UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8606321694

PHYSICS **5054/21**

Paper 2 Theory **May/June 2012**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer any **two** questions.
Write your answers in the spaces provided on the Question Paper.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **16** printed pages.

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Section A

Answer **all** the questions in this section. Answer in the spaces provided.

1 An astronaut standing on the Moon throws a stone vertically upwards. The stone leaves his hand at time $t = 0$. The line on Fig. 1.1 shows how the velocity v of the stone varies with time t until $t = 2.0\,s$.

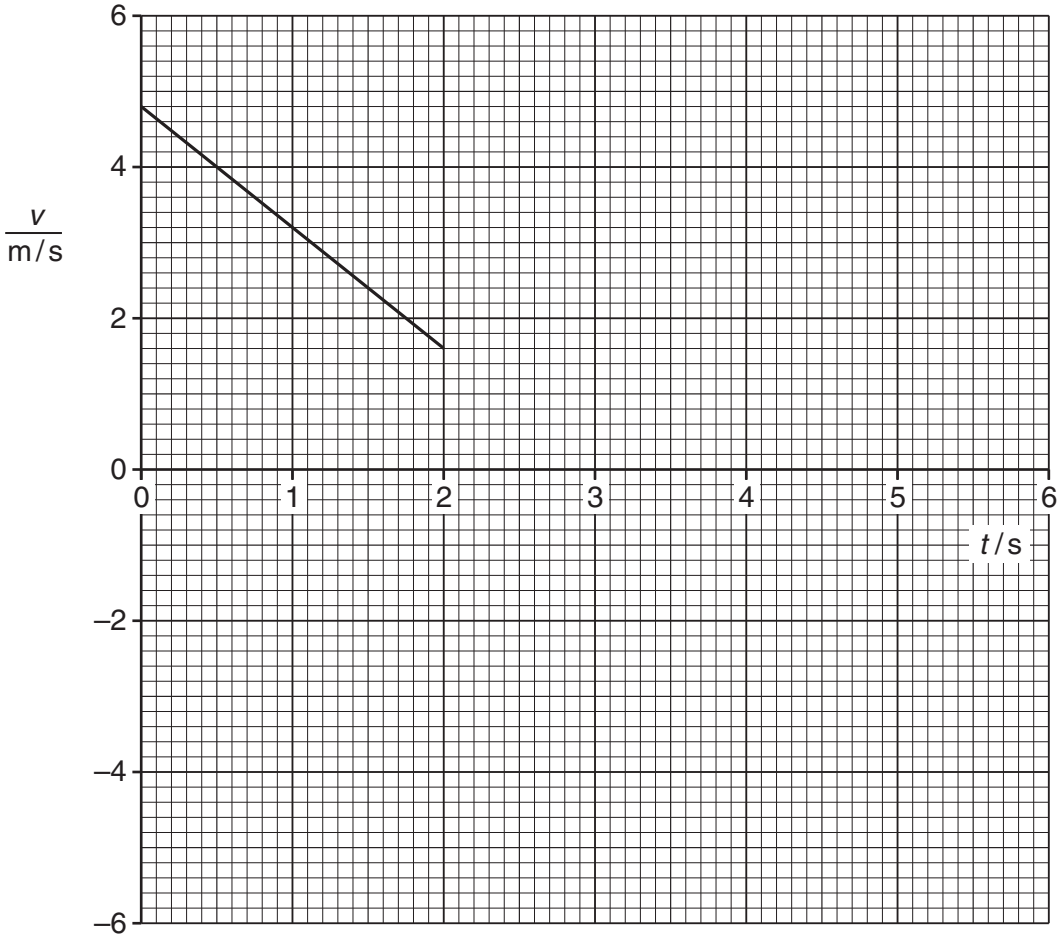


Fig. 1.1

(a) After rising, the stone falls. The astronaut catches the stone at $t = 6.0\,s$. There is no air resistance on the Moon.

(i) Complete Fig. 1.1 until $t = 6.0\,s$. [1]

(ii) State the value of t when the stone is at its highest point.

.....[1]

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(b) Calculate the acceleration of the stone between $t = 0$ and $t = 2.0\,s$.

acceleration = ...[2]

(c) A stone is thrown vertically upwards on the Earth with the same initial velocity.
State two ways in which the velocity-time graph for this stone differs from Fig. 1.1.

1. .....

2. .....
[2]

2 Fig. 2.1 shows a windsurfer, sail and board.

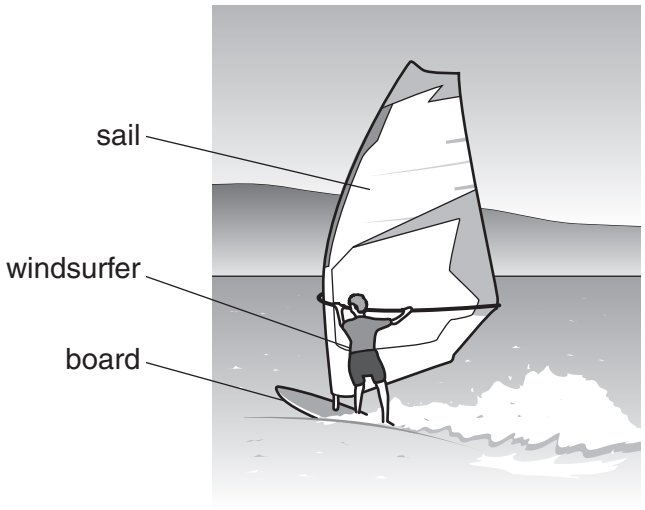


Fig. 2.1

The total mass of the windsurfer, sail and board is 90 kg. They travel at a constant speed of 5.0 m/s.

(a) Calculate the total kinetic energy of the windsurfer, sail and board.

kinetic energy = ...[2]

(b) The wind exerts a forward force on the sail.

(i) Explain, in terms of the forces acting, why the board travels at a constant speed.

.....

.....

.....[2]

(ii) The wind does work on the sail. Explain, in terms of the conservation of energy, why the total kinetic energy does not increase.

.....

.....

.....[1]

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3 A student measures the pressure inside a bicycle tyre using a pressure gauge he has constructed. Fig. 3.1 shows the apparatus he uses. The piston and rod move along the smooth cylindrical tube.

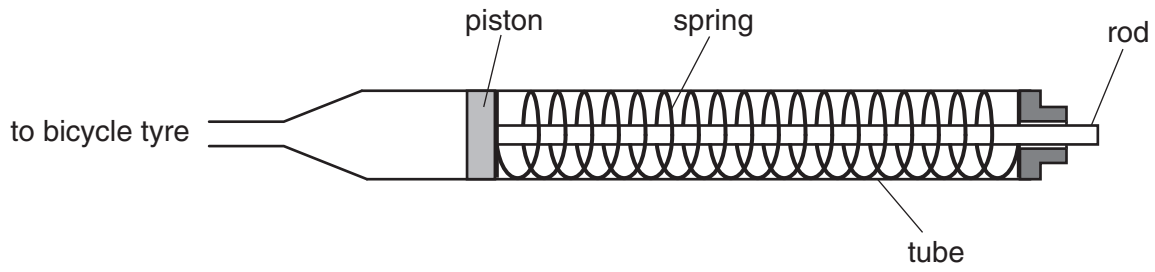


Fig. 3.1

The change in length of the spring is proportional to the force applied to the spring. A force of 2.8 N compresses the spring by 2.0 cm.

The student connects the pressure gauge to the tyre. Air from the tyre exerts a force on the piston. As the piston moves, the spring is compressed. The piston moves 10 cm to the right and then stops.

(a) Calculate the force exerted on the piston by the spring.

force = ...[1]

(b) The cross-sectional area of the piston is $3.0 \times 10^{-5}\,m^2$. Calculate the pressure of the air inside the tyre.

pressure = ...[2]

(c) Suggest one change to the apparatus so that the piston moves a smaller distance when measuring the same pressure.

.....[1]

(d) Each time that the pressure gauge is used, the pressure in the tyre falls slightly. The temperature stays constant. Describe, using ideas about molecules, why the pressure falls.

.....

.....

.....

.....[2]

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4 A student slowly heats a sample of solid wax in a test-tube.
Fig. 4.1 shows how the temperature of the wax varies with time *t*.

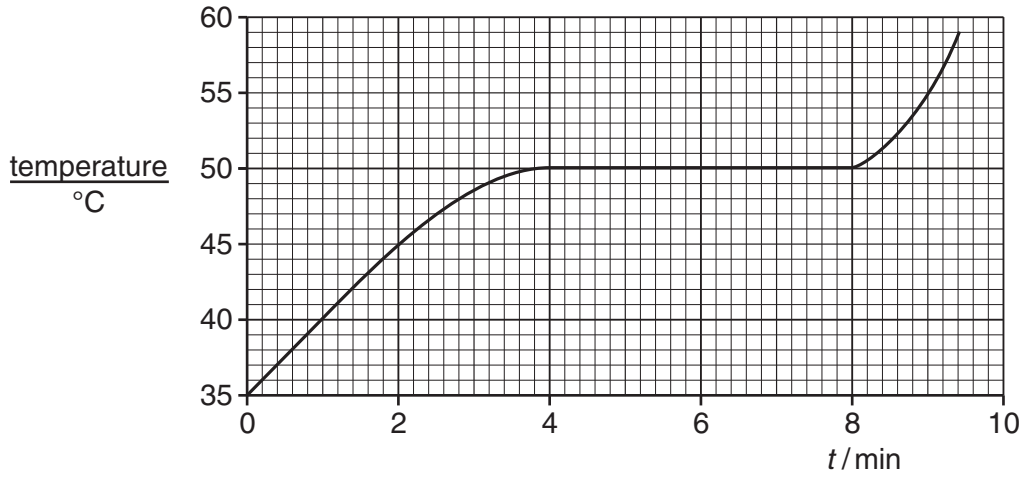


Fig. 4.1

(a) State what is meant by the *melting point* of a substance.

.....

.....[1]

(b) Thermal energy (heat) passes into the wax throughout the experiment.

(i) Describe what effect this energy has on the wax between $t = 0$ and $t = 4$ min.

.....

.....[1]

(ii) Describe and explain what effect this energy has on the wax between $t = 4$ min and $t = 8$ min.

.....

.....

.....[2]

(c) The wax expands as the temperature rises. It expands more between $t = 8$ min and 9 min than between $t = 0$ and 1 min. Explain why.

.....

.....[1]

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5 Fig. 5.1 shows the electromagnetic spectrum.

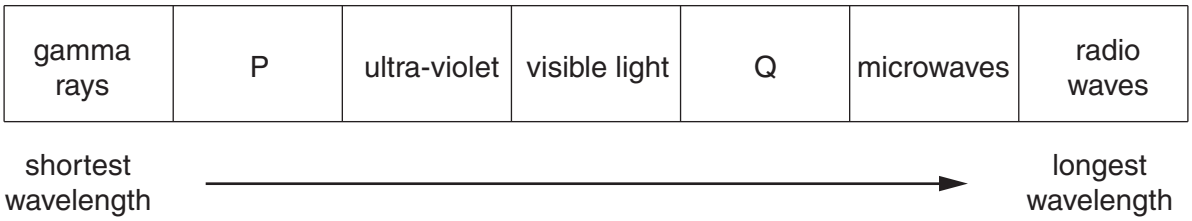


Fig. 5.1

Two components of the spectrum, P and Q, have not been named.

(a) State the name of

(i) component P,

.....[1]

(ii) component Q.

.....[1]

(b) All electromagnetic waves have a wavelength and a frequency. They all have changing magnetic and electric fields. State two other properties of all electromagnetic waves.

1. .....

.....

2. .....

.....

[2]

(c) State the component of the electromagnetic spectrum used for satellite communication.

.....[1]

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6 A sound from an electronic organ is played into a microphone which is connected to a cathode-ray oscilloscope (c.r.o.). Fig. 6.1 shows the trace on the c.r.o. produced by the sound.

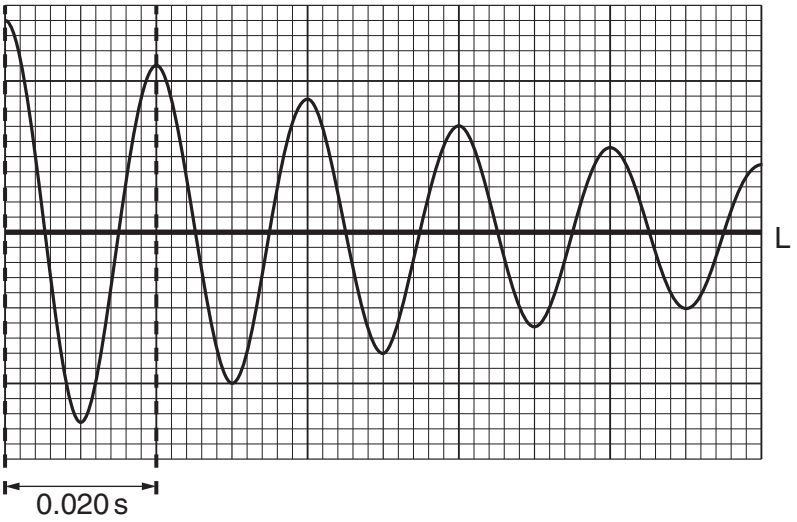


Fig. 6.1

The horizontal line marked L is the trace seen when there is no sound.

(a) (i) State how Fig. 6.1 shows that the loudness of the sound decreases with time.

.....[1]

(ii) State how Fig. 6.1 shows that the pitch of the sound is constant.

.....

.....[1]

(b) (i) State what is meant by the *frequency* of a wave.

.....

.....[1]

(ii) The time for one complete cycle of the wave in Fig. 6.1 is 0.020 s.
Calculate the frequency of the wave.

frequency = ...[2]

(iii) Determine the time taken for the amplitude of the trace in Fig. 6.1 to decrease to half its initial value.

time = ...[1]

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7 Fig. 7.1 is the circuit diagram of a circuit set up by a student.

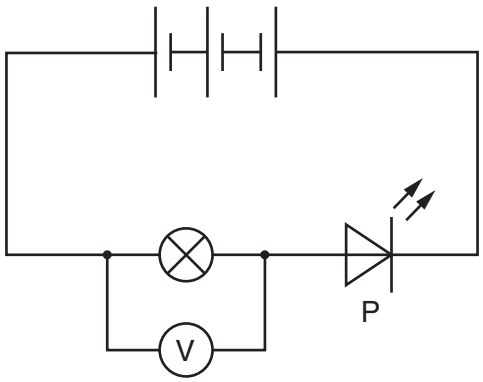


Fig. 7.1

The student uses three cells, each of electromotive force (e.m.f.) 1.5V. The cells are connected in series, as shown.

(a) State the name of component P.

.....[1]

(b) State what is meant by the *electromotive force* of a cell.

.....

.....[1]

(c) The student expects the reading on the voltmeter to be 4.5V. The actual reading is 0.2V.

Suggest **two** reasons why the voltmeter reading is much less than 4.5V.

.....

.....

.....[2]

(d) **(i)** In the space below, draw three cells connected in parallel.

[1]

(ii) State one advantage of connecting cells in parallel.

.....

.....[1]

8 **(a)** A magnet is placed on a bench, as shown in Fig. 8.1a. End P of a rod is held above each end of the magnet in turn, as shown in Fig. 8.1b and in Fig. 8.1c. One end of the magnet is lifted off the bench in both cases.

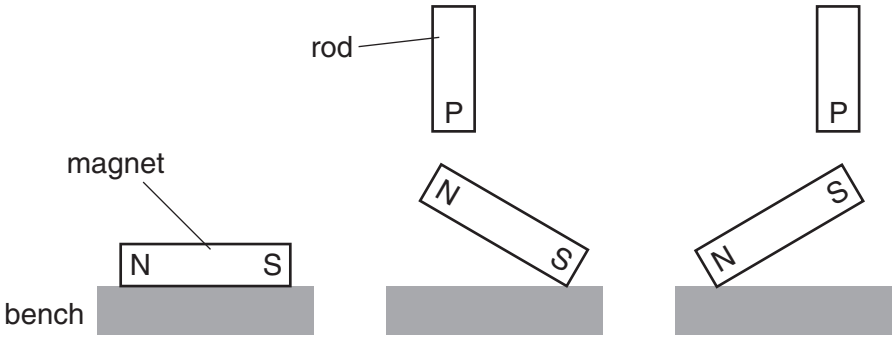


Fig. 8.1a **Fig. 8.1b** **Fig. 8.1c**

(i) Suggest what material the rod is made from.

.....[1]

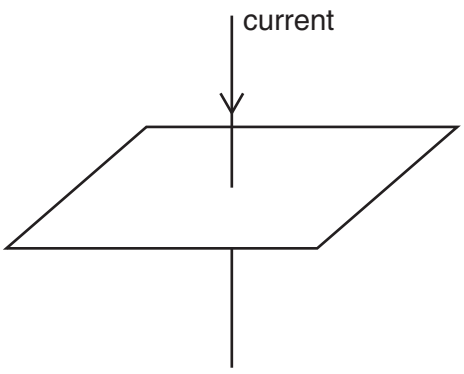
(ii) Explain how the rod lifts each end of the magnet off the bench.

.....

.....

.....[2]

(b) Fig. 8.2 and Fig. 8.3 show views of a wire carrying a current downwards through a horizontal board.



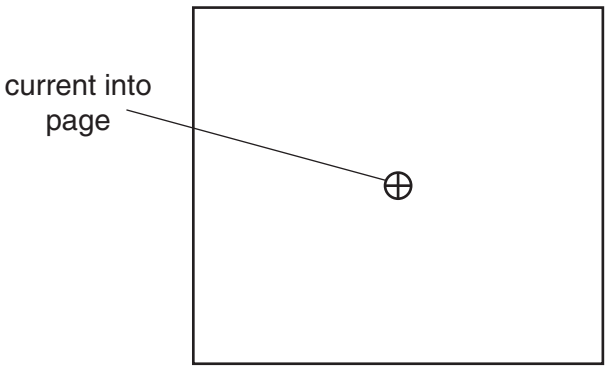


Fig. 8.2 **Fig. 8.3** (viewed from above)

(i) On Fig. 8.3, draw the magnetic field due to the current in the wire. [2]

(ii) The magnetic field is stronger closer to the wire. State how the magnetic field lines indicate that the field is stronger.

.....

.....[1]

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Section B

Answer **two** questions from this section. Answer in the spaces provided.

9 Fig. 9.1a shows a room heater. Fig. 9.1b is a diagram of the electric circuit of the heater.

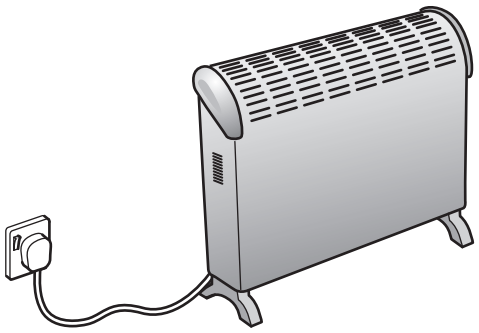


Fig. 9.1a

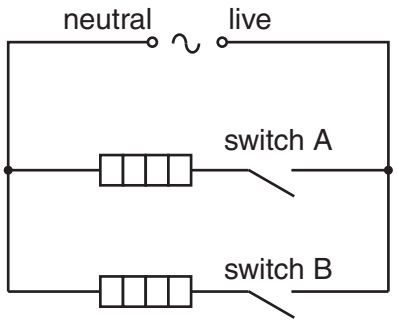


Fig. 9.1b

The fuse has not been drawn on the circuit diagram in Fig. 9.1b.

(a) (i) On Fig. 9.1b, draw the symbol for a fuse in the correct position. [2]

(ii) State the part of the room heater to which the earth wire is connected.

.....[1]

(iii) The earth wire reduces the chance of an electric shock if a fault develops in the room heater.

1. State one fault that causes an electric shock when a person uses the room heater without an earth connection.

.....

.....[1]

2. Explain how using an earth connection prevents an electric shock.

.....

.....

.....[2]

(b) (i) This type of room heater is very efficient. Explain what this means.

.....

.....[1]

(ii) The room heater is a convector heater. Describe and explain how thermal energy (heat) passes around a room by convection.

.....

.....

.....

.....

.....[3]

(c) Fig. 9.2 shows the power output of the room heater when each switch is closed.

	power / W
switch A only closed	600
switch B only closed	
both switches closed	2100

Fig. 9.2

(i) Determine the power output of the room heater when only switch B is closed.

power output = ... [1]

(ii) The room heater is used with both switches closed for 2.5 hours.

Calculate the energy output of the room heater

1. in kilowatt-hours,

energy = ... kW h [2]

2. in joules.

energy = ... J [2]

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10 (a) Fig. 10.1 shows the path of a ray of blue light as it passes through a glass prism.

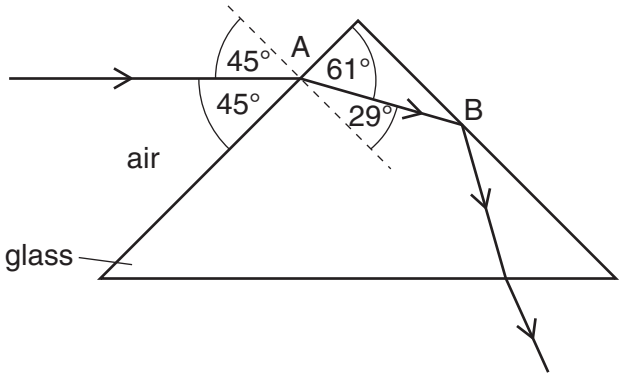


Fig. 10.1

(i) State the wave term used to describe what happens to the ray of light at A.

.....[1]

(ii) Using angles from Fig. 10.1, calculate the refractive index of the glass.

refractive index = ...[3]

(iii) Explain why the ray does not emerge from the prism at B.

.....

.....[2]

(iv) Fig. 10.2 shows a second, horizontal, ray of blue light striking the prism at point C.

On Fig. 10.2, continue the path of the second ray through and out of the glass prism. [2]

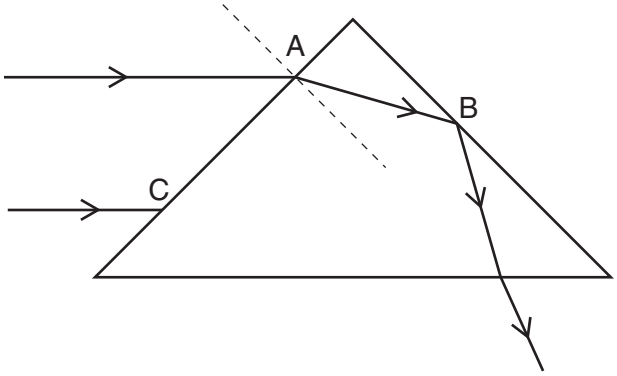


Fig. 10.2

(b) The camera lens shown in Fig. 10.3 is used to photograph the object O.

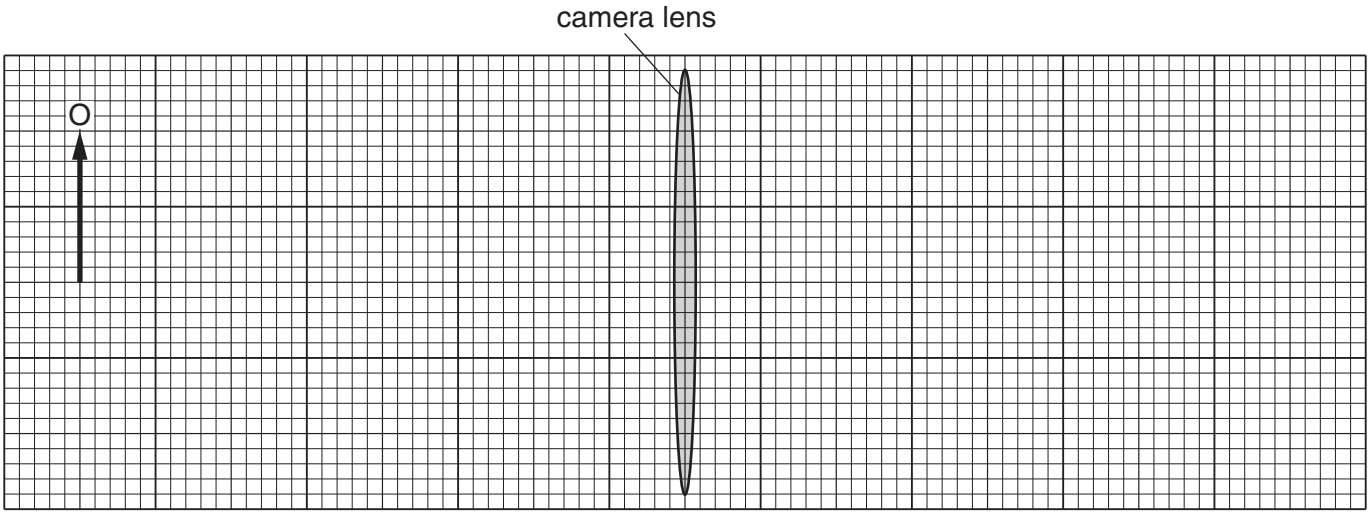


Fig. 10.3 (full scale)

The object O is 2.0 cm high and is placed 8.0 cm from the centre of the lens. The lens has a focal length of 3.0 cm.

(i) Draw rays on Fig. 10.3 to find the position and height of the image formed by the lens. Label the image I. [3]

(ii) Determine the height of the image.

.....[1]

(iii) The image formed by the lens is a real image.

1. Explain the difference between a real image and a virtual image.

.....

.....

.....[1]

2. Explain how a converging lens is used to produce and view a virtual image.

.....

.....

.....

.....[2]

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11 Fig. 11.1 shows part of a smoke detector.

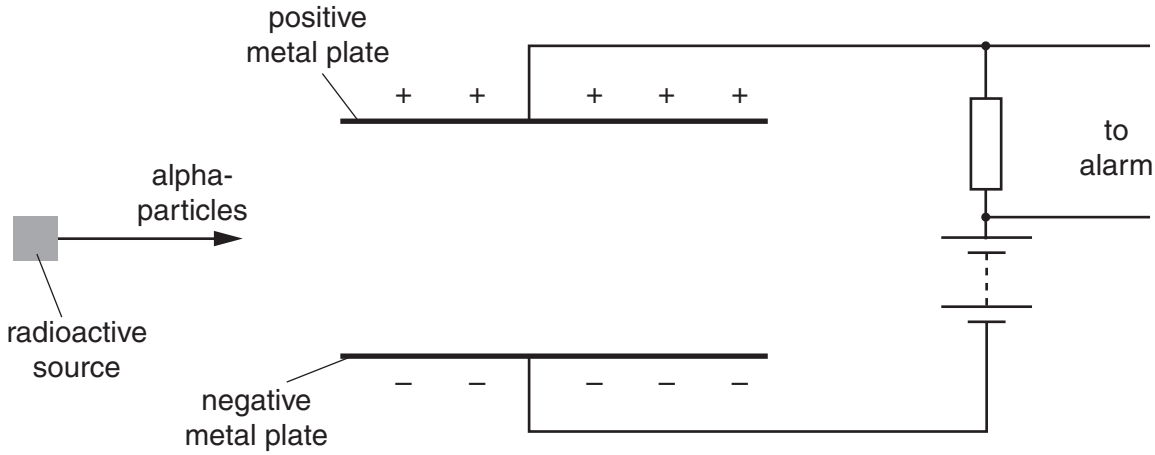


Fig. 11.1 (not to scale)

Alpha-particles from the radioactive source ionise the air between the metal plates. There is then a small current in the resistor. When smoke enters the detector, the current changes and the alarm sounds.

(a) Explain why a source emitting only gamma-rays is unsuitable for use in the smoke detector.

.....

.....[1]

(b) There is an electric field between the metal plates.

(i) On Fig. 11.1, draw the electric field between the plates. [3]

(ii) The alpha-particles in Fig. 11.1 are deflected slightly as they pass through the electric field.

Explain why the alpha-particles are deflected and state the direction of the deflection.

.....

.....

.....[2]

(c) State and explain how the path of gamma-rays differs from the path of alpha-particles as they pass through an electric field.

.....

.....

.....

.....[2]

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(d) The source used is the radioactive isotope americium-241, which has a half-life of 500 years.

(i) A sample of americium-241 is left for 1500 years. Determine the fraction of the original number of atoms of americium-241 left in the sample after this time.

fraction = ...[2]

(ii) Another isotope of the same element, americium-242, has a half-life of 16 hours. Explain why the half-life of americium-242 makes this isotope unsuitable for use in a smoke detector.

.....

.....

.....[1]

(iii) Atoms of americium-241 and americium-242 contain protons, neutrons and electrons.

1. State **two** similarities in the structure of an atom of americium-241 and an atom of americium-242.

.....

.....

.....[2]

2. Describe the difference between an atom of americium-241 and an atom of americium-242.

.....

.....

.....[2]

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