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F17 Dr. Baugh
CHEM 20A Section 1F
Quiz 1

100/100

Name: Jacob Kaufman

Question 1: An electron is placed at the origin of coordinates. Another electron is placed 2 Å away in the -x direction.

a. Determine the potential energy of this interaction

$V(r) = k\frac{q_1 q_2}{r}$

$= (8.99\times10^{9})\frac{(-1.6\times10^{-19})(-1.6\times10^{-19})}{(2\times10^{-10})} = \boxed{1.2\times10^{-18}\ J}$

b. Determine the magnitude of the force of this interaction. In which direction will the force act upon the electron at the origin?

1.) $F(r) = k\frac{q_1 q_2}{r^2}$

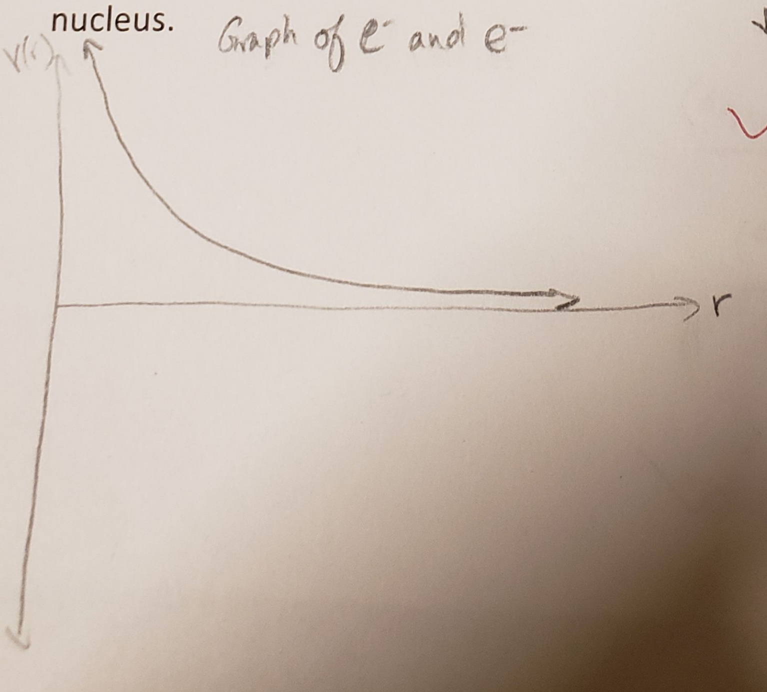
$= (8.99\times10^{9})\frac{(-1.6\times10^{-19})(-1.6\times10^{-19})}{(2\times10^{-10})^2}$

$= \boxed{5.8\times10^{-9}\ N}$

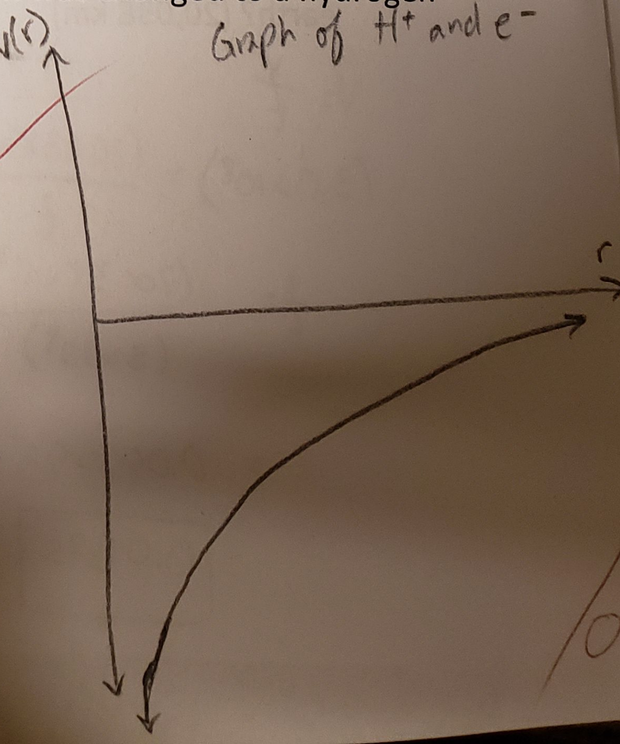
2.) The force will act in the positive x direction on the electron at the origin.

c. Sketch a graph showing the potential energy of the system as a function of distance between the two particles. Show a second graph depicting how the first graph would change if the first electron was changed to a hydrogen nucleus.

Graph of e⁻ and e⁻



Graph of H⁺ and e⁻



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Question 2: Household microwaves typically utilize frequencies of approximately 2.5 GHz ($2.5*10^3$ MHz).

a. Determine the wavelength of a typical microwave.

$\nu = (2.5\times10^3 MHz)\left(\frac{10^3 kHz}{MHz}\right)\left(\frac{10^3 Hz}{kHz}\right)$

$= 2.5\times10^3\times10^3\times10^3 Hz = 2.5\times10^9 Hz$

$c = \lambda\nu \Rightarrow 3.0\times10^8 = \lambda(2.5\times10^9) \Rightarrow \lambda = 0.12 m$ ✓

b. Determine the energy of this wave.

$E = h\nu$

$E = (6.626\times10^{-34})(2.5\times10^9)$

$= 1.7\times10^{-24} J$ ✓

c. Determine the wavelength of this wave in nm. How does this compare to visible light?

$0.12 m\left(\frac{10^9 nm}{m}\right) = 1.2\times10^8 nm$ ✓

This wavelength is longer than that of visible light ✓

d. How long would it take to send a microwave signal halfway around the earth? (20,038 km)

$V = \frac{X}{t}$

$(3.0\times10^8) = \frac{(20038\times10^3)}{t}$

$t = \frac{(20038\times10^3)}{(3\times10^8)}$

$= 0.0667935 s$

$= 0.067 s$ ✓

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