For Examiner's Use

Section B

Answer **one** question from this Section in the spaces provided.

6 **(a)** Define *magnetic flux density*.

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.... [2]

(b) Ions in the atmosphere are affected by the magnetic field produced by long straight current-carrying cables carrying a large current. Fig. 6.1 shows a current-carrying cable carrying a current of 80 A towards the left. At point P, a distance 0.80 m from the cable, an ion travels directly towards the cable at a speed of 1.0×10^{3} m s^{-1} and follows the path shown in Fig. 6.1. The charge of the ion is $+1.6 \times 10^{-19}$ C. Ignore the effects of the Earth's magnetic field.

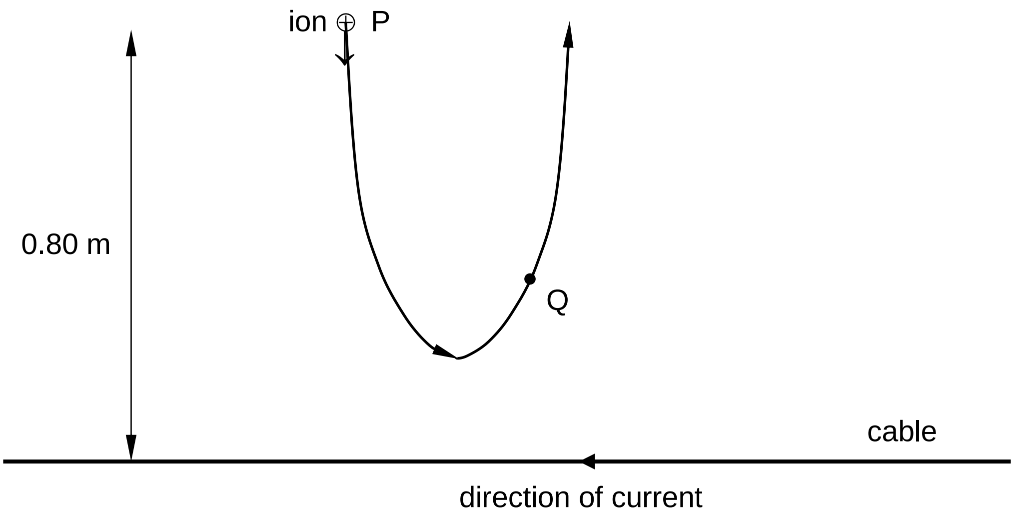

Fig. 6.1

(i) Calculate the force acting on the ion when it is at point P.

force = ... N [3]

[Turn over

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(ii) On Fig. 6.1, indicate the force acting on the ion when it is at point Q. Label the force *F*. [1]

(iii) Explain the shape of the path taken by the ion in Fig. 6.1.

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(c) Fig. 6.2 shows a bar magnet being released from a height above a coil.

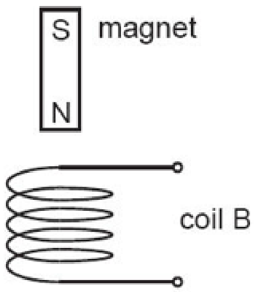

Fig. 6.2

The terminals of the coil are connected to a voltage sensor and datalogger which records the induced e.m.f. as the magnet falls through the coil.

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Fig. 6.3 shows the variation with time of the induced e.m.f.

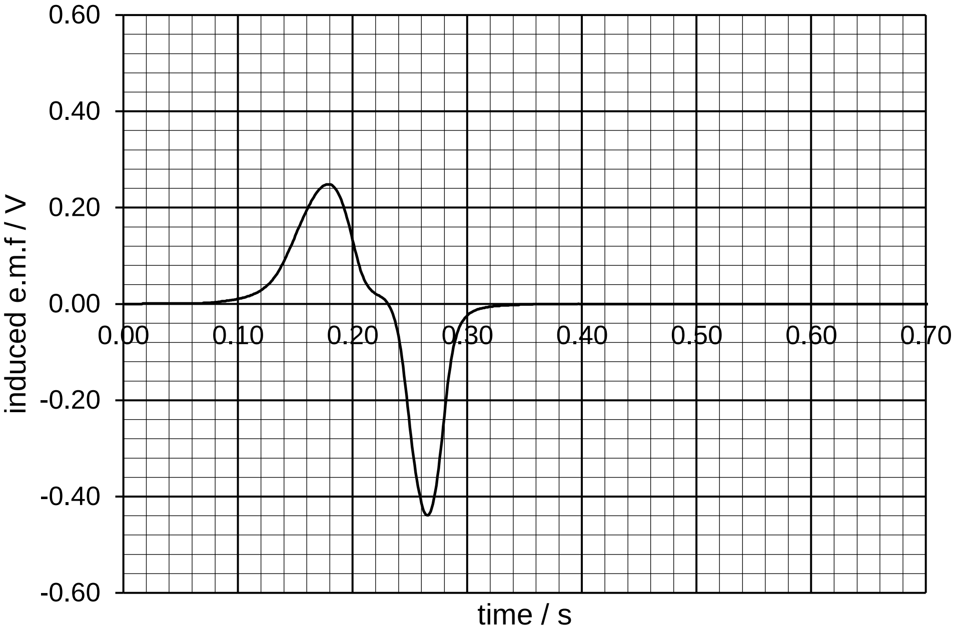

Fig. 6.3

(i) Using the laws of electromagnetic induction, explain the following features of the graph in Fig. 6.3.

1. The magnitude of the induced e.m.f. changes with time.

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2. The induced e.m.f. has opposite sign.

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3. The magnitude of the maximum e.m.f. is different at 0.18 s and 0.26 s.

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[Turn over

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(ii) The coil in Fig. 6.2 is replaced with a longer coil of similar material such that the length is much longer than the magnet. The magnet is now released from the same height above the coil.

On Fig. 6.3, sketch a graph to show how the induced e.m.f would vary with time when the magnet falls through the longer coil. Label the graph L. [2]

(d) A sinusoidal alternating current source of frequency 50 Hz is connected to a resistor R of resistance 2.0 kΩ, an ideal diode and an oscilloscope, as shown in Fig. 6.4. The r.m.s. current through the resistor is 5.0 mA. Assume the oscilloscope has infinite resistance.

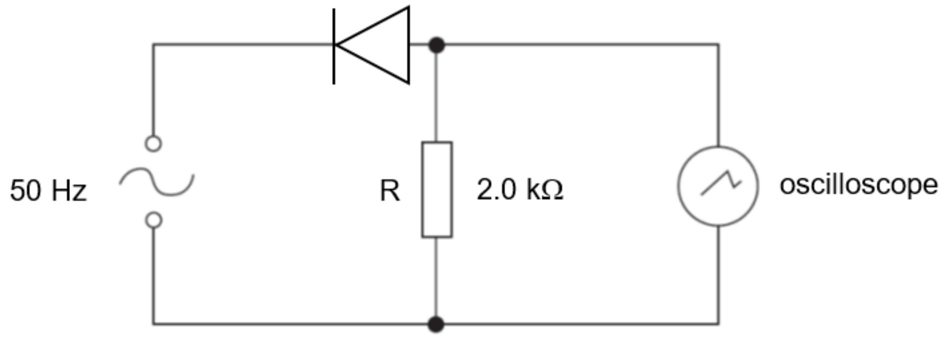

Fig. 6.4

(i) Calculate the peak value of the voltage across R.

peak voltage = ……………………… V [2]

(ii) Fig. 6.5 represents the screen of the oscilloscope, each square being 1 cm × 1 cm. The time base of the oscilloscope is set at 5 ms cm^{-1} and the voltage sensitivity is 5.0 V cm^{-1}.

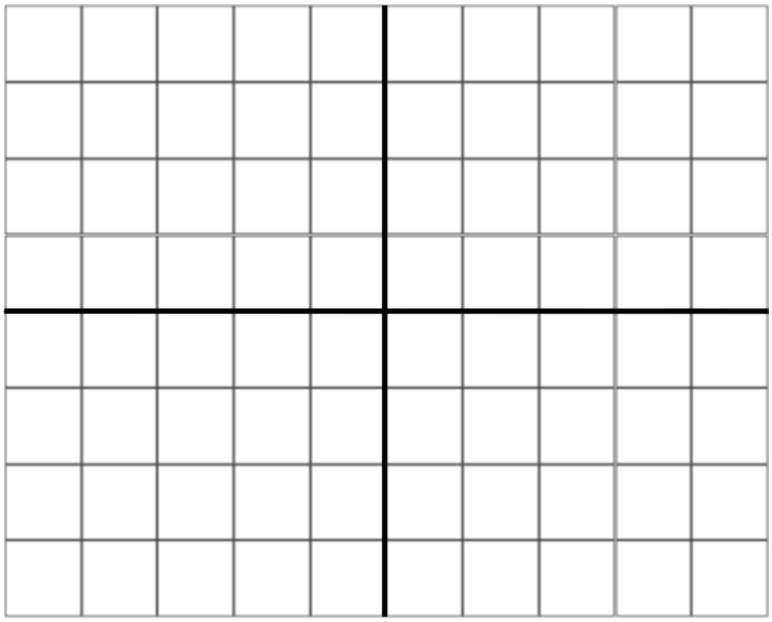

Fig. 6.5

On Fig. 6.5, sketch the signal seen on the screen of the oscilloscope. [2]

[Total: 20]