DPP 03

SOLUTION

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1. $B = \frac{\mu_0 I R^2 N}{2[R^2+y^2]^{3/2}}$

$$\varepsilon = -\frac{d\phi}{dt} = -A\frac{dB}{dt} = -\pi r^2 \frac{dB}{dt}$$

$$\frac{dB}{dt} = -\frac{\mu_0 I R^2\, N}{2} \times \frac{3}{2}\frac{1}{[R^2+y^2]^{5/2}} \times 2y \times \frac{dy}{dt}$$

$$\frac{dB}{dt} = -\frac{3\mu_0 I R^2\, N}{2}\frac{yv}{[R^2+y^2]^{5/2}}$$

Use the $\frac{dB}{dt}$ value to get the induce voltage.

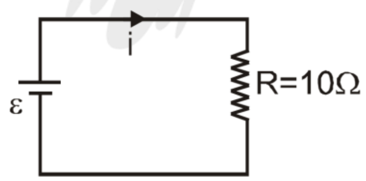
2. For $0 < t < 1$ s, $i = Bv\ell/R = 1$ A (Anticlockwise)

For $1\text{ s} < t < 3$ s, $\phi =$ constant so $i = 0$,

For $3\text{ s} < t < 4$ s, $i = Bv\ell/R = 1$ A (Clockwise),

For $t > 4$s, $i = 0$

3. Equivalent ckt.

(a) 

$$i = \frac{\varepsilon}{R} = \frac{BV\ell}{R} = \frac{(0.1)(50\times10^{-2})(2\times10^{-2})}{10} = 0.1\text{ m A}$$

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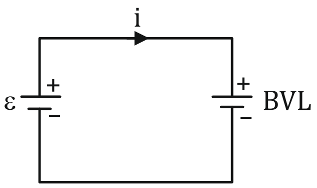
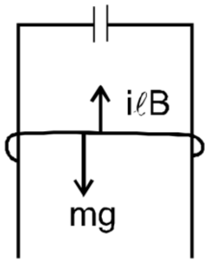
4. 

(a) $i = \frac{\varepsilon - BV\ell}{r}$ Clockwise

5. 

Acceleration $a = \frac{mg - i\ell B}{m}$ ...(i)

here $i = \frac{dq}{dt} = \frac{d}{dt}(c\varepsilon) = C\frac{d\varepsilon}{dt}$

$i = C\frac{d}{dt}(BV\ell) = CB\ell\frac{dV}{dt}$

$i = CB\ell a$ ...(ii)

By using eq. (i) and (ii)

$ma = mg - (CB\ell a)\ell B$

$[m + CB\ell^2]a = mg$

$a = \frac{mg}{m + CB^2\ell^2}$, $v = 0 + at = \frac{mgt}{m + CB^2\ell^2}$

6. $\varepsilon_{max} = \frac{1}{2} B\omega_{max}\ell^2$

$mg\ell(1 - \cos\theta) = \frac{1}{2}mV^2$

$V^2 = 2g\ell(1 - \cos\theta)$

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$$\omega_{max} = \frac{V}{\ell} = \sqrt{\frac{2g(1-\cos\theta)}{\ell}} = \sqrt{\frac{2g \times 2\sin^2\theta/2}{\ell}} = 2\sin\theta/2\sqrt{\frac{g}{\ell}}$$

$$\varepsilon_{max} = \frac{1}{2}B\ell^2 \times 2\sin\theta/2\sqrt{\frac{g}{\ell}}$$

$$\varepsilon_{max} = B\ell\sqrt{g\ell}\sin\theta/2$$

7. $\varepsilon = A\frac{dB}{dt} = \pi(1)^2 6 = 6\pi V$

$E \times 2\pi r = A\frac{dB}{dt} = 6\pi$

$E = \frac{3}{r} = \frac{3}{1} = 3$ volt / meter.

$i = \frac{\varepsilon}{R} = \frac{6\pi}{1\times2\pi r} = \frac{3}{r} = \frac{3}{1} = 3$amp.

8. $B = \mu_0 nI$

$\varepsilon = \frac{d\phi}{dt} = A\frac{dB}{dt} = \pi(1\times10^{-2})^2 \times \mu_0 \times \frac{2000}{1} \times \frac{dI}{dt}$

$= \pi\mu_0 \times 10^{-4} \times 2000 \times 0.01$

$\Delta\phi = 2 \times \frac{d\phi}{dt} = 4\pi \times 10^{-3} \times \mu_0$

$= 16\pi^2 \times 10^{-10}$ Weber.

(b) $E = \frac{\varepsilon}{2\pi r} = \frac{2\pi\times10^{-3}\times\mu_0}{2\pi\times1\times10^{-2}}$

$= 0.1\mu_0 = 4\pi \times 10^{-8}$ V/m.

9. $e = -\frac{d\phi}{dt} = -\frac{d(B.A)}{dt} = \pi R^2\frac{d(4t^2)}{dt} = -8\pi R^2 t$

min. force required to move ring is $= \mu mg$

μ is coeff. of friction

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at t = 2Sec emf, $V = 16\pi R^2$

Force on ring $= qE = \frac{qV}{2\pi R} = \frac{16q\pi R^2}{2\pi R} = 8qR = \mu mg$

So, $\mu = \frac{8qR}{mg}$

10. $\because \phi = B \cdot A$

A = area of $\triangle$ OLN

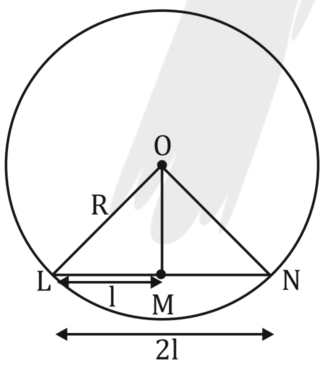
$OM = \sqrt{R^2 - l^2}$

$A = \frac{1}{2} \times 2l \times \sqrt{R^2 - l^2}$

$A = l\sqrt{R^2 - l^2}$

$\varepsilon = \frac{d\phi}{dt} = \frac{dB \cdot A}{dt} = A\frac{dB}{dt}$ $\because A =$ constent

$\varepsilon = A\frac{dB \cdot t}{dt} = B \cdot A = B_0 l\sqrt{R^2 - l^2}$



11. Consider a free electron in the disc at point P distant x from centre of disc.

The magnetic force on free electron is = evB = eωxB

Centrifugal force= $m\omega^2 x$

For net force on the electron at P at be zero

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i.e., $e\omega xB = m\omega^2 x$

or $\omega = \frac{eB}{m}$