InkPhysics

ANSWER BOOK

Electromagnetic induction: Faraday and Lenz

Magnetic fields · Year 13

AQA 3.7.5.4 · CIE 20.5 · OCR A 6.3.3

10 questions · 30 marks

NAVY EDITION

SECTION A · Warm-up

A1 The magnitude of the induced emf is equal to the rate of change of flux linkage: emf = $N\,\Delta\Phi/\Delta t$. [2]

A2 emf = $\Delta(N\Phi)/\Delta t = 0.60/0.20 = 3.0$ V. [2]

A3 The direction of the induced current (or emf) is always such as to oppose the change in flux that produces it. [1]

SECTION B · Standard

B1 emf = $Blv = 0.25 \times 0.30 \times 4.0 = 0.30$ V. [3]

B2 emf = $N A\,\Delta B/\Delta t = 200 \times 0.01 \times (0.50 - 0.10)/0.40 = 2.00$ V. [4]

B3 emf = $\Delta(N\Phi)/\Delta t = 0.80/0.010 = 80$ V. [3]

B4 If the induced current aided the change in flux, it would reinforce itself and release energy from nothing. Instead the current opposes the change, so work must be done against it to keep the change going; that work is the source of the electrical energy generated, in line with conservation of energy. [3]

SECTION C · Stretch

C1 $\omega = 2\pi f = 2\pi \times 50$. Peak emf = $NBA\omega = 100 \times 0.30 \times 0.02 \times (2\pi \times 50) = 188.5$ V. [4]

C2 (a) emf = $Blv = 0.40 \times 0.20 \times 3.0 = 0.24$ V. (b) I = emf/$R = 0.24/2.0 = 0.12$ A. (c) $F = BIl = 0.40 \times 0.12 \times 0.20 = 0.0096$ N (to balance the opposing magnetic force). [4]

C3 As the magnet enters, the flux through the coil increases, so the induced current flows in the direction that makes the near face of the coil a north pole, opposing the magnet's approach. This repulsion slows the magnet, and the current reverses as the magnet leaves and the flux falls. [3]