Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

3920493364

PHYSICS **5054/22**

Paper 2 Theory **October/November 2014**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

Electronic calculators may be used.
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.

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Section A

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

1 A student suspends a spring from a clamp stand. He measures the unstretched length of the spring with no load attached. He then attaches different loads to the lower end of the spring and measures the new lengths of the spring.

Fig. 1.1 shows how the total length of the spring depends on the load attached.

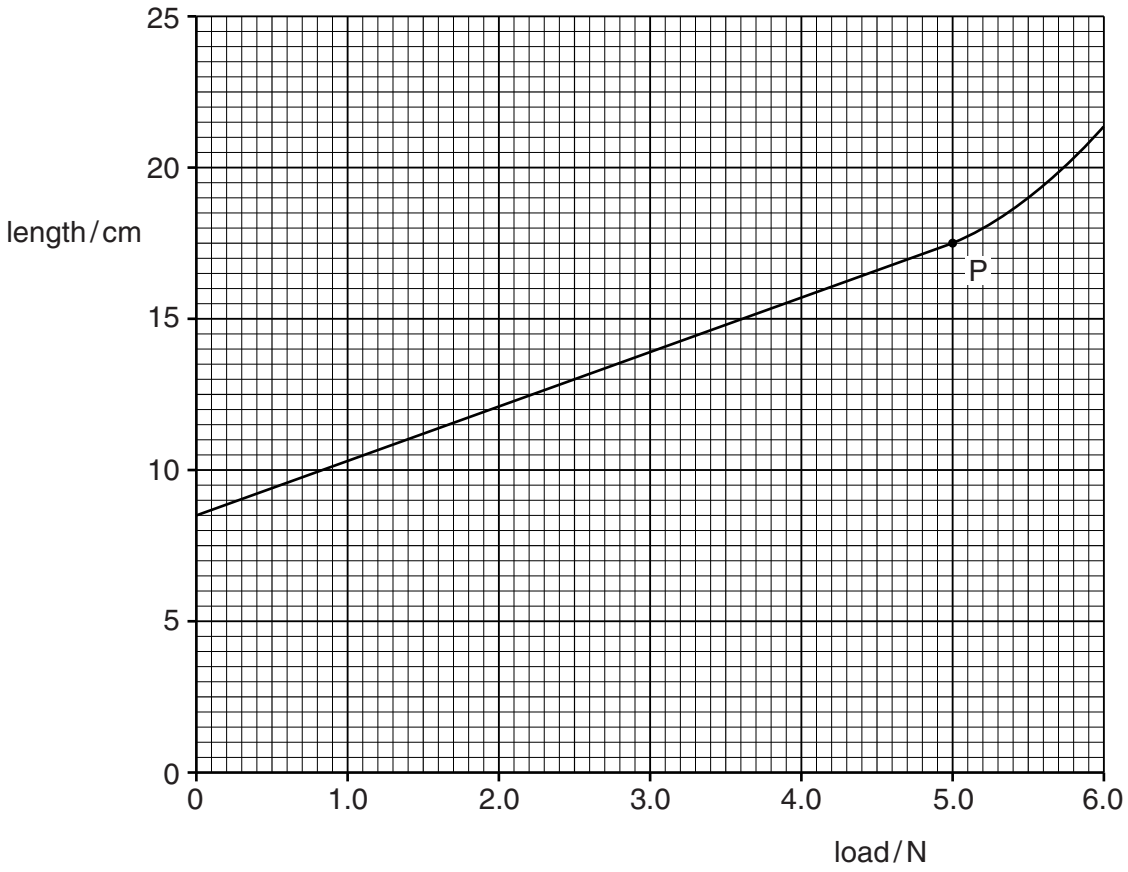


Fig. 1.1

(a) At point P on Fig. 1.1, the line stops being straight and begins to curve.

State the name of point P.

.....[1]

(b) **(i)** Using Fig. 1.1, determine the unstretched length of the spring.

unstretched length = ...[1]

(ii) Calculate the extension of the spring for a load of 4.0 N.

extension = ...[1]

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(c) The student attaches a small block of wood to an identical spring. The extension of the spring is 2.7 cm. The gravitational field strength g is 10 N / kg.

Calculate the mass of the block of wood.

mass = ...[2]

2 In hospitals, doctors and nurses operate taps with their elbows in order to avoid contamination.

Fig. 2.1 shows a hospital tap with a long handle.

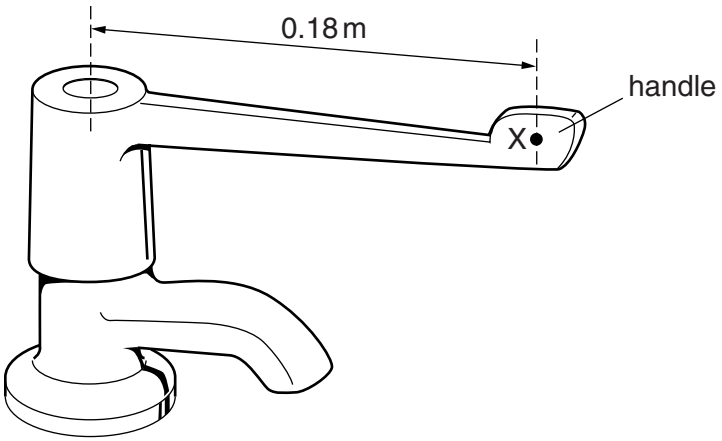


Fig. 2.1

(a) A nurse applies a force of 2.5 N at a point X on the handle, 0.18 m from the axis of the tap.

(i) Calculate the maximum moment about the axis that this force can produce.

moment = ...[2]

(ii) The moment produced by the nurse is less than this maximum value.

Suggest one reason why this is so.

.....

.....[1]

(b) State how the force needed to operate the tap is affected by the length of the handle.

.....

.....[1]

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3 Fig. 3.1 shows a helium cylinder being used at a funfair to inflate balloons that float in the air.

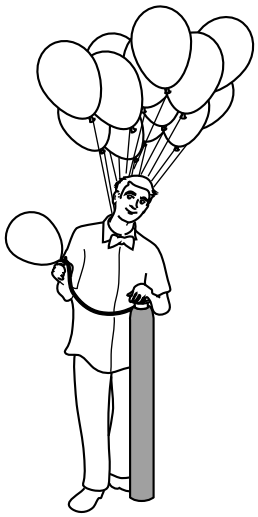


Fig. 3.1

Initially, all the helium is stored in the cylinder at a pressure of 2.0×10^7 Pa.

When no more balloons can be filled, all the helium occupies a total volume of 1.8 m^3 and is at a pressure of 1.0×10^5 Pa. The temperature of the helium has not changed.

(a) Calculate, stating the formula used, the initial volume of the helium in the cylinder.

volume = ...[3]

(b) The balloon seller takes the cylinder back to the helium supplier and it is refilled. The mass of helium in the cylinder is 0.30 kg.

(i) Calculate the density of helium in the cylinder.

density = ...[2]

(ii) The mass of the empty cylinder is 16 kg.

Suggest why weighing the cylinder is not an accurate method of determining the amount of helium supplied.

.....

.....[1]

4 Fig. 4.1 shows a black car going up a hill on a bright, sunny day.

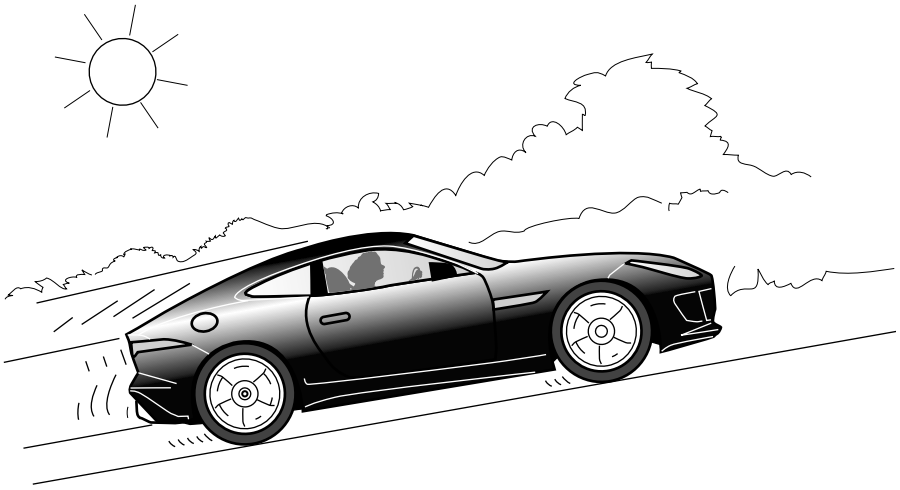


Fig. 4.1

(a) State

(i) one way in which the car is gaining thermal energy,

.....

.....[1]

(ii) one way in which the car is losing thermal energy.

.....[1]

(b) The car accelerates up the hill. In addition to the changes in the thermal energy of the car, there are other energy changes taking place.

Describe the other energy changes occurring as the car moves.

.....

.....

.....

.....[3]

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5 A test-tube contains solid wax. The melting point of the wax is 58 °C.

The test-tube is partially immersed in a beaker of boiling water and the wax melts. A thermometer is placed in the liquid wax.

At time $t = 0$, the thermometer reads 90 °C and the test-tube is immediately removed from the water. The test-tube then cools to room temperature of 23 °C.

(a) The temperature of the wax changes as it cools to room temperature.

On the axes of Fig. 5.1, sketch a graph to show how the temperature changes with time *t*. Mark on the temperature axis 90 °C, 58 °C and 23 °C. [3]

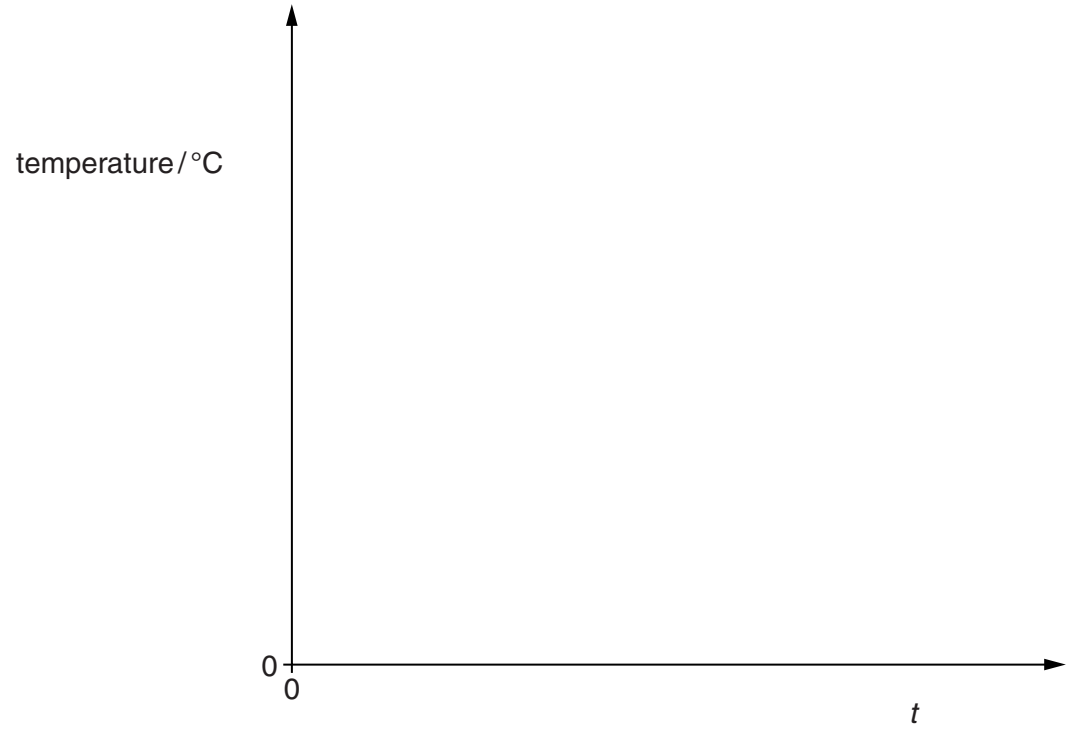


Fig. 5.1

(b) On the completed graph of Fig. 5.1, mark a point H, where half of the wax is solid and half is liquid. [1]

(c) The specific latent heat of fusion of the wax is 220 J / g and the mass of the wax is 45 g.

Calculate the thermal energy released by the wax as it solidifies.

thermal energy = ...[2]

6 **(a)** State what happens to the molecules of a gas as its temperature increases.

.....

.....[1]

(b) Fig. 6.1 shows a runner in a long distance race. He tips water over himself to keep cool.



Fig. 6.1

(i) Explain, in terms of molecules, how the evaporation of water keeps the runner cool.

.....

.....

.....

.....[3]

(ii) At one point in the race, a strong breeze blows past the runner and the water evaporates more quickly.

Suggest one reason why the water evaporates more quickly in the breeze.

.....

.....[1]

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7 The circuit of Fig. 7.1 includes an ammeter, a 6.0 Ω resistor, a length of metal resistance wire and three 1.5 V cells connected in parallel.

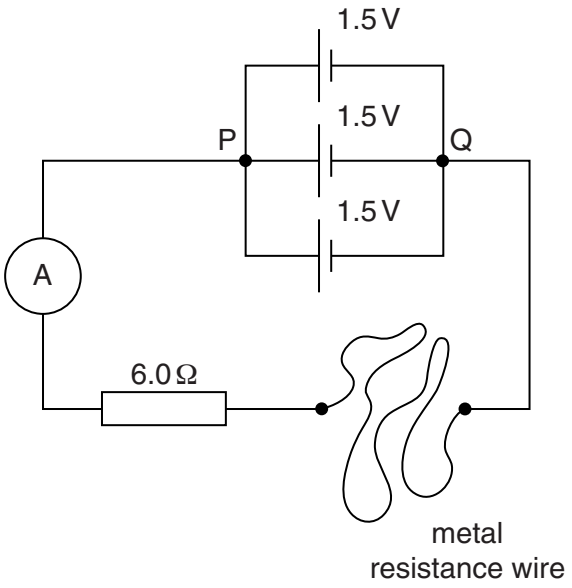


Fig. 7.1

(a) State

(i) one advantage of using cells in parallel rather than using a single cell,

.....

.....[1]

(ii) the potential difference (p.d.) between points P and Q in the circuit of Fig. 7.1.

p.d. = ...[1]

(b) (i) The ammeter in Fig. 7.1 reads 0.075 A.

Calculate the resistance of the resistance wire.

resistance = ...[3]

(ii) The temperature of the metal resistance wire increases.

State and explain the effect of this temperature increase on the ammeter reading.

.....

.....

.....[2]

8 Fig. 8.1 shows the structure of a simple alternating current (a.c.) generator.

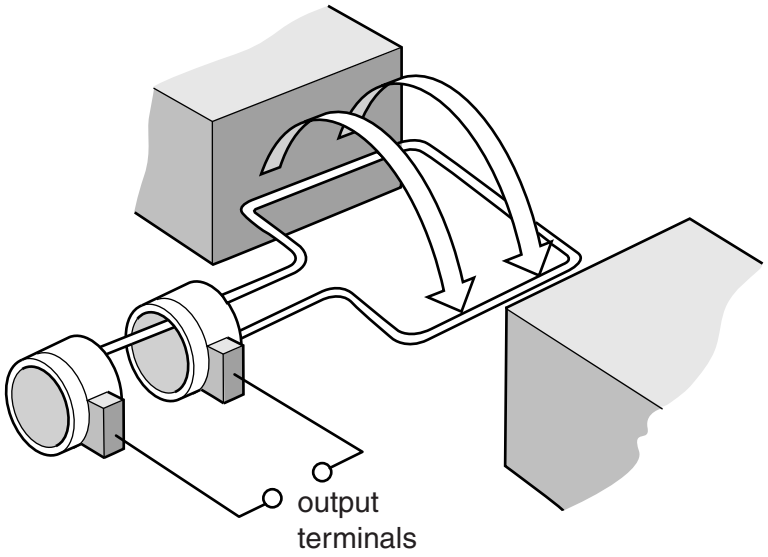


Fig. 8.1

(a) On Fig. 8.1, label

- the coil of the generator with the letter C,
- a slip ring with the letter S,
- a carbon brush with the letter B.

[2]

(b) The a.c. generator is operating and the arrows on Fig. 8.1 show the direction of rotation.

Explain why there is an electromotive force (e.m.f.) between the two output terminals.

.....

.....

.....

.....[3]

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(c) The output terminals of the a.c. generator are connected to a cathode-ray oscilloscope (c.r.o.). Fig. 8.2 shows the trace on the screen of the c.r.o.

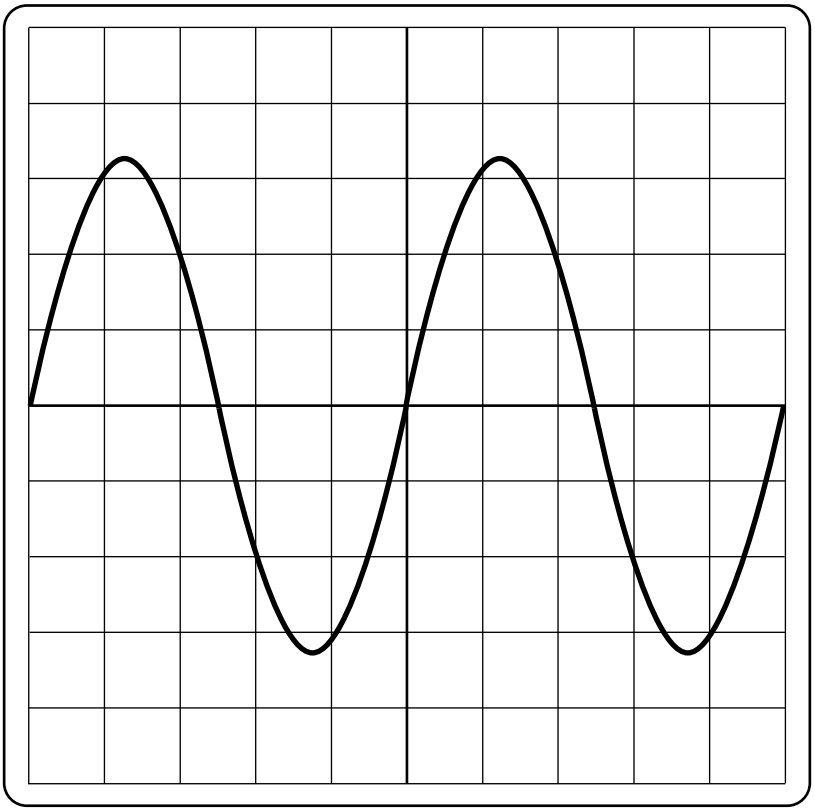


Fig. 8.2

Describe how the trace and a setting on the c.r.o. are used to find the time for one revolution of the coil of the a.c. generator. You may draw on Fig. 8.2 if you wish.

.....

.....

.....[2]

Section B

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

9 **(a)** Explain what is meant by *uniform acceleration*.

.....

.....

.....[2]

(b) Acceleration is a vector quantity.

State how a vector quantity differs from a scalar quantity.

.....

.....[1]

(c) A rock from space is travelling in a straight line at high speed when it enters the Earth's atmosphere. Fig. 9.1 is the speed-time graph for the rock from time $t = 0$ to time $t = 50$ s.

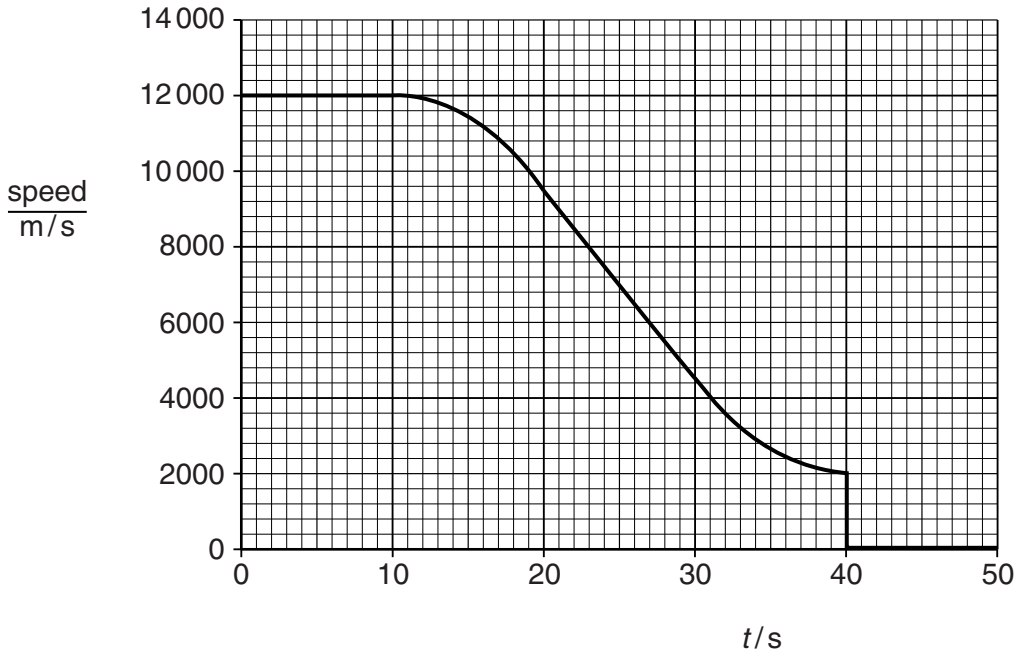


Fig. 9.1

(i) On Fig. 9.1, mark

- a letter X, where the rock is moving with a constant speed,
- a letter Y, where the rock has a uniform deceleration,
- a letter Z, where the rock has a non-uniform deceleration.

[3]

(ii) At time $t = 25\,s$, the mass of the rock is 8.4 kg. For the time $t = 25\,s$, determine

1. the size of the acceleration of the rock,

acceleration = ...[3]

2. the size of the resultant force on the rock.

force = ...[2]

(iii) Fig. 9.2 shows the rock at $t = 25\,s$.

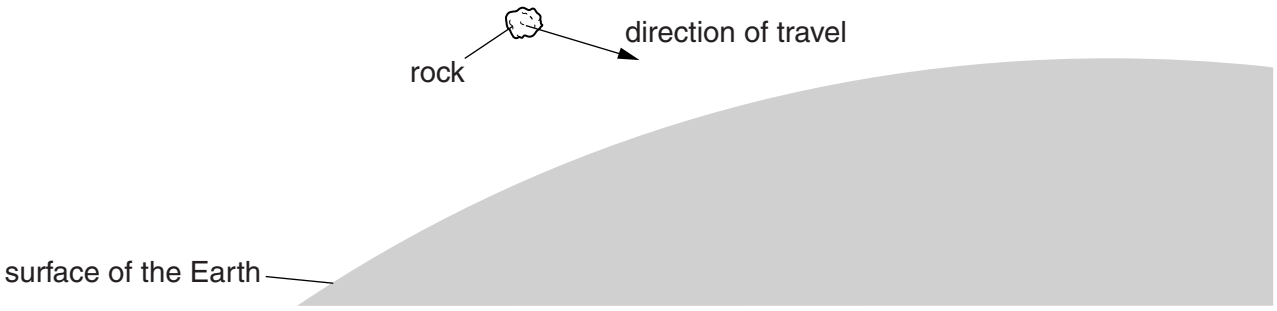


Fig. 9.2 (not to scale)

1. On Fig. 9.2, draw and label two arrows to show the directions of the gravitational force *F* and the air resistance *R* acting on the rock. [2]

2. Suggest why the size of the air resistance changes as the rock travels through the Earth's atmosphere.

.....

.....[1]

(iv) Suggest what happens to the rock at $t = 40\,s$.

.....

.....[1]

10 **(a)** State the speed of light in air.

.....[1]

(b) Fig. 10.1 shows a ray of blue light passing from air into a glass block and refracting at the surface.

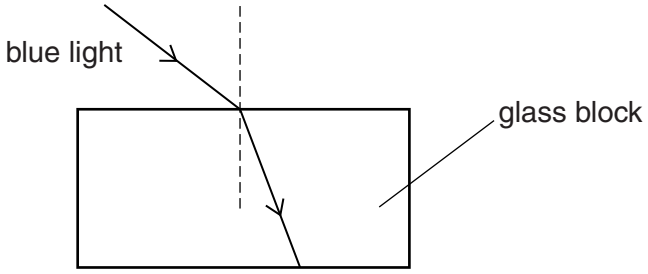


Fig. 10.1 (not to scale)

(i) As the light enters the glass, state what happens to

1. the speed of the light,

.....[1]

2. the frequency of the light,

.....[1]

3. the wavelength of the light.

.....[1]

(ii) On Fig. 10.1, mark and label the angle of incidence *i* and the angle of refraction *r*. [2]

(c) The refractive index of glass for blue light is 1.5.

(i) A ray of blue light strikes the surface of a glass block at an angle of incidence of 89°.

Calculate the angle of refraction of the light in the block.

angle of refraction = ...[3]

(ii) Explain why the angle of refraction of blue light in glass is always less than 45°.

.....

.....

.....

.....[2]

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(d) Blue light, travelling in air, strikes the side of a different glass block and continues in the same direction as it enters the glass block. Fig. 10.2 shows the ray of light and the shape of the glass block. The critical angle for this glass is 42°.

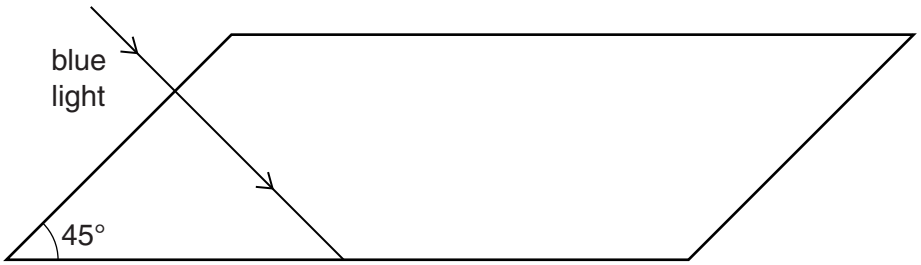


Fig. 10.2

(i) Explain why the light continues in the same direction as it enters the glass block.

.....

.....

.....[2]

(ii) On Fig. 10.2, complete the path of the light until it leaves the glass. [2]

11 Strontium-90 ($^{90}_{38}$Sr) is a radioactive isotope. A nucleus of strontium-90 decays by the emission of a beta-particle (β).

(a) Define the term *isotope*.

.....

.....[2]

(b) For a neutral atom of strontium-90, state

(i) the number of electrons,

number of electrons = ...[1]

(ii) the number of neutrons.

number of neutrons = ...[1]

(c) When a nucleus of strontium-90 decays, it becomes a nucleus of yttrium (symbol Y).

Complete the equation for this decay.

$$^{90}_{38}\text{Sr} \rightarrow \text{.....}^{\text{.....}}\text{Y} + \text{.....}^{\text{.....}}\beta$$ [2]

(d) A sample initially contains 6.0×10^8 atoms of strontium-90.

(i) The half-life of strontium-90 is 29 years.

Calculate the number of strontium-90 atoms that remain in the sample after 87 years.

number of atoms = ...[2]

(ii) Describe an experiment that shows that the sample emits only beta-particles.

.....

.....

.....

.....

.....

.....[4]

(iii) A teacher says that the emission of beta-particles from strontium-90 is random.

1. Explain what is meant by *random* in this context.

.....

.....[1]

2. State **two** ways in which the emission of beta-particles from strontium-90 is random.

.....

.....[2]

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