WORKSHOP 5.2 2/13/09

C29-3

a) At the turning point, the p^+ (proton) is at rest, and thus has no KE. at 10fm, the PE is 2×10^{-12} J. Thus $E_{tot}^{final} = 2\times10^{-12}$ J. Far away, the PE is 0. Thus $E_{tot}^{initial} = KE^{initial}$ then by conservation of energy,

$$\boxed{KE^{initial} = 2\times10^{-12}\,J}$$

b) at 20fm, the PE is 1×10^{-12} J, so by cons. of Energy,

$E_{tot} = 1\times10^{-12}\,J + KE = 2\times10^{-12}\,J \Rightarrow \boxed{KE = 1\times10^{-12}\,J}$

c) ~~for energy, the direction of motion is~~ Energy is independent of direction of motion, so again,

$\boxed{KE = 1\times10^{-12}\,J}$ (only position matters for PE)

C29-4

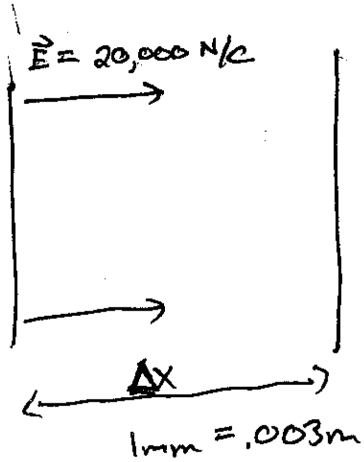
a) the electric potential energy is $\frac{Kq_1q_2}{r} = -\frac{3Kq^2}{r}$ $q = |q_{e^-}|$

since charges have opp. sign!

from point i to f, r increases, so potential is closer to zero. However, the PE is negative so PE has increased.

b) So long as nothing else is acting on the electron, and E_{tot}=const, KE decreases as PE increases, so the electron has slowed down.

$\boxed{29\text{-}2}$



$$KE = \overset{\text{work done}}{F}\Delta x = -|\vec{E}|q\Delta x = \frac{1}{2}m v_{final}^2$$

↓

also is difference in PE

$$PE_i = U_0 \qquad PE_f = U_0 - |E|q\Delta x$$

$$\Delta PE = -|E|q\Delta x$$

$$v_f^2 = \frac{-2|\vec{E}|q\Delta x}{m} \qquad v_f = \left[\frac{2|\vec{E}|(-q)\Delta x}{m}\right]^{1/2}$$

$$= \left[\frac{2(20{,}000\ N/C)(1.6\times10^{-19}C)(.001m)}{(9.11\times10^{-31}kg)}\right]^{1/2}$$

$$\boxed{v_f = 2.7\times10^{6}\ m/s}$$

$\boxed{29\text{-}3}$ From problem 2, we have:

$$v_f = \left[\frac{2|\vec{E}|q\Delta x}{m}\right]^{1/2}.$$

In going from p^+ to He^+, all we've done is increased the mass by a factor of 4 (ΔPE is the same)

$$\left(\text{or just } v_f = \sqrt{\frac{2\Delta PE}{m}}\right)$$

so $$\frac{v_f^{proton}}{v_f^{He^+}} = \frac{\sqrt{\frac{2\Delta PE}{m_{p^+}}}}{\sqrt{\frac{2\Delta PE}{m_{He^+}}}} = \sqrt{\frac{m_{He^+}}{m_p}} = \sqrt{\frac{4\cancel{u}}{\cancel{u}}} = 2$$

$$\boxed{v_{He^+} = \frac{1}{2}v_{p^+} = 25{,}000\frac{m}{s}}$$

29-5 The electric potential energy is <u>additive</u>, so we need only compute the individual potentials and sum them

$$PE_{top} = \frac{K q_p q_{e^-}}{r_{top}} \qquad PE_{bot} = \frac{K q_p q_{e^-}}{r_{bot}}$$

$$r_{top} = r_{bottom} = \sqrt{(.5\,nm)^2 + (2.0\,nm)^2}$$

$$q_p = -q_{e^-} = 1.6\times10^{-19}C$$

$$\boxed{PE_{tot} = \frac{1}{4\pi\varepsilon_0}\,\frac{2\times(1.6\times10^{-19}C)^2}{\sqrt{(.5\times10^{-9}m)^2+(2\times10^{-9}m)^2}} = 2.23\times10^{-19}J}$$

29-8 A dipole in an E-field has potential energy

$$U_{dipole} = -\vec{p}\cdot\vec{E}$$

when not aligned (perpendicular):

$$\vec{p}\cdot\vec{E} = 0$$

when aligned, $\vec{p}\cdot\vec{E} = |\vec{p}||\vec{E}|$

so $U^{aligned}_{dipole} - U^{aligned}_{dipole} = 0 - (-|\vec{p}||\vec{E}|) = |\vec{p}||\vec{E}|$

$$|\vec{E}| = \frac{\Delta U}{|\vec{p}|} = \frac{(1.0\times10^{-21}\overset{N\cdot m}{J})}{(6.2\times10^{-30}C\cdot m)} = 1.6\times10^{8}N/C$$

$$\boxed{|\vec{E}| = 1.6\times10^{8}N/C}$$