ECE 321 – Electronics I
Skills Review Block I (Physics)
Fall 2016

Name __________________________ **Section** _________

ACADEMIC SECURITY. This Skills Review is NEVER released from academic security.

INTEGRITY: Your honor is extremely important. This academic security policy is designed to help you succeed in meeting academic requirements while practicing the honorable behavior our country rightfully demands of its military. Do not compromise your integrity by violating academic security or by taking unfair advantage of your classmates.

Collaboration Policy: No collaboration allowed. This is individual effort. You may not seek help from other cadets, only DFEC faculty members and other DF faculty members. All help must be properly documented.

Permissible References: Any except a Skills Review from previous semesters.

Grading: The Skills Review will count as two quiz grades.

Overview: This exercise is intended to refresh some of the core concepts you learned in circuits, mathematics, physics and chemistry. These subject areas are relevant to the study of semiconductor devices and their use in electronics. The quality/readability of your work is important and <u>points will be deducted if we cannot understand or read your solutions</u>. You may attach additional pages to this handout if you need more space. Regardless of how you complete the problems, you **must** show your work to receive full credit.

Problem 1 (10 pts) _______ (Block I)

Problem 2 (10 pts) _______ (Block I)

Problem 3 (10 pts) _______ (Block I)

Problem 4 (10 pts) _______ (Block II)

Problem 5 (10 pts) _______ (Block II)

Problem 6 (10 pts) _______ (Block II)

Problem 7 (10 pts) _______ (Block III)

Problem 8 (10 pts) _______ (Block III)

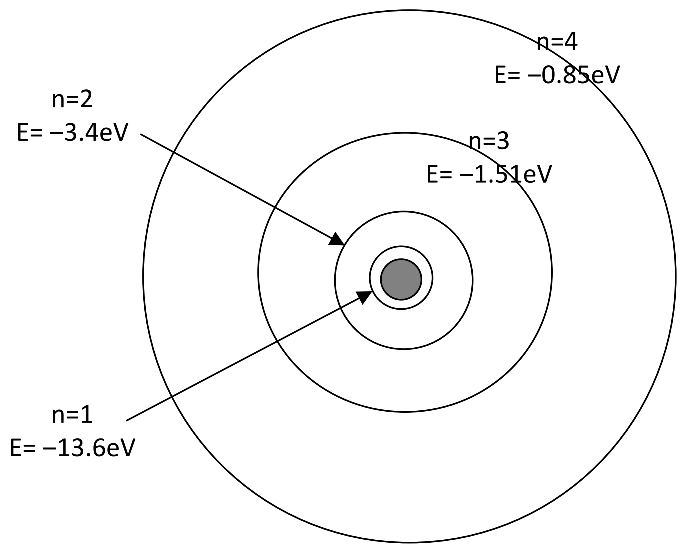
Total _______ **Grade ________**

Problem 1: Chemistry and Physics

The energy possessed by electrons bound to a hydrogen nucleus may be described by the equation:

$$E = -13.6\ eV / n^2$$

where n is the principle quantum number having only integer values and eV is an electron Volt. The energies are negative because we define 0 eV to be the "vacuum level", or the energy when an electron is 'just' free from the influence of the hydrogen nucleus. Thus an electron in the "ground state" where n=1, must acquire 13.6 eV to become free of the nucleus. The Bohr model illustrates this idea.



A. What happens to energy as an electron falls from the 4th shell to the 1st? Is energy gained or lost? Where does the energy go? Calculate the wavelength, λ, associated with this transition.

B. Can an electron be in the n = 2.35 shell? If so, what is the energy of that electron? If not, why not?

Problem 2: Physics Review

a) Calculate the average speed (in cm/sec) of electrons in a 0.6 mm (0.06 cm) diameter copper wire carrying 400 mA of direct current. Assume copper wire has 1.8×10^{23} electrons/cm^3 (n) and that the charge of an electron, $q = -1.6 \times 10^{-19}$ coulombs.

*Solution: The average speed of an electron in a wire can be found by using the **drift velocity** equation. It states* $v_d = \frac{J}{nq}$ *where J is the current density or current per (cross-sectional) area, n is the number of electrons per unit volume and q is the charge of an electron in coulombs.*

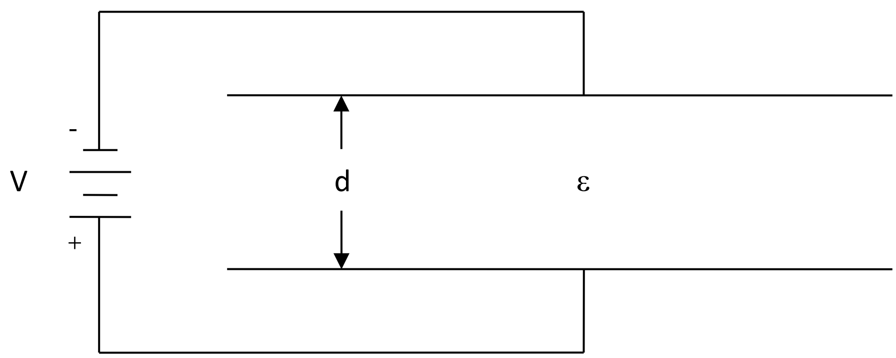
Therefore average speed of electrons is v_d (electron drift velocity) = 0.0049 cm/sec.

Determine whether this number is correct or not. If it is correct demonstrate the correctness using both numbers and units. If it is incorrect, show the correct value. In particular, show how to calculate *J*.

b) If the resistance of 1 meter of homogeneous copper wire is 4.9 mΩ assuming the same current as in part (a), what is the value of the electric field along the wire (in µV/cm)?

Recall the electric field is given by the derivative of the voltage with respect to distance, **E** = - dV/dx.

Problem 3: Physics Review



The figure above shows a parallel-plate capacitor attached to a battery of voltage V. An insulator with permittivity **ε** separates the two plates.

a. With the applied voltage shown, draw/indicate the type of charge that accumulates on each plate.

b. Clearly indicate on the figure the direction of the electric field **E** induced between the two plates.

c. State the relationship between the induced electric field **E** and applied voltage **V** for the parallel-plate capacitor above.