

/30

ELEC 4705 - Quiz 2

Thurs. Oct. 19th 2017

Name:

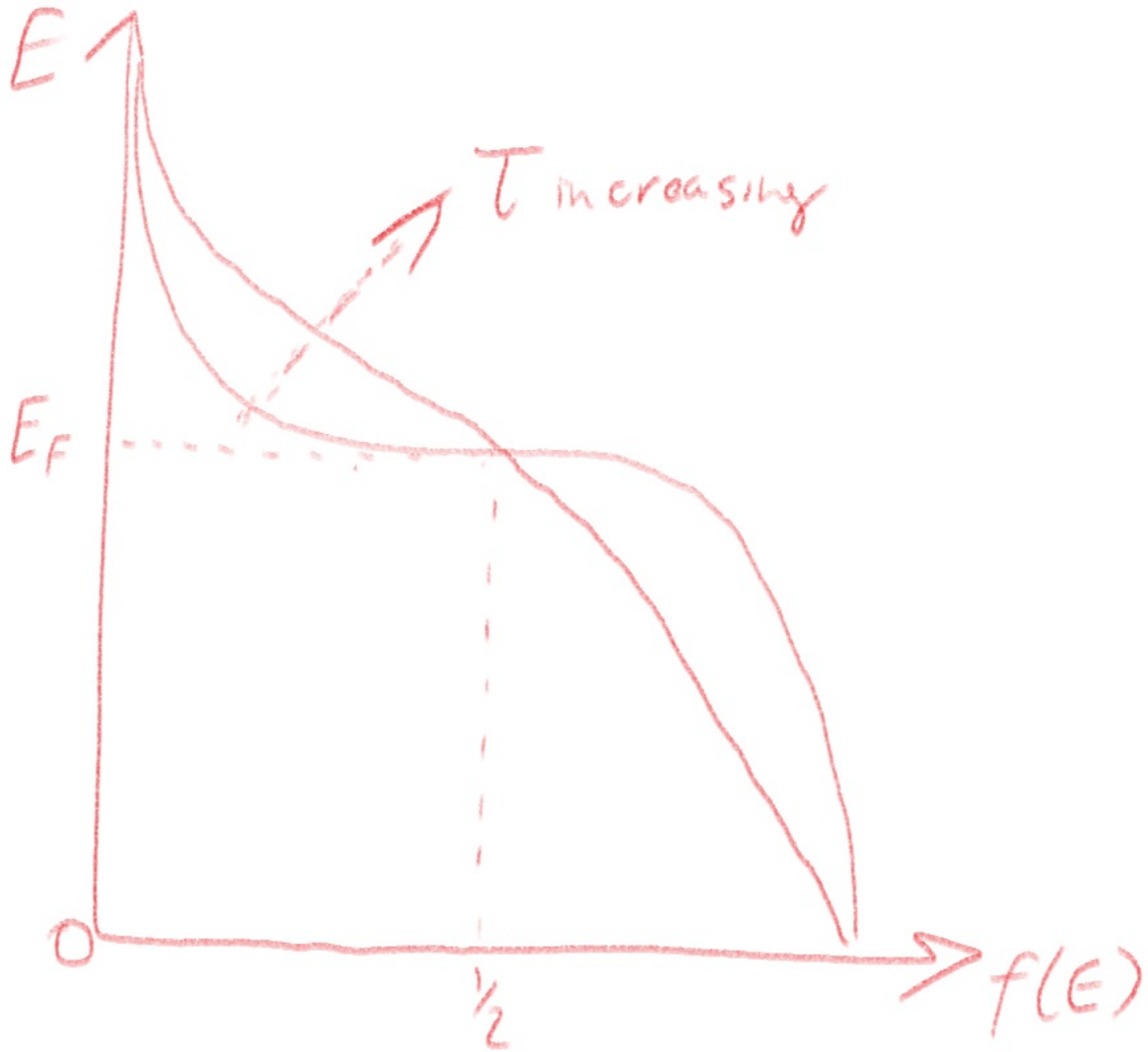
Student Number:

1. Electrons!

- a) Why can't electrons be described by Boltzmann Statistics?
What statistical distribution describes them instead? [2]

This is because they are fermions and so the pauli exclusion principle has to be accounted for in the statistics. They are instead governed by the fermi-dirac distribution.

b) Sketch this distribution, label major features, and show how it changes with an increase in T . [4]



- c) The distribution you named in the last question is given by equation 1. What do $f(E)$, E , E_F , k , and T represent? [5]

$$f(E) = \frac{1}{1 + \exp\left(\frac{E - E_F}{kT}\right)} \quad (1)$$

$f(E)$ is the probability of finding an electron at or below the specified energy, E is the electron energy, E_F is the fermi level, k is Boltzmann's constant, and T is the temperature of the system

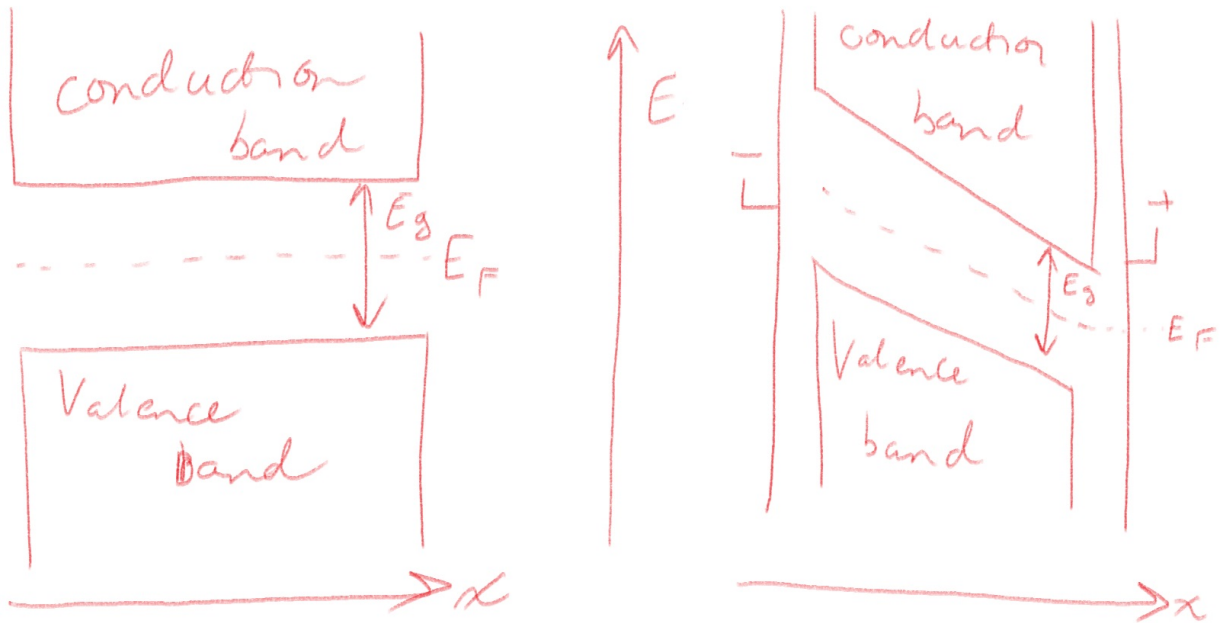
- d) Equation 2 is incomplete. Complete the equation and describe what term was needed to complete it, as well as what the equation gives. [3]

$$n = \int_0^{\infty} f(E) ____ dE \quad (2)$$

The missing piece of the equation is $g(E)$, which gives the density of states at a given energy. This equation gives the concentration of electrons at or above E

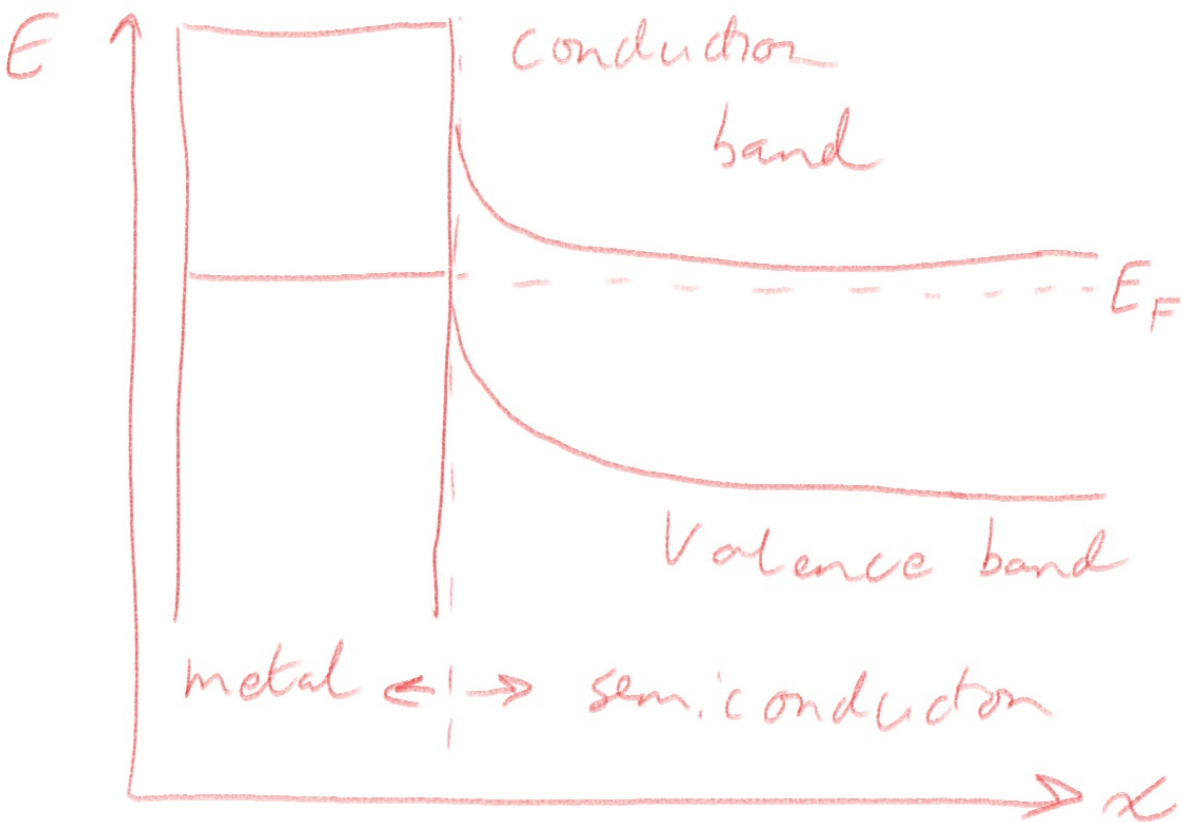
2. Band Structure, and Crystals!?

- a) Draw and label an approximation of a band structure for a semiconductor and its features, then draw the same band but with a voltage applied. [4]



- b) Draw and label the band diagram for a Schottky junction, and explain (with the help of the diagram or others) how this can be used as a detector. [5]

Because light is quantized, light of correct energy can excite (be absorbed by) an electron from the valence band to the conduction band of the Schottky diode and the intrinsic field of the diode will separate the electron hole pair and create a flow of current.



c) Describe how resistance arises in a semiconductor. [3]

Resistance is a result of an electron's mobility being reduced by thermal vibrations of the atoms in the crystal, and the presence of defects that scatter the electrons.

3. Semiconductors?

a) What are p-type and n-type materials? [2]

p-type materials and n-type materials are semi conductors that have been doped to give improved electrical characteristics. P-type materials are doped with acceptors and n-types with donors.

b) What kind of device is created by connecting a p-type material to an n-type material and what would you expect to happen if you applied a reverse bias to this device? [2]

By combining the two, a diode is created. A diode acts almost like a one way valve for current flow, and so when a reverse bias is applied, no current flows.