Unit 18 · Electromagnetic Induction

HARDER PRACTICE QUESTIONS

Full marks 32

Write your answers on separate paper. Show your working.

1 Spot the error [3]

Find the mistake in the working and correct it.

An ideal step-up transformer has 100 turns on its primary and 2000 on its secondary, and the primary current is 4.0 A. Nirmala wrote:
"$\frac{I_S}{I_P} = \frac{N_S}{N_P}$, so $I_S = 4.0 \times \frac{2000}{100} = 80$ A."

2 Read the data [4]

The flux through each turn of a 50-turn coil was recorded.

t (s)	0	0.1	0.2	0.3	0.4
Φ (mWb)	0	2	4	4	0

Taking the flux to change steadily between readings, find the e.m.f. from 0 to 0.2 s, from 0.2 to 0.3 s and from 0.3 to 0.4 s, and sketch a graph of e.m.f. against time.

3 Predict, then explain [3]

Write your prediction first, then explain it.

A flat copper plate swings as a pendulum through the gap between the poles of a strong magnet. Predict how its swinging compares with i. no magnet, ii. the same plate with deep slots cut across it, like a comb. Then explain.

4 Show that [3]

A long solenoid of length l has N turns, each of area A. Show that its self-inductance is $L = \frac{\mu_0 N^2 A}{l}$.

5 Estimate it [3]

In Kathmandu the vertical component of the Earth's field is about 34 μT. A car drives at 72 km/h. Estimate the e.m.f. between the two ends of its metal front axle, 1.5 m long. Could Amrita measure it by joining a voltmeter in the car across the two ends? Why?

6 Which explanation fits? [2]

A transformer on the mains gets slightly warm even with nothing joined to its secondary. Bikash says it is copper loss, I^2R in the windings. Muna says it is the iron losses, hysteresis and eddy currents in the core. Who is more likely right? Why?

7 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Suman wrote: "A magnet held still inside a coil keeps a current flowing in it. A transformer works on d.c. as well as a.c. A coil's e.m.f. is greatest when the flux through it is greatest."

8 Work backwards [3]

A rod 0.50 m long slides at a steady 5.0 m/s on rails joined by a resistor R, at right angles to a field of 0.40 T. A force of 0.050 N keeps it moving. Find the current, the resistance R (ignore the rails' and rod's resistance) and the power put in.

9 Design it [4]

A small hydropower plant must send 50 kW to a village along a line of total resistance 0.50 Ω. Its generator gives 230 V.

i. Find the power lost in the line if it is sent at 230 V.
ii. Find the loss if a transformer first steps it up to 11 kV.
iii. What turns ratio does that transformer need?
iv. What must be done at the village end, and why?

10 What if? [2]

Two coils sit side by side on a table, end to end along one axis. What happens to their mutual inductance if the second coil is i. turned so its axis is at right angles to the first's, ii. given a soft iron core passing through both? Why?

11 Make your own [2]

Write a problem about a coil whose answer is "the energy stored is 0.50 J". Solve it to show it works.