| 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**.

## 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)<br>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

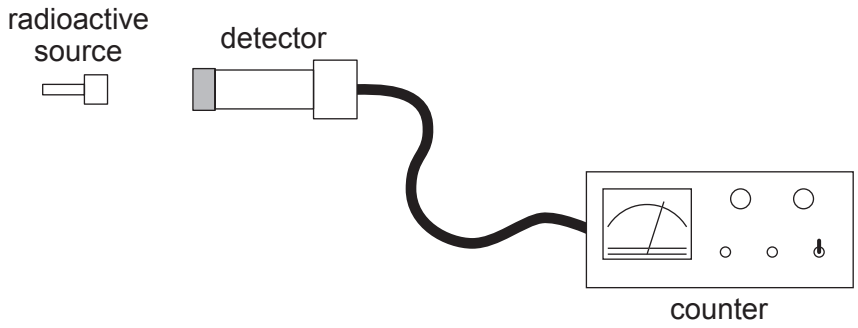
| Prefix | Multiplier |
|---|---|
| p | $10^{-12}$ |
| n | $10^{-9}$ |
| μ | $10^{-6}$ |
| m | $10^{-3}$ |

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

Examiner only

*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

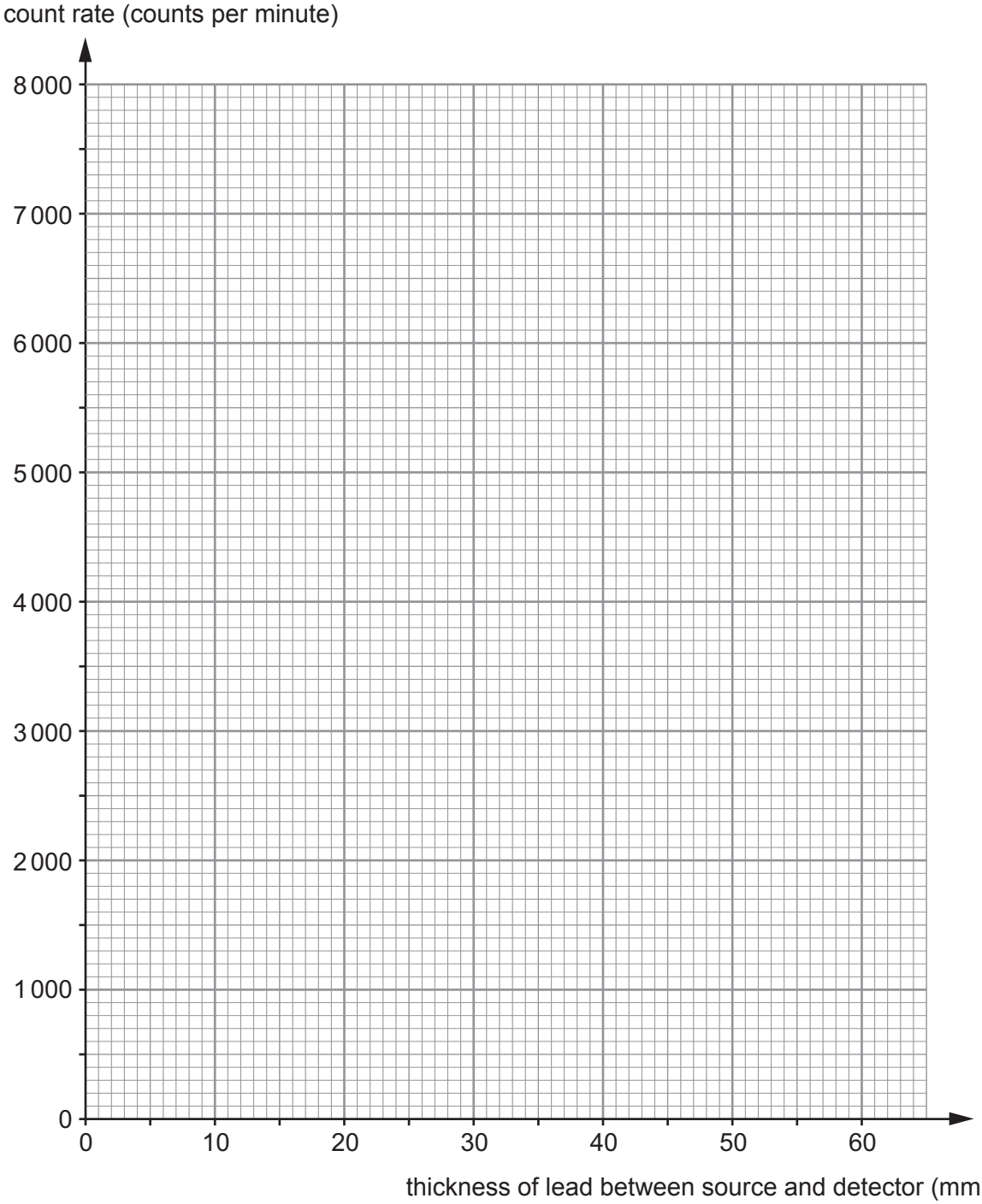
Examiner only

*(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 |

Examiner only

(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]

.....

.....

.....

Examiner only

(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]

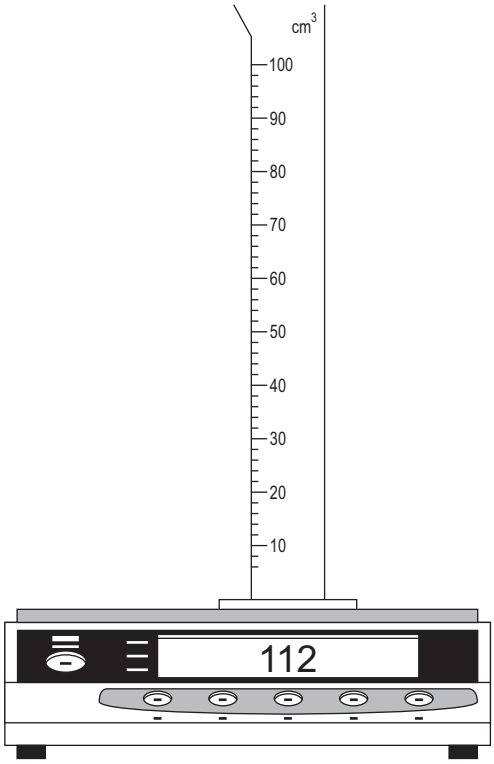
.....

.....

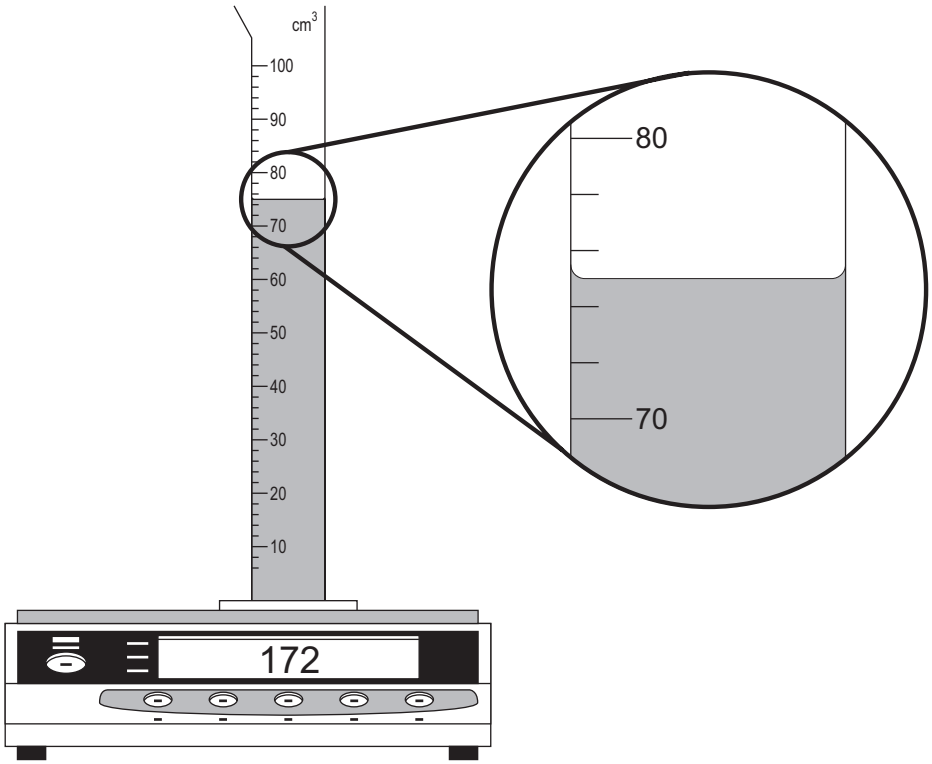
12

# BLANK PAGE

**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.



Examiner only

*(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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

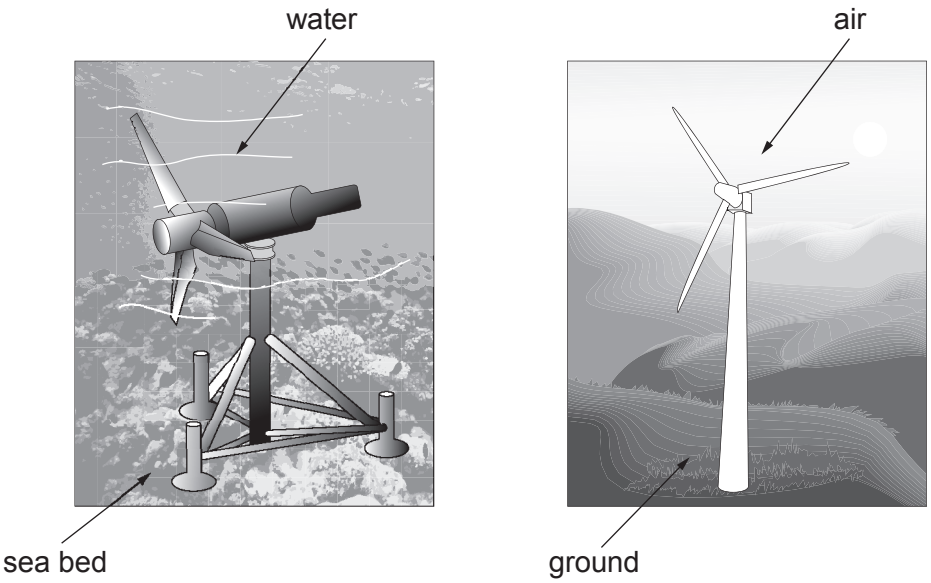
(ii) State **two** ways in which the density of the oil could be found to a greater accuracy. [2]

1. .....

2. .....

Examiner only

*(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 |

Examiner only

(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]

.....

.....

.....

12

Examiner only

**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]

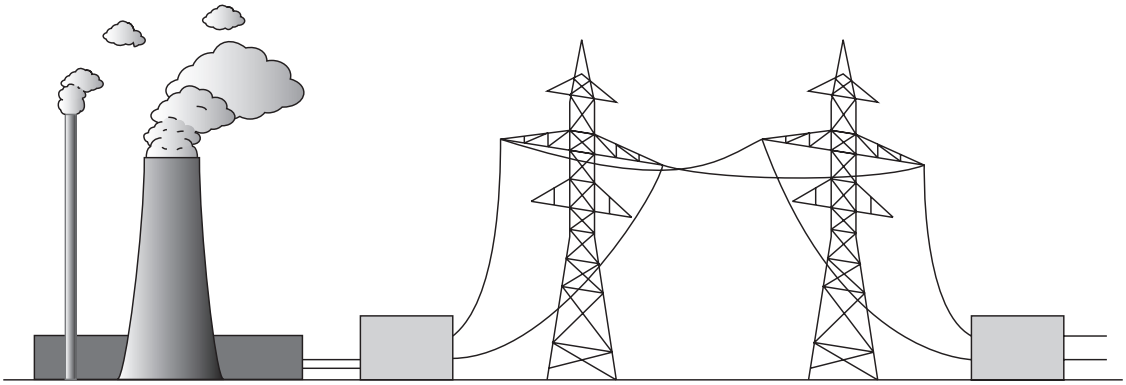
energy = ..... J

6

# BLANK PAGE

Examiner only

**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 $2 \times 10^9$ W of power, delivering it at a current of $4 \times 10^4$ 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

Examiner only

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

.....

.....

.....

.....

.....

.....

.....

9

Examiner only

**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]

.....

.....

.....

Examiner only

(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 $9.5 \times 10^{12}$ 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

Examiner only

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

.....

.....

.....

(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]

.....

.....

.....

15

Examiner only

**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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6

**END OF PAPER**