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**	

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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 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)*.

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 = $\frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}}$ × 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. *(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]

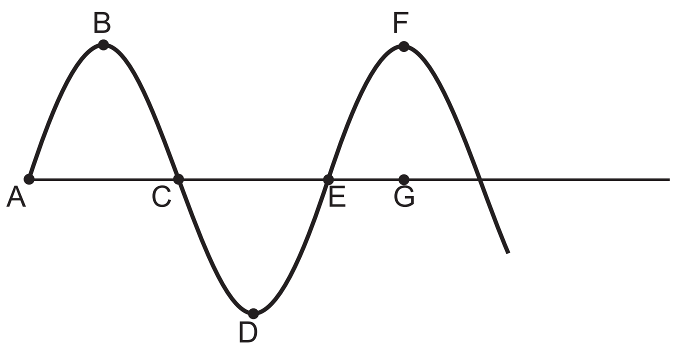
(ii) Complete the sentences below by underlining the correct phrase in each bracket. [3]

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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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]

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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: $\text{time} = \dfrac{\text{distance}}{\text{speed}}$;

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]

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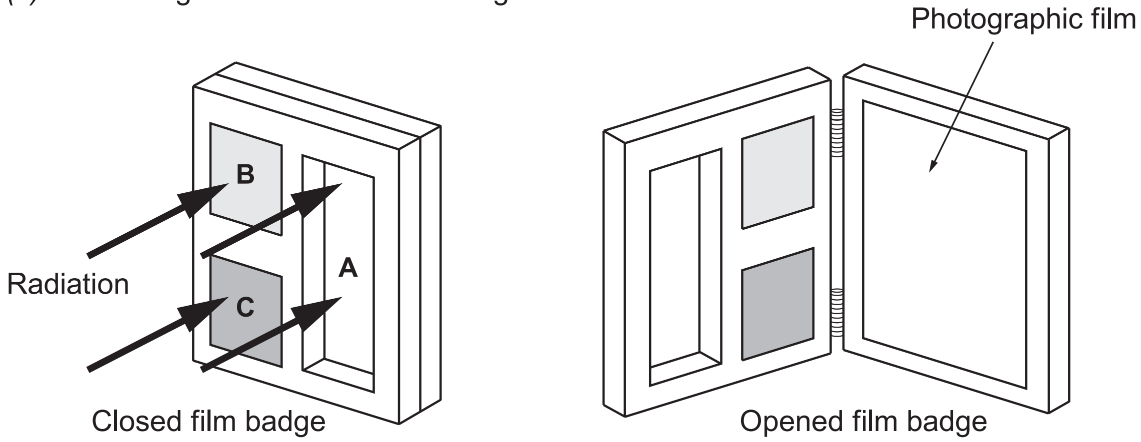
(b) The diagram shows the film badge that is used.



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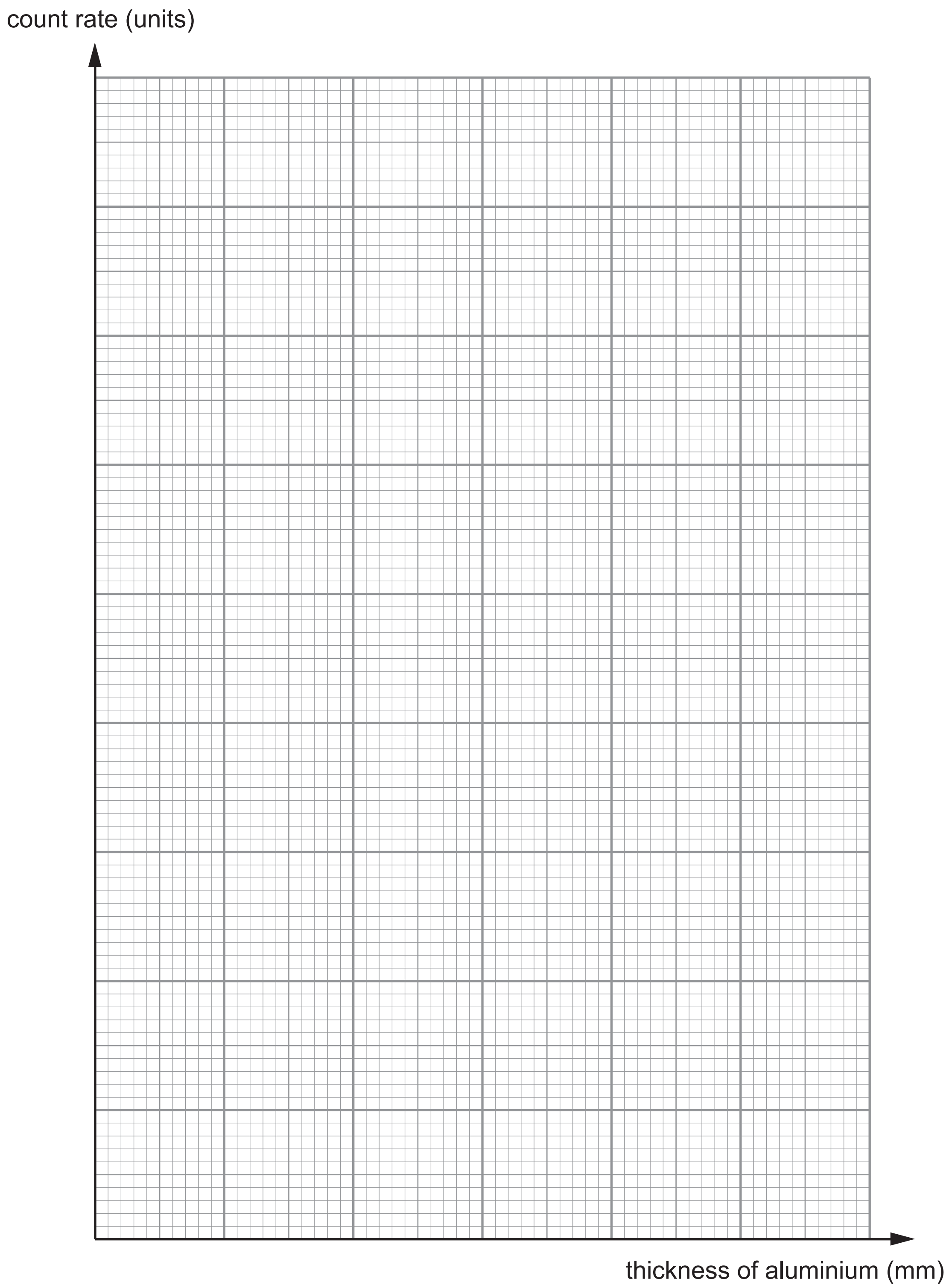
(i) Plot the data on the grid below and draw a suitable line. [3]



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

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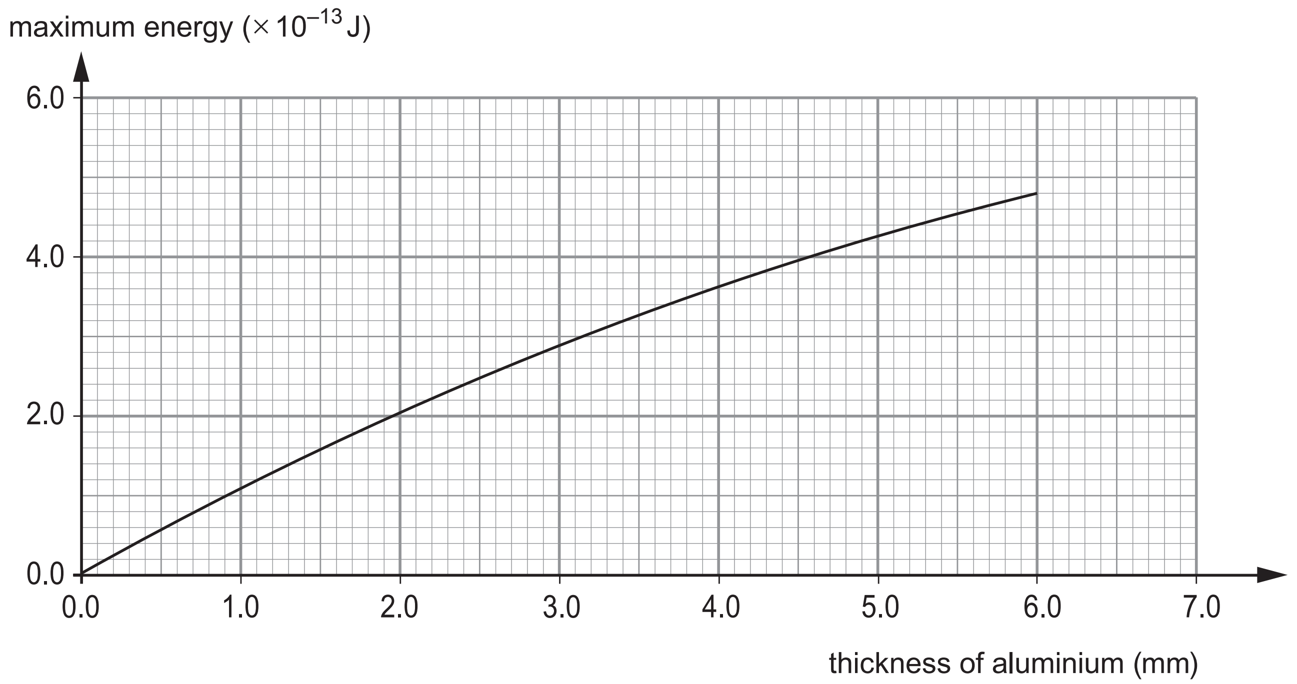
(iii) The following graph shows how the penetration of the beta particles through aluminium is related to their energy.



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]

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

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

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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]

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(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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