GHW # 2: Chapter 1- Your Name: Destiny Rivet

20/20

Key Questions (relatively simple to answer using the Focus Information)

1. What was discovered and the significance of each experiment:

   a) J.J. Thompson using cathode-ray tubes or Crook's tubes:
   Thompson's experiment discovered electrons and electron mass. e/m

   b) Millikan's Oil Drop Experiment:
   Millikan's experiment discovered the charge of the electron. The charge of an electron is 1.62×10^{-19} Coulombs.

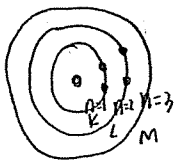
   c) Rutherford's a-particle Experiments:
   Rutherford's experiment discovered the nucleus of an atom.

   d) Moseley's X-ray experiment:
   Moseley's experiment discovered the number of protons which leads to the founding of the atomic number. Arranged the periodic table.

   f) Chadwick's bombardment of ^{9}Be with á-particles
   Chadwick's experiment discovered neutrons that contain no charge in the nucleus.

2. **(Spectroscopic Information)** What are following series of lines in hydrogen emission spectrum?
   a. Paschen $n_f = 3$, $n_i = 4, 5, 6, 7, \ldots, \infty$
   b. Blamer $n_f = 2$, $n_i = 3, 4, 5, 6, \ldots, \infty$
   c. Lyman $n_f = 1$, $n_i = 2, 3, 4, 5, \ldots, \infty$
   d. Brakett $n_f = 4$, $n_i = 5, 6, 7, 8, \ldots, \infty$

3. What is Bohr model of atom?



$E = -2.178 \times 10^{-18} \left(\frac{1}{n^2}\right)$

$\Delta E = -2.178 \times 10^{-18} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) J$

The Bohr model of an Atom depicts the Atom as a small positively charged nucleus surrounded by electrons that travel in circular orbits around the nucleus.

4. Calculate the wavelength of light that can excite the electron in a ground state hydrogen atom to n = 7 energy level.

$\Delta E = -2.178 \times 10^{-18} J \left[1/n_f^2 - 1/n_i^2\right] J$

$\Delta E = -2.178 \times 10^{-18} J \left[1/7^2 - 1/1^2\right] J$

$\Delta E = -2.178 \times 10^{-18} J \left[1/49 - 1/1\right] J$

$\Delta E = -2.178 \times 10^{-18} J \left[0.02041 - 1\right] J$

$\Delta E = -2.178 \times 10^{-18} J \left[-0.97959\right] J$

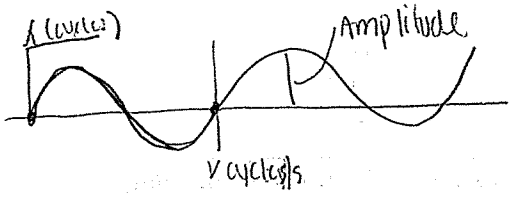
$= 2.134 \times 10^{-18} J$ (+ absorption)

$\lambda = hc/E$

$\lambda = \frac{6.626 \times 10^{-34} Js \times 3.00 \times 10^{8} m/s}{2.13 \times 10^{-18} J}$

$\lambda = 9.31 \times 10^{-16} J$

5. Why was a wave mechanical model required to describe the arrangement of electrons around the nucleus of an atom?
   It shows that electrons can be treated as particles and waves. Electrons can be applied to the wave theory and particle theory.



6. What are the characteristics of waves?

Some characteristics of waves are: wavelength, frequency, speed, amplitude, constructive interference, destructive interference, reflection, refraction, and diffraction of waves.

7. What is a standing wave?

A standing wave is when a vibration of a system in which some particular points remain fixed while others between them vibrate with the maximum amplitude.

8. What is electromagnetic radiation (EMR)?

Electromagnetic radiation (EMR) is a kind of radiation including visible light, radio waves, gamma rays, & x-rays, in which electric & magnetic fields vary simultaneously.

9. What is wave-particle duality of matter and its significance?

Wave-particle duality is the concept that every elementary particle or quantic entity may be partly described in terms not only of particles, but also of waves. It expresses the inability of the classical concepts "particle" or "wave" to fully describe the behavior of quantum-scale objects.

10. What is Schrödinger Wave Equation and Its Significance to atomic structure?

2nd derivative w/ respect to x → $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0$

Schrödinger wave function; position; energy; potential energy

Schrödinger wave eqn. is significant to atomic structure by describing the quantum aspects of the system.

11. Describe the sub-level in the n=4 energy level with l= 2.

$\psi_{4,2,\dots}$
n=4 l=2
l = 0, 1 2 4 ⟩ 4d ⇒ when n=4 & l=2 it will be a 4d sub-level.

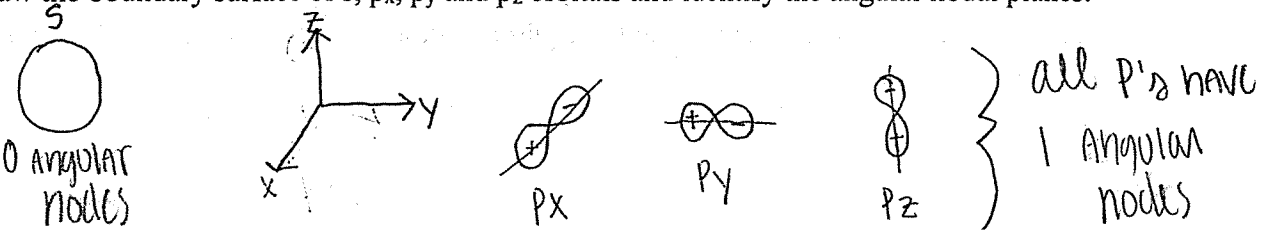
12. Degeneracy of following sub-levels:

i) s-sub-level: degeneracy = 1
ii) p-sub-level: degeneracy = 3
iii) d-sub-level: degeneracy = 5
iv) f-sub-level: degeneracy = 7

13. How many angular nodes are in 2p, 3p and 3d orbitals?

2p = 1 angular node
3p = 1 angular node
3d = 2 angular node ⟩ Angular nodes stay fixed.

14. Draw the boundary surface of s, p_x, p_y and p_z orbitals and identify the angular nodal planes.



15. What is:

a) Wave function?
Comes from solutions coming from Schrödinger equation (Ψ_{n,l,m_l,m_s} etc...). This describes the electron wave shape & Er gives the energy.

b) Heisenberg uncertainty principle and significance to atomic structure?
It is impossible to measure two properties of a quantum object, such as its position & momentum with infinite precision.

c) Max Born interpretation of wave function?
Ψ^2 = probability of finding electron in given space.

d) Nodal surface?
Ψ change +1 to -1 value at nodal surface 
Ψ^2 change electron density + value - 0 - value 

e) d) Atomic orbitals?
Is a mathmatical function that describes the wave-like behavior of either one electron or pair of electrons in an atom.

16. Construct a quantum number tree for the principal quantum number n = 5

n=5

0	0	5s
1	-1, 0, 1	5p
2	-2, -1, 0, 1, 2	5d
3	-3, -2, -1, 0, 1, 2, 3	5f
4	-4, -3, -2, -1, 0, 1, 2, 3, 4	5g

17. Identify the orbital that has $n = 5$ and $l = 1$,
The orbital that has n=5 & l=1 is the 5p orbital

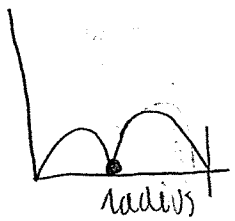
18. Describe the radial and angular component of a wave function.
A radial node is a circular ring that occurs as the principle quantum number increases. An angular node is a flat plane.

19. Explain the general rule used to find the number of radial and angular nodes of a wave function.
total = n-1 radial = n-1-l
Angular = l

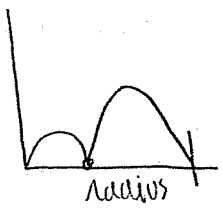
20. Nodes in a 4d orbital:
a) Total nodes = (n-1) = 4-1 = 3
b) Radial nodes = n-1-l = 1
c) Angular nodes = l = 2

21. Plots of radial probability function: $[R_{n,l}(r)]^2$ Vs r (radius) for various *n* and *l* values
   a) n =2 and l =0 radial = n-l-ℓ = 2-1-0 = 1
   b) n =3 and l =1 radial = n-l-ℓ = 3-1-1 = 1

(A)



(B)



22. Describe the classification of elements in the Mendeleyev's periodic tables.
Mendeleyev's periodic table classified the then known 56 elements based off of their physical & chemical properties. in the increasing order of the atomic masses in table form. Elements w/ similar properties recurred at regular intervals & fell in certain groups or familie (Transition & main groups combine) (8)

23. Describe the classification of elements in the modern periodic tables.
The modern periodic tables classified the elements by gas, transition metal, & etc. It increases by atomic number. It has 18 groups. It goes from smaller to bigger elements. Basically follows orbitals.

24. What is Effective Nuclear charge of an electron in a multi-electron atom?
The Effective Nuclear Charge (Z_{eff}) is the net positive charge experienced by an electron in a multi-electron atom. The term "effective" is used because the shielding effect of negatively charged electrons prevents higher orbitals electrons from experiencing the full nuclear charge.

25. Penetration & Shielding of an Electron in multi-electron atom and how does it affect the filling order as given by "Building Up" principle?
Penetration is how close an electron is found to the nucleus. Shielding is how far an electron is found to the nucleus. It affects the filling order as given by "Building up Principle" by filling close to nucleus first.

20/20

GHW # 2: Chapter 1- Your Name: Emily Williams

Key Questions (relatively simple to answer using the Focus Information)

1. What was discovered and the significance of each experiment:

   a) J.J. Thompson using cathode-ray tubes or Crook's tubes:
   the electron. Important in finding the negatively charged particles

   b) Millikan's Oil Drop Experiment:
   discovered the size of the charge of the electron

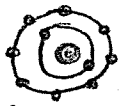
   c) Rutherford's a-particle Experiments:
   discovered the nucleus of the atom

   d) Moseley's X-ray experiment:
   discovered that the frequency of the xrays produced by each element depended on its position on the periodic table

   f) Chadwick's bombardment of ^{9}Be with α-particles
   discovered the existence of neutrons which is how people eventually figured out neutrons + atomic number = atomic mass

2. **(Spectroscopic Information)** What are following series of lines in hydrogen emission spectrum?
   a. Paschen
   $n_f = 3$ $n_i = 4,5,6,7...$
   b. Blamer
   $n_f = 2$ $n_i = 3,4,5,6...$
   c. Lyman
   $n_f = 1$ $n_i = 2,3,4,5...$
   d. Brakett
   $n_f = 4$ $n_i = 5,6,7,8...$

3. What is Bohr model of atom?
   It's a planetary type model of the atom where the principle quantum represents a new orbit and the nucleus is at the center of the atom



4. Calculate the wavelength of light that can excite the electron in a ground state hydrogen atom to n = 7 energy level.

$$-2.178\times10^{-18}\left(\frac{1}{7^2}-\frac{1}{1^2}\right) = -4.445\times10^{-19} - \left(-217.8\times10^{-19}\right) = 2.13355\times10^{-18}\,J$$

$$\lambda = \frac{hc}{E} = \frac{6.626\times10^{-34}\times3.0\times10^{8}}{2.134\times10^{-18}} = \frac{19.878\times10^{-26}}{2.134\times10^{-18}} = 9.315\times10^{-8}\,m$$

5. Why was a wave mechanical model required to describe the arrangement of electrons around the nucleus of an atom?
   It shows the different orbitals and where/how the electrons orbit around the nucleus.

6. What are the characteristics of waves?

- wavelength
- amplitude
- reflection
- frequency
- constructive interference
- refraction
- speed
- destructive interference
- diffraction of waves

7. What is a standing wave?

a wave where each point on the axis of a wave has a constant amplitude ranging from zero at nodes to the maximum at the antinodes

8. What is electromagnetic radiation (EMR)?

a form of energy in many forms like radio waves, microwaves, x-rays, gamma rays, etc

9. What is wave-particle duality of matter and its significance?

when light exhibits properties of both waves and particles.

10. What is Schrödinger Wave Equation and Its Significance to atomic structure?

Second derivative with respect to Z

$$\frac{\partial^2\Psi}{\partial x^2} + \frac{\partial^2\Psi}{\partial y^2} + \frac{\partial^2\Psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E - V)\Psi = 0$$

∂z^2: position; Ψ: Shrodinger wave function; E: energy; V: potential energy

11. Describe the sub-level in the n= 4 energy level with l= 2.

n=4 atomic orbitals

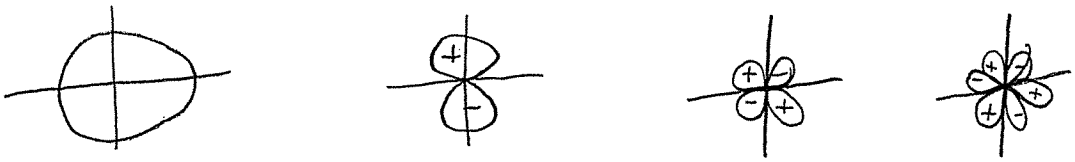
l = 0, 1, 2, 3

S p d f

4d

12. Degeneracy of following sub-levels:

i) s-sub-level: ii) p-sub-level: iii) d-sub-level: iv) f-sub-level:



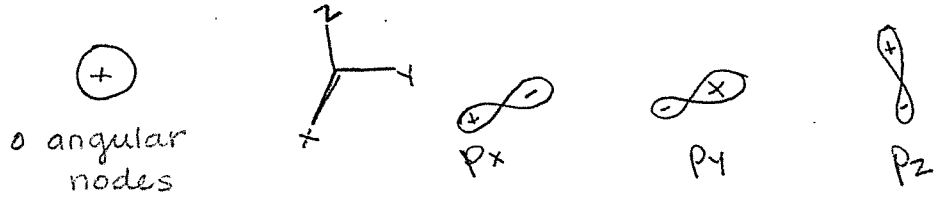
13. How many angular nodes are in 2p, 3p and 3d orbitals?

2p n=2 $l = n-1 = 1$ angular node

3p n=3 $l = n-1-l = 1$ angular node

3d n=3 $l = n-1 = 2$ angular nodes

14. Draw the boundary surface of s, p_x, p_y and p_z orbitals and identify the angular nodal planes.



15. What is:

a) Wave function?
Solutions of Schrödinger equation X_{n,l,m_l,m_s} etc... X_{1s}, X_{2s}, X_{2p}
describes the electron wave shape and energies of electron

b) Heisenberg uncertainty principle and significance to atomic structure?

$$\Delta x \Delta p \geq \frac{h}{2}$$

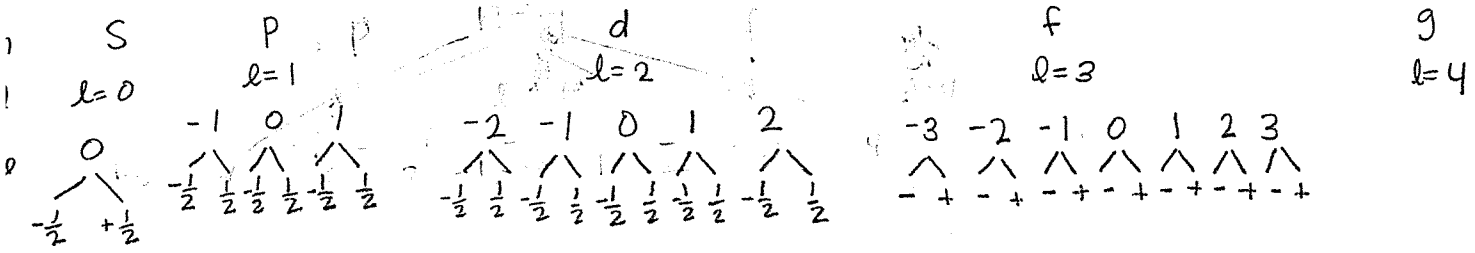
c) Max Born interpretation of wave function?

Ψ^2 = probability of finding the electron in a given space

d) Nodal surface?
Ψ change positive to negative value at nodule surface 
Ψ^2 change the electron density + to − 0 value 

e) d) Atomic orbitals?
it describes the wave-like behavior of either one electron or pair of electrons in an atom.

16. Construct a quantum number tree for the principal quantum number n = 5



17. Identify the orbital that has $n = 5$ and $l = 1$,

5p $5p_x$ $5p_y$ $5p_z$

18. Describe the radial and angular component of a wave function.
radial wave function = $R_{n,l,(r)}$
angular wave function = $Y_{l,m_l}(\theta, \Phi)$

19. Explain the general rule used to find the number of radial and angular nodes of a wave function.
total = n − 1
angular = l
radial = n − 1 − l

20. Nodes in a 4d orbital:
a) Total nodes = (n − 1) = 4 − 1 = 3
b) Radial nodes = (n − 1 − l) = 4 − 1 − 2 = 1
c) Angular nodes = l = 2

d = 2 angular nodes

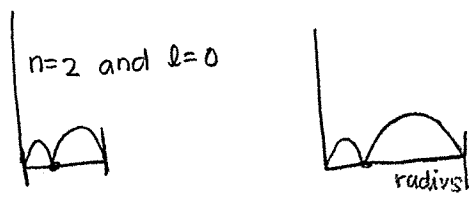
21. Plots of radial probability function: $[R_{n,l}(r)]^2$ Vs r (radius) for various n and l values

a) n =2 and l =0
b) n =3 and l =1

radial $= n-1-l = 2-1-0 = 1$

$= n-1-l = 3-1-1 = 1$

a



22. Describe the classification of elements in the Mendeleyev's periodic tables.

The periodic elements were organized by their similar properties

23. Describe the classification of elements in the modern periodic tables.

There are groups

Group 1 - alkali metal

Group 2 - alkaline earth metal

Group 3 - halogens

Group 4 - noble gases

- main group metals become more reactive as you go down a group
- reactivity of nonmetals decreases as you go down a group
- transition metals become less reactive as you go down a group

24. What is Effective Nuclear charge of an electron in a multi-electron atom?

Z_{eff} is less than atomic number since electrons screen each other from the nucleus and depends on the n and l quantum number of an electron

25. Penetration & Shielding of an Electron in multi-electron atom and how does it affect the filling order as given by "Building Up" principle?

Penetration:
There is more of a chance of electrons being located close to the nucleus with a greater penetration. Penetration electrons are in the orders $s > p > d > f$

Shielding:
Shields of other electrons depends on penetration and the orbital type. Shielding power of electrons in orbitals of that same shell are $s > p > d > f$