10 Worksheet

Intermediate level

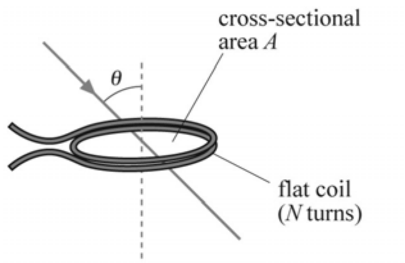
1 A flat coil of N turns and cross-sectional area A is placed in a uniform magnetic field of flux density B. The plane of the coil is normal to the magnetic field.

a Write an equation for:

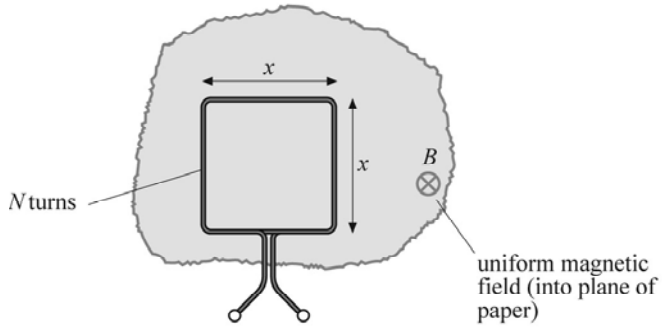
i the magnetic flux ϕ through the coil [1]

ii the magnetic flux linkage for the coil. [1]

b The diagram shows the coil when the magnetic field is at an angle θ to the normal of the plane of the coil.
What is the flux linkage for the coil? [1]



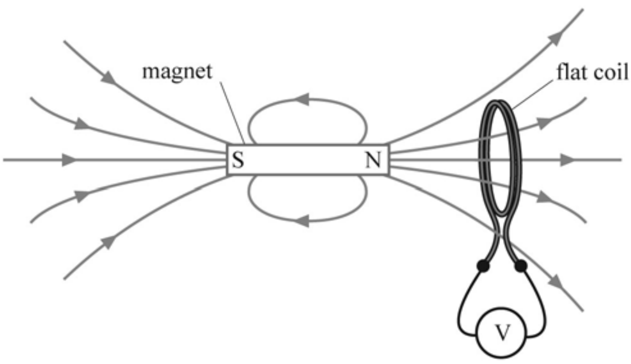
2 A square coil of N turns is placed in a uniform magnetic field of magnetic flux density B.
Each side of the coil has length x.
What is the magnetic flux linkage for this coil? [2]



3 The diagram shows a magnet placed close to a flat circular coil.

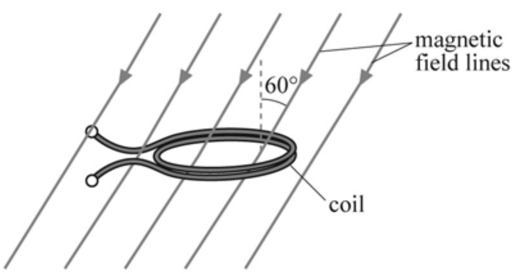
a Explain why there is no induced e.m.f. even though there is magnetic flux linking the coil. [1]

b Explain why there is an induced e.m.f. when the magnet is pushed towards the coil. [2]



4 A coil of cross-sectional area 4.0×10^{-4} m^2 and 70 turns is placed in a uniform magnetic field.

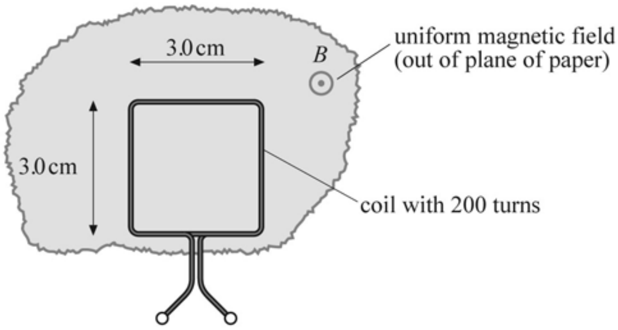
a The plane of the coil is at right-angles to the magnetic field.
Calculate the magnetic flux density when the flux linkage for the coil is 1.4×10^{-4} Wb. [3]



b The coil is placed in a magnetic field of flux density 0.50 T.
The normal to the coil is at an angle of 60° to the magnetic field, as shown in the diagram.
Calculate the flux linkage for the coil. [3]

5 A square coil is placed in a uniform magnetic field of flux density 40 mT.

The plane of the coil is normal to the magnetic field. The coil has 200 turns and the length of each side of the coil is 3.0 cm.



a Calculate:

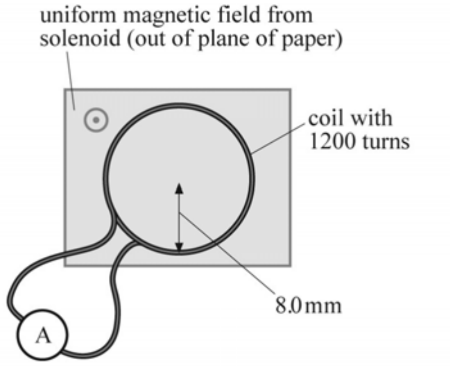
i the magnetic flux ϕ through the coil [2]

ii the magnetic flux linkage for the coil. [2]

b The plane of the coil is turned through 90°. What is the change in the magnetic flux linkage for the coil? [2]

Higher level

6 A flat circular coil of 1200 turns and of mean radius 8.0 mm is connected to an ammeter of negligible resistance. The coil has a resistance of 6.3 Ω. The plane of the coil is placed at right-angles to a magnetic field of flux density 0.15 T from a solenoid.

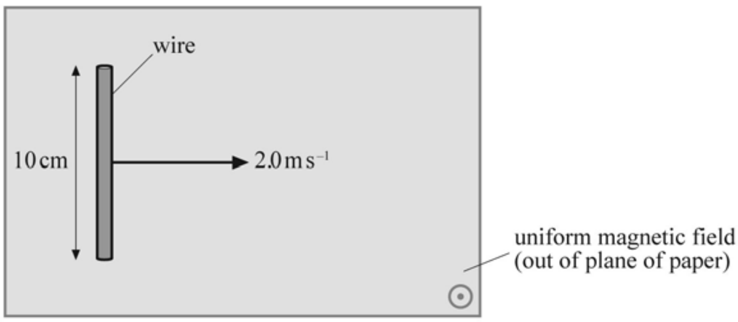


The current in the solenoid is switched off. It takes 20 ms for the magnetic field to decrease from its maximum value to zero. Calculate:

a the average magnitude of the induced e.m.f. across the ends of the coil [5]

b the average current measured by the ammeter. [2]

7 The diagram shows a straight wire of length 10 cm moved at a constant speed of 2.0 m s^{-1} in a uniform magnetic field of flux density 0.050 T.



For a period of 1 second, calculate:

a the distance travelled by the wire [1]

b the area swept by the wire [1]

c the change in the magnetic flux for the wire (or the magnetic flux ‘cut’ by the wire) [2]

d the e.m.f. induced across the ends of the wire using your answer to **c** [2]

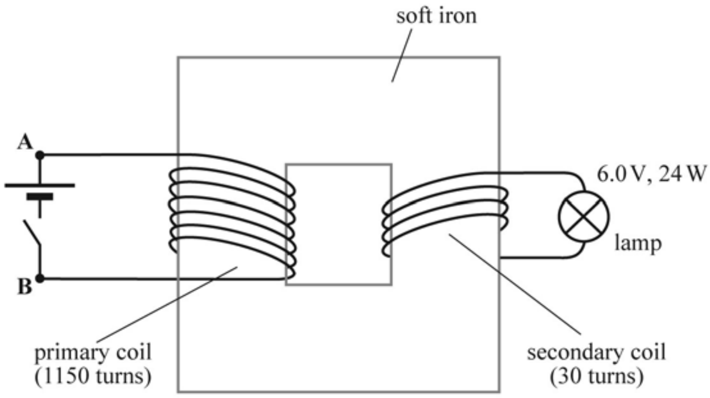
e the e.m.f. induced across the ends of the wire using $E = BvL$. [1]

8 A circular coil of radius 1.2 cm has 2000 turns. The coil is placed at right-angles to a magnetic field of flux density 60 mT. Calculate the average magnitude of the induced e.m.f. across the ends of the coil when the direction of the magnetic field is *reversed* in a time of 30 ms. [5]

Extension

9 The diagram below shows a step-up transformer.

The primary coil has 1150 turns and the secondary coil has 30 turns. The ends of the secondary coil are connected to a lamp labelled as '6.0 V, 24 W'. The ends **AB** of the primary coil are connected to a 1.5 V cell and a switch. The switch is initially closed and the lamp is off. The switch is suddenly opened and the lamp illuminates for a short time.



a Explain why the lamp illuminates only for a short period. [4]

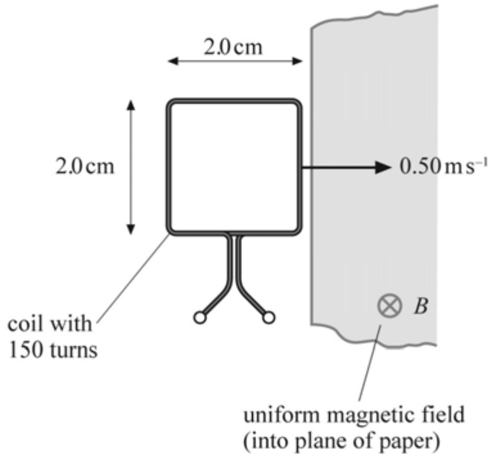
b The cell and the switch are disconnected from the primary coil. The ends **AB** are now connected to an alternating voltage supply. The potential difference across the lamp is 6.0 V.

i Calculate the current in the lamp. [2]

ii What is the input voltage to the primary coil? [2]

10 The diagram shows a square coil about to enter a region of uniform magnetic field of magnetic flux density 0.30 T.

The magnetic field is at right-angles to the plane of the coil. The coil has 150 turns and each side is 2.0 cm in length. The coil moves at a constant speed of 0.50 m s^{-1}.



a **i** Calculate the time taken for the coil to enter completely the region of magnetic field. [1]

ii Determine the magnetic flux linkage through the coil when it is all within the region of magnetic field. [2]

b Explain why the induced e.m.f. is constant when the coil is entering the magnetic field. [1]

c Use your answer to **a** to determine the induced e.m.f. across the ends of the coil. [4]

d What is the induced e.m.f. across the ends of the coil when it is completely within the magnetic field? Explain your answer. [2]

11 A wire of length L is placed in a uniform magnetic field of flux density B.
The wire is moved at a constant velocity v at right-angles to the magnetic field.
Use Faraday's law of electromagnetic induction to show that the induced e.m.f. E across the ends of the wire is given by $E = BvL$.

Hence calculate the e.m.f. induced across the ends of a 20 cm long rod rolling along a horizontal table at a speed of 0.30 m s^{-1}. (The vertical component of the Earth's magnetic flux density is about 40 μT.) [8]

Total: $\frac{\quad\quad}{65}$ Score: %

