AC Basics

Question paper

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Alternating Currents
Sub Topic	AC Basics
Paper Type	Theory
Booklet	Question paper

Time Allowed: **52 minutes**

Score: **/43**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** The mean value of an alternating current is zero.

Explain

(i) why an alternating current gives rise to a heating effect in a resistor,

.....

.....

..... [2]

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

.....

.....

.....

..... [2]

(b) A simple iron-cored transformer is illustrated in Fig. 7.1.

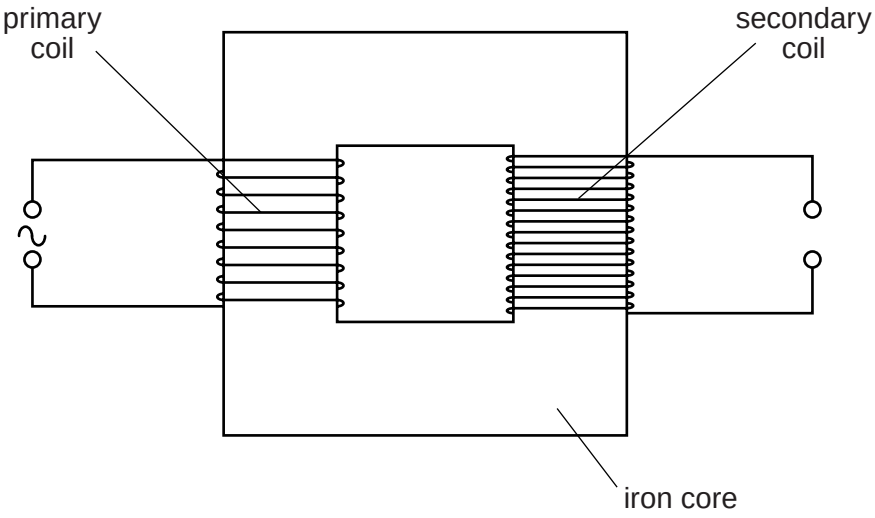

Fig. 7.1

(i) State Faraday's law of electromagnetic induction.

.....

.....

..... [2]

(ii) Use Faraday's law to explain why the current in the primary coil is not in phase with the e.m.f. induced in the secondary coil.

.....

.....

.....

.....

..... [3]

2 The variation with time t of the output V of an alternating voltage supply of frequency 50 Hz is shown in Fig. 6.1.

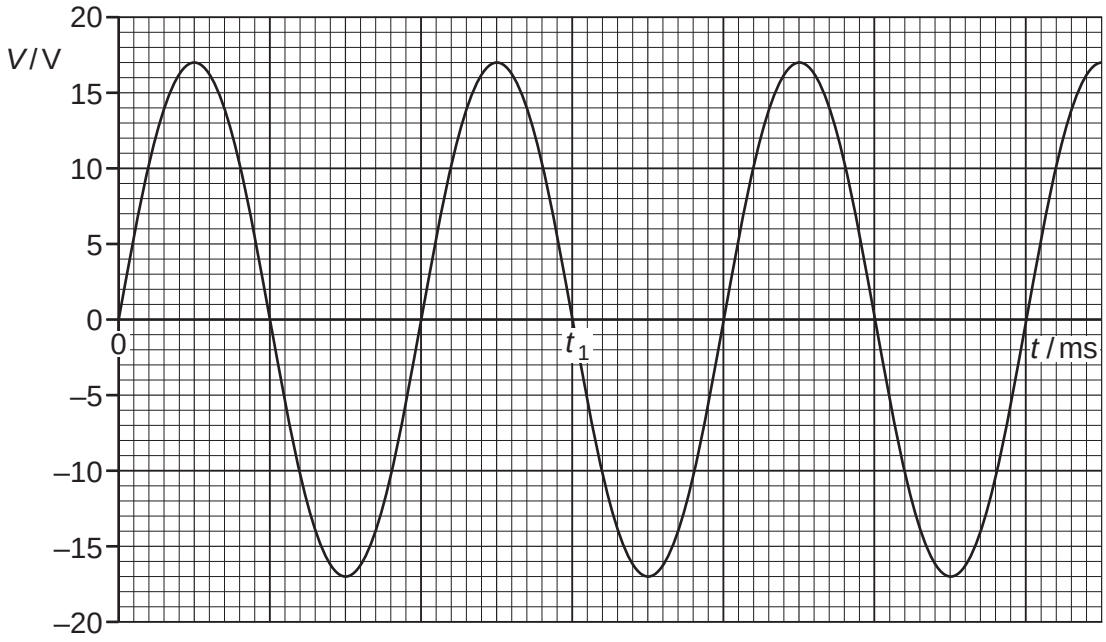

Fig. 6.1

(a) Use Fig. 6.1 to state

(i) the time t_1,

t_1 = ... s [2]

(ii) the peak value V_0 of the voltage,

V_0 = ... V [1]

(iii) the root-mean-square voltage V_{rms},

V_{rms} = ... V [1]

(iv) the mean voltage $\langle V \rangle$.

$\langle V \rangle$ = ... V [1]

(b) The alternating supply is connected in series with a resistor of resistance 2.4 Ω.
Calculate the mean power dissipated in the resistor.

power = ... W [2]

3 An alternating current supply is connected in series with a resistor R, as shown in Fig. 6.1.

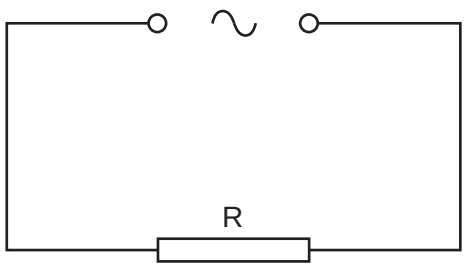

Fig. 6.1

The variation with time t (measured in seconds) of the current I (measured in amps) in the resistor is given by the expression

$$I = 9.9\sin(380t).$$

(a) For the current in the resistor R, determine

(i) the frequency,

frequency = ... Hz [2]

(ii) the r.m.s. current.

r.m.s. current = ... A [2]

(b) To prevent over-heating, the mean power dissipated in resistor R must not exceed 400W.
Calculate the minimum resistance of R.

resistance = ... Ω [2]

4 The variation with time t of the current I in a resistor is shown in Fig. 6.1.

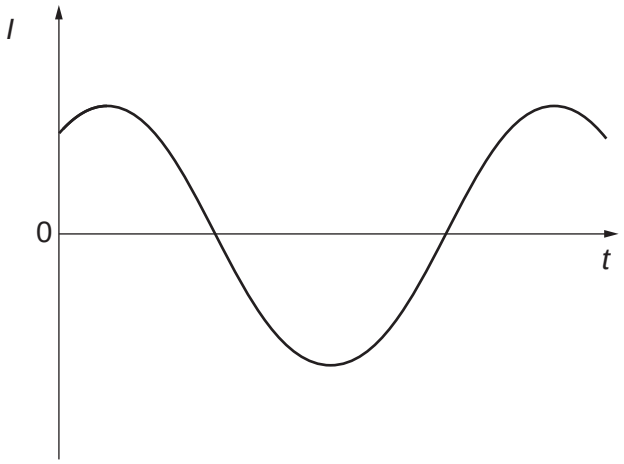

Fig. 6.1

The variation of the current with time is sinusoidal.

(a) Explain why, although the current is not in one direction only, power is converted in the resistor.

.....

.....

..... [2]

(b) Using the relation between root-mean-square (r.m.s.) current and peak current, deduce the value of the ratio

$$\frac{\text{average power converted in the resistor}}{\text{maximum power converted in the resistor}}.$$

ratio = ... [3]

5 **(a)** Explain what is meant by the *root-mean-square* (r.m.s.) value of an alternating voltage.

.....

.....

..... [2]

(b) An alternating voltage V is represented by the equation

$$V = 220 \sin(120\pi t),$$

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

For this alternating voltage, determine

(i) the peak voltage,

peak voltage = ... V [1]

(ii) the r.m.s. voltage,

r.m.s. voltage = ... V [1]

(iii) the frequency.

frequency = ... Hz [1]

(c) The alternating voltage in **(b)** is applied across a resistor such that the mean power output from the resistor is 1.5 kW.

Calculate the resistance of the resistor.

resistance = ... Ω [2]

6 **(a)** Explain, in terms of heating effect, what is meant by the *root-mean-square (r.m.s.) value* of an alternating current.

.....

.....

..... [2]

(b) State the relation between the peak current I_0 and the r.m.s. current I_{rms} of a sinusoidally-varying current.

..... [1]

(c) The value of a direct current and the peak value of a sinusoidal alternating current are equal.

(i) Determine the ratio

$$\frac{\text{power dissipation in a resistor of resistance } R \text{ by the direct current}}{\text{power dissipation in the resistor of resistance } R \text{ by the alternating current}}.$$

ratio = ... [2]

(ii) State one advantage and one disadvantage of the use of alternating rather than direct current in the home.

advantage .....

.....

disadvantage .....

..... [2]

(d) A current I varies with time t as shown in Fig. 5.1.

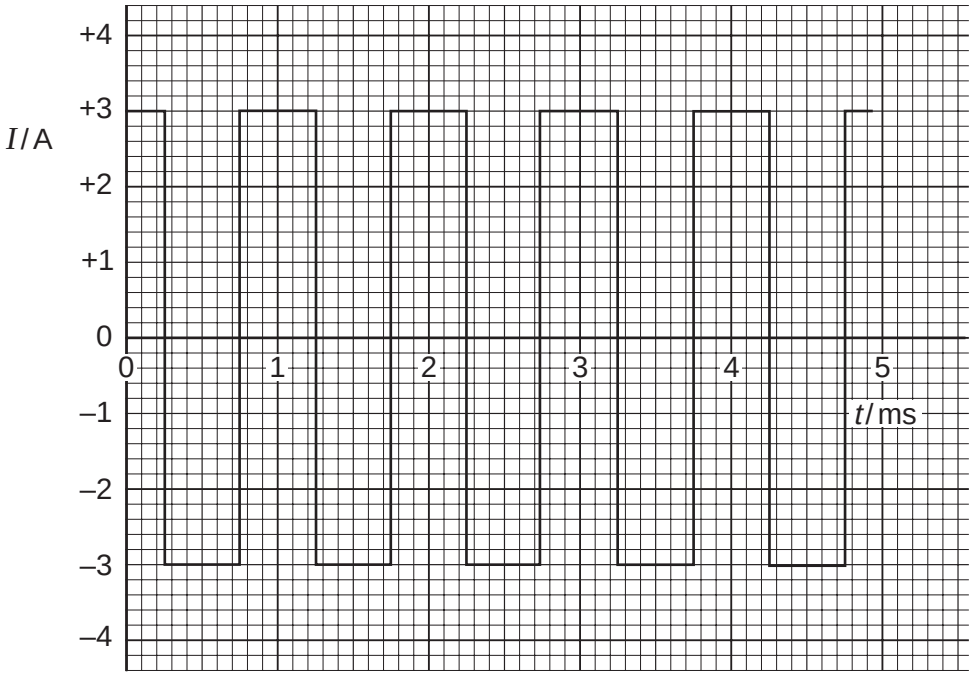

Fig. 5.1

For this varying current, state

(i) the peak value,

peak value = ... A [1]

(ii) the r.m.s. value.

r.m.s. value = ... A [1]