Test 1 for Modern Physics, TTVN.

Please show all your work on these problems. You may use your book and other resources. This is due to Dr. Craig by Feb. 21. They can be emailed to dcraig at wtamu.edu (I prefer PDF files) or faxed to 806-651-5255.

1. Determine the minimum separation for Na^+ and Cl^- if they are just to be bound. Consider the ions as point charges. The ionization energy of Na is 5.14 eV, the electron affinity for Cl is 3.62 eV and the dissociation energy of NaCl is 3.58 eV.

2. A) The interatomic spacing for BrF is 0.176 nm. What is its moment of inertia? Assume that the isotopes are Bromine-79 and Fluorine-19 to get the nuclear masses.

   B) What will be the frequency separation between adjacent lines in the rotational spectrum of this form of BrF?

3. An approximate expression for the potential energy of two ions as a function of their separation is

$$U(r) = -\frac{ke^2}{r} + \frac{b}{r^9}$$

   The first term is the usual Coulomb interaction, while the second term is introduced to account for the repulsive effects of the two ions at small distances. Find b as a function of the equilibrium spacing r_0.

4. Turn in a complete solution to problem 12-10 in your text.

5. Turn in a complete solution to problem 12-13 in your text, which is based on 12-10 above.

6. It is convenient to describe the motion of an electron (or hole) in a band by giving it an *effective mass*, m^*, defined by

$$\frac{1}{m^*} = \frac{1}{\hbar^2}\frac{d^2E}{dk^2}$$

   where k is the wave number($k = 2\pi/\lambda$). For a free electron ($p = \hbar k$), show that $m^* = m$.

   (In a crystal lattice, the energy $E(k)$ depends on the lattice potential, giving a different effective mass for the particle.)

7. Calculate the fractional change in the current through a *p-n* junction diode when the forward bias is changed from +0.1 V to +0.2 V.