

1

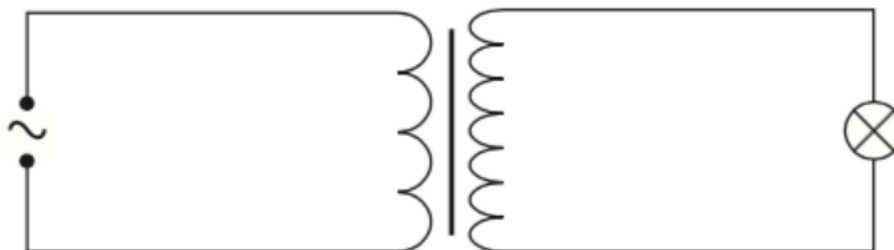
Which line, **A** to **D**, gives correct units for both magnetic flux and magnetic flux density?

	magnetic flux	magnetic flux density
A	Wb m^{-2}	Wb
B	Wb	T
C	Wb m^{-2}	T m^{-2}
D	T m^{-2}	Wb m^{-2}

(Total 1 mark)

2

The primary coil of a step-up transformer is connected to a source of alternating pd. The secondary coil is connected to a lamp.



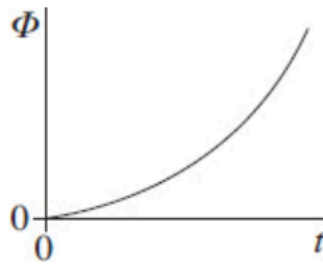
Which line, **A** to **D**, in the table correctly describes the ratios of flux linkages and currents through the secondary coil in relation to the primary coil?

	Secondary magnetic flux linkage Primary magnetic flux linkage	Secondary current Primary current
A	< 1	< 1
B	> 1	< 1
C	> 1	> 1
D	< 1	> 1

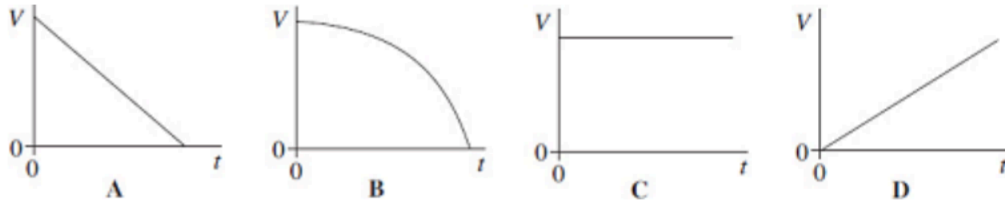
(Total 1 mark)

3

The graph shows how the magnetic flux, Φ , passing through a coil changes with time, t .



Which one of the following graphs could show how the magnitude of the emf, V , induced in the coil varies with t ?



(Total 1 mark)

4

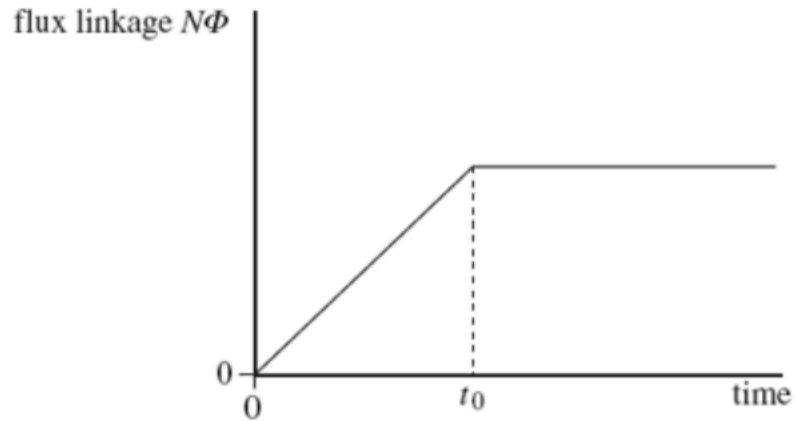
A 500 turn coil of cross-sectional area $4.0 \times 10^{-3} \text{ m}^2$ is placed with its plane perpendicular to a magnetic field of flux density $7.5 \times 10^{-4} \text{ T}$. What is the value of the flux linkage for this coil?

- A $3.0 \times 10^{-6} \text{ Wb turns}$
- B $1.5 \times 10^{-3} \text{ Wb turns}$
- C 0.19 Wb turns
- D 94 Wb turns

(Total 1 mark)

5

The graph shows how the flux linkage, $N\Phi$, through a coil changes when the coil is moved into a magnetic field.

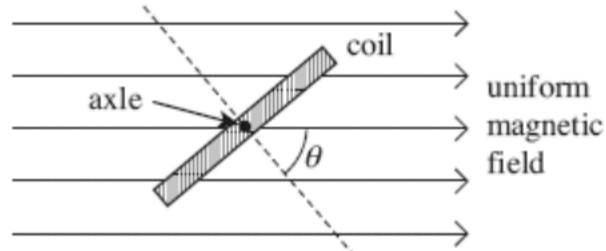


The emf induced in the coil

- A increases then becomes constant after time t_0 .
- B is constant then becomes zero after time t_0 .
- C is zero then increases after time t_0 .
- D decreases then becomes zero after time t_0 .

(Total 1 mark)

6



A coil of 50 turns has a cross-sectional area of $4.2 \times 10^{-3} \text{ m}^2$. It is placed at an angle to a uniform magnetic field of flux density $2.8 \times 10^{-2} \text{ T}$, as shown in the diagram, so that angle $\theta = 50^\circ$.

What is the change in flux linkage when the coil is rotated anticlockwise until $\theta = 0^\circ$?

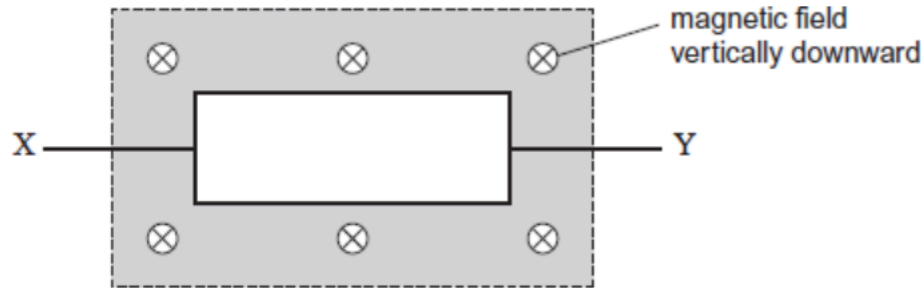
- A The flux linkage decreases by $2.1 \times 10^{-3} \text{ Wb turns}$.
- B The flux linkage increases by $2.1 \times 10^{-3} \text{ Wb turns}$.
- C The flux linkage decreases by $3.8 \times 10^{-3} \text{ Wb turns}$.
- D The flux linkage increases by $3.8 \times 10^{-3} \text{ Wb turns}$.

(Total 1 mark)

7

A rectangular coil of area A has N turns of wire. The coil is in a uniform magnetic field, as shown in the diagram.

When the coil is rotated at a constant frequency f about its axis XY , an alternating emf of peak value ε_0 is induced in it.



What is the maximum value of the magnetic flux linkage through the coil?

- A $\frac{\varepsilon_0}{2\pi f}$
- B $\frac{\varepsilon_0}{\pi f}$
- C $\pi f \varepsilon_0$
- D $2\pi f \varepsilon_0$

(Total 1 mark)

8

The magnetic flux through a coil of N turns is increased uniformly from zero to a maximum value in a time t . An emf, E , is induced across the coil.

What is the maximum value of the magnetic flux through the coil?

- A $\frac{Et}{N}$
- B $\frac{N}{Et}$
- C EtN
- D $\frac{E}{Nt}$

(Total 1 mark)

9

An aircraft, of wing span 60 m, flies horizontally at a speed of 150 m s^{-1} . If the vertical component of the Earth's magnetic field in the region of the plane is $1.0 \times 10^{-5} \text{ T}$, what is the magnitude of the magnetic flux cut by the wings in 10 s?

- A $1.0 \times 10^{-5} \text{ Wb}$
- B $1.0 \times 10^{-4} \text{ Wb}$
- C $9.0 \times 10^{-2} \text{ Wb}$
- D $9.0 \times 10^{-1} \text{ Wb}$

(Total 1 mark)

10

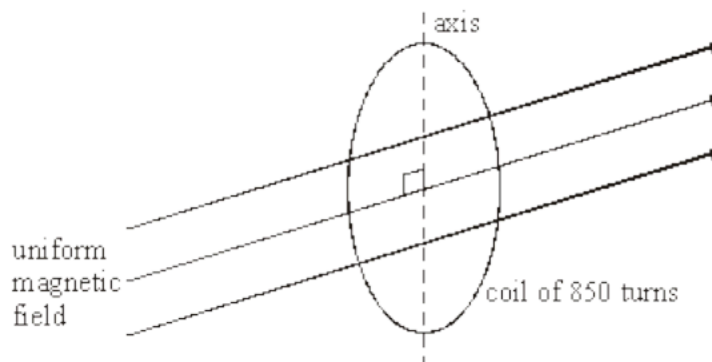


Figure 1

A circular coil of diameter 140 mm has 850 turns. It is placed so that its plane is perpendicular to a horizontal magnetic field of uniform flux density 45 mT, as shown in **Figure 1**.

- (a) Calculate the magnetic flux passing through the coil when in this position.

(2)

- (b) The coil is rotated through 90° about a vertical axis in a time of 120 ms.

Calculate

- (i) the change of magnetic flux linkage produced by this rotation,

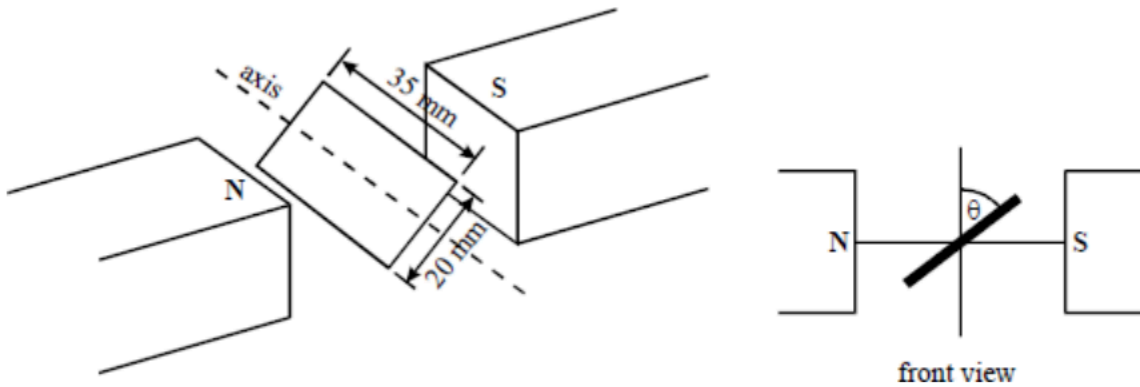
- (ii) the average emf induced in the coil when it is rotated.

(4)

(Total 6 marks)

11

A rectangular coil measuring 20 mm by 35 mm and having 650 turns is rotating about a horizontal axis which is at right angles to a uniform magnetic field of flux density $2.5 \times 10^{-3} \text{ T}$. The plane of the coil makes an angle θ with the vertical, as shown in the diagrams.



- (a) State the value of θ when the magnetic flux through the coil is a minimum.

(1)

- (b) Calculate the magnetic flux passing through the coil when θ is 30° .

(2)

- (c) What is the maximum *flux linkage* through the coil as it rotates?

(2)

(Total 5 marks)

12

- (a) Explain what is meant by the term *magnetic flux linkage*. State its unit.

(2)

- (b) Explain, in terms of electromagnetic induction, how a transformer may be used to step down voltage.

(4)

- (c) A minidisc player is provided with a mains adapter. The adapter uses a transformer with a turns ratio of 15:1 to step down the mains voltage from 230 V.

- (i) Calculate the output voltage of the transformer.

(2)

- (ii) State **two** reasons why the transformer may be less than 100% efficient.

(2)

(Total 10 marks)

Mark schemes

1	B		[1]
2	B		[1]
3	D		[1]
4	B		[1]
5	B		[1]
6	B		[1]
7	A		[1]
8	A		[1]
9	D		[1]
10	(a) $\Phi (= BA) = 45 \times 10^{-3} \times \pi \times (70 \times 10^{-3})^2$ (1) $= 6.9 \times 10^{-4} \text{ Wb}$ (1) ($6.93 \times 10^{-4} \text{ Wb}$) (b) (i) $N\Delta\Phi (= NBA - 0) = 850 \times 6.93 \times 10^{-4}$ (1) $= 0.59 \text{ (Wb turns)}$ (1) (0.589 (Wb turns)) (if $\Phi = 6.9 \times 10^{-4}$, then 0.587 (Wb turns)) (allow C.E. for value of Φ from (a)) (ii) induced emf $(= N \frac{\Delta\Phi}{\Delta t}) = \frac{0.589}{0.12}$ (1) $= 4.9 \text{ V}$ (1) (4.91 V) (allow C.E. for value of Wb turns from (ii))		
11	(a) $\theta = 90^\circ$ (or 270° or $\frac{\pi}{2}$ or $\frac{3\pi}{2}$) (1)		

2

4

[6]

(b) $\Phi = BA \cos\theta$ (1)
 $= 2.5 \times 10^{-3} \times 35 \times 10^{-3} \times 20 \times 10^{-3} \times \cos 30^\circ = 1.5 \times 10^{-6} \text{ Wb}$ (1)

2

(c) $\Phi_{\max} = 2.5 \times 10^{-3} \times 35 \times 10^{-3} \times 20 \times 10^{-3} \text{ (Wb)}$ (1) ($= 1.75 \times 10^{-6}$)
 flux linkage $= 650 \times 1.75 \times 10^{-6} = 1.1(4) \times 10^{-3} \text{ (Wb turns)}$ (1)

2

[5]

12

(a) product of flux and number of turns

B1

Wb or equivalent

C1

(2)

(b) changing primary magnetic field due to alternating voltage

B1

(applied to primary)

varying flux links with secondary

B1

induced emf $\propto$ rate of change of flux linkage

B1

$N_S < N_P$ so less voltage on secondary

C1

(4)

(c) (i) equation or correct substitution

C1

15.3 V

A1

(2)

(ii) <100% flux linkage / flux leakage / copper losses / iron losses / hysteresis losses **not** just "heating" or "heat loss"

B2

(2)

[10]