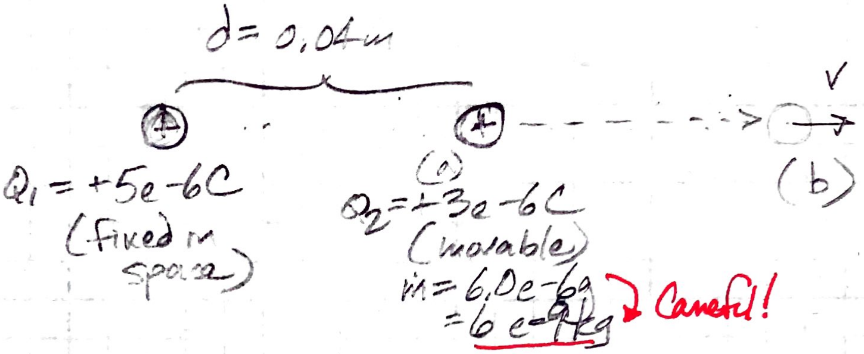
7.29



a) Find potential energy of Q_2 at this position.

$$\Delta U = U_f - U_i = -\int_{r_i}^{r_f} \vec{F} \cdot dr$$

$$U_f - U_i = -\int \frac{kq_1q_2}{r^2}\,dr$$

$$= -kq_1q_2 \int_{r_i}^{r_f} \frac{1}{r^2}\,dr$$

$$= -kq_1q_2\left(-\frac{1}{r}\right)\Big|_{r_i}^{r_f} = -kq_1q_2\left(\frac{-1}{r_f} - \frac{-1}{r_i}\right)$$

$$U_f - U_i = kq_1q_2\left(\frac{1}{r_f} - \frac{1}{r_i}\right)$$

As before take potential energy $U_i = 0$ at $r_i = \infty$

$$\boxed{U = \frac{kq_1q_2}{r}}$$

$$U = \frac{(9e9)(5e-6)(3e-6)}{(0.04)} = \boxed{3.38\ J}$$

b) If Q is released, how fast is it travelling at 8.0 cm?

$$\Sigma E_i = \Sigma E_f$$

$$U_i + K_i = U_f + K_f$$

$$3.38\,J + 0 = \frac{kqQ}{r} + \frac{1}{2}mv^2$$

$$3.38 = \frac{(9e9)(5e-6)(3e-6)}{0.08} + \frac{1}{2}(6e-9\,kg)v^2$$

$$v = \boxed{2.38e4\ m/s}$$

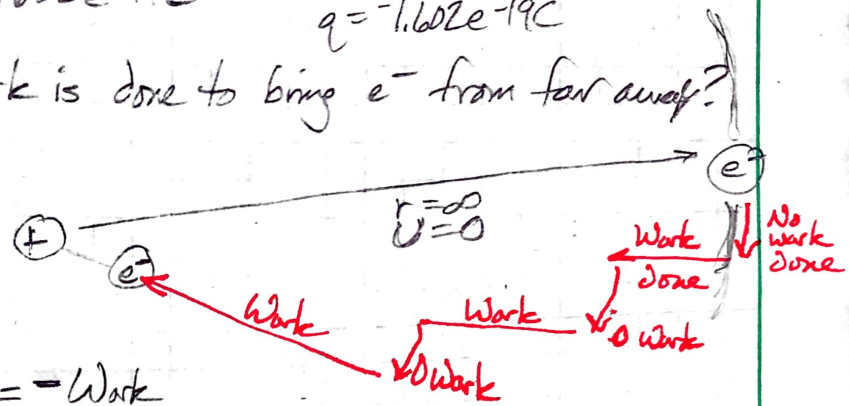
7.31

$r = 0.529\,\text{Å} = 0.529e{-10}\,m$

proton, $q = {}^{+}1.602e{-19}C$

electron, $q = {}^{-}1.602e{-19}C$

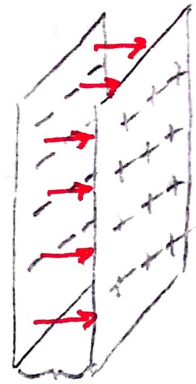
How much Work is done to bring e^- from far away?



$$\Delta U = U_f - U_i = -\text{Work}$$

$$\text{Work done} = -(U_f - U_i)$$
$$= U_i - U_f$$
$$= 0_\infty - \frac{k q_1 q_2}{r}$$
$$= -\frac{(9e9)(-1.602e{-19}C)(+1.602e{-19})}{0.529e{-10}}$$
$$= \boxed{4.37e{-18}J}$$

7.36



Conducting plates with Electric field between them.

E

$d = 0.01\,m$

$$\Delta V \equiv \frac{\Delta U}{q} \quad \text{(by definition)}$$

$$\Delta U = -\int_{x_i}^{x_f} F \cdot ds$$

$$= -\int_{x_i}^{x_f} qE \cdot ds$$

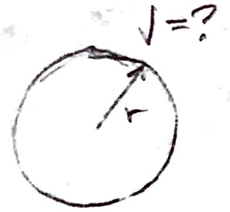
$$\Delta U = -qEd$$

$$\Delta V = \frac{-qEd}{q} = -Ed \quad \text{(for parallel plates w/ constant E.)}$$

$$E = \frac{\Delta V}{d} = \frac{7.5e4\,V}{0.01\,m}$$

$$= \boxed{7.5e6\ N/C}$$

7.45



$d = 0.500\ \text{cm}$
$= 5.0e{-3}\ \text{m}$, so $r = 2.5e{-3}$

$q = 40.0\ \text{pC}$
$= 40e{-12}\ \text{C}$

$$U_f - U_i = -\int F \cdot dr$$
$$= -\int qE \cdot dr$$
$$\Delta V = \frac{\Delta U}{q} = -\int E \cdot dr$$
$$V_f - V_i = -\int_{\infty}^{r} \frac{kQ}{r^2}\, dr$$

0 at $r = \infty$

$$V = kQ \, -\int_{\infty}^{r} \frac{1}{r^2}\, dr = kQ \, -\left(-\frac{1}{r}\right)\Big|_{\infty}^{r}$$
$$= kQ \; \frac{1}{r} - \frac{1}{\infty}$$
$$\boxed{V = \frac{kQ}{r}}$$

$$V = \frac{(9e9)(40e{-12})}{2.5e{-3}} = \boxed{144\ \text{V}}$$