UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9180656846

PHYSICS **5054/21**

Paper 2 Theory **October/November 2010**

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.

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.

For Examiner's Use	
Section A	
Q8	
Q9	
Q10	
Total	

This document consists of **14** printed pages and **2** blank pages.

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[Turn over

Section A

For Examiner's Use

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

1 A window cleaner drops a sponge from the balcony of a hotel at time $t = 0$. Fig. 1.1 is the speed-time graph for the motion of the sponge.

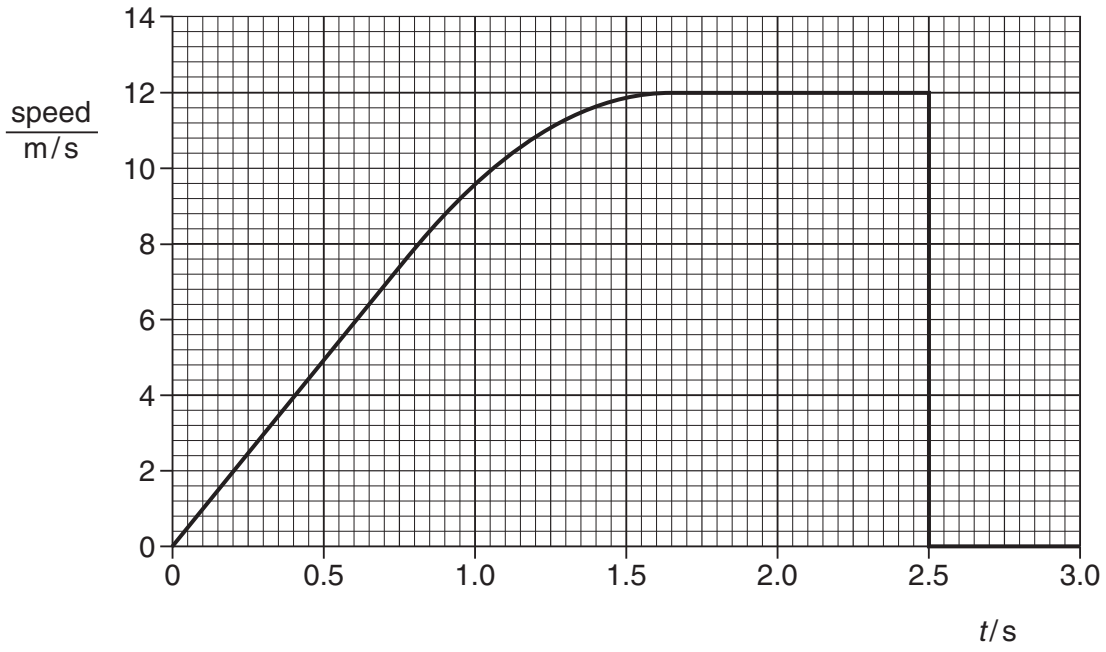


Fig. 1.1

(a) State a value for t when the sponge is

(i) moving with a uniform speed,

..... [1]

(ii) accelerating at a non-uniform rate,

..... [1]

(iii) decelerating.

..... [1]

(b) Calculate the distance travelled by the sponge between $t = 0$ and $t = 0.75$ s.

distance = ... [2]

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2 Fig. 2.1 shows the planet Venus orbiting the Sun in a circular orbit at constant speed.

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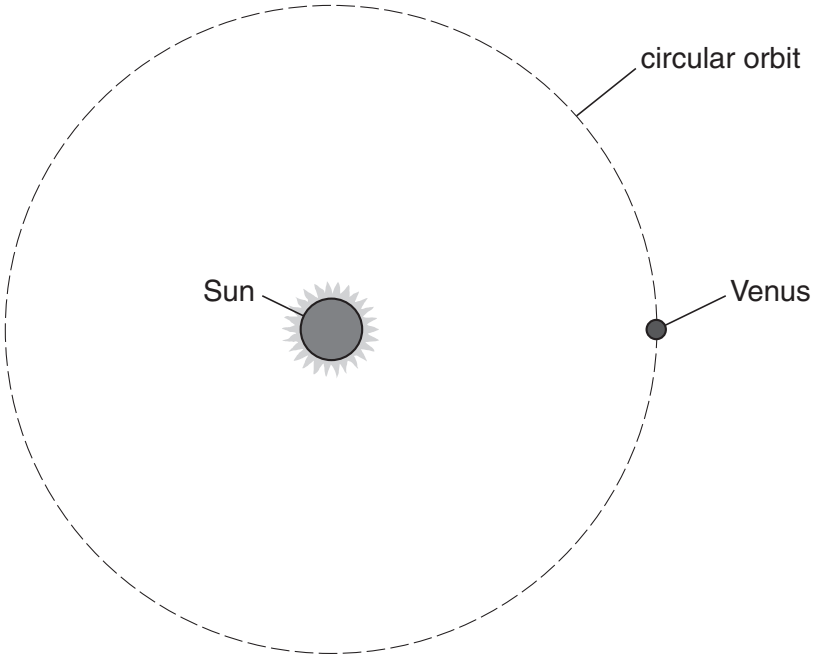


Fig. 2.1 (not to scale)

A force acting on Venus keeps it moving in a circle.

(a) State the name of this force and the object that causes it.

.....

..... [2]

(b) **(i)** On Fig. 2.1, draw an arrow through Venus that represents the direction of its acceleration. [1]

(ii) The size of this acceleration is $9.7 \times 10^{-3}\,m/s^2$ and the mass of Venus is $4.9 \times 10^{24}\,kg$. Calculate the size of the force acting on the planet.

force = ... [2]

(c) As time passes, the planet Venus moves a considerable distance around the circular orbit. State why no work is done by the force acting on the planet as it moves.

.....

.....

..... [2]

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[Turn over

For Examiner's Use

3 **(a)** State the *principle of conservation of energy*.

.....

.....

..... [2]

(b) Fig. 3.1 shows a miner using a head torch powered by a battery pack. The battery pack contains the cells that power the filament lamp in the head torch.

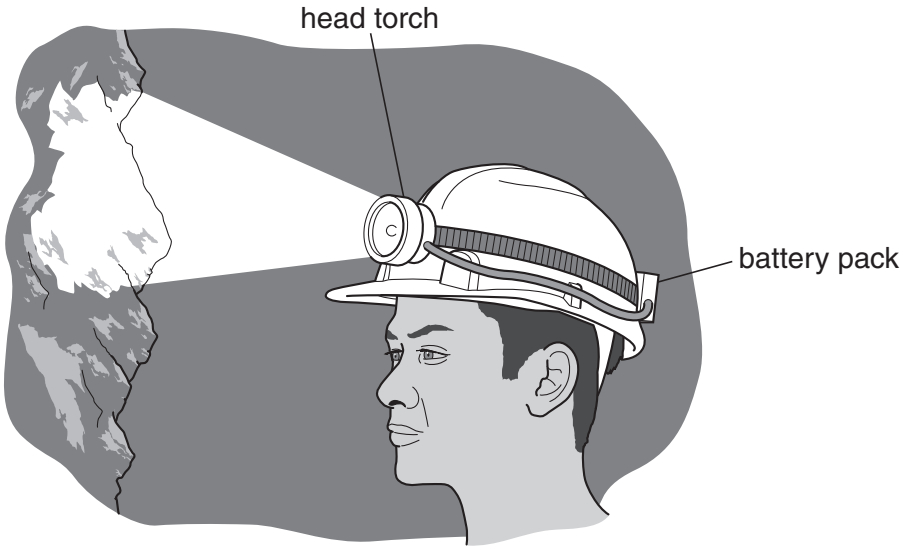


Fig. 3.1

(i) State the main energy change that takes place in the cells.

.....

..... [2]

(ii) State two different forms of energy that are produced in the filament lamp.

1. .....

2. .....

[2]

(c) An identical battery pack powers a different head torch that uses light-emitting diodes (LEDs) instead of the filament lamp. The two torches are equally bright but the efficiency of the torch using the LEDs is much higher.

State how the amounts of the different forms of energy produced in the LEDs compare with the amounts produced in the filament lamp.

.....

.....

..... [2]

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4 A large number of television sets in a shop are tuned to the same station. The signal travels to some of the sets via a satellite in orbit above the Earth.

(a) (i) Explain why only electromagnetic waves are used to transmit the television signal.

.....

..... [1]

(ii) State the region of the electromagnetic spectrum used to transmit the television signal.

.....

..... [1]

(iii) Suggest why satellites are sometimes used to transmit television signals.

.....

..... [1]

(b) The other television sets receive the signal directly from a ground-based transmitter very near to the shop. A salesman notices that the signal sent via the satellite arrives 0.24 s later than the signal sent directly to the other television sets.

The speed of electromagnetic waves is 3.0×10^8 m/s.

Calculate the distance travelled by the television signal in 0.24 s.

distance = ... [2]

5 A motor car has a 12 V electrical supply. Fig. 5.1 shows a heating element in the rear window. This heater uses a current of 35 A from the supply.

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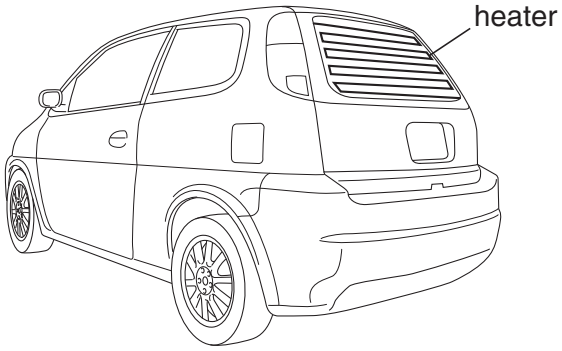


Fig. 5.1

(a) Calculate

(i) the power developed by the heater,

power = ... [2]

(ii) the thermal energy (heat) generated by the heater in 2.0 minutes.

thermal energy = ... [3]

(b) One cold morning, the rear window of this car is covered in ice. Ice has a specific latent heat of fusion of 330 J / g.

(i) Calculate the maximum mass of ice that this heater melts in 2.0 minutes.

mass = ... [2]

(ii) State two reasons why the actual quantity of ice melted in 2.0 minutes may be less than the value calculated.

1. .....

2. .....

[2]

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6 Fig. 6.1 shows the coil of a loudspeaker attached to a cardboard cone. One pole of a stationary cylindrical magnet lies near to the coil.

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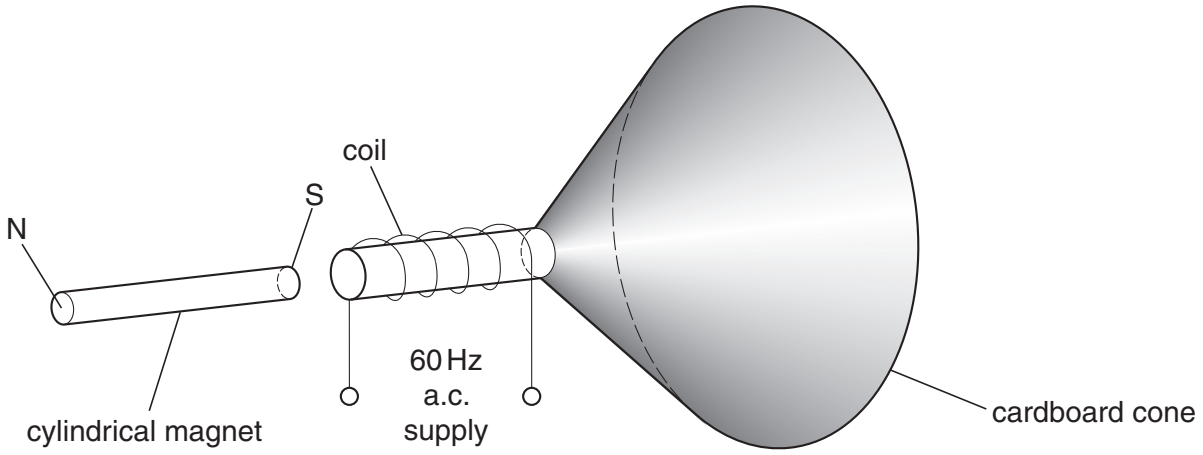


Fig. 6.1

There is an alternating current in the coil of the loudspeaker. A student hears the note produced.

(a) (i) Explain why the cone of the loudspeaker vibrates.

.....

.....

.....

..... [3]

(ii) Explain how the vibrating cone produces sound waves in the air.

.....

.....

..... [2]

(b) A stronger cylindrical magnet is now used. State the difference in the note heard.

.....

..... [1]

7 A householder installs a burglar alarm. The alarm does not operate for the first 200 s after it is switched on. This time delay lets the householder leave the house and lock up without setting off the alarm.

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Fig. 7.1 is a circuit inside the burglar alarm.

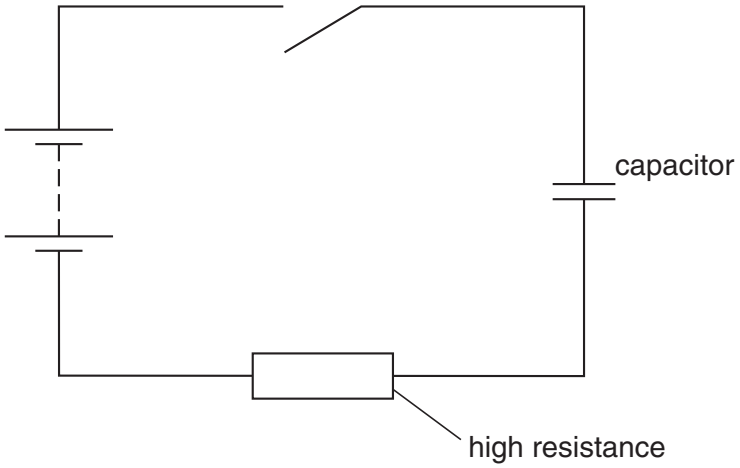


Fig. 7.1

Initially, the switch is open.

(a) (i) The switch is now closed. Explain what happens to the potential difference across the capacitor as time passes.

.....

.....

..... [2]

(ii) Suggest how this circuit may be used for the time delay of the burglar alarm.

.....

..... [1]

(b) The capacitor in the circuit is uncharged when the burglar alarm is first switched on. A current then starts to charge the capacitor and after 200 s, the charge stored is 5.4×10^{-7} C.

Calculate the average value of the current during this time.

current = ... [2]

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Please turn over for Section B.

Section B

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

8 A car has a gas-filled shock absorber for each of its four wheels. Fig. 8.1 shows one of these shock absorbers.

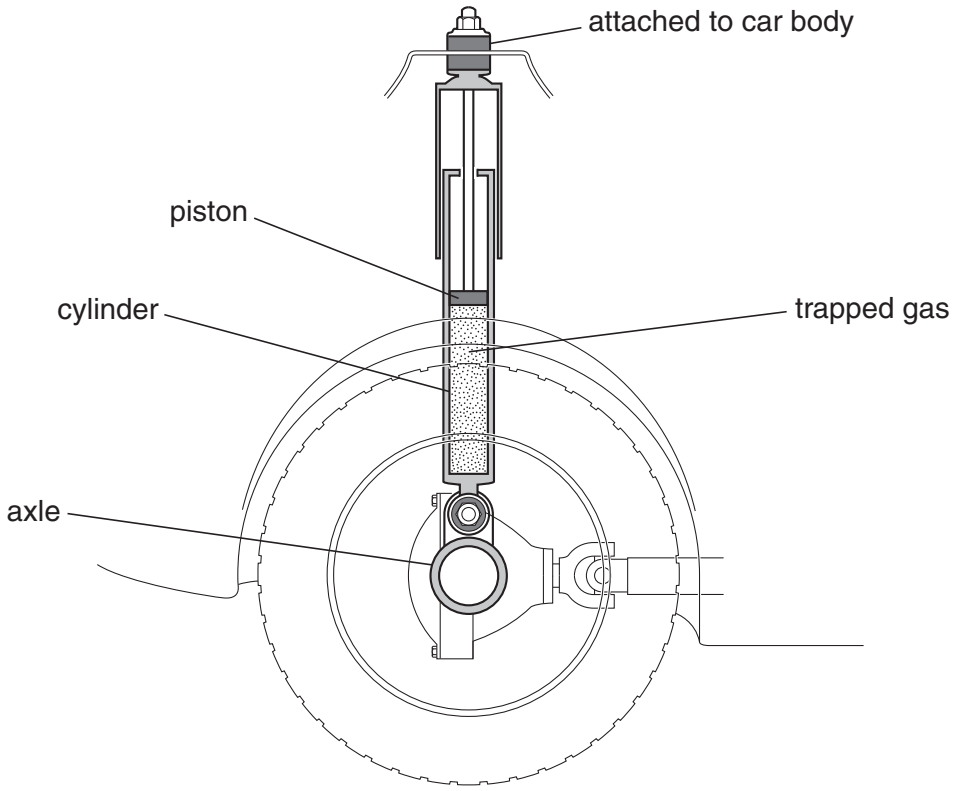


Fig. 8.1

The axles are attached to the cylinders. The body of the car is supported by the four pistons, which can move up and down inside the cylinders. Each piston has a cross-sectional area of 35 cm^2.

(a) A driver of mass 70 kg gets into the car. Calculate

(i) the driver's weight,

weight = ... [2]

(ii) the average increase in the pressure of the gas in the cylinders.

pressure increase = ... [3]

(b) (i) Explain in detail how the molecules of the gas trapped inside the cylinder by the piston exert a pressure on the cylinder.

For Examiner's Use

.....

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.....

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.....

.....

..... [4]

(ii) The temperature of the trapped gas remains constant. Explain why the pressure of the gas increases as the piston is moved further into the cylinder.

.....

.....

..... [2]

(c) At the end of a long journey, the temperature of the trapped gas in the shock absorbers has increased substantially.

(i) State what happens to the molecules of the trapped gas due to the temperature increase.

.....

..... [1]

(ii) State and explain the effect of the increased temperature of the gas on the height of the car body above the road surface.

.....

.....

.....

.....

..... [3]

For Examiner's Use

9 **(a)** Fig. 9.1 shows a young boy lying on his back on the bottom of a swimming pool. He is holding his breath and his eyes are open. A red light is positioned on the ground at Q.

At first the boy's head is touching the pool wall. He notices that, as he slides away from the pool wall, his eye reaches a point P where he first sees the light at Q. Fig. 9.1 shows the boy in this position.

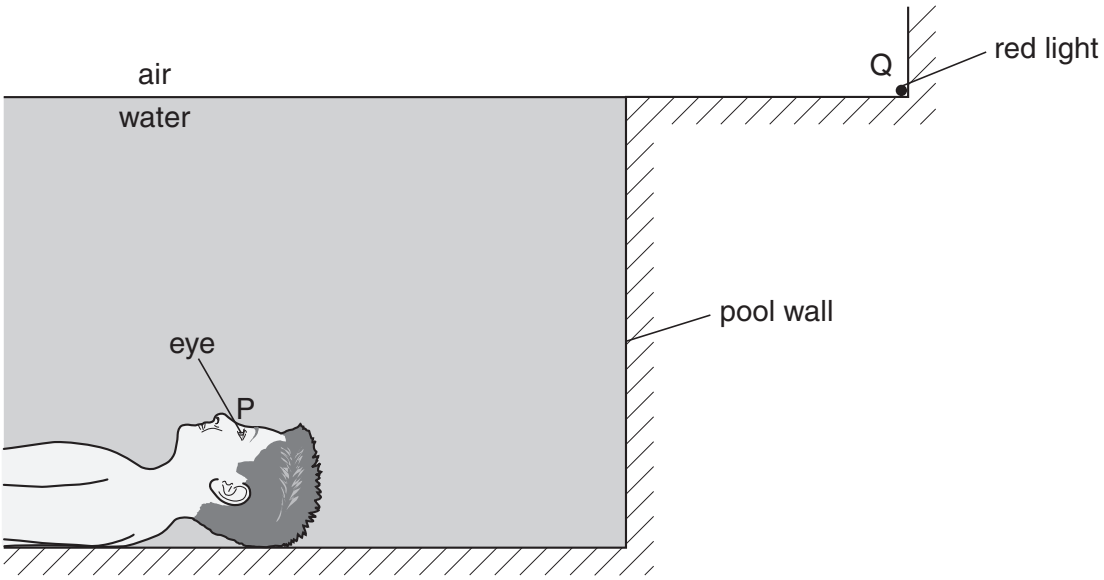


Fig. 9.1

(i) On Fig. 9.1, draw the ray of light travelling from Q to P. Mark the critical angle for light in water and label it C. [2]

(ii) Explain why the boy is unable to see the red light at Q when his eye is closer to the pool wall than P.

.....

.....

..... [2]

(iii) The critical angle is 49°. Calculate the refractive index of water.

refractive index = ... [2]

(iv) The red light is now replaced with a blue light. State the effect of this on the wavelength of the light in the air.

..... [1]

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(b) A small, very brightly illuminated display is located at the back of a projector. The projector lens produces an inverted and magnified image of the display on a white classroom wall.

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Fig. 9.2 is a scale diagram showing the position and size of both the display and the image on the wall. R is a point on the display.

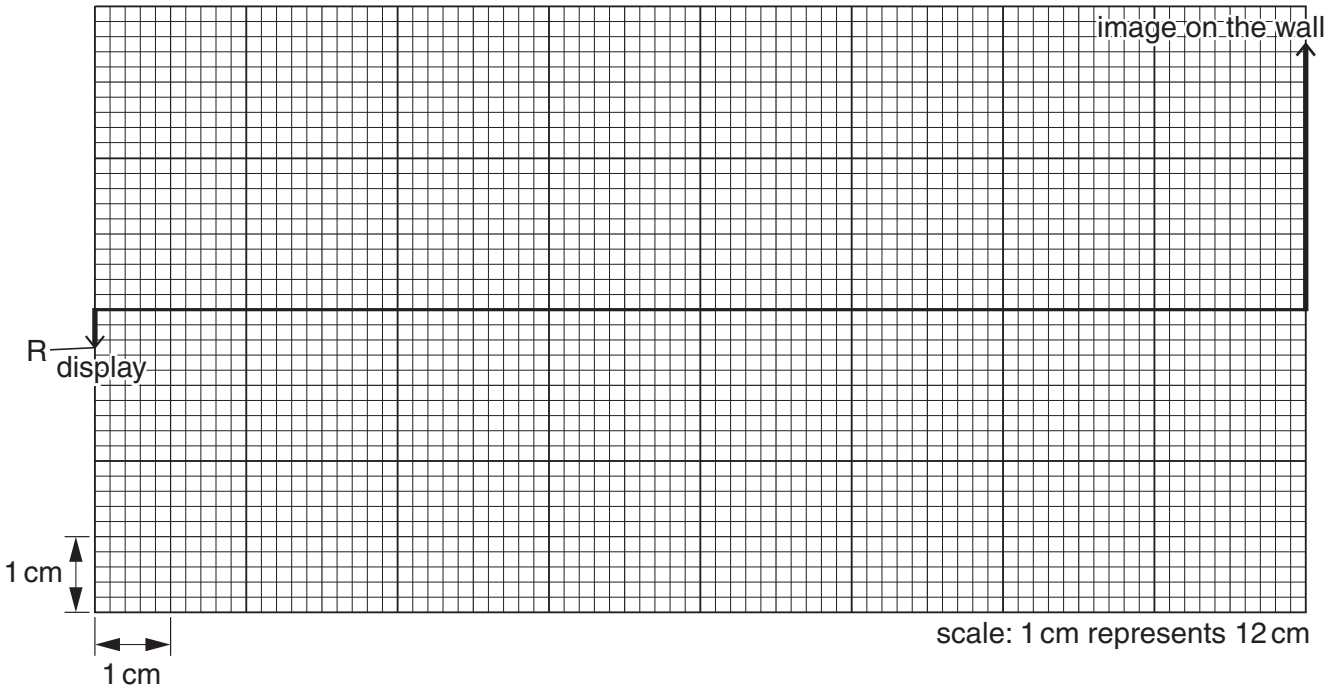


Fig. 9.2

(i) The image is inverted and magnified. State two other properties of the image.

1. .....

2. .....
[2]

(ii) On Fig. 9.2, draw the straight-line ray from R to the image. [1]

(iii) On Fig. 9.2, draw a vertical line representing the lens and label it L. [1]

(iv) A second ray from R to the image passes through a focal point (principal focus) of the lens. On Fig. 9.2, draw this ray and use it to mark this focal point. Label this focal point F. [2]

(v) Determine the focal length of the lens.

focal length = ... [2]

10 An atom of phosphorus (chemical symbol P) is composed of 15 electrons, 17 neutrons and 15 protons.

For Examiner's Use

(a) For this atom, state

(i) the proton number (atomic number), ... [1]

(ii) the nucleon number (mass number). ..... [1]

(b) This phosphorus atom is radioactive. As it decays to an atom of sulfur (chemical symbol S), it emits a beta-particle (symbol β).

(i) Write a nuclear equation for this decay.

[3]

(ii) Explain what is meant by a *beta-particle*.

.....

..... [2]

(iii) A sample of radioactive material contains many of these phosphorus atoms. Describe an experiment to investigate whether the sample emits only beta-particles. A diagram may be included.

.....

.....

.....

.....

.....

.....

..... [4]

(c) This isotope of phosphorus has a radioactive half-life of 14.3 days.

For Examiner's Use

(i) Explain what is meant by *radioactive half-life*.

.....

.....

..... [2]

(ii) A solution containing such phosphorus atoms is used in a medical procedure. When it is prepared, the solution has an activity of 1400 counts/second. The solution cannot be used when its activity falls below 350 counts/second.

Calculate the maximum time between preparing and using the solution.

time = ... [2]

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