9 (a) The coil in a generator is situated in a uniform magnetic field as shown in Fig. 9.1.

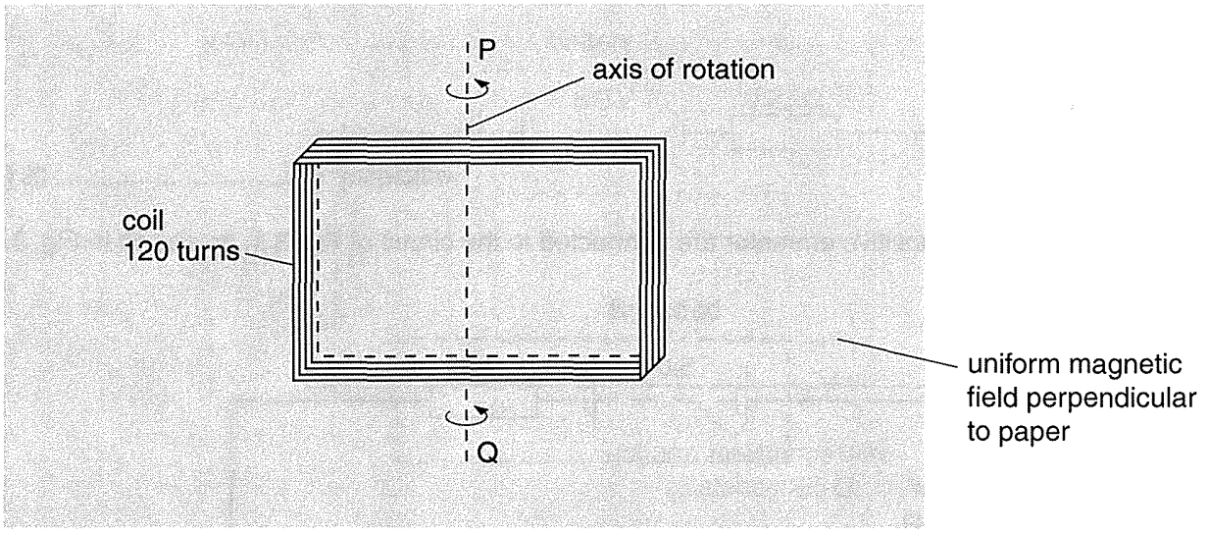

Fig. 9.1

The coil is rotated about the axis PQ as shown in Fig. 9.1. An electromotive force (e.m.f.) is induced in the coil. The e.m.f. is measured with a cathode-ray oscilloscope (c.r.o.).

The Y-plates sensitivity of the c.r.o. is 0.050 V cm^{-1} and the time-base setting is 8.0 ms cm^{-1}.

The waveform displayed on the c.r.o. is shown in Fig. 9.2.

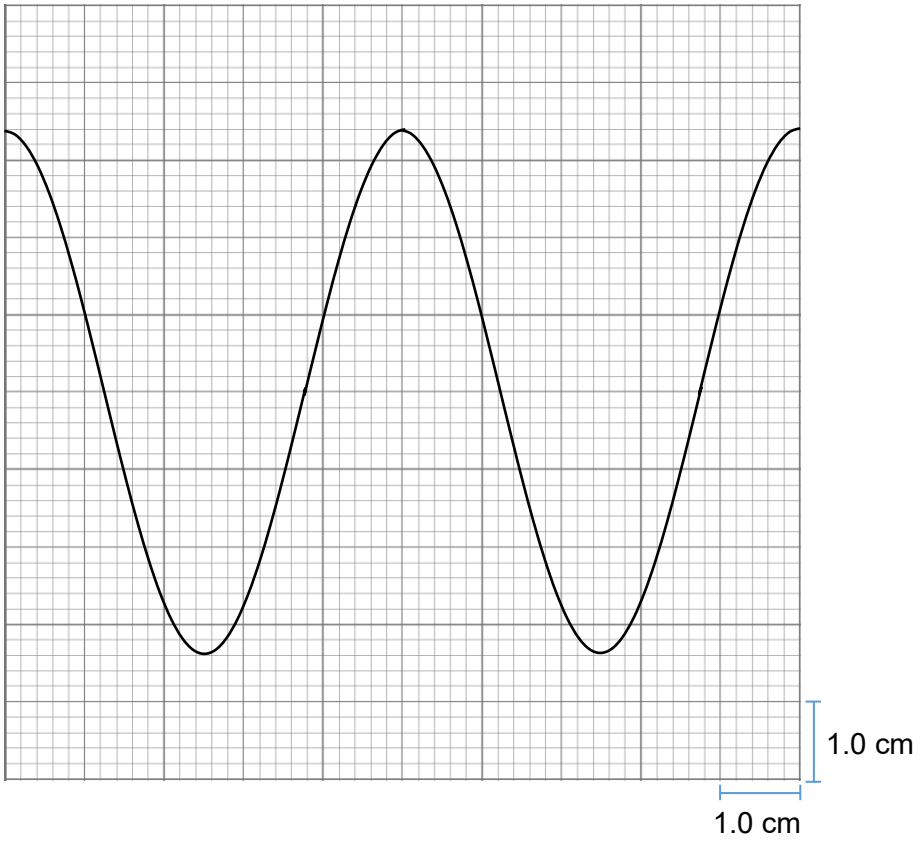

Fig. 9.2

(i) Use Faraday's law of electromagnetic induction to explain the variation of the e.m.f. induced in the coil.

……

……

……

……

……

……

…… [3]

(ii) Using Fig. 9.2, calculate

1. the maximum induced e.m.f.

maximum e.m.f. = …….. V [2]

2. the frequency.

frequency = ……. Hz [2]

(iii) With reference to Fig. 9.1, state how the coil is positioned relative to the magnetic field when the induced e.m.f. in the coil is maximum.

……

…… [1]

(iv) The coil has 120 turns and a cross-sectional area of 1.3×10^{-3} m^2.

The maximum induced e.m.f. E_0 is given by the expression

E_0 = maximum magnetic flux linkage $\times$ angular speed of the coil.

Use this expression and your answers in **(a)(ii)** to calculate the magnetic flux density of the field.

magnetic flux density = ……. T [2]

(b) An electric heater has a resistance of 38 Ω at its working temperature. The variation with time t of the supply voltage V connected between the terminals of the heater is given by

$$V = 240 \sin 377t$$

where V is measured in volts and t is in seconds.

(i) By reference to heating effect, explain what is meant by the *root-mean-square* (r.m.s.) value of an alternating current.

……

…… [2]

(ii) Determine the frequency f of the supply voltage

f = …… Hz [2]

(iii) Determine the power dissipation of the heater.

power = …….. W [3]

(iv) On Fig. 9.3, show the variation with time *t* of the power *P* dissipated in the heater for two periods of the alternating voltage. The alternating voltage has period *T*.

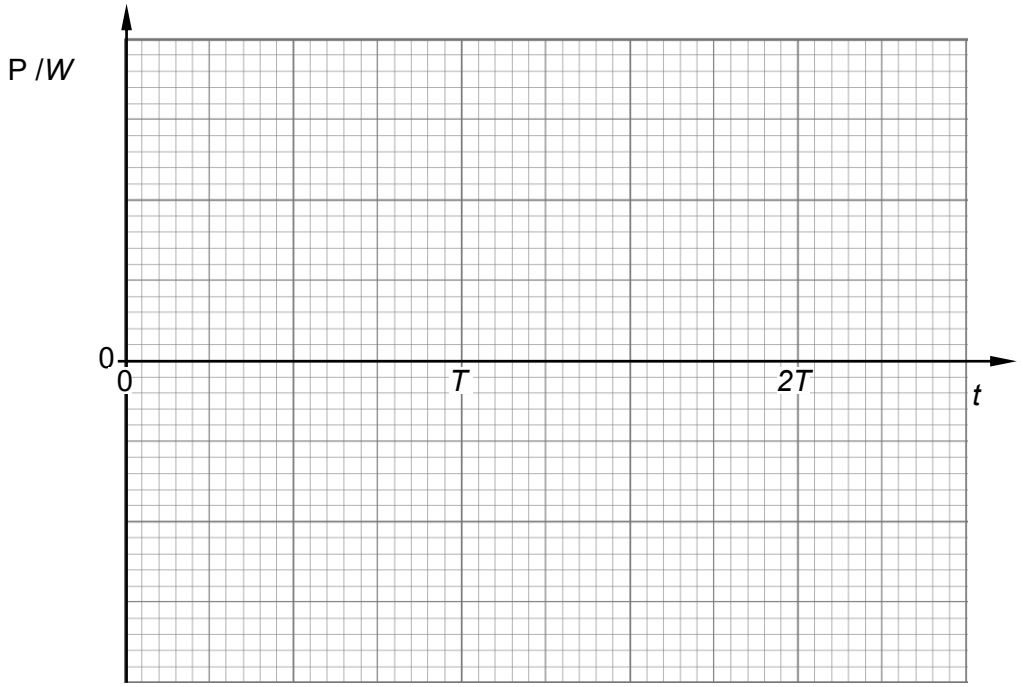

Fig. 9.3

[3]

[Total: 20 marks]