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	

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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 **4**(*a*) and **6**(*a*).

Equations and Units

Physics 1

power = voltage × current $P = VI$

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

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

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

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

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

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

Physics 2

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

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

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

distance travelled = area under a velocity-time graph

acceleration = gradient of a velocity-time graph

momentum = mass × velocity $p = mv$

resultant force = mass × acceleration $F = ma$

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

work = force × distance $W = Fd$

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

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

Physics 3

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

$v = u + at$ where u = initial velocity
$v^2 = u^2 + 2\,ax$ $\quad v$ = final velocity
$x = ut + \frac{1}{2}at^2$ $\quad a$ = acceleration
$x = \frac{1}{2}(u + v)t$ $\quad x$ = displacement
t = time

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

$\frac{pV}{T}$ = constant $\quad p$ = 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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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]

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(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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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

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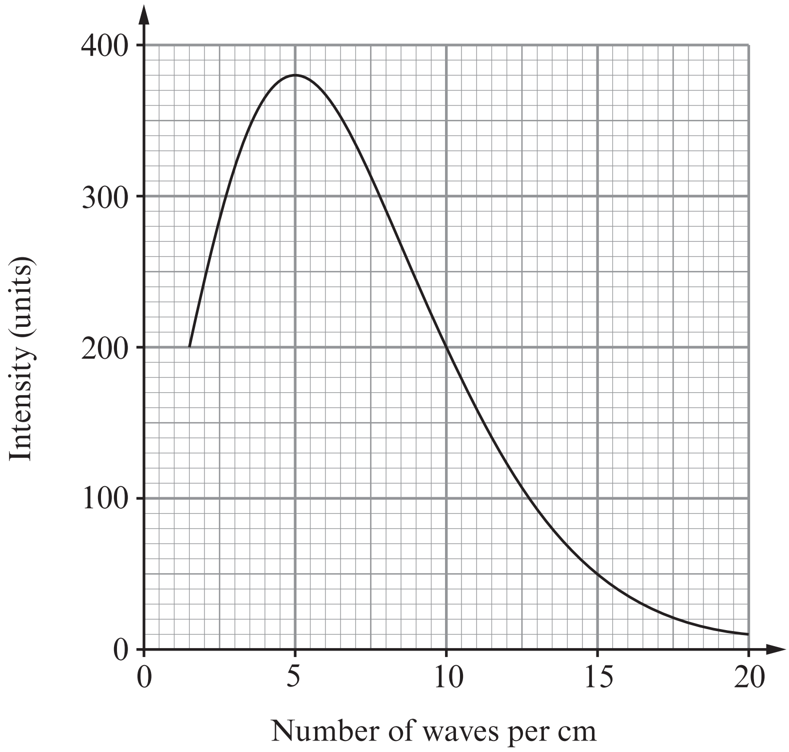
3. Cosmic microwave background radiation (CMBR) fills the entire universe. The COBE satellite measured the spectrum of the cosmic microwave background radiation in 1990. The results are shown below.



(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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Examiner only

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

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

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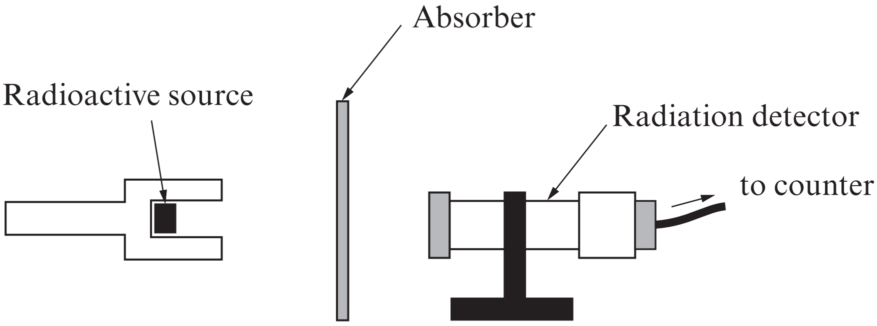
4. A radiation detector is used to **measure the background radiation**. It shows that after 60 seconds the radiation count was 30.

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]

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

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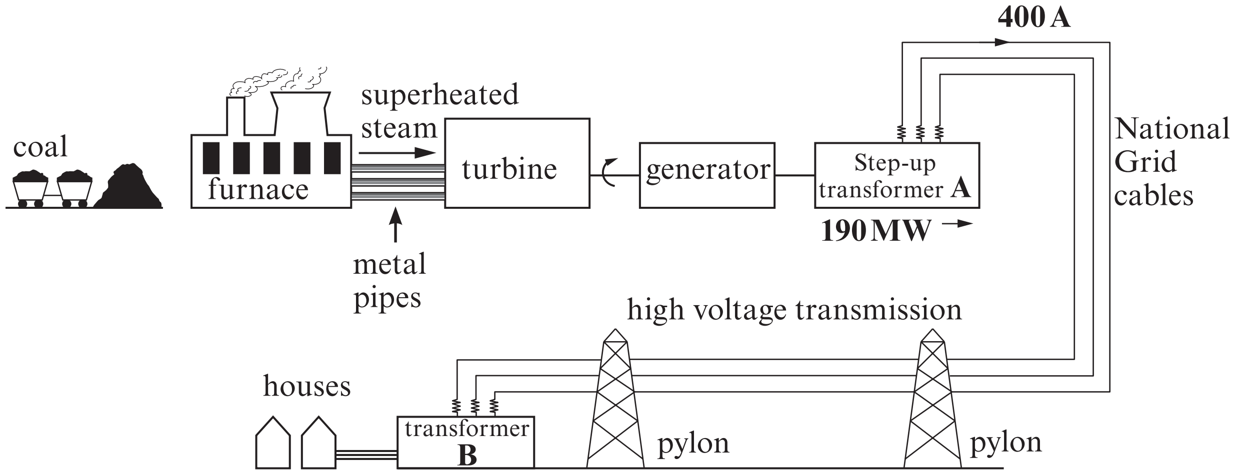
5. A coal-fired power station has a step-up transformer that delivers 190 MW of electrical power at a current of 400 A to the National Grid.



(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]

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

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Examiner only

(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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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]

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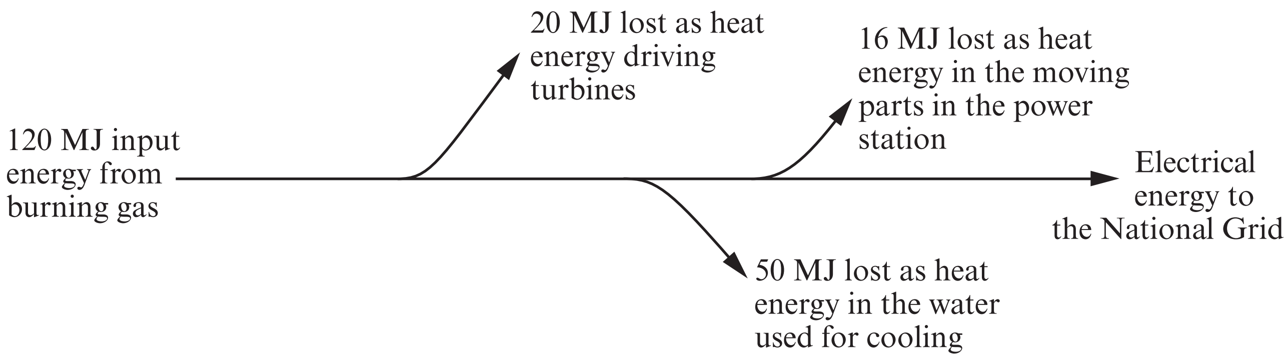
(b) The energy flow diagram for a gas-powered power station is shown below.



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.

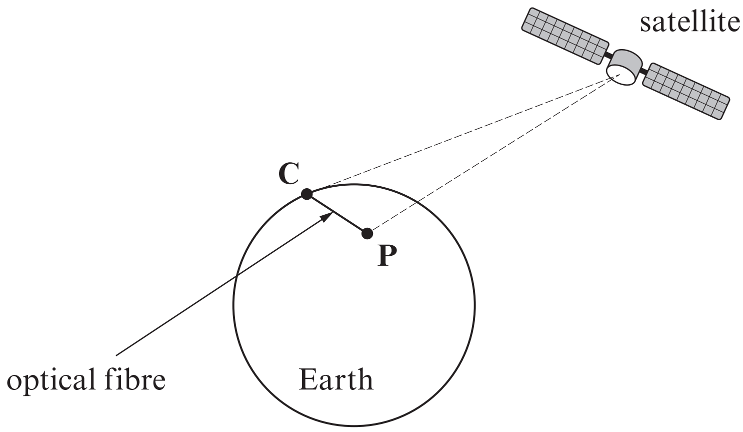

Diagram not to scale.

(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]

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

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THERE ARE NO MORE QUESTIONS IN THE EXAMINATION.