Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0190166048

PHYSICS **5054/21**

Paper 2 Theory **May/June 2020**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **two** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Blank pages are indicated.

DC (NF/CB) 182474/3

BLANK PAGE

Section A

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

1 Fig. 1.1 shows the thinking distance and the braking distance for a car being driven along a dry road and along a wet road at the same speed.

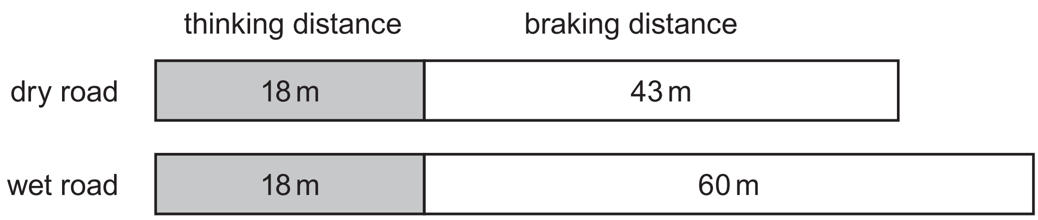

Fig. 1.1

(a) Calculate the total stopping distance for the car on the wet road.

distance = ... [1]

(b) Complete the sentence.

The thinking distance is the distance travelled between seeing a hazard and ....

.... [1]

(c) (i) Suggest why the thinking distance is the same on both roads.

....

....

.... [1]

(ii) Explain why the braking distance is larger when the road is wet.

....

....

....

.... [2]

[Total: 5]

2 A student performs an experiment to mark the centre of mass C on a thin piece of card. There are two holes in the card.

Fig. 2.1 shows the card and two lines that the student draws on the card.

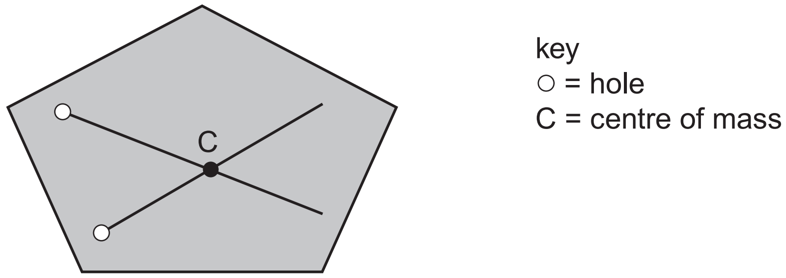

Fig. 2.1

(a) Describe a method used to draw these two lines in their correct positions on the card.

Make clear what extra apparatus is needed. You may draw a diagram, if you wish.

....

....

....

....

....

....

.... [3]

(b) The student holds the card loosely between her fingers. The card is vertical, resting with its lower edge on a bench as shown in Fig. 2.2.

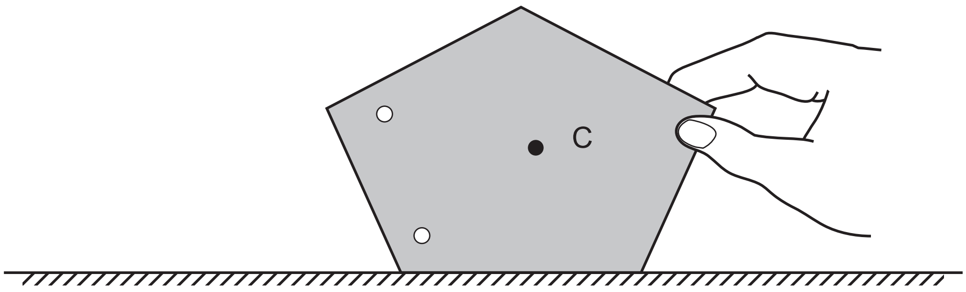

Fig. 2.2

The card is tilted slightly, as shown in Fig. 2.3, and then released.

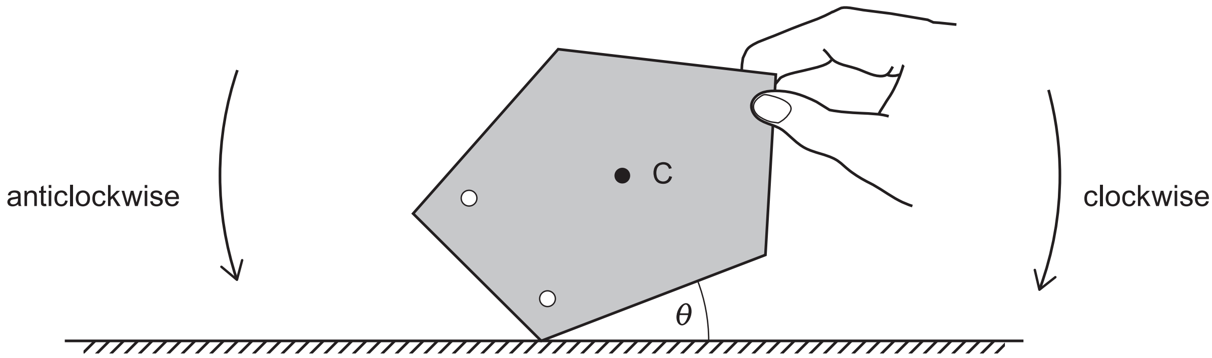

Fig. 2.3

When angle θ is small, the card falls clockwise, back to the position shown in Fig. 2.2.

(i) Explain why the card falls anticlockwise when θ is large.

....

....

....

.... [2]

(ii) State one change to the card that makes it more stable.

....

.... [1]

[Total: 6]

3 A student suspends a spring from a support. He attaches different loads to the lower end of the spring. For each load attached, he measures the extension of the spring.

Fig. 3.1 shows the extension–load graph obtained.

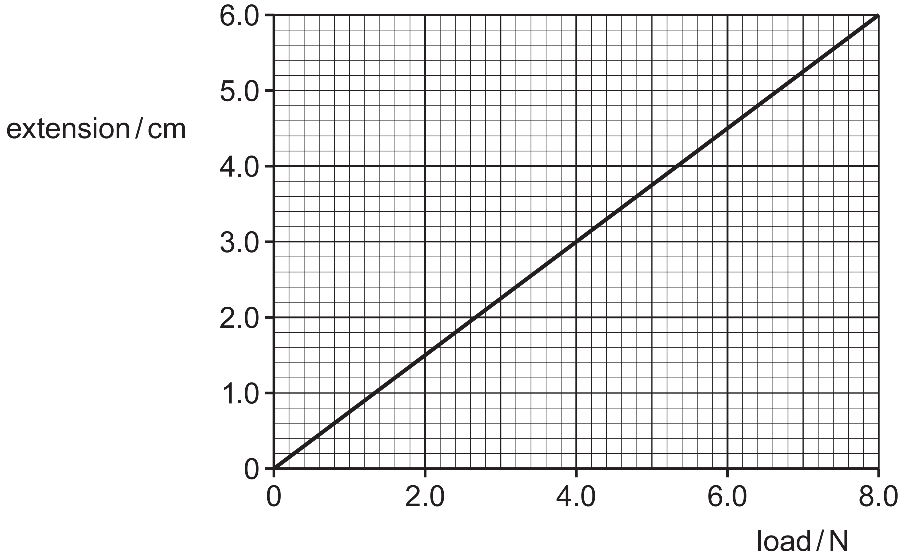

Fig. 3.1

(a) The extension of the spring is directly proportional to the load.

State the **two** features of the graph that show this.

1. ....

2. .... [2]

(b) Describe how the student can show that the spring reaches its limit of proportionality at 8.0 N.

....

....

....

....

....

.... [2]

(c) The spring is used in a simple device known as an accelerometer, shown in Fig. 3.2.

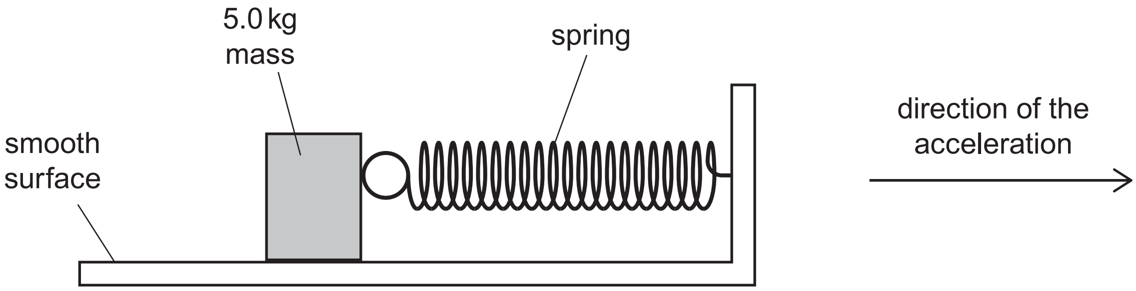

Fig. 3.2

The spring is fixed at one end and attached to a mass of 5.0 kg at the other end.

The mass rests on a smooth, horizontal surface. There is no friction between the mass and the surface.

The whole device is placed in a car.

The car accelerates and the student notices that the extension of the spring is 3.0 cm.

Using Fig. 3.1, calculate the acceleration of the car.

acceleration = ... [3]

[Total: 7]

4 Glass and iron are both conductors of heat. However, glass is a poor conductor of heat and iron is a good conductor of heat.

(a) Describe, using ideas about particles, how the conduction of heat takes place in glass and in iron. You should make it clear why iron is a better conductor of heat.

conduction in glass ....

....

....

....

....

conduction in iron ....

....

....

....

....

[4]

(b) Fig. 4.1 shows apparatus used to show expansion.

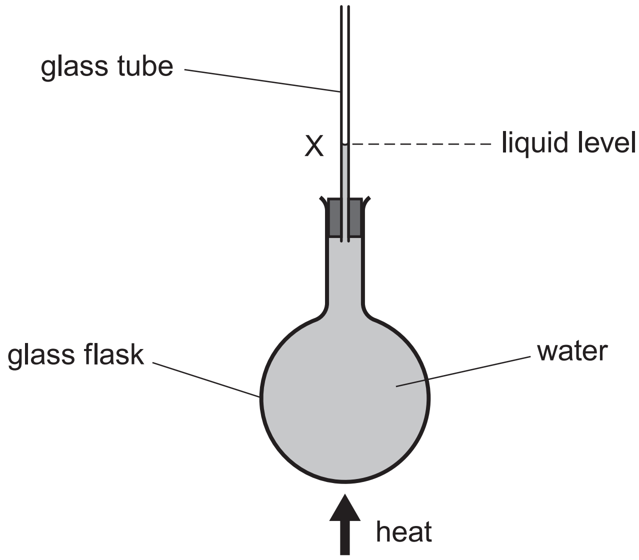

Fig. 4.1

The glass flask, full of water, is heated. A student is surprised when the liquid level X in the glass tube falls for a few seconds before it rises.

(i) Suggest why the liquid level falls and why it then rises.

....

....

....

....

.... [2]

(ii) Describe how heat is transferred throughout the water in the glass flask.

....

....

....

....

.... [2]

[Total: 8]

5 **(a)** Use the relationship between pressure, force and area to explain why it is harder to cut something with a blunt knife than with a sharp knife.

....

....

.... [2]

(b) Experimental measurements on gas pressures were made by Robert Boyle.

He showed that $p_1V_1 = p_2V_2$ where p_1 and p_2 are the initial and final pressures of a gas, and V_1 and V_2 are the initial and final volumes of the gas.

(i) State **two** quantities that must remain constant when this equation is used.

1. ....

2. ....
[2]

(ii) Fig. 5.1 shows the molecules of a gas as the volume of the gas is halved.

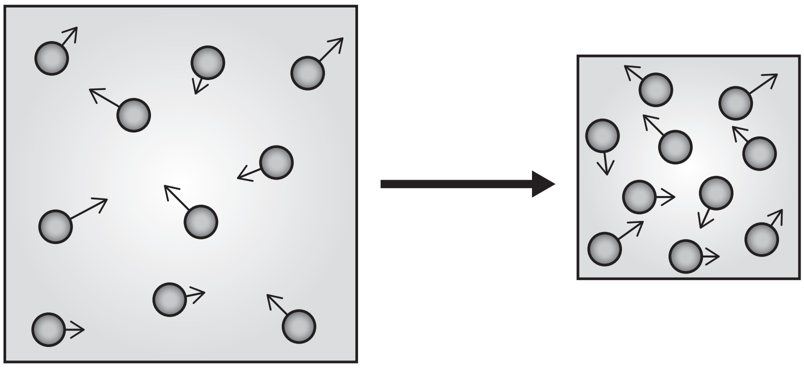

Fig. 5.1 (not to scale)

The equation suggests that when the volume of a gas halves the pressure doubles.

Using ideas about molecules, explain why this happens.

....

....

....

.... [2]

[Total: 6]

6 A dentist uses a plane mirror to see the back of a tooth.

(a) A plane mirror produces an image of an object.

Describe the position of this image.

....

....

.... [2]

(b) Fig. 6.1 shows the plane mirror used by the dentist to see the point labelled X on the tooth.

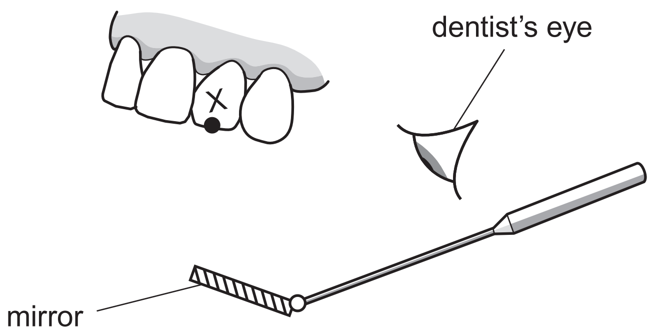

Fig. 6.1

On Fig. 6.1:

(i) mark the position of the image of X formed by the mirror [1]

(ii) draw a ray of light from X to show how the dentist can see the tooth. [2]

(c) State **one** characteristic of the image formed by the plane mirror other than its position.

....

.... [1]

[Total: 6]

7 Two isotopes of carbon are carbon-12 and carbon-14.

One of these isotopes, carbon-14, undergoes radioactive decay.

(a) Describe what is meant by *radioactive decay*.

....

.... [2]

(b) Carbon-12 has a proton number (atomic number) of 6 and a nucleon number (mass number) of 12.

Complete Table 7.1 for a neutral atom of each of these two isotopes.

Table 7.1

	carbon-12	carbon-14
number of protons	6	
number of neutrons		
number of electrons		

[2]

(c) A sample of carbon-14 is contained in a thin aluminium container of thickness 0.2 mm.

Radiation from the sample is detected outside the container.

When the thickness of the aluminium is increased to 6 mm, no radiation from the sample is detected outside the container.

(i) State the type of radiation which is stopped by increasing the thickness of the aluminium.

.... [1]

(ii) Explain how you know that the sample does **not** emit one other type of radiation.

....

....

....

.... [2]

[Total: 7]

Section B

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

8 Fig. 8.1 shows a lamp from a car. It contains two metal filaments.

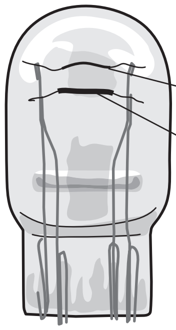

Fig. 8.1

(a) (i) Complete the boxes to describe the transfer of energy that takes place when the lamp is switched on.

.... energy	→	.... and .... energy

[3]

(ii) The efficiency of the metal filament lamp is less than 10%.

State what is meant by *efficiency*.

....

.... [2]

(b) The two filaments are usually connected in parallel to a car battery.

A student investigates what happens when the filaments are connected in series, rather than in parallel. He uses the same battery for the investigation.

State whether the current, the voltage across each filament and the total power produced *increases*, *decreases* or *stays the same* when the two filaments are connected in series.

current ....

voltage ....

power ....

[2]

(c) Fig. 8.2 shows the current–voltage graph for the two filaments.

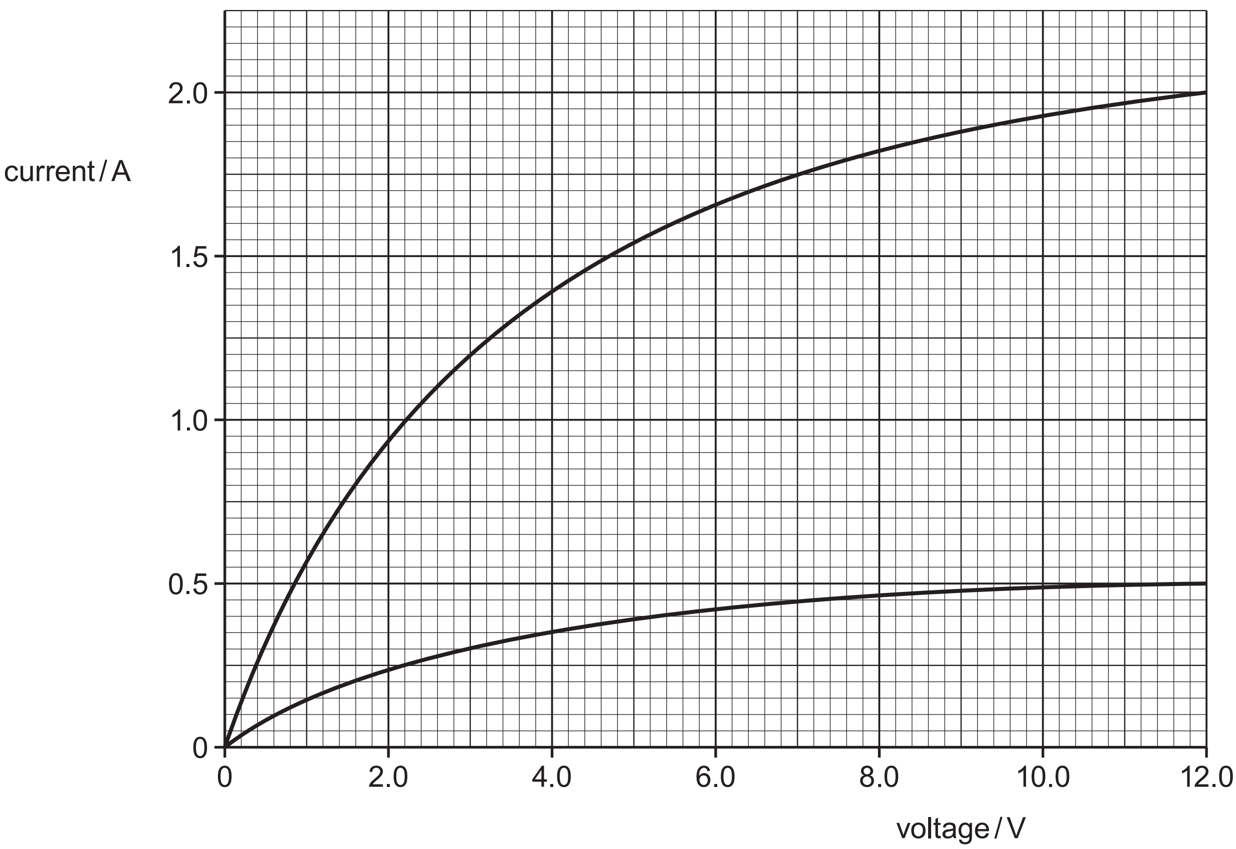

Fig. 8.2

(i) Calculate the total resistance of the two filaments when they are connected in parallel to a voltage of 12 V.

resistance = ... [3]

(ii) The two filaments are made from the same type of metal and have the same length, when uncoiled. They both operate at the same temperature.

Suggest why one filament has a resistance that is greater than that of the other filament.

....

.... [1]

(d) Fig. 8.3 shows a relay used to switch on a car headlamp.

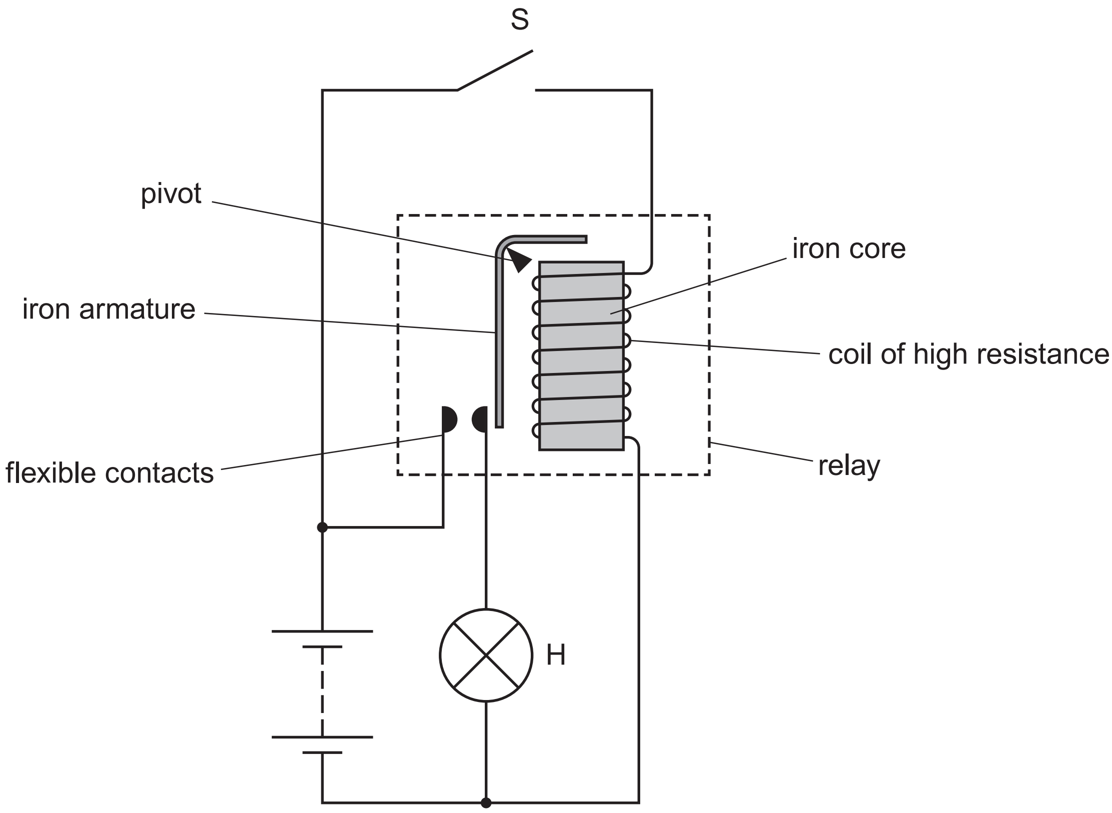

Fig. 8.3

Explain why headlamp H lights up when switch S is closed.

....

....

....

....

....

.... [4]

[Total: 15]

9 Ultrasound and X-rays are both used in medical imaging.

(a) **(i)** Define what is meant by *ultrasound*.

....

.... [2]

(ii) Describe what happens to ultrasound waves as they meet the boundary between two different materials.

....

.... [2]

(iii) To produce the image of an unborn child, an ultrasound emitter and receiver are placed close together on the mother's skin.

Fig. 9.1 shows pulses detected by the receiver.

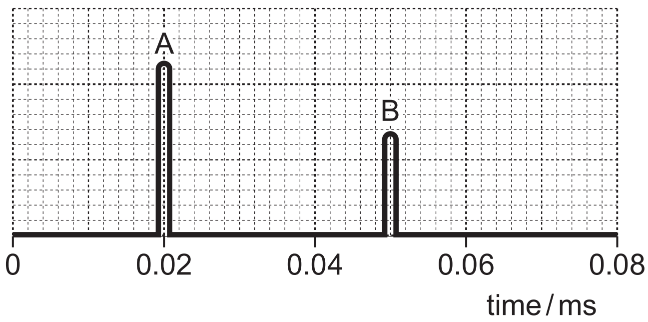

Fig. 9.1

Pulse A is the emitted pulse and pulse B is the first pulse that returns from the unborn child.

The average speed of ultrasound in human tissue is 1500 m / s.

Calculate the distance between the emitter and the child.

distance = ... [3]

(iv) The speed of ultrasound in human tissue is close to the speed of sound in water.

Suggest approximate values for the speed of sound in gases and solids.

speed in gases ....

speed in solids ....
[2]

(b) Fig. 9.2 shows an X-ray image of a hand. An X-ray detector is placed just below the hand. An image of the bones and human tissue around the bones is formed on a screen by the detector.

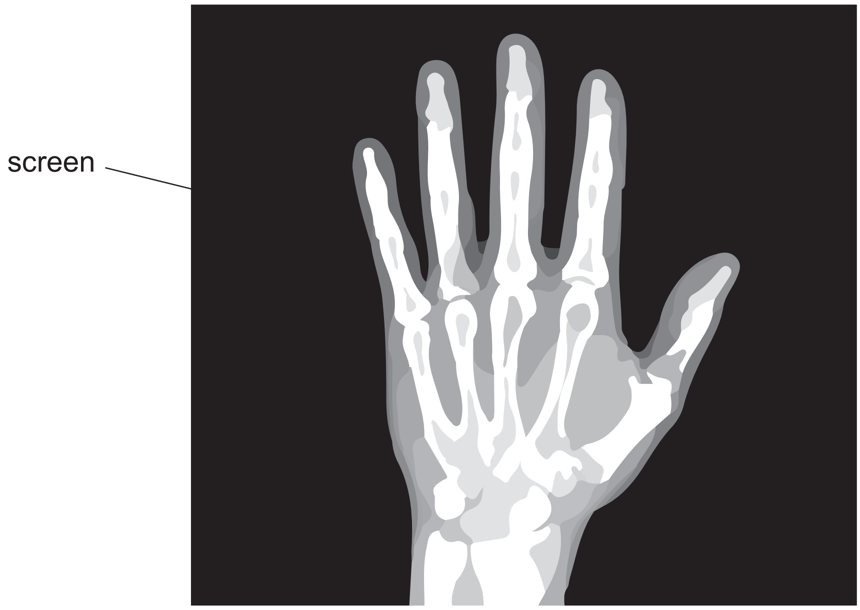

Fig. 9.2

(i) Describe what happens to the X-rays to produce the image.

....

....

....

....

.... [3]

(ii) The wavelength of the X-rays used is 2.0×10^{-9} m. The speed of electromagnetic waves is 3.0×10^{8} m/s.

Calculate the frequency of the X-rays.

frequency = ... [2]

(iii) Suggest one reason why X-rays are **not** used to form an image of an unborn child.

....

.... [1]

[Total: 15]

10 Fig. 10.1 shows a motor lifting a mass. Fig. 10.2 shows part of the circuit diagram of the connections to the motor.

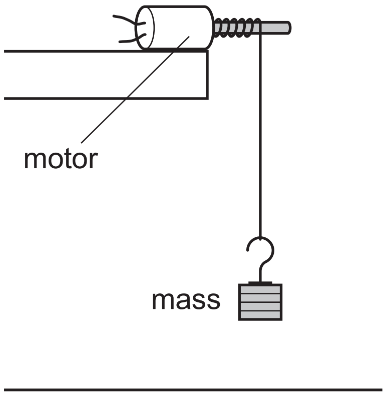

Fig. 10.1

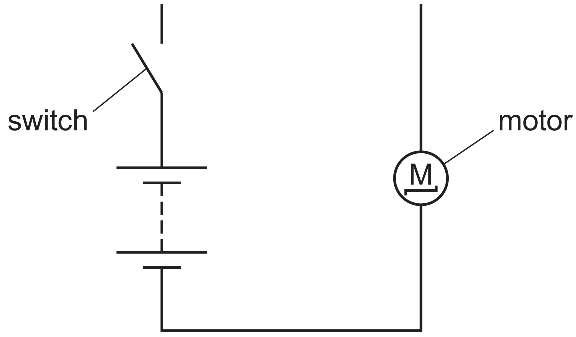

Fig. 10.2

(a) The current in the motor is 1.5A and the voltage supplied by the battery is 8.0V.

(i) Complete the circuit diagram in Fig. 10.2 to show an ammeter and a voltmeter in the correct positions to take these measurements while the motor is working. [2]

(ii) The motor takes 4.0s to lift the mass.

Calculate the electrical energy transferred to the motor in this time.

energy = ... [2]

(iii) The motor lifts the 150g mass through a height of 80cm in the 4.0s.

Calculate the gravitational potential energy gained by the mass.

The gravitational field strength *g* = 10N/kg.

gravitational potential energy = ... [3]

(iv) State **two** reasons why the gravitational potential energy gained by the mass is less than the electrical energy supplied to the motor.

1. ....

2. ....

[2]

(b) Fig. 10.3 shows the structure of the motor.

When the mass reaches the top of its motion, the switch is opened. This disconnects the battery and causes the mass to fall. The coil turns as the mass falls.

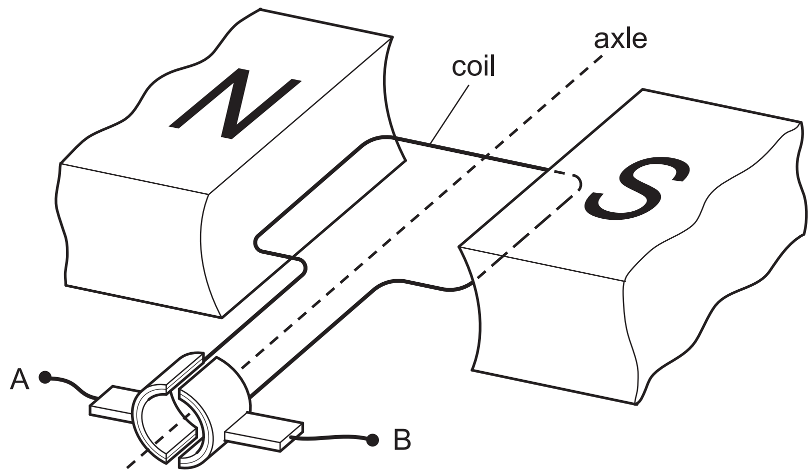

Fig. 10.3

As the coil turns, a small voltage is produced.

(i) Explain why a voltage is produced as the coil turns.

....

....

.... [3]

(ii) As the mass falls, a student connects a wire between the points A and B shown in Fig. 10.3.

He notices that the mass takes a longer time to fall when the wire is connected.

The student suggests that this is an example of Lenz's law.

State Lenz's law and suggest why the mass takes longer to fall.

....

....

....

....

....

.... [3]

[Total: 15]

BLANK PAGE