Homework — Part 1: Review of the lesson

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

Key formulas (all in the data booklet, except ε_0)

$\varepsilon = BvL \quad F = BIL \quad I = \frac{\varepsilon}{R} \quad P = Fv = I^2R \quad \varepsilon = -N\frac{\Delta\Phi}{\Delta t} \quad \omega = 2\pi f$

A coil of N turns entering a field: $\varepsilon = NBvL$ (only the side that cuts the field). Generator: peak emf $\varepsilon_0 = BAN\omega$ (not in the booklet).

Max flux linkage → emf = 0. Frequency × 2 → peak emf × 2, period × ½.

Level 1 — Basic

1. A metal rod of length 35 cm moves at 6.0 m s^{-1} perpendicular to a uniform magnetic field of 0.20 T. **Calculate** the emf induced across the rod.

[2]

2. A generator gives a peak emf of 8.0 V and the period is 0.050 s.

(a) **Calculate** the frequency of rotation. [1]

(b) The coil now turns twice as fast. **State** the new peak emf and the new period. [2]

Level 2 — Intermediate

3. Two horizontal rails lie on the page and are joined at the **left-hand** end by a resistor of 0.50 Ω. The magnetic field of 0.25 T is **into** the page. A rod of length 0.40 m slides to the **right** at a constant 4.0 m s^{-1}.

(a) **Calculate** the emf and the current. [2]

(b) **Calculate** the force needed to keep the rod moving at constant speed. [1]

(c) **Show that** the power of this force equals the power dissipated in the resistor. [1]

(d) **Determine** the direction of the current in the rod (up or down the page). Use Lenz's law. [2]

4. A square coil of 25 turns has sides of 6.0 cm. It moves at a constant 0.30 m s^{-1} into, through and out of a region of uniform field $B = 0.50$ T. The region is 18 cm wide. The field is perpendicular to the coil.

(a) **Calculate** the emf while the coil enters the field. [2]

(b) **Sketch** the graph of emf against time from the moment the coil starts to enter the field until it has left. Mark the times on the axis. [3]

Level 3 — Exam-style

5. Paper 1A

A coil rotates at constant speed in a uniform magnetic field. At one instant the plane of the coil is **parallel** to the field. What are the flux linkage and the induced emf at this instant?

A. flux max, emf max B. flux max, emf zero C. flux zero, emf max D. flux zero, emf zero

[1]

6. Paper 2

A generator coil has 200 turns and area $1.5 \times 10^{-3}\ \mathrm{m}^2$. It rotates at 50 Hz in a uniform magnetic field of 0.12 T. At $t = 0$ the plane of the coil is perpendicular to the field.

(a) **Calculate** the maximum flux linkage. **[1]**

(b) The peak emf is $\varepsilon_0 = BAN\omega$. **Calculate** ε_0. **[2]**

(c) **Sketch**, on the same time axis, the variation of the flux linkage and of the emf for one period. Label the period. **[3]**

(d) The coil is connected to a lamp. **Explain**, with reference to energy, why the coil is now harder to turn. **[2]**

Answers (short)

1	0.42 V
2	(a) 20 Hz (b) 16 V; 0.025 s
3	(a) 0.40 V; 0.80 A (b) 0.080 N (c) $Fv = I^2R = 0.32$ W (d) up the page
4	(a) 0.23 V (0.225) (b) +0.23 V for 0.20 s → 0 for 0.40 s → −0.23 V for 0.20 s
5	C
6	(a) 0.036 Wb (b) 11 V (c) flux: cosine, emf: sine, period 0.020 s (d) current opposes the rotation (Lenz); work done = energy for the lamp