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P7D Quiz 29 Aug 2003 PRINTED NAME NASSER ABBASI

1.) A wire carrying a current of 5.00 A is to be formed into a circular loop of one turn. If the required value of the magnetic field at the center of the loop is 10.0 μT, what is the required radius?

$B = \frac{\mu_0 I}{2 r \pi} \Rightarrow r = \frac{\mu_0 I}{2B}$ +4

$r = \frac{(4\pi \times 10^{-7})(5)}{2(10 \times 10^{-6})} = \frac{(5)(4\pi)}{2} 10^{-7+5} = 10\pi(10^{-2})$

$\simeq \pi 10^{-1} \simeq (3.1) 10^{-1} \simeq$ 0.31 meter

2.) A 2.00-nF capacitor with an initial charge of 5.10 μC is discharged through a 1.30-kΩ resistor. (a) Calculate the current through the resistor 9.00 μs after the resistor is connected across the terminals of the capacitor. (b) What charge remains on the capacitor after 8.00 μs? (c) What is the maximum current in the resistor?

$e = 2.17$
$e^2 = 4$
$e^3 = 8$
$e^{-1} = \frac{1}{2.1} \simeq .5$

$q = q_0 e^{-t/RC}$, but $I = \frac{dq}{dt}$

$I = \frac{dq}{dt} = q_0\left(-\frac{1}{RC}\right)e^{-t/RC} = -\frac{q_0}{RC} e^{-t/RC}$

at $t = 9 \times 10^{-6}$ sec.

(a) $I = -\frac{(5.1 \times 10^{-6})}{(1.3 \times 10^{3})(2 \times 10^{-9})} e^{-\frac{9 \times 10^{-6}}{(1.3 \times 10^3)(2 \times 10^{-9})}}$ +2

$= \frac{-(5.1)}{(1.3)(2)} 10^{-6-3+9} e^{-\frac{9}{(2)(1.3)} 10^{-6-3+9}} \cong \frac{-5}{2.5} 10^{0} e^{-3}$

$\simeq -2e^{-3} \simeq$ $\frac{-2}{e^3}$ A

(b) $q = q_0 e^{-t/RC}$, at $t = 8 \times 10^{-6}$ sec

$q = (5.1 \times 10^{-6}) e^{-\frac{8 \times 10^{-6}}{(1.3 \times 10^3)(2 \times 10^{-9})}}$ +2 $\simeq (5 \times 10^{-6}) e^{-\frac{8}{(1.3)(2)} 10^{-6-3+9}}$

$\simeq (5 \times 10^{-6}) e^{-\frac{4}{1.3}} \simeq (5 \times 10^{-6}) e^{-2.5} \sim$ $\frac{5 \times 10^{-6}}{e^{2.5}}$ C

(c) Max $I = \frac{5.1 \times 10^{-6}}{(1.3 \times 10^3)(2 \times 10^{-9})} \simeq$ ~~$\frac{5.1}{(1.3)(2)}$~~ OK $\simeq \frac{5}{2.5}$ ~~x~~ 2.4A +1

P7D Quiz 5 Sep 2003 PRINTED NAME NASSER ABBASI

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1.) In a 250-turn automobile alternator, the magnetic flux in each turn is $\Phi_B = (2.5 \times 10^{-4}\ \text{T-m}^2)\cos(\omega t)$, where ω is the angular speed of the alternator. The alternator is geared to rotate three times for each engine revolution. When the engine is running at an angular speed of 1,000 rev/min, determine (a) the induced emf in the alternator as a function of time and (b) the maximum emf in the alternator.

314 rad/se.

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$\omega = 314$ rad/sec.

a) $\mathcal{E} = -N\frac{d\Phi}{dt} = -N\frac{d}{dt}\left(2.5\times10^{-4}\cos(314t)\right)$

$= (250)(2.5\times10^{-4})(314)\sin(314t)$

$= (250)(750\times10^{-4})\sin(314t) = \boxed{1875\times10^{-2}\ \text{V/m}\ \sin(314t)}$

b) max Emf when $\sin(\omega t) = 1$ since max $\sin = 1$

so max Emf $= \boxed{1875\times10^{-2}\ \text{V/m}}$

2.) A small air-core solenoid has a length of 4.00 cm and a radius of 0.250 cm. If the inductance is to be 0.060 mH, how many turns per centimeter are required?

7.8×10^{3}

$L = \frac{\mu_0 N^2 A}{l}$

so $N = \sqrt{\frac{L l}{\mu_0 A}} = \sqrt{\frac{(0.06\times10^{-3})(4\times10^{-2})}{(4\pi\times10^{-7})(\pi\times(0.25\times10^{-2})^2)}}$

turns ~~over 4 cm length.~~

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$= ~~7.8\times10^{3}~~$ ~~Turns per meter~~

P7D Quiz 8 Aug 2003 PRINTED NAME Nasser Abbasi

1.) An airplane is flying through a thundercloud at a height of 2000 m. If there are charge concentrations of +40 C at a height of 3000 m within the cloud and of -40 C at a height of 1000 m, what is the electric field E at the aircraft?

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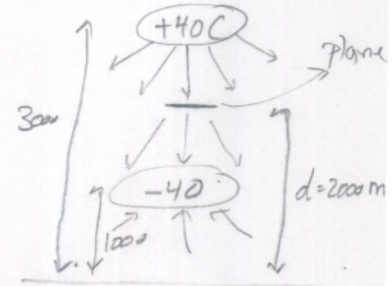
treating concentration of charge as a point charge.

so E due to the +40 C at the plane $= K_e \frac{q}{d^2} \approx 9\times10^9 \frac{(40)}{1000}$ 2

E due to the −40 C at the plane $= K_e \frac{q}{d^2} \sim 9\times10^9 \frac{40}{1000}$ 2



so Final E is $(2)(9\times10^9)\frac{40}{1000} \sim 80\times9\times10^6 \sim 72\times10^7$ N/C

direction of E is downwards

2.) A positively charged bead having a mass of 1.00 g falls from rest in a vacuum from a height of 5 m in a uniform vertical electric field with a magnitude of 1×10^4 N/C. The bead hits the ground at a speed of 21 m/s. Determine (a) the direction of the electric field (up or down) and (b) the charge on the bead.

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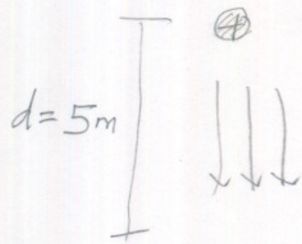

mass $= 1\times10^{-3}$ Kg

$E = 10^4$ N/C

a) First assume NO E exist. then final speed is found from

$\frac{1}{2}mv^2 = mgd$

$\Rightarrow v = \sqrt{2gd} \sim \sqrt{(2)(10)5} \sim \sqrt{100} \sim$ 10 m/s

but final speed was greater than this. this implies the field was assisting g. hence E is downwards.

b) from $a = \frac{qE}{m} \Rightarrow q = \frac{ma}{E}$

but $v_f^2 = v_i^2 + 2ah$ ($v_i = 0$) $\Rightarrow a = \frac{(21)^2}{(2)(5)}$

so $q = \frac{\left(\frac{441}{10} - g\right)10^{-3}}{10^4}$ (since gravity) $= \frac{\left(\frac{441}{10} - 10\right)10^{-3}}{10^4}$

$= (44.1 - 10)\frac{10^{-3}}{10^4} \sim 34\times10^{-7} \sim 3.4\ \mu C$