Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5633514449

PHYSICS **5054/21**

Paper 2 Theory **October/November 2018**

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.

This document consists of **17** printed pages and **3** blank pages.

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Section A

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

1 A girl of mass 35 kg, on a bicycle, accelerates from rest and travels down a slope in a straight line. The girl does not use the pedals.

Fig. 1.1 shows that the gradient of the slope is constant.

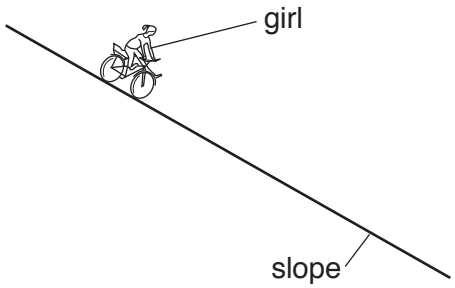


Fig. 1.1

(a) Calculate the resultant force on the girl when she is accelerating at 2.6 m / s^2.

resultant force = ... [2]

(b) At first, her acceleration is constant. At time t_1, her acceleration starts to decrease gradually until she is travelling at a constant speed in a straight line.

(i) On Fig. 1.2, sketch a speed-time graph for the girl from when she starts moving until she is travelling at a constant speed. [2]

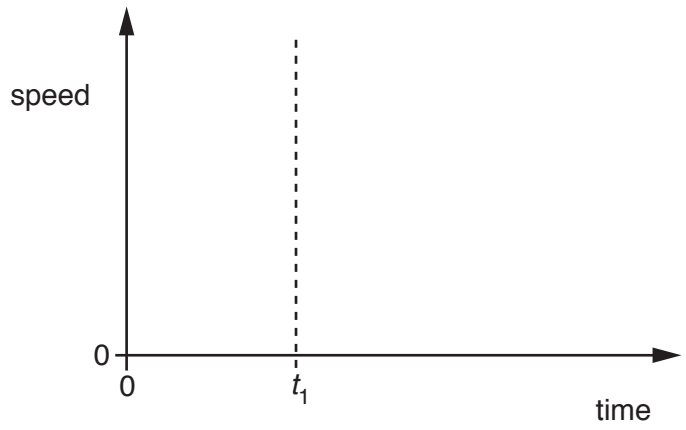


Fig. 1.2

(ii) State how the distance travelled is found from a speed-time graph.

.....

..... [1]

2 A small crack appears in an oil tank and a stream of oil is pushed out through the crack. The oil hits the floor at P where a puddle of oil starts to form.

Fig. 2.1 shows the oil tank.

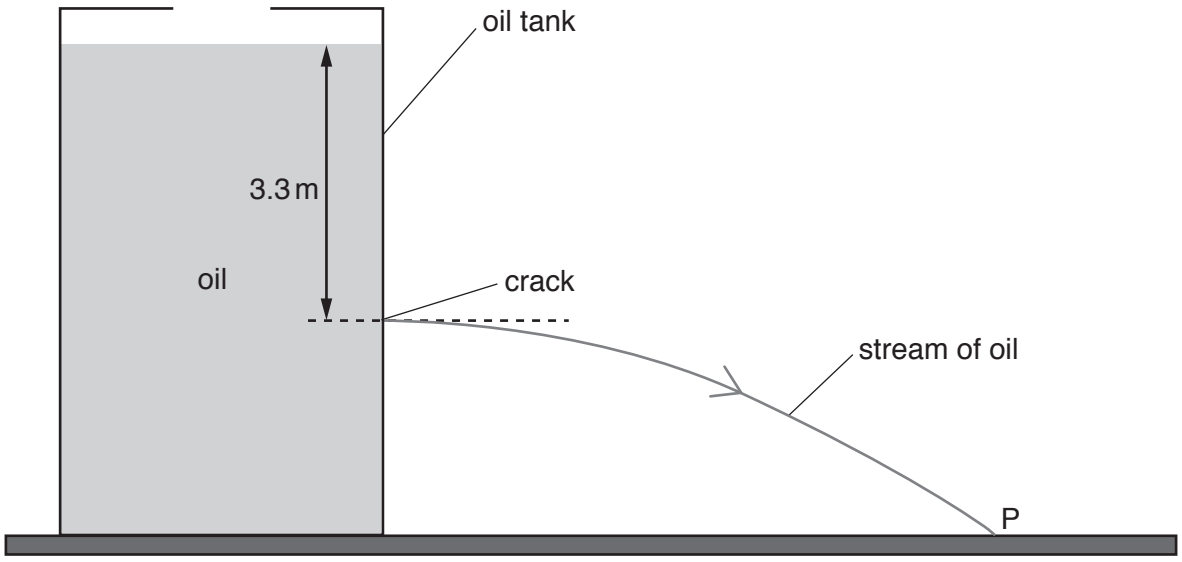


Fig. 2.1

The gravitational field strength g is equal to 10 N / kg.

(a) The density of the oil is 940 kg / m^3 and the crack is 3.3 m below the surface of the oil.

(i) Calculate the pressure due to the oil at the level of the crack.

pressure = ... [2]

(ii) Explain why the atmospheric pressure does not affect the rate at which the oil is pushed out through the crack.

.....

..... [1]

(b) As time passes, the point where the oil hits the floor moves away from P and towards the tank.

Explain why this happens.

.....

.....

..... [2]

3 A student uses the apparatus shown in Fig. 3.1 to obtain the extension-load graph of a spring.

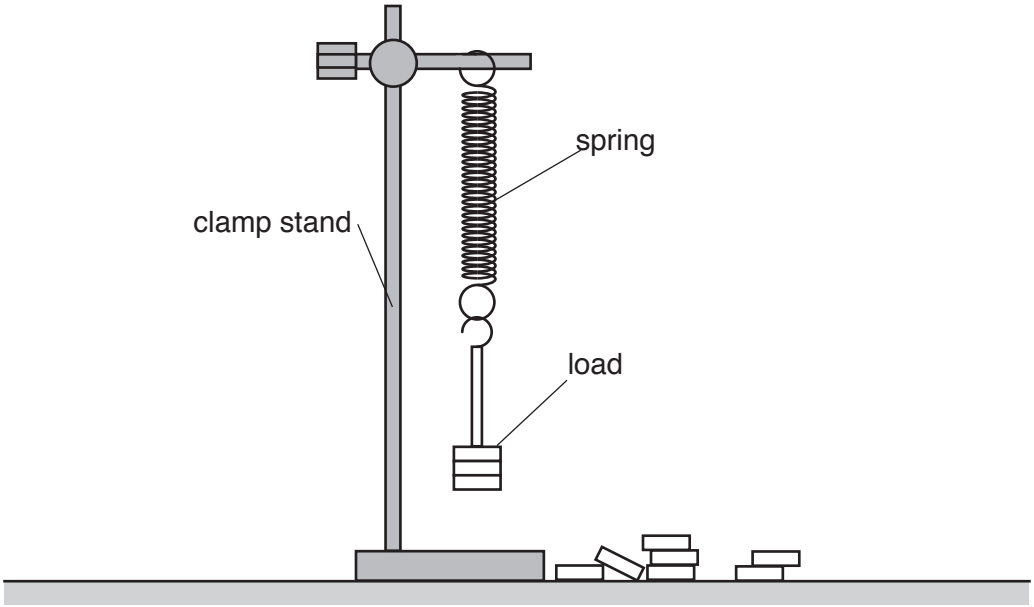


Fig. 3.1 (not to scale)

The weights of the loads are known. The student suspends loads of increasing size from the spring and determines the different extensions produced.

Fig. 3.2 is the graph the student obtains.

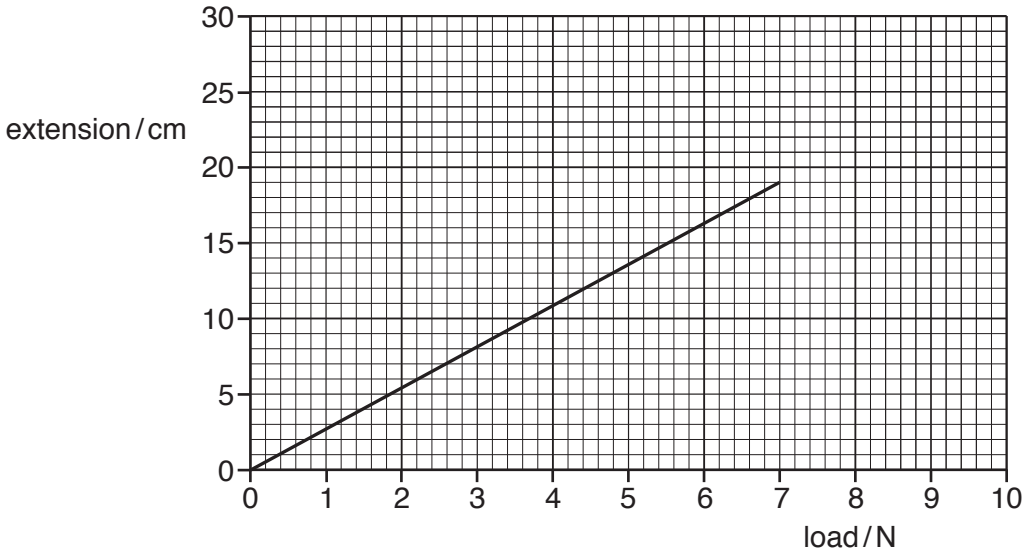


Fig. 3.2

The spring reaches its limit of proportionality when the load is 7.0 N.

(a) On Fig. 3.2, sketch the shape of the graph for loads greater than 7.0 N. [1]

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(b) All the loads are removed from the spring. A block of wood is suspended from the end of the spring. The length of the spring increases from 4.9 cm to 13.4 cm.

Determine the weight of the wooden block.

weight = ... [2]

(c) The student takes a second spring that is identical to the one in Fig. 3.1 and hangs it next to the first spring.

Fig. 3.3 shows a light rod passing through the rings at the lower ends of the springs.

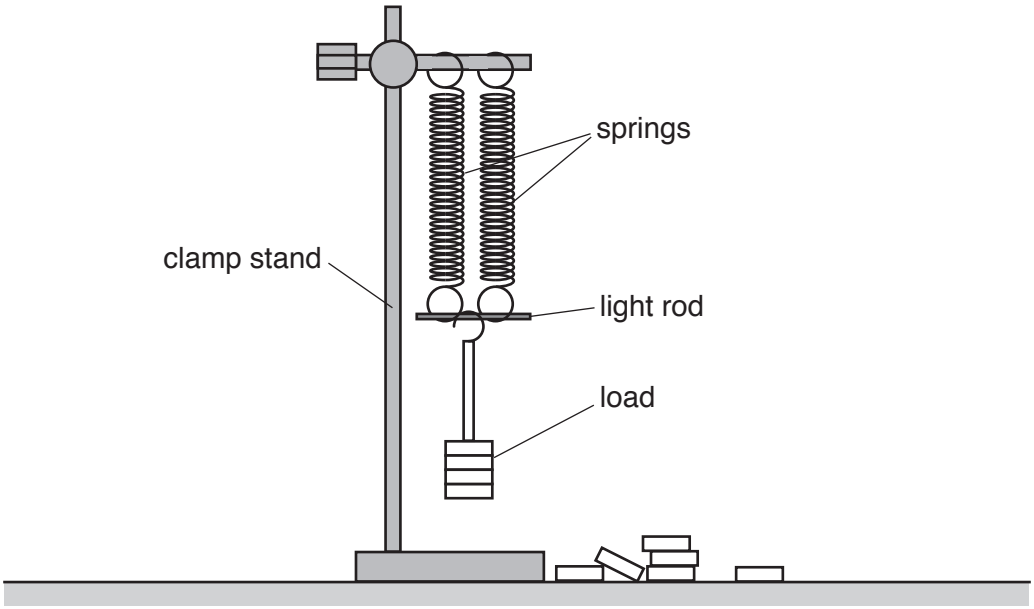


Fig. 3.3 (not to scale)

The student repeats the experiment and gradually increases the load to 9.0 N.

State and explain whether the limit of proportionality is reached.

.....

.....

.....

..... [2]

4 A rock from space is travelling at high speed towards the Earth.

(a) Complete the equation for the kinetic energy of an object travelling with a speed v and state what any other terms in the equation represent.

kinetic energy =

[1]

(b) The mass of the rock is 0.60 kg. When it hits the Earth, its average temperature increases by 25 °C.

(i) The specific heat capacity of the rock is 560 J/(kg °C).

Calculate the increase in the internal energy of the rock.

increase in internal energy = ... [2]

(ii) Use the answer from **(b)(i)** to determine the minimum possible speed of the rock when it hits the Earth.

minimum speed = ... [2]

(iii) Suggest one reason why the speed determined in **(b)(ii)** is less than the actual speed of the rock when it hits the Earth.

.....

..... [1]

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5 A nurse uses a mercury-in-glass, clinical thermometer to measure the temperature of a patient.

Fig. 5.1 shows the structure of a clinical thermometer.

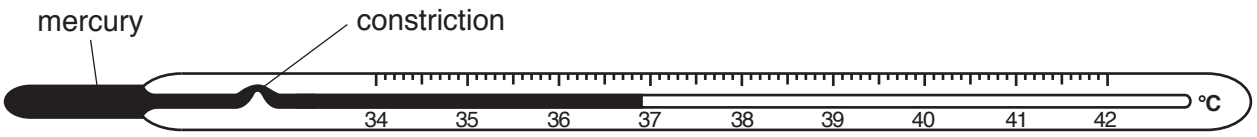


Fig. 5.1

(a) The clinical thermometer has a small range and a high sensitivity.

(i) State what is meant by

1. *range*,

.....

..... [1]

2. *sensitivity.*

.....

..... [1]

(ii) State and explain one feature of this clinical thermometer that produces a high sensitivity.

.....

.....

.....

..... [2]

(b) State the purpose of the constriction in the clinical thermometer.

.....

..... [1]

(c) Explain, in terms of the mercury molecules, how an increase in temperature produces an increased reading on the thermometer.

.....

.....

.....

.....

..... [3]

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[Turn over

6 Fig. 6.1 is the view from above of a stationary magnet and a small compass on a laboratory bench.

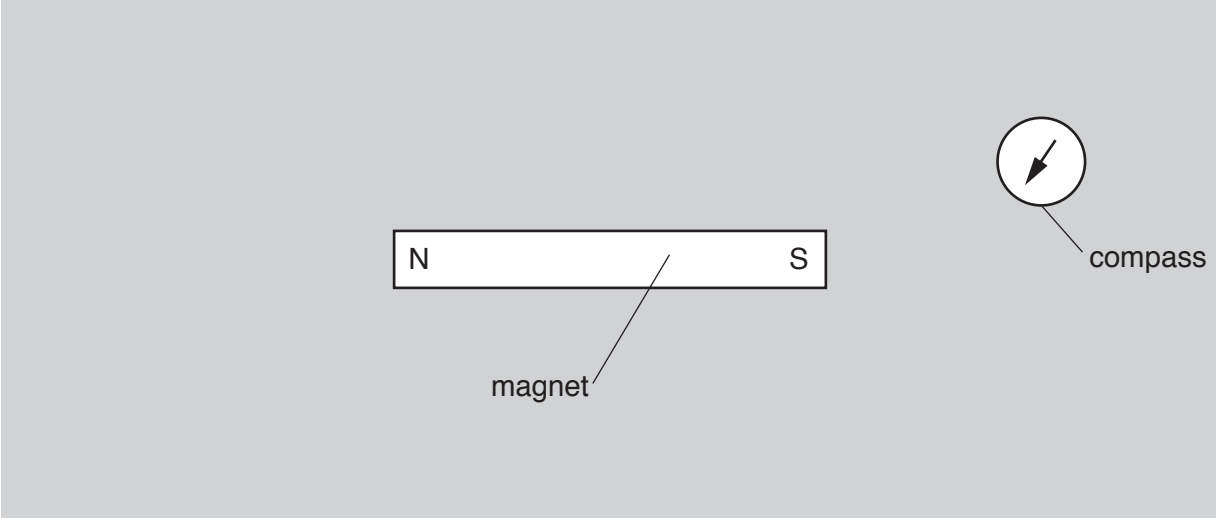


Fig. 6.1

(a) State the material from which the compass needle is made.

..... [1]

(b) Describe how the small compass is used to plot magnetic field lines in the region surrounding the magnet.

.....

.....

.....

.....

..... [3]

(c) An unmagnetised iron bar PQ is placed near to the magnet on the laboratory bench.

Fig. 6.2 shows the two poles of the magnet and PQ.

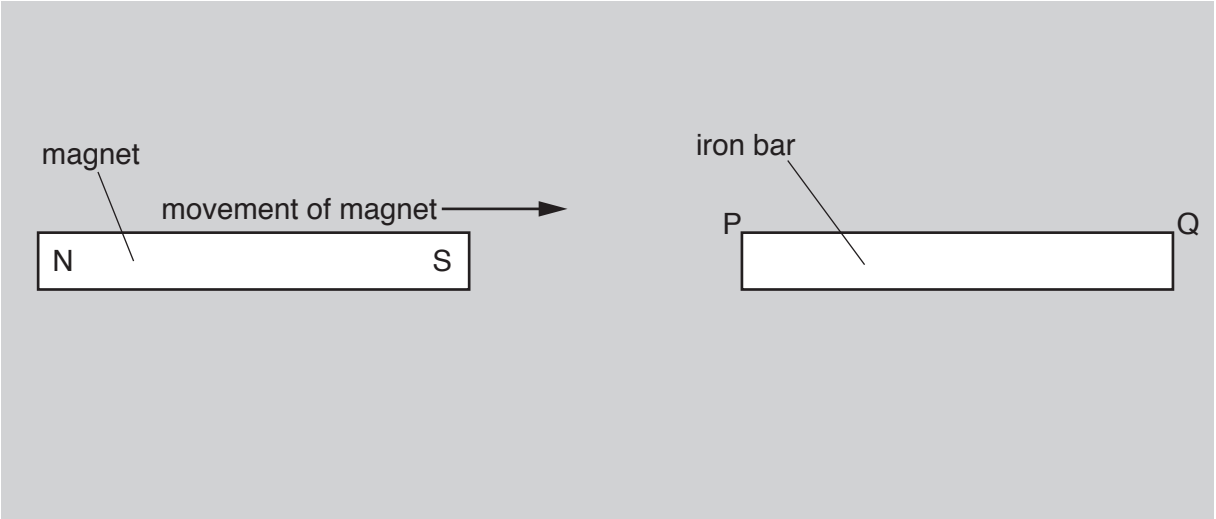


Fig. 6.2

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The iron bar is initially at rest and the magnet is moved to the right very slowly.

When the magnet is a short distance from the iron bar, the iron bar moves very quickly to the left towards it.

Explain why the iron bar is attracted to the magnet.

.....

.....

.....

..... [3]

7 A student sets up the circuit shown in Fig. 7.1.

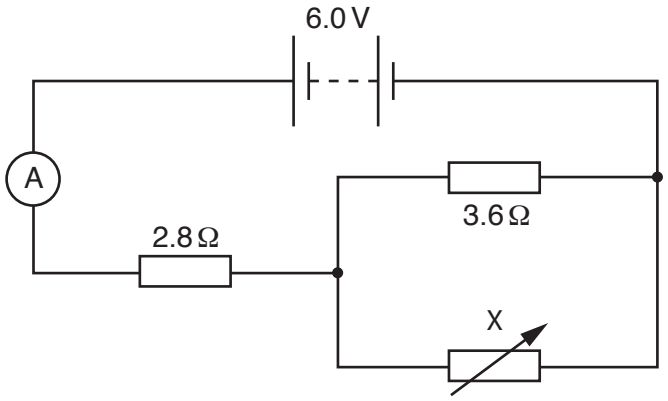


Fig. 7.1

The electromotive force (e.m.f.) of the battery is 6.0 V.

(a) The resistance of the variable resistor X is set to 1.8 Ω.

Determine

(i) the total resistance of the circuit,

resistance = ... [3]

(ii) the current measured by the ammeter.

current = ... [2]

(b) **(i)** State what is meant by the potential difference (p.d.) across a component in a circuit.

.....

..... [1]

(ii) Add to Fig. 7.1 the symbol for a component that is measuring the p.d. across the 2.8 Ω resistor. [1]

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(iii) The resistance of X is increased.

Explain why the p.d. across the 2.8 Ω resistor decreases.

.....

.....

..... [2]

Section B

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

8 A bucket of water is pulled up out of a well using a rope. Fig. 8.1 shows the rope winding on to a cylinder as the handle is turned.

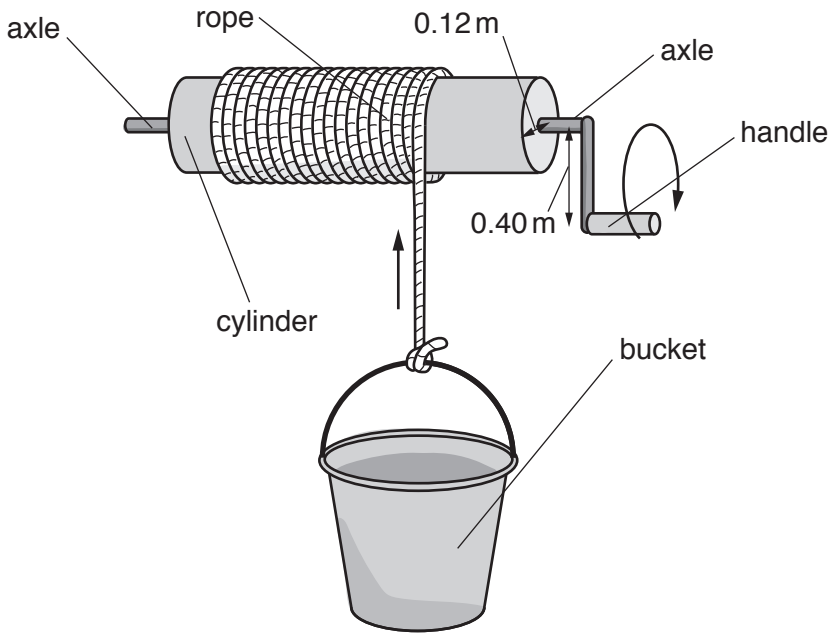


Fig. 8.1

The empty bucket has a mass of 1.0 kg.

(a) Complete the sentences that describe mass by filling in the gaps.

The mass of a body is a measure of the amount of .....

in the body. It resists a change in the state of ..... of

the body. [2]

(b) When the bucket is full, it contains $2.4 \times 10^{-2}\,m^3$ of water.

The gravitational field strength g is equal to 10 N/kg.

(i) Explain what is meant by a *gravitational field*.

.....

..... [1]

(ii) The density of water is 1000 kg / m^3.

Determine the total weight of the bucket and the water.

weight = ... [3]

(c) The radius of the cylinder is 0.12 m and the handle is 0.40 m from the axle of the cylinder. The weight of the bucket and the water produce a moment that acts on the cylinder.

(i) Calculate this moment.

moment = ... [2]

(ii) Calculate the minimum force on the handle that balances this moment.

force = ... [1]

(d) A farmer pulls the bucket of water up at a constant speed. He needs to exert a force on the handle that is greater than that calculated in **(c)(ii)**. He notices that there is a slight increase in temperature where the axle is in contact with the frame holding it.

(i) Suggest two reasons why the force exerted is greater than the value calculated.

1. .....

.....

2. .....

.....

[2]

(ii) State the energy changes that are taking place as the bucket is being lifted at a constant speed.

.....

.....

..... [3]

(e) State what can be deduced about the forces acting on the bucket when it is travelling upwards at a constant speed.

.....

..... [1]

9 Some waves are longitudinal and some waves are transverse.

(a) State how a longitudinal wave differs from a transverse wave.

.....

..... [1]

(b) A vibrating rod produces a water wave in a ripple tank. Fig. 9.1 shows the crests of the wave passing into the right-hand section of the tank where the depth of the water is different from the depth in the rest of the tank.

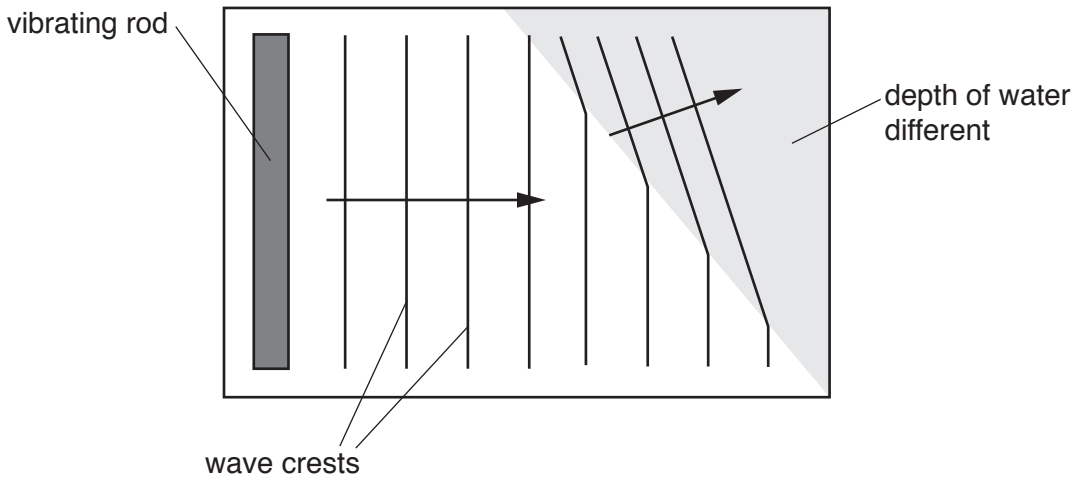


Fig. 9.1

The arrows on Fig. 9.1 show the direction of travel of the wave in the two sections of the ripple tank.

(i) In the left-hand section of the tank, the wavelength of the wave is 0.019 m and it travels at 0.17 m / s.

Calculate the frequency of the wave.

frequency = ... [2]

(ii) State what happens to the frequency of the wave, as it passes into the right-hand section of the tank.

..... [1]

(iii) Using Fig. 9.1, state and explain what happens to the speed of the wave as it passes into the right-hand section of the tank.

.....

.....

..... [2]

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(c) Fig. 9.2 shows light, in air, striking the vertical side of a rectangular glass block at an angle of incidence of 60°.

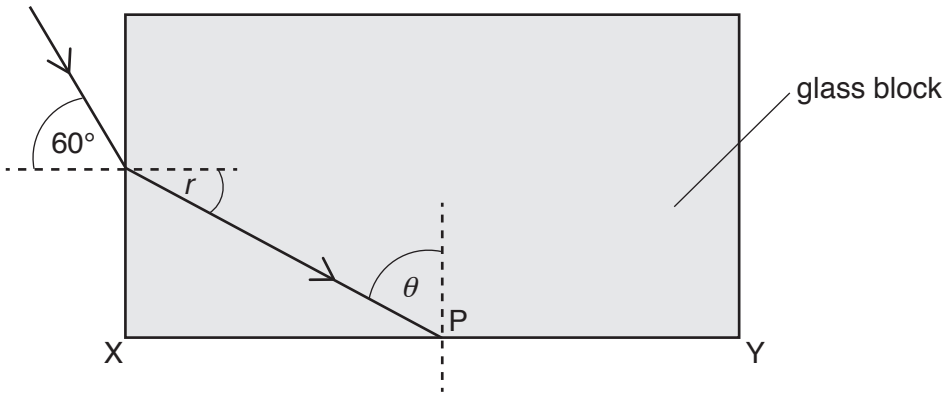


Fig. 9.2

The refractive index of the glass is 1.6. The light travels in the glass and strikes side XY at P.

(i) Underline all the terms that describe a light wave.

electromagnetic **longitudinal** **transverse**

[1]

(ii) At the point where the light enters the glass, the angle of refraction is *r*.

Calculate angle *r*.

r = ... [2]

(iii) **1.** Calculate the critical angle *c* for light travelling in the block.

c = ... [2]

2. At P, the angle θ between the ray and the normal is given by $\theta = 90° - r$.

State and explain what happens to the light when it strikes side XY.

.....

.....

..... [2]

3. On Fig. 9.2, draw the path of the light after it strikes side XY at P and the path of the light when it is again travelling in the air. [2]

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10 (a) Two neutral atoms are atoms of different isotopes of the same element.

State

(i) one similarity in the structures of these two atoms,

..... [1]

(ii) one difference between the structures of these two atoms.

..... [1]

(b) The isotope plutonium-239 decays by the emission of an alpha-particle (symbol α) to an isotope of uranium (symbol U). The half-life for this decay is 2.4×10^4 years.

(i) Complete the equation for this decay.

$$^{239}_{94}\text{Pu} \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}\text{U} + {}^{\cdots\cdots}_{\cdots\cdots}\alpha$$

[3]

(ii) The count rate measured due to a pure sample of plutonium-239 is 6400 counts / second.

Calculate the count rate after a period of 1.2×10^5 years has elapsed.

count rate = ... [3]

(iii) Fig. 10.1 shows an alpha-particle entering a uniform magnetic field.

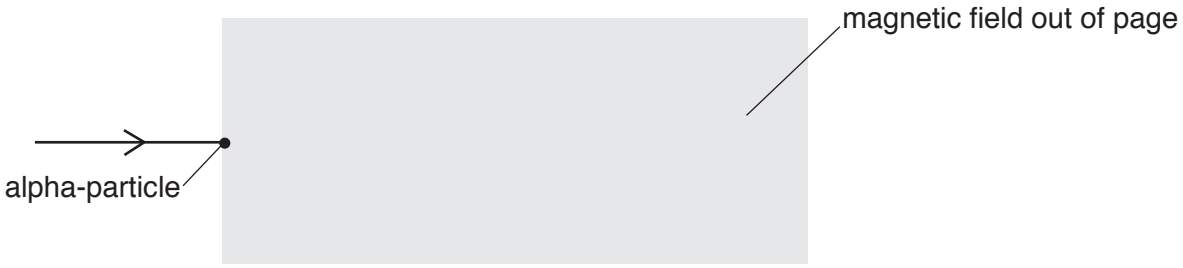


Fig. 10.1

1. On Fig. 10.1, draw the path of the alpha-particle in the magnetic field. [2]

2. Explain why the alpha-particle follows the path you drew in **(b)(iii)1**.

.....

..... [1]

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(c) In a nuclear reactor at a power station, plutonium-239 is made to undergo nuclear fission.

(i) State what is meant by *nuclear fission*.

.....

..... [1]

(ii) State what happens to a plutonium-239 nucleus in the nuclear reactor to cause fission.

.....

..... [1]

(iii) State one advantage of generating electricity in a nuclear power station rather than using

1. an oil-fired power station,

.....

..... [1]

2. an array of wind turbines.

.....

..... [1]

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