PHYS 225 – Final Exam Questions Written by Students

1.1, 1.2, 1.3

1. How are electrons configured in the elements?

2. What would be the definition of valence electrons and when is an atom excited?

3. What is Bohr's model of the atom?

4. Atom X has an energy ground state of -25 eV. It has 6 other distinct energy levels with values of -20 eV, -15 eV, -12 eV, -10 ev, -4 eV, and -2.5 eV. Calculate the possible wavelengths of light that can be emitted from this atom.

5. Write the electronic configuration for Calcium (^{20}Ca).

6. Write the four quantum numbers for carbon (^{6}C).

7. Describe the Bohr model of the atom.

8. What is the difference between atomic mass and molar mass.

9. Describe how secondary bonding occurs.

1.4, 1.5

1. Given that the average energy of a moecule is given by x(1/2)KT, what is the value of x for a monatomic molecule?

2. What would integrating the Maxwell-Boltzmann distribution from 0 to infinity give you?

3. The expression $e^{-E/KT}$ shows up routinely in Kinetic Molecular Theory. What is its name?

4. What does the Kinetic Molecular Theory predict about the pressure of a gas?

5. Most materials expand when exposed to heat. Why do they expand?

6. What does the Maxwell-Boltzmann distribution function tell us about the behavior of a gas?

7. Are particle collisions perfectly elastic or is energy lost? If so, how is energy lost?

8. What are the three degrees of freedom that relate to a gas' pressure and temperature?

9. What is molar heat capacity?

10. Why do diatomic gases have more energy per mole than monatomic gases?

11. What is (physically) specific heat?

12. Explain the difference between primary bonding (ionic, covalent, metallic) and secondary bonding (Van der Waals).

3.1.1, 3.1.2

1. Light is considered to be (circle all that apply):
   I. An electromagnetic wave
   II. Photons
   III. A quantum of energy $E = h\upsilon$

Discuss the double slit experiment and/or the photoelectric effect in support of your answer.

2. Discuss the differences between the classical and modern definitions of light intensity.

3. How are the work function and the stopping potential of a material related?

4. An element has a work function of 3.65eV. What is the longest wavelength radiation that can cause photoemission of electrons?

5. A) 91kg man is moving at 1.34m/s. What is his wavelength?
   B) How fast would he have to be walking to have a visible wavelength (400nm)?

6. What is the diffraction angle of electrons with wavelength 2.5nm if the distance between planes is 2nm?

7. A 440nm wavelength light is shined onto a surface, and the resulting angle is 33 degrees what is the thickness of the material.

8. A photoconductor has a work function of 5.6eV what frequency of light must be shined on the photoconductor for it to ionize an electron.

9. What is the DeBroglie wavelength of a 4500Kg elephant charging at 5m/s.

3.3, 3.4, 3.5

1. If a wave packet is made up of only one wave, what do we know about the particle?

a. We are very certain of both the particle's momentum and position.
b. We are very certain of the particle's momentum but not very certain of the particle's position.
c. We are not very certain of the particle's momentum but very certain of the particle's position.
d. We are not very certain of either the particle's momentum or position.

2. True/False When there is more than one solution to a wave equation, the sum of all of the solutions is also a solution to the equation.

3. Explain why your answer from the question above supports the idea that particles behave as waves.

4. What is the correlation between the number of nodes and the energy?
a. the less nodes, the higher the energy
b. the more nodes, the higher the energy
c. the more nodes, the lower the energy
d. none of the above

5. When do levels begin to be quantized?
a. when L is measured in meters
b. when L is measured in centimeters
c. when L is measured in nanometers
d. when L is measured in micrometers

6. Why is there a possibility that an electron will tunnel?
a. There is no way that the electron will tunnel.
b. The energy is described by the Boltzmann distribution, which says that there is always a chance.
c. An electron will always get through.
d. It is dependent on the material in which the electron is placed.

7. The electron confined to the infinite potential well is one of the simplest solutions to Schrodinger's wave equation. The quantization of energy levels allowed are

$$E = h^2n^2/ (8mn^2)$$

where n is the integer that dictates discrete energy levels, it is brought about mainly by what cause?

A. The fact that the well is very small, on the order of nanometers.
B. Boundary conditions that say the energy at the well walls must be zero.
C. The electron weighs so little compared to other particles that its wavelength is longer than a proton.

8. The wave function of a free electron extends through all space. What quantity is known, and what quantity is totally uncertain?

A. Position x is known because the wavelength is defined, Momentum is uncertain because the probability amplitude is unknown.
B. Momentum is known to some limit, while position is also known to some limit. Where delta x * delta P >= probability amplitude.
C. Momentum is known because the wavelength is defined, while position is uncertain because probability amplitude extends through all space.
D. Neither can be known with any certainty because the electron is free.

9. True/False The phenomenon of electron tunneling is awesome.

10. An electron tunneling scanning microscope can work in two main modes, what are the two modes?

A. Constant current variable voltage, or constant voltage variable current.
B. Constant height, variable current, or constant current, variable height.
C. Electrons can tunnel?

3.7, 4.1, 4.2

1. True/False In the H_2 molecule we cannot have two sets of identical atomic 1s orbitals because it would violate the Pauli Exclusion principle.

2. Draw the waveforms for a bonding and antibonding molecular orbital.

3. True/False Conduction in a metal is due to the drift of electrons around the Fermi level.

4. In the band theory of solids what is the work function Φ?

A) The energy of the top-most filled level as measured from the bottom of the band.
B) The energy difference between the top-most filled level and vacuum level.
C) The energy from the very bottom to the very top of the band.

5. Sketch a possible molecular orbit of 3 H atoms, and draw its corresponding probability sketch.

6. True or False. A boundary condition for a hydrogenic atom is: $\varphi \rightarrow 0$ as $r \rightarrow \infty$.

7. True or False The most probable place to find an electron in a hydrogenic atom is in its ground state at the bohr radius.

8. When two atoms are brought together, their identical wavefunctions interfere and overlap. Two new wave functions are created, the bonding and antibonding. Draw each of these. Do the new wavefunctions have the same energy?

9. Why in metals do various band energies (for example, 2s and 2p) overlap? And is this a conductor, insulator, or semi-conductor?

10. How is the energy affected by two electrons colliding, causing excitation of one electron?

11. Why does the overlap of full atomic orbital states not lead to bonding?

12. Since the work function is the "minimum energy" required to excite an electron out from the metal, what would be the longest wavelength radiation required?

4.4, 4.5, 4.6, 4.7

1. What are the different ways to move electrons up to the higher energy level in a semiconductor, so that they can conduct?

2. What is the difference between electron mass and effective electron mass?

3. What are the limits on the integral for calculating the density of states? Why?

4. Sketch the plot of Fermi-Dirac statistics. Label the important points on the graph.

5.1, 5.2

1. If a semiconductor is pure, that is non-doped, then it is:
   A) Extrinsic and Number of n = Number of p
   B) Extrinsic and Number of n < Number of p
   C) Extrinsic and Number of n > Number of p
   D) Intrinsic and Number of n = Number of p
   E) Intrinsic and Number of n < Number of p
   F) Intrinsic and Number of n > Number of p

2. In an intrinsic semiconductor, the Fermi energy level is ______, for an n-type extrinsic semiconductor the Fermi energy _____ , finally for a p-type extrinsic semiconductor the Fermi energy______.
   A) at the midpoint, is towards the conduction band, is towards the valence band
   B) at the midpoint, is towards the valance band, is towards the conduction band
   C) towards the valance band, is at the midpoint, is at the midpoint
   D) towards the conduction band, is at the midpoint, is at the midpoint
   E) is at the midpoint, is at the midpoint, is at the midpoint

3. True/False As temperature increases, the resistivity of a semiconductor decreases.

4. Why is an N-type semiconductor often better than a P-type semiconductor? (Both semiconductors have same concentrations of N_A and N_D, also n_i is the same for both materials)

5. Given a silicon intrinsic semiconductor with 10^5 atoms of impurities, at least how many atoms and with what would you dope it with to create an N-type semiconductor?

6. Given an N-type semiconductor with resistance of 1 Ω cm^3, μ_e= 1400 cm^2/V·s, μ_h= 450 cm^2/V·s, and n_i= 1.01*10^{10} cm^{-3}, layout how you would calculate the concentration of donor atoms and any assumptions you make in the calculation.

7. Match the characteristics of the two types of semi conductors

Intrinsic	a.pure semi conductor
	b. n type
Extrinsic	c. doped semi semiconductor
	d. p type semi conductor
	e. transistor
	f. n=p
	g. diode
	h. greater conductivity at lower temperatures

8. Why is electron mobility greater than hole mobility?

9. What effect does temperature have on conductors and semiconductors?

10. How are the number of holes and electrons related in an intrinsic semiconductor?

11. What are the advantages of an intrinsic semiconductor over an extrinsic semiconductor?

12. How can we take an extrinsic semiconductor and make it intrinsic?

6.1, 6.2, 6.7, 6.9

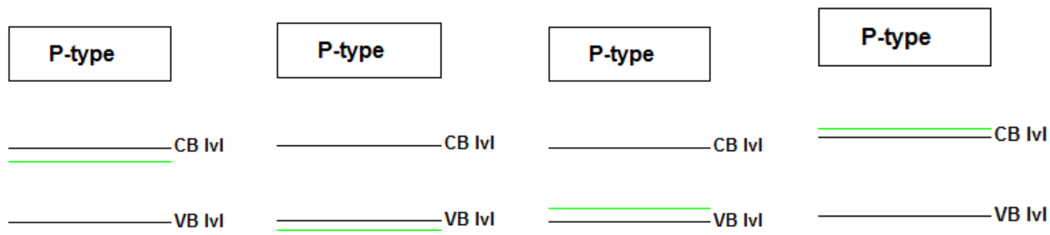
1. Draw the net space charge density graph of a uniformly doped p n region semiconductor. Explain and label the graph be sure to relate charge to the width.

2. Explain electrons and holes in terms of distribution. Show concentration per energy

3. Explain the concept of diffusion current.

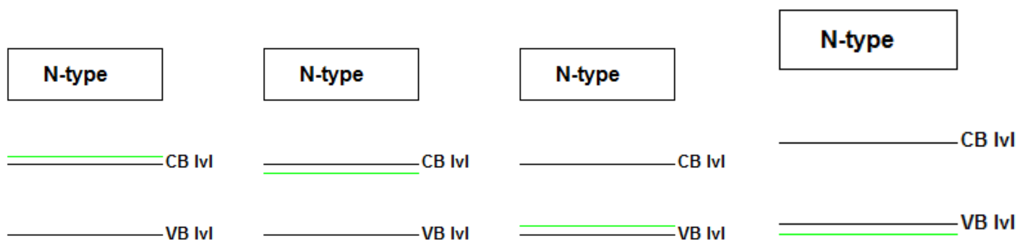
4. In a P-type band diagram, where is the Fermi level (**gray line**) most likely?

A. B. C. D.



5. In a N-type band diagram, where is the Fermi level(**green line**) most likely?

A. B. C. D.



6. Why is using light emitting diodes (LED) for traffic light a bad idea in the winter?

7. Briefly explain what injection of excess minority carriers is. Make sure to include specifically what minority carriers are.

8. Using the law of Junction, what can we say about the concentration of holes and electrons when the applied voltage is zero? Why does this make sense?

9. An LED has a band gap of 5eV. What is the wavelength of its emitted light? Can we see this light?