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MAGNETISM (A2 CORE)

CIE Past Paper Questions from

1.Magnetic Fields , **2.** Electromagnetic Induction

<u>Value given in data booklet</u> (for this topic)

permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}

Q.1 (a) Fig.1.1 shows a long solenoid with the current direction as shown by the arrows. On Fig. 1.1, sketch the magnetic flux pattern in and around the solenoid. [3]

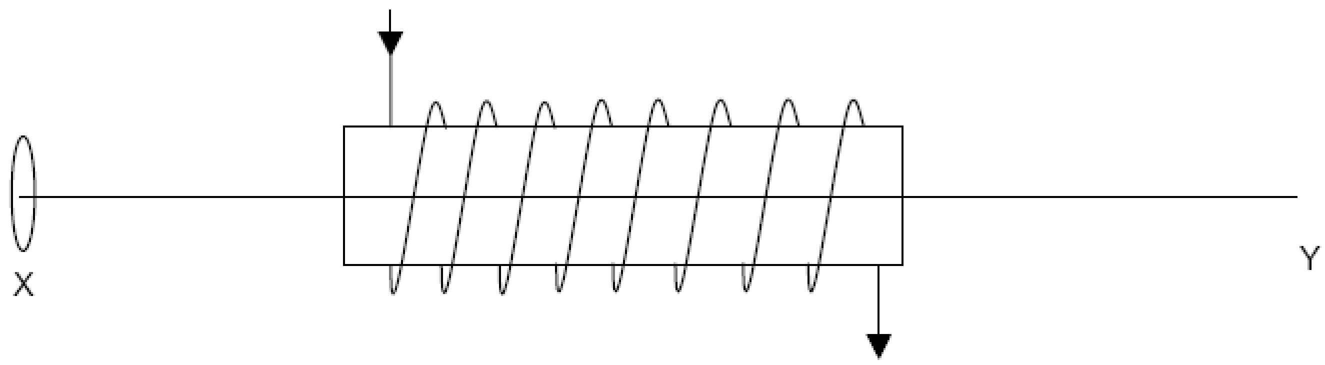

Fig. 1.1

(b) A coil is placed at X, with its axis parallel to that of the coil, and is then moved along the centre line of the solenoid to Y. Describe how the magnetic flux linkage through the coil varies as it is moved from X to Y.

....

....

.... [3]

(c) It is found that there is an e.m.f. induced in the coil when it is moved steadily from X to Y.
Explain why this e.m.f. occurs and describe how the magnitude and direction of the e.m.f. change during the movement of the coil.

....

....

....[3]

{*Q.5/Specimen paper/9702 code-June 2002*}

Q.2 (a) Two similar coils **A** and **B** of insulated wire are wound on to a soft-iron core, as illustrated in Fig. 2.1.

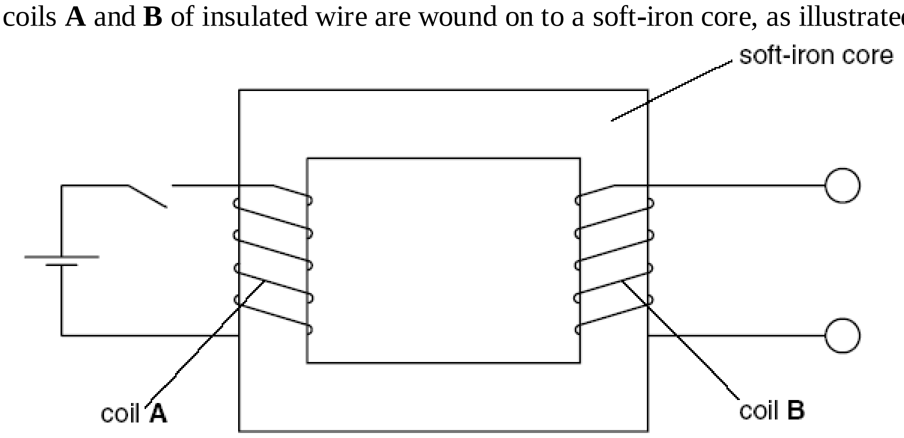

Fig. 2.1

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When the current *I* in coil **A** is switched on and then off, the variation with time *t* of the current is shown in Fig. 2.2.

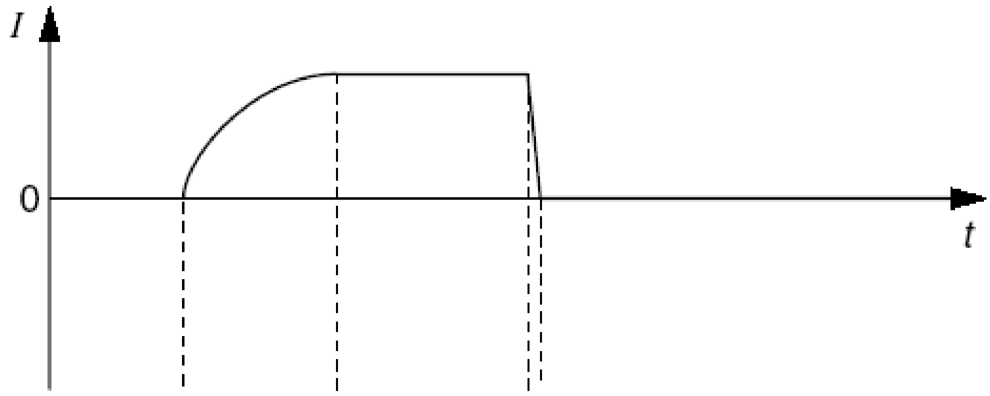

Fig. 2.2

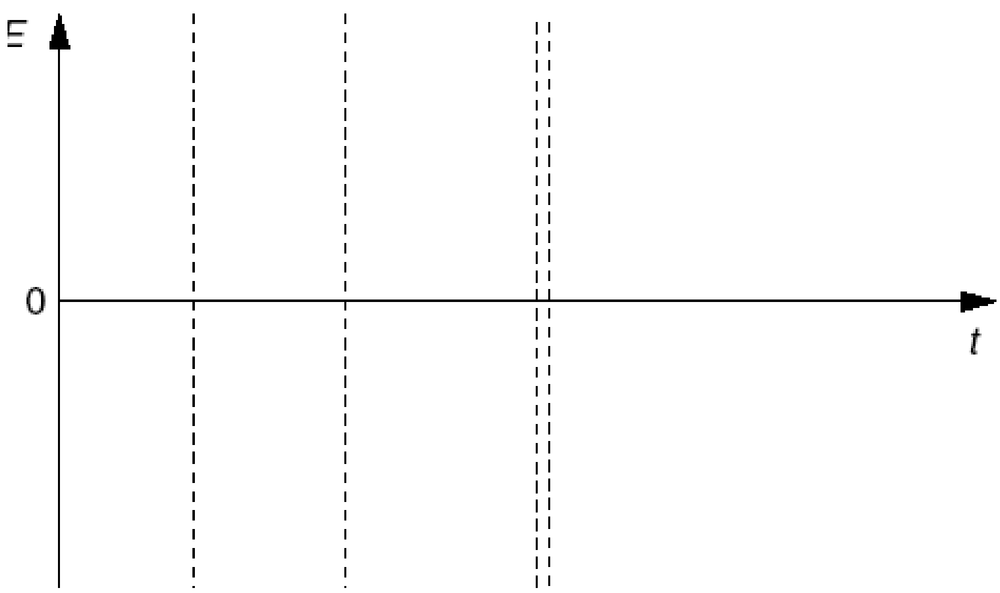

Fig. 2.3

On Fig. 2.3, draw a graph to show the variation with time *t* of the e.m.f. *E* induced in coil **B**. [3]

{*Q.6/June 2002/9702-4*}

Q. 3 A metal wire is held taut between the poles of a permanent magnet, as illustrated in Fig. 3.1.

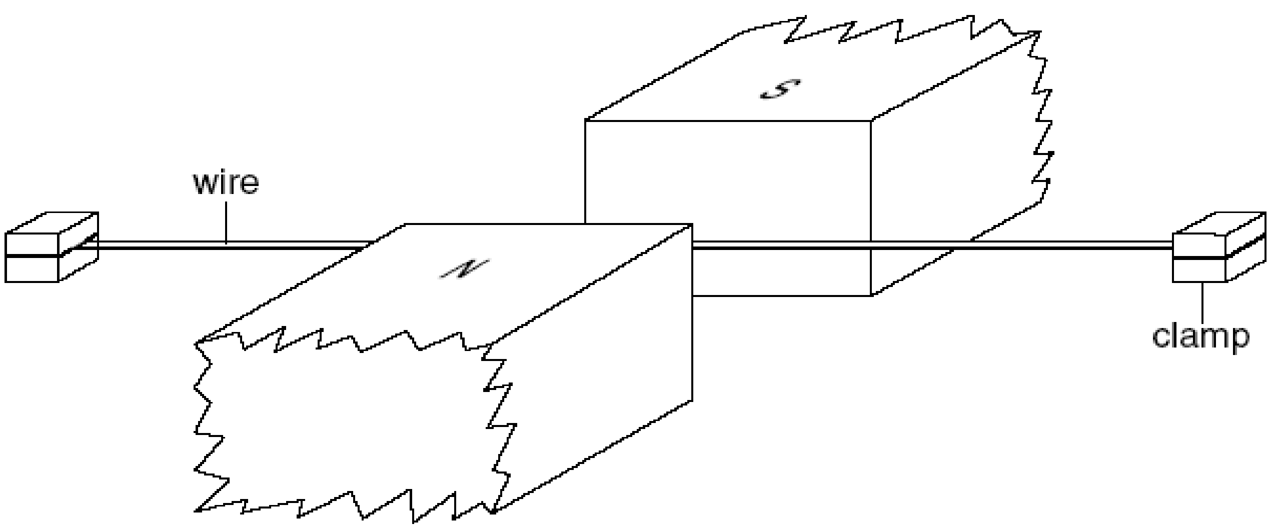

Fig. 3.1

A cathode-ray oscilloscope (c.r.o.) is connected between the ends of the wire. The Y-plate sensitivity is adjusted to 1.0mVcm^{-1} and the time base is 0.5 ms cm^{-1}.

The wire is plucked at its centre. Fig. 2.2 shows the trace seen on the c.r.o.

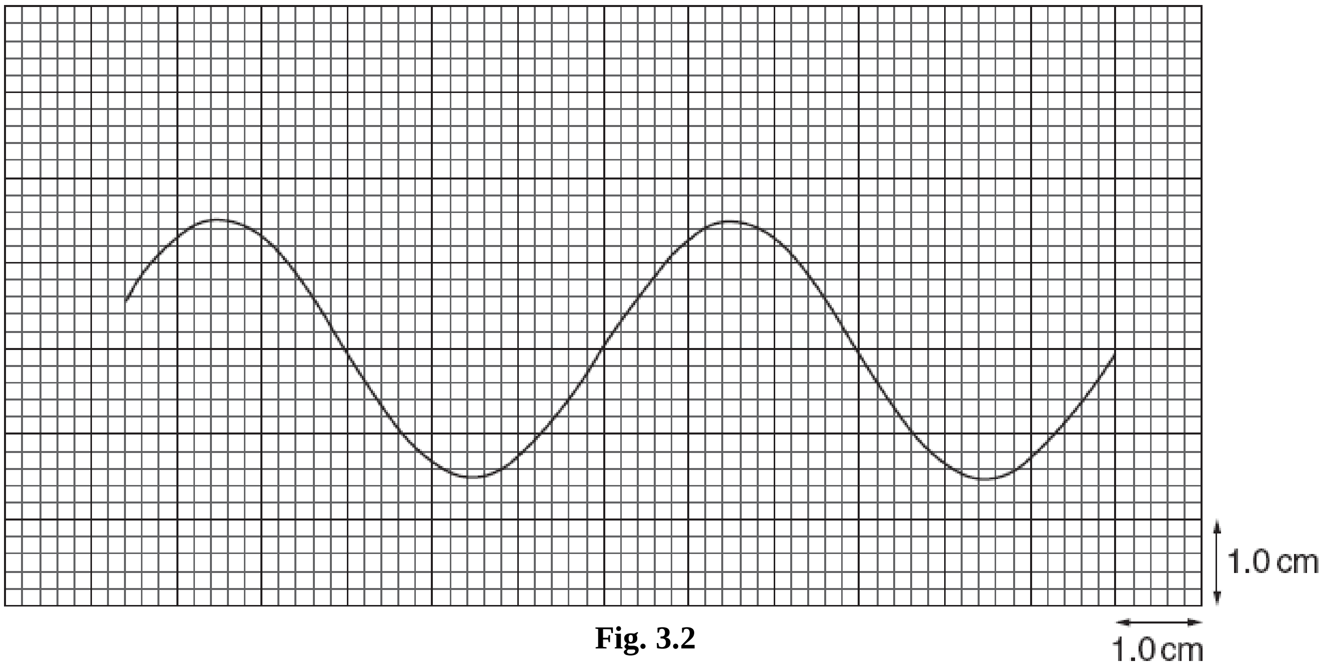

Fig. 3.2

(a) Making reference to the laws of electromagnetic induction, suggest why

(i) an e.m.f. is induced in the wire,

....

....

....**[2]**

(ii) the e.m.f. is alternating.

....

....

....**[2]**

(b) Use Fig. 3.2 and the c.r.o. settings to determine the equation representing the induced alternating e.m.f.

equation: .... [4]

{*Q.7/Nov. 2002/9702-4*}

Q. 4 An aluminium sheet is suspended from an oscillator by means of a spring, as illustrated in Fig. 4.1.

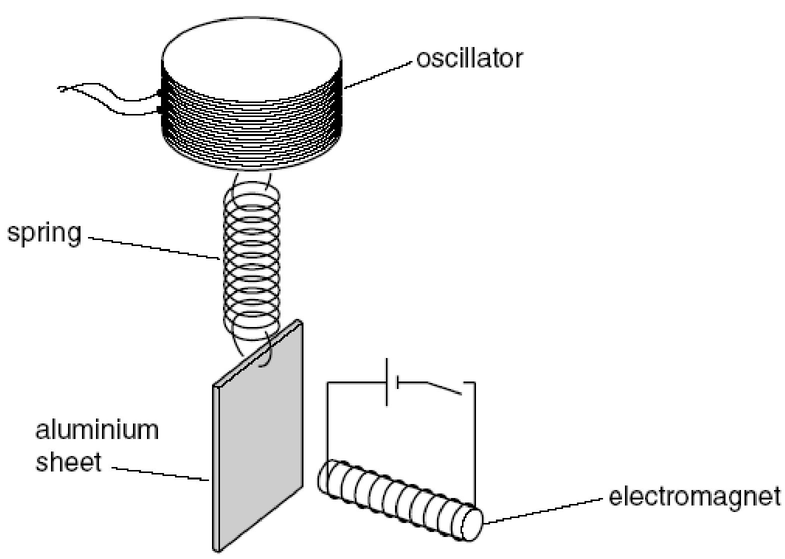

Fig. 4.1

An electromagnet is placed a short distance from the centre of the aluminium sheet.
The electromagnet is switched off and the frequency *f* of oscillation of the oscillator is gradually increased from a low value. The variation with frequency *f* of the amplitude *a* of vibration of the sheet is shown in Fig. 4.2.

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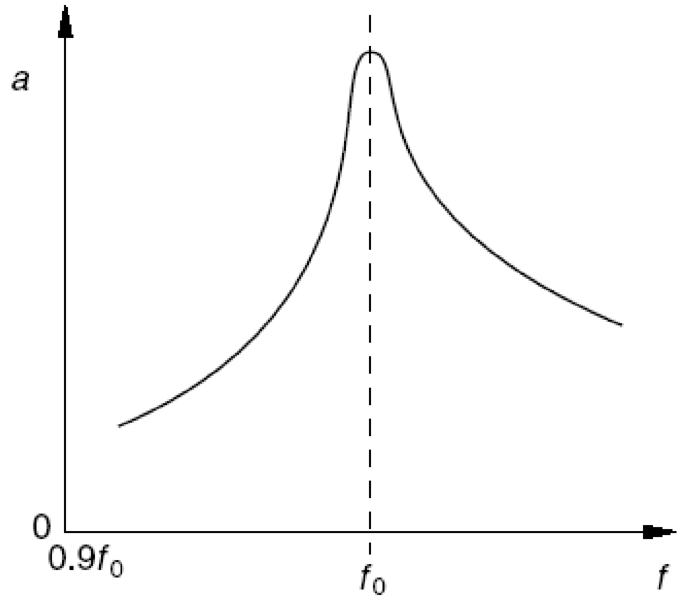

Fig. 4.2

A peak on the graph appears at frequency f_0.

(a) Explain why there is a peak at frequency f_0.

....

....

.... [2]

(b) The electromagnet is now switched on and the frequency of the oscillator is again gradually increased from a low value. On Fig. 4.2, draw a line to show the variation with frequency f of the amplitude a of vibration of the sheet. [3]

(c) The frequency of the oscillator is now maintained at a constant value. The amplitude of vibration is found to decrease when the current in the electromagnet is switched on.
Use the laws of electromagnetic induction to explain this observation.

....

....

....

.... [4]

{*Q.3/June 2003/9702-3*}

Q. 5 (a) Define the tesla, the magnetic flux density.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(b) The aluminium frame ABCD of a window measures 85 cm x 60 cm, as illustrated in the figure 5.1.

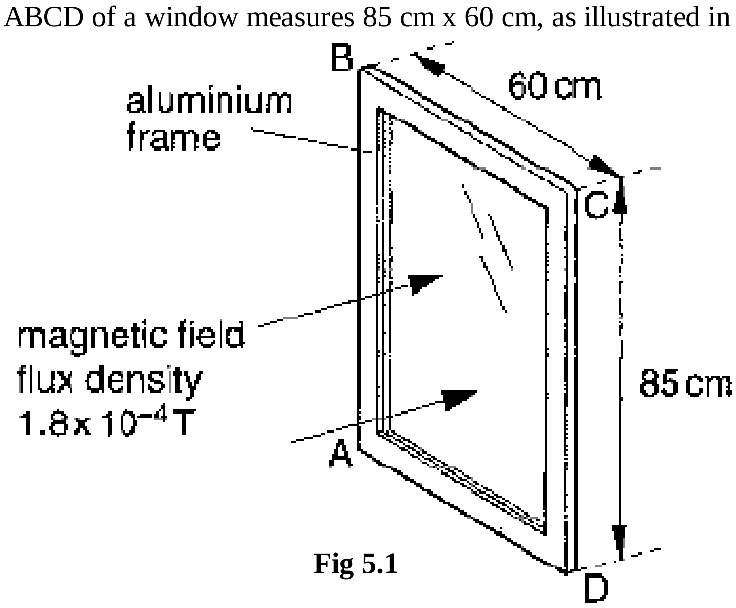

Fig 5.1

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The window is hinged along the edge AB.
When the window is closed, the horizontal component of Earth's magnetic effect, of flux density 1.8 x 10^{-4} T, is the normal to the window.

(i) Calculate the magnetic flux through the window.

Magnetic flux = ………………………… Wb [2]

(ii) The window is now opened in a time of 0.20 s. When open, the plane of the window is parallel to the Earth's magnetic field.
For the opening of the window,

1. state the change in the flux through the window,

change = ……………………………….. Wb.

2. calculate the average e.m.f. induced in the side CD of the frame.

e.m.f. = ……………………………… [3]

(iii) Suggest, with a reason, whether the e.m.f. calculated in (ii)2gives rise to a current in the frame ABCD.

……

…………………..………………………………………………………………………………………..…[1]

{*Q. 5/Nov. 2003/9702-4*}

Q. 6 A small coil is positioned so that its axis lies along the axis of a large bar magnet, as shown in Fig. 6.1.

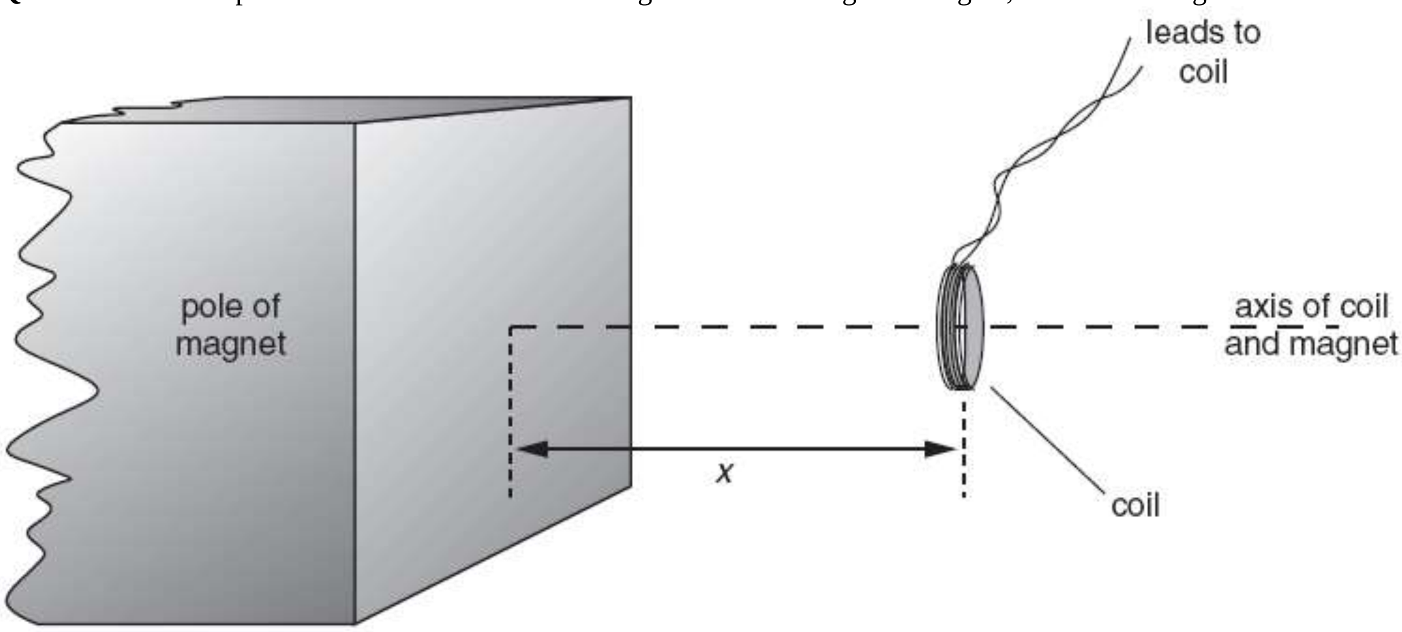

Fig. 6.1

The coil has a cross-sectional area of 0.40 cm^2 and contains 150 turns of wire.

The average magnetic flux density *B* through the coil varies with the distance *x* between the face of the magnet and the plane of the coil as shown in Fig. 6.2(next page).

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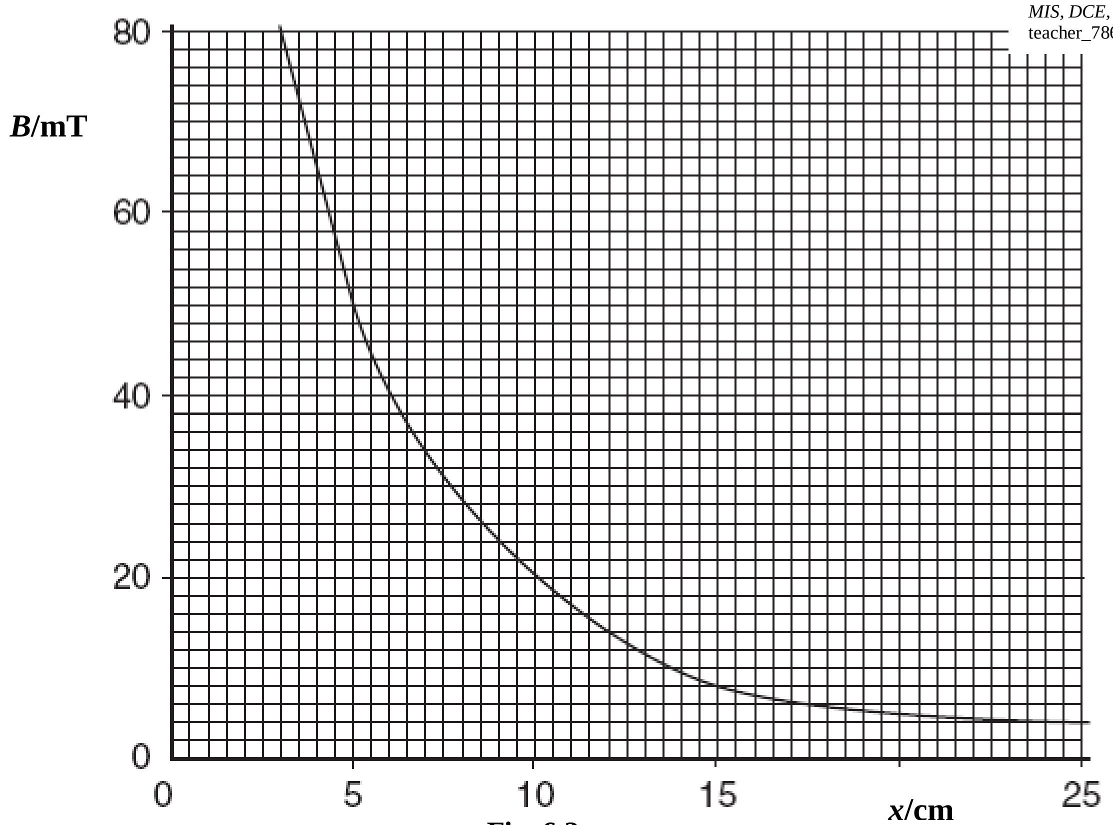

Fig. 6.2

(a) (i) The coil is 5.0 cm from the face of the magnet. Use Fig. 6.2 to determine the magnetic flux density in the coil.

magnetic flux density = ... T

(ii) Hence show that the magnetic flux linkage of the coil is 3.0×10^{-4} Wb.

[3]

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

....

....

....[2]

(c) The coil is moved along the axis of the magnet so that the distance x changes from x = 5.0 cm to x = 15.0 cm in a time of 0.30 s. Calculate

(i) the change in flux linkage of the coil,

change = ... Wb [2]

(ii) the average e.m.f. induced in the coil.

e.m.f. = ... V [2]

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(d) State and explain the variation, if any, of the speed of the coil so that the induced e.m.f. remains constant during the movement in **(c)**.

....

....

....[3]

{*Q.4/June 2004/9702-4*}

Q. 7 An ideal iron-cored transformer is illustrated in Fig. 7.1.

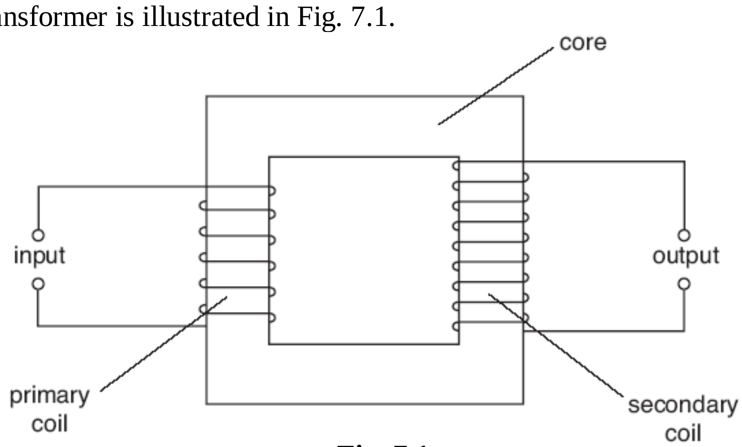

Fig. 7.1

(a) from Alternating Current topic [two parts of 4 marks]

(b) Fig. 7.2 shows the variation with time t of the current Ip in the primary coil. There is no current in the secondary coil.

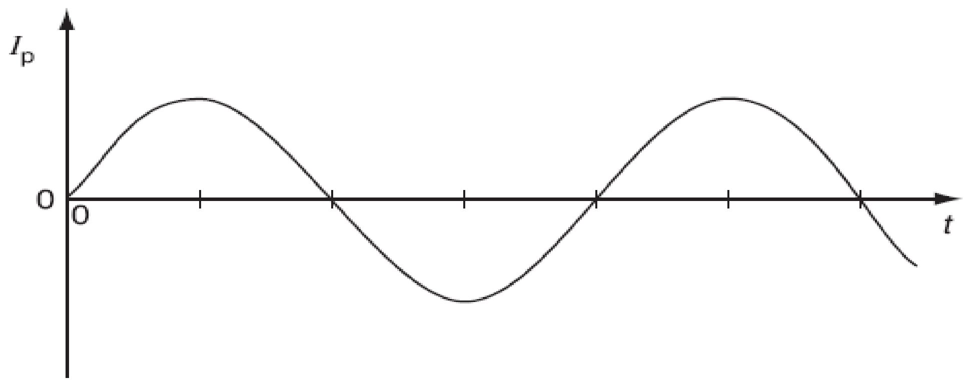

Fig. 7.2

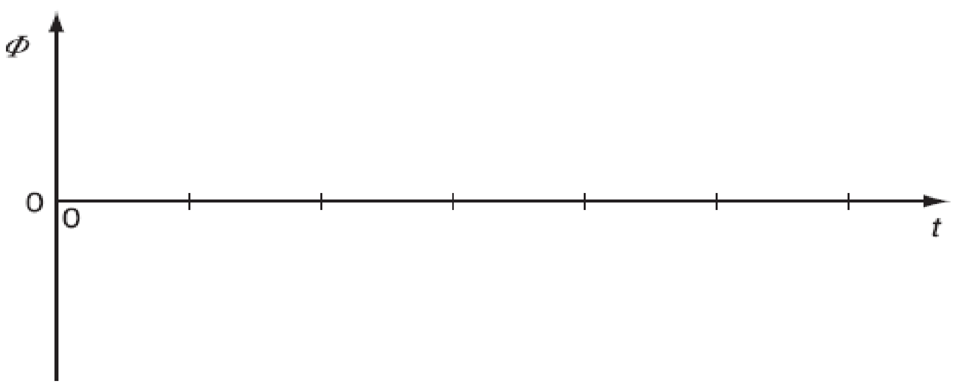

Fig. 7.3

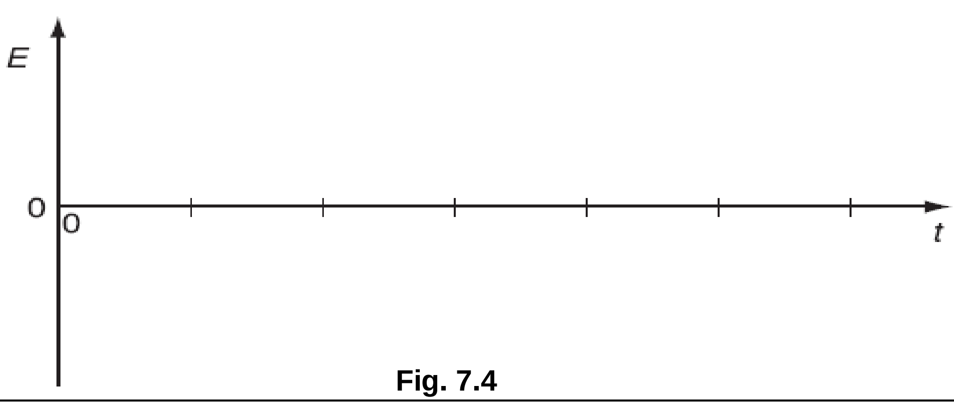

Fig. 7.4

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(i) Complete Fig. 7.3 to show the variation with time *t* of the magnetic flux *Φ* in the core. [1]

(ii) Complete Fig. 7.4 to show the variation with time *t* of the e.m.f. *E* induced in the secondary coil. [2]

(iii) Hence state the phase difference between the current *I*p in the primary coil and the e.m.f. *E* induced in the secondary coil.

phase difference = ... [1]

{*Q.6/June 2005/9702-4*}

Q. 8 (a) Define *magnetic flux density.*

....

....

....

.... [3]

(b) A flat coil consistes of *N* turns of wire and has area *A*. The coil is placed so that its plane is at an angle *θ* to a uniform magnetic field of flux density *B*, as shown in Fig. 8.1

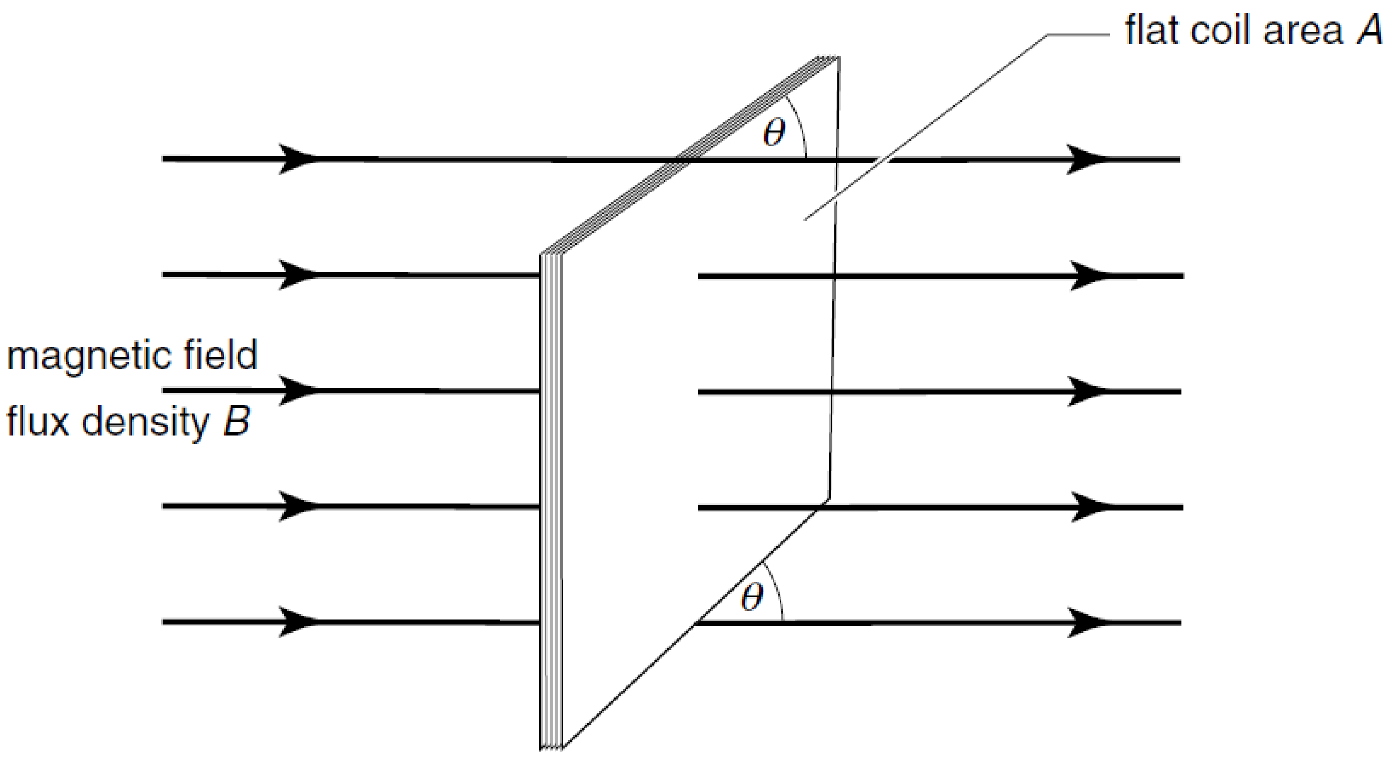


Fig. 8.1

Using the symbols *A*, *B*, *N* and *θ* and making reference to the magnetic flux in the coil, derive an expression for the magnetic flux linkage through the coil.

[2]

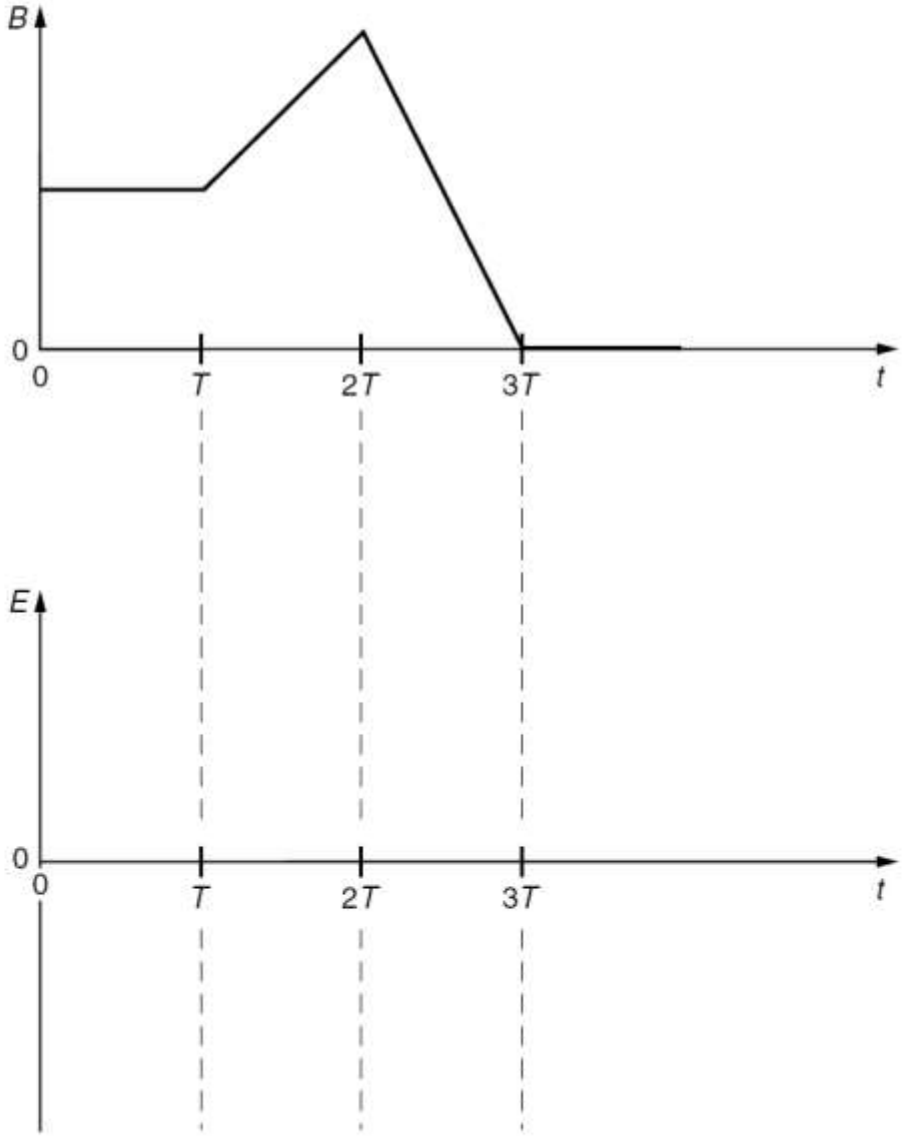
(c)(i) State Faraday's law of electromagnetic induction.

....

....

.... [2]

(ii) The magnetic flux density B in the coil is now made to vary with time t as shown in Fig. 8.2.



On Fig. 8.3, sketch the variation with time t of the e.m.f. E induced in the coil. [3]

{*Q. 6/Nov.2005/9702-4*}

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Q Fig.1 shows a light aluminium rod resting between the poles of a magnet. A current is passed through the rod from two brass strips connected to a power supply.

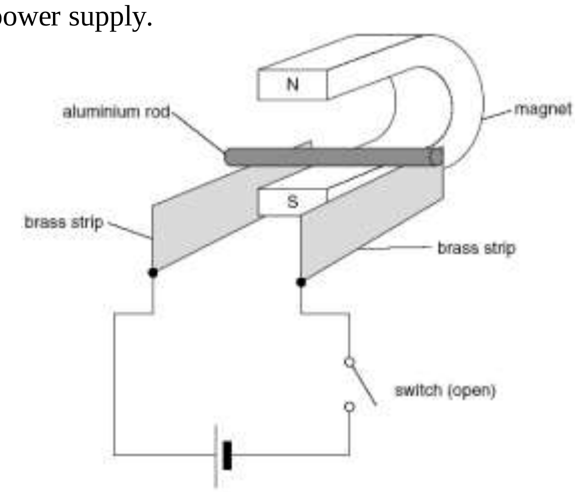

Fig. 1

(a) On Fig. 1, draw the direction of the current in the rod when the switch is closed. [1]

(b) State which way the rod moves when the switch is closed. Give a reason for your answer.

....

.... [2]

(c) State the effect on the movement of the rod when

(i) the current is increased,

....

(ii) the current is reversed.

.... [2]

Q. 3

(a) f_0 is at natural frequency of spring (system) B1
this is at the driver frequency .... B1 [2]
(allow 1 mark for recognition that this is resonance)

(b) line: amplitude less at all frequencies B1
peak flatter B1
peak at f_0 or slightly below f_0... B1 [3]

(c) (aluminium) sheet cuts the magnetic flux/field.............................. B1
(so) currents/e.m.f. <u>induced</u> in the (metal) sheet B1
these currents dissipate energy M1
less energy available for the oscillations A1
so amplitude smaller .... A0 [4]
('current opposes motion of sheet' scores one of the last two marks)

June 2004

(a) field producing force of 1.0 N m^{-1} on wire *OR* $B = F/IL\sin\theta$...........M1
carrying current of 1.0 A normal to field *OR* symbols explained ... A1 [2]

(b) (i) $\phi = BA$
$= 1.8 \times 10^{-4} \times 0.60 \times 0.85$ C1
$= 9.18 \times 10^{-5}$ Wb .... A1 [2]

(ii)1 $\Delta\phi = 9.18 \times 10^{-5}$ Wb.. A1

(ii)2 $e = (N\Delta\phi)/\Delta t$
$= (9.18 \times 10^{-5})/0.20$ C1
$= 4.59 \times 10^{-4}$ V .... A1 [3]

(iii) there is an e.m.f. and a complete circuit
OR no resultant e.m.f. from other three sides
OR no e.m.f. in AB so yes .... B1 [1]

June 2004

(a) e.g. amplitude is not constant or wave is damped B1
do not allow 'displacement constant'
should be (-)cos, (not sin) B1 **[2]**

(b) T = 0.60 s C1
$\omega = 2\pi/T$ = 10.5 rad s^{-1} *(allow 10.4 → 10.6)* A1 **[2]**

(c) same period B1
displacement always less M1
amplitude reducing appropriately A1 **[3]**
for 2nd and 3rd marks, ignore the first quarter period

Total **[7]**

Q. 8 Nov. 2005

(a)	(numerically equal to) force per unit length ………………………………	M1	
	on straight conductor carrying unit current ……………………………..	A1	
	normal to the field ………………………………………………………	A1	**[3]**
(b)	flux through coil = $BA \sin\theta$ …………………………………………….	B1	
	flux linkage = $BAN \sin\theta$ ………………………………………………	B1	**[2]**
(c)(i)	(induced) e.m.f. proportional to ………………………………………	M1	
	rate of change of flux (linkage) ………………………………………….	A1	**[2]**
(ii)	graph: two square sections in correct positions, zero elsewhere …..	B1	
	pulses in opposite directions ……………………………………	B1	
	amplitude of second about twice amplitude of first …………..	B1	**[3]**