Essential Pre-Uni Physics H7.1

A Level

Complete the questions in the table. Give your answers to 2 significant figures.

Magnetic flux density / T	Area of coil	Angle between plane of coil and magnetic field lines / $^\circ$	Number of turns	Magnetic flux linkage / $\mathrm{Wb\,turns}$
2.0	$2.0\,\mathrm{m} \times 1.0\,\mathrm{m}$	90	40	(a)
0.00232	$5.0\,\mathrm{cm} \times 5.0\,\mathrm{cm}$	60	2400	(b)

Part A First row

a) What is the magnetic flux linkage?

Part B Second row

b) What is the magnetic flux linkage?

Essential Pre-Uni Physics H7.4

A Level

Part A Rate of change of flux linkage

Calculate the rate of change in the magnetic flux linkage in a $400\,\mathrm{turn}$ coil of area $3.0 \times 10^{-4}\,\mathrm{m}^2$ when the magnetic field is reduced from $0.20\,\mathrm{T}$ to zero in $0.40\,\mathrm{s}$. Assume that the field lines are perpendicular to the plane of the coil.

Part B Induced voltage

What is the voltage induced across the coil? Give your answer to 2 significant figures.

Gameboard:
STEM SMART Physics 41 - School of Fields - Induction

Essential Pre-Uni Physics H7.5

A Level

Complete the questions in the table. Give your answers to 2 significant figures.

Initial flux linkage / $\mathrm{Wb\,turns}$	Final flux linkage / $\mathrm{Wb\,turns}$	Time taken for flux to change / s	Voltage induced / V
30	60	0.2	(a)
200	0	(b)	400

Part A Voltage induced

a) What is the induced voltage to 2 significant figures?

Part B Time taken for flux to change

b) What is the time taken for the flux to change to 2 significant figures?

Gameboard:
STEM SMART Physics 41 - School of Fields - Induction

Essential Pre-Uni Physics H7.6

A Level

Part A Induced voltage

a) A single turn coil of $10\,\mathrm{cm} \times 5.0\,\mathrm{cm}$ sits, stationary, in a $21000\,\mathrm{T}$ magnetic field, at right angles to the plane of the coil. What is the voltage induced across the ends of the wire?

Part B Increasing the area

b) The coil is made using flexible wiring. The coil area is increased steadily to $10\,\mathrm{cm} \times 10\,\mathrm{cm}$ by stretching it over the course of $0.020\,\mathrm{s}$. Calculate the voltage induced across the ends of the wire.

Part C Field parallel to the wires

c) What would the answer to part (b) have been if the magnetic field were parallel to the sides of the coil which were originally $5.0\,\mathrm{cm}$ long?

Gameboard:
STEM SMART Physics 41 - School of Fields - Induction

Electromagnetic Induction - Moving Wire 21.1

A Level

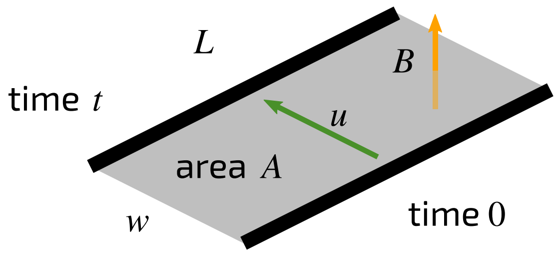

Figure 1: A wire is moved through the magnetic field. The magnetic field is perpendicular to both the wire and the velocity.

Quantities:

B magnetic flux density (T)
u speed of wire $(\mathrm{m\,s^{-1}})$
w distance moved by wire (m)
V induced voltage (V)
L wire length (m)
t time taken (s)

A area swept through $(\mathrm{m^2})$
q charge of carriers (C)
F_{B} magnetic force (N)
F_{E} electric force (N)
E electric field $(\mathrm{N\,C^{-1}})$

Equations:

$$A = Lw \qquad w = ut \qquad V = \frac{\mathrm{d}(BA)}{\mathrm{d}t} = \frac{BA}{t}$$

$$F_{\mathrm{B}} = quB \qquad F_{\mathrm{E}} = qE \qquad E = V/L$$

Use the equations above to write down expressions for:

Part A Area swept out

the area A swept through by the wire using u, Δt and L.

The following symbols may be useful: `A, Delta t, L, u`

Part B Magnetic flux cut

the magnetic flux BA cut by the wire using u, Δt and L.

The following symbols may be useful: `A, B, Delta t, L, u`

Part C Rate of flux cutting

the rate of cutting flux $\mathrm{d}(BA)/\mathrm{d}t$.

The following symbols may be useful: `A, A, B, B, Derivative(_, t), E, L, V, q, t, u`

Part D Voltage induced in the wire

the voltage V induced in the wire by Faraday's Law.

The following symbols may be useful: `A, B, E, L, V, q, t, u`

Part E Magnetic force on a charge q inside the wire

the magnetic force on a charge q inside the wire.

The following symbols may be useful: `A, B, E, F, L, V, q, t, u`

Part F Equivalent electric field

the strength of an electric field E along the wire that could produce the same force on the charge.

The following symbols may be useful: `A, B, E, L, q, t, u`

Part G Voltage between wire ends

the voltage V that would exist between the ends of the wire, if that electric field was uniform.

The following symbols may be useful: `A, B, E, L, V, q, t, u`

Gameboard:
STEM SMART Physics 41 - School of Fields - Induction

Electromagnetic Induction - Rotating Coil 22.1

A Level

A generator contains a coil of wire rotating uniformly in a uniform magnetic field.

Quantities:

ε EMF (V)
N number of turns
ϕ magnetic flux (Wb)
B flux density (T)
A_0 coil area (m^2)
t time (s)

A component of coil area linking flux (m^2)
ω angular frequency $(\mathrm{rad\,s^{-1}})$
Subscript $_{\mathrm{rms}}$ represents root mean square values
$\frac{\mathrm{d}}{\mathrm{d}t}$ means *rate of change of a quantity*

Equations:

$$\varepsilon = -N\frac{\mathrm{d}\phi}{\mathrm{d}t} \qquad \phi = BA \qquad A = A_0\cos\omega t$$

$$\varepsilon_{\mathrm{rms}} = \sqrt{(\varepsilon^2)_{\mathrm{mean}}} \qquad \frac{\mathrm{d}\cos\omega t}{\mathrm{d}t} = -\omega\sin\omega t$$

Use the equations above to derive expressions for:

Part A Magnetic flux

the magnetic flux ϕ in terms of B, A_0 and t.

The following symbols may be useful: `A_0, B, cos(), omega, phi, sin(), t, tan()`

Part B EMF

the EMF ε in terms of B, A_0, N, ω and t.

The following symbols may be useful: `A_0, B, N, cos(), epsilon, omega, sin(), t, tan()`

Part C Maximum EMF

the maximum EMF $\varepsilon_{\mathrm{max}}$.

The following symbols may be useful: `A_0, B, N, cos(), epsilon_max, omega, sin(), t, tan()`

Part D RMS EMF

the root mean squared EMF $\varepsilon_{\mathrm{rms}}$ in terms of $\varepsilon_{\mathrm{max}}$.

The following symbols may be useful: `epsilon_max`, `epsilon_rms`

Gameboard:

STEM SMART Physics 41 - School of Fields - Induction

Electromagnetic Induction - Rotating Coil 22.3

A Level

A $5.00\,\mathrm{cm}$ long square coil with 10 turns is slowly rotated in a magnetic field of $80.0\,\mathrm{mT}$ at a rate of $20.0\,\mathrm{rpm}$ (revolutions per minute). Calculate

Part A Angular frequency

Calculate the angular frequency in $\mathrm{rad\,s^{-1}}$.

Part B EMF induced

Calculate the magnitude of the EMF induced $1.00\,\mathrm{s}$ after the EMF was zero.

Part C Maximum EMF induced

The magnitude of the maximum EMF induced.

Gameboard:

STEM SMART Physics 41 - School of Fields - Induction

Essential Pre-Uni Physics H8.9

GCSE A Level

All transformers are perfectly efficient unless you are told otherwise.

Calculate the current in the load fed by the secondary of a 90% efficient step down transformer where the primary has $50\times$ as many turns as the secondary, and where the primary current is $5.0\,\mathrm{A}$? Give your answer to 3 significant figures.