Unit #3 Review Problems Answers

1. $m_1 = m_2 = 300\,000\,kg$
$r = 1.0\,km = 1.0 \times 10^3\,m$
$F_g = ?$

$$F_g = \frac{G m_1 m_2}{r^2}$$

$$F_g = \frac{(6.67 \times 10^{-11}\,N m^2/kg^2)(300000\,kg)^2}{(1.0 \times 10^3\,m)^2}$$

$$F_g = 6.0 \times 10^{-6}\,N$$

2. a) $m = 2 m_E = 2(5.98 \times 10^{24}\,kg)$
$g = ?$
$r = r_E = 6.38 \times 10^6\,m$

$$g = \frac{G m}{r_E^2}$$

$$g = \frac{(6.67 \times 10^{-2}\,N m^2/kg^2)(2(5.98 \times 10^{24}\,kg))}{(6.38 \times 10^6\,m)^2}$$

$$g = 19.6\,N/kg$$

b) $v_e = ?$

$$v_e = \sqrt{\frac{2GM}{r}}$$

$$v_e = \sqrt{\frac{2(6.67 \times 10^{-11}\,N m^2/kg^2)(2(5.98 \times 10^{24}\,kg))}{6.38 \times 10^6\,m}}$$

$$v_e = 1.58 \times 10^4\,m/s$$

c) $v_{orbital} = ?$

$$v = \sqrt{\frac{Gm}{r}}$$

$$v = \sqrt{\frac{(6.67 \times 10^{-11}\,N m^2/kg^2)(2(5.98 \times 10^{24}\,kg))}{6.38 \times 10^6\,m}}$$

$$v = 1.12 \times 10^4\,m/s.$$

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3. $F_e = 1.4 \times 10^{-2}\ N$

a) $F_e = \frac{Kq_1q_2}{(4r)^2} = \frac{1}{16} F_e = 8.75 \times 10^{-4}\ N$

$= 8.8 \times 10^{-4}\ N$

b) $F_e = G\frac{2q_1 2q_2}{r^2} = 4F_e = 5.6 \times 10^{-2}\ N$

c) $F_e = \frac{4}{16} F_e = \frac{1}{4} F_e = 3.5 \times 10^{-3}\ N$

4.

* looking at the electric field lines, the field will add
∴ use $q_2 = |-1.0 \times 10^{-6} C|$

$q_1 = 4.0 \times 10^{-6} C$
$q_2 = -1.0 \times 10^{-6} C$
$r_1 = 40.0\ cm = 0.400\ m$
$r_2 = 30.0\ cm = 0.300 m$
$\mathcal{E}_T = ?$

$\mathcal{E}_T = \mathcal{E}_1 + \mathcal{E}_2$

$\mathcal{E}_T = \frac{kq_1}{r_1^2} + \frac{kq_2}{r_2^2}$

$\mathcal{E}_T = (9.0 \times 10^9\ Nm^2/C^2)\left[\frac{(4.0 \times 10^{-6} C)}{0.400 m^2} + \frac{1.0 \times 10^{-6} C}{0.300 m^2}\right]$

$\mathcal{E}_T = 3.2 \times 10^5\ N/C$

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5a) $q = 1\times10^{-5}\,C$
$\mathcal{E} = 50\,N/C$

$F_e = ?$

$F_e = q\mathcal{E}$

$F_e = (1\times10^{-5}\,C)(50\,N/C)$

$F_e = 5\times10^{-4}\,N$

b) $\Delta d = 1.0\,m$
$E_{K_2} = ?$

$\Delta E_K = W = F_e \Delta d$
$\Delta E_K = (5\times10^{-4}\,N)(1.0\,m)$
$\Delta E_K = 5\times10^{-4}\,J$

But $E_{K_1} = 0\,J \therefore E_{K_2} = 5\times10^{-4}\,J$

c) $v = 2.5\times10^{4}\,m/s$
$m = ?$

$E_{K_2} = \frac{1}{2}mv^2 \Rightarrow m = \frac{2E_{K_2}}{v^2}$

$m = \frac{2(5\times10^{-4}\,J)}{(2.5\times10^{4}\,m/s)^2}$

$m = 1.6\times10^{-12}\,kg$
$= 2\times10^{-12}\,kg$

6. $V = 120\,V$
$d = ?$
$\mathcal{E} = 450\,N/C$

$qV = q\mathcal{E}d \Rightarrow d = \frac{V}{\mathcal{E}}$

$d = \frac{120\,V}{450\,N/C}$

$d = 2.67\times10^{-1}\,m$

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7. $d = 12\,m$
$I = 4.5\times10^{3}\,A$
$B = ?$

$$B = \frac{\mu_0 I}{2\pi d}$$

$$B = \frac{(4\pi\times10^{-7}\ Tm/A)(4.5\times10^{3}A)}{2\pi(12m)}$$

$$B = 7.5\times10^{-5}\,T$$

* direction depends on current flow

Scenario 1

Scenario 2

8. $N = 12$
$r = 2.5\,cm = 0.025\,m$
$I = 0.52\,A$
$B = ?$

$$B = \frac{\mu_0 N I}{2r}$$

$$B = \frac{(4\pi\times10^{-7}\ Tm/A)(12)(0.52A)}{2(0.025m)}$$

$$B = 1.6\times10^{-4}\,T$$

9. $F = ?$
$d = 3.5\,m$
$I_1 = I_2 = 1.5\times10^{4}\,A$
$L = 190\,m$

$$F = \frac{\mu_0 I_1 I_2 L}{2\pi r}$$

$$F = \frac{(4\pi\times10^{-7}\ Tm/A)(1.5\times10^{4}A)^{2}(190m)}{2\pi(3.5m)}$$

$$F = 2.4\times10^{3}\,N$$

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10. $r = ?$

$m = 6.64 \times 10^{-27}\ kg$

$v = 2.0 \times 10^{6}\ m/s$

$B = 2.9 \times 10^{-5}\ T$

$q = +2$

$= 2(1.602 \times 10^{-19}\ C)$

$$r = \frac{mv}{qB}$$

$$r = \frac{(6.64 \times 10^{-27}\ kg)(2.0 \times 10^{6}\ m/s)}{2(1.602 \times 10^{-19}\ C)(2.9 \times 10^{-5}\ T)}$$

$$r = 1.4 \times 10^{3}\ m$$

Direction? Assume $\vec{B}$ into page

α particle has +2 charge

$\therefore$ counterclockwise.