons why a power company would prefer to build a gas power station rather than a hydroelectric power station. [2]

1. .....

.....

2. .....

.....

(b) Explain why the total commissioning and decommissioning cost for a nuclear power station is so high. [2]

.....

.....

.....

.....

.....

7

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5. A householder is considering using a **renewable** energy source to help him save money on electricity bills. He used some information from a local store to draw up the following table.

	Installation cost (£)	Saving per year (£)	Payback time (years)	Maximum power output (W)	Conditions needed
Wind turbine	1 200	600	2	5 400	Average wind speed 4 m/s, (maximum 12 m/s)
Roof top photovoltaic cells (PV)	14 000	.....	7	1 800	South-facing roof

(A photovoltaic cell (PV) converts sunlight energy into electrical energy.)

(a) What is meant by a **renewable** energy source? [1]

.....

.....

(b) (i) **Complete the table** by calculating the saving per year for the roof top photovoltaic cells (PV). [1]

(ii) Give reasons why the payback times for the wind turbine **and** roof top photovoltaic cells (PV) may be different from both those shown in the table. [2]

.....

.....

.....

.....

.....

(c) Explain how the introduction of roof top photovoltaic cells (PV) and wind turbines would benefit the environment. [2]

.....

.....

.....

.....

.....

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6. A householder has bought a plug-in monitor to check the amount of energy used by different appliances.



(a) A kettle was found to use 300 000 J of energy in 150 s. Use an equation from pages 2 and 3 to calculate the power of the kettle. [2]

Power = ... W

(b) When the monitor was used with a freezer, the power was found to be 100 W. The freezer was switched on for 5 hours.

Use the equations:

$$\text{units used (kWh)} = \text{power (kW)} \times \text{time (h)}$$

$$\text{cost} = \text{units used (kWh)} \times \text{cost per unit}$$

to calculate the cost of the electricity used, if one unit costs 12 p. [4]

Cost = ... p

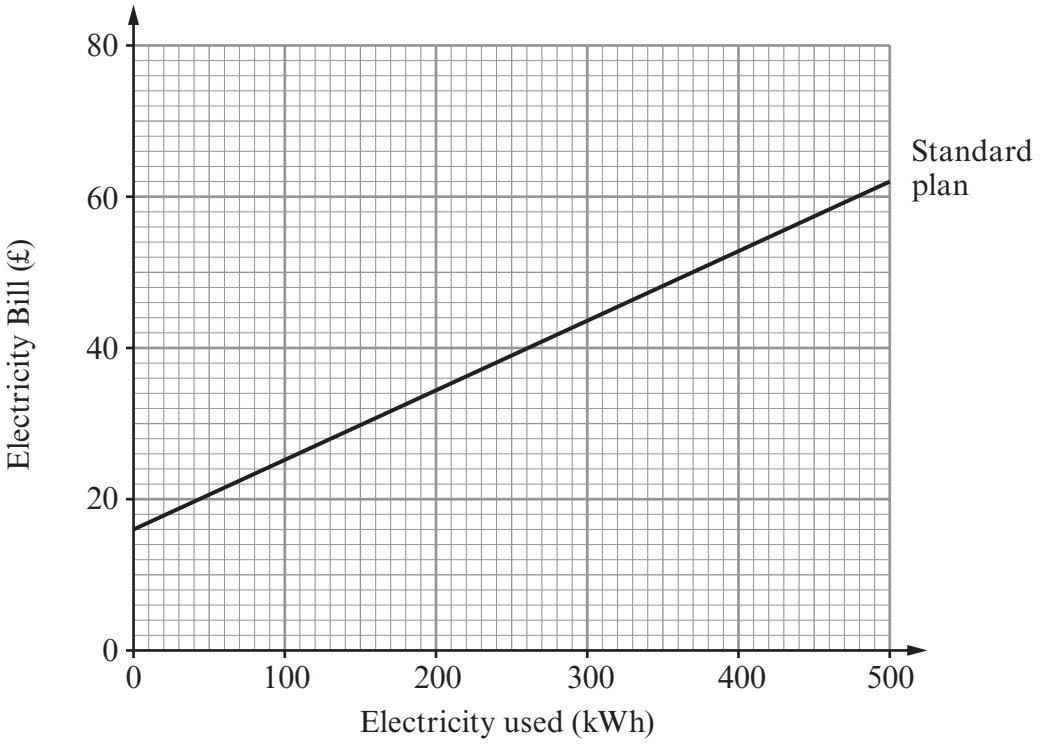
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(c) The householder can choose to pay for electricity on a Standard plan or an Economy plan.

The cost of the Standard plan for three months is shown on the grid below.



The table shows how the Economy plan cost changes with the number of kWh used during a three month period.

Number of kWh	0	100	200	300	400	500
Economy plan cost (£)	0	16	32	48	64	80

(i) **Plot the Economy plan data** on the same grid. [3]

(ii) Which plan would you recommend to a householder who uses 200 kWh every three months? [1]

.....

Give a reason for your answer.

..... [1]

(iii) State the minimum number of kWh a householder should use in a three month period before she decides to switch to the Standard plan. [1]

..... kWh

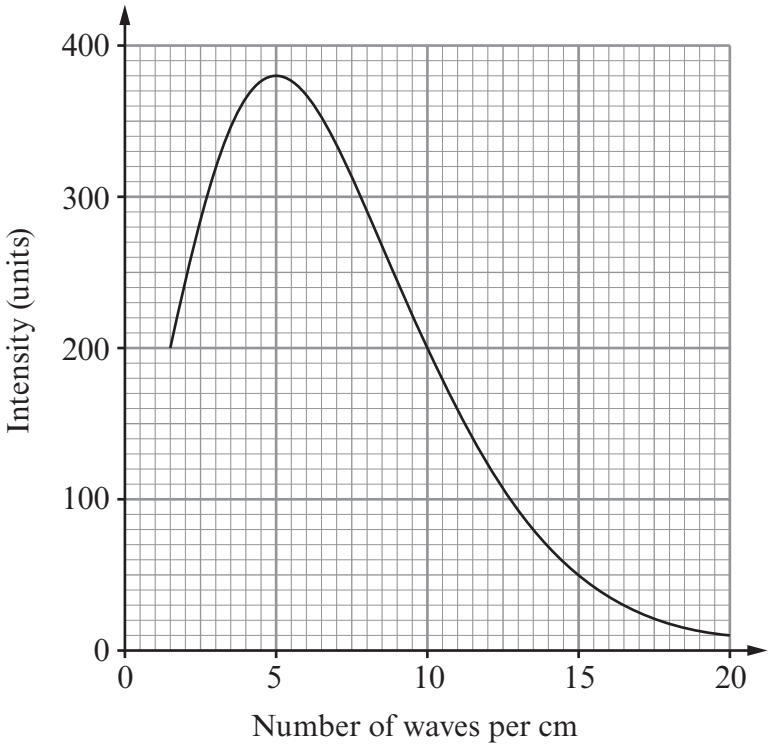
12

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7. Cosmic microwave background radiation (CMBR) fills the entire universe. The COBE satellite measured the spectrum of the cosmic microwave background radiation in 1990. The results are shown below.



(a) Use the graph to answer the following questions.

(i) State the intensity of the most intense microwaves detected. ..... units [1]

(ii) **Calculate** the wavelength, in millimetres, of the most intense microwaves. [2]

Wavelength = ... mm

(b) The cosmic microwave background radiation (CMBR) provides evidence for the origin of the universe.

(i) Name the theory that CMBR supports. ..... [1]

(ii) Describe this theory. [2]

.....

.....

.....

.....

6

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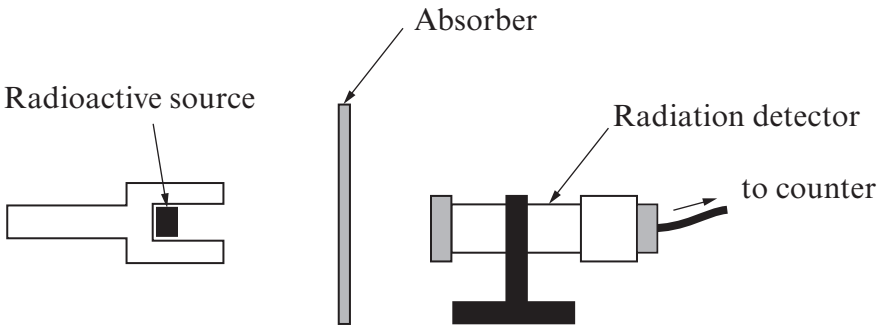
Turn over for Question 8

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8. A radiation detector is used to **measure the background radiation**. It shows that after 60 seconds the radiation count was 30.

It is then used to find the types of radiation that a radioactive source emits.



A number of different absorbers are placed, one at a time, between the detector and the radioactive source.
For each absorber, the average number of counts per second received by the detector is worked out.
The results shown in the table **include background radiation**.

Type of absorber	Average counts per second
None	25
Paper	5
Aluminium	5
Lead	2

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(a) Explain how **all** of the results are used to determine the types of radiation emitted by the radioactive source. Give a full account of your reasoning. [6 QWC]

(b) (i) State a method of storing the radioactive source safely, when it is not in use. [1]

(ii) Explain why it needs to be stored in this way. [2]

9

THERE ARE NO MORE QUESTIONS IN THE EXAMINATION.

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GCSE MARKING SCHEME

SUMMER 2012

SCIENCE - PHYSICS

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2012 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

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PHYSICS 1

FOUNDATION TIER

Question			Marking details	Marks Available
1.	*(a)*	(i)	Step-down transformer	1
		(ii)	Ticks in box 2, 4 & 5 [for each extra tick – 1 mark]	3
	(b)	(i)	700 [MJ]	1
		(ii)	lost as heat	1
		(iii)	equation (1) correct subs of 1000 & 300 (1) 30[%] (1)	3
			Question total	**[9]**
2.	*(a)*	(i)	4 [m]	1
		(ii)	50 [cm]	1
	(b)		Correct substitution (1) answer 0.7 [Hz] (1) **ecf** for wavelength	2
	(c)		Subs of 2.8 (1) answer 280 [m] (1)	2
			Question total	**[6]**
3.	*(a)*		Travel at the same speed [in a vacuum] / transverse waves / transfer energy / can be reflected / refracted / are not ionising	1
	(b)		Different wavelength / frequency / energy	1
	(c)		Infra red/visible (1) microwaves,(1) microwaves/infra red (1)	3
			Question total	**[5]**
4.	*(a)*	(i)	Gas	1
		(ii)	Use of 800 and 2 (1) = 400 (1)	2
		(iii)	Generating costs are cheaper or cost per unit is cheaper (1) output power is more (1) [or compare using numbers]	2
	(b)		Containment (1) to absorb radiation (1) **or** Containment of the waste (1) because it remains radioactive for a long time (1) **The 2nd mark must be linked to the 1st mark**.	2
			Question total	**[7]**
5.	*(a)*		Easily replaced / replenished / will not run out / sustainable Don't accept can use it again – treat this as neutral with other acceptable answer	1
	(b)	(i)	[£] 2000	1
		(ii)	Wind - variable wind speed (1) Solar - hours of sunshine / roof may not face South or intensity of Sun (1) Fuel costs could change (1) **Award a maximum of 2 marks only**	2
	(c)		Reduces CO_2 (1) which reduces the greenhouse effect / global warming (1) **or** Less SO_2 (1) which results in less acid rain (1) **or** Use less fossil fuels (1) so less extraction needed / less CO_2 / less SO_2 (1) Don't accept less pollution. **The 2nd mark must be linked to the 1st mark**.	2
			Question total	**[6]**

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Question			Marking details	Marks Available
6.	*(a)*		Subs (1) answer 2000 [W] (1)	2
	(b)		Units used = power x time $\frac{100x5(1)}{1000(1)}$ 0.5 **ecf** x 12 (1) 6 [p] (1) If convert to £ must be correct and no p present. If no workings shown: £0.06 (4 marks) 6000 p (3 marks), £60 (3 marks), 0.06 p (3 marks), 6 000 000 p (2 marks), 60 p (2 marks), 120 p (2 marks) If kettle used award a maximum of 2 marks	4
	(c)	(i)	All plots correct (2), 4 plots correct (1), 3 or less plots correct (0), line of best fit that passes through the origin (1)	3
		(ii)	Economy plan **ecf** (1) cheaper (1)	2
		(iii)	240[kWh] **ecf** accept 235 - 245	1
			Question total	**[12]**
7.	*(a)*	(i)	380[units]	1
		(ii)	$\frac{10}{5}$ (1) = 2 [mm] (1) [$\frac{1}{5}$ = 0.2 Award 1 mark only]	2
	(b)	(i)	Big Bang	1
		(ii)	Universe started at one point / singularity (1) [matter thrown out] by an explosion (1)	2
			Question total	**[6]**

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Question			Marking details	Marks Available
8.	*(a)*		**Indicative content:** The count rate due to background radiation needs to be determined first. This is 0.5 counts per second. The paper absorber reduces the count rate showing that alpha radiation must be emitted, since it will be blocked by paper. The aluminium absorber does not affect the count rate so beta radiation cannot be present. Thick lead reduces the count rate, but it still remains above the background level, showing that gamma radiation must also be emitted. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
	(b)	(i) (ii)	Stored in a lead [lined] container To absorb / block radiation (1) which would be harmful / to prevent exposure (1) **The 2nd mark must be linked to the 1st mark**. **Question total**	1 2 **[9]**
			Total For Foundation Tier paper	**60**

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PHYSICS 1

HIGHER TIER

Question			Marking details	Marks Available
1.	*(a)*		Easily replaced / replenished / will not run out / sustainable Don't accept can use it again – treat this as neutral with other acceptable answer	1
	(b)	(i)	[£] 2000	1
		(ii)	Wind - variable wind speed (1) Solar - hours of sunshine / roof may not face South or intensity of Sun (1) Fuel costs could change (1) **Award a maximum of 2 marks only**	2
	(c)		$\frac{5400}{1800}$ (1) = 3 x 4 = 12 [m^2] (1)	2
	(d)		Reduces CO_2 (1) which reduces the greenhouse effect / global warming (1) **or** Less SO_2 (1) which results in less acid rain (1) **or** Use less fossil fuels (1) so less extraction needed / less CO_2 / less SO_2 (1) Don't accept less pollution. **The 2nd mark must be linked to the 1st mark**.	2
			Question total	**[8]**
2.	*(a)*		Subs (1) answer 2000 [W] (1)	2
	(b)		Units used = power x time $\frac{100x5(1)}{1000(1)}$ 0.5 **ecf** x 12 (1) 6 [p] (1) If convert to £ must be correct and no p present. If no workings shown: £0.06 (4 marks) 6000 p (3 marks), £60 (3 marks), 0.06 p (3 marks), 6 000 000 p (2 marks), 60 p (2 marks), 120 p (2 marks) If kettle used award a maximum of 2 marks	4
			Question total	**[6]**
3.	*(a)*	(i)	380 [units]	1
		(ii)	$\frac{10}{5}$ (1) = 2 [mm] (1) [$\frac{1}{5}$ = 0.2 Award 1 mark only]	2
	(b)	(i)	Big Bang	1
		(ii)	Universe started at one point / singularity (1) [matter thrown out] by an explosion (1)	2
	(c)	(i)	Wavelength increasing / [spectral] lines or light shift to the red end	1
		(ii)	How far away/ from us the galaxy is (1) how fast the galaxy is moving away (1) [moving away can be implied in part (i)]	2
			Question total	**[9]**

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Question			Marking details	Marks Available
4.	*(a)*		**Indicative content:** The count rate due to background radiation needs to be determined first. This is 0.5 counts per second. The paper absorber reduces the count rate showing that alpha radiation must be emitted, since it will be blocked by paper. The aluminium absorber does not affect the count rate so beta radiation cannot be present. Thick lead reduces the count rate, but it still remains above the background level, showing that gamma radiation must also be emitted. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
	(b)		More harmful inside because alpha [particles](1) are more ionising / are unable to leave the body (1) **or** more harmful outside because gamma [rays] (1) can penetrate into the body (1) Any reference to beta only award 0 marks. **The 2nd mark must be linked to the 1st mark**.	2
			Question total	**[8]**

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Question			Marking details	Marks Available
5.	*(a)*		$P = VxI$ (1) $190 \times 10^6 = V \times 400$ sub / manip (1) MW conversion $V = 475\,000$ [V] (1) [0.475 or 475 Award 2 marks]	3
	(b)		[Large V] gives low I (1) So less heat / energy / power losses / more efficient (1) **The 2nd mark must be linked to the 1st mark**.	2
	(c)		Steps down / decreases <u>voltage</u>	1
	(d)	(i)	Lagging of pipe / insulation (1) makes the external surface temperature lower / it reduces the effect of air being heated by the pipe (1) **The 2nd mark must be linked to the 1st mark**.	2
		(ii)	Shiny surface / painted in a light colour (1) so less heat emitted [from outer surface] / heat reflected off the [inner surface] (1) **The 2nd mark must be linked to the 1st mark**.	2
			Question total	**[10]**
6.	*(a)*		**Indicative content:** The advantages of nuclear are it produces no air pollution and it produces a high power output from steady and reliable sources. The advantages of gas are the supply is piped and it produces no solid waste alongside it does not contribute to acid rain. The disadvantages of nuclear are the disposal of the radioactive waste and the possibility of radioactive leaks from natural disasters occurring. Acts of terrorism are also a potential threat and the decommissioning process is long and costly. The disadvantages of gas are the supply of gas is insecure and limited and burning the gas causes air pollution. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
	(b)		Output energy = 34 [MJ] (1) Efficiency = $\frac{34}{120}$ x 100% (sub) (1) = 28.3[%] / 28[%] (1)	3
			Question total	**[9]**

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Question			Marking details	Marks Available
7.	*(a)*		$v = f\lambda$ Substitution (1) $v = 4 \times 10^{14}$ x 5×10^{-7} Answer (1) $v = 2$ x 10^{8} [m/ s] $t = \frac{4.5x10^{5}}{2x10^{8}}$ **ecf** for v Manipulation(1) $t = 2.25$ x 10^{-3} [s] Answer (1)	4
	(b)	(i)	$v = \frac{d}{t}$ Substitution (1) Use of 2 (or 0.5) (1) $d = \frac{3 \text{ x} 10^{8} \text{ x } 0.24}{2} = 3.6$ x 10^{7} [m] Answer (1)	3
		(ii)	Satellite needs to be above a **fixed point** on the Earth (1) so satellite dishes do not have to be moved (1) **The 2nd mark must be linked to the 1st mark**.	2
	(c)		Much less time taken or quicker or faster by the optical fibre / not affected by the weather	1
			Question total	**[10]**

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Surname	Centre Number	Candidate Number
Other Names		0

NEW GCSE

4463/01

SCIENCE A
FOUNDATION TIER
PHYSICS 1

A.M. FRIDAY, 20 January 2012

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**9**	
3.	**4**	
4.	**6**	
5.	**6**	
6.	**6**	
7.	**6**	
8.	**5**	
9.	**8**	
10.	**5**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may 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.

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.

You are reminded of the necessity for good English and orderly presentation in your answers.

A list of equations is printed on pages 2 and 3. In calculations you should show all your working.

You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **9***(b)*.

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Equations and Units

Physics 1

energy transfer = power × time $E = Pt$

units used (kWh) = power (kW) × time (h)
cost = units used × cost per unit

$$\% \text{ efficiency} = \frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$$

$$\text{density} = \frac{\text{mass}}{\text{volume}} \qquad \rho = \frac{m}{V}$$

wave speed = wavelength × frequency $v = \lambda f$

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

Physics 2

power = voltage × current $P = VI$

$$\text{current} = \frac{\text{voltage}}{\text{resistance}} \qquad I = \frac{V}{R}$$

$$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}} \qquad a = \frac{\Delta v}{t}$$

momentum = mass × velocity $p = mv$

resultant force = mass × acceleration $F = ma$

$$\text{force} = \frac{\text{change in momentum}}{\text{time}} \qquad F = \frac{\Delta p}{t}$$

work = force × distance $W = Fd$

Physics 3

$$\text{pressure} = \frac{\text{force}}{\text{area}} \qquad p = \frac{F}{A}$$

$v = u + at$
$x = \frac{1}{2}(u + v)t$

where u = initial velocity
v = final velocity
a = acceleration
t = time
x = displacement

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Units

1 k Wh = 3.6 MJ
T / K = θ / °C + 273

SI multipliers

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

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

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*Answer **all** questions.*

1. *(a)* Electrical power is made and distributed around the country using the following:

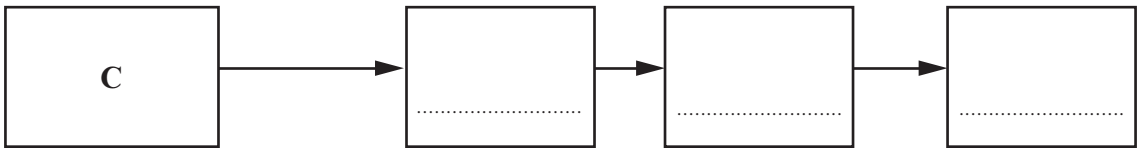
A Step-down transformer to homes

B National grid power lines

C Power station

D Step-up transformer

Put the letters **A**, **B**, **C** and **D** in the correct order into the boxes of the flowchart below. The first has been done for you. [2]



(b) List **three** things that must be taken into account when deciding whether to build a nuclear or a coal-fired power station. [3]

1. .....

2. .....

3. .....

5

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2. *(a)* An incomplete diagram of the electromagnetic spectrum is shown. Complete it using words from the following list. [2]

X-rays
Sound waves
Infra-red

Radio waves	Microwaves	.....	Visible light	Ultra-violet	.....	Gamma

Increasing frequency

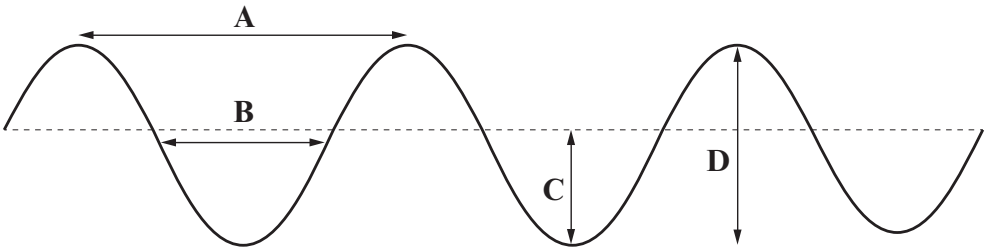
(b) Complete **each** sentence that follows by **underlining** the correct statement in brackets.

(i) The speed of gamma radiation is (less than / the same as / greater than) the speed of radio waves in a vacuum.

(ii) The frequency of microwaves is (less than / the same as / greater than) the frequency of infra-red.

(iii) The wavelength of microwaves is (less than / the same as / greater than) the wavelength of infra-red. [3]

(c) The diagram shows a wave.



(i) How many wavelengths are shown in the diagram? .....

(ii) Which label, **A**, **B**, **C**, or **D**, represents the amplitude of the wave? .....

(iii) **On the same diagram draw a wave** with a larger amplitude and a smaller wavelength. [4]

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3. The table gives some data on 6 planets:

Planet	Distance from Sun (million km)	Average surface temperature (°C)	Type of Atmosphere
Mercury	57	180	None
Venus	108	400	Carbon dioxide and thick cloud
Earth	150	15	Mainly nitrogen
Mars	228		Mainly carbon dioxide and very thin
Jupiter	778	–120	Hydrogen
Saturn	1429	–180	Hydrogen

(a) Which planet is 4 times as far from the Sun as Mercury? ..... [1]

(b) (i) Estimate the surface temperature of Mars. ..... °C [1]

(ii) Explain why the average surface temperature of Venus is higher than that of Mercury even though Venus is further from the Sun. [2]

.....

.....

.....

.....

4

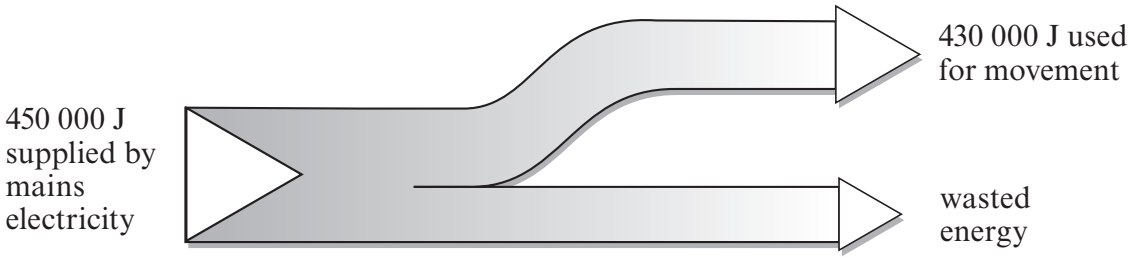
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4. *(a)* The statements below are about energy sources.
Tick (✓) the correct statements. [3]

Photovoltaic cells give out dangerous gases.	☐
Burning gas in a power station adds to global warming.	☐
Coal is a renewable source.	☐
Wind turbines produce no air pollution.	☐
Oil is a non-renewable source.	☐

(b) The energy flow diagram is shown for a modern moving electric car.



(i) Calculate the number of joules of wasted energy. [1]

..... J

(ii) Name **two** types of energy that would be wasted in a moving electric car. [2]

.....

6

Turn over.

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5. Read the passage below and answer the questions that follow.

When white light passes through a prism it separates into a spectrum of colours.

The spectrum of our closest star, the Sun, is crossed by dark lines.

Spectrum of our Sun



blue green yellow red

Each element in the outer atmosphere of the Sun absorbs light of a certain colour to produce each dark line. This is how we know what elements are in the Sun.

(a) What happens when scientists pass the light of a star through a prism? [1]

.....

(b) What produces the dark lines? [1]

.....

.....

(c) Helium was first discovered in the Sun. How would scientists have done this? [1]

.....

.....

(d) (i) How would the dark lines in the spectrum of a star in a distant galaxy be different from those in the spectrum of our Sun? [2]

.....

.....

.....

(ii) Why does this difference occur? [1]

.....

.....

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6. Students measure the speed of sound using two different methods.

(i) **Method 1:** Two students stand in front of a wall. One starts a stopwatch as the other hits two wooden blocks together once.



(from esfscience.wordpress.com/category/physics/page/2/)

As soon as the students hear the echo from the wall they stop the stopwatch. The time measured is 0.56 s. They measure the distance to the wall as 98 m.
Use this information and an equation from page 2 to calculate the speed of sound in air. [3]

Speed of sound = ... m/s

(ii) **Method 2:** In a laboratory they find that the wavelength of a sound wave of frequency 260 Hz is 1.3 m.
Use this information and an equation from page 2 to calculate the speed of sound waves in air. [2]

Speed of sound waves = ... m/s

(iii) The true speed of sound in air is 330 m/s.
Method 1 is less accurate than **Method 2**. Suggest a reason for this. [1]

.....

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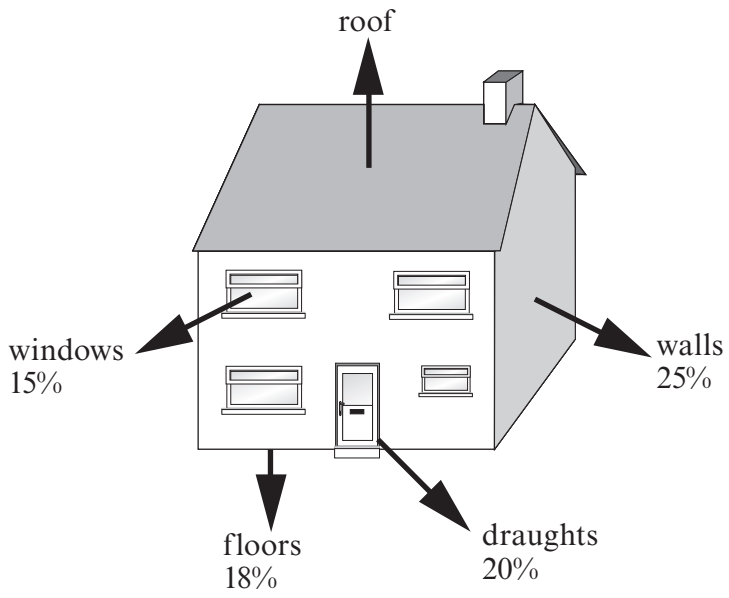
6

Turn over.

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7. The diagram shows how energy is lost from a house.



(a) (i) Calculate the percentage energy loss through the roof. [1]

..... %

(ii) State a method of reducing energy loss through the roof. [1]

.....

.....

(iii) Explain **how** this method reduces energy loss through the roof. [2]

.....

.....

.....

.....

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(b) The table gives information about reducing energy loss from a house.

Method	Cost	Savings per year	Payback time in years
Double glazed windows	£2800	£140	.....
Under floor insulation	£800	£80	10
Cavity wall insulation	£800	£160	5

(i) **Complete the table** to show the payback time for double glazed windows. [1]

(ii) State why the householder should install cavity wall insulation instead of under floor insulation even though they cost the same. [1]

.....

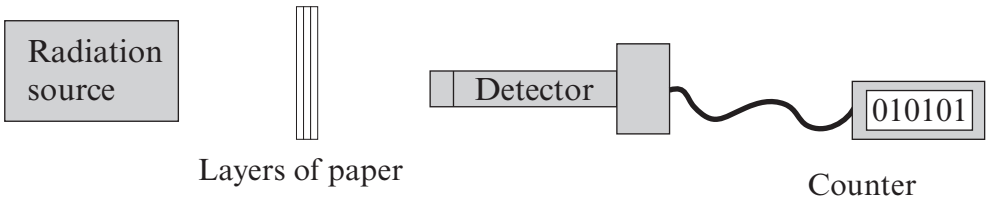
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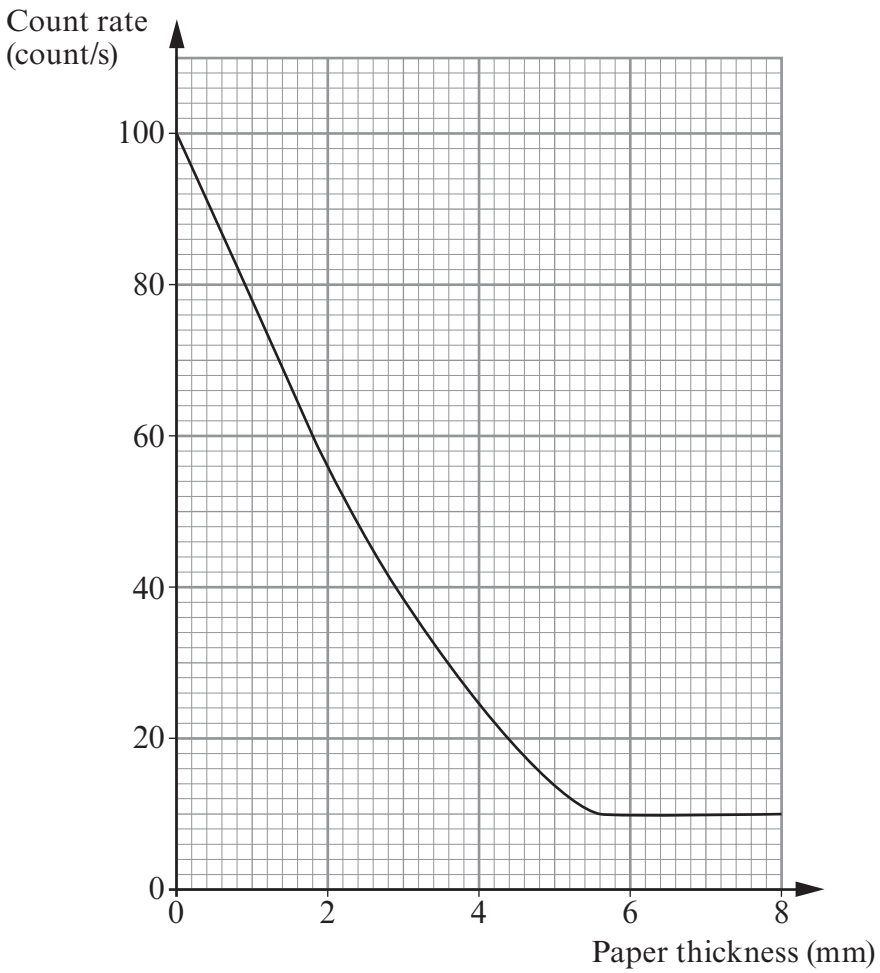
Turn over.

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8. A student set up an experiment to see how much nuclear radiation could pass through different thicknesses of paper.



The following graph was plotted from the results obtained:



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(a) Use the graph to complete the table of results that was obtained. [1]

Count rate (count/s)	Paper thickness (mm)
20	.....
40	2.9
60	1.8
80	0.9
100	0.0

(b) Use the graph to estimate the value of the background radiation and show how you arrived at your answer. [2]

.....

.....

.....

Background radiation = ... count/s

(c) The radioactive source only emitted one type of nuclear radiation.

Name the type of radiation emitted by the source and state how you arrived at your answer. [2]

Type of radiation: .....

.....

.....

5

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Turn over.

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9. The National Grid is a system that supplies electrical energy to users all over the country.

(a) State **two** ways in which the National Grid system maintains a reliable energy supply to all users. [2]

1. .....

.....

2. .....

.....

(b) Explain why step-up and step-down transformers are used in the National Grid. [6 QWC]

.....

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8

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10. Compact fluorescent lamps (CFL), with a life of 10 000 hours, have replaced filament light bulbs. Light-emitting diodes (LED), with a life of 50 000 hours, are being developed. Information about both types of lights is given in the table below.

	LED	CFL
Power (W)	6	14
kWh of electricity used over 50 000 hours	300	**A** .....
Cost of using electricity	£36	**B** .....
Price per bulb	£23	£2.50
Bulbs needed for 50 000 hours of use	1	5
Cost of bulbs over 50 000 hours	£23	.....
Total cost for 50 000 hours	£59	.....

(i) The cost of electricity is 12 p / kWh.
Use the equations:

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

cost = units used × cost per unit

to complete boxes **A** and **B** in the table. [3]

(ii) Complete the table to show that the total cost of buying and using **five** CFLs is more than buying and using **one** LED. [2]

THERE ARE NO MORE QUESTIONS IN THE EXAMINATION.

5

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WJEC
CBAC

GCSE MARKING SCHEME

SCIENCE – PHYSICS (NEW)

JANUARY 2012

INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2012 examination in GCSE SCIENCE – PHYSICS (NEW). They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

Unit	Page
P1 (NEW) Foundation Tier	1
P1 (NEW) Higher Tier	5

UNIT P1

FOUNDATION TIER

Question			Answer / Explanatory Notes	Marks Available
1.	*(a)*		D B A All correct → (2); Any 1 correct (1)	2
	(b)		3 reasonable points (must be clear if referring to Nuclear or Coal) from: Commissioning costs (Nuc) Nuclear - away from population Running costs (incl. fuel) Transport costs (coal) Decommissioning costs (Nuc) Coal running out Security Background radn^{n} Pollution (Coal) Space to store rad waste (nuc)	3 **5**
2.	*(a)*		Order of insertion: Infra-red (1) X-rays (1)	2
	(b)	(i) (ii) (iii)	the same as (1) less than (1) greater than (1)	3
	(c)	(i) (ii) (iii)	3 (1) **C** (1) At least 1 complete cycle drawn with larger amplitude (1) and smaller wavelength (1) [accept separate diagram if clear].	4 **9**
3.	*(a)*		Mars	1
	(b)	(i)	approx - 67 (^{0}C) [accept 0 to -100°C]	1
		(ii)	CO_2 (1) Greenhouse effect / heat trapped in Earth (1) [accept converse e.g. no atmosphere <u>on Mercury</u>(1), so no greenhouse effect (1)] 2nd mark must link to 1st mark.	2 **4**

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Question			Answer / Explanatory Notes	Marks Available
4.	*(a)*		Correct statements – 3 × (1) Burning gas in a power station adds to global warming Wind turbines produce no air pollution Oil is a non-renewable source [Additional ticks – 1 for each]	3
	(b)	(i)	20,000 (J)	1
		(ii)	Heat / thermal (1), sound (1) – 1 any additional types [Light – neutral]	2 **6**
5.	*(a)*		they get a spectrum [of the star] / splits the light up	1
	(b)		absorption in the star's atmosphere	1
	(c)		New dark lines observed – identified as new element (He) ["New" or "unknown" lines/element]	1
	(d)	(i)	lines moved (1) so they have a larger wavelength / towards red end of spectrum [implies 1st mark] (1) ("redshifted" 2 marks – but not *the spectrum becomes redder*]	2
		(ii)	Because the universe is expanding / because the galaxy [accept: "Star"] is moving away	1 **6**
6.		(i)	speed = $\frac{2(1)\times 98}{0.56}$ (1) = 350 (m/s) (1) [NB lack of × 2 → 2 max] [175 m/s → (2)]	3
		(ii)	v = 260 × 1.3 = 338 m/s [subst in $v = f\lambda$ (1); answer (1)]	2
		(iii)	Any 1 sensible answer from: • air movement • inaccuracy of only doing 1 measurement • inaccuracy of timings (starting/stopping stopwatch) / reaction times • distraction from other noises	1 **6**

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Question			Answer / Explanatory Notes	Marks Available
7.	*(a)*	(i)	22%	1
		(ii)	[Loft / roof] insulation (accept silver foil on inside of tiles, fibreglass, rockwool)	1
		(iii)	Two appropriate points: Insulator (1) because it has trapped air (1) **or** reflects [heat] radiation (1) back in (1) [Reference to convection (1) with linked reason, e.g. temperature at bottom of roof space is lower (1)] 2nd mark must link to the first mark.	2
	(b)	(i)	20 (years)	1
		(ii)	Shorter payback time / Save more [per year] [or equiv] / walls lose most heat	1
				6
8.	*(a)*		4.4	1
	(b)		10 (count/s) (1) Any 1× (1) from: All radiation from source stopped by paper, [so only background remains] / Graph flattens at 10 units / accept cand. showing on graph	2
	(c)		β / beta (1) α is stopped by [thin] paper [but β is not] / γ would not show any attenuation [however expressed] [accept any correct and relevant reference to different penetration.] (1) [2nd mark only available if 1st mark is given.]	2
				5

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Question			Answer / Explanatory Notes	Marks Available
9.	*(a)*		Any 2 × (1) from • Supply to grid can vary to match demand ✓ • all power stations connected to grid ✓ • can cope if one breaks down. ✓	2
	(b)		**Indicative content:** Transformers are used to step-up voltage, resulting in decreased current so less energy loss along cables. Then step-down transformer reduces voltage to consumer, because high voltages are dangerous in the home. The use of step-up and step-down transformers makes for more-efficient energy transfer. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6 **8**
10.		(i)	A = 700 kWh Conversion to kW (1) Answer (1) [700 → 2 marks; 700000 → (1)] B = [£]84 (1) [e.c.f. from A, if 8400 must be 8400 p]	3
		(ii)	Cost of buying 5 CFL = [£]12.50 (1) [no e.c.f.] Total cost for 5 CFLs = [£]96.50 (1) [e.c.f. from B, allow 9650]	2 **5**
			Total marks for Foundation Tier	**60**

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HIGHER TIER

Question			Answer / Explanatory Notes	Marks Available
1.		(i)	speed $= \frac{2(1)\times 98}{0.56}$ (1) = 350 (m/s) (1) [NB lack of × 2 → 2 max] [175 m/s → (2)]	3
		(ii)	v = 260 × 1.3 = 338 m/s [subst in $v = f\lambda$ (1); answer (1)]	2
		(iii)	Any 1 sensible answer from: air movement • inaccuracy of only doing 1 measurement • inaccuracy of timings (starting/stopping stopwatch) / reaction times • distraction from other noises	1 **6**
2.	*(a)*		Any 2 × (1) from • Supply to grid can vary to match demand ✓ • all power stations connected to grid ✓ • can cope if one breaks down. ✓	2
	(b)	(i)	substitution(1), matching units (award 1 mark even if eq incorrect), e.g. 950 000 000/25 000, ans 38 000 (A) (1 mark – allow ecf from non matching units, e.g. 38 →(2)]	3
		(ii)	**Indicative content:** Transformers are used to step-up voltage, resulting in decreased current so less energy loss along cables. Then step-down transformer reduces voltage to consumer, because high voltages are dangerous in the home. The use of step-up and step-down transformers makes for more-efficient energy transfer. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6 **11**

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Question			Answer / Explanatory Notes	Marks Available
3.	*(a)*		4.4	1
	(b)		10 (count/s) (1) Any 1× (1) from: All radiation from source stopped by paper, [so only background remains] / Graph flattens at 10 units / accept cand. showing on graph	2
	(c)		β / beta (1) α is stopped by [thin] paper [but β is not] / γ would not show any attenuation [however expressed] [accept any correct and relevant reference to different penetration.] (1) [2nd mark only awarded if first mark is given]	2 **5**
4.		(i)	A = 700 kWh Conversion to kW (1) Answer (1) [700 → 2 marks; 700000 → (1)] B = [£]84 (1) [e.c.f. from A, if 8400 must be 8400 p]	3
		(ii)	Cost of buying 5 CFL = [£]12.50 (1) [no e.c.f.] Total cost for 5 CFLs = [£]96.50 (1) [e.c.f. from B, allow 9650]	2
		(iii)	Both emit same light output (1), power used by led is less than cfl (1), 14/6 or or 2.33 times less (1) [3rd point implies 2nd] [accept converse argument]	3 **8**
5.	*(a)*	(i)	[atoms of a] gas <u>absorb</u> light at specific wavelengths….(1) light passes through gas / lines are characteristic of the elements in the gas. (1) NB 2nd mark must link to the 1st.	2
		(ii)	[Chemical] composition / make-up of [the atmosphere of] the star or equiv. **Or –** speed of recession of the star / galaxy	1
	(b)		For distant galaxy: lines would be further red shifted [Or the wavelengths of the lines would be larger in the distant galaxy] (1), galaxy moving away faster. [or because the universe has expanded more since the radiation from the first galaxy was sent out](1) NB 2nd mark must link to the 1st.	2
	(c)	(i)	Sensible scales [linear, points occupying at least half the grid] (1) Accurate plots [within ½ a minor scale division] (1) Good line of best fit – drawn using a ruler (1) [independent mark]	3
		(ii)	The recession speed is [directly] proportional to the distance [or, e.g. if the distance doubles the speed doubles](2) [The greater the distance the greater the recession speed , or positive correlation→ (1)]	2
		(iii)	matter ‘expelled’ from a Big Bang (1) Galaxies must have come from one point / back in time must have been closer together (1) 2nd mark must link to 1st.	2 **12**

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Question			Answer / Explanatory Notes	Marks Available
6.	*(a)*		Any 2 × (1) from: • High cost …..✓ • [Relatively] low power output / produces less electricity ✓ • ….. so a long payback period ✓ • Intermittent ✓	2
	(b)	(i)	Any 1 × (1) from: • Reduced energy / electricity bills [for the householder] ✓ • [Generous] feed-in tariffs✓ Any 1 × (1) from • Reduced burning of fossil fuels …✓ • …so reduction in greenhouse gas / CO_2 [accept acid rain] emission ✓ [1 mark only for an air-pollution effect] + 1× (1) for any other bullet point.	3
		(ii)	trees/plants absorb take in as much CO_2 (1) as they give out [when burnt] (1)	2
	(c)		Naming any one method, e.g. loft insulation / cavity wall insulation / double glazing / draft excluders (1) Description of how reduction achieved for that method in terms of conduction, convection or radiation (1) More detail in energy transfer explanation (1) NB 2nd and 3rd mark must link to 1st mark.	3
				10

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Question			Answer / Explanatory Notes	Marks Available
7.		(i)	Any 2 × (1) from • Travel though a vacuum ✓ • Transverse waves ✓ • Travel at same speed [through space] ✓ • Transfer energy **or** information ✓ • Other wave property, e.g. reflection, refraction, interference ✓] •	2
		(ii)	**Indicative content**: The Earth absorbs sunlight, eventually radiates energy [or heat] back out. Some of this radiation makes it into space. The rest of it ends up getting absorbed in the atmosphere, by carbon dioxide, methane gas and water vapor. After these components in our atmosphere absorb all this heat, they re-emit energy (also in the form of radiation / heat). The heat that doesn't make it out through Earth's atmosphere keeps the planet warmer than it would be without the atmosphere. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4** marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2** marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and many inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6 **8**
			Total for higher tier paper	**60**

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