A Level · OCR · Physics

37 mins   4 questions

Structured Questions

Electromagnetic Induction

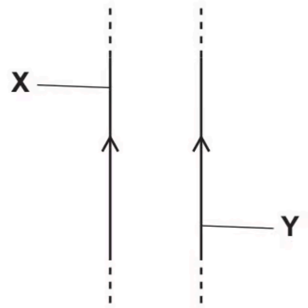
Magnetic Flux / Magnetic Flux Linkage / Faraday's & Lenz's Laws / Calculating Induced E.m.f / A.C Generator / Transformers

Easy (1 question)	/7
Medium (2 questions)	/19
Hard (1 question)	/11
Total Marks	**/37**

Scan here to return to the course
or visit savemyexams.com

Easy Questions

1 (a) The diagram below shows two long vertical current-carrying wires **X** and **Y**.



The direction of the current in each wire is the same.

Explain why wire **Y** experiences a force and deduce the direction of this force.

[3]

....

....

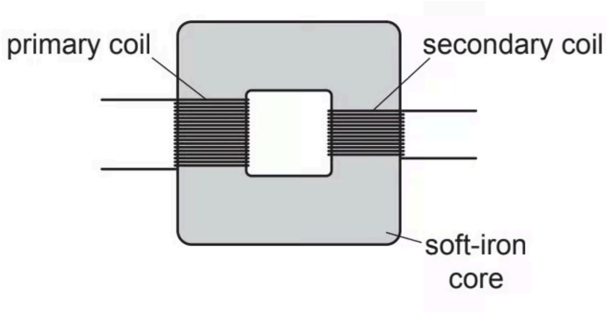
....

(3 marks)

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

[1]

ii) The diagram below shows a simple transformer constructed by a student.



Describe how the student can do an experiment in the laboratory to show that the maximum electromotive force (e.m.f.) *E* induced in the secondary coil is directly proportional to the number of turns *N* on the secondary coil.

[3]

(4 marks)

Medium Questions

1 (a) A student conducts an experiment to confirm that the uniform magnetic flux density B between the poles of a magnet is 30 mT.

A current-carrying wire of length 5.0 cm is placed perpendicular to the magnetic field.

The current I in the wire is changed and the force F experienced by the wire is measured. Fig. 22.1 shows the graph plotted by the student.

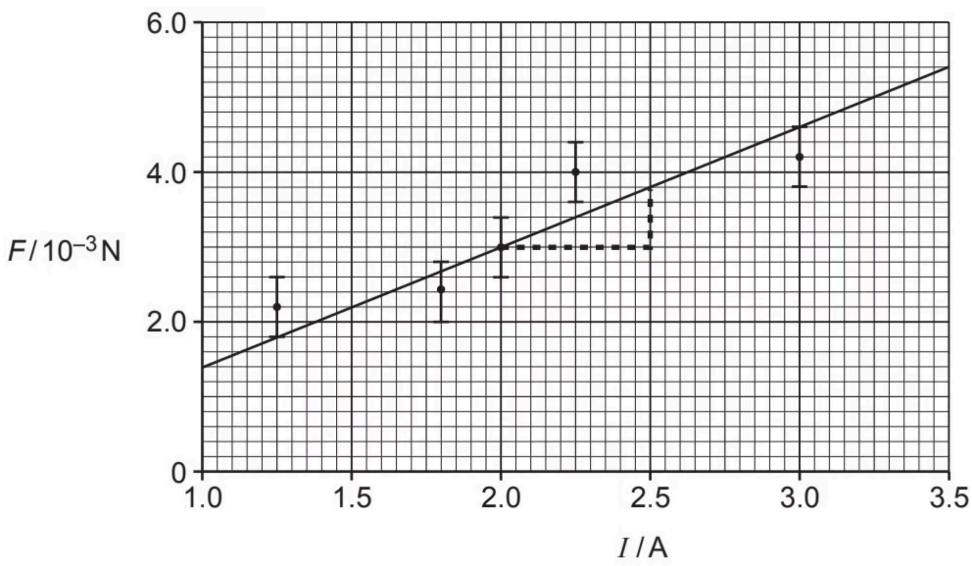


Fig. 22.1

The student's analysis is shown on the graph of Fig. 22.1 and in the space below.

$F = BIL$ gradient $= BL = \dfrac{(3.8 - 3.0) \times 10^{-3}}{2.5 - 2.0} = 0.0016$

$B = \dfrac{0.0016}{0.05} = 0.032$ T = 32 mT

This is just 2 mT out from the 30 mT value given by the manufacturer, so the experiment is very accurate.

Evaluate the information from Fig. 22.1 and the analysis of the data from the experiment. No further calculations are necessary.

[6]

(6 marks)

(b) b)

Fig. 22.2 shows a transformer circuit.

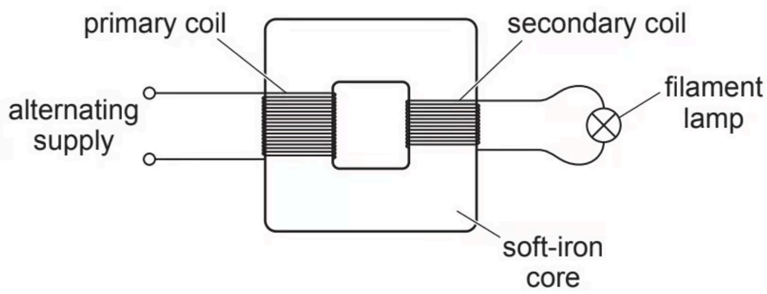


Fig. 22.2

The primary coil is connected to an alternating voltage supply. A filament lamp is connected to the output of the secondary coil.

i) Use Faraday's law of electromagnetic induction to explain why the filament lamp is lit.

[3]

ii) The primary coil has 400 turns and the secondary coil has 20 turns. The potential difference across the lamp is 12 V and it dissipates 24 W. The transformer is 100%

efficient.

1. Calculate the current in the primary coil.

current = ... A **[2]**

2. The alternating voltage supply is replaced by a battery and an open switch in series. The switch is closed. The lamp is lit for a short period of time and then remains off.

Explain this observation.

[2]

....

....

....

....

....

....

....

(7 marks)

2 (a) Fig. 21.1 shows a coil of a simple generator rotating in a uniform magnetic field.

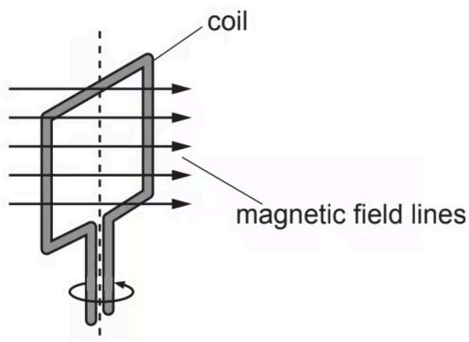


Fig. 21.1

The coil has 85 turns of insulated wire. The cross-sectional area of the coil is 14cm^2. Fig. 21.2 shows the variation of magnetic flux density B through the plane of the coil with time t as it rotates.

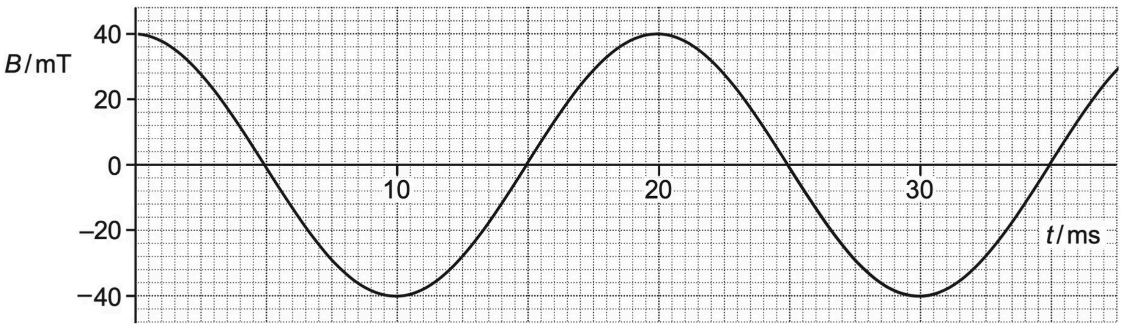


Fig. 21.2

i) Explain why the electromotive force (e.m.f.) induced across the ends of the coil is a **maximum** at the times when B = 0.

[1]

ii) Draw a tangent to the curve in Fig. 21.2 when B = 0, and hence determine the **maximum** e.m.f. induced across the ends of the coil.

maximum e.m.f. = ... V **[3]**

(4 marks)

(b) Fig. 21.3 shows the variation of the e.m.f. induced across the ends of the coil with time t.

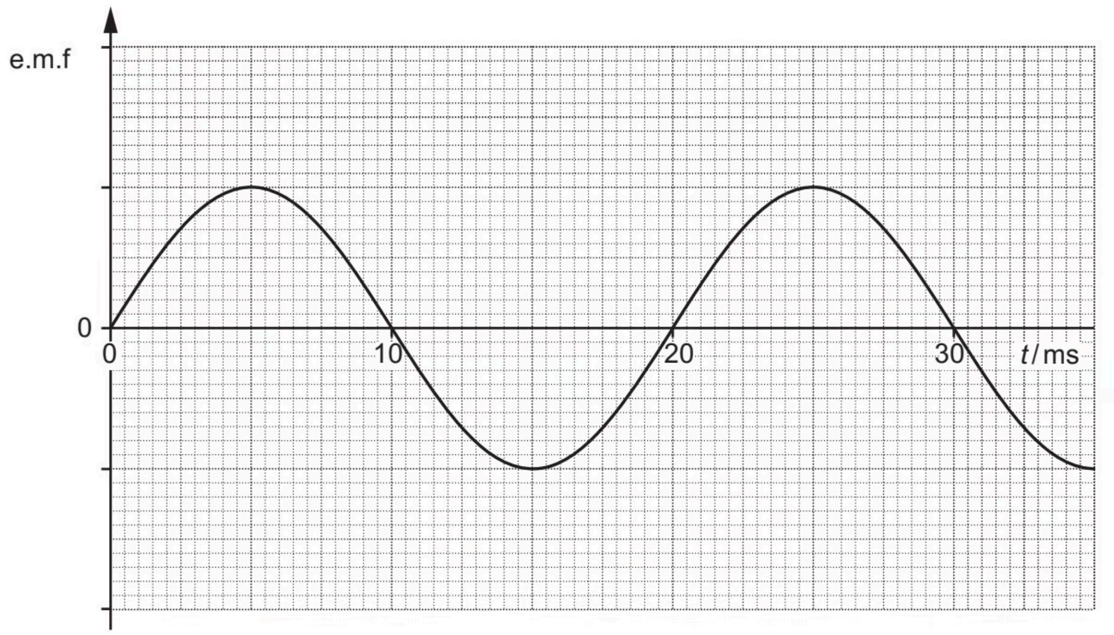


Fig. 21.3

The magnitude of the magnetic flux density of the uniform field is now halved and the coil is rotated at twice its previous frequency. On Fig. 21.3 sketch the new variation of the e.m.f. induced with time t.

[2]

(2 marks)

Hard Questions

1 (a) A magnet rotates inside a shaped soft iron core. A coil is wrapped around the iron core as shown in Fig. 5.1. The coil is connected to an oscilloscope.

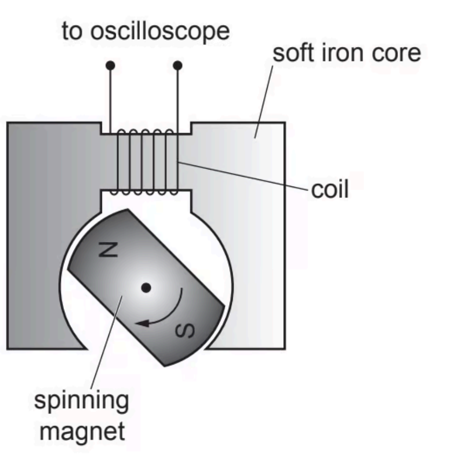


Fig. 5.1

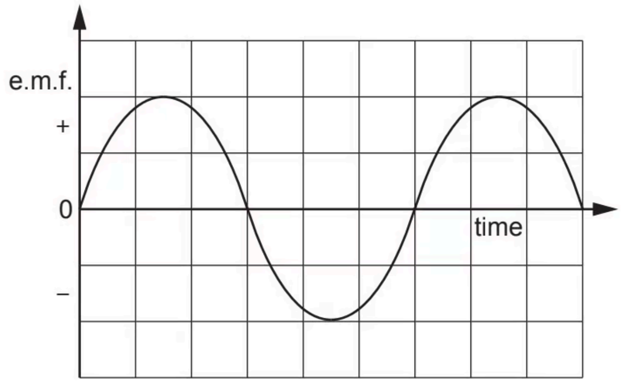


Fig. 5.2

The spinning magnet induces an e.m.f. in the coil. A graph of the e.m.f. displayed on the oscilloscope screen is shown in Fig. 5.2.

i) Explain the shape of the graph in terms of the magnetic flux linking the coil.

[2]

ii) On Fig. 5.3 sketch a graph of the magnetic flux linkage of the coil against time. The variation of the induced e.m.f. across the coil is shown as a dotted line.

[1]

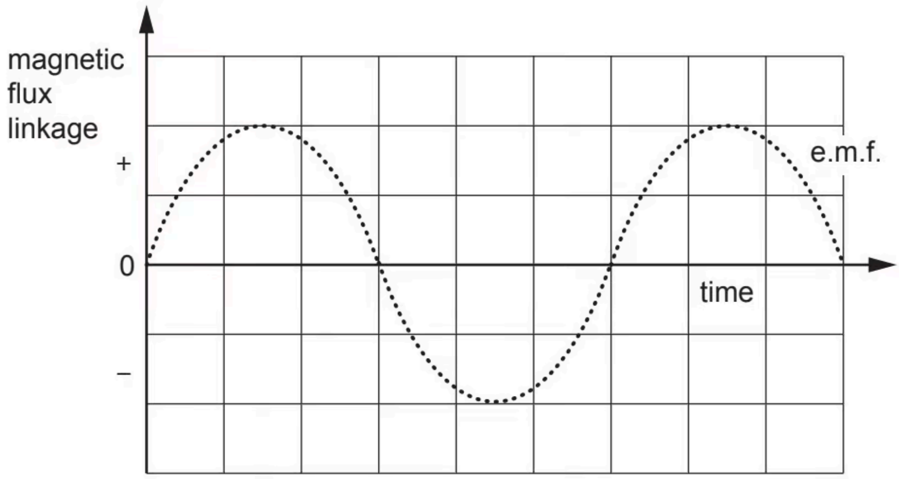


Fig. 5.3

iii) The coil shown in Fig. 5.1 has 150 turns. The maximum induced e.m.f. V_0 across the coil is 1.2 V when the magnet is rotating at 24 revolutions per second.

Calculate the maximum magnetic flux through the coil using the equation

$$V_0 = 2\pi \times (\text{frequency}) \times (\text{maximum magnetic flux linkage})$$

Give a unit with your answer.

maximum flux = ... unit .... **[2]**

....

....

....

....

....

(5 marks)

(b) A student is given a transformer with coils **X** and **Y**, as shown in Fig. 5.4.

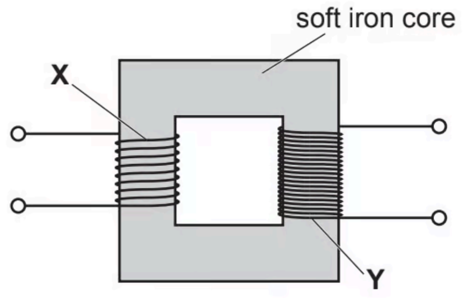


Fig. 5.4

The student is intending to investigate how the maximum induced e.m.f. V_0 in coil **Y** depends on the frequency f of the alternating current in coil **X**.

The changing magnetic flux density in coil **X** induces an e.m.f. in coil **Y**. Faraday's law indicates that the maximum induced e.m.f. V_0 should be directly proportional to f.

Describe how you would investigate the suggested relationship between V_0 and f in the laboratory using these coils. In your description include all of the equipment used and how you would analyse the data collected.

Use the space below to draw a suitable diagram.

[6]

....

....

....

....

....

....

(6 marks)