AK Gonzalez
Phys 135B
M/W

Midterm 1

1) Unit 0: Electrostatics I & II

KHDUDCM

$1p = 1.6 \cdot 10^{-19} C$

$2\mu C = 12 \cdot 10^{-6} C$

① $50g \cdot \frac{1\,mol}{63.5g} \cdot \frac{6.02 \cdot 10^{23}\ atoms}{1\,mol} = 4.74 \cdot 10^{23}$ atoms of Cu

$(29)(4.74 \cdot 10^{23}) = 1.37 \cdot 10^{25}$ protons = Total $\Rightarrow 1.37 \cdot 10^{25} e^-$

$2 \cdot 10^{-6} C \cdot \frac{1p}{1.6} = 1.25 \cdot 10^{13}$ protons = removed $\Rightarrow 1.25 \cdot 10^{13} e^-$

$\frac{\#\ of\ e^-\ r}{\#\ of\ e^-\ tot.} = \frac{1.25 \cdot 10^{13}}{1.37 \cdot 10^{15}} = \boxed{9.06 \cdot 10^{-13}}$

(a) (d)

② 5cm, 10 cm, 5cm

① $+4\mu C$ ② $+2\mu C$ ③ $+6\mu C$

$1cm = 0.01m$ $1\mu C = 10^{-6} C$ $k = 8.99 \cdot 10^9 \frac{Nm^2}{C^2}$

a) $F_{1,2} = k\frac{|q_1 q_2|}{r^2} = (8.99 \cdot 10^9)\frac{|(4 \cdot 10^{-6})(2 \cdot 10^{-6})|}{(0.05)^2} = 28.768\ N$ (d)

$F_{1,3} = (8.99 \cdot 10^9)\frac{|(6 \cdot 10^{-6})(2 \cdot 10^{-6})|}{(0.05)^2} = 43.152\ N$

$43.152 - 28.768 = \boxed{14.384\ N}$

b) The force should be away from the $+6\mu C$ charge, meaning to the left in this case. $+4^{\circ}$ F_2 $+6^{\circ}$ (a) (d)

③ 3cm, 8cm, 11cm

$+q$ $-2q$ $+q$

$F_{1,3}$ $F_{2,3}$

$F = k\frac{|q_1 q_2|}{r^2}$ $q = 1\mu C$

$F_{1,3} = (8.99 \cdot 10^9)\frac{|(-2 \cdot 10^{-6})(10^{-6})|}{(0.05)^2} = 7.192\ N$

$F_{2,3} = (8.99 \cdot 10^9)\frac{(-2 \cdot 10^{-6})(10^{-6})}{(0.03)^2} = 19.978\ N$

$F_3 = 19.978 - 7.192 = \boxed{12.786\ N}$ to the right

④ 10cm, 6cm, 3cm, 3cm; 1cm, 5cm, 8cm, 11cm, 14cm

① $-2q$ ② $+q$ ③ $+3q$ ④ $-q$

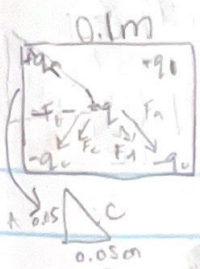
ϵ_1 ϵ_2 ϵ_3 ϵ_4

$k = 8.99 \cdot 10^9 \frac{Nm}{C}$

$\epsilon = k\frac{|q|}{r^2}$ $\Longrightarrow$ $\epsilon_{tot} = \epsilon_2 + \epsilon_3 + \epsilon_4 - \epsilon_1$

$\epsilon_{tot} = \left(8.99 \cdot 10^9 \frac{10^{-6}}{(0.04)^2}\right) + \left(8.99 \cdot 10^9 \frac{3 \cdot 10^{-6}}{(0.03)^2}\right) + \left(8.99 \cdot 10^9 \frac{10^{-6}}{(0.03)^2}\right) - \left(8.99 \cdot 10^9 \frac{2 \cdot 10^{-6}}{(0.11)^2}\right)$

$= \boxed{4.07 \cdot 10^7\ N/C}$



q_a & $q_b = 7.5\cdot10^{-6}$C $q = 2\cdot10^{-6}$C

q_c & $q_d = -7.5\cdot10^{-6}$C

5) $a^2+b^2=c^2 \Rightarrow c=\sqrt{(0.5)^2+(0.5)^2} = 0.071\,m = r$

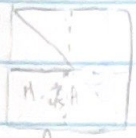
$F_a = k\frac{q\cdot q_a}{r^2} = (8.99\cdot10^9)\frac{(7.5\cdot10^{-6})(2\cdot10^{-6})}{(0.071)^2}$

BOTH CAN TOA $T_a = 26.751N$

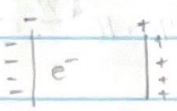
$T_{ay} = (26.751)\cos(45) = 18.92\,N$

$F_{tot} = (8.92)(4) = \boxed{75.68\,N}$

* Forces will go towards q_c & q_d (down)



KINDUCTION



mass $e^- = 9.11\cdot10^{-31}$

6) a) $40\,keV = 40\cdot10^3\,V$ $1e^- = -1.6\cdot10^{-19}$C

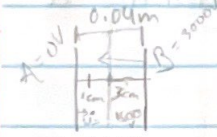
$\Delta V = \frac{\Delta PE}{q_{e^-}} \Rightarrow (10^{-19})\,40\cdot10^3 = \frac{\Delta PE}{1.6\cdot10^{-19}}(1.6\cdot10^{-19}) \Rightarrow 6.4\cdot10^{-15}\,J = \Delta PE = KE$

$KE = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(6.4\cdot10^{-15})}{9.11\cdot10^{-31}}} = \boxed{1.19\cdot10^8\,m/s}$ Max speed

b) $\frac{V}{m} = \frac{N}{C}$ $V = \frac{E}{q} = \frac{J}{C}$

$\frac{J/C}{m} = \frac{N}{C}$ $W = F\cdot d$ $J = Nm$

$\frac{J}{mC} = \frac{N}{C} \Rightarrow \frac{Nm}{mC} = \frac{N}{C} \Rightarrow \frac{N}{C} = \frac{N}{C}$



$E = 7.5\cdot10^4$

$V_{AB} = ?$

7) a) $V_{AB} = E\cdot d = (7.5\cdot10^4)(0.04) = \boxed{3000\,V}$

b) $\frac{1}{4}(3000) = \boxed{750\,V}$

c) $V = Ed \Rightarrow E = \frac{V}{d}$ $V = 80\cdot10^{-3}\,V$ $d = 9\cdot10^{-9}\,m$

$= \frac{80\cdot10^{-3}}{9\cdot10^{-9}} = \boxed{8.89\cdot10^6\,V/m}$

32

8) $q = 2(1.6\cdot10^{-19}) = 3.2\cdot10^{-19}$C $1ev = 1.6\cdot10^{-19}\,J$

$E = 32\cdot10^3\,eV\cdot\frac{1.6\cdot10^{-19}\,J}{1\,eV} = 5.12\cdot10^{-15}\,J = \Delta PE$

$\Delta V = \frac{\Delta PE}{q} = \frac{5.12\cdot10^{-15}\,J}{3.2\cdot10^{-19}\,C} = 16\cdot10^3\,V$

$V_{AB} = Ed \Rightarrow E = \frac{V_{AB}}{d} = \frac{16\cdot10^3}{0.02} = \boxed{8\cdot10^5\,V/m}$

$E = 5\,MeV = 5\cdot10^6\,eV$

9) $(79)(1.6\cdot10^{-19}) = 1.264\cdot10^{-17}$C $2(1.6\cdot10^{-19}) = 3.2\cdot10^{-19}$C

$5\cdot10^6\,eV\cdot\frac{1.6\cdot10^{-19}\,J}{1\,eV} = 8\cdot10^{-13}\,J$

$\Delta V = \frac{\Delta PE}{q} = \frac{8\cdot10^{-13}}{3.2\cdot10^{-19}} = 2.5\cdot10^6\,V$ $V = \frac{kQ}{r} \Rightarrow r = \frac{kQ}{V} = \frac{(8.99\cdot10^9)(1.264\cdot10^{-17})}{2.5\cdot10^6}$

$= \boxed{4.55\cdot10^{-14}\,m}$

2) Unit 1 Capacitors, current, and DC circuits

(1) $Q = 3 \cdot 10^{-6}$ C $V = 120$ V

$Q = CV \Rightarrow C = \frac{Q}{V} = \frac{3 \cdot 10^{-6}}{120} = \boxed{2.5 \cdot 10^{-8}\ F}$

(2) a) $C = 10 \cdot 10^{-6}$ F $V = 9 \cdot 10^{3}$ V $E = ?$ or U

$U = \frac{1}{2} CV^2 = \frac{1}{2}(10 \cdot 10^{-6})(9 \cdot 10^{3})^2 = \boxed{405\ J}$

b) $Q = CV = (10 \cdot 10^{-6})(9 \cdot 10^{3}) = \boxed{0.09\ C}$

c) $V = ?$ $C = 8 \cdot 10^{-6}$ F U or $E = 40$ J

$U = \frac{1}{2} CV^2 \Rightarrow V = \sqrt{\frac{2U}{C}} = \sqrt{\frac{2(40)}{8 \cdot 10^{-6}}} = 3.1162 \cdot 10^{3}$ V

$\frac{CV^2}{2}\left(\frac{(2)}{C}\right)$

d) $Q = CV = (8 \cdot 10^{-6})(3.162 \cdot 10^{3}) = \boxed{0.025\ C}$

(3) $C = 10 \cdot 10^{-6}$ F $V = 9 \cdot 10^{3}$ V

$C_{tot} = C_1 + C_2 + \ldots$

$\hookrightarrow \frac{10 \cdot 10^{-6}}{4} = \boxed{2.5 \cdot 10^{-6}\ F}$ (each capacitor)

$Q = CV = (2.5 \cdot 10^{-6})(9 \cdot 10^{3}) = \boxed{2.25 \cdot 10^{-10}\ C}$

Parallel may be better because the voltage is the same for every capacitor, keeping it consistant especially for an AED.

KHOUDOM

(4) $A = \pi\left(\frac{10^{-3}}{2}\right)^2 = 7.85 \cdot 10^{-7}$ $L = ?$ $R = 2\ \Omega$ copper $\rho = 1.72 \cdot 10^{-8}\ \Omega m$

$A = \pi r^2$

$1mm = 10^{-3} m$

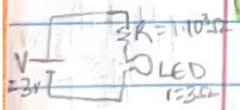
$R = \frac{\rho L}{A} \Rightarrow L = \frac{RA}{\rho} = \frac{(2)(7.85 \cdot 10^{-7})}{1.72 \cdot 10^{-8}} = \boxed{91.28\ m}$

$A = \frac{\rho L}{R} \frac{A}{2} =$

(5) a) $R = 1 \cdot 10^{3}\ \Omega$ $V = 3$V

$+3$

$1003\ \Omega$ $I = ?$



$V = IR \Rightarrow I = \frac{V}{R} = \frac{3}{1003} = \boxed{2.99 \cdot 10^{-3}\ A}$

$V = IR = (2.99 \cdot 10^{-3})(1 \cdot 10^{3}) = 2.99$V (voltage dropped)

b) $P_{LED} = I_{LED} V_{LED} = (2.99 \cdot 10^{-3})(2.99) = \boxed{8.94 \cdot 10^{-3}\ W}$

c) $I = \frac{\Delta Q}{\Delta t} \Rightarrow \Delta Q = I \Delta t = (2.99 \cdot 10^{-3})(600) = \boxed{1.794\ C}$

$10 mm \cdot \frac{60s}{1 mm} = 600s$

ABDULLAH

3) Unit 2: DC Circuits with Resistors in Series & Parallel, RC Circuits

1) a) $R_1 = 10 \cdot 10^3\ \Omega$ $R_2 = 5 \cdot 10^3\ \Omega$ $R_3 = ?$ $R_{tot} = 2 \cdot 10^3\ \Omega$

$$\frac{1}{2 \cdot 10^3} = \frac{1}{10 \cdot 10^3} + \frac{1}{5 \cdot 10^3} + \frac{1}{R_3}$$

$$0.0005 = 0.0003 + \frac{1}{R_3}$$

$$-0.0003 \quad -0.0003$$

$$0.0002 = \frac{1}{R_3} \Rightarrow R_3 = \frac{1}{.0002} = \boxed{5000\ \Omega \text{ or } 5 \cdot 10^3\ \Omega}$$

b) $\Delta V = 12\text{V}$ $I = ?$ $R_{tot} = 2 \cdot 10^3\ \Omega$

$$V = IR \Rightarrow I = \frac{V}{R} = \frac{12}{2 \cdot 10^3} = \boxed{0.006\text{A or } 6 \cdot 10^{-3}\text{A}}$$

c) $I_1 = \frac{12}{10 \cdot 10^3} = \boxed{1.2 \cdot 10^{-3}\text{ A}}$ $I_2 = \frac{12}{5 \cdot 10^3} = \boxed{2.4 \cdot 10^{-3}\text{A}}$ $I_3 = \frac{12}{5 \cdot 10^3} = \boxed{2.4 \cdot 10^{-3}\text{A}}$

2) a) Series $V = 1.5\text{V} \times 2 = 3\text{V total}$ $R = 500\ \Omega$ $I = ?$ $P = ?$

$$I = \frac{V}{R} = \frac{3}{500} = \frac{3}{500} = \boxed{0.006\text{A}} \text{ or } 6 \cdot 10^{-3}\text{A}$$

$$P = IV = (0.006)(3) = \boxed{0.018\text{W}}$$

Parallel $V = 3\text{V} \times 2 = 6\text{V total}$ $R = 500\ \Omega$ $I = ?$ $P = ?$

$$I = \frac{6}{500} = \boxed{0.012\text{A}} \text{ or } 12 \cdot 10^{-3}\text{A}$$

$$P = IV = (0.012)(6) = \boxed{0.072\text{W}}$$

b) $R = 505\ \Omega$

$$I = \frac{3}{505} = \boxed{5.94 \cdot 10^{-3}\text{ A}}$$

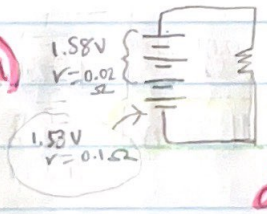
$$P = (5.94 \cdot 10^{-3})(3) = \boxed{0.01782\text{ W}}$$

$R = 505\ \Omega$

$$I = \frac{V}{505} = \boxed{11.88 \cdot 10^{-3}\text{ A}}$$

$$P = (11.88 \cdot 10^{-3})(6) = \boxed{0.07128\text{W}}$$

3) a)



b) $I_{Tot} = \frac{V_{Tot}}{R_{Tot}} = \frac{3(1.58) + 1.53}{3(0.02) + 0.1 + 10} = \boxed{0.617\text{ A}}$

c) $P_L = I_L^2 R_L = (0.617)^2 (10) = \boxed{3.81\text{ W}}$

d) $I_L = \sqrt{\frac{P_L}{R_L}} = \sqrt{\frac{0.5}{10}} = 0.224\text{A}$

$$R_{Tot} = \frac{V_{Tot}}{I_{Tot}} \Rightarrow 3(02) + 10 + R_4 = \frac{3(1.58) + 1.53}{0.224}$$

$$10.06 + R = 27.99$$

$$-10.06 \quad -10.06$$

$$\boxed{R = 17.93\ \Omega}$$

4) $\frac{1\text{min}}{72\text{ beats}} = 0.014\text{ bpm}$ $C = 25 \cdot 10^{-6}$ $I = 0.632\text{A}$

$$0.014 \frac{b}{\text{min}} \cdot \frac{60\text{sec}}{1\text{min}} = 0.84\text{ bps}$$

$$\tau = RC \Rightarrow R = \frac{\tau}{C} = \frac{0.84}{25 \cdot 10^{-9}} = \boxed{3.36 \cdot 10^7\ \Omega}$$

5) $\tau = 1 \cdot 10^{-4}\text{s}$ $R = 1 \cdot 10^3\ \Omega$ $C = ?$

$$R = \frac{\tau}{C} = \frac{1.1^{-4}}{1 \cdot 10^3} = \boxed{1 \cdot 10^{-7}\text{ F}}$$

4) Unit 3: Magnetism I

1

Case	V direction	B direction	F direction
a	down	out	right
b	up	right	out
c	right	in	down
d	—	—	—

* There's no (d)

B = 1.25 T
F = $1.4 \cdot 10^{-16}$ N
$q_e = 1.6 \cdot 10^{-19}$ C
V = $4 \cdot 10^3$ m/s

2 $F = qvB\sin\theta \Rightarrow \sin\theta = \frac{F}{qvB} = \frac{1.4 \cdot 10^{-16}}{(1.6 \cdot 10^{-19})(4 \cdot 10^3)(1.25)} (\sin^{-1}) = \boxed{10.1°}$

$\rightarrow 180° - 10.1° = \boxed{169.9°}$

3 a) $r = \frac{mv}{qB} \Rightarrow q = \frac{mv}{rB} = \frac{(2.66 \cdot 10^{-26})(5 \cdot 10^6)}{(0.231)(1.2)} = \boxed{4.8 \cdot 10^{-19} C}$

b) $\frac{Q_{16}}{C} = \frac{4.8 \cdot 10^{-19}}{-16 \cdot 10^{-19}} = \boxed{3}$

c) Can't have a fraction of an electron, therefore has to be an integer

d) $r = \frac{mv}{qB} = \frac{(2.37 \cdot 10^{-23})(5 \cdot 10^6)}{(4.8 \cdot 10^{-19})(1.2)} = \boxed{205.73 m}$

16:18
=0.89

4 $F = ILB\sin\theta = (100)(0.25)(2)\sin 90 = \boxed{50N}$

.25

5 $\tau = NIAB\sin\theta \Rightarrow \frac{\tau}{NIA\sin\theta} = B = \frac{300}{(200)(25)(.2^2)(\sin 90)} = \boxed{1.5 T}$

6

case	B direction
a	out
b	right
c	left

450NW = $450 \cdot 10^6$

$\mu_0 = 4\pi 10^{-7}$

7 $B = \frac{\mu_0 I}{2\pi r}$

$P = IV \Rightarrow I = \frac{P}{V} = \frac{450 \cdot 10^6}{300\,000} = 1500 A$

$= \frac{(4\pi 10^{-7})(1500)}{2\pi(20)} = \boxed{1.5 \cdot 10^{-5} T}$

8 N=? V=? I=? | B=1T r=5m

$B = \frac{\mu_0 NI}{2\pi r}$

$NI = \frac{2\pi r B}{\mu_0} = \frac{2\pi(5)(1)}{4\pi \cdot 10^{-7}} = 2.5 \cdot 10^7$

$B = \frac{\mu_0 I}{2\pi r} \left(\frac{2\pi r}{\mu_0}\right)$

$\Rightarrow \frac{2\pi r B}{\mu_0}$