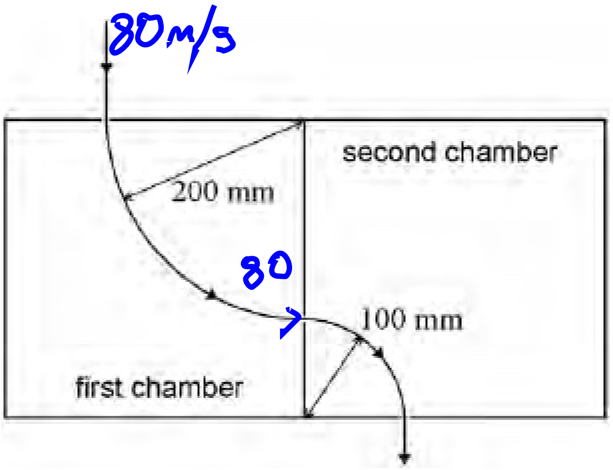
1 Different magnetic fields are present in the two chambers shown. A particle enters the first chamber at a velocity of 80 m s^{-1} and is deflected into a circular path of radius 200 mm
In the second chamber it follows a circular path of radius 100 mm



The particle leaves the second chamber at a speed of

its velocity wont change. It will be deflected into a circular motion which has a radius dependent on that velocity, the mass, and the force.

A 20 m s^{-1} ○

B 40 m s^{-1} ○

[✓ **C**] 80 m s^{-1} ○

D 160 m s^{-1} ○

(Total 1 mark)

2 A coil with 20 circular turns each of diameter 60 mm is placed in a uniform magnetic field of flux density 90 mT.

Initially the plane of the coil is perpendicular to the magnetic field lines as shown in **Figure X**.

Figure X

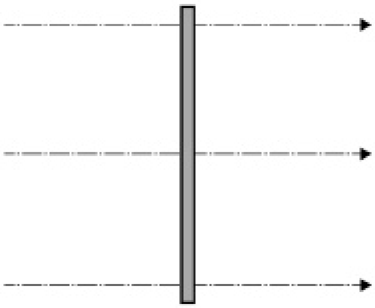
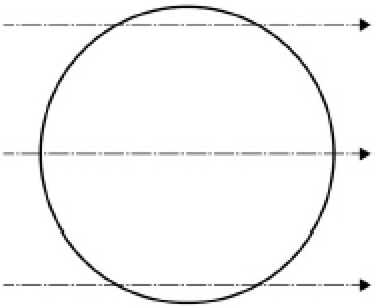


Figure Y



The coil is rotated about a vertical axis by 90° in a time of 0.20 s so that its plane becomes parallel to the field lines as shown in **Figure Y**.
Assume that the rate of change of flux linkage remains constant.

What is the emf induced in the coil?

$B = 90 mT$

$\Phi = BA = 2.54 \times 10^{-4}$

$\varepsilon = -N\frac{d\Phi}{dt} = -\frac{20 \times 2.5 \times 10^{-4}}{0.2}$

$= 25 mV$ ✓

A zero ○

B 1.3 mV ○

[✓ **C**] 25 mV ○

D 100 mV ○

(Total 1 mark)

3 The mean power dissipated in a resistor is 47.5 μW when the root mean square (rms) voltage across the resistor is 150 mV.

What is the peak current in the resistor?

$P_{rms} = V_{rms} \times I_{rms}$

$I_{rms} = 3.1\dot{6} \times 10^{-4}$

$\therefore I_p = I_{rms} \times \sqrt{2}$

A 2.3×10^{-4} A ○

[✓ **B**] 4.5×10^{-4} A ○

C 2.3×10^{3} A ○

D 4.5×10^{3} A ○

(Total 1 mark)

4 A horizontal copper wire of mass 4.0×10^{-3} kg and length 80 mm is placed perpendicular to a horizontal magnetic field of flux density 0.16 T. The magnetic force acting on the wire supports the weight of the wire.

need I $BIL = mg$

How many electrons are passing a point in the wire in each second?

$\Rightarrow I = \frac{mg}{BL} = 3.1\,A$

$= 3.1\,C/s$

$\therefore$ no of $e^- = \frac{3.1}{1.6 \times 10^{-19}}$

A 1.9×10^{18} ○

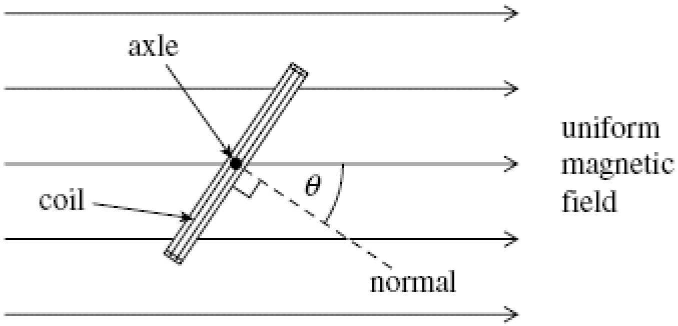
[✓ B] 1.9×10^{19} ○

C 1.9×10^{20} ○

D 1.9×10^{21} ○

(Total 1 mark)

5 The figure below shows an end view of a simple electrical generator. A rectangular coil is rotated in a uniform magnetic field with the axle at right angles to the field direction. When in the position shown in the figure below the angle between the direction of the magnetic field and the normal to the plane of the coil is θ.



(a) The coil has 50 turns and an area of 1.9×10^{-3} m^2. The flux density of the magnetic field is 2.8×10^{-2} T. Calculate the flux linkage for the coil when θ is 35°, expressing your answer to an appropriate number of significant figures.

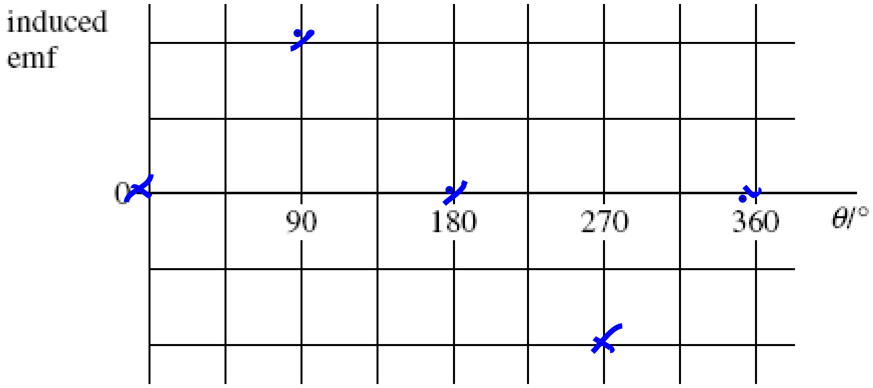
F.L. $= BAN\cos\theta \quad = 2.2 \times 10^{-3}$ (2 sf)

answer = ______________________ Wb turns

(3)

(b) The coil is rotated at constant speed, causing an emf to be induced.

(i) Sketch a graph on the outline axes to show how the induced emf varies with angle θ during one complete rotation of the coil, starting when $\theta = 0$. Values are not required on the emf axis of the graph.



max at $\theta = 90$.

0 at $\theta = 0$

(1)

(ii) Give the value of the flux linkage for the coil at the positions where the emf has its greatest values.

answer = 0 Wb turns

(1)

(iii) Explain why the magnitude of the emf is greatest at the values of θ shown in your answer to part (b)(i).

E is ∝ rate of change of flux.

This greatest at $\theta = 90$ (when ← & 270°

actual F.L. is zero).

reference perhaps to $E = BAN\omega \sin \omega t$

(3)

(Total 8 marks)

6 A sinusoidal alternating voltage source of frequency 500 Hz is connected to a resistor of resistance 2.0 kΩ and an oscilloscope, as shown in **Figure 1**.

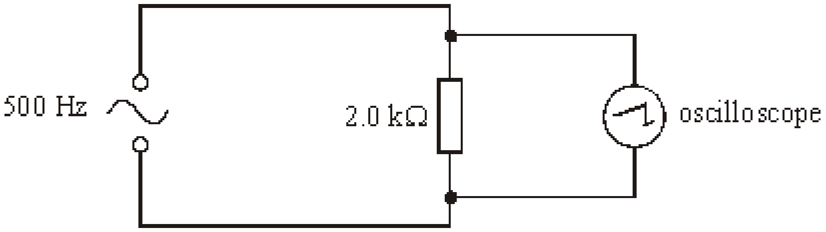


Figure 1

(a) The rms current through the resistor is 5.3 mA. Calculate the peak voltage across the resistor.

V rms from Ohm's Law = 10·6V

peak = 15V

(2)

(b) The settings on the oscilloscope are

timebase: 250 µs per division,
voltage sensitivity: 5.0 V per division.

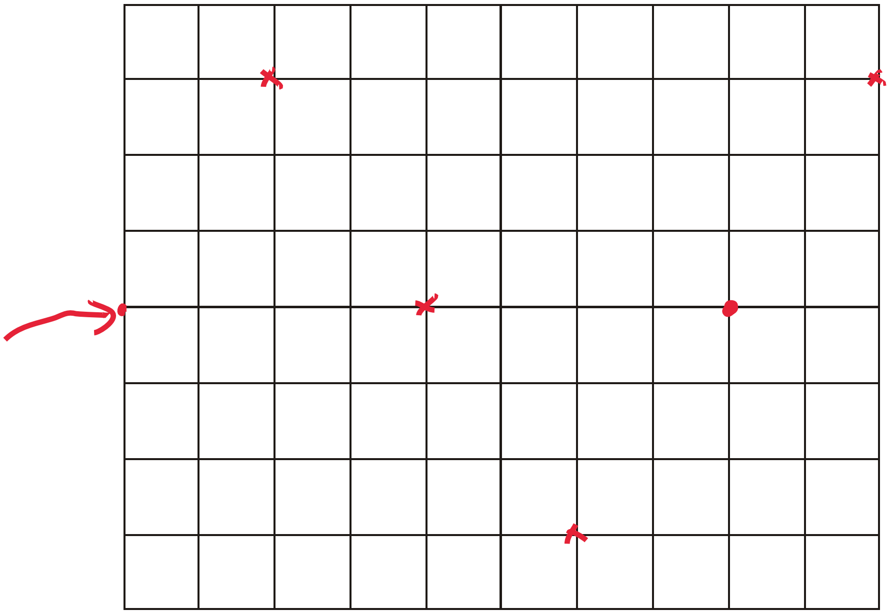
so ± 3 divs (y)

Draw on the grid, which represents the screen of the oscilloscope, the trace that would be seen.

$f = 500Hz \Rightarrow T = 2\times10^{-3}$ which

equals $2\times10^{-3}/250\times10^{-6} = 8$ divisions

(x)



zero (y)

Sin wave

(4)

(Total 6 marks)

Mark schemes

1 **C**

[1]

2 **C**

[1]

3 **B**

[1]

4 B

[1]

5 (a) flux linkage (= $N\phi$ = $BAN \cos \theta$)

= $2.8 \times 10^{-2} \times 1.9 \times 10^{-3} \times 50 \times \cos 35°$ **(1)**

= 2.2×10^{-3} (Wb turns) **(1)**

answer must be to **2 sf** only **(1)**

3

(b) (i) reasonable sine curve drawn on axes, showing just one cycle, starting at emf = 0 **(1)**

1

(ii) the flux linkage in these positions is **zero** **(1)**

1

(iii) induced emf µ (or =) rate of change of flux (linkage) **(1)**

flux (linkage) through the coil changes as it is rotated **(1)**

from maximum at $\theta = 0$, 180° to zero at 90° and 270° **(1)**

rate of change is greatest when plane of coil is parallel to B [**or** reference to $\varepsilon = BAN\omega \sin \omega t$, **or** $\varepsilon = BAN\omega \sin \theta$] **(1)**

because coil then cuts flux lines perpendicularly
[**or** $\varepsilon = BAN\omega \sin \omega t$ shows ε is greatest
when ωt = 90° or 270°] **(1)**

max 3

[8]

6 (a) ($V = IR$ gives) $V_{rms} = (5.3 \times 10^{-3} \times 2 \times 10^{3}) = 10.6$ (V) **(1)**
$V_0 = V_{rms}\sqrt{2} = 10.6\sqrt{2} = 15$ V **(1)** (14.99 V)
[or calculate I_0 (= 7.5 mA) and then V_0]

2

(b) (use of $T = \frac{1}{f}$ gives) $T = \frac{1}{500}$ = 2 × 10^{-3} = 2 0(ms) **(1)**

trace to show:
correct wave shape (sinusoidal) **(1)**
correct amplitude (3 divisions) **(1)**
correct period (8 divisions) **(1)**

4

[6]