MODEL ANSWER
A2 PHYSICS
MAGNETIC FIELD & EM INDUCTION

11 JUNE 2008 PHY5

3. Inside a long solenoid, the magnetic field strength (flux density) along the axis is $\mathbf{B = \mu_0 n I}$.

(a) Based on $F = B I l$ and $F = \mu_0 I_1 I_2 l / 2\pi r$
Left hand side of the equation, unit for $\mathbf{B = N A^{-1} m^{-1}}$
Right hand side of the equation: Unit for $\mathbf{\mu_0 = N A^{-2}}$ / Unit for $\mathbf{n = m^{-1}}$ / Unit for $\mathbf{I = A}$
$\mathbf{\mu_0 n I = N A^{-2} m^{-1} A = N A^{-1} m^{-1}}$
Therefore [B] = [μ_0 n I].

(b) **n** is defined as number of turns per unit length. Given the length per unit turns of coil is 50 μm.
Magnetic field strength, $\mathbf{B = \mu_0 n I}$
$\mathbf{= 4\pi \text{ X } 10^{-7} \text{ X } (1/50 \text{ X } 10^{-6}) \text{ X } 0.40}$
$\mathbf{= \underline{0.010 \text{ T}}}$

(c) (i) Current that travels through point A has the same direction as the current that travels through point B**.** Using Fleming Left Hand Rule**,** current [assuming going into the page] that passes through A will bring about a magnetic force moving towards A, while current [assuming going into the page] that passes through B will lead to a magnetic force moving towards B. As a result, this will produce an attractive force between them.

Meanwhile current that passes through point C has the opposite direction as the current that travels through point D. Using Fleming Left Hand Rule**,** current [assuming coming out of the page] that passes through **C** will bring about a magnetic force moving below C, while current [assuming going into the page] that passes through D will lead to a magnetic force moving upward from D. As a result, this will produce an repulsive force between them.

(ii) Graph curve for CD is mirror image of the original in time axis, where the force is zero at the same time. The negative force value should be only half of the original amplitude due to distance between C and D 100 μm compared with distance between A and B 50 μm. The peaks are at y = -2.

5. (a) Given the mean value of the e.m.f. during the process is 0.12 V, the peak e.m.f is 0.24 V, so the scale interval should be 0.1 V

(b) (i) Using **e.m.f., $\mathbf{E = - N [d\Phi / dt]}$**
$\mathbf{-0.12 = - 5000 [\Delta\Phi / \{40 \text{ X } 10^{-3}\}]}$
$\mathbf{\Delta\Phi = 9.6 \text{ X } 10^{-7} \text{ Wb}}$
The magnetic flux through the coil before rotation is approximately **1 μWb**

(ii) Magnetic flux density**, $\mathbf{B = \Phi / A}$**
$\mathbf{= [9.6 \text{ X } 10^{-7}] / [\pi \text{ X } 0.005^2]}$
$\mathbf{= \underline{0.012 \text{ T}}}$

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