WJEC GCSE PHYSICS

PHYSICS



EXAM QUESTION PACK

UNIT P1 HIGHER TIER 4463 PAPERS

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4463/02

S16-4463-02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

A.M. MONDAY, 20 June 2016

1 hour

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

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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 **2***(d)* and **6**(iii).

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
power = voltage × current	$P = VI$
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
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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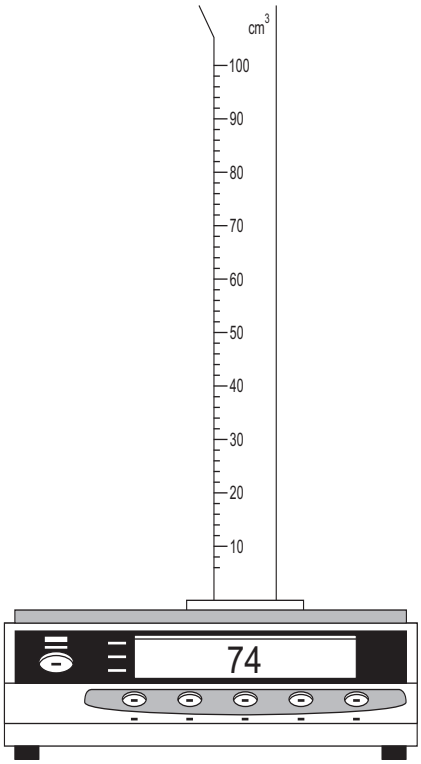
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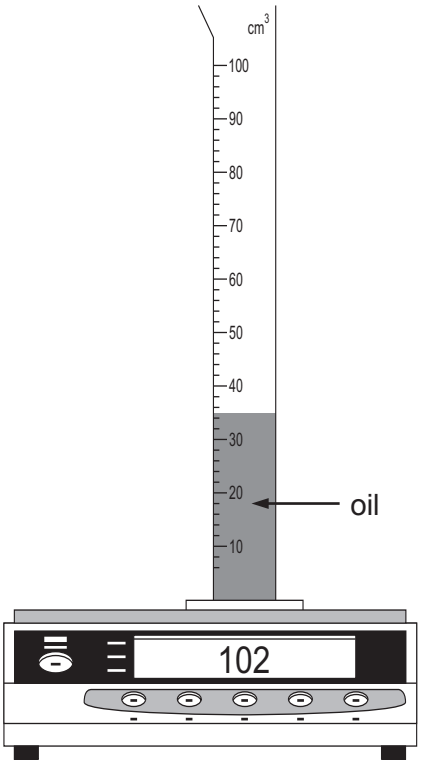
Answer **all** *questions.*

1. 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).

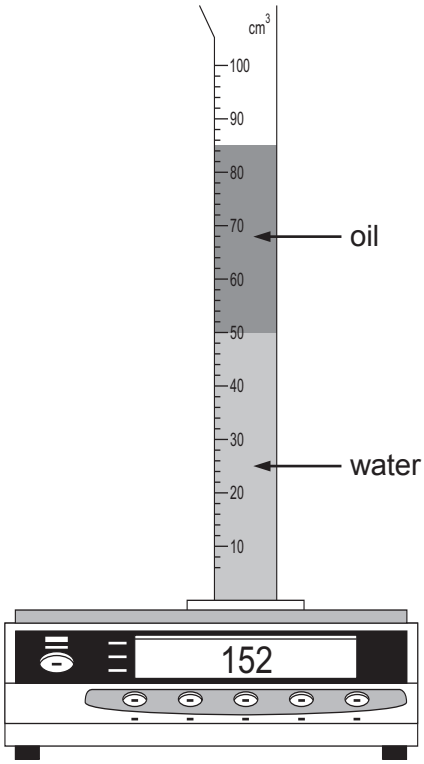
She places the empty measuring cylinder on to the balance.



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



Some water was then added to the cylinder.

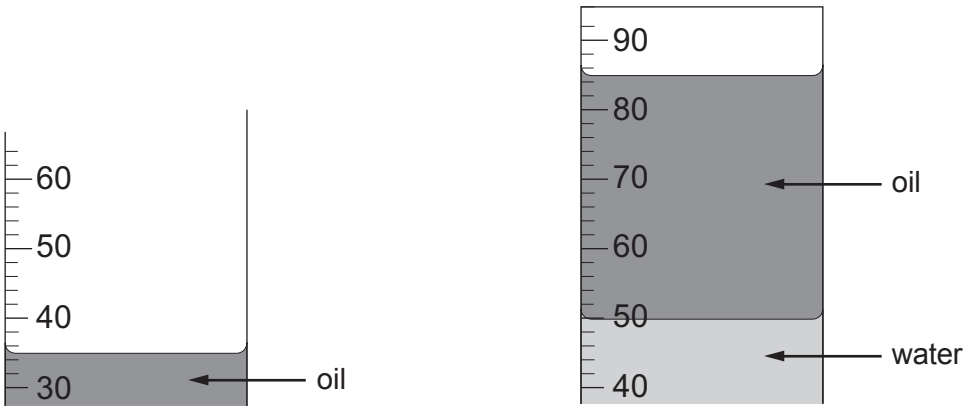


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The liquid levels in the measuring cylinder are shown below.



(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 = ...

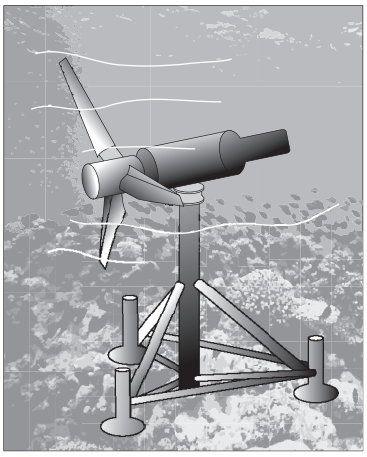
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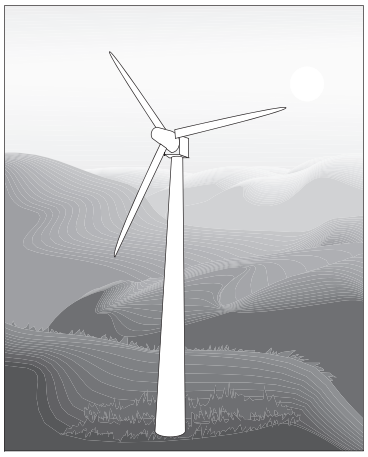
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(b) Electrical energy can be generated from wind and from moving water. The density of air is 1.3 kg/m^3 and the density of water is 1 000 kg/m^3.



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]

.....

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

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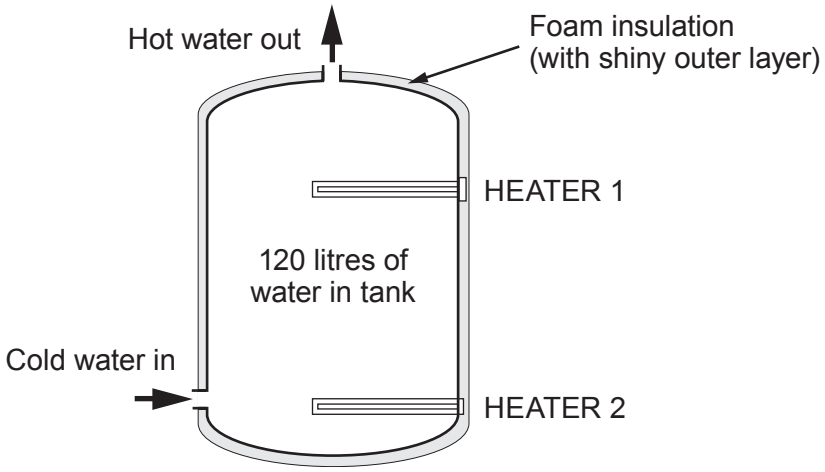
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2. A hot water tank that is covered in foam insulation contains a total of 120 litres of water. It has two electric heaters, either of which may be used to heat water to the same final temperature. Heater **1** is used during the day and heater **2**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

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(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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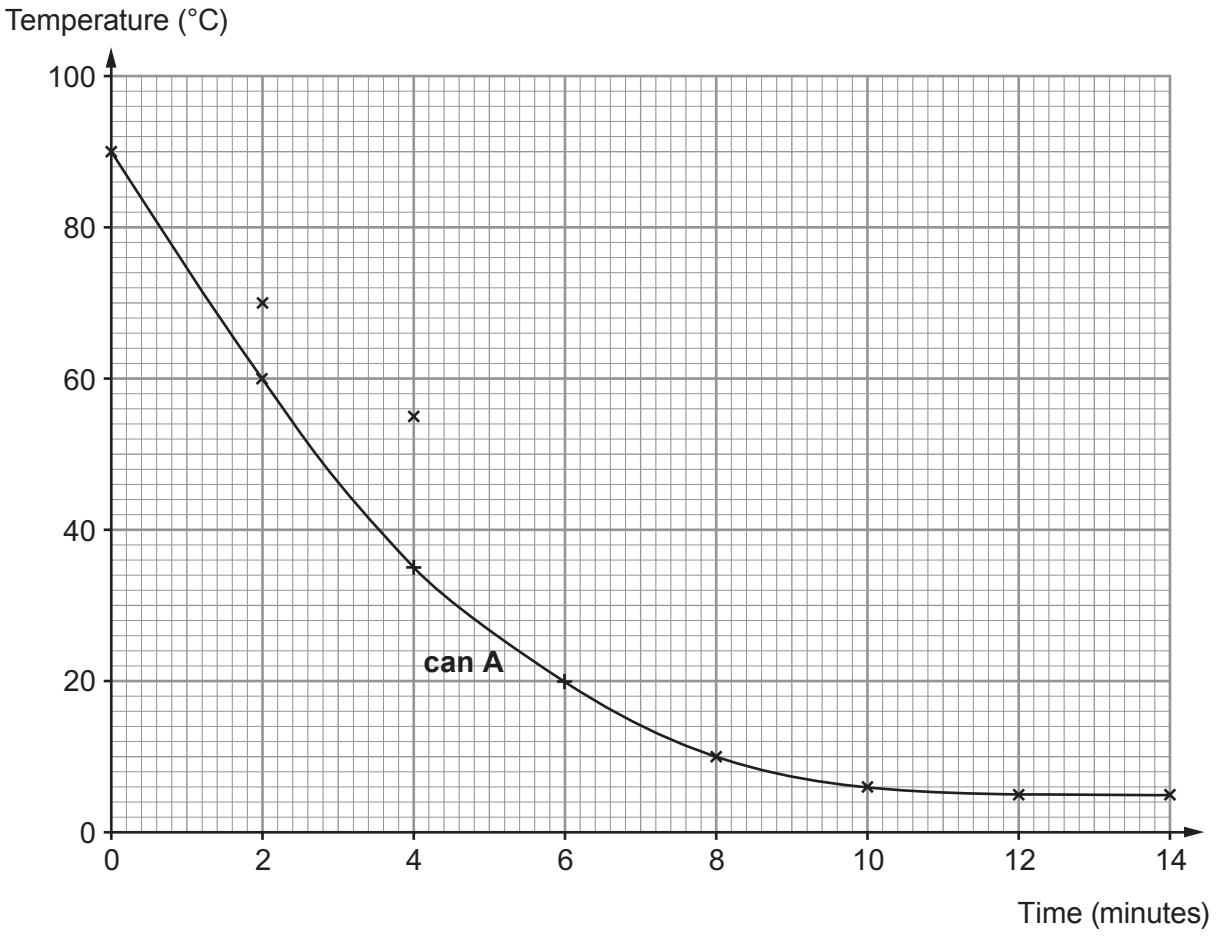
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3. Two metal cans, labelled **A** and **B** are identical apart from their colour. One is painted black and the other silver. They are both filled with 100 cm^3 of water at 90 °C and left to cool in a fridge. Their temperatures are recorded every 2 minutes.
The data for **can A** has been presented on the graph below.
The data collected for **can B** is shown in the table.

Time (minutes)	0	2	4	6	8	10	12	14
Temperature of **can B** (°C)	90	70	55	43	34	27	22	18

(a) (i) Plot the data for **can B** on the grid below and draw a suitable line.
(The first three points have been plotted for you.) [3]



(ii) At what time is the **difference** in temperature between the two cans 10 °C ? [1]

..... minutes

(iii) State the temperature in the fridge during the experiment. [1]

..... °C

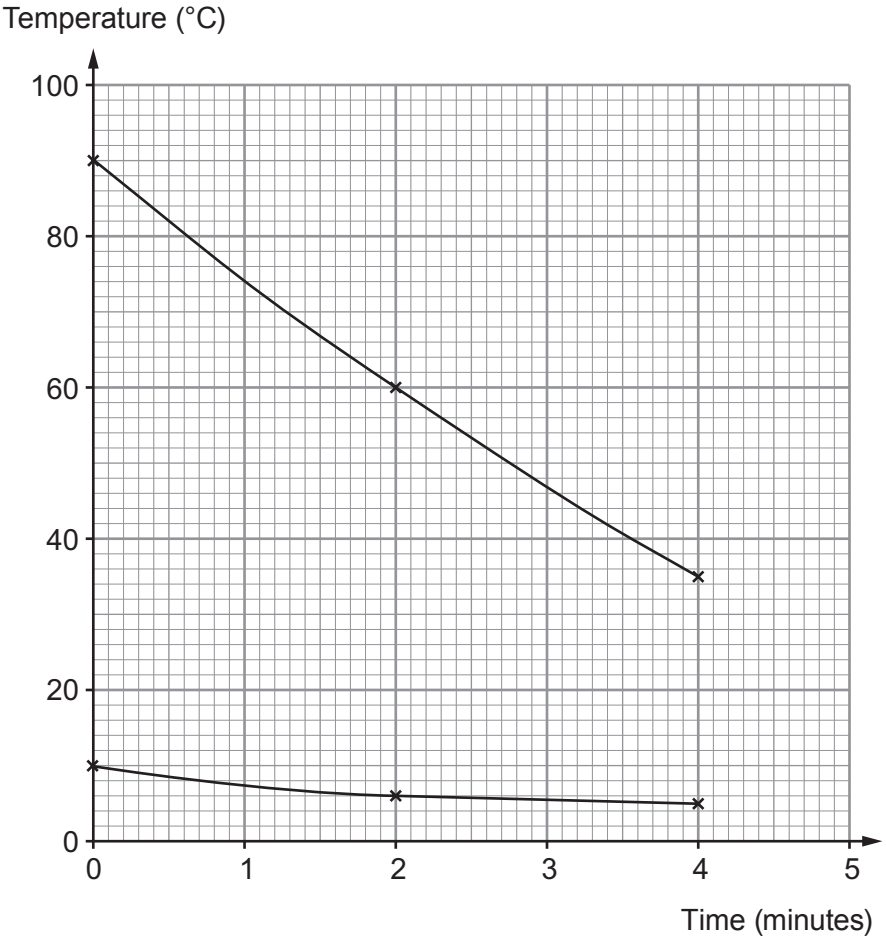
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(b) A student decides to do an experiment **using can A only**. This time, **only the starting temperature of the water is changed each time**.
The chosen starting temperatures are 90 °C, then 35 °C and finally 10 °C.
Only can A was used and data was collected for just 4 minutes. The cooling curves for starting temperatures of 90 °C and 10 °C are drawn on the graph below.

(i) **Add to the graph** a line showing the cooling curve for the can with a starting temperature of 35 °C. [2]



(ii) Explain in terms of conduction and radiation why the temperature drop for the top curve is greater than for the bottom curve. [3]

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Examiner only

(c) **Can B** emits infra-red radiation with a range of wavelengths between 8 μm and 10 μm. Use an equation from page 2 to calculate the **maximum** frequency of the infra-red radiation emitted from **can B**. (Speed of light, $c = 3 \times 10^8$ m/s) [4]

frequency = ... Hz

14

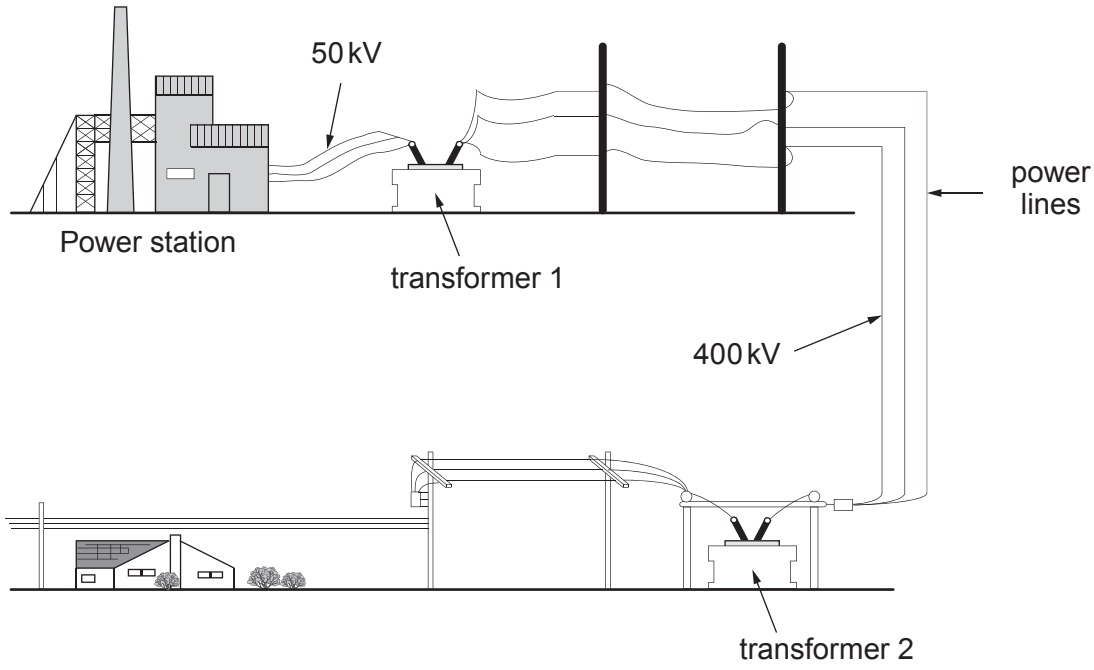
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4. A power station delivers an output of 2×10^8 W of electricity at 50 kV which is changed to 400 kV for transmission.

(a) Explain how the National Grid provides a reliable supply of electricity. [2]



(b) Use an equation from page 2 to calculate the current in the National Grid power lines. (You can assume that transformer 1 is 100% efficient.) [3]

current = ... A

(c) In fact some energy is lost as heat in transformers. Explain how the use of the **two** transformers is still more **energy efficient** than transmitting the electricity at 50 kV along the National Grid. [3]

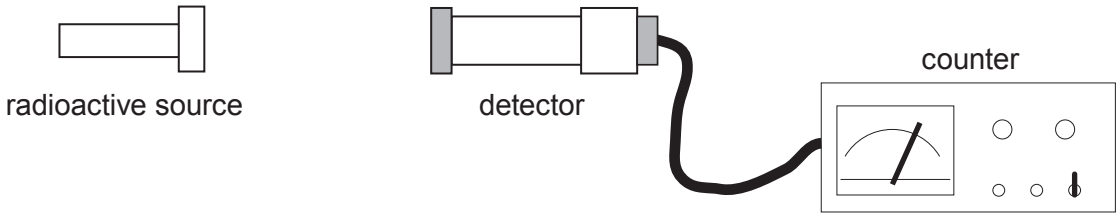
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5. Some radioactive elements emit more than one type of radiation. The apparatus below was used to investigate the radiation emitted from a particular source which was placed 5 cm from a detector.



The table shows the mean count rate in counts per minute (cpm) read from the detector when different absorbers were placed, **one at a time**, between it and the source.
All figures have been **corrected for background radiation**.

Original count rate (cpm) with no absorber	Count rate (cpm) with 2 cm lead absorber	Count rate (cpm) with 5 cm lead absorber	Count rate (cpm) with a paper absorber	Count rate (cpm) with 3 mm aluminium absorber
2000	400	60	600	600

(a) (i) By how many counts per minute does the 2 cm lead absorber reduce the count rate? [1]

..... cpm

(ii) What type of radiation passes through 3 mm of aluminium? [1]

.....

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(b) (i) State how much of the original count rate was produced by beta radiation. [1]

..... cpm

(ii) Explain your answer. [2]

.....

.....

.....

(c) The figures in this experiment have all been **"corrected for background radiation"**. State what is meant by the phrase "corrected for background radiation". [1]

.....

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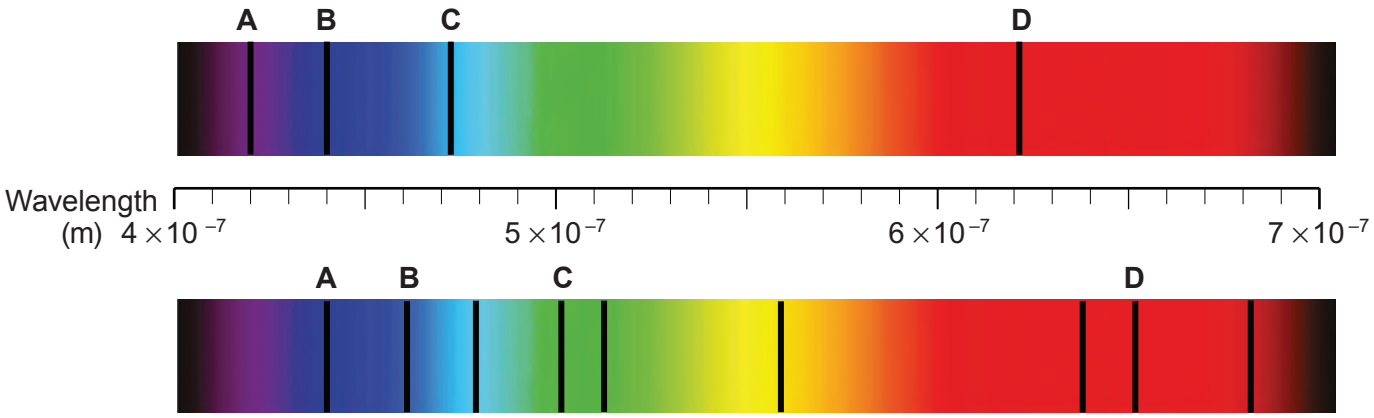
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6. The first diagram below shows the spectrum of white light after it is passed through hydrogen in the laboratory.

The second spectrum comes from a galaxy that is 4×10^9 light years away.

(i) State the time taken for light to travel from the galaxy to us. [1]

.....



(ii) Calculate the change in wavelength of the line **A** between the laboratory spectrum and the galaxy's spectrum. [1]

wavelength change = ... m

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(iii) Explain what information can be obtained about the galaxy by comparing the spectra opposite.
(Do not include in your answer the development of theories of the Universe.) [6 QWC]

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END OF PAPER

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GCSE MARKING SCHEME

SUMMER 2016

SCIENCE - PHYSICS P1
4463/01/02

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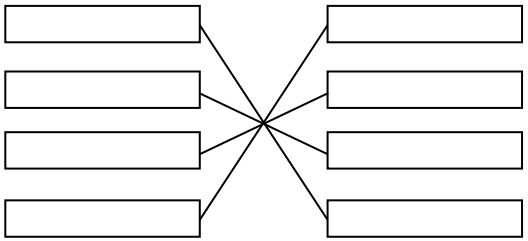
INTRODUCTION

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

4463/02

W16-4463-02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

A.M. THURSDAY, 14 January 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**11**	
3.	**6**	
4.	**13**	
5.	**7**	
6.	**16**	
Total	**60**	

4463 020001

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 answers to question **3** and **6***(c)*.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
power = voltage × current	$P = VI$
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
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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Examiner only

Answer **all** *questions.*

1. *(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]

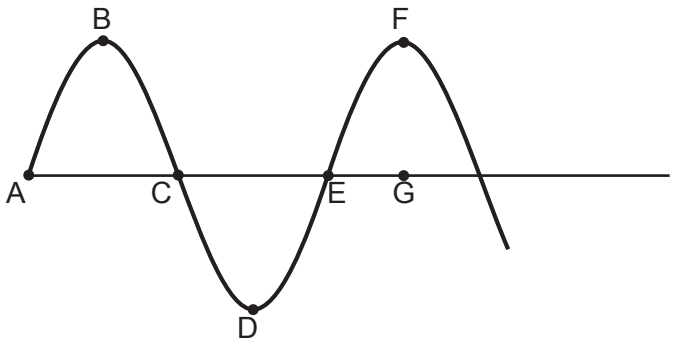
(ii) Complete the sentences below by underlining the correct phrase in each bracket. [3]

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) 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.

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4463 020003

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2. 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

4463 020005

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3. **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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4. Nuclear power station workers wear a film badge to monitor their exposure to the different types of nuclear radiation.

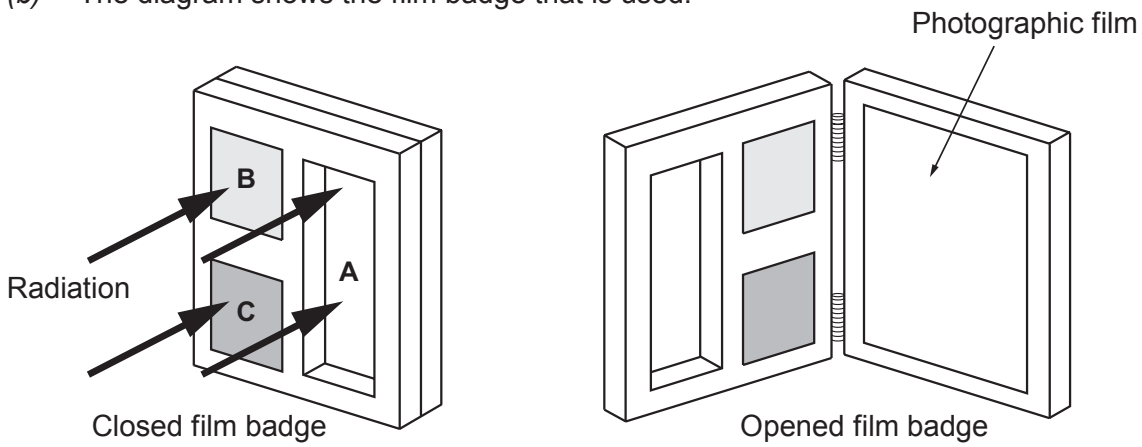
(a) Explain why it is important to monitor exposure to radiation. [2]

.....

.....

.....

(b) 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.

Each month the photographic film is developed. It turns black where it has been exposed to radiation. Areas not exposed to radiation do not turn black.

(i) Complete the table to show the results expected on the photographic film with the different types of radiation. Use the phrases "**black**" or "**not black**". [2]

Type of radiation	Window A	Window B	Window C
Alpha	black	not black	not black
Beta	.....	.....	.....
Gamma	.....	.....	.....

(ii) Explain why the film badge is not allowed to be worn underneath clothing. [2]

.....

.....

.....

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Turn over.

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(c) To determine the thickness of aluminium used in the film badge, a nuclear scientist carries out an experiment to determine the penetration of beta particles through aluminium. Different thicknesses of aluminium sheets were placed between the beta source and the Geiger Muller (GM) tube.

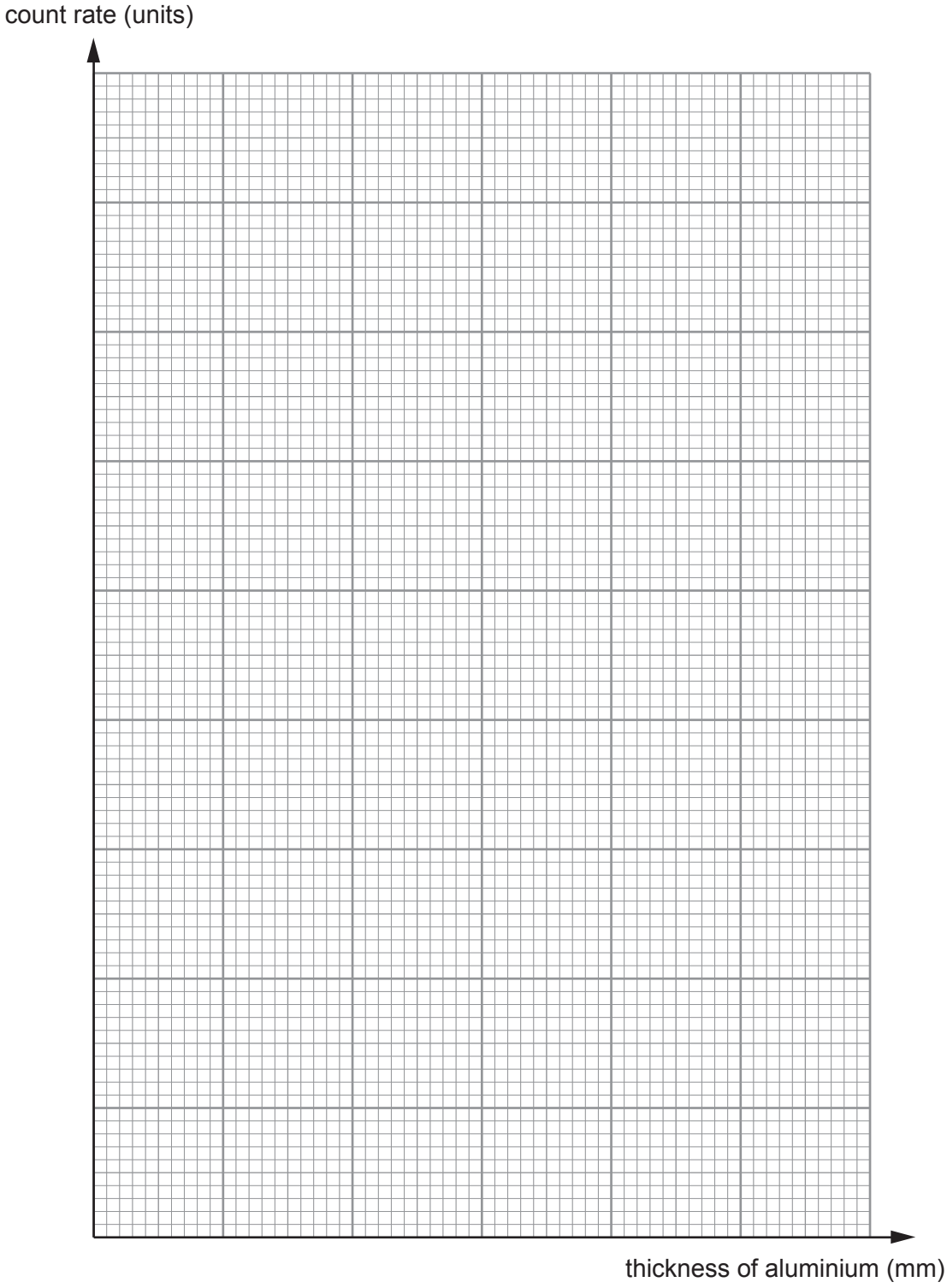
Thickness of aluminium between source and GM tube (mm)	Count rate (units) (corrected for background radiation)
0.0	85.0
0.5	59.0
1.0	40.0
2.0	19.0
2.5	10.0
3.0	4.0
3.5	0.0
4.0	0.0
5.0	0.0

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



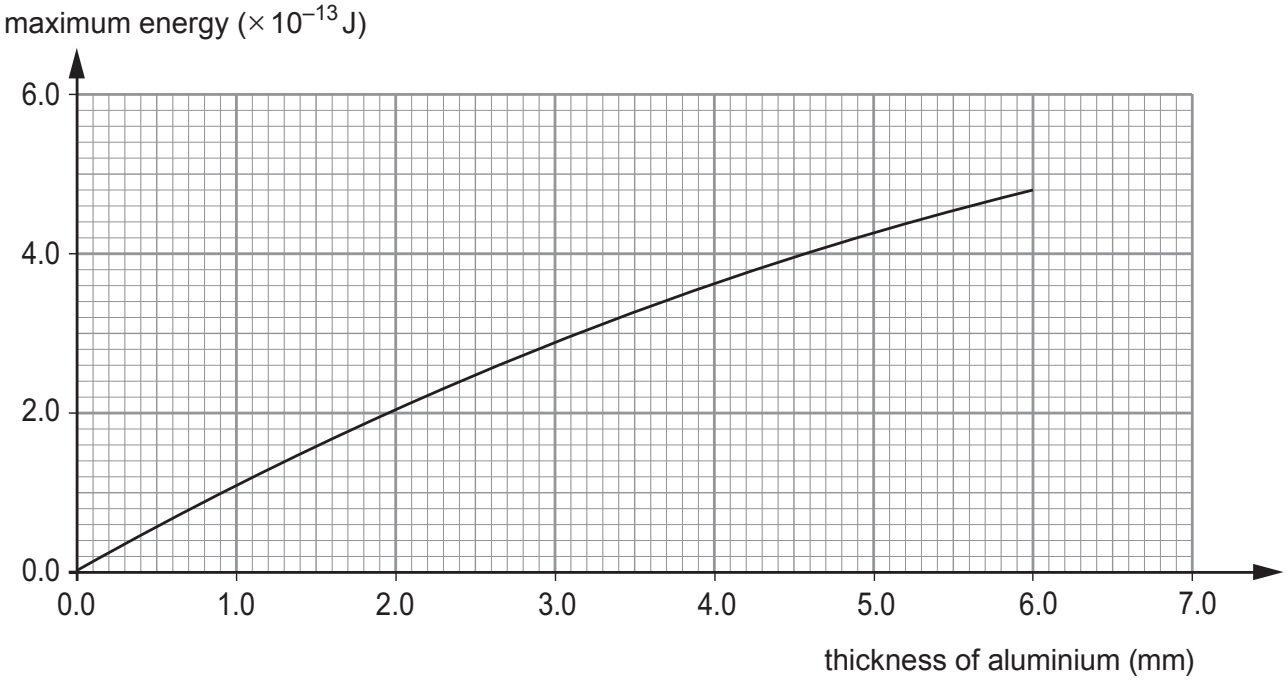
(ii) Use the graph to describe the relationship between the count rate and the thickness of aluminium. [2]

.....

.....

Examiner only

(iii) The following graph shows how the penetration of the beta particles through aluminium is related to their energy.



Using this information and your graph on page 9 determine the maximum energy of a beta particle emitted from the source. [2]

maximum energy = ... × 10⁻¹³ J

13

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5. (i) Explain how scientists in the nineteenth century were able to reveal the chemical composition of stars. [3]

.....

.....

.....

.....

.....

.....

(ii) Describe the findings arising from Sir Edwin Hubble's measurements on the spectra of distant galaxies. [2]

.....

.....

.....

.....

(iii) Explain how the presence of Cosmic Microwave Background Radiation (CMBR) supports the Big Bang theory. [2]

.....

.....

.....

.....

7

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6. The first modern tidal barrage power station was built in 1966 at La Rance in France. The table below gives information about the La Rance Barrage.

Number of turbines	24
Water volume flow through each turbine	175 to 700 m^3/s
Water power input per turbine	4 to 16 MW
Maximum power output per turbine	10 MW
Mean power output per turbine	2.6 MW
Maximum output voltage	3.5 kV

(a) Use the information in the table and equations from page 2 to answer the following questions. Assume all the turbines are in operation.

(i) Calculate the maximum mass of water flowing through the entire barrage each second. (Density of water = 1 000 kg/m^3.) [3]

mass = ... kg

(ii) Calculate the maximum current drawn from the entire barrage. [3]

current = ... A

(iii) Calculate the % efficiency of power transfer by one turbine at maximum power. [2]

% efficiency = ...

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(b) Explain why the power output is not constant. [2]

(c) Plans are being considered to build a very large tidal barrage on the river Severn between South Wales and South West England. Discuss the advantages and disadvantages of such a scheme. [6 QWC]

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END OF PAPER

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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

4463/02

S15-4463-02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

A.M. MONDAY, 15 June 2015

1 hour

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

4463 020001

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 questions **2***(d)* and **6**.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
power = voltage × current	$P = VI$
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
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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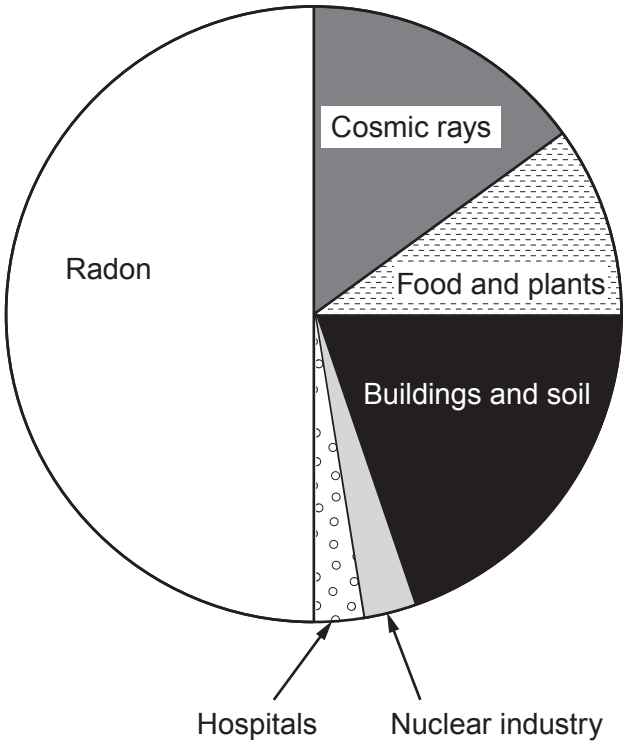
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Answer **all** *questions.*

1. The 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]

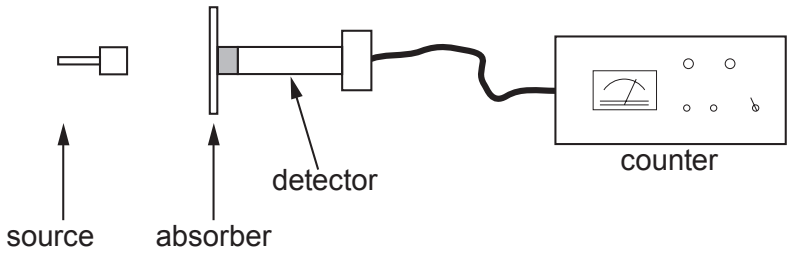
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(b) A radiation detector is connected to a counter in a classroom. Absorbers were placed directly in front of the detector in an attempt to find which radiation was being given off by the radioactive source americium-241.



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]

.....

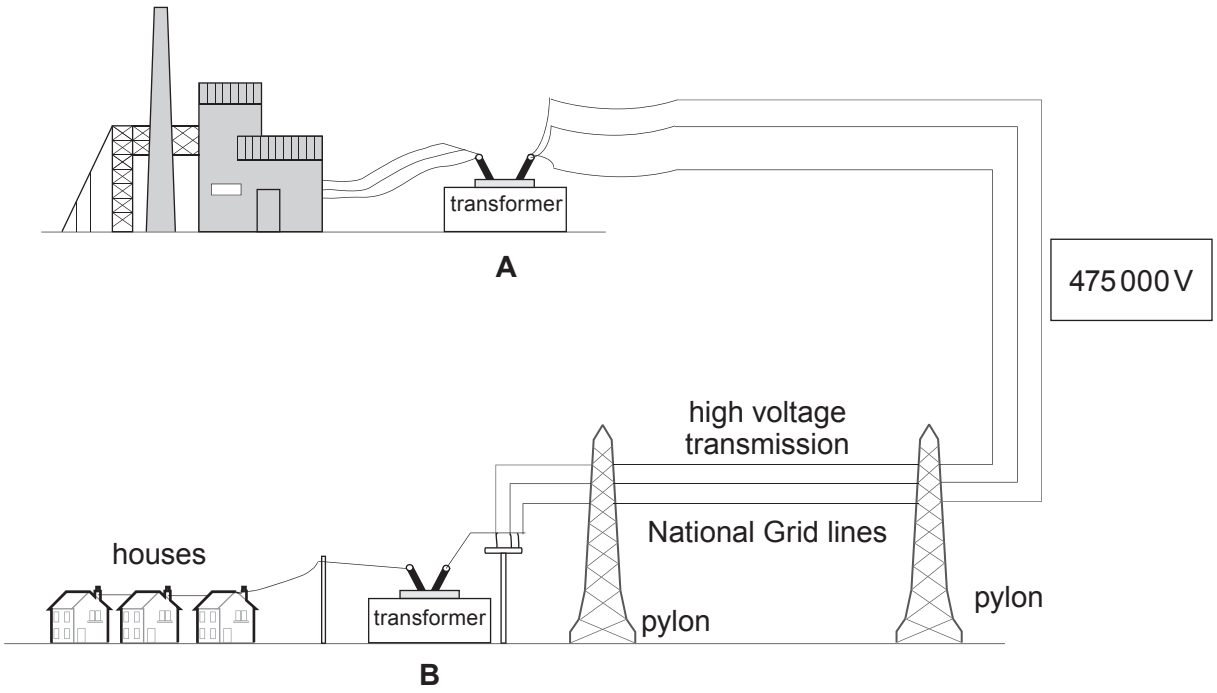
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2. A diagram of the National Grid is shown below.



(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.

(i) Write down the input power to the National Grid in watts. [1]

power = ... W

(ii) Use an equation from page 2 to calculate the current. [2]

current = ... A

(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.

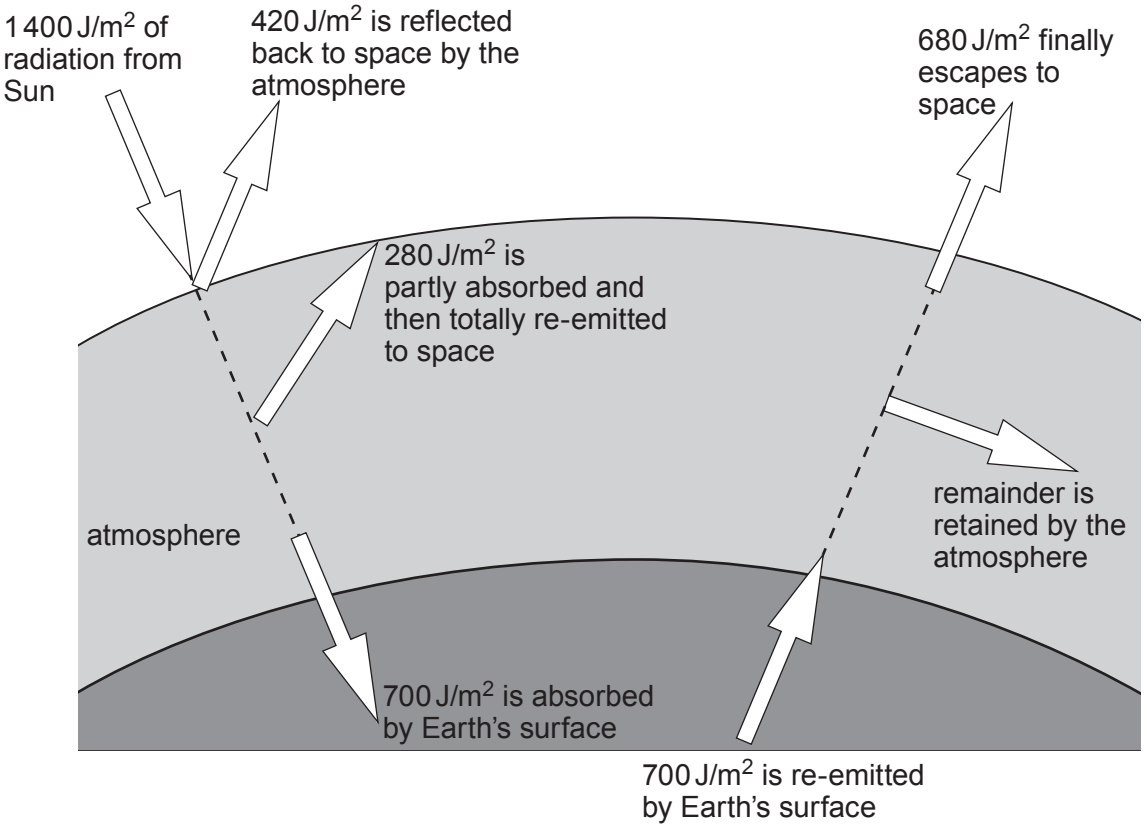
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3. Some of the energy from the Sun strikes the Earth. At one period in time, what happened to the energy falling on each m^2 in 1 second is shown on the diagram below.



Use the diagram above to answer the following questions.

(a) (i) Calculate the energy per m^2 from the Sun that is retained by the atmosphere each second. [1]

..... J/m^2

(ii) A solar panel is designed to produce electricity from radiation received from the Sun. Such a panel is 20% efficient at converting the energy striking it.
Calculate the area of the solar panels that is needed to give an output of 1 kJ every second. [4]

area = ... m^2

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(b) Describe, giving named parts of the electromagnetic spectrum, how the presence of the atmosphere causes the greenhouse effect. (Hint: Do not use **data** from the diagram opposite.) [3]

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.....

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8

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Turn over.

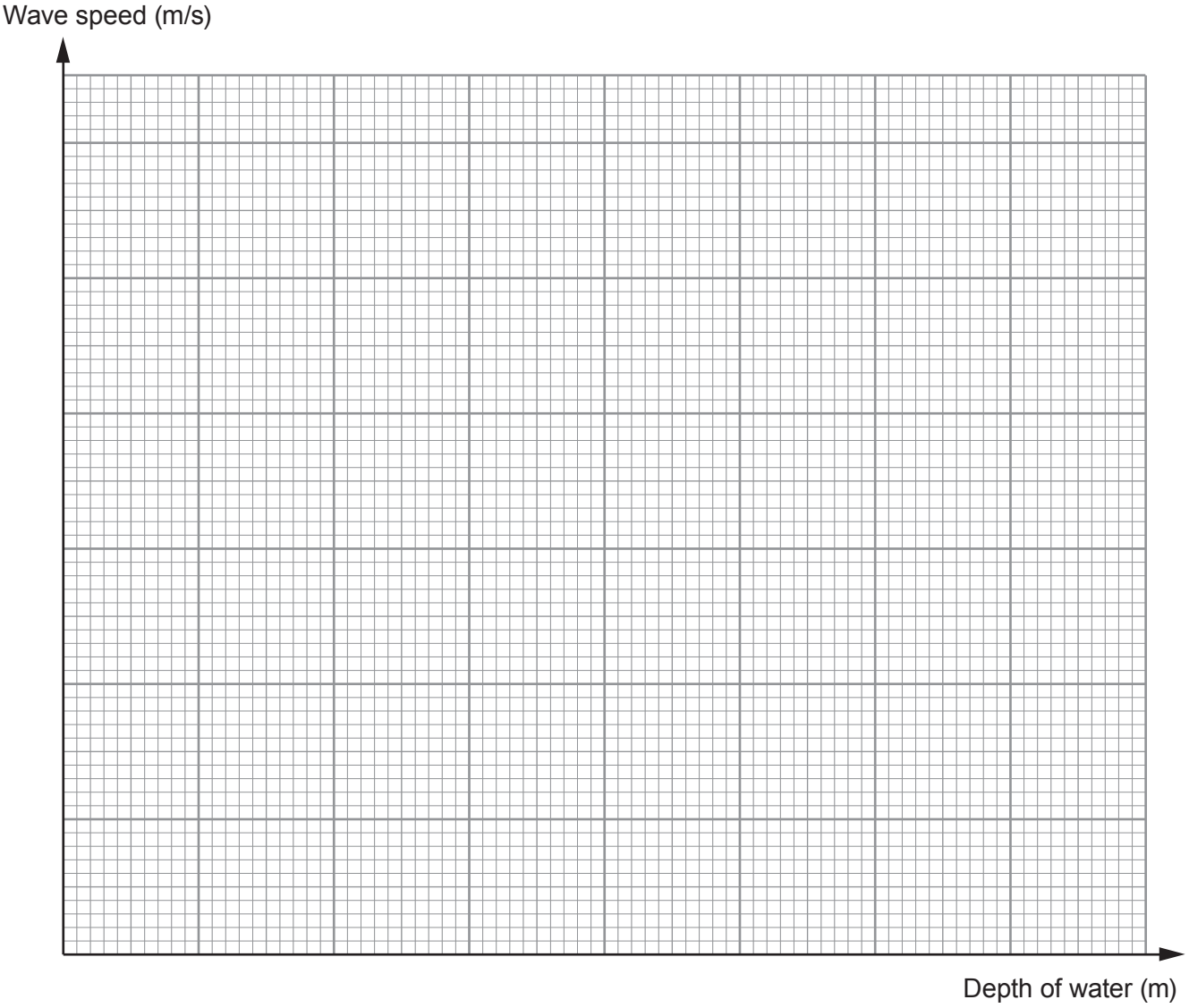
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4. The data below shows how the speed of water waves changes with the depth of water.

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

Depth of water (m)	Wave speed (m/s)
0.0	0.0
0.5	1.8
1.5	3.8
2.5	4.9
3.5	5.7
4.0	6.0



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(ii) Describe how the wave speed changes with the depth of water. [2]

.....

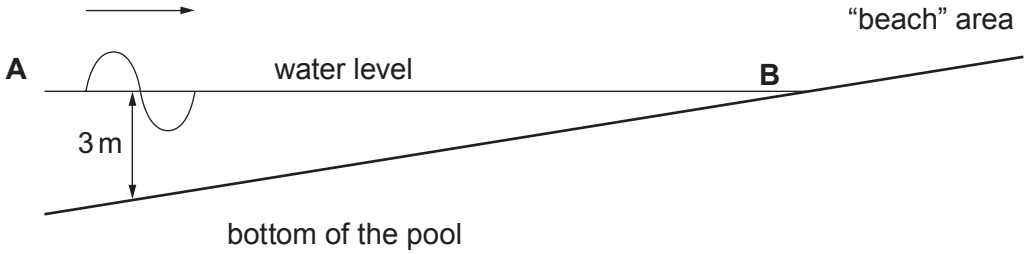
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(b) Use the graph to answer the following question.
Water waves produced by a wave machine in a swimming pool have a wavelength of 8.1 m where the depth of water is 3.0 m.

(i) Use an equation from page 2 to calculate the frequency of these waves in the pool. [3]

frequency = ... Hz

(ii) As the waves travel from **A** to **B** in the pool, their frequency remains constant. Explain what happens to their wavelength. [2]



.....

.....

.....

10

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5. Solar panels are fitted to a house. They save money 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 a feed-in tariff of 14 p for every unit of electricity generated.

A householder spends £7 500 fitting solar panels to their roof. The mean power output is 3 kW and they generate 3 900 units (kWh) in one year (52 weeks). The householder uses all of these units.

(a) Use an equation from page 2 to calculate the mean number of hours a week for which the solar panels generate electricity. [2]

time = ... hours

(b) (i) Calculate the expected pay-back time for the system. [4]

time = ... years

(ii) Explain how this pay-back time would be affected if the cost of a unit of electricity increased. [2]

.....

.....

.....

(c) It is estimated that fitting photo-voltaic (p.v.) systems reduces CO_2 emissions by 0.5 kg for every unit (kWh) of electricity produced. Calculate how much CO_2 will be saved by this household in total if the solar panels have a lifetime of 25 years. [2]

CO_2 savings = ... kg

10

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6. Discuss the evidence for the Big Bang theory.
Include in your answer reference to the following:

- cosmological red shift of spectra from distant stars and galaxies;
- Cosmic Microwave Background Radiation (CMBR). [6 QWC]

6

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.

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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

4463/02

W15-4463-02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

P.M. THURSDAY, 15 January 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**16**	
3.	**8**	
4.	**7**	
5.	**6**	
6.	**15**	
Total	**60**	

4463 020001

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 answers to questions **2***(c)* and **6***(c)*.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
power = voltage × current	$P = VI$
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
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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Examiner only

Answer **all** *questions.*

1. 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]

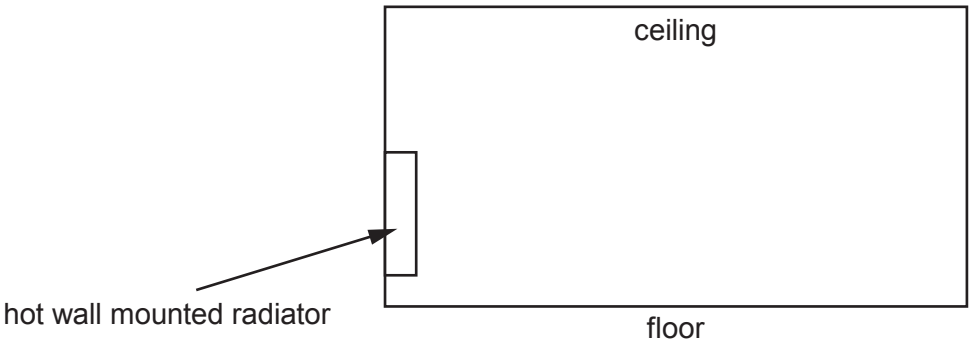
counts received = ...

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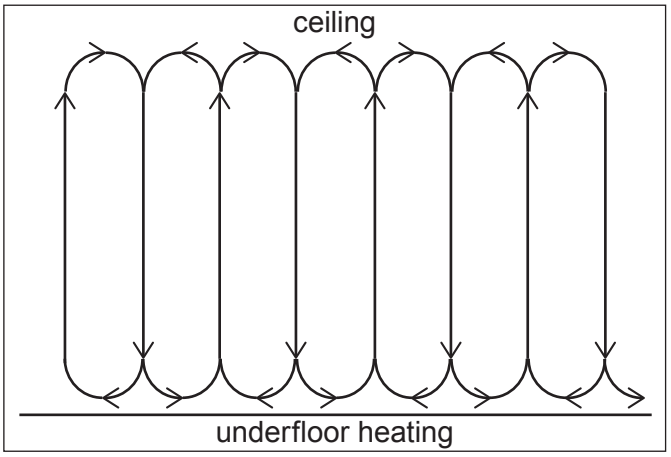
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Examiner only

2. *(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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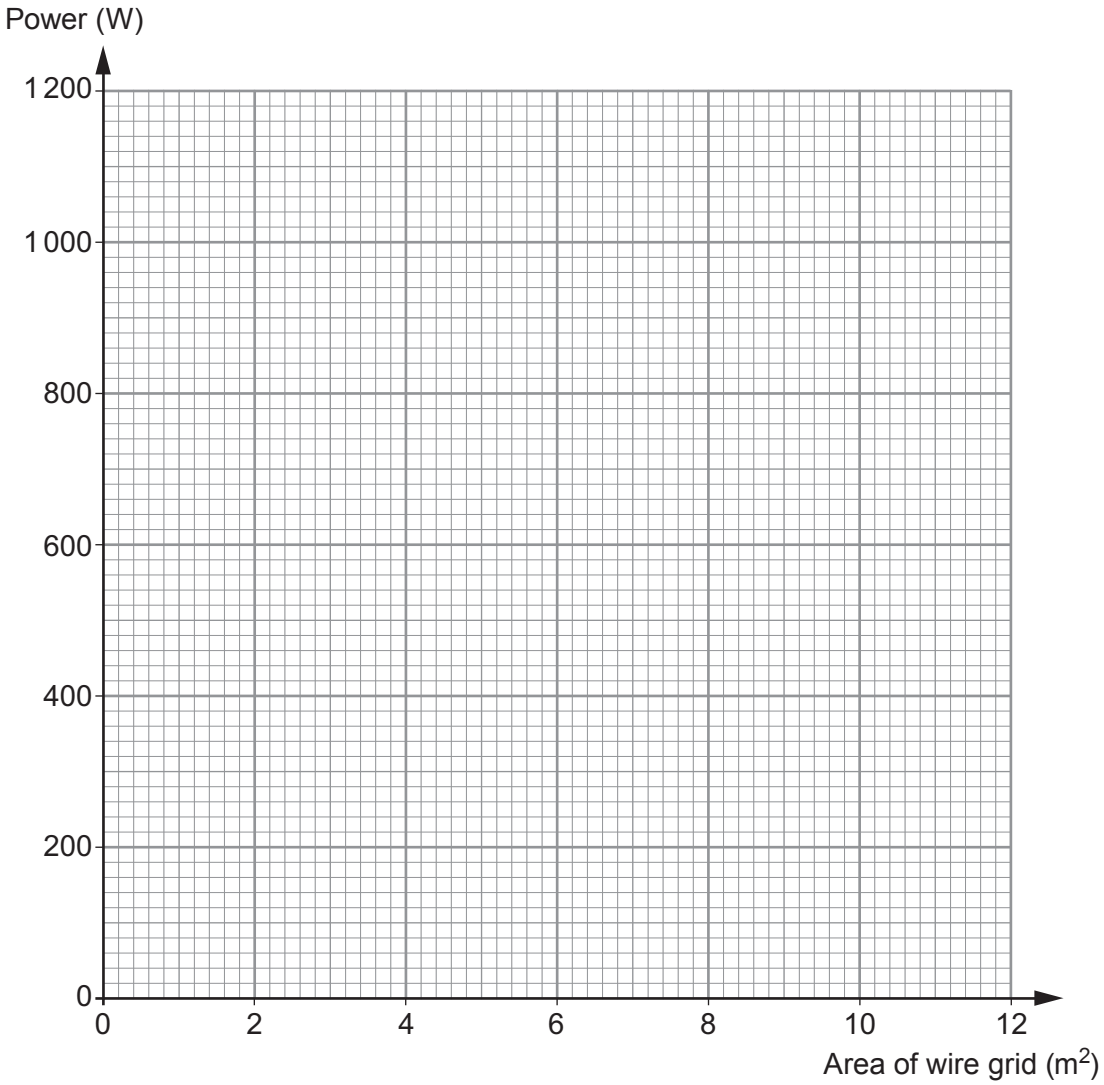
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Examiner only

(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	1 200

(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]

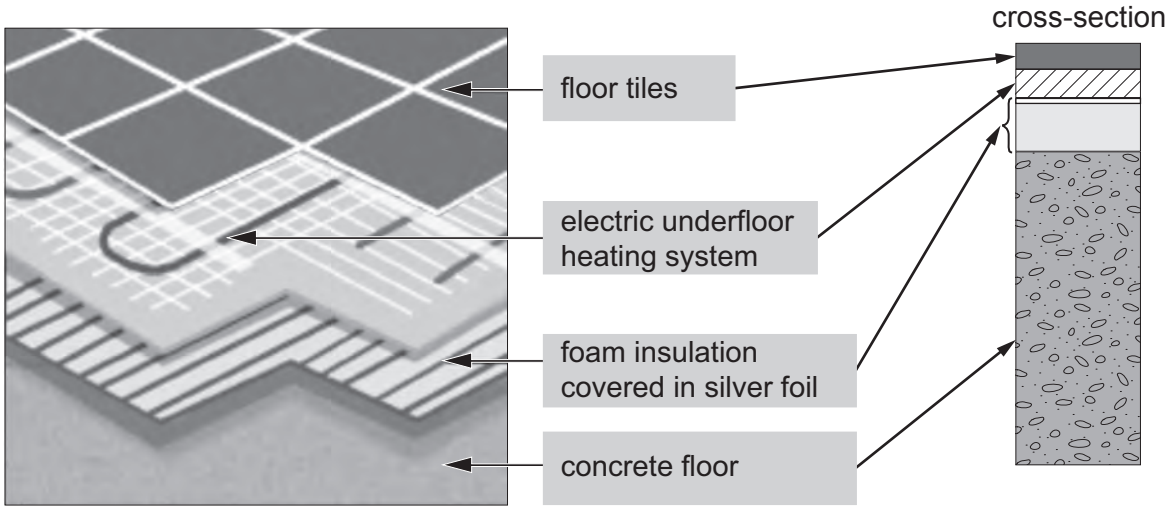
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(c) The diagrams show how the underfloor heating system is laid under tiles.



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.

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3. Drax is a large coal-fired power station with a generating capacity of 3950 MW. This power is transmitted through the National Grid to consumers with an efficiency of 92%.

(i) Explain how this high efficiency is achieved by the National Grid system. [3]

.....

.....

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.....

.....

.....

(ii) Use an equation from page 2 to calculate the power available for use by consumers. [2]

power = ... MW

(iii) Mains electricity is supplied to a home at 230 V at a maximum current of 80 A.
Use an equation from page 2 and your answer to part (ii) to calculate the minimum number of homes that could be supplied by the Drax power station. [3]

number of homes = ...

8

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Turn over.

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4. The Andromeda Galaxy is 2.22×10^6 light years away from Earth. Part of its spectrum is shown below.



(i) How long does light from Andromeda take to reach Earth? [1]

time = ...

(ii) Explain how the dark lines crossing the spectrum are produced. [3]

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(iii) Fred Hoyle proposed the Steady-State theory of the Universe in 1948. This suggested that the Universe has always looked the same over time. Explain why red shift measurements **and** the discovery of Cosmic Microwave Background Radiation (CMBR) did not support this theory. [3]

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5. A mobile phone network uses microwaves to transmit signals between mobile phones and masts. The microwaves have a frequency of 1.5 GHz and travel at a speed of 3×10^8 m/s. The maximum distance that a phone can be from a mast and still receive a signal is 35 km.

(i) Use an equation from page 2 to calculate the wavelength of the microwaves. [3]

wavelength = ... m

(ii) Use an equation from page 2 to calculate the maximum time for a signal to travel from a phone to a mast 35 km away. [3]

time = ... s

6

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6. *(a)* What is the purpose of the National Grid? [2]

.....

.....

.....

(b) A large wind turbine can supply a mean power of 0.95 MW to the National Grid. The table shows the **length of time** during a typical week when the turbine generated electricity.

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Length of time electricity generated (minutes)	495	0	1 440	900	600	1 440	525

(i) Using an equation from page 2 calculate the energy output (in MWh) of the wind turbine for the week. [3]

energy output = ... MWh

(ii) The cost of commissioning the wind turbine is £650 000. The electricity it produces is sold to the National Grid at 5 p per kWh. Calculate the expected payback time. (Payback time is the time taken to repay the £650 000 cost.) [4]
Assume the energy output for a typical week is constant.

payback time = ... weeks

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(c) Discuss the advantages and disadvantages of using wind turbines such as in part *(b)* for the large scale production of electricity for distribution by the National Grid. [6 QWC]

Consider the following information when writing your answer:

- power demand from the National Grid is typically 40 GW;
- a nuclear power station typically produces an output of 2.5 GW;
- reliability of output;
- environmental considerations.

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15

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

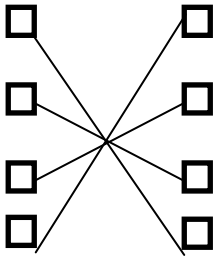
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GCSE Science - Physics 1 Mark Scheme

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

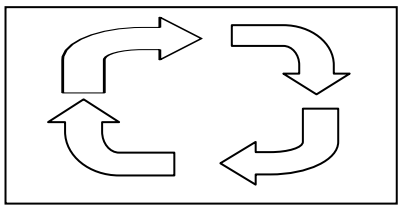
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Question			Marking details	Marks
		(iii)	rocks / cosmic / radon / food / Sun / buildings **Accept** soil / ground / correctly named rocks e.g. granite Don't accept Earth / air / named foods **Question total**	1 **[7]**
4.	(a)		700 [security light] (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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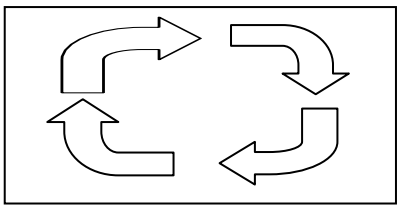
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Question			Marking details	Marks
			1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific 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

4463/02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

A.M. MONDAY, 16 June 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**12**	
3.	**6**	
4.	**9**	
5.	**15**	
6.	**6**	
Total	**60**	

4463
020001

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 answers to questions **2***(a)*(i) and **6**.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
power = voltage × current	$P = VI$
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
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}

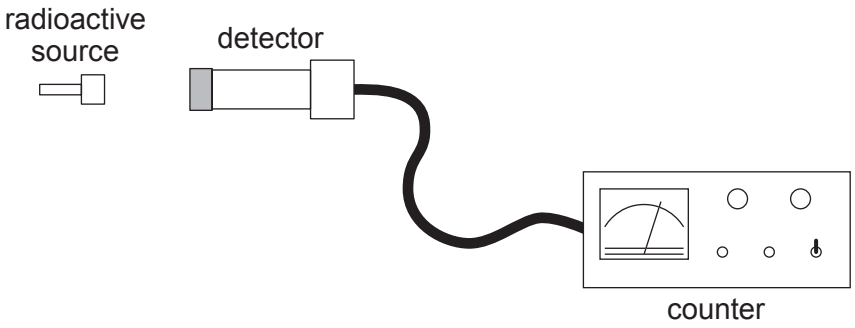
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Answer **all** *questions.*

1. 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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Turn over.

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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.

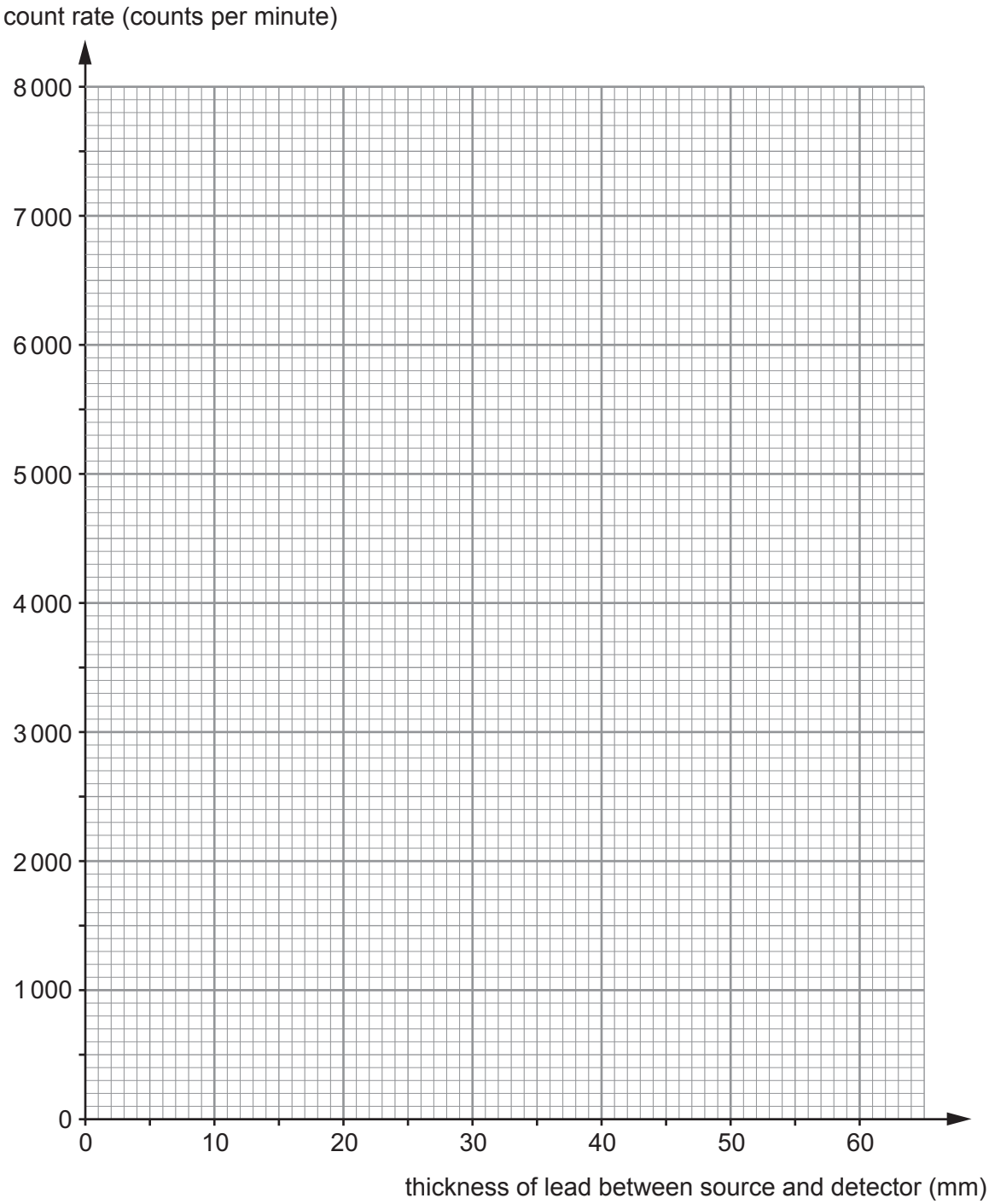
Thickness of lead between source and detector (mm)	Count rate (counts per minute)
0	8000
10	4000
30	1000
40	500
50	250

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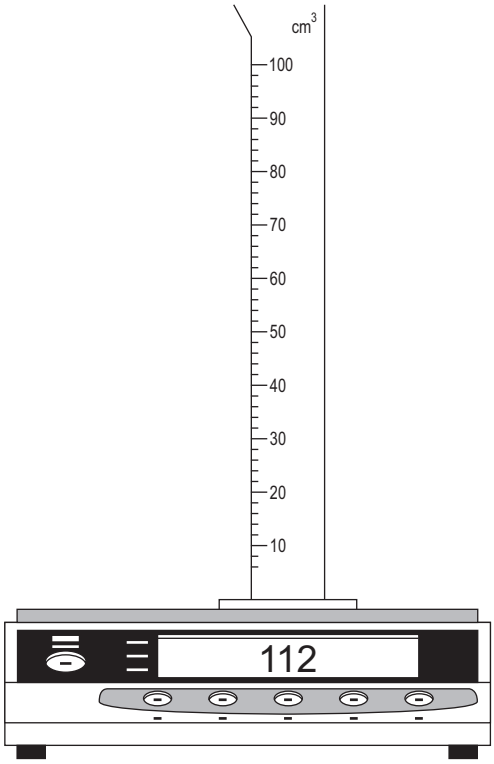
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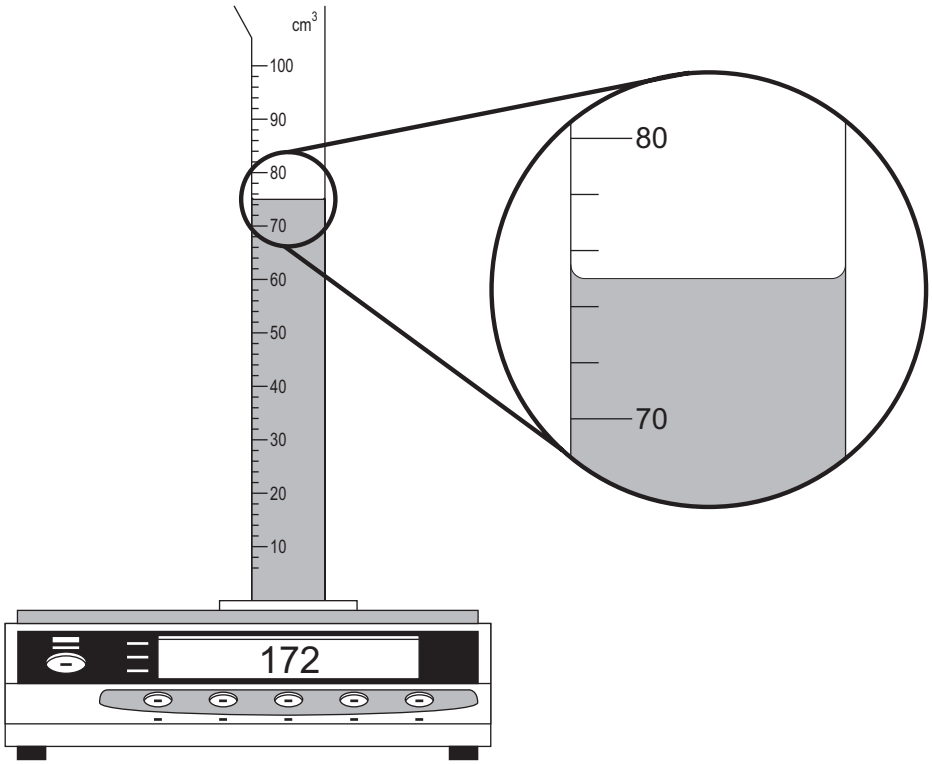
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2. A pupil wants to find the density of an oil. She uses a chemical balance which measures to the nearest gram (g). She places an empty measuring cylinder on to the balance.



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



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(a) (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]

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

1. .....

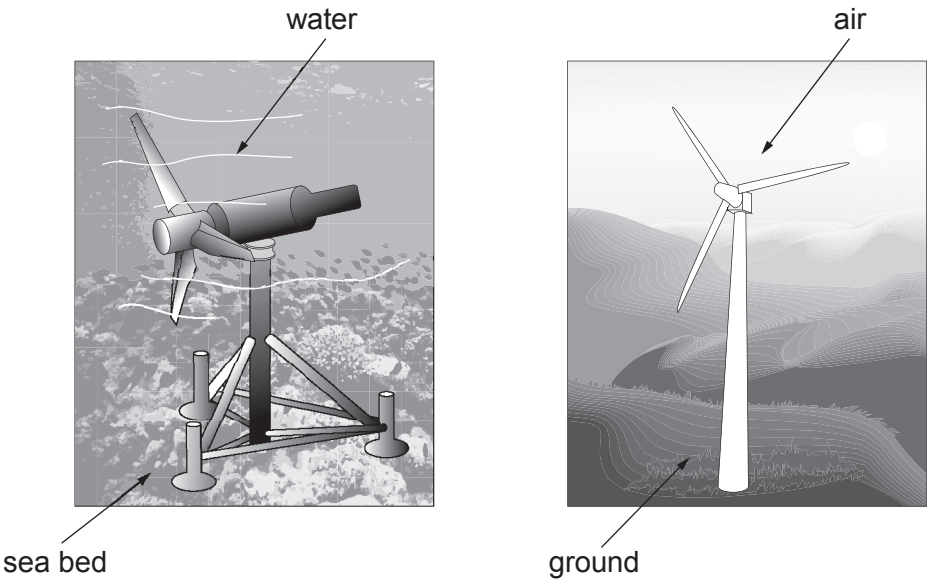
2. .....

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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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3. An electric heater has the following label attached to it.

Serial number A3462012
230 V 1 500 W
50 Hz

It is used for 8 hours each day for 2 weeks. The cost of the electricity used is £25.20.

(a) Use this information and equations from page 2 to calculate the cost, in pence, of 1 unit (kWh) of electricity. [4]

cost = ... p

(b) Use an equation from page 2 to calculate the number of joules of electrical energy converted to heat and light in this 2 week period. [2]

energy = ... J

6

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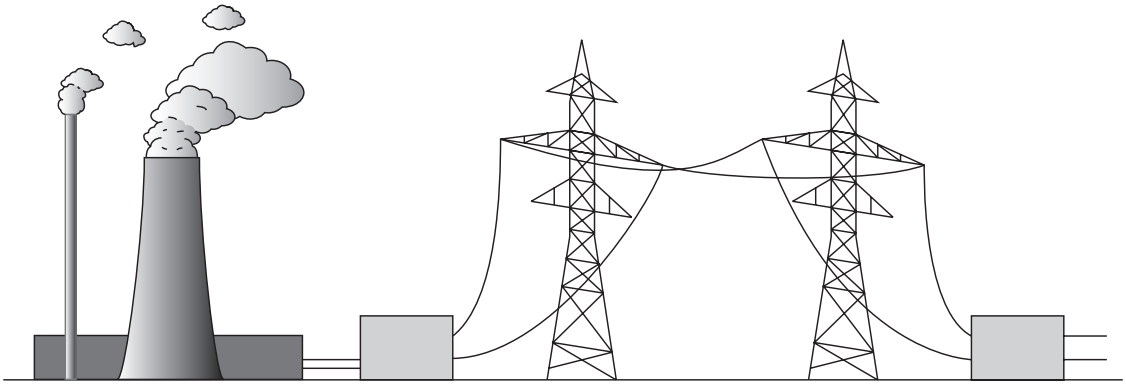
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4. The diagram shows part of the National Grid that delivers electrical power to homes and industry from power stations.



(a) The power station generates 2×10^9 W of power, delivering it at a current of 4×10^4 A to the step-up transformer.

(i) Use an equation from page 2 to calculate the output power, given that the transformer is 99% efficient. [1]

power = ... W

(ii) Use your answer to (i) and equations from page 2 to calculate the output current from this transformer, given that it steps up the voltage by a factor of 8. [4]

current = ... A

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(b) Explain why it is necessary to use transformers in the transmission of electricity to homes along the National Grid. [4]

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5. The graph below shows how the velocity of galaxies moving away from the Earth (called their recession velocity) depends on their distance away from us (in light years).



Sir Edwin Hubble put forward this theory.
"The recession velocity of a galaxy is directly proportional to its distance from Earth."

(a) (i) State how the graph supports Hubble's theory. [2]

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(ii) The gradient (steepness) of the graph is called the "Hubble constant".

Its value is given by: Hubble constant = $\frac{1}{\text{age of the Universe}}$

Explain how the gradient of this line will change in the future. [2]

.....

.....

.....

(b) The speed of recession of a distant galaxy is measured as 6 000 km/s.
Use the graph to calculate the distance of this galaxy from Earth. Give your answer in km. (A light year is equivalent to 9.5×10^{12} km.) [2]

distance = ... km

(c) The wavelength of a particular absorption line from the distant galaxy is measured as 669.4 nm. It is found to have been red shifted by 13.1 nm. Calculate the expected frequency of the same absorption line if measured in a laboratory experiment on Earth.
You should use an equation from page 2 to obtain your answer.
(Speed of light in vacuum, $c = 3 \times 10^8$ m/s.) [5]

frequency = ... Hz

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(d) (i) Explain how Cosmic Microwave Background Radiation (CMBR) provides evidence that supports the Big Bang Theory. [2]

.....

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(ii) Space has a temperature of about –270 °C (3 K) and is filled with CMBR energy. Explain why the temperature of space will decrease as the Universe continues to expand. [Note that the energy of a wave is directly proportional to its frequency.] [2]

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6. In an answer to a recent exam question, a candidate wrote: *"A SINGLE geostationary satellite stays in the same place and is the only way of relaying all electromagnetic waves around the world."*
Explain, in detail, what is wrong with the above statement. [6 QWC]

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END OF PAPER

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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.

	Page
Physics 1 - Foundation Tier	1
Physics 1 - Higher Tier	5
Physics 2 - Foundation Tier	11
Physics 2 - Higher Tier	15
Physics 3 - Foundation Tier	19
Physics 3 - Higher Tier	23

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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

4463/02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

P.M. THURSDAY, 16 January 2014

1 hour

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

4463
020001

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 answers to questions **2***(c)* and **7**.

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Equations

density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
power = voltage × current	$P = VI$
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
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. 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]

.....

.....

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12

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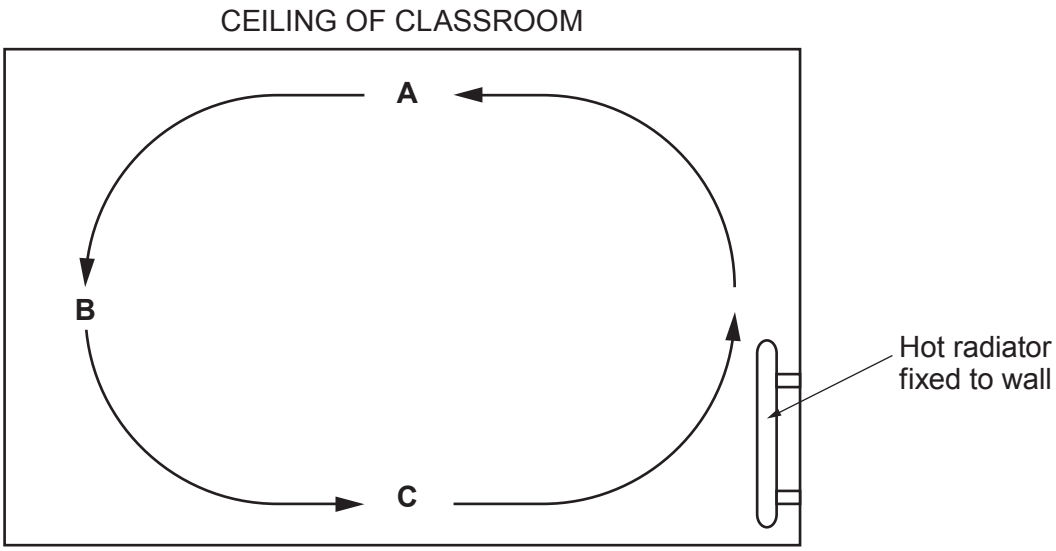
Examiner only

2. *(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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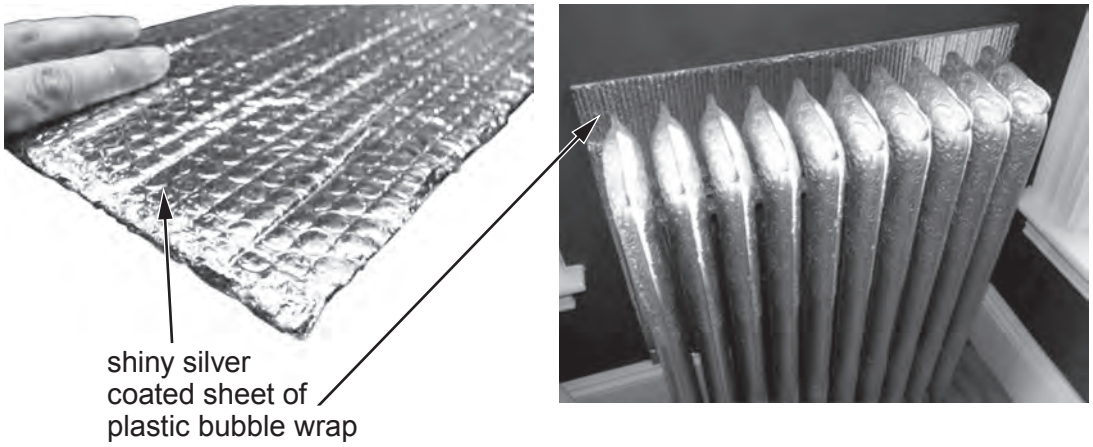
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(c) A shiny silver coated sheet of plastic bubble wrap is placed on the wall behind the radiator. Explain how this can reduce heat loss from the classroom by conduction, convection and radiation. [6 QWC]



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3. Waves can travel across the surface of water. Their speed depends upon the depth of the water.
Water is placed into a plastic tray. The depth of water is measured.
Some pupils time how long it takes a wave to travel 4 **lengths** of the tray.
They repeat the timing for each depth of water.
Here are the results obtained from their experiment.

Depth of water (cm)	Time taken 1 (s)	Time taken 2 (s)	Mean time (s)	Wave speed (cm/s)
0				0
0.5	3.2	2.8	3.0	30
1.0	2.0	2.2	2.1	43
1.5	1.7	1.7	1.7	53
2.0	1.6	1.4	1.5	60
3.0	1.4	1.2	.....	69

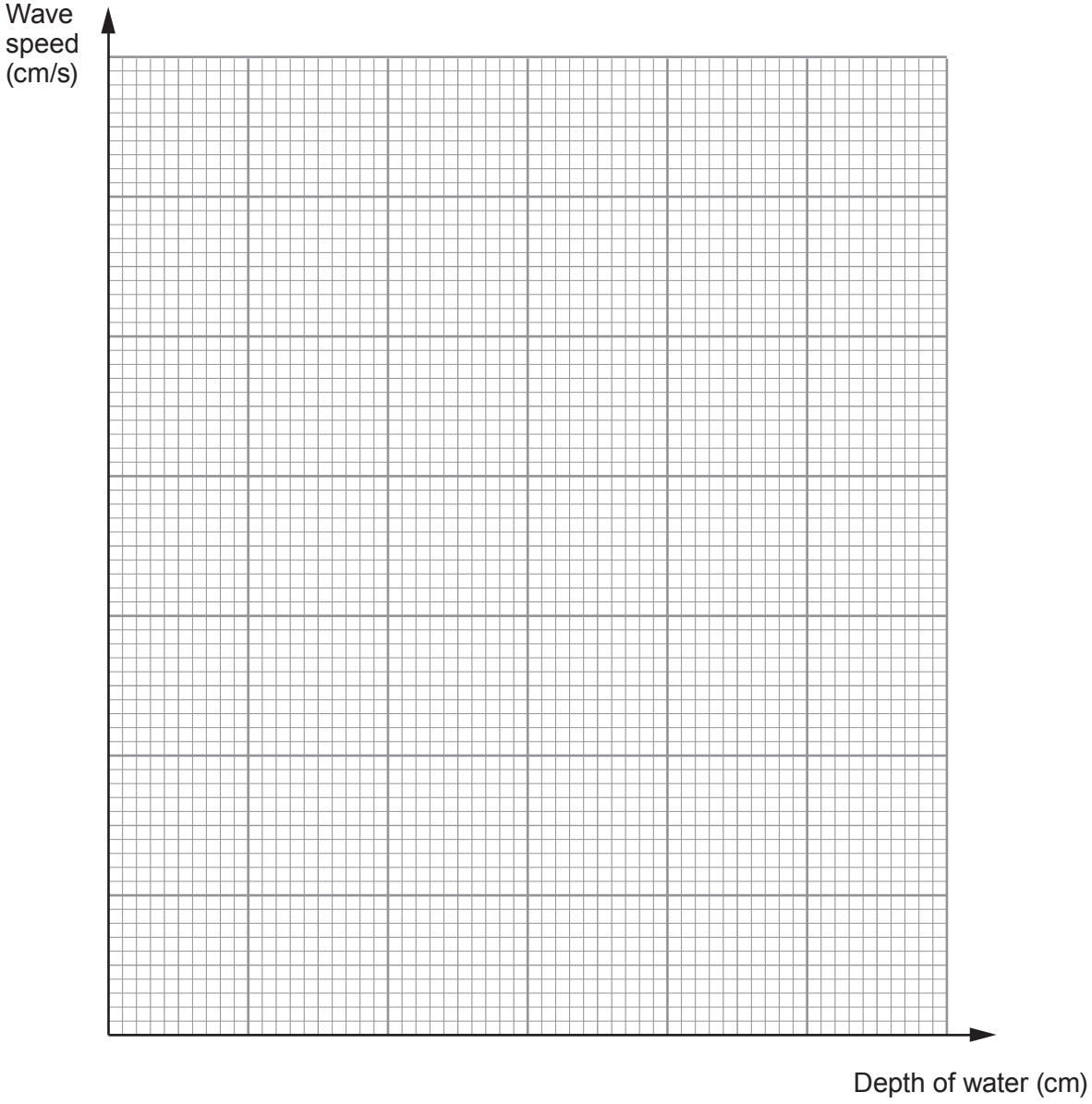
(a) Complete the table to show the missing mean time at a water depth of 3.0 cm. [1]

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(b) (i) Plot the data on the grid below and draw a suitable line to show how the wave speed depends upon the depth of water. [3]



(ii) Describe how the wave speed changes with an increasing depth of water. [2]

.....

.....

(iii) Use the graph to find the wave speed for water that has a depth of 2.5 cm. [1]

Wave speed ..... cm/s

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(c) Using data from the table and an equation from page 2, calculate the length of the plastic tray. [3]

Length = ... cm

10

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4. The table below shows how the electrical demand in the UK during one evening in the winter is met by suppliers.

Origin	Power (MW)
UK	41 758
Transferred in from France	996
Transferred in from Netherlands	992
Transferred in from Ireland	254

(i) The efficiency of transmission along the National Grid is approximately 90%. Use an equation from page 2 to calculate the power consumption of users. [3]

Power = ... MW

(ii) Explain how the National Grid is designed to provide such a high transmission efficiency. [2]

.....

.....

.....

(iii) There are electrical supply lines between the UK and northern France. The undersea section consists of eight 46 km long, 270 kV cables in parallel, between Folkestone (UK) and Sangatte (France). Assuming the power is **shared equally** between these 8 cables, use an equation from page 2 to calculate the current through each cable during the evening referred to above. [3]

Current =..... A

8

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5. A list of radioisotopes and their decay mode is shown in the table below.

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Radioisotope	Decay mode
Radon - 272	α
Strontium - 90	β
Silver - 110	β and γ
Iodine - 131	γ
Radium - 226	α and γ

The table below shows the count rate detected from three of the radioisotopes above when different absorbers are placed between the source and counter. The distance between the counter and the radioisotope is fixed at 2 cm.

Radioisotope	Count rate (units)			
	No absorber	Paper	Aluminium	Lead
X	21	20	21	6
Y	74	73	56	15
Z	44	32	33	12

Use the information in **both** tables to identify radioisotopes **X, Y** and **Z** giving your reasoning. [5]

Radioisotope **X** is .....

Reasoning:

.....

.....

.....

Radioisotope **Y** is .....

Reasoning:

.....

.....

.....

Radioisotope **Z** is .....

Reasoning:

.....

.....

.....

5

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6. *(a)* An incomplete diagram of the electromagnetic (em) spectrum is shown below.

(i) Complete the **first column** to show the missing ionising regions in order of decreasing frequency. [2]

Region of em spectrum	Wavelength range (m)
Gamma rays	.....
.....	.....
.....	.....
Visible light	.....

(ii) Typical wavelength ranges for each region of the em spectrum in metres are listed below in a random order.

4×10^{-7} to 7×10^{-7}	$< 1 \times 10^{-11}$	1×10^{-9} to 4×10^{-7}	1×10^{-11} to 1×10^{-9}

Use these values to **complete** the wavelength column in the table above. [2]

(b) One ionising region of the em spectrum has wavelengths in the range 4×10^{-7} to 1×10^{-9} m. Use an equation from page 2 to calculate the maximum frequency of this region of the em spectrum. The wave speed of em waves is 3×10^{8} m/s. [3]

maximum frequency = ... Hz

7

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7. State what is meant by absorption spectra **and** explain how they can provide information about stars and galaxies. [6 QWC]

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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

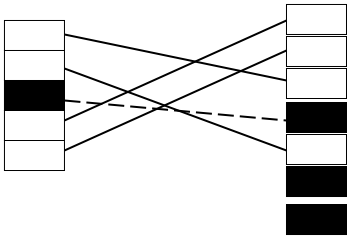
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GCSE Science - Physics 1 Mark Scheme

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

4463/02

SCIENCE A/PHYSICS

PHYSICS 1
HIGHER TIER

A.M. TUESDAY, 18 June 2013

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**17**	
3.	**6**	
4.	**11**	
5.	**7**	
6.	**7**	
Total	**60**	

4463
020001

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 answers to questions **2***(b)* and **6***(b)*.

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Equations

$\text{density} = \dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
power = voltage × current	$P = VI$
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
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. 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]

.....

.....

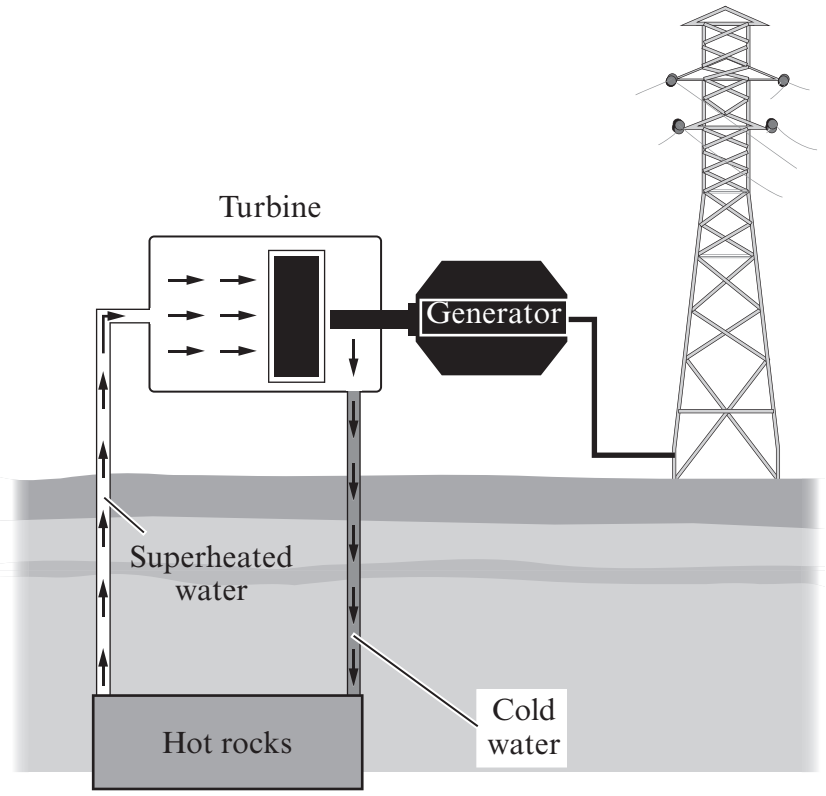
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(b) Plans have been revealed for what will be the first geothermal power station to be built in the UK. A 3 MW geothermal power station will be built at the Eden Project in Cornwall.

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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Turn over.

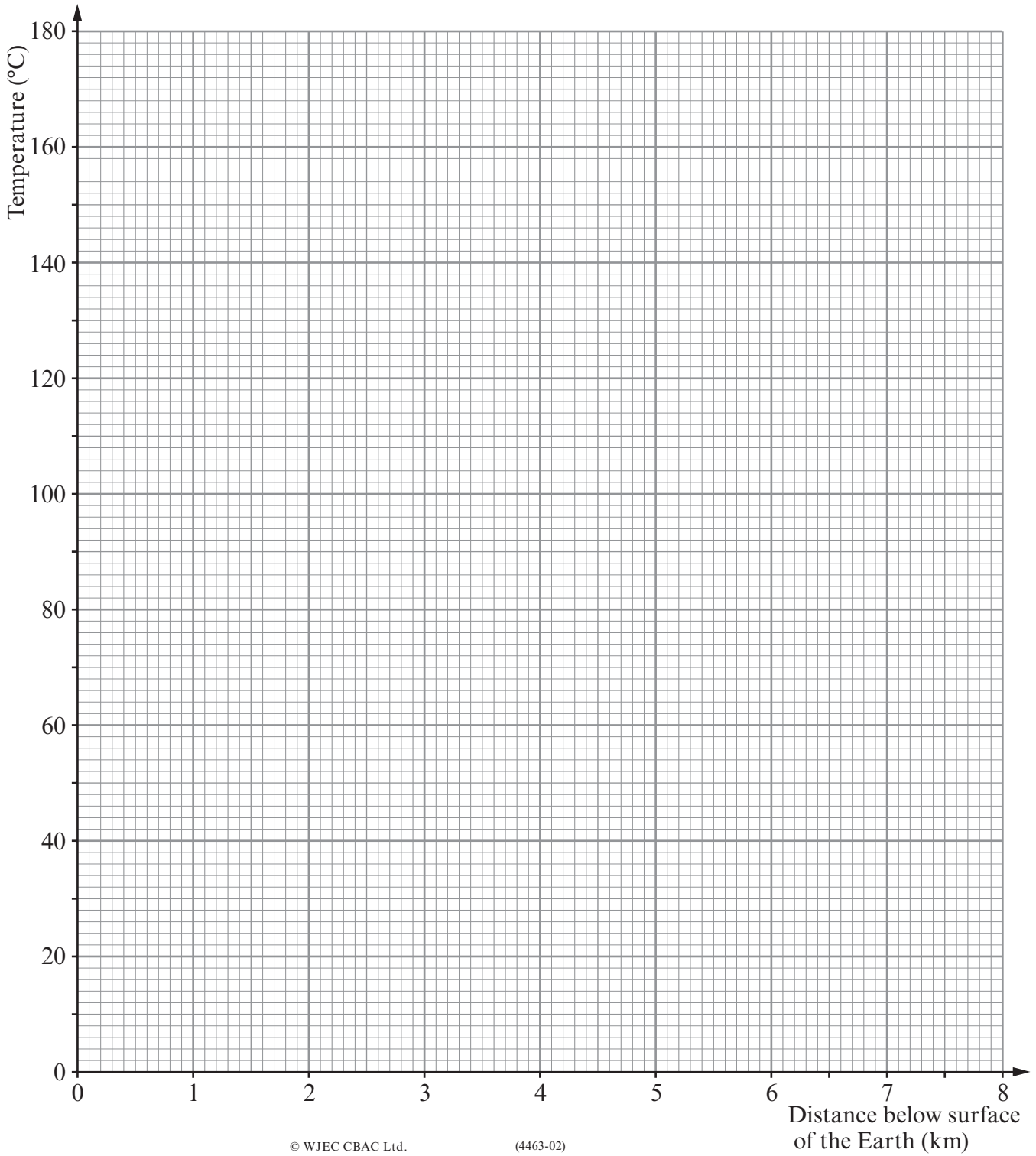
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(c) The table below shows the temperature at different distances below the surface of the Earth.

Examiner only

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 2000 W of power. [2]

number of homes = ...

12

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2. 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]**

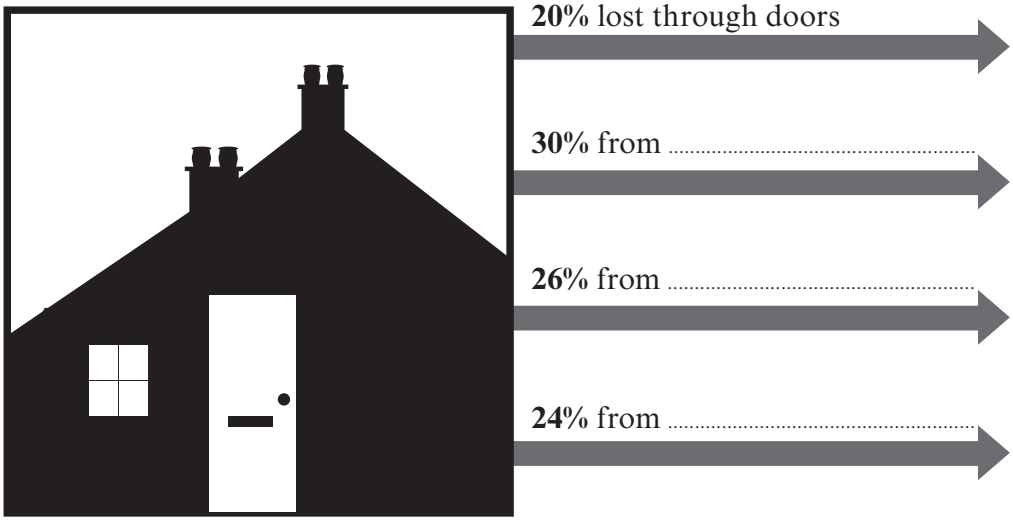
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(c) The diagram shows the percentages of energy lost from the house if it is **fully insulated**. Label the arrows to show which part of the house each percentage comes from. *One has been done for you.* You should refer to the table on page 8. [2]



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

.....

.....

.....

(e) The family in the house is advised to reduce the temperature in the main living area in winter time to save money. Explain how this would increase the payback time for the improvements that are undertaken. [2]

.....

.....

.....

(f) Insulating the cavity wall reduces the energy loss per second by 1 700 W. Use this information to calculate the time taken to save £120. One unit of electricity costs 15 p. [3]

You should use the following equations:

$$\text{Units saved} = \frac{\text{saving}}{\text{cost per unit}} \qquad \text{Time (h)} = \frac{\text{units saved}}{\text{power (kW)}}$$

Time = ... hours

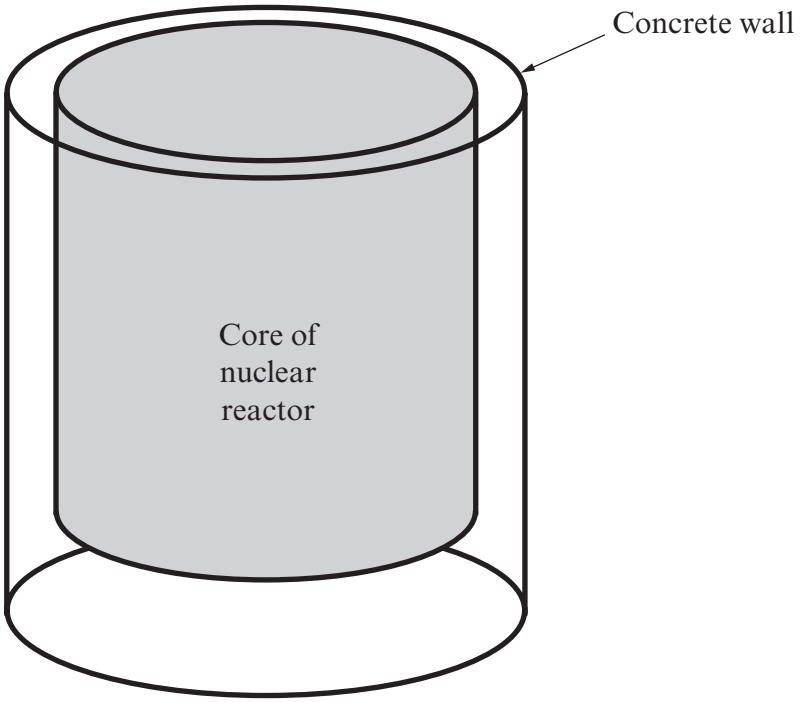
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3. The core of a nuclear reactor is shielded by concrete.



(a) Compare the effectiveness of different thicknesses of concrete in absorbing each of the three types of radiation. [3]

.....

.....

.....

(b) (i) State **one** method for the long term storage of radioactive waste. [1]

.....

.....

(ii) Outline **one** advantage and **one** disadvantage of storing the waste in this way. [2]

.....

.....

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6

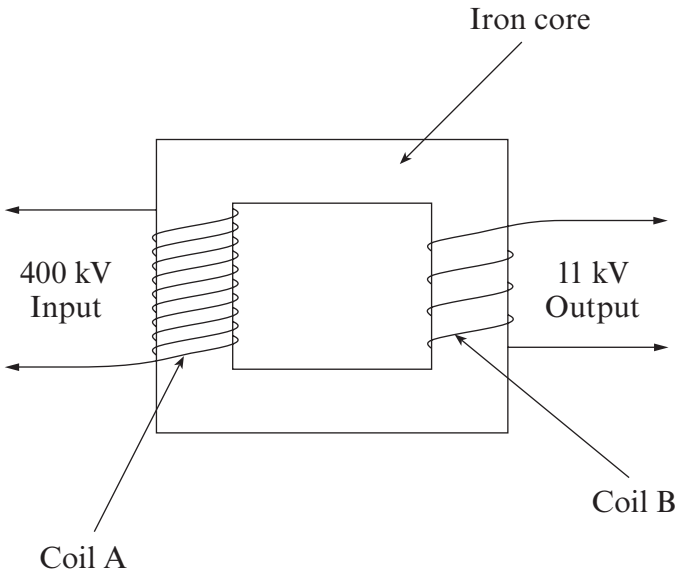
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4. The diagram shows a transformer that is made up of two coils and an iron core. Transformers are used in the supply of electricity to homes, schools and industry. The one shown below has an input power of 10 MW and is 99% efficient.



(a) (i) Describe the National Grid. [2]

.....

.....

.....

(ii) Explain why electrical power is transmitted at high voltages in the National Grid. [2]

.....

.....

.....

(b) (i) Name the type of transformer shown in the above diagram and give a reason for your answer. [1]

.....

.....

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(ii) Use an equation from page 2 to calculate the current in the input coil. [3]

input current = ... A

(iii) Use the equation:

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

to calculate the power delivered to the output coil and give its unit. [3]

output power = ... unit =.....

11

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5. *(a)* In answer to a question about geosynchronous satellites, a candidate wrote:
"A geosynchronous satellite *stays in the same place in space* and *orbits the Earth in the same time as Earth orbits."*
The answer earned zero marks. Re-write the answer in the space below, correcting the parts in italics. [2]

.....

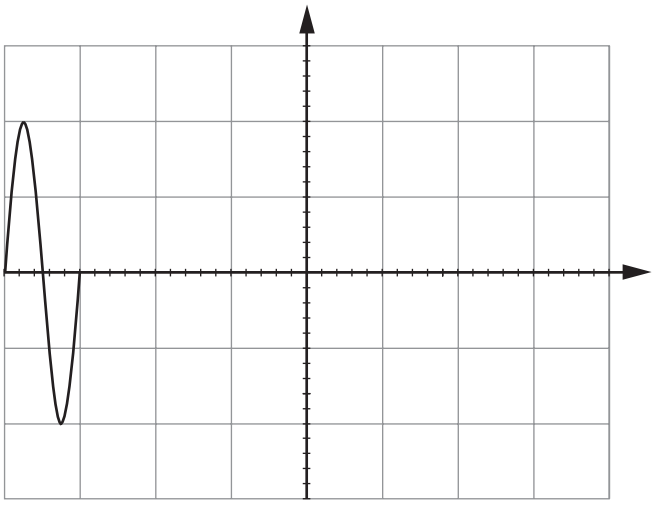
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(b) When a geosynchronous satellite is placed in orbit around the Earth, it is tested by sending a pulse of electromagnetic radiation to it.

A **weaker** pulse is received back on Earth a short time later. The sent pulse is shown on the C.R.O. grid below.

Horizontal scale = 0.1 s/cm
Vertical scale = 0.2 V/cm



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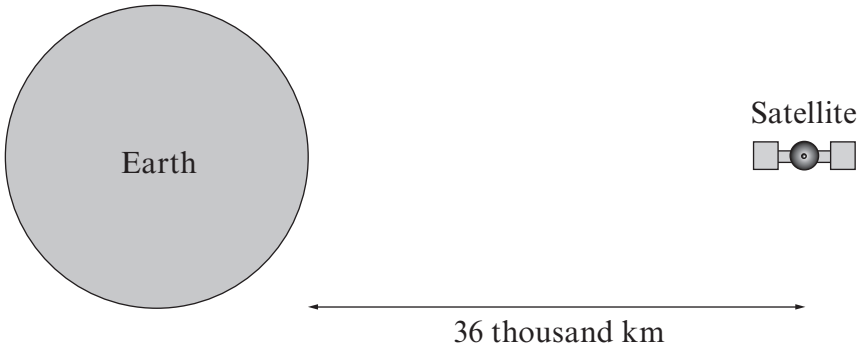
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(i) Calculate the amplitude of the sent pulse. [2]

..... V

(ii) The height above Earth of a geostationary satellite is 36 thousand km.



It takes 0.12 s for a microwave signal to travel 36 thousand km.
State why it takes 0.24 s for the signal to be received back at the station. [1]

.....

(iii) **Draw** the received pulse on the C.R.O. grid on the opposite page. [2]

7

TURN OVER FOR QUESTION 6

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6. *(a)* The nearest star to our solar system is called Proxima Centauri. It is about 4 light years away. State what the term "4 light years" means. [1]

.....

.....

(b) The spectrum of light coming from galaxies is crossed with dark lines.



Explain how the dark lines arise on the spectrum and outline the information that they give about those galaxies. [6 QWC]

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7

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

4463/02

SCIENCE A
HIGHER TIER
PHYSICS 1

P.M. THURSDAY, 17 January 2013

1 hour

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

4463
020001

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 answers to questions **4***(a)* and **8**.

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Equations

$\text{density} = \dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
power = voltage × current	$P = IV$
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
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. 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]

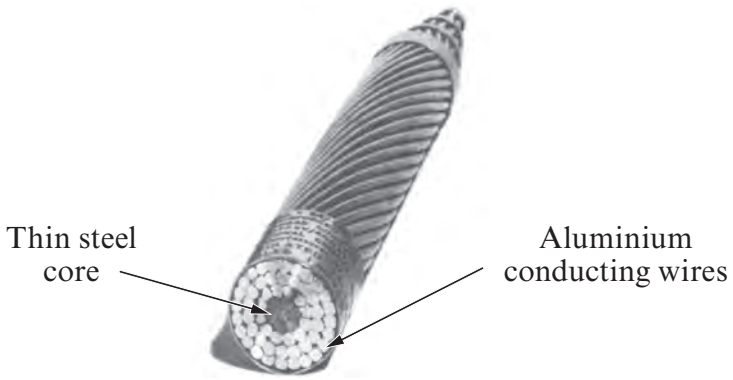
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(iii) Explain why actual overhead cables are made from a thin steel core surrounded by aluminium conducting wires. [3]



.....

.....

.....

.....

.....

(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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4463 020005

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2. 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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3. *(a)* Describe the National Grid. [2]

.....

.....

.....

.....

(b) The picture shows a transformer that supplies electricity to consumers from the National Grid.



(i) Explain the purpose of this transformer. [2]

.....

.....

(ii) Use an equation from page 2 to calculate the current drawn from the transformer when the output power is 0.46 MW and the voltage is 230 V. [3]

current = ... A

7

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

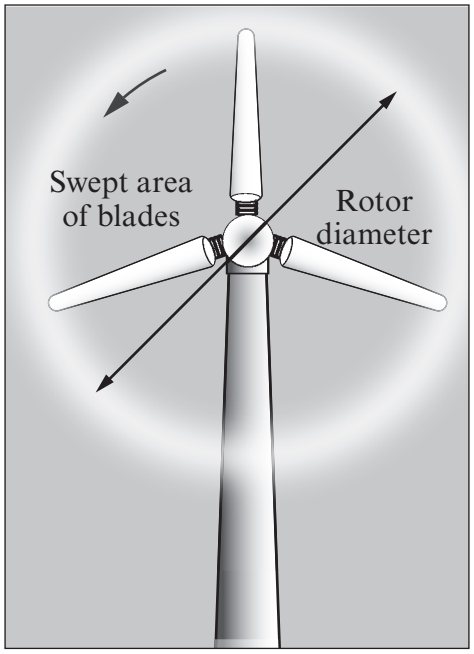
How they compare		
	A wind turbine	A nuclear power station
Overall cost of generating electricity (p/kWh)	5.6	2.8
Maximum power output (MW)	2	3600
Lifetime (years)	15	45
Waste produced	None	Radioactive waste
Lifetime carbon footprint (g of CO_2/kWh)	4.64/5.25 (onshore/offshore)	5
Commissioning cost (£ million)	3	4000

(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.



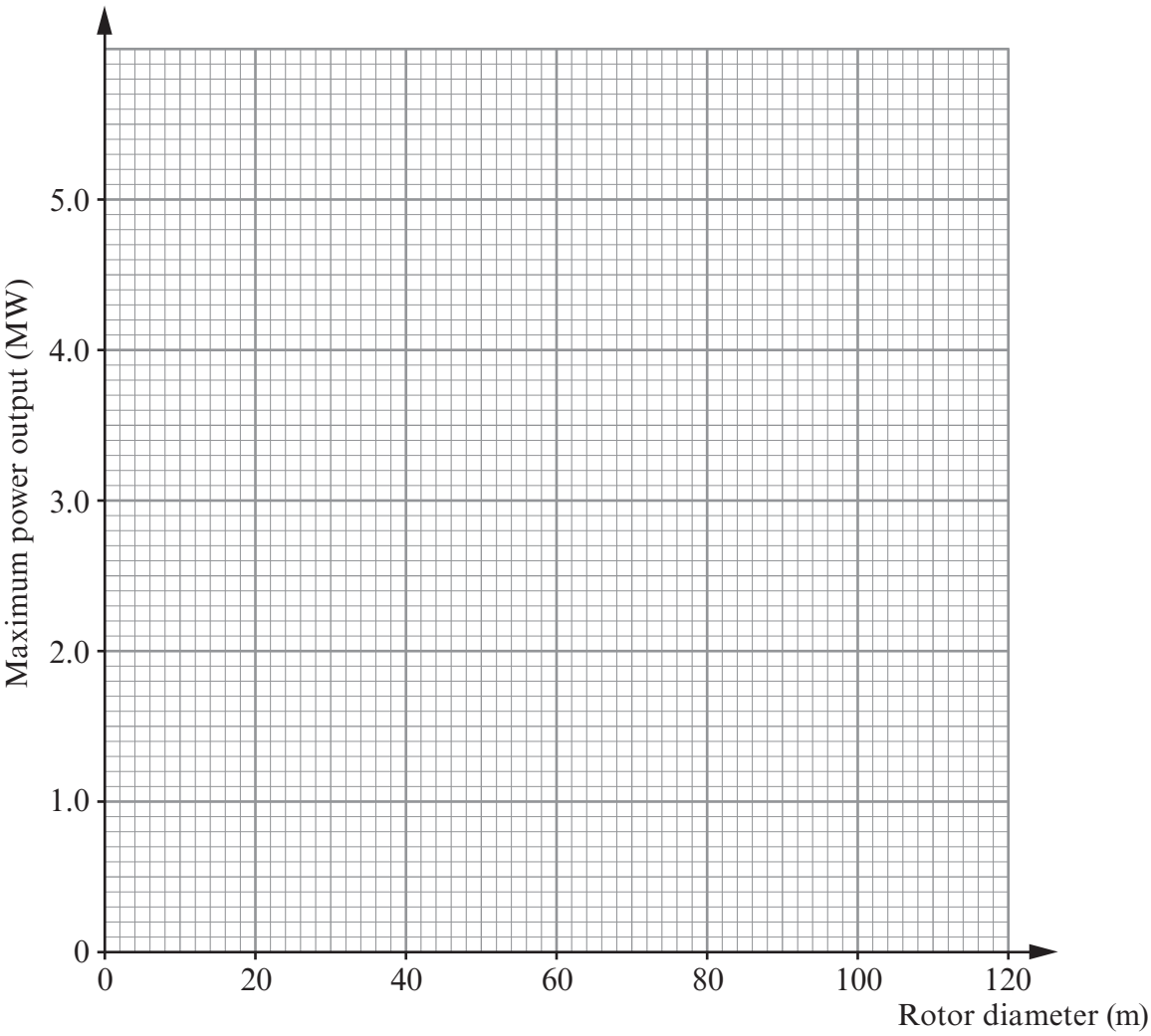
Rotor diameter (m)	Maximum power output (MW)
40	0.5
60	1.1
80	2.0
90	3.0
110	4.5

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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) A wind turbine, of rotor diameter 90 m, operates with an efficiency of 60%. Use an equation from page 2 to calculate the input power from the wind which produces the maximum power output. [3]

input power = ... MW

14

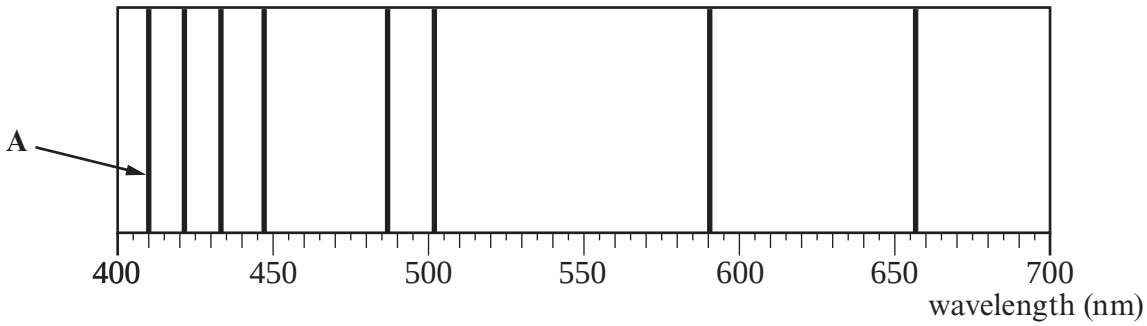
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Turn over.

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5. The diagram shows a spectrum from a star. The spectrum is crossed by dark lines. Astronomers use this information to determine which elements make up the star.



(a) Identify the elements present in the star by putting a **Y** (yes) or **N** (no) in the last column of each row in the table below. [2]

Element	Wavelengths (nm)	Present in star?
Helium	447, 502	.....
Iron	431, 467, 496, 527	.....
Hydrogen	410, 434, 486, 656	.....
Sodium	590	.....

(b) Electromagnetic waves travel at a speed of 3×10^8 m/s through space.

(i) Use an equation from page 2 to calculate the frequency at which the dark line labelled **A** appears. (1 nm = 1×10^{-9} m.) [3]

frequency = ... Hz

(ii) The spectrum is from a star that is 8.6 light years away. Use an equation from page 2 to convert this distance to metres. (1 year = 3.2×10^7 s.) [3]

distance = ... m

8

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6. Brachytherapy is a type of internal radiotherapy, which involves putting a solid radioactive material close to, or inside, the cancerous growth. The radioisotope used emits low energy gamma rays. This is different from external radiotherapy which is normally given as a series of short, daily treatments in the radiotherapy department using high energy gamma rays.

(i) Explain why alpha sources are unsuitable for **both** types of radiotherapy treatments described above to be effective. [2]

.....

.....

.....

(ii) Suggest why the gamma rays used in brachytherapy are low energy compared to those used in external gamma radiotherapy. [2]

.....

.....

.....

(iii) Explain why gamma rays are used to treat cancer tumours. [2]

.....

.....

.....

6

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7. The table shows the heat lost per second through parts of a house. The temperature inside the house is 20 °C and the outside temperature is 9 °C.

Part of house	Insulation	Heat energy lost per second (J)
ATTIC	None	3 000
	Fibre glass laid on floor of attic	400
CAVITY WALL	None	2 000
	Insulated with foam	700
WINDOWS	Single glazed	2 000
	Double glazed	1 200

(a) (i) Find the total energy lost per second from the house if the attic and cavity wall are insulated and it has single glazed windows. [1]

energy loss per second = ... J

(ii) Use your answer to *(a)*(i) to write down the power (in kW) needed to keep the temperature of the house at 20 °C. [1]

power = ... kW

(iii) The power calculated in *(a)*(ii) is provided by electrical heating. Use equations from page 2 to find the cost of keeping the temperature of the house constant at 20 °C for 10 hours. One unit of electricity costs 13 p. [2]

cost = ...

(b) Explain why the cost calculated above would be different if the temperature outside the house dropped to 5 °C during this time. [2]

.....

.....

.....

.....

6

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8. Explain what is meant by the term 'cosmological red shift' **and** how it provides evidence for the origin of the Universe. [6 QWC]

6

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

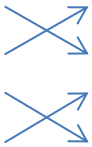
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GCSE Science - Physics 1 Mark Scheme

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

4463/02

SCIENCE A
HIGHER TIER
PHYSICS 1

P.M. FRIDAY, 15 June 2012

1 hour

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

4463 020001

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 answers to questions **4***(a)* and **6***(a)*.

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Equations and Units

Physics 1

power = voltage × current $\qquad P = VI$

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

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

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

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

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

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

Physics 2

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

power = current^2 × resistance $\qquad P = I^2R$

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

distance travelled = area under a velocity-time graph

acceleration = gradient of a velocity-time graph

momentum = mass × velocity $\qquad p = mv$

resultant force = mass × acceleration $\qquad F = ma$

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

work = force × distance $\qquad W = Fd$

$$\text{kinetic energy} = \frac{\text{mass} \times \text{speed}^2}{2} \qquad \text{KE} = \tfrac{1}{2}mv^2$$

$$\text{change in potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{height} \qquad \text{PE} = mgh$$

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Physics 3

$$\frac{\text{primary coil voltage}}{\text{secondary coil voltage}} = \frac{\text{primary coil turns}}{\text{secondary coil turns}} \qquad \frac{V_1}{V_2} = \frac{N_1}{N_2}$$

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

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

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

$\frac{pV}{T}$ = constant

where p = pressure, V = volume, T = kelvin temperature

$E = mc^2$

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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Examiner only

Answer **all** *questions.*

1. 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) of area 4 m^2	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]

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(c) Calculate the area of roof top photovoltaic cells (PV) needed to produce the same maximum power as a wind turbine. [2]

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

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8

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Turn over.

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2. 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

6

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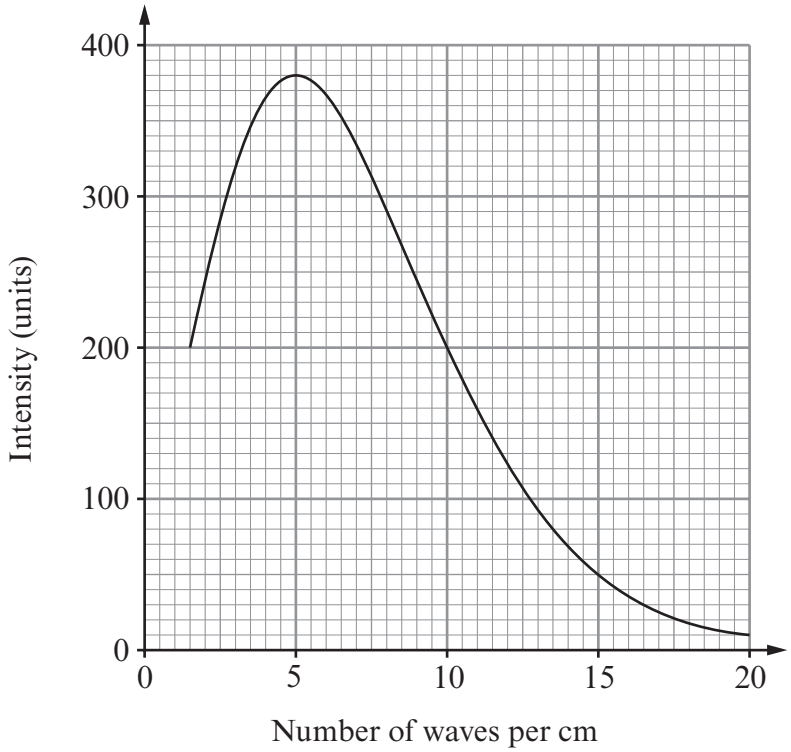
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3. Cosmic microwave background radiation (CMBR) fills the entire universe. The COBE satellite measured the spectrum of the cosmic microwave background radiation in 1990. The results are shown below.



(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]

.....

.....

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(c) Cosmological red shift also gives evidence for the origin of the universe.

(i) State the meaning of the term **red shift**. [1]

.....

.....

(ii) Light from galaxies differs in the amount of red shift that we observe. State what such differences tell us about the galaxies. [2]

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9

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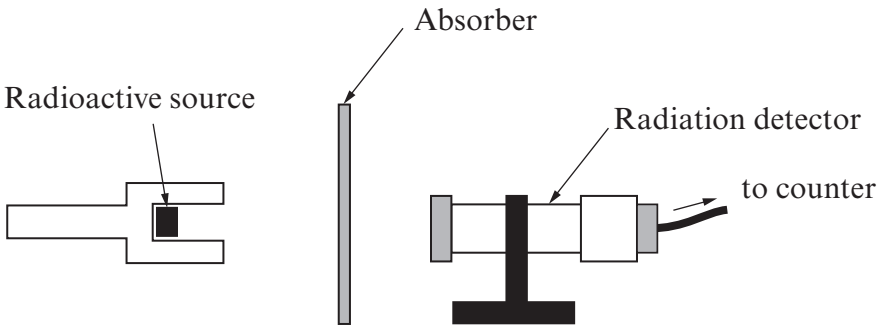
Turn over.

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4. 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) Explain whether this radioactive source would be more harmful inside or outside the body. [2]

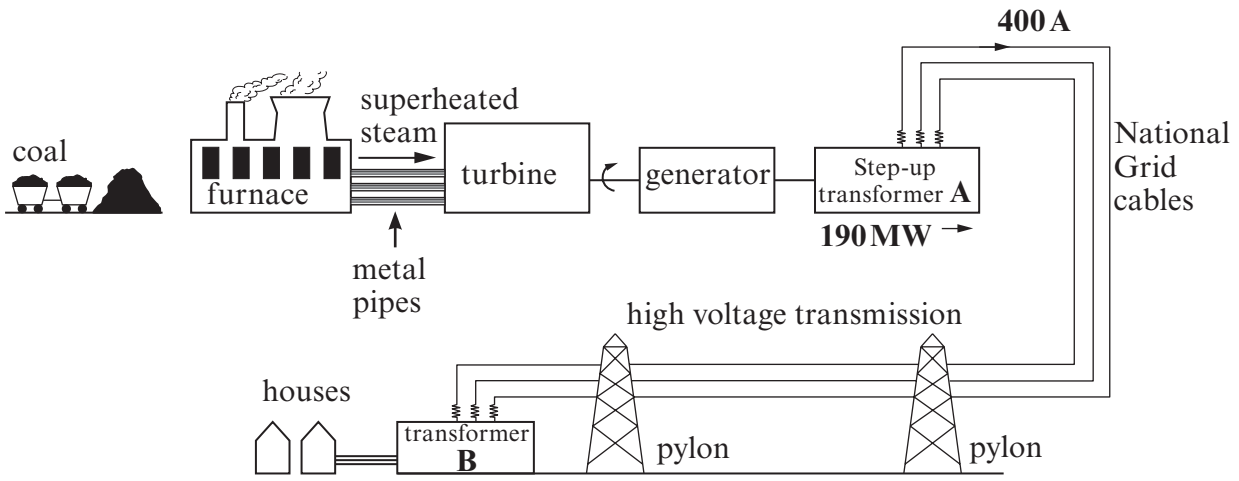
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5. A coal-fired power station has a step-up transformer that delivers 190 MW of electrical power at a current of 400 A to the National Grid.



(a) Use an equation from pages 2 and 3 to calculate the voltage across the National Grid cables. [3]

Voltage = ... V

(b) Explain why the voltage from a power station is stepped up before it is transmitted along the National Grid cables. [2]

.....

.....

.....

.....

(c) State the purpose of transformer **B**. [1]

.....

.....

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(d) Superheated steam at a temperature of 400 °C is transferred through metal pipes from the furnace to the turbine.

(i) Explain how heat loss from the metal pipes by convection can be reduced. [2]

.....

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(ii) Explain how heat loss from the metal pipes by radiation can be reduced. [2]

.....

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10

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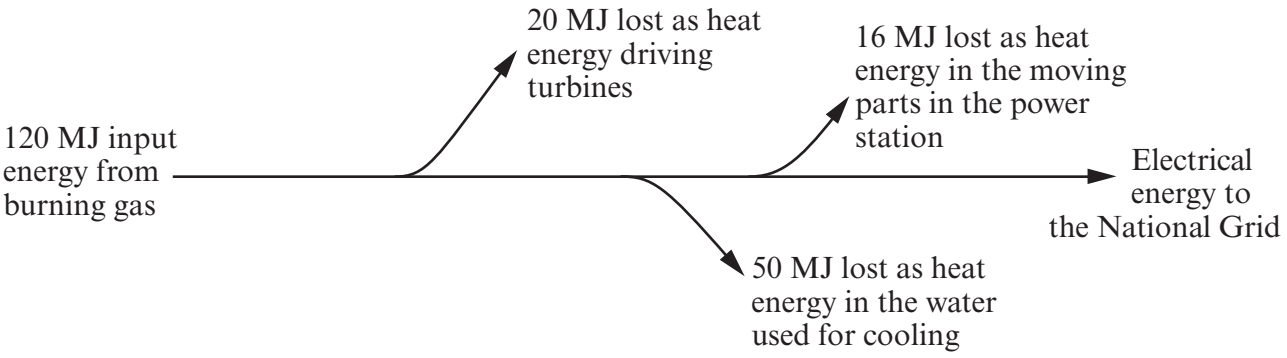
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Turn over.

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6. *(a)* It is proposed to build a power station to generate electricity. The two options considered are nuclear and gas-powered. Compare the suitability of each option. [6 QWC]

(b) The energy flow diagram for a gas-powered power station is shown below.



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

Efficiency = ... %

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7. Communications between **Cardiff (C)** and **Paris (P)** can be achieved by:
- Using an infra-red signal via an optical fibre link;
- Using a microwave signal via a satellite in a geosynchronous orbit.

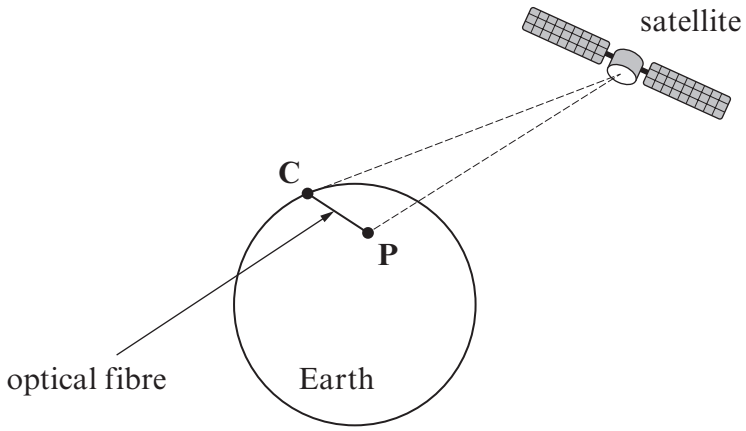


Diagram not to scale.

(a) The frequency of infra-red waves used in the optical fibre is 4×10^{14} Hz and their wavelength is 5×10^{-7} m.
Using equations from pages 2 and 3, calculate the time it takes the signal to travel from **Cardiff to Paris** if the optical fibre is 4.5×10^{5} m long. [4]

Time taken = ... s

(b) (i) Use an equation from pages 2 and 3 to find the approximate height of the geosynchronous satellite above the Earth, if the time delay between sending out a signal from Cardiff before it is detected at Paris is 0.24 s. The speed of microwaves through space is 3×10^{8} m/s. [3]

Height above Earth = ...m

Turn over for the rest of Question 7.

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(ii) Explain why the satellite must be in a geosynchronous orbit. [2]

.....

.....

.....

.....

(c) Give **one** advantage of sending signals from Cardiff to Paris by the optical fibre link instead of using the geosynchronous satellite. [1]

.....

.....

.....

10

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

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NEW GCSE

4463/02

SCIENCE A
HIGHER TIER
PHYSICS 1

A.M. FRIDAY, 20 January 2012

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**11**	
3.	**5**	
4.	**8**	
5.	**12**	
6.	**10**	
7.	**8**	
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 answers to questions **2***(b)*(ii) and **7**(ii).

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Equations and Units

Physics 1

power = voltage × current $P = VI$

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

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

power = current^2 × resistance $P = I^2R$

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

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 $W = Fd$

$$\text{kinetic energy} = \frac{\text{mass} \times \text{speed}^2}{2} \qquad \text{KE} = \tfrac{1}{2}mv^2$$

$$\text{change in potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{height} \qquad \text{PE} = mgh$$

Physics 3

$$\frac{\text{primary coil voltage}}{\text{secondary coil voltage}} = \frac{\text{primary coil turns}}{\text{secondary coil turns}} \qquad \frac{V_1}{V_2} = \frac{N_1}{N_2}$$

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

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

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

$\frac{pV}{T}$ = constant

where p = pressure, V = volume, T = kelvin temperature

$E = mc^2$

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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020003

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*Answer **all** questions.*

1. 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 pages 2 and 3 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 pages 2 and 3 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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Examiner only

2. 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) (i) A new gas fired power station is designed to produce a power output of 950 MW at a voltage of 25 kV. Using an equation from pages 2 and 3, calculate the output current **in amps** from the power station. [3]

Output current = ... A

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

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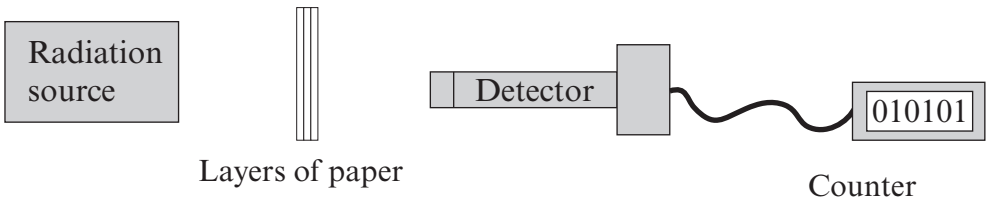
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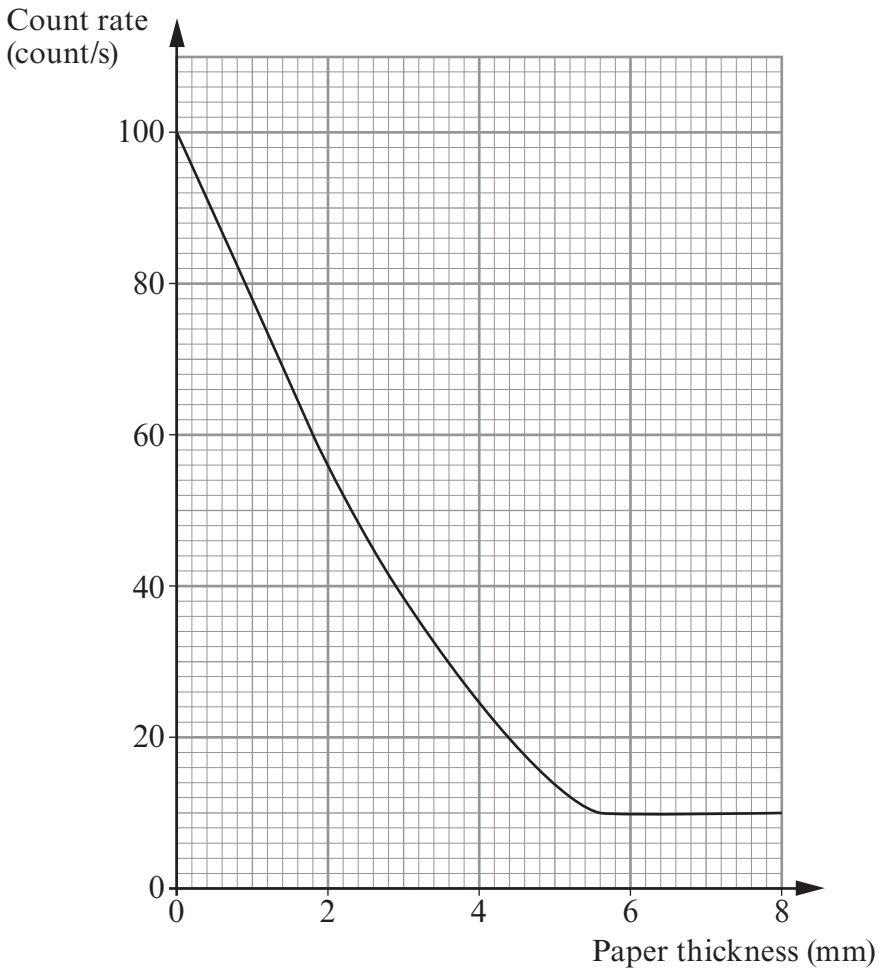
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3. A student set up an experiment to see how much nuclear radiation could pass through different thicknesses of paper.



The following graph was plotted from the results obtained:



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Examiner only

(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]

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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: .....

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Examiner only

4. 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]

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(iii) Both types of light are equivalent to a 60 W filament light bulb. Use the information in the table to explain why the LED is **more than twice** as efficient as a CFL. [3]

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Turn over.

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Examiner only

5. *(a)* In 1802, William Hyde Wollaston was the first person to discover that the spectrum from the Sun was crossed with dark lines.

Spectrum of our Sun



blue green yellow red

Later, Joseph von Fraunhofer measured the wavelengths of these lines.

(i) Explain why the spectra from stars are crossed with dark lines. [2]

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(ii) What information about the star do these dark lines reveal? [1]

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(b) **Describe** how the appearance of the spectra from a near and distant galaxy would be different, and **explain** why this difference occurs. [2]

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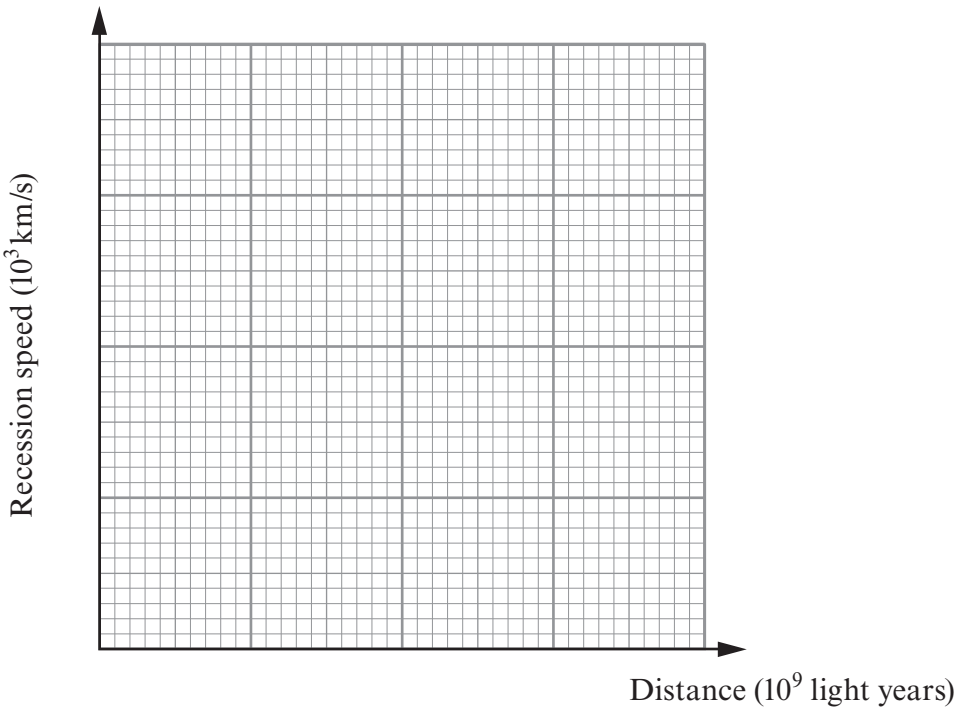
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(c) Edwin Hubble's measurements on the spectra of galaxies allowed him to calculate their speed of recession (moving away). His results are shown in the table below.

Recession speed (10^3 km/s)	0	5.0	14.0	41.0	68.0
Distance (10^9 light years)	0	0.2	0.8	1.9	3.2

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



(ii) Describe the relationship between recession speed and distance. [2]

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(iii) Explain how Hubble's measurements provided evidence for the origin of the universe. [2]

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Examiner only

6. Many homeowners, concerned by the rising costs of energy, are looking at different methods of home power generation.

Method	Set-up cost (£)	Power output (kW)
Photovoltaic cells	9 000	2
Small wind turbines	4 000	3
Biomass	5 000	15

(a) State **two** disadvantages for the homeowner of home power generation. [2]

1. .....

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2. .....

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(b) (i) Describe the advantages to the homeowner and the environment of installing photovoltaic cells rather than receiving all their electricity from the National Grid. [3]

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(ii) Home biomass power generators burn wood pellets or logs. Explain why, over time, they have a negligible effect on the carbon dioxide concentration in the atmosphere. [2]

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Examiner only

(c) Homeowners could also reduce their demand for energy by reducing heat losses from their homes. Explain how this could be achieved. [3]

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PLEASE TURN OVER FOR QUESTION 7

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Examiner only

7. (i) State **two** properties common to all types of electromagnetic radiation. [2]

1. .....

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2. .....

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(ii) Describe how the greenhouse effect produces a heating effect on the Earth. [6 QWC]

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THERE ARE NO MORE QUESTIONS IN THE EXAMINATION.

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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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