Homework — Part 1: Review of the lesson

6 problems. Solve them in your notebook. Show every step: formula → numbers → answer with unit.

Key formulas (in the data booklet: Φ and ε)

$\Phi = BA\cos\theta$ flux linkage $= N\Phi$ $\varepsilon = -N\dfrac{\Delta\Phi}{\Delta t}$ (for the size of the emf use $\dfrac{\Delta(N\Phi)}{\Delta t}$)

θ is the angle between B and the **normal** to the coil. $1\ \text{Wb} = 1\ \text{T m}^2$. Change cm to m first ($1\ \text{cm}^2 = 10^{-4}\ \text{m}^2$).

Level 1 — Basic

1. A square loop has sides of 8.0 cm. It is in a uniform magnetic field $B = 0.35$ T.

(a) The field is perpendicular to the loop ($\theta = 0°$). **Calculate** the magnetic flux through the loop. **[2]**

(b) The loop is turned so that the angle between the field and the normal to the loop is $40°$. **Calculate** the new flux. **[1]**

2. A coil has 80 turns. The magnetic flux through each turn changes from 3.0×10^{-3} Wb to 7.0×10^{-3} Wb in 0.20 s.

(a) **Determine** the average emf induced in the coil. **[2]**

(b) The same change of flux takes 0.40 s instead. **State** the new average emf. **[1]**

Level 2 — Intermediate

3. A circular coil has 250 turns and radius 3.5 cm. The coil is in a uniform magnetic field, perpendicular to the plane of the coil. The field falls uniformly from 0.60 T to 0.10 T in 25 ms.

(a) **Calculate** the initial flux linkage of the coil. **[2]**

(b) **Determine** the average emf induced in the coil. (Hint: 25 ms = 0.025 s.) **[2]**

4. The south pole of a bar magnet is pushed towards the left end of a coil. The coil is connected to a resistor.

(a) **State** the magnetic pole that forms at the left end of the coil. **[1]**

(b) **Explain** your answer to (a) using Lenz's law. **[2]**

(c) The magnet is now held still inside the coil. **State** the emf in the coil and give a reason. **[1]**

Level 3 — Exam-style

5. Paper 1A

A flat coil has 200 turns and area $2.0 \times 10^{-3}\ \mathrm{m}^2$. The magnetic field is uniform. The angle between the field and the normal to the coil is 60° and does not change. The magnetic flux density increases from 0.10 T to 0.30 T in 0.020 s. What is the average emf induced in the coil?

A. 0.010 V B. 2.0 V C. 3.5 V D. 4.0 V

[1]

6. Paper 2

A circular coil has 60 turns and radius 2.5 cm. The coil is in a uniform magnetic field of flux density 0.12 T. The plane of the coil is perpendicular to the field.

(a) **State** Faraday's law of electromagnetic induction. **[1]**

(b) **Calculate** the magnetic flux linkage of the coil. **[2]**

(c) The coil is turned through 180° in 0.040 s. **Determine** the average emf induced in the coil. **[3]**

(d) A strong magnet is dropped down a long vertical copper tube. It falls much more slowly than a piece of non-magnetic metal of the same size. **Explain**, using Lenz's law, why the magnet falls slowly. **[3]**

Answers (short)

1	(a) 2.2×10^{-3} Wb ($A = 6.4 \times 10^{-3}\ \mathrm{m}^2$) (b) 1.7×10^{-3} Wb
2	(a) 1.6 V (b) 0.80 V (half)
3	(a) 0.58 Wb ($A = 3.85 \times 10^{-3}\ \mathrm{m}^2$) (b) 19 V
4	(a) south pole (b) the flux linkage increases; the induced current makes a field that opposes the change, so the coil repels the magnet (south pole at the near end) (c) zero, because the flux linkage is not changing
5	B
6	(a) induced emf = rate of change of flux linkage (b) 1.4×10^{-2} Wb (c) 0.71 V (d) changing flux induces currents in the tube; their field opposes the motion of the magnet (upward force), so the net force down is smaller