南洋女子中学校
**NANYANG GIRLS' HIGH SCHOOL**
**Preliminary Examination 2022**
**Secondary Four 'O' Level**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |

# PHYSICS 6091/02

Paper 2 **29 Aug 2022, Monday**

**1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, index 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.

**Sections A and B**
Answer **all** questions. Question 13 has a choice of parts to answer.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B. At the end of examination fasten all your work securely together.
The number of marks is given in the brackets [ ] at the end of each question or part question.

| Examiner's Use | |
|---|---|
| Paper 1 | |
| | |
| Section A | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| Section B | |
| 11 | |
| 12 | |
| 13 | |
| Total | |
| | 120 |
| | % |

## Section A (50 marks)

Write your answers in the spaces provided.

**1** A 30 N block is suspended from a ceiling with two cables, $C_1$ and $C_2$, as shown in Fig. 1.1.

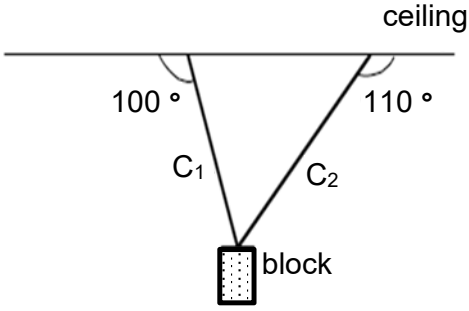


**Fig. 1.1**

**(a)** On Fig. 1.1, draw and label the forces acting on the block. [1]

**(b)** With the aid of a scale diagram, determine the magnitude of the forces acting along $C_1$ and $C_2$.

magnitude of force along $C_1$ = .....

magnitude of force along $C_2$ = ..... [3]

**2** A children's ride consists of a steel cable running between two posts of different heights as shown in Fig. 2.1.

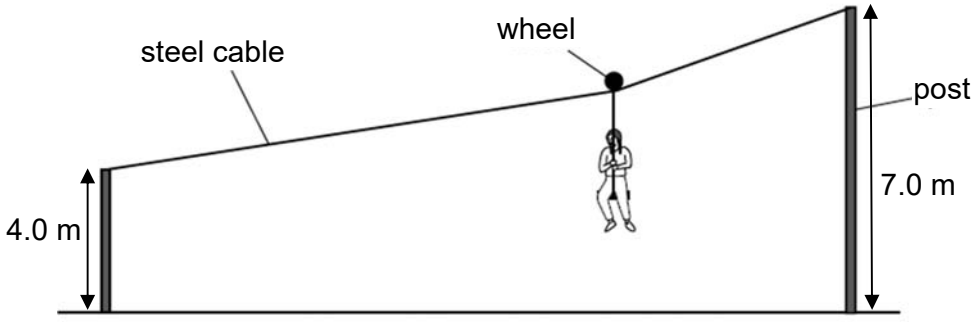


**Fig. 2.1**

A girl starts the ride from rest at the higher post. Her horizontal motion has an initial uniform acceleration for 3.0 s followed by a constant speed of 2.4 m/s for a further 5.0 s before coming to rest at the lower post after decelerating for the last 1.0 s.

**(a)** What does *uniform acceleration* mean?

.....

..... [1]

**(b)** On Fig. 2.2, draw a speed-time graph for the horizontal motion of the girl.

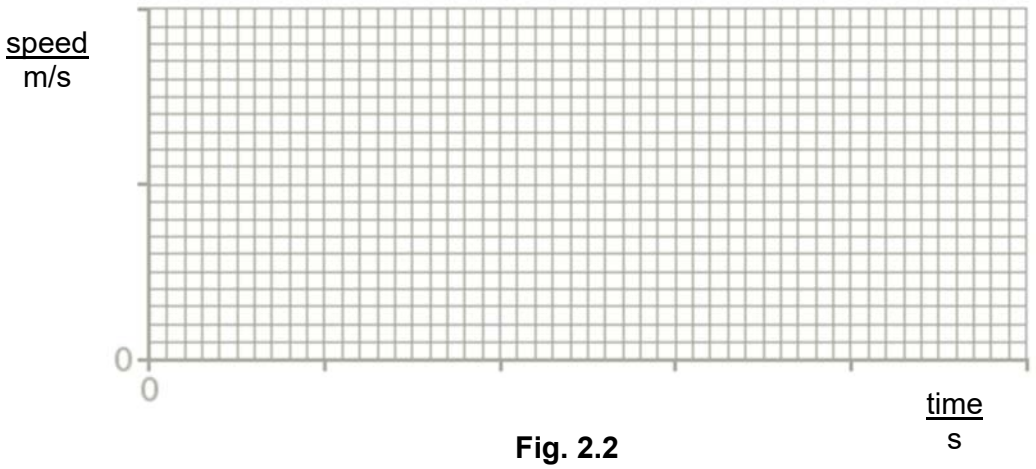


**Fig. 2.2**

[2]

**(c)** Calculate

**(i)** the horizontal distance travelled by the girl,

horizontal distance = ..... [2]

**(ii)** the average horizontal speed for the whole ride.

average speed = ..... [1]

**(d)** If conservation of gravitational potential energy and kinetic energy of the girl is assumed, calculate the speed of the girl when she reaches the lower post.

speed = ..... [2]

**3** A student wishes to confirm the density of an aluminum rod, given as 2.7 g/cm$^3$.
She measures the mass of the rod to be 86.4 g.
She then places the rod into a measuring cylinder filled with 40 cm$^3$ of water.

**(a)** If the given density of aluminum is true, determine the final reading on the measuring cylinder when the rod is fully immersed in the water.

final reading on measuring cylinder = ..... [2]

**(b)** State how the density of the rod will change if the rod is placed in hot water.

..... [1]

**4** Fig. 4.1 shows a system for raising a piece of metal weighing 2000 N. The piece of metal is freely pivoted at A.

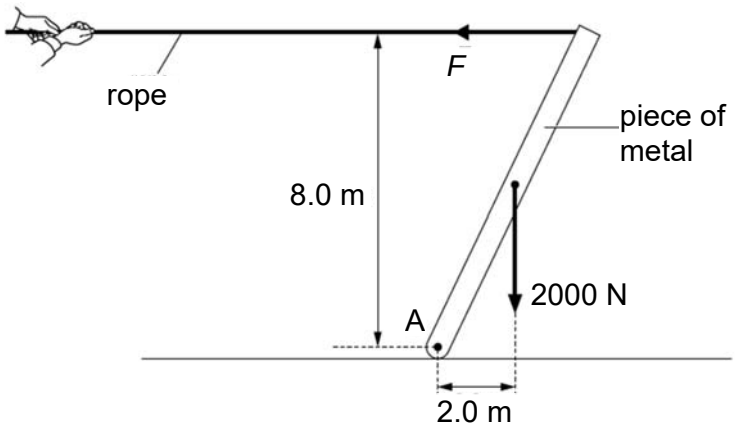


**Fig. 4.1**

A man pulls on the rope with a force *F* and keeps the piece of metal in equilibrium in the position shown in Fig. 4.1.

**(a)** By taking moments about A, calculate the force *F*.

*F* = ..... [2]

**(b)** As the piece of metal rotates anti-clockwise, explain how the force required to keep the piece of metal in equilibrium changes.

.....

.....

.....

.....

..... [2]

**5** A water wave passes a floating log as shown in Fig. 5.1.

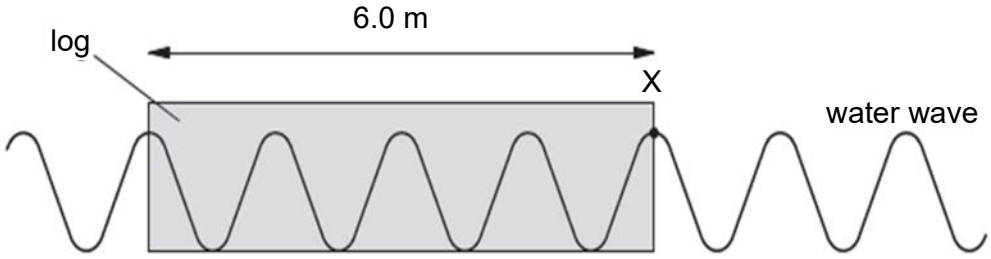


**Fig. 5.1**

The log is 6.0 m long and 5 complete waves pass the end X of the log in 12.5 s.

**(a)** Describe how the motion of the water particles tells us that the water wave is a transverse wave.

.....

.....

..... [1]

**(b)** Determine

**(i)** the wavelength of the wave,

wavelength of the wave = ..... [1]

**(ii)** the frequency of the wave,

frequency of the wave = ..... [1]

**(iii)** the speed of the wave.

speed of the wave = ..... [2]

**6** Fig. 6.1 below shows a **scaled** diagram of a laboratory thermometer L. The scale in °C is marked and a temperature reading of 28 °C is marked $T_L$.

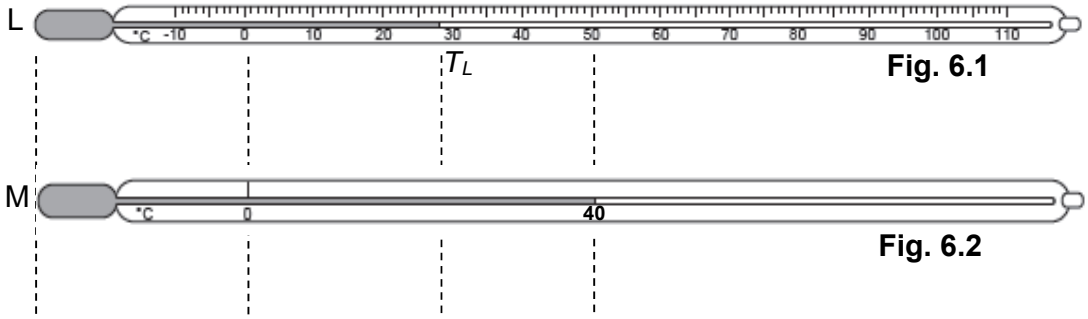


**Fig. 6.1**

**Fig. 6.2**

**(a)** State the thermometric property for the thermometer shown in Fig. 6.1.

.....

[1]

**(b)** Thermometer M is similar to L but has a different scale. The 50 °C mark on L corresponds to the 40 °C mark on M as shown in Fig. 6.2.
Mark on thermometer M in Fig. 6.2, the position of the thread when the temperature is $T_L$. Label this position $T_M$.
Show your working to determine the position of $T_M$ in the space below.

[2]

**(c)** When thermometer L is placed into a beaker of boiling water, the reading shows 100 °C as the water continues to be heated.
Explain why the temperature does not rise although the water continues to be heated.

.....

.....

.....

.....

.....

.....

[2]

**7** Fig. 7.1 shows the top view of a shop floor. A shop staff at P monitors the display counter behind a wall using a plane mirror.

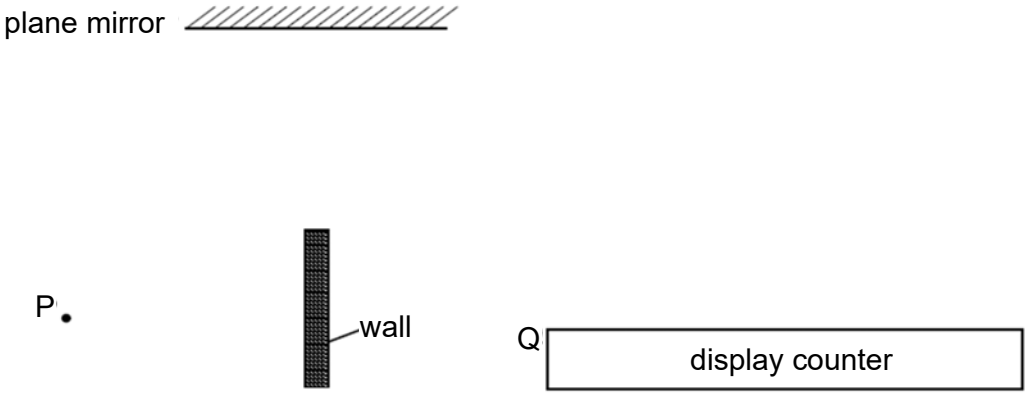


**Fig. 7.1**

Answer the following questions on Fig. 7.1.

**(a)** Locate the image of the corner of the display counter, Q in the plane mirror. Label the image R. [1]

**(b)** Draw one light ray to show how an eye at P is able to see R. [1]

**(c)** The plane mirror is too short to allow a staff at P to monitor the entire display counter. Draw one light ray to determine the minimum length of mirror required to monitor the entire display counter. Label the extension EF. [2]

**8** Fig. 8.1 below shows a home-made lightning alert device. It consists of two metal bells, A and B, which are mounted on insulating stands. An uncharged light metal sphere on the end of a nylon thread is free to swing about the point O. The bell B is connected to Earth.

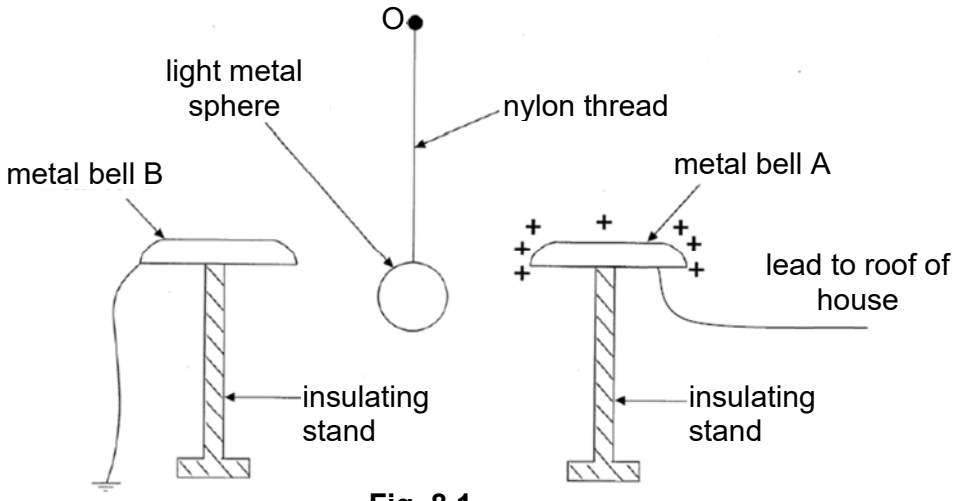


**Fig. 8.1**

When a thundercloud is near, bell A becomes positively charged. The sphere then swings between A and B, striking the bells and causing them to ring.

**(a)** Explain why the metal sphere moves towards A when a thundercloud is near.

.....

.....

.....

.....

..... [2]

**(b)** A typical lightning discharge has a current of 30 kA and takes an average time of 0.20 s to discharge.
Calculate the amount of charge in a lightning flash.

amount of charge = ..... [2]

**9** Fig. 9.1 is a circuit diagram showing a 12 V e.m.f. source connected to resistance wires, P and Q, and a fixed resistor. The resistances of P and Q are 18 Ω and 30 Ω respectively.

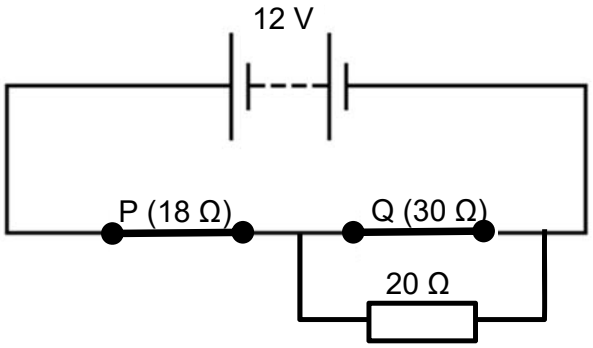


**Fig. 9.1**

**(a)** Explain what is meant by *electromotive force*.

.....

..... [1]

**(b)** Calculate

**(i)** the effective resistance of the circuit,

effective resistance = ..... [2]

**(ii)** the potential difference across the 20 Ω resistor,

potential difference = ..... [2]

**(iii)** the current through the 20 Ω resistor,

current = ..... [2]

**(c)** The two resistance wires in the circuit are made of material of the same resistivity. The ratio of the cross-sectional areas of P:Q = $A_P$:$A_Q$ = 2:3. Determine the ratio of their lengths $L_P$:$L_Q$.

ratio of the lengths $L_P$:$L_Q$ = ..... [2]

**10** Fig. 10.1 below shows a simple d.c. motor. The coil rotates clockwise.

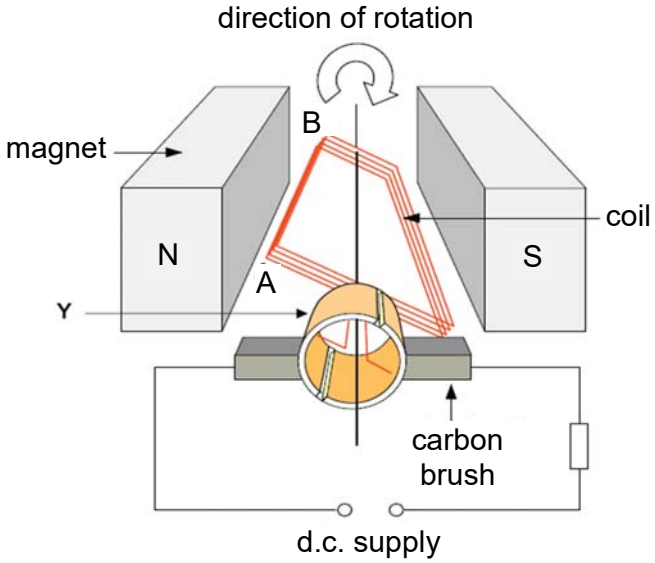


**Fig. 10.1**

**(a)** On Fig. 10.1, mark the direction of the current along side AB of the coil. [1]

**(b)** **(i)** Identify the part labelled Y.

.....

[1]

**(ii)** Explain how Y enables the coil to rotate continuously in one direction.

.....

.....

.....

.....

..... [2]

## Section B (30 marks)

Write your answers in the spaces provided.

**11** One type of parking lot sensor makes use of an ultrasonic system. The sensor has an ultrasound transmitter and a receiver. The sensor is connected to an indicator light which shows red if a parking lot is occupied and green if it is available.

Fig. 11.1 shows the set-up for one such sensor. The transmitter sends a pulse of ultrasound downwards and the receiver detects the ultrasound after it is reflected up. The reference value is height of the sensor from the parking lot floor and the tolerance value allows for changes in the reference value e.g. due to unevenness on the floor.

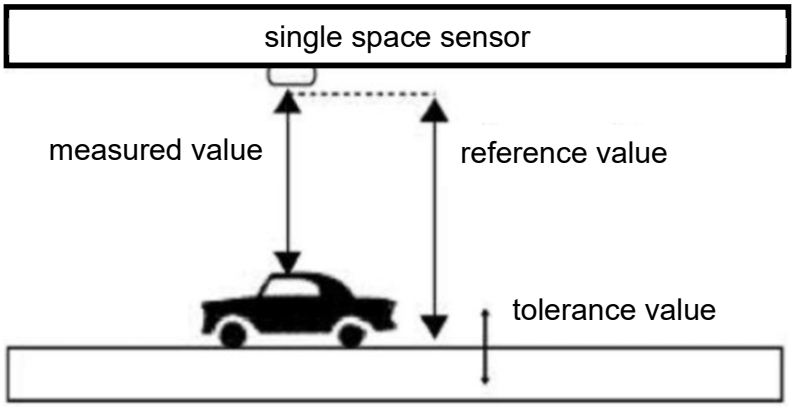


**Fig. 11.1**

**(a)** What is ultrasound?

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--- [1]

**(b)** What is an advantage of using ultrasound for such sensors?

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--- [1]

**(c)** Ultrasound signals are emitted from the transmitter every 50 ms. Fig. 11.2 shows the energy of the emitted signals from the transmitter and their reflected signals over a period of time for one of the parking lots.

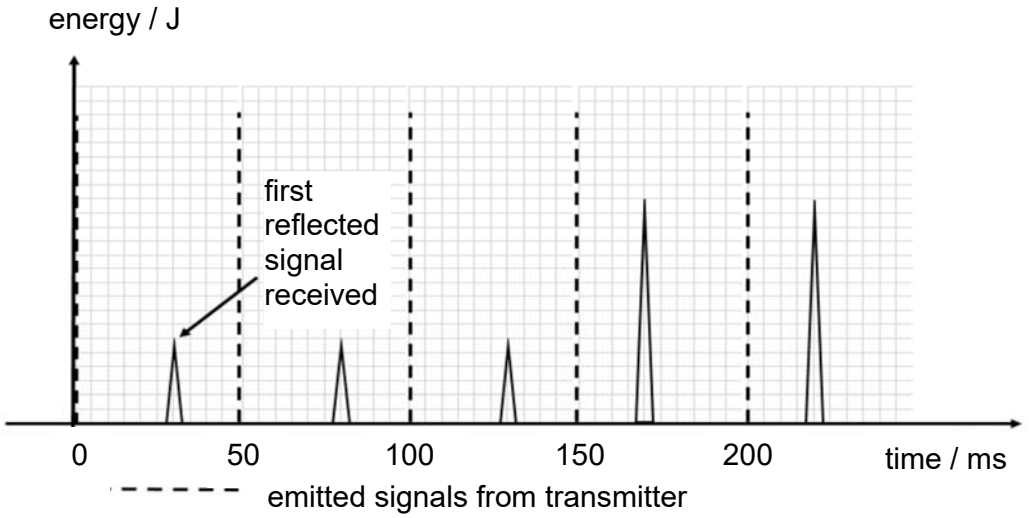


**Fig. 11.2**

**(i)** State the time at which the receiver first detects a vehicle in the lot.

time vehicle is first detected = ..... [1]

**(ii)** Explain two differences in the received signals when the parking lot is vacant and when it is occupied.

.....

.....

.....

.....

..... [3]

**(iii)** The speed of sound in air is 340 m $s^{-1}$ and the frequency of the ultrasound emitted by the transmitter is 25 kHz.
Calculate the distance between the top of the vehicle and the sensor.

distance = ..... [2]

**(iv)** If the system is now set up underwater, state one change in the graph shown in Fig. 11.2.

.....

.....

..... [1]

**(d)** Suggest a reason why this ultrasound system may not be suitable for an open air carpark, even if the set-up is weatherproof.

.....

.....

..... [1]

**12** Fig. 12.1 shows a compass. When no magnet is close by, the compass needle points to the Earth's north.

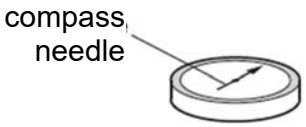


**Fig. 12.1**

**(a)** Two such compasses are now placed near a bar magnet as shown in Fig. 12.2. On the two compasses, draw the compass needles with their directions clearly shown.

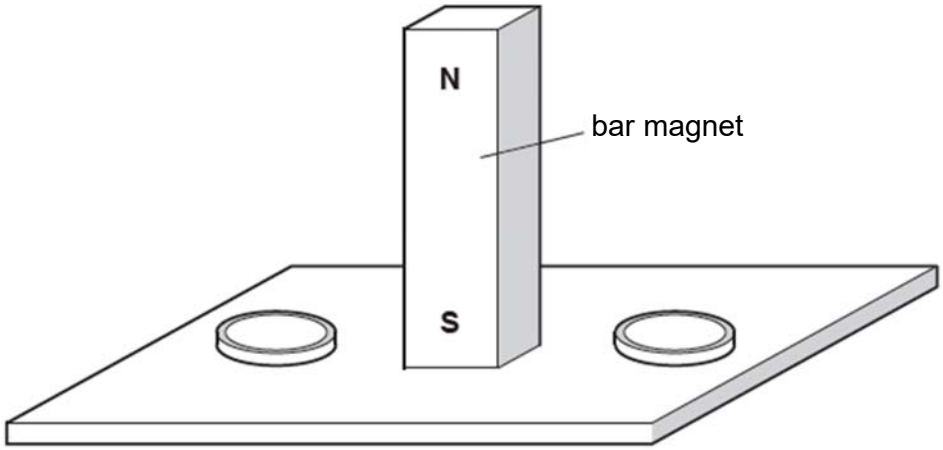


**Fig. 12.2**

[2]

**(b)** The structure of a relay is shown in Fig. 12.3. Closing the switch in the circuit will close the contacts to a secondary circuit (not shown).

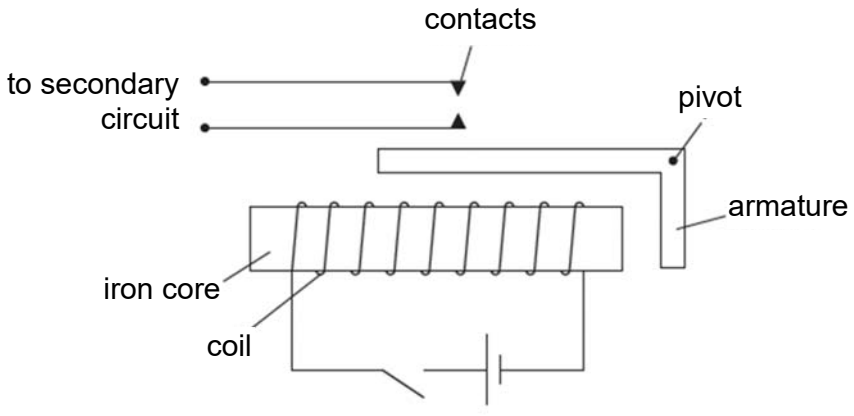


**Fig. 12.3**

**(i)** Explain how closing the switch will close the contacts.

.....

.....

.....

.....

.....

.....

..... [3]

**(ii)** Suggest a material to be used for the armature and explain your choice of material.

.....

.....

.....

..... [2]

**(iii)** Suggest one advantage of using a relay to switch on a secondary circuit.

.....

.....

..... [1]

**(iv)** To strengthen the effect of the iron core and coil, a suggestion is made to use two iron cores. Complete Fig. 12.4 to show how you would complete the circuit. The original iron core and coil is drawn for you.

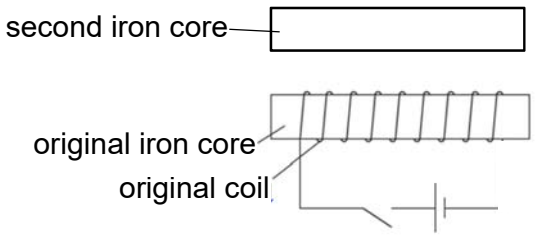


**Fig. 12.4** [2]

**13 EITHER**

The main parts of an electric grill are shown in Fig. 13.1. An electric current in the heating element causes it to glow red hot.

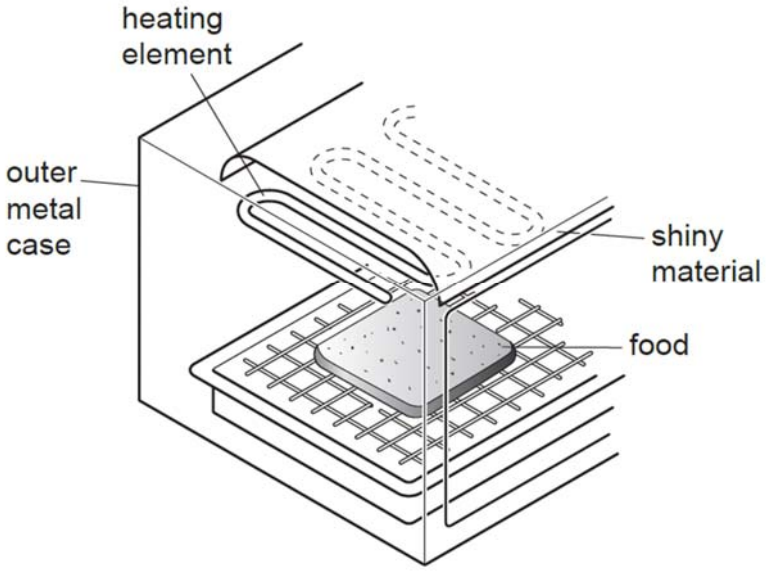


**Fig. 13.1**

**(a)** Name the type of electromagnetic radiation responsible for cooking the food.

.....[1]

**(b)** A layer of shiny material is placed between the heating element and the top of the metal case of the grill. Explain one way in which it improves the function or design of the electric grill.

.....

.....

.....

.....

.....

.....[2]

**(c)** When the grill is plugged into a 230 V mains supply and turned on, a current of 8.3 A flows in the circuit.

**(i)** Complete Table 13.1 to indicate the voltage and current in the live, neutral and earth wires of the circuit of the electric grill when it is on.

| | voltage / V | current / A |
|---|---|---|
| live wire | | |
| neutral wire | | |
| earth wire | | |

[2]

**Table 13.1**

**(ii)** The earth wire is a safety feature in household mains supply. Explain how the earth wire in the electric grill works as a safety device.

.....

.....

.....

.....

.....

..... [2]

**(iii)** Calculate the power rating of the electric grill when it is working normally.

power rating = ..... [2]

**(iv)** State the effect of connecting the electric grill to a 115 V mains supply.

.....

..... [1]

**OR**

Two coils of insulated wire are wound round an iron ring as shown in Fig. 13.2. Coil P is connected to a d.c. source and a switch. The switch is open. Coil S is connected to a sensitive centre-zero galvanometer.

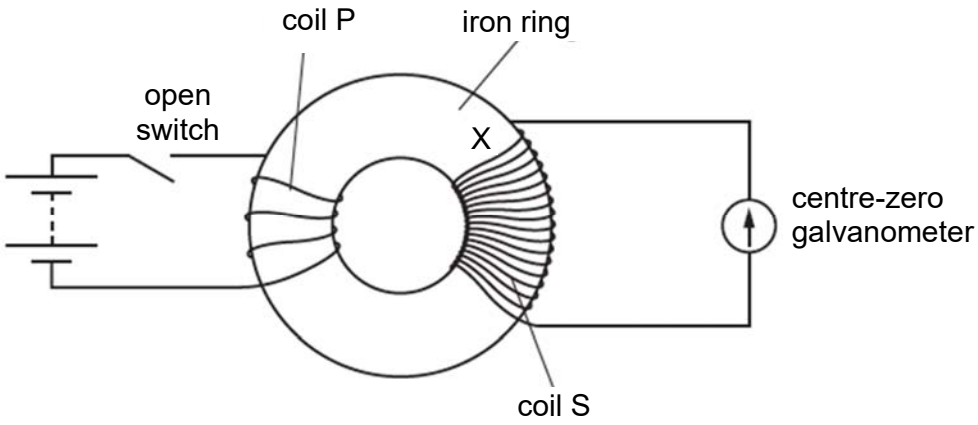


**Fig. 13.2**

The switch is closed.

**(a)** On Fig. 13.2,

**(i)** mark the direction of the current in coil P, [1]

**(ii)** draw the magnetic field pattern in the iron ring, [2]

**(iii)** determine the momentary magnetic pole set up at end X of coil S. [1]

**(b)** As the switch is closed, the galvanometer deflects to the right and then returns to zero.

**(i)** Explain why there is a deflection on the galvanometer.

.....

.....

.....

..... [2]

**(ii)** The switch is opened. State and explain what happens to the deflection on the galvanometer.

.....

.....

.....

..... [2]

**(iii)** Without changing coil P, state two changes to the apparatus that will cause a greater deflection on the galvanometer.

1. .....

.....

2. .....

..... [2]

**End of Paper**

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