

How changing flux creates an emf

Physics grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Award marks for method as well as for the final answer. Accept answers within rounding and follow through an earlier slip. Do not penalise a missing unit more than once in each question.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB D.4

Question 1 Defining flux (2 marks)

Magnetic flux is the **product of the flux density and the area, with the cosine of the angle between the field and the normal**: $\Phi = BA \cos \theta$. Its unit is the **weber** (T m^2).

Marking: 1 mark for the definition, 1 mark for the unit.

Question 2 Tilted coil (2 marks)

$\Phi = BA \cos \theta = 0.25 \times 0.030 \times \cos 40^\circ = \mathbf{5.7 \times 10^{-3} \text{ Wb}}$ (5.7 mWb).

Marking: 1 mark for substitution, 1 mark for answer with unit.

Question 3 Faraday's law (3 marks)

a) The induced emf is **proportional to the rate of change of flux linkage**.

b) $\epsilon = N\Delta\Phi/\Delta t = 400 \times 3.0 \times 10^{-3} / 0.15 = \mathbf{8.0 \text{ V}}$.

Marking: a) 1 mark. b) 1 mark for substitution, 1 mark for answer.

Question 4 Lenz's law (3 marks)

a) A **south pole**, which attracts the receding north pole.

b) The induced current opposes the motion, so work must be done to pull the magnet away. This work is transferred to electrical energy in the coil. If the effect helped the motion, energy would be created from nothing.

Marking: a) 1 mark. b) 1 mark for opposing the motion, 1 mark for work done becomes electrical energy.

Question 5 Sliding rod (3 marks)

$\epsilon = BLv = 0.35 \times 0.45 \times 1.8 = \mathbf{0.28 \text{ V}}$. $I = \epsilon/R = 0.2835 / 0.20 = \mathbf{1.4 \text{ A}}$.

Marking: 1 mark for the emf, 1 mark for the formula for I , 1 mark for the answer.

Question 6 Reading a generator graph (3 marks)

a) Peak emf **12 V**; period **20 ms**.

b) $f = 1/T = 1 / 0.020 = \mathbf{50\ Hz}$; $\omega = 2\pi f = \mathbf{314\ rad/s}$.

Marking: a) 1 mark. b) 1 mark for f , 1 mark for ω .

Question 7 Open and closed coil (2 marks)

In a closed coil an induced current flows. By Lenz's law it produces a field that **opposes the approach** of the magnet, so extra work must be done. In an open coil no current flows, so there is no opposing force.

Marking: 1 mark for induced current, 1 mark for opposing force and extra work.

Question 8 Falling magnet (2 marks)

The magnet is **accelerating** under gravity, so it moves faster as it leaves. The flux changes more rapidly, so $\Delta\Phi/\Delta t$ and the emf are larger.

Marking: 1 mark for faster at exit, 1 mark for larger rate of change of flux.