Paper 2A	☐ s.f. ☐ formula	70

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS **6091/02**

Paper 2 Structured and Free Response

29 August 2025
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black link.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For examiner's use only:

Section A	/ 70
Section B	/ 10
Total	**/ 80**

Overall	Marks	%
Paper 1	40	30%
Paper 2A	70	50%
Paper 2B	10	
Paper 3	40	20%

Section A

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

1 A ball is released from rest above the ground. Fig. 1.1 shows the variation with time of the velocity of the ball.

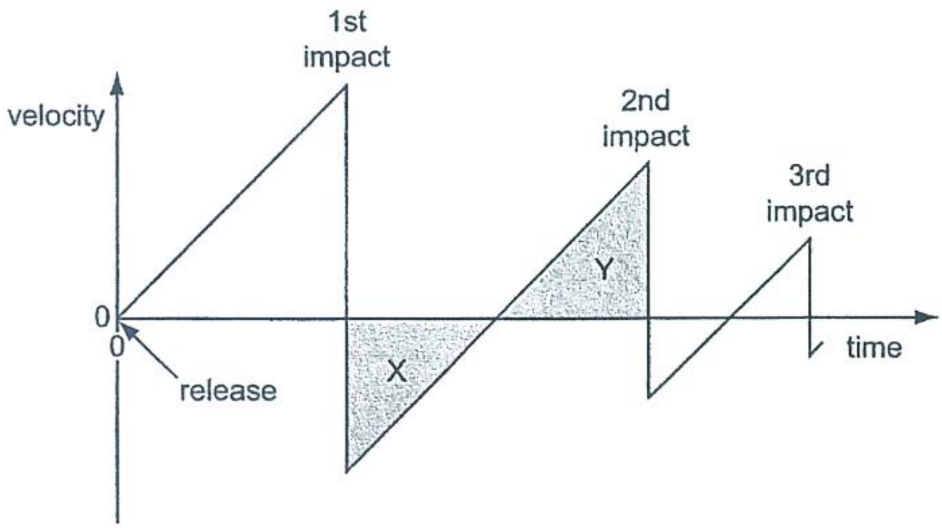

Fig. 1.1

(a) **(i)** State the gradient of the graph (with units) from t = 0 s to the time of the ball's first impact with the ground.

.... [1]

(ii) Describe the motion of the ball from t = 0 s to the time the ball reaches its maximum height after its **first** impact with the ground.

....

....

....

.... [2]

(iii) Explain why areas X and Y are equal.

....

.... [1]

(b) The ball is subsequently released from rest the same distance above the ground, but with significant air resistance. The ball does **not** reach its terminal velocity during its motion.

(i) Sketch, on Fig. 1.1, the variation of the velocity of the ball with time from t = 0 s to the time of the ball's **first** impact with the ground.

[1]

(ii) Explain, in terms of forces acting, why the velocity of the ball varies as sketched in **(b)(i)**.

....

....

.... [2]

2 Fig. 2.1 shows the position of a person's teeth (comprising incisors and molars), and his masseter muscle used to move the lower jawbone.

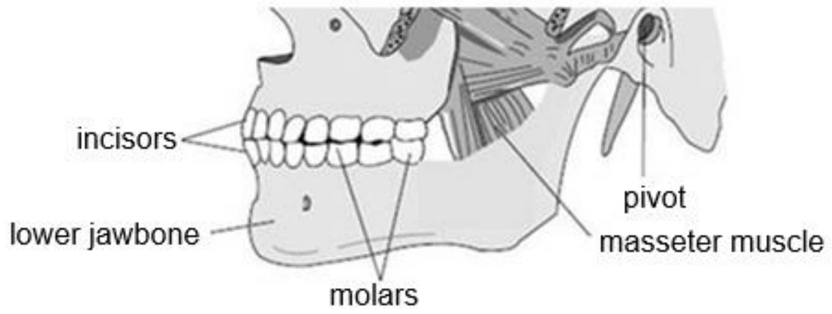

Fig. 2.1

Fig. 2.2 shows a simplified model of the lower jawbone of negligible mass. The model consists of two straight parts of length 7.0 cm and 4.0 cm, making an angle of 50° to each other. During one particular bite of a piece of food, a downward force of 45 N is applied on the incisors at the front of the lower jawbone, while an upward muscle force *F* is exerted by the masseter muscle at the back of the lower jawbone.

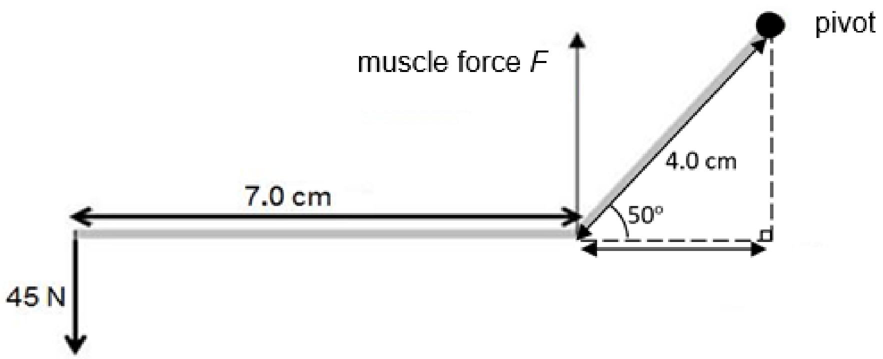

Fig. 2.2

(a) The lower jawbone is in equilibrium.

Determine the magnitude of the muscle force *F* applied by the masseter muscle.

magnitude of muscle force *F* = ... [2]

(b) Hence, determine the magnitude and direction of the force applied on the pivot.

magnitude of force on pivot = ...

direction = ... [2]

(c) Suggest, for the same moment created by the jawbone, why the molars used for crushing hard food are found at the back, rather than the front of the jaw.

....

....

....

.... [2]

(d) Incisors are sharper than molars. Using concepts of pressure, suggest why incisors are used for cutting meat rather than molars for the same force exerted by incisors and molars.

....

....

.... [2]

3 A hot steel rod is cooled by plunging it into cold water, as shown in Fig. 3.1.

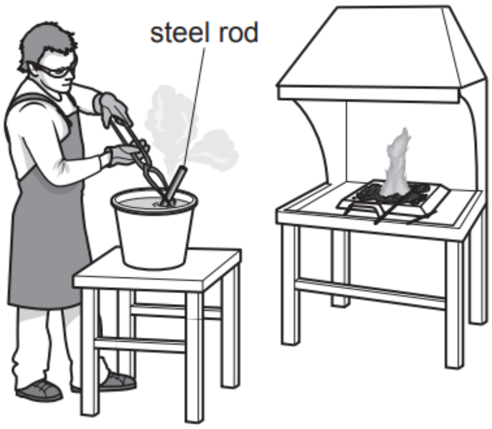

Fig. 3.1

(a) The steel rod has a mass of 2.0 kg and is initially at a temperature of 500 °C. It cools to 50 °C when placed in the water.

The specific heat capacity of steel is 460 J / (kg °C).

(i) State what is meant by *specific heat capacity*.

....

....

.... [2]

(ii) Calculate the energy transferred by heating from the steel rod to the water as it cools to 50 °C. Assume no energy is transferred to the surrounding air during this process.

energy transferred = ... [2]

(b) When the water and the steel rod are at a temperature of 50 °C, energy is subsequently transferred from the water to the air above it by a convection current.

Describe how the convection current is produced in the air.

....

....

....

.... [3]

4 Fig. 4.1 is a full-scale diagram that represents a sound wave of frequency 5.1 kHz in air. Sound waves are longitudinal waves.

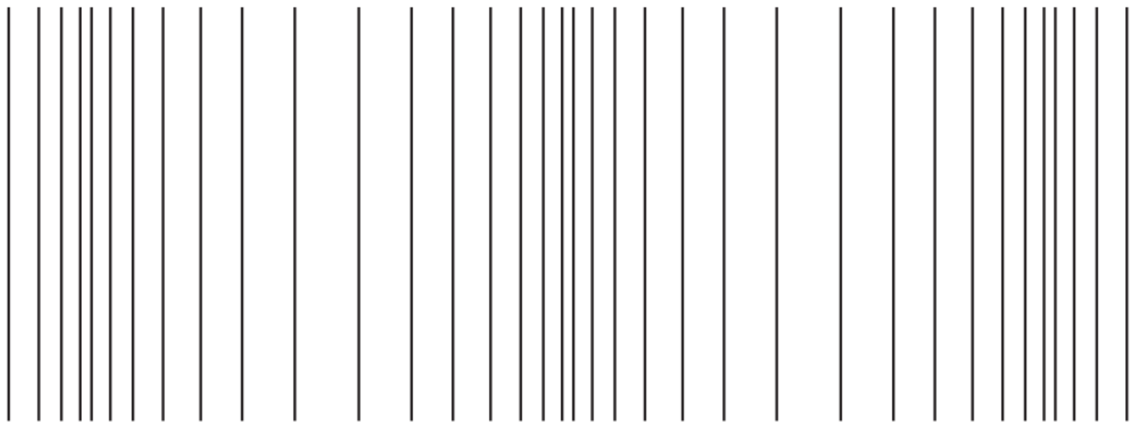

Fig. 4.1

(a) State what is meant by a *longitudinal wave*.

....

.... [1]

(b) **(i)** On Fig. 4.1, mark accurately with a cross, the position of one centre of compression labelled with the letter **C,** and of one centre of rarefaction labelled with the letter **R**.

[2]

(ii) Using the full-scale diagram, measure the wavelength of this sound wave.

wavelength = ... [1]

(iii) Calculate the speed of sound in air.

speed of sound = ... [2]

(c) Both sound and light are waves.

Sound travels faster in glass than in air, but light travels faster in air than in glass.

Explain why this is so.

....

....

....

.... [2]

5 **(a)** The list below contains three components of the electromagnetic (EM) spectrum.

infra-red radiation **gamma rays** **visible light**

(i) Arrange the components in order of increasing wavelength.

.... [1]

(ii) State two properties that these components have in common.

....

.... [2]

(b) Satellites are used in the transmission of television signals, as shown in Fig. 5.1.

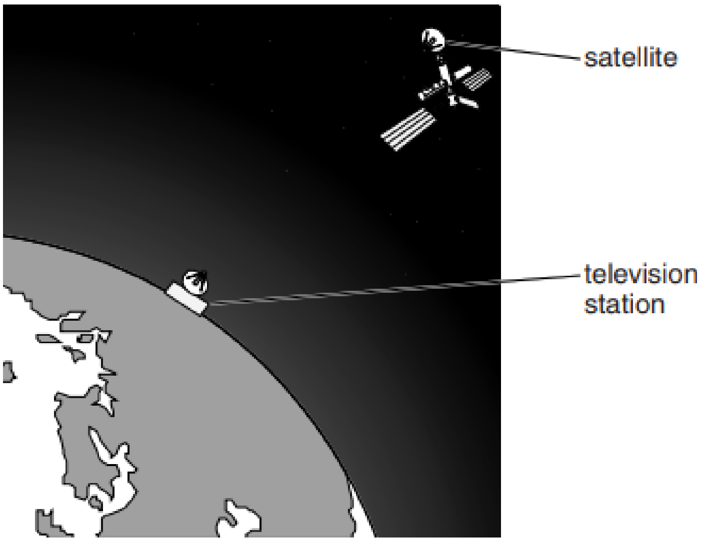

Fig. 5.1

(i) State which component of the EM spectrum is used to transmit the television signal to the satellite.

.... [1]

(ii) State another component of the EM spectrum that is also used to transmit television signals, but without using satellites.

.... [1]

(iii) Suggest one advantage of using a satellite to transmit television signals.

....

.... [1]

6 An object is placed 4.5 cm in front of a thin converging lens of unknown focal length as shown in Fig. 6.1. The image formed is the same size as the object and on the opposite side of the lens from the object.

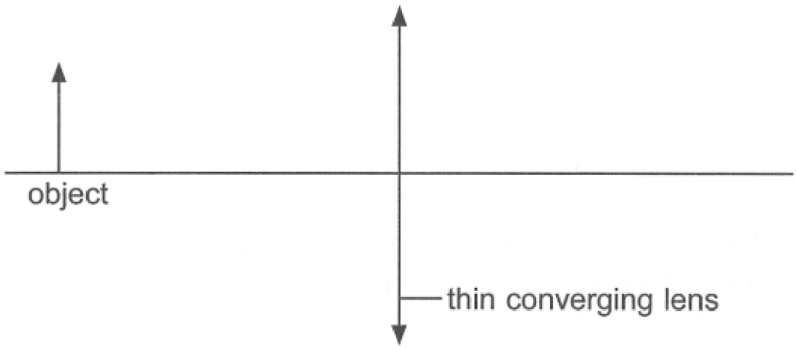

Fig. 6.1

(a) State what is meant by *focal length*.

....

.... [1]

(b) On Fig. 6.1, draw a ray diagram to determine the focal length of the lens. Show any necessary working below.

focal length = ... [3]

(c) Describe how one of the characteristics of the image changes during the following adjustments to the position of the object:

(i) the object distance is decreased from 4.5 cm to 4.0 cm.

....

.... [1]

(ii) the object distance is decreased from 2.0 cm to 1.0 cm.

....

.... [1]

7 A teacher carries out an experiment on radioactivity using the apparatus as shown in Fig. 7.1.

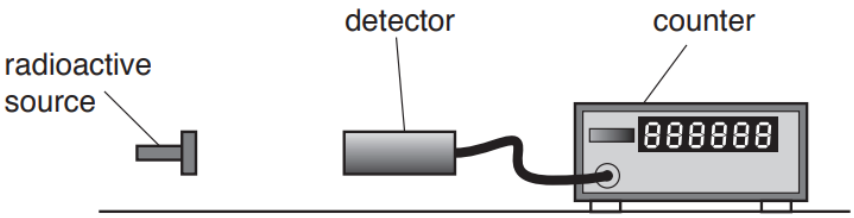

Fig. 7.1 (not to scale)

The count rate is a measurement of the count per minute.

(a) **(i)** State the name of one type of radiation detector.

.... [1]

(ii) State one safety precaution the teacher must take when using a radioactive source.

....

.... [1]

(b) **(i)** State what is meant by *background radiation*.

....

.... [1]

(ii) The teacher measures the count rate due to the source.

Describe how the count rate is corrected for the background radiation.

....

....

.... [2]

(c) The count rate is recorded for various distances *d* between the source and the detector. Fig. 7.2 shows a graph of the results obtained.

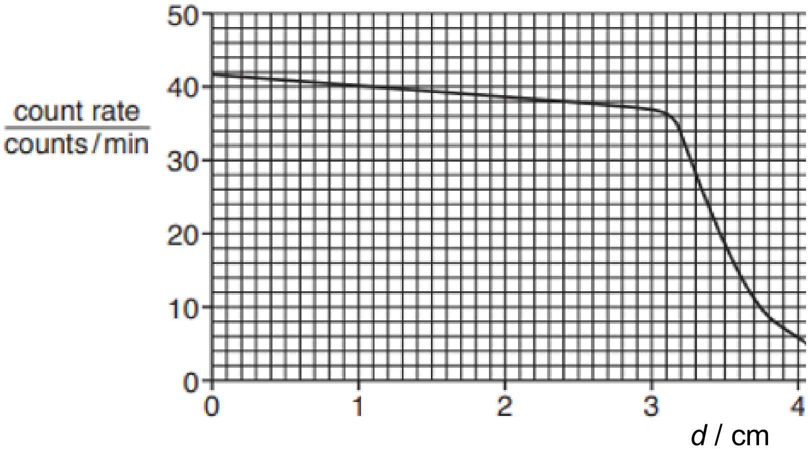

Fig. 7.2

(i) The background radiation is 2 counts / min.

On Fig. 7.2, sketch a graph of the corrected count rate for distances *d* up to 4.0 cm.

[1]

(ii) State and explain the type of radiation emitted by the radioactive source.

....

.... [2]

8 At night, a bright floodlight is used to illuminate a building. The floodlight is a metal filament lamp. It is connected in series with a variable resistor, a 240 V alternating current (a.c.) power supply, a switch and a fuse.

When the floodlight is first switched on, the resistance of the variable resistor is at its maximum value. In the following few minutes, the variable resistor is adjusted so that its resistance decreases slowly to zero. This causes the brightness of the floodlight to increase until it reaches a maximum. At maximum brightness, the current in the floodlight is 12 A.

(a) Draw a circuit diagram with the correct circuit symbols to show the connections between the a.c. power supply, variable resistor, floodlight, switch and fuse.

[2]

(b) Show that the resistance of the floodlight at maximum brightness is 20 Ω.

[1]

(c) State and explain what happens to the resistance of the floodlight as its brightness increases.

....

....

.... [2]

(d) The fuse is removed and the insulation of the live and neutral wires are both damaged. The circuit remains closed.

During an inspection when the switch is still closed, an electrical engineer accidentally causes the exposed live wire and the exposed neutral wire to be in contact in the plug.

State and explain a possible hazard in this scenario.

....

....

.... [2]

(e) At night, there is less light surrounding the building.

An electrical engineer suggested directly replacing the variable resistor with a light-dependent resistor, so that the floodlight becomes brighter at night compared to in the day.

Explain, using potential divider concept, why the electrical engineer's suggestion is not feasible.

....

....

....

.... [3]

9 Motors and generators are important components of modern electrical systems that help to transfer energy between different stores.

(a) Fig. 9.1 shows a rider on an electric scooter.

Fig. 9.1

The scooter contains a battery and a motor to drive the back wheel.

Describe how energy is transferred from the chemical potential store of the battery through the motor to the kinetic store of the scooter.

....

....

.... [2]

(b) Fig. 9.2 shows a typical a.c. generator.

A resistor of resistance 10 Ω is connected across the output terminals. It can be assumed that the resistances of the coil, the slip rings and carbon brushes are negligible.

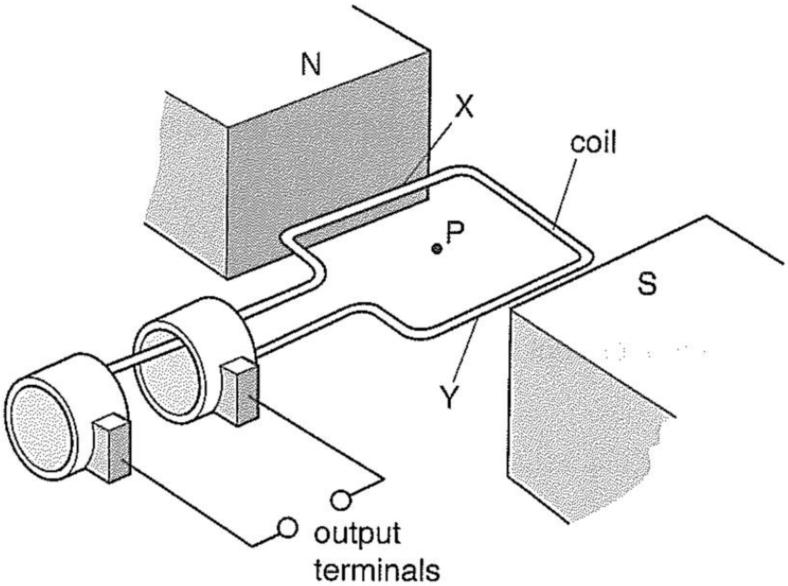

Fig. 9.2

Table 9.1 shows the relationship between the number of revolutions per second of the coil, the maximum induced electromotive force (e.m.f.) V_{max} in the coil and the maximum current I_{max} in the coil.

Table 9.1

number of revolutions per second of coil	V_{max} / V	I_{max} / A
1 000	12	1.15
2 000	24	2.30
3 000	36	3.45

(i) State the relationship between the number of revolutions per second of the coil and V_{max}.

....

.... [1]

(ii) Explain the relationship stated in **(i)**.

....

....

.... [2]

(iii) Explain why the values of I_{max} in Table 9.1 are smaller than the theoretical values of induced current, calculated using V_{max} / R, where R is the resistance of the resistor (10 Ω).

....

....

....

.... [2]

(iv) Describe the difference between the function of a split-ring commutator in a d.c. motor and the function of the slip rings in an a.c. generator.

....

....

....

.... [2]

(v) Fig. 9.3 shows how the output voltage V of the generator varies with time when there are 1 000 revolutions per second of the coil.

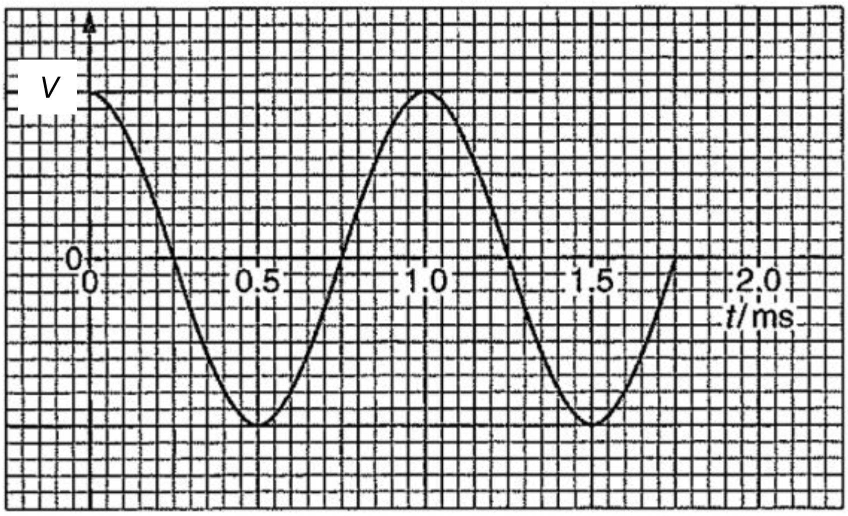

Fig. 9.3

The slip rings in Fig. 9.2 are replaced by a split-ring commutator.

On Fig. 9.3, sketch the variation of the output voltage of the generator with time due to this replacement.

[1]

Paper 2B	☐ s.f. ☐ formula	10

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
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PHYSICS **6091/02**

Paper 2 Structured and Free Response

29 August 2025

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

Section B

Answer only **one** of the two questions.

10 Fig. 10.1 shows a section through a very old bicycle tyre that is made of solid rubber.

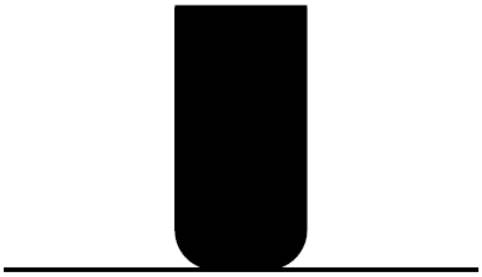

Fig. 10.1

(a) The solid rubber tyre exerts a pressure on the ground.

(i) Define *pressure*.

....

.... [1]

(ii) The mass of the bicycle and rider is 60 kg and the total area of the tyres in contact with the road is 2.4×10^{-3} m^2. The gravitational field strength is 10 N / kg.

Calculate the pressure exerted on the road. Show all necessary working.

pressure = ... [3]

(b) Fig. 10.2 shows a modern tyre that contains air.

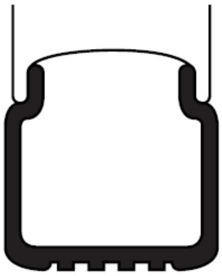

Fig. 10.2

(i) Describe and explain the difference between the motion of the rubber molecules in the old tyre in Fig. 10.1 and the air molecules in Fig. 10.2.

....

....

....

....

.... [3]

(ii) On a hot day, the temperature of the modern tyre increases.

State and explain, using ideas about molecules, what happens to the pressure in the tyre.

....

....

....

.... [3]

11 Electric fields and magnetic fields can be useful or dangerous, depending on the context in which they exert influence on objects.

(a) Fig. 11.1 shows two pieces of soft iron in the magnetic field of a strong permanent magnet.

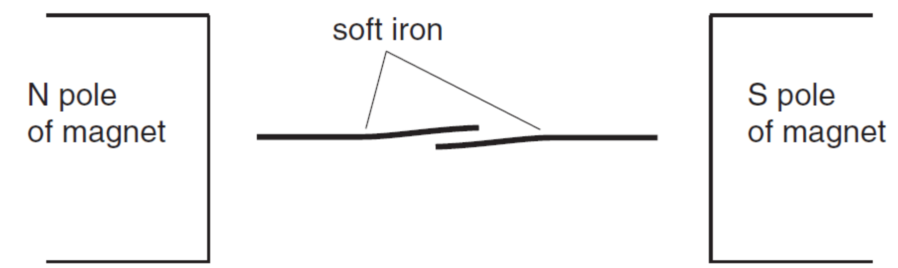

Fig. 11.1

The pieces of soft iron become magnetised.

(i) On Fig. 11.1, mark the magnetic poles produced at each end of both pieces of soft iron.

[1]

(ii) Fig. 11.2 shows a reed switch.

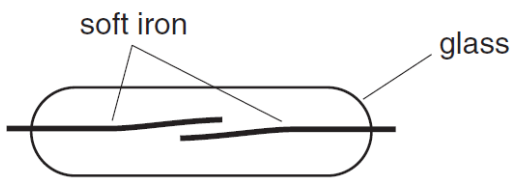

Fig. 11.2

The reed switch is placed between the poles of the strong permanent magnet.

State and explain what happens.

....

....

.... [2]

(iii) Fig. 11.3 shows two separate electrical circuits.

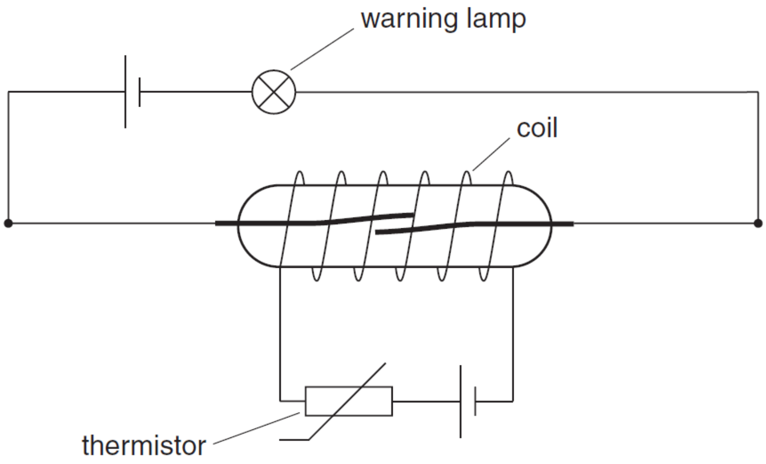

Fig. 11.3

One circuit consists of a reed switch, a cell and a warning lamp. The other circuit consists of a thermistor, another cell, and a coil wound round the reed switch. The thermistor is at the same temperature as the air around it.

1. State what happens to the thermistor when the temperature of the air rises.

.... [1]

2. Explain why the warning lamp lights up when the air temperature rises.

....

....

....

.... [2]

(b) Electrostatic charges can be placed on objects by friction.

(i) State the name of the charged particle that is transferred from one object to another in this process.

.... [1]

(ii) Fig. 11.4 shows petrol being pumped into a can. Electrostatic charges build up on the petrol and the pipe.

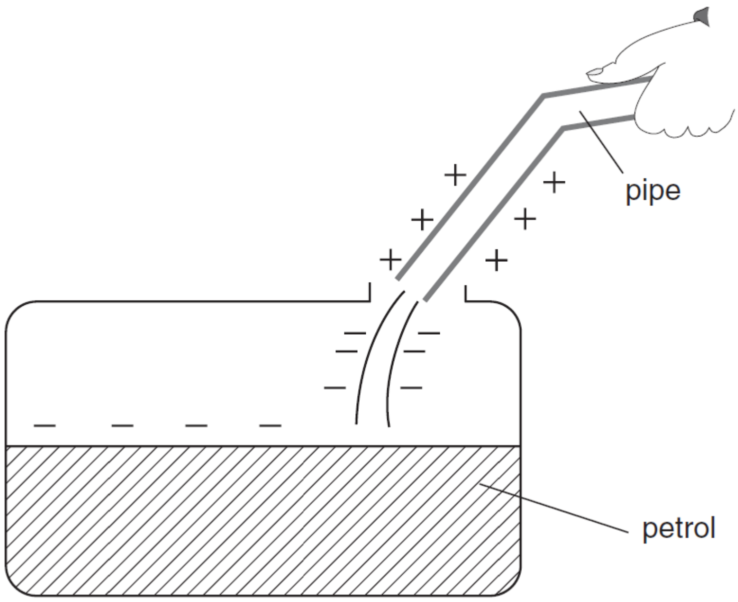

Fig. 11.4

1. Explain why this is dangerous.

....

....

....

.... [2]

2. State what can be done to stop the electrostatic charge building up in this way.

....

.... [1]

--- END OF PAPER ---