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PHYS 223 University Physics III
Exam 1

September 17, 2014

Name J. C. DALY

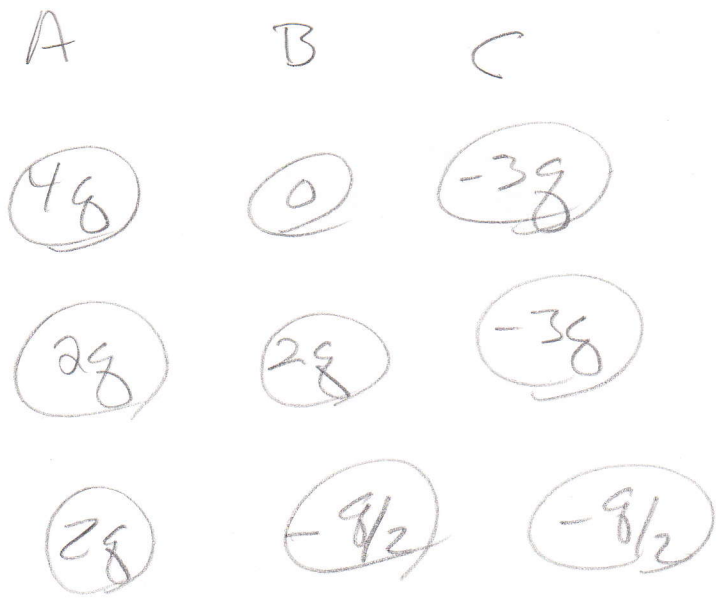
1. Consider three identical metal spheres, A, B, and C. Sphere A carries a charge of +4q. Sphere B carries a charge of no net charge. -q. Sphere C carries a charge of -3q. Spheres A and B are touched together then separated. Sphere C is then touched to sphere B.

   a. How much charge ends up on sphere C? $-3/2$

   What is the total charge on the three spheres

   b. before they are allowed to touch each other and $1q$

   c. after they have touched? $1q$



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2. An electron with a velocity of 4.0×10^4 m/s in the x direction enters a region where there is an electric field in the y direction equal to 5.0×10^5 N/C as shown in Figure 2.

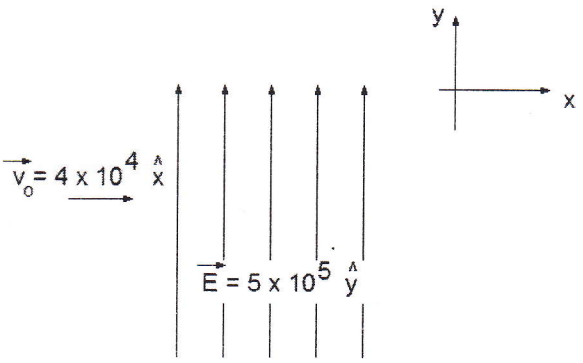

Figure 2

What is the velocity of the electron after one picosecond (10^{-12} seconds)? _____

$v_x = 4 \times 10^4$ m/s

$v_y = a_y t$

$a_y = \frac{F}{m} = \frac{qE}{m} = \frac{-1.6 \times 10^{-19} * 5 \times 10^{+5}}{9.1 \times 10^{-31}}$

$a_y = -0.879 \times 10^{17}$ m/s^2

$v_y = a_y t = -0.879 \times 10^{17} * 10^{-12}$

$v_y = -0.879 \times 10^5$ m/s

$\vec{v} = v_x \hat{x} + v_y \hat{y} = 4 \times 10^4 \hat{x} - 8.79 \times 10^4 \hat{y}$

$\vec{v} = 9.657 \angle -65.5^\circ$

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3. There are three charges, Q_1 1 uC located at the origin (0,0), Q_2 -2 uC located on the y axis at y= 4 m (0,4), and Q_3 5 uC located on the x axis at x = 3 m (3,0), as shown in Figure 3.

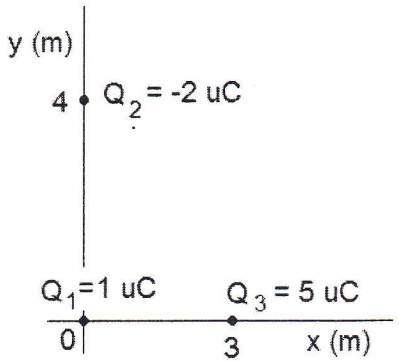

Figure 3

What is the force exerted on Q_3? $.0040 \angle 45.4^\circ$

$$\vec{F} = \vec{F}_1 + \vec{F}_2$$

$$\vec{F}_1 = \frac{Q_1 Q_3}{4\pi\epsilon_0 r^2}\hat{r} = \frac{10^{-6} * 5\times10^{-6}}{4\pi\, 8.854\times10^{-12} * 9}\hat{x}$$

$$\vec{F}_1 = 0.00499\,\hat{x}$$

$$\vec{r}_2 = 3\hat{x} - 4\hat{y} \qquad r_2^2 = 5^2 = 25$$

$$\hat{r}_2 = \frac{\vec{r}_2}{r_2} = \frac{3\hat{x} - 4\hat{y}}{5}$$

$$\vec{F}_2 = \frac{Q_3 Q_2}{4\pi\epsilon_0 r_2^2}\hat{r}_2 = \frac{5\times10^{-6} * (-2\times10^{-6})}{4\pi * 8.854\times10^{-12} * 25}\left(\frac{3\hat{x} - 4\hat{y}}{5}\right)$$

$$\vec{F}_2 = \frac{-10}{4\pi\, 8.854}\left[\frac{3}{125}\hat{x} - \frac{4}{125}\hat{y}\right]$$

$$\vec{F}_2 = -0.002157\,\hat{x} + 0.002876\,\hat{y}$$

$$\vec{F}_1 = 0.00499\,\hat{x}$$

$$\vec{F} = \vec{F}_1 + \vec{F}_2 = 0.002833\,\hat{x} + 0.002876\,\hat{y}$$

$$\vec{F} = 0.0040 \angle 45.4^\circ$$

Physical Constants

Constant	Symbol	Magnitude
Avogadro's Number	N_A	6.022×10^{23} molecules/mole
Boltzmann's constant	k	1.38×10^{-23} J/K = 8.62×10^{-5} eV/K
Stefan-Boltzmann constant	σ	5.67×10^{-8} J/(s*m^2*K^4)
Electronic charge	q	1.6×10^{-19} C
Electronvolt	eV	1.6×10^{-19} J
Planks constant	h	6.625×10^{-34} J-s
Thermal voltage, kT, at 300 °K	V_t	25.8 mV
Velocity of light	c	3×10^8 m/s
Permeability of free space	u_o	1.257×10^{-6} H/m
Permittivity of free space	ε_o	8.854×10^{-12} F/m
Free-electron mass	m	9.1×10^{-31} kg

Atomic Masses

Element	Symbol	Atomic Mass	Atomic Number
Hydrogen	H	1.00794 u	1
Helium	He	4.00260 u	2
Lithium	Li	6.941 u	3
Beryllium	Be	9.0122 u	4
Boron	B	10.811 u	5
Carbon	C	12.0107 u	6
Nitrogen	N	14.0067 u	7
Oxygen	O	15.9994 u	8
Fluorine	F	18.9984 u	9
Neon	N	20.1797 u	10
Sodium	Na	22.9897 u	11
Magnesium	Mg	24.305 u	12
Aluminum	Al	26.9815 u	13
Silicon	Si	28.0855 u	14
Phosphorus	P	30.9738 u	15

Thermal properties of Water

Specific Heat Capacity	c	4186 J/(kg*C°)
Latent Heat of Fusion	L_f	33.5×10^4 J/kg
Latent Heat of Vaporazation	L_v	22.6×10^5 J/kg