Section A	☐ s.f. ☐ formula	50

Name:		Index Number:		Class:	

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

PHYSICS

6091/02

Paper 2 Theory

15 September 2021

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 that you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions.

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 workings in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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.

For examiner's use only:

Section A	/ 50
Section B	/ 30
Total Marks	**/ 80**

Paper	Type of Paper	Marks	Weighting
1	Multiple Choice	40	30 %
2	Theory	80	50 %
3	Practical	40	20 %

Section A

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

1 A rock from space is travelling in a straight line at high speed when it enters the Earth's atmosphere.

Fig. 1.1 is the speed-time graph for the rock from time $t = 0$ to time $t = 50$ s.

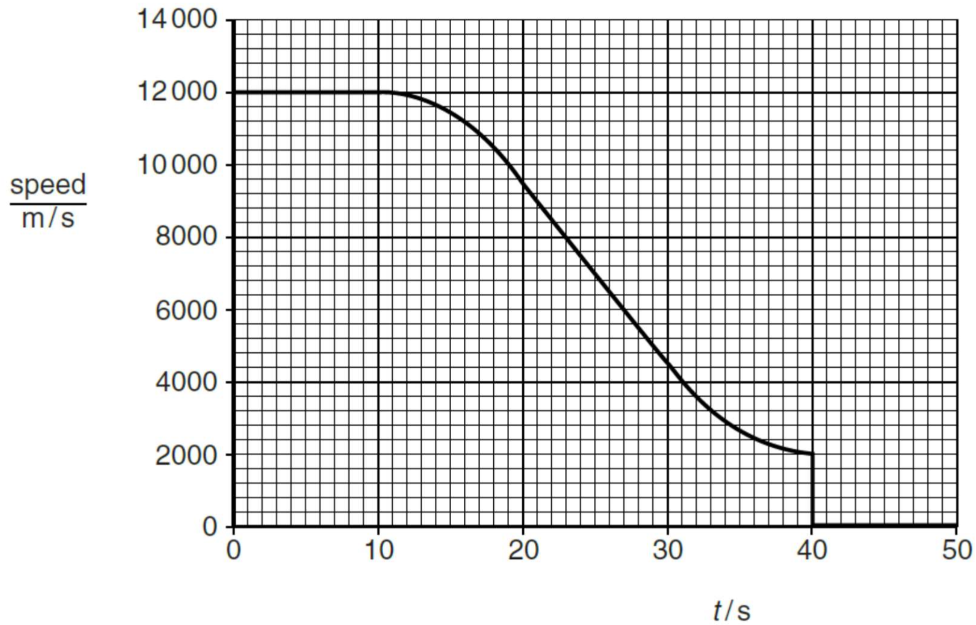

Fig. 1.1

(a) **(i)** On Fig. 1.1, mark with

1. a letter X, where the rock is moving with a constant speed,

2. a letter Y, where the rock has a non-uniform deceleration.

[2]

(ii) At time $t = 25$ s, the mass of the rock is 8.4 kg.

Determine, at this instant,

1. the magnitude of the acceleration of the rock,

acceleration = ... [2]

2. the magnitude of the resultant force on the rock.

force = ... [1]

(b) **(i)** Fig. 1.2 shows the rock at time $t = 25$ s.

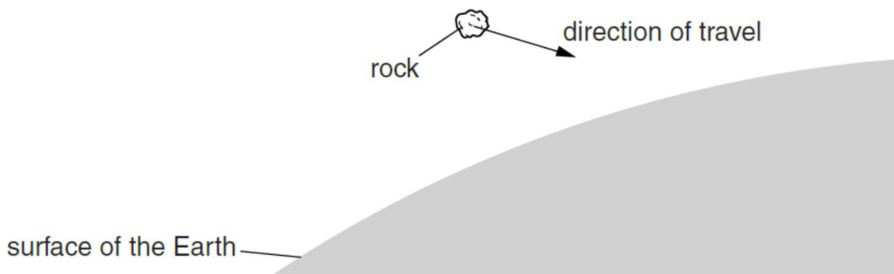

Fig. 1.2

1. On Fig. 1.2, draw and label an arrow to show the direction of the gravitational force F acting on the rock.

[1]

2. Explain why the direction of travel of the rock changes as it travels through the Earth's atmosphere.

....

....

.... [2]

(ii) State what happens to the rock at time $t = 40$ s.

.... [1]

2 Fig. 2.1 shows a screwdriver of mass 64 g resting in equilibrium on a pivot.

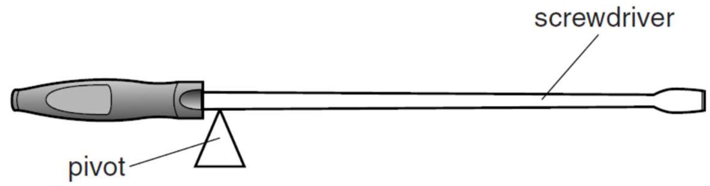

Fig. 2.1

(a) **(i)** Calculate the magnitude of the normal contact force from the pivot acting on the screwdriver.

force = ... [1]

(ii) A student suggested that the weight of the screwdriver and the normal contact force of the pivot acting on the screwdriver form an action-reaction pair.

Explain why the student is wrong.

....

.... [1]

(b) **(i)** On Fig. 2.1, mark and label with a letter C, the centre of gravity of the screwdriver.

[1]

(ii) Explain why the screwdriver will not be in equilibrium if it is pivoted at a different point.

....

....

.... [2]

3 A person whose weight is 500 N is standing on a platform with negligible weight as shown in Fig. 3.1.

The platform is resting on a piston whose cross-sectional area is 2.0×10^{-2} m^2. The piston causes a height of water *h* to be supported by the piston.

The value of the atmospheric pressure is 1.0×10^5 Pa and the density of water is 1000 kg m^{-3}.

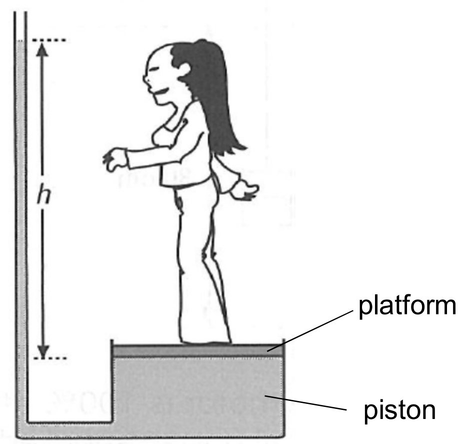

Fig. 3.1

(a) Calculate the value of *h*.

h = ______________ [2]

(b) The column on the left-hand side is no longer exposed to the atmosphere and it is sealed such that the top part of the column is a vacuum.

State and explain how the value of *h* would change.

____

____ [2]

4 Fig. 4.1 shows a black car going up a hill on a bright, sunny day.

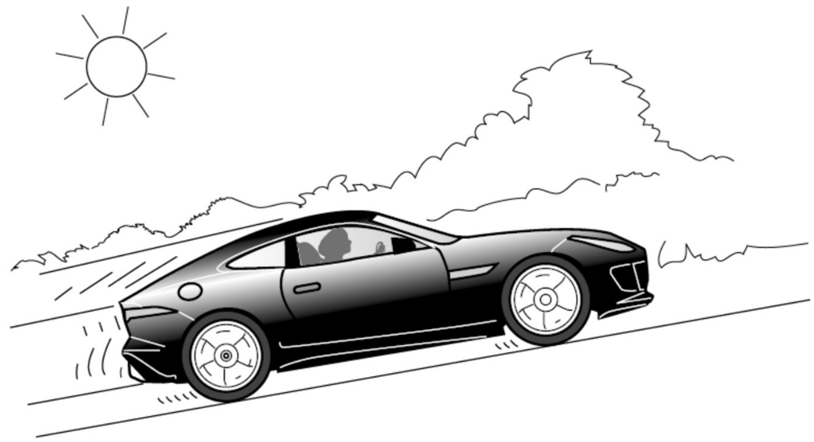

Fig. 4.1

(a) State

(i) one way in which the car is **gaining** thermal energy,

....

.... [1]

(ii) one way in which the car is **losing** thermal energy.

....

.... [1]

(b) The car accelerates up the hill. In addition to the changes in the thermal energy of the car, there are other energy changes taking place.

State the other energy changes that occur as the car moves up the hill.

....

....

.... [2]

5 Fig. 5.1 shows an old coin displayed in a museum.

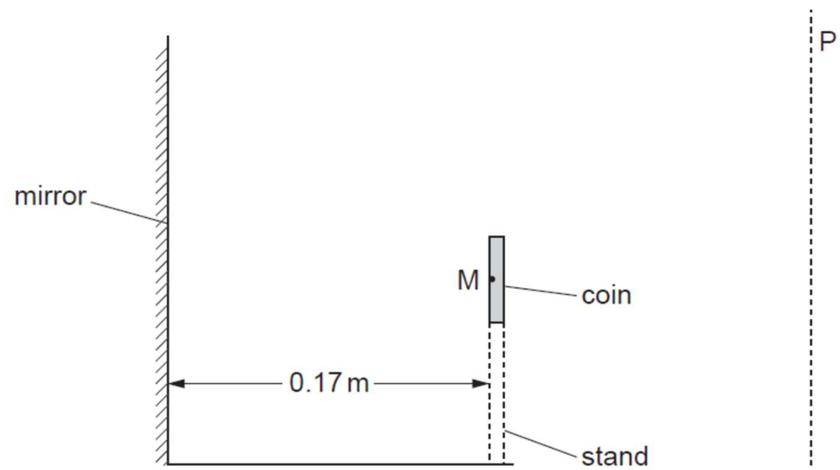

Fig. 5.1

The coin is vertical and is supported by a stand. A mirror 0.17 m behind the coin ensures that the back of the coin can be seen by a visitor looking from the line P.

M is a point on the coin.

(a) On Fig. 5.1,

(i) draw two rays of light from M to show how its image is produced, [2]

(ii) label its image with a letter *I*. [1]

(b) State the distance from point M on the coin to its image.

distance = ... [1]

6 Fig. 6.1 shows a young boy lying on his back on the bottom of a swimming pool. He is holding his breath and his eyes are open. A red light is positioned on the ground at Q.

At first the boy's head is touching the pool wall. He notices that, as he slides away from the pool wall, his eye reaches a point P where he first sees the light at Q. Fig. 6.1 shows the boy in this position.

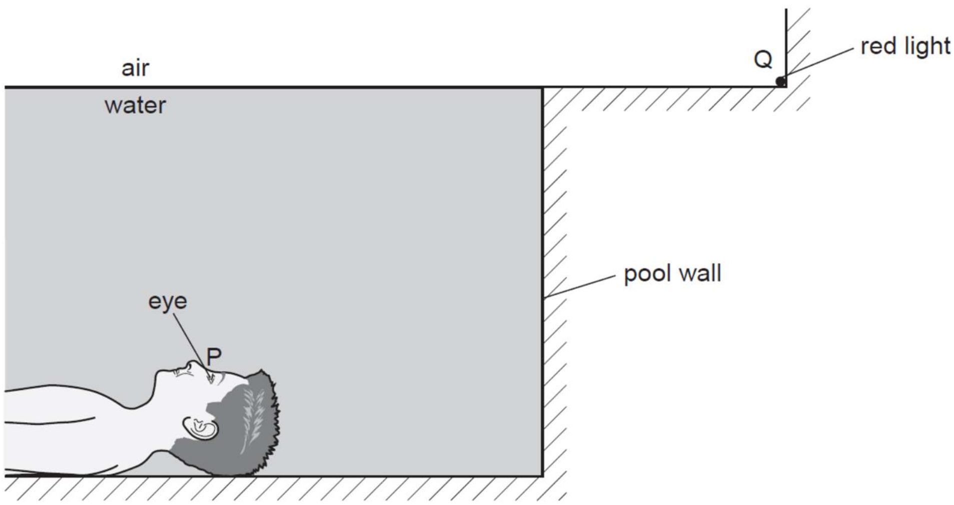

Fig. 6.1

(a) On Fig. 6.1, draw the ray of light travelling from Q to P. [1]

(b) **(i)** The critical angle is 49°.

Calculate the refractive index of water.

refractive index = ... [2]

(ii) Hence, explain why the boy is unable to see the red light at Q when his eye is closer to the pool wall than when his eye is at point P.

....

....

.... [2]

7 A large number of television sets in a shop are tuned to the same station. The television signal travels to some of the television sets via a satellite orbiting the Earth and to other television sets directly from a ground-based transmitter.

(a) **(i)** Explain why only electromagnetic waves are used to transmit the television signal.

....

.... [1]

(ii) State the region of the electromagnetic spectrum used to transmit the television signal.

.... [1]

(iii) Suggest why satellites are sometimes used to transmit television signals instead of a ground-based transmitter.

....

.... [1]

(b) A salesman notices that the television signal sent via the satellite arrives 0.24 s later than the one sent directly from the ground-based transmitter.

Calculate the additional distance travelled by the television signal from the satellite.

distance = ... [2]

8 A positively charged plastic rod is placed just above a metal plate. The metal plate rests on an insulator and is connected to the earth by an earthing wire as shown in Fig. 8.1.

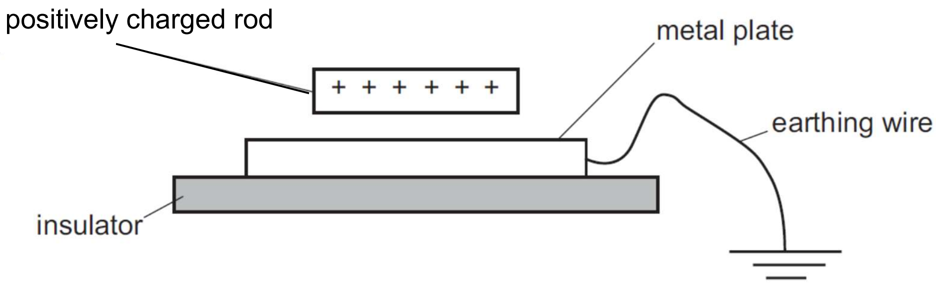

Fig. 8.1

A student disconnects the earthing wire and then removes the positively charged rod.

(a) State and explain the type of charge on the metal plate **after** the positively charged rod is removed.

....

....

.... [2]

(b) The experiment is repeated. This time the student removes the positively charged rod **before** removing the earthing wire.

State and explain if the type of charge on the metal plate now would be different.

....

....

.... [2]

9 A microwave oven is rated at 650 W and is connected to a 230 V mains supply. The microwave has a fuse but no earth wire.

Due to wear and tear, the insulation of the mains cable has worn away. The live wire touches the outer metal casing of the microwave oven.

(a) **(i)** State and explain the hazard if the outer metal casing is not earthed.

....

....

.... [2]

(ii) Explain why a fuse is needed in the circuit even after an earth wire is connected to the outer metal casing.

....

....

.... [2]

(b) The microwave oven is turned on for 45 minutes. Calculate the amount of electricity used in kWh.

amount of electricity used = ... kWh [1]

10 **(a)** When there are no other magnetic fields present, the needle of a plotting compass points due north in the Earth's magnetic field. This is shown in Fig. 10.1.

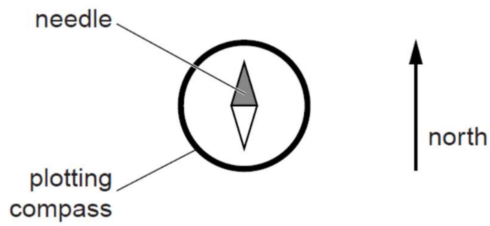

Fig. 10.1

The plotting compass is placed close to a permanent magnet, first at position A and then at position B, as shown in Fig. 10.2.

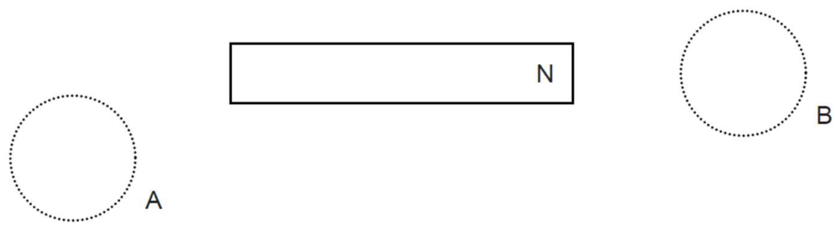

Fig. 10.2

The magnetic field due to the permanent magnet is very much stronger than the magnetic field of the Earth.

On Fig. 10.2, draw arrows in the two circles A and B to show the direction in which the compass needle points, when the compass is at A and B respectively.
[2]

(b) Describe an electrical method that is used to demagnetise a permanent magnet. You may include a diagram in your answer.

....

....

....

.... [3]

Section B	☐ s.f. ☐ formula	/ 30

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PHYSICS **6091/02**

Paper 2 Theory **15 September 2021**

1 hour 45 minutes

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

Section B

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

11 A student sets up the apparatus as shown in Fig. 11.1 in order to determine a value for the specific latent heat of fusion of ice.

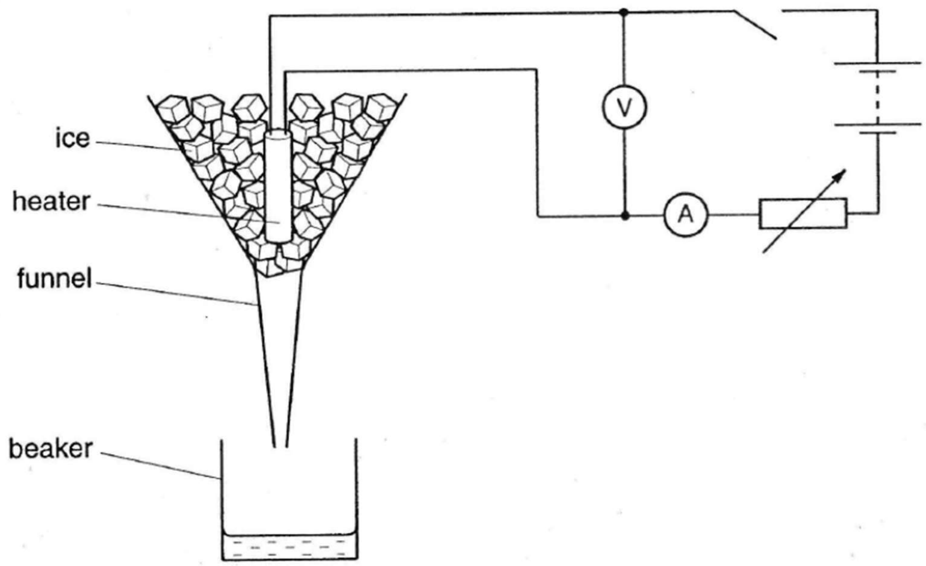

Fig. 11.1

A heater is placed in the funnel, surrounded by pure melting ice. The student measures the mass of the melted ice in the beaker below at regular intervals before and after switching on the heater.

During the heating process, the current is adjusted so that the readings on the voltmeter and ammeter are kept constant. The voltmeter reading is 11.5 V and the ammeter reading is 5.2 A.

The variation with time t of the mass m of melted ice in the beaker is shown in Fig. 11.2.

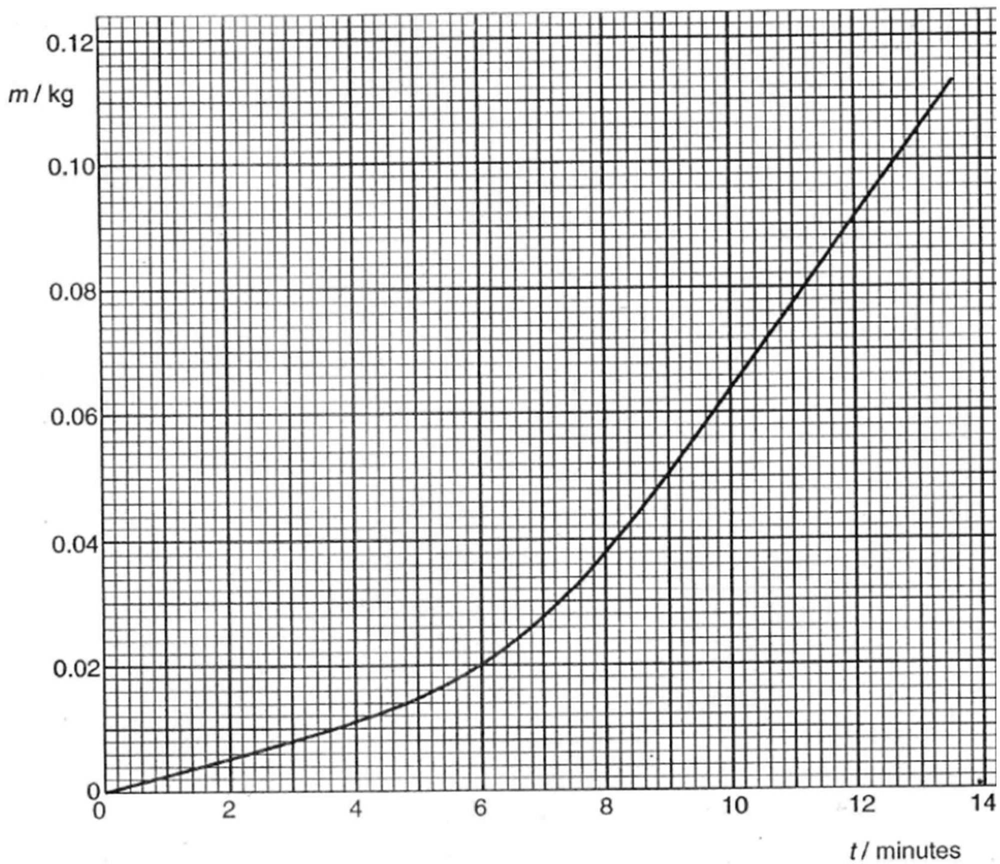

Fig. 11.2

The heater is **only** switched on at t = 4.0 min and is kept switched on.

(a) Explain why the mass of ice of melted ice increases even before the heater is switched on.

....

.... [1]

(b) Explain why the mass of ice melted does not increase linearly with respect to time from t = 4.0 min to t = 8.0 min.

....

.... [1]

(c) **(i)** Determine the mass of ice melted at t = 8.0 min.

mass = ... [1]

(ii) Hence, determine the mass of the ice melted from t = 8.0 min to 12.0 min.

mass = ... [1]

(d) **(i)** Calculate the power output of the heater.

power = ... [2]

(ii) Hence, determine a value for the specific latent heat of fusion of ice.

specific latent heat of fusion = ... [2]

(e) State and explain how the specific latent of fusion obtained in **(d)(ii)** would be different, if ice was taken from the freezer directly to replace the melting ice in the funnel.

....

....

.... [2]

12 **(a)** State two scenarios where a charged particle in a magnetic field does not experience a magnetic force.

1. ______________________________

2. ______________________________ [2]

(b) A loosely coiled spring is suspended from a fixed point as shown in Fig. 12.1.

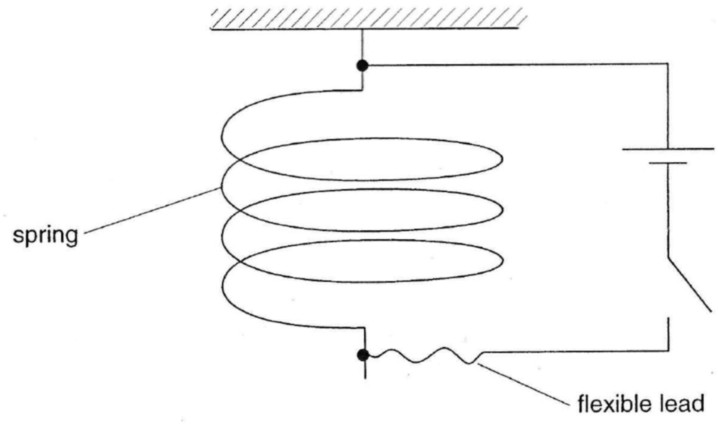

Fig 12.1

Electrical connections are attached to the ends of the spring. When the current is switched on, there is a small change in the length of the spring.

(i) On Fig. 12.1 above, draw an arrow in the spring to show the direction of the current.

[1]

(ii) On Fig. 12.2 below, draw the magnetic field lines due to a current-carrying wire. You should also draw arrows on the lines to show the direction of the magnetic field.

[2]

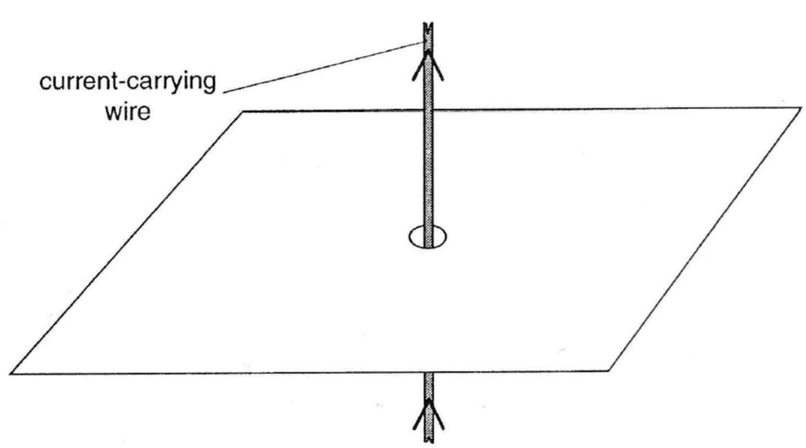

Fig. 12.2

(iii) Using your answers to **(b)(i)** and **(b)(ii)**, state and explain whether the spring expands or contracts when the current is switched on.

....

....

.... [2]

(c) Fig. 12.3 below shows a circuit breaker.

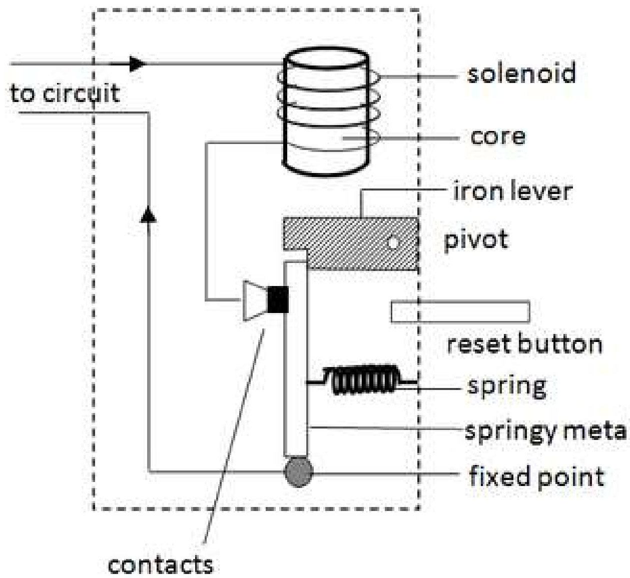

Fig. 12.3

Explain briefly how the circuit breaker works.

....

....

....

.... [3]

13 **(a)** Define *potential difference* across an electrical component.

....

.... [1]

(b) A battery of e.m.f. 6.0 V is connected to a network of resistors and a voltmeter, as shown in Fig. 13.1.

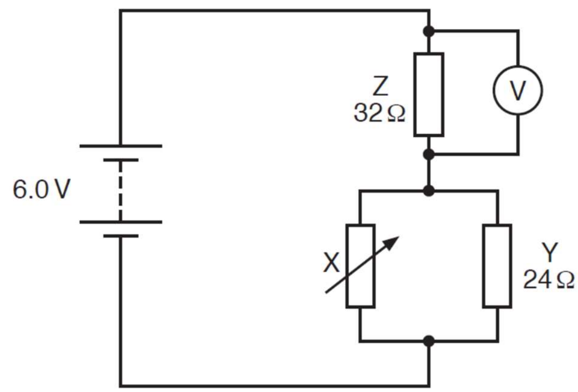

Fig. 13.1

Resistor Y has a resistance of 24 Ω and resistor Z has a resistance of 32 Ω.

(i) The resistance R_X of the variable resistor X is adjusted until the voltmeter reads 4.8 V.

Calculate

1. the current in resistor Z,

current = ... [1]

2. the amount of charge that flows through the battery in a time interval of 25 s,

charge = ... [2]

3. the total resistance of X and Y connected in parallel,

resistance = ... [2]

4. the resistance R_X.

R_X = ... [2]

(ii) The resistance R_X is now decreased.

State and explain the change, if any, to the voltmeter reading.

....

....

.... [2]

End of Paper