Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

0325858218

PHYSICS **5054/22**

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.

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Section A

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

1 Fig. 1.1 shows part of the speed–time graph for an athlete in a race.

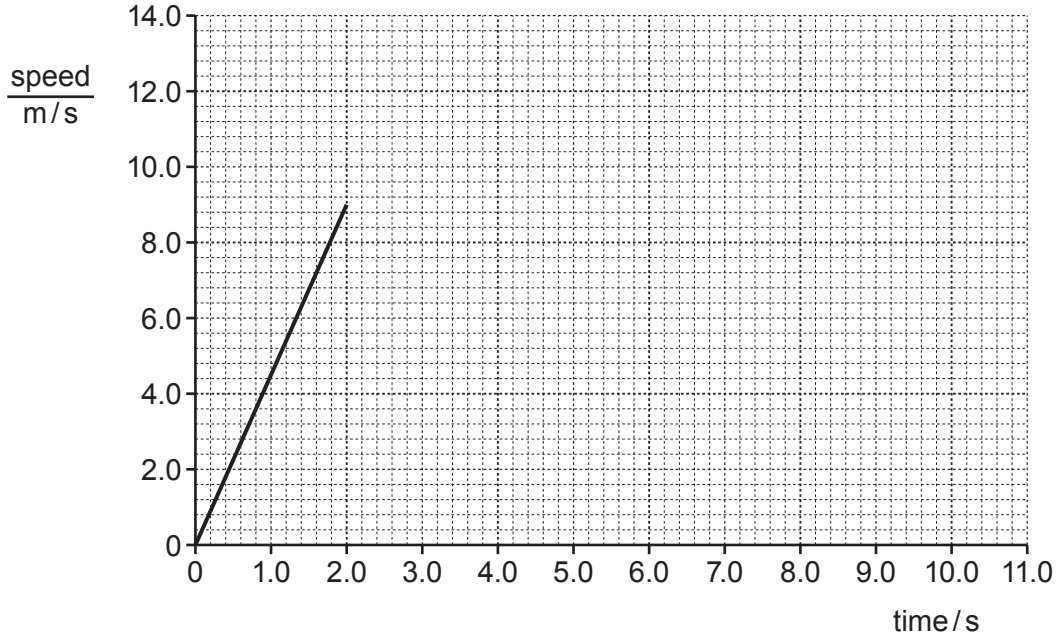


Fig. 1.1

(a) During the race, the acceleration of the athlete is uniform in the first 2.0 s.

State how the graph shows that the acceleration is uniform.

.....

..... [1]

(b) Determine the distance travelled by the athlete in the first 2.0 s.

distance = ... [2]

(c) During the rest of the race:

- from 2.0 s to 5.5 s, the acceleration of the athlete decreases
- at 5.5 s, the athlete reaches a maximum speed of 12 m / s
- from 5.5 s to 8.0 s, the athlete travels at a speed of 12 m / s
- from 8.0 s to 11.0 s, the athlete decelerates, finishing the race at a speed of 10 m / s.

On Fig. 1.1, complete the speed–time graph for times between 2.0 and 11.0 s. [3]

[Total: 6]

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2 Fig. 2.1 shows the thinking distance and the braking distance for a car driven at 100 km / h.

The car has old, smooth tyres.

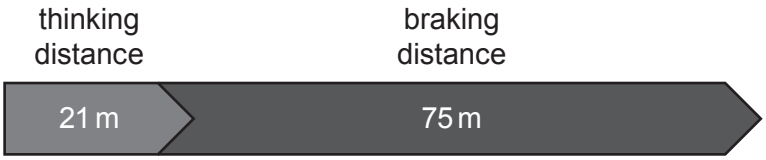


Fig. 2.1

(a) Calculate the total stopping distance for the car.

stopping distance = ... [1]

(b) The car is now fitted with new tyres.

At a speed greater than 100 km / h, the total stopping distance is the same as in **(a)**.

(i) State and explain the effect that the increase in speed and the use of new tyres have on the thinking distance.

effect .....

explanation .....

.....

..... [2]

(ii) State and explain the effect that the increase in speed and the new tyres have on the braking distance.

effect .....

explanation .....

.....

..... [2]

[Total: 5]

3 Fig. 3.1 shows part of a hydraulic press that is used to compress waste paper into a brick for burning.

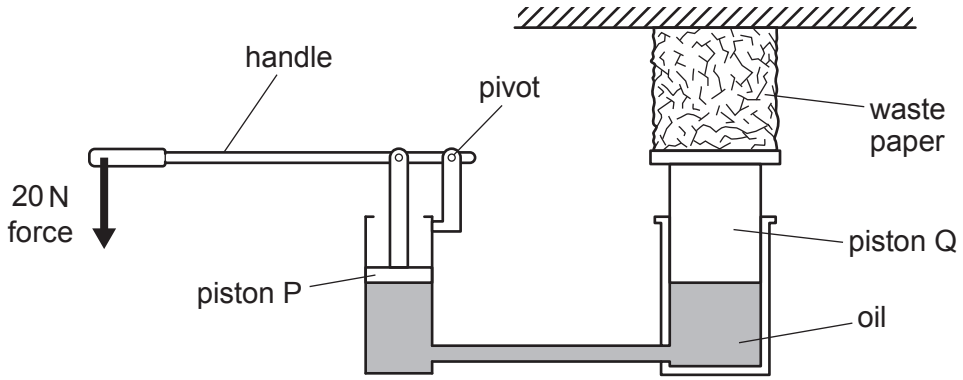


Fig. 3.1

A force of 20 N is exerted downwards on the end of the handle.

(a) The force on the handle creates a moment about the pivot.

(i) Define the *moment of a force*.

.....

.....

.....

..... [2]

(ii) Explain why the force exerted on piston P is greater than the force exerted on the handle.

.....

.....

..... [1]

(b) Explain how the hydraulic press enables a greater force to be exerted on piston Q than is exerted on piston P.

.....

.....

.....

.....

..... [2]

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(c) In moving the handle downwards, the 20 N force moves through a distance of 0.60 m and piston Q rises by 0.020 m.

The force exerted by piston Q on the paper is 400 N.

Calculate:

(i) the work done in moving the handle downwards

work = ... [2]

(ii) the efficiency of the hydraulic press.

efficiency = ... [2]

[Total: 9]

4 **(a)** Two mirrors, A and B, are inclined at an angle of 60° to each other.

Light strikes mirror A at an angle of 30°, as shown in Fig. 4.1.

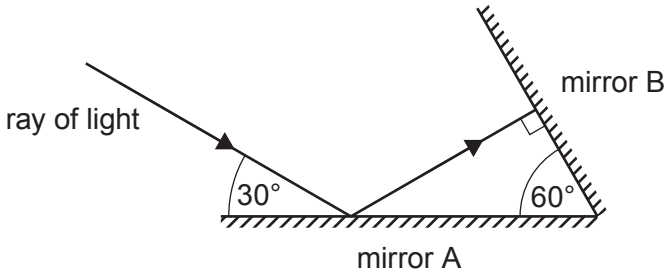


Fig. 4.1

(i) Determine the angle of incidence at mirror A.

angle of incidence at A = ... [1]

(ii) Determine the angle of incidence at mirror B.

angle of incidence at B = ... [1]

(iii) Describe the path of the reflected ray after it leaves mirror B.

.....

..... [1]

(b) A plane mirror hanging on a wall is used to form the image of an object.

State **three** characteristics of the image formed.

1. .....

2. .....

3. .....

[3]

[Total: 6]

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5 The components of the electromagnetic spectrum have different uses.

Microwaves are used in cooking and ultraviolet rays are used in sterilisation.

(a) Draw **one** line from each component of the spectrum to another suitable use for that component.

component	use
microwaves	sunbeds
	television controller
ultraviolet	satellite television
	airport security check of cases

[2]

(b) Fig. 5.1 shows a microwave oven used to heat soup. The container for the soup is a glass bowl.

Microwaves created inside the oven are reflected by the metal walls.

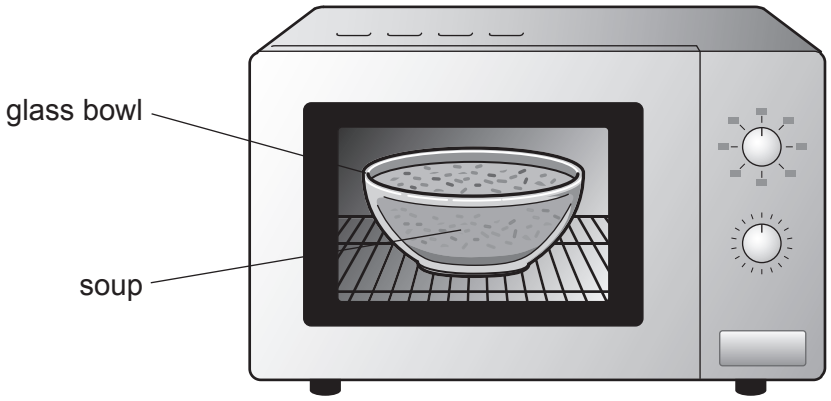


Fig. 5.1

(i) Explain why the choice of material for the container is important in microwave cooking.

.....

.....

..... [1]

(ii) The soup is mostly water.

Microwaves are completely absorbed by a few centimetres of water.

As a result, microwaves do not reach the centre of the soup.

The instructions suggest that, after the microwave oven is turned off, the soup:

- is not stirred
- is left for some minutes so that the centre becomes hot.

State the name of and describe each of the **two** processes by which thermal energy transfers throughout the soup after the microwave oven is turned off.

name of first process .....

description .....

.....

.....

name of second process .....

description .....

.....

..... [3]

[Total: 6]

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6 The clothes iron shown in Fig. 6.1 is connected to the electrical mains.

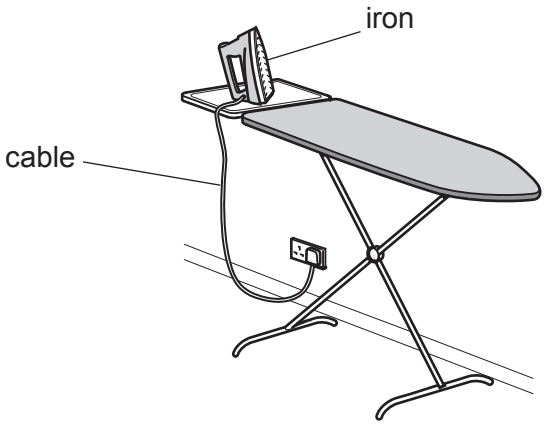


Fig. 6.1

(a) The boxes in the left column below contain some electrical hazards. The boxes in the right column contain methods of protection from these hazards.

For each hazard, draw **one** line to the appropriate method of protection.

electrical hazard	**method of protection**
worn insulation on the cable to the iron	earth wire and fuse in plug correctly connected to iron
loose live wire in the iron touches its metal case	circuit breaker correctly connected in circuit
cable becomes too hot because current is too high	visual check of cable before connecting to mains

[2]

(b) The power of the iron is 1200 W. The cost of 1 kW h of electrical energy is 20 cents (20 c).

(i) Define the *kilowatt-hour* (kW h).

.....

..... [1]

(ii) The iron is on at full power for 20 minutes.

Calculate the cost of running the iron for this time.

cost = ... [2]

[Total: 5]

7 Radon-222 is an isotope of radon which undergoes a series of radioactive decays.

Fig. 7.1 is a diagram showing the proton number (atomic number) and nucleon number (mass number) of nuclei involved in the series of decays.

The point P represents a nucleus of radon-222.

Starting at P, a nucleus of radon-222 decays to Q; then from Q to R; then from R to S; then from S to T; and finally from T to U.

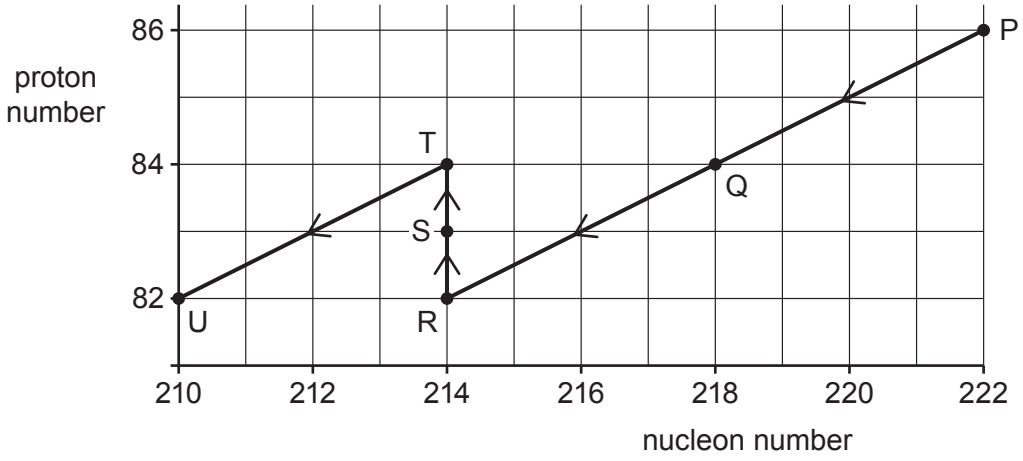


Fig. 7.1

(a) (i) State two points on Fig. 7.1 which represent isotopes of the same element.

..... [1]

(ii) Different isotopes of the same element have different atomic compositions.

State how the composition of their atoms is different.

.....

..... [1]

(b) A nucleus of radon-222 emits an alpha-particle as it decays.

(i) The radioactive decay of a single nucleus is random.

Explain what is meant by the *random* radioactive decay of a nucleus.

.....

.....

..... [1]

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(ii) In nuclide notation, radon-222 is written as $^{222}_{86}Rn$.

When a nucleus of radon-222 emits an alpha-particle (α), it decays to an isotope of polonium (Po).

Complete the decay equation below for this decay.

$$^{222}_{86}Rn \rightarrow \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix} Po + \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix} \alpha$$

[2]

(c) (i) State the name of the particle emitted as a nucleus of R decays to a nucleus of S.

..... [1]

(ii) Describe the change in the composition of a nucleus of R as it decays to a nucleus of S.

.....

.....

..... [2]

[Total: 8]

Section B

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

8 Fig. 8.1 shows the circuit diagram of a temperature gauge. It contains an ammeter, a thermistor, a fixed resistor R and a battery.

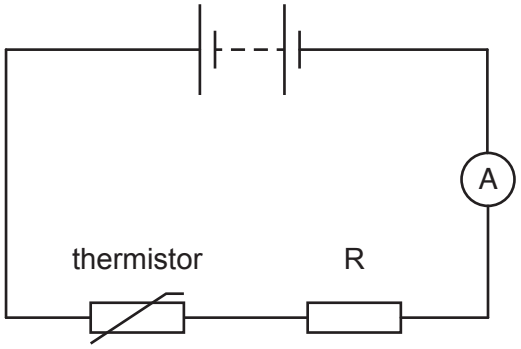


Fig. 8.1

The current is measured at different temperatures and a graph of the results is shown in Fig. 8.2.

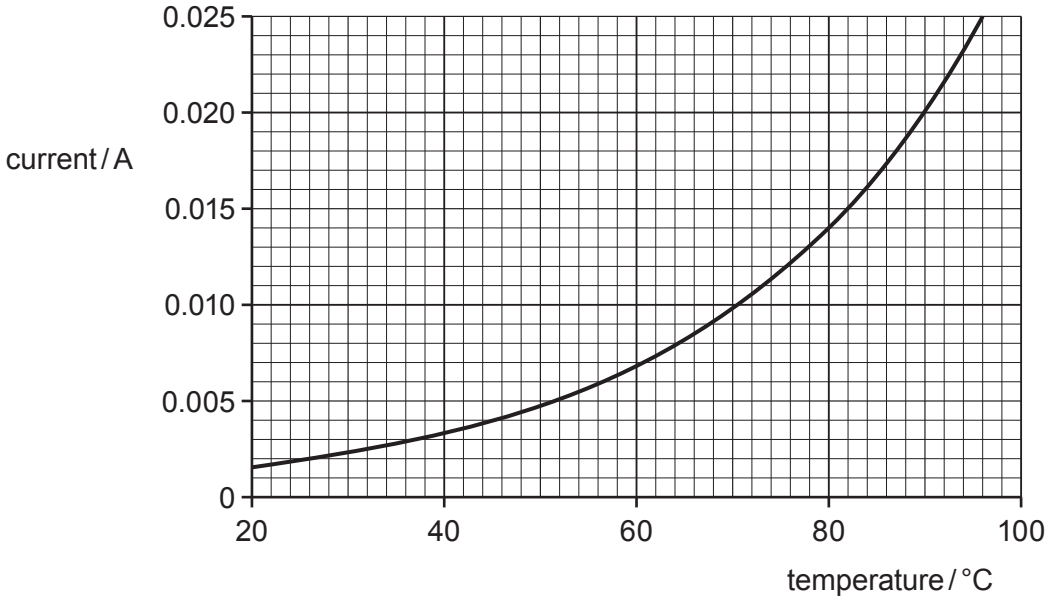


Fig. 8.2

(a) (i) State how the resistance of the thermistor changes with temperature and explain how Fig. 8.2 shows this change.

.....

.....

..... [2]

(ii) Resistance and current are used for the measurement of temperature.

State **one** other physical property that is used for the measurement of temperature.

.....

..... [1]

(b) A temperature scale involves the use of fixed points.

State what is meant by:

(i) *the ice point*

.....

..... [1]

(ii) *the steam point*.

.....

..... [1]

(c) At 80 °C, the potential difference (p.d.) across the thermistor is 3.6 V.

(i) State what is meant by *potential difference*.

.....

..... [1]

(ii) Calculate the resistance of the thermistor when the temperature is 80 °C.

resistance = ... [3]

(iii) The electromotive force (e.m.f.) of the battery is 25 V.

Calculate the resistance of the resistor R.

resistance = ... [2]

(d) The current scale on the ammeter is linear.

Using values from Fig. 8.2, a student marks the scale on the ammeter with temperature values that correspond to the values of the current.

The temperature is then read directly from the temperature scale on the ammeter.

(i) State what is meant by a *sensitive* thermometer.

.....

.....

..... [1]

(ii) State and explain at which temperatures this thermometer is most sensitive.

.....

.....

.....

..... [2]

(e) The temperature gauge is used to measure the temperature of a room.

Suggest why the temperature obtained using the gauge is slightly higher than the actual temperature of the room.

.....

..... [1]

[Total: 15]

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9 **(a)** Fig. 9.1 shows a simple relay used to switch a mains electric motor on and off.

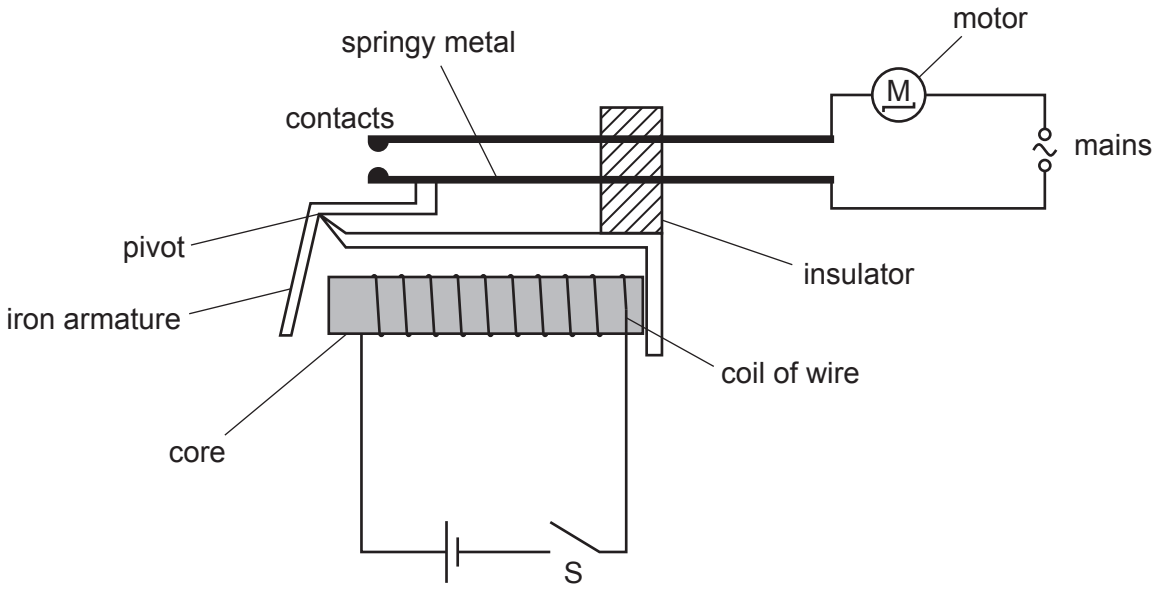


Fig. 9.1

(i) Explain why the motor switches on when switch S is closed.

.....

.....

.....

..... [3]

(ii) Explain why the core is made of iron rather than steel.

.....

.....

..... [2]

(iii) A student suggests that the motor can be turned on and off without a relay.

He suggests connecting the mains to a simple switch in series with the motor.

Suggest **one** reason why, in some situations, using the relay is better.

.....

..... [1]

(b) Fig. 9.2 shows the coil of wire wrapped around a cardboard tube. There is no core.

There is an electric current in the wire in the direction shown by the arrows.

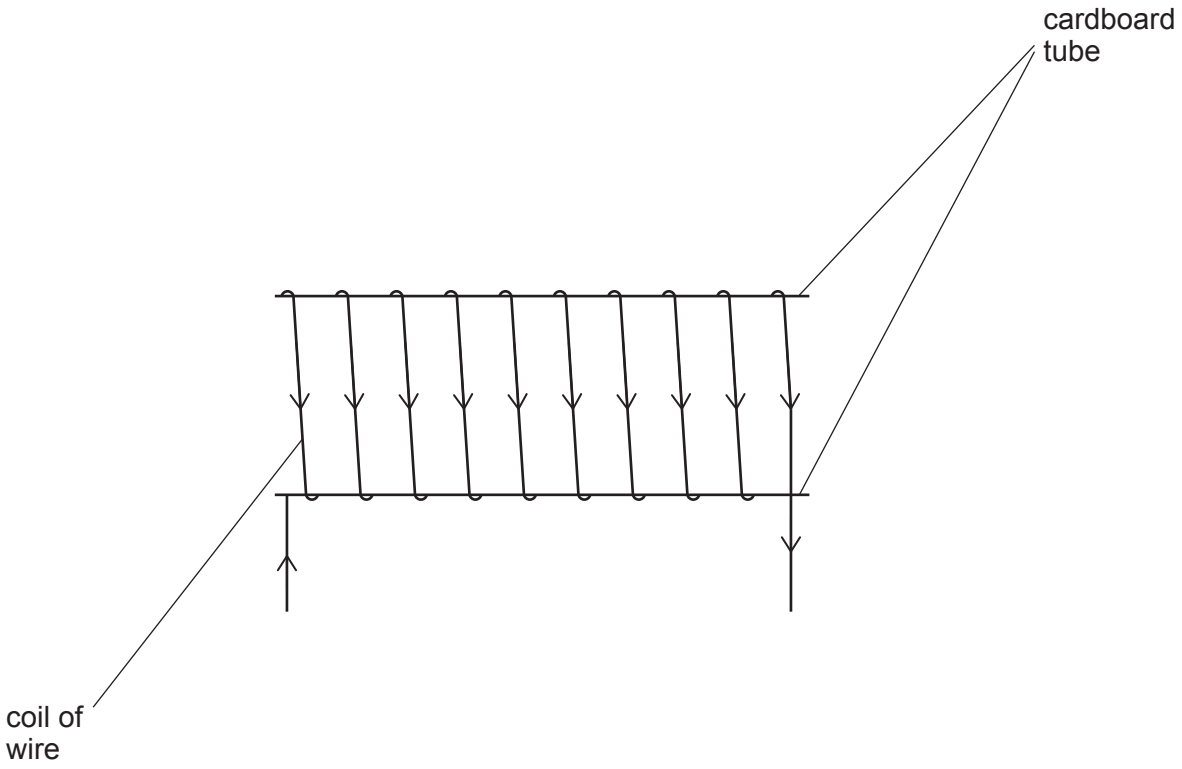


Fig. 9.2

(i) On Fig. 9.2, draw the pattern of the magnetic field inside and around the coil. Mark the direction of this magnetic field. [4]

(ii) On Fig. 9.2, mark the N-pole of the coil. [1]

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(c) The supply of current to the coil is removed.

The ends of the coil are connected to a sensitive ammeter, as shown in Fig. 9.3.

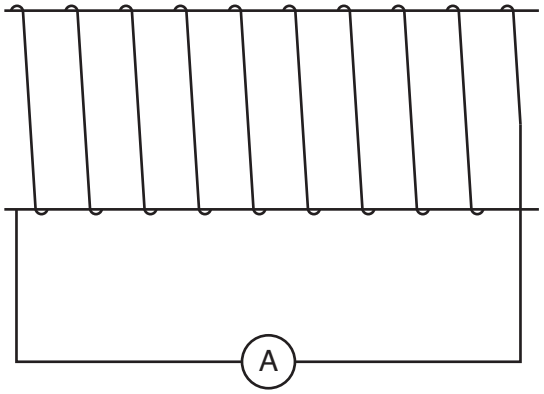


Fig. 9.3

(i) Describe **how** a permanent magnet is used to produce a **large** reading on the ammeter.

.....

.....

.....

..... [2]

(ii) Explain **why** a current is produced in **(i)**.

.....

.....

..... [2]

[Total: 15]

10 An oscilloscope is a device used to display waveforms.

(a) Inside the oscilloscope, a beam of electrons is emitted from a metal filament by thermionic emission.

The emitted electrons are accelerated away from the filament by a potential difference of 2000 V.

(i) State what must happen to the metal filament for thermionic emission to occur.

.....

..... [1]

(ii) Explain why the electrons accelerate away from the filament.

.....

.....

..... [1]

(iii) The charge on one electron is 1.6×10^{-19} C.

Calculate the maximum kinetic energy of one electron after it has been accelerated through 2000 V.

kinetic energy = ... [2]

(b) Fig. 10.1 is the trace on the screen of the oscilloscope.

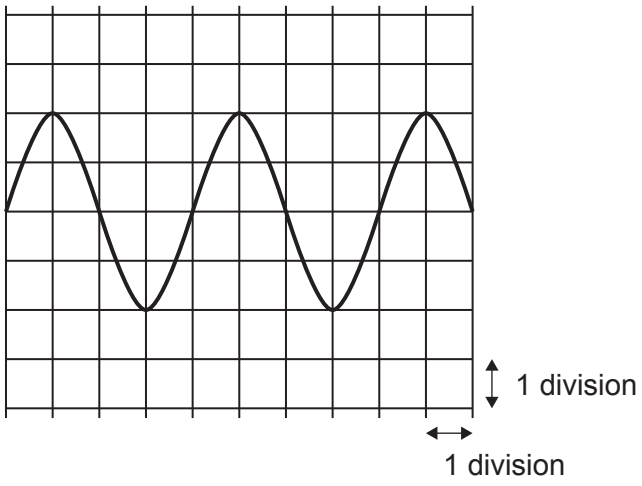


Fig. 10.1

The settings on the oscilloscope are 10 ms / division for the *x*-axis and 3.0 V / division for the *y*-axis.

(i) Calculate the amplitude of the trace shown in Fig. 10.1.

amplitude = ... [2]

(ii) Calculate the time for one oscillation (complete wavelength) of the trace shown in Fig. 10.1.

time = ... [1]

(c) The trace shown in Fig. 10.1 is caused by a sound.

The sound travels through the air to a microphone from the place that it is made. The microphone is connected to the oscilloscope which displays the waveform shown.

(i) Sound is a type of wave.

State which type.

..... [1]

(ii) Describe the motion of the air molecules as the sound passes through the air to the microphone.

.....

.....

..... [2]

(iii) Describe and explain how the trace on the screen changes as the pitch of the sound becomes higher. The settings on the oscilloscope are unchanged.

.....

.....

..... [2]

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(d) A student investigates what happens when a diode is connected between the microphone and the oscilloscope.

Fig. 10.2 shows the circuit that he uses.

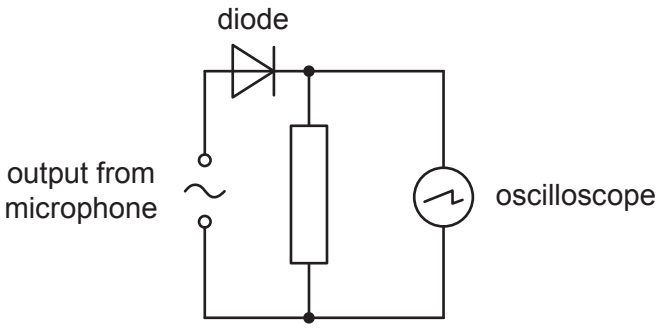


Fig. 10.2

Without the diode, the output from the microphone is an alternating current and the trace is as shown in Fig. 10.1 on page 18.

(i) Describe the action of the diode on the current from the microphone.

.....

..... [1]

(ii) On the grid in Fig. 10.3, sketch the trace seen on the screen when the diode is used.

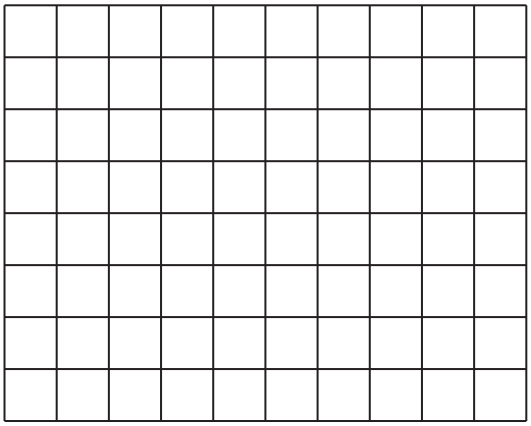


Fig. 10.3

[2]

[Total: 15]

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