HW5

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① $K\dfrac{4.76E{-}9 \cdot 5.72E{-}9}{0.136} = 1.802E{-}6$

$K\dfrac{4.76E{-}9 \cdot 1.65E{-}9}{0.898} = -1.182E{-}7$

$K\dfrac{5.72E{-}9 \cdot 1.65E{-}9}{0.525} = -1.618E{-}7$

$U_{Tot} = 1.522E{-}6$

③ $$K\frac{Q \cdot -Q}{x} + K\frac{Q \cdot -Q}{y} + K\frac{Q \cdot Q}{\sqrt{x^2+y^2}} +$$

$$K\frac{-Q \cdot -Q}{\sqrt{x^2+y^2}} + K\frac{-Q \cdot Q}{x} + K\frac{Q \cdot -Q}{y} = U_{tot}$$

$$\Delta U = -\left(2\left(\frac{-KQ^2}{x}\right) + 2\left(\frac{-KQ^2}{y}\right) + 2\left(\frac{KQ^2}{\sqrt{x^2+y^2}}\right)\right)$$

④ $q = 1.602E{-}19$

$\Delta V = 0-(-80.5E{-}3)$

$\Delta U = 80.5E{-}3/1.602E{-}19$

$\Delta U = q\Delta V$

⑤ $KE = -\Delta U$

$\Delta E = \Delta U + \Delta K$

$\Delta E = 6.81N \cdot 17.8E{-}3m = 0.1212J$

$\Delta U = 7.25 \cdot 8.3E{-}3 = 0.0602J$

$\Delta K = 0.1212J - 0.0602J = 0.061J$

(7)

$$\Delta U = k\frac{qq}{r} = \frac{1}{2}mv^2$$

$$9E9 \cdot \frac{2.10E\text{-}12 \cdot 3.5E\text{-}12}{2 \cdot 3.75E\text{-}6} = \frac{1}{2} \cdot 2 \cdot 9.05E\text{-}14\,kg \cdot v^2$$

$$V_f = 312.2\,m/s$$

$$F = 9E9\frac{2.10E\text{-}12 \cdot 3.5E\text{-}12}{(2 \cdot 3.75E\text{-}6)^2} = 0.001176$$

$$a = F/m \quad a = \frac{0.001176}{9.05E\text{-}14} = 1.299E10\,m/s^2$$

(8)

Need r to be distance from edge of ring

$$\Delta U = k\frac{-Qq}{\sqrt{10R^2}} + k\frac{Qq}{\sqrt{2R^2}} = \frac{1}{2}mv^2$$

$$= -\frac{kQq\sqrt{2}}{\sqrt{20}R} + \frac{kQq\sqrt{10}}{\sqrt{20}R}$$

$$= \frac{kQq(\sqrt{10}-\sqrt{2})}{\sqrt{20}R} = \frac{1}{2}mv^2$$

$$V = \sqrt{\frac{2kQq(\sqrt{10}-\sqrt{2})}{\sqrt{20}Rm}}$$

(9)

$$k\int_0^{0.227m} \frac{\left(\frac{0.290C}{0.227m}\right)(0.290C)}{\sqrt{0.186^2+\ell^2}} = \frac{k \cdot Q^2}{L}\int_0^{0.227m} \frac{1}{\sqrt{r^2+\ell^2}}\,d\ell$$

Identity: $\frac{k \cdot Q^2}{L} \cdot \ln\left(\frac{\ell}{r} + \frac{\sqrt{r^2+\ell^2}}{r}\right)\Big|_0^{0.227m}$ 3444932286 J

$\Delta U = 344932286\ J = \frac{1}{2} m v^2$

$v = 450822\ m/s$

(10) $E = \frac{F}{Q}$

$\text{Vertical} = E\cos(55.2^\circ) = \frac{F}{Q}$

$F = 7.82\ \frac{N}{C} \cos(55.2^\circ) \cdot -77.8E-6\ C = -3.472E-4\ N$

$W = -3.472E-4\ N \cdot 0.156\ m = -5.417E-5\ J$

$\Delta E = \Delta U + \Delta K$

$-5.417E-5 = \Delta U + 0$

$\Delta V = -(-5.417E-5\ J / -77.8E-6\ C)$

$\Delta V = -0.696\ V$

(12) For uniformly charged sphere: $V = \frac{kq}{R}$

To find the work needed we add infinite charges to the surface of the sphere:

$dU = V\,dq$ (the work to add dq)

$$\Delta U = \int_0^Q V\,dq = \int_0^Q \frac{kq}{R}\,dq = \left.\frac{kq^2}{2R}\right|_0^Q \quad \frac{kQ^2}{2R}$$

$$\Delta U = U_f - U_i = \frac{kQ^2}{2}\left(\frac{1}{R_f} - \frac{1}{R_i}\right)$$

$$= \frac{k}{2}\left(\frac{V_0 R_i}{k}\right)^2\left(\frac{1}{R_f} - \frac{1}{R_i}\right)$$