midterm 1

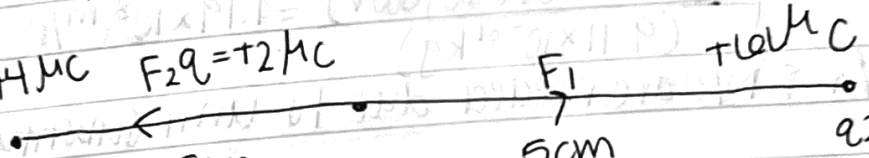
Unit 0 Electrostatics 1 & 2

1) charge : 2μC

$n = \frac{50}{63.5} = \left(\frac{50}{63.5}\right)(29)(6.023\times10^{23}) = 1.3761\times10^{25}$

$\frac{Q}{e} = \frac{2\times10^{6}}{1.6\times10^{-19}} = 1.25\times1013$

$\frac{1.25\times10^{13}}{1.3761\times105} = \boxed{9.09\times10^{13}}$

2) 

force on 2μC b/c of +4μC

$F_1 = \frac{kq_1q_1}{d_2} = \frac{(9\times10^{9})(4\times10^{-6})(2\times10^{-10})}{(5\times10^{-2})^2} = 28.8\,N$ towards right

force on 2μC b/c of +6μC

$F_2 = \frac{kq_2q_2}{d^2} = \frac{(9\times10^{9})(6\times10^{-6})(2\times10^{-6})}{(5\times10^{-2})^2} = 43.2\,N$ towards left

(a) $R_T = F_2 - F_1 = 43(2) - 28.8 = 14.4N$

(b) the force is away from 6μC (opposite direction

3) $F_{net} = -F_1 + F_2 = (9\times10^{9})[-2(1\times10^{-6})^2/(0.05^2) + (2(1\times10^{-6})^2)/(0.03^2)$
$= 14.11N$

5) $q_a - q_b = 7.5\,\mu C$ the force is going ↓

$q_c = q_d = -7.5\,\mu C$

$q_0 = 2\,\mu C$ $d = 0.1$

$r = \frac{d}{\sqrt{2}}$

$F_1 = \frac{kq_0q_a}{r^2} + \frac{kq_0q_d}{r^2}\hat{j} = \frac{2(9\times10^9)(7.5)(2\times10^{-12})}{(0.1/\sqrt{2})^2}$

$= \boxed{54\ N}$

6) $K.E. = (\frac{1}{2})mv^2 = eV$

$v = \sqrt{\frac{2eV}{m}}$ $\quad v = \sqrt{\frac{2(1.6\times10^{-19}C)(40{,}000V)}{(9.11\times10^{-31}kg)}} = 1.19\times10^8\ m/s$

units of V/m & N/C are needed due to unit substitution

7)

8) $d = 2\,cm$
$\Rightarrow d = 2 \times 10^{-2}\,m$
$(qE)\ q = 32.0\,keV$
$(2e)(E)(2\times10^{-2})m = 32\times10^{3}\,eV$

$E = \frac{32\times10^{3}}{2(2\times10^{-2})}\left(\frac{V}{m}\right)$ $E = 8\times10^{6}\ V/m$ {electric field between plates

a) Initial KE = Final Potential Energy

$(5\times10^{6})(1.6\times10^{-19}) = \frac{kq_1q_2}{d}$

$8\times10^{-3} = \frac{[(9\times10^{9})(2)(1.6\times10^{-19})(79)(1.6\times10^{-19}]}{d}$

$d = 456\times10^{-16}$
$= 4.5\times10^{-14} = \boxed{45fm}$

Unit 1: Capacitors, current and DC circuits

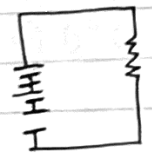
1) $C = \frac{3.00\ \mu C}{120\ V} = 0.025\ \mu F$ OR microfarads

Unit 2: DC circuits w/ resistors in series and parallel, RC circuits

1) ~~$R_{tot} = 2k\Omega$ and $R_3 = 5k\Omega$~~
~~$R_3 = R_{for} - R_1 - R_2$~~
~~$R_3 = 2k\Omega - 10\Omega - 5k\Omega$~~
~~$R_3 = -13k\Omega$~~

$\tau = 1 \times 10^{-4}$ $\quad R = 1 \times 10^3 R$ $\quad \frac{\tau}{R} = C = \frac{1 \times 10^{-4}}{1 \times 10^3} = \boxed{1 \times 10^{-7} F}$

3) a)



$R_L = 10\Omega$
$I_L = 0.617A$

$I_T = V_T / R_T = \frac{3(1.58) + 1.53}{3(0.02) + 0.1 + 10} = 0.617A$

$P_L = I_L^2 R_L = (0.617)^2(10) = 3.81W$

$P_L = I_L^2 R_L \Rightarrow 0.5 = I^2(10) \Rightarrow I_L\ 0.224A$

$I_T = \frac{3(1.58) + 1.53}{3(0.02) + r + 10} = 0.224 = \frac{6.27}{10 + r}$ $\quad r = 18\Omega$

4) $0.0139 \text{ min/beat} \left(\frac{60 \text{ s}}{1 \text{ min}}\right) = 0.833 \frac{\text{s}}{\text{min}}$

$T = RC \Rightarrow 0.833 = R(25 \times 10^{-9})$

$R = 3.33 \times 10^{7} \ \Omega$

unit 3 : magnetism 1

1)

2) $q = -1.6 \times 10^{-19} C$ $v = 4.1 \times 10^3 m/s$
$B = 1.25 T$, $F = 1.4 \times 10^{-16} N$
$|G| = qvB \sin\theta$

$1.4 \times 10^{-16} = 1.6 \times 10^{-19} (4.1 \times 10^3)(1.25 \sin\theta)$

$$\frac{1.4 \times 10^{-16}}{(1.6 \times 10^{-19})(4.1 \times 10^3)(1.25)} = 0.1707$$

$\theta = 9.8^\circ$ or 170.2°

4) $1 cm \rightarrow 0.01 m$
$25 cm = 0.25 m$
$2.00 T$ for B, $100 A$ for I and $0.25 m$ for L
$F = 2.00 T \times 100 A \times 0.25 m = 50 N$

5) $L = 20\text{cm} = 0.2\text{m}$

# of turns $N = 200$, current $I = 25\text{A}$

Force on each side $F = 1000B\ \text{N}$

Torque to opposite force $F \cdot L = 200B\ \text{N-m}$

given $200B = 300$

$\Rightarrow \boxed{B = 1.5\text{T}}$

6)

Case	B direction
a	
b	
c	

7) Current $I = P/V = \dfrac{450 \times 10^6}{300{,}000} = 1500\text{A}$

magnetic field $B = \mu_0 I / 2\pi^2 = 10^{-7} \times \dfrac{4\pi^2 \times 1500}{2\pi \times 20}$

$B = 150 \times 10^{-7}\text{T}$

$\boxed{B = 1.5 \times 10^{-5}\text{T}}$