

Modern Physics: PHYS 3705

Midterm II

NAME:_____

1) A particle of mass m is bound to a very heavy core through the attractive force law $F = k/R^5$, where R is the distance between the particle and the core (k is a constant)

Use Bohr/deBroglie quantization to determine the R_n and the E_n for circular orbits. Recall that for such a force law the potential energy is $E_{pot} = \frac{-k}{4R^4}$. Show all your work!

2) An element is found whose photon attenuation length (see figure below) has its highest energy 'jag' at .074 MeV. Identify the element and show your work.

3) Beaker A contains a four-carbon unsaturated **ring** molecule (see figure) and Beaker B contains a four-carbon unsaturated **linear** molecule. Unsaturated in this context means that the electrons involved in binding the carbons to each other are free to move between carbons, and thus down the length of the molecule.

Each carbon contributes two electrons to the ring/linear system (but also being cognizant of the Pauli exclusion principle which places no more than two electrons into each wave), and the potential energy of the electrons can be thought of as a negative constant term identical for the two molecules (chemists talk about the angles necessary in the ring molecule as causing a kind of strain energy, but we ignore that here!)

(a) (QUALITATIVE) Determine which molecule has lower total energy.

(b) (QUANTITATIVE) Compute that energy difference in units of electron volts per molecule. Assume C-C bond length is the same 2.7 Angstroms for each molecule.

4) In a photoelectric effect experiment a particular photocathode is found to require a stopping voltage of 1.1 Volts when the wavelength is 300 nm and 2.3 Volts when the wavelength is decreased to 220 nm.

On the basis of these data, determine the composition of the photocathode from the following list;

Ca 3.2 eV
K 2.1 eV
Na 2.3 eV
Au 4.8 eV

5) Compute the deBroglie wavelength of a proton ($m = 1.67 \times 10^{-27}$ Kg) accelerated through a potential difference of 10,000 volts.

Explain why or why not this proton would make a useful probe for the atomic structure of a crystal lattice.