2-1

A) Assuming both charges to be point charges, we have an initial potential energy of

$$U_o = \frac{k_e q_1 q_2}{r} = \frac{9 \times 10^9 (1.31 \times 10^{-17}) 3.2 \times 10^{-19}}{4 \times 10^{-14}} = 9.4 \times 10^{-14}\ \mathrm{J}\ .$$

B) The rest of the questions (B, C, and D) are basically the same. Since the electric force is conservative, we expect energy to be conserved:

$$U_o = U(r) + K$$

$$U_o = \frac{k_e Q q}{r} + \tfrac{1}{2} m v^2 \quad \rightarrow \quad v(r) = \sqrt{\frac{2}{m}\left(U_o - \frac{k_e Q q}{r}\right)}\ .$$

Then,

r = 10^{-12} m (passing the atom's innermost electrons)	$v(r) = \sqrt{\frac{2}{6.67 \times 10^{-27}}\left(9.4 \times 10^{-14} - \frac{9 \times 10^9 (1.31 \times 10^{-17}) 3.2 \times 10^{-19}}{10^{-12}}\right)}$ $= 4.11 \times 10^6\ \mathrm{m/s}$
r = 10^{-10} m (exiting the outer layers of electrons)	$v(r) = \sqrt{\frac{2}{6.67 \times 10^{-27}}\left(9.4 \times 10^{-14} - \frac{9 \times 10^9 (1.31 \times 10^{-17}) 3.2 \times 10^{-19}}{10^{-10}}\right)}$ $= 5.29 \times 10^6\ \mathrm{m/s}$
r = ∞	$v(r) = \sqrt{\frac{2}{6.67 \times 10^{-27}}(9.4 \times 10^{-14} - 0)} = 5.31 \times 10^6\ \mathrm{m/s}$