

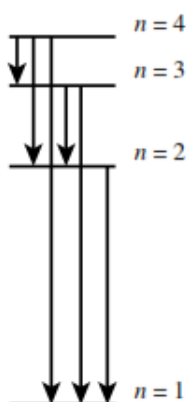
**THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY
ACADEMIC YEAR 2022
TERM 1
CHE1000: INTRODUCTION TO CHEMISTRY**

TUTORIAL SHEET 3:

19th April, 2022

Note: Kindly submit your books to your tutorial group representatives who will later submit to your respective tutors before the due date, **25th April, 2022 at 16:00 hrs.**

- The Bohr's atomic model was an improvised model to explain successfully the failures of Rutherford's planetary model of an atom. State 3 drawbacks of the Bohr's atomic model.
- A carbon–oxygen double bond in a certain organic molecule absorbs radiation that has a frequency of $6.0 \times 10^{13} \text{ s}^{-1}$.
 - What is the energy of this radiation of (i) 3 photons and (ii) 2 moles of photons?
 - A carbon–oxygen bond in a different molecule absorbs radiation of wavelength equal to 5600 nm. Is this radiation more or less energetic?
- Molybdenum metal must absorb radiation with a minimum frequency of $1.09 \times 10^{15} \text{ s}^{-1}$ before it can eject an electron from its surface via the photoelectric effect.
 - What is the minimum energy needed to eject an electron?
 - What wavelength of radiation will provide a photon of this energy?
 - If molybdenum is irradiated with light of wavelength of 120 nm, what is the maximum possible kinetic energy of the emitted electrons?
- Using the Rydberg formula, calculate the wavelength of light emitted when a hydrogen atom relaxes from $n = 6$ to $n = 2$. Is this light in the visible region of electromagnetic spectrum? If so, what colour is it?
- Consider only the transitions involving the first four energy levels for a hydrogen atom:



- How many emissions are possible for an electron in the $n = 4$ level as it goes to the ground state?

- b) Which electronic transition is the lowest energy?
- c) Which electronic transition corresponds to the shortest wavelength emission?
6. Calculate the energy required for an electron to jump from level $n = 1$ to level $n = 3$, and hence state whether energy has been absorbed or emitted.
7. A particle has a velocity that is 70 % of the speed of light and weighs 206.8 times the mass of an electron. Find the wavelength of this particle?
8. Which of the following statements is (are) *true*?
- a) In the hydrogen, the $2s$ orbital is larger than the $3s$ orbital.
- b) An orbital is the same as a Bohr orbit.
- c) The third energy level has three sublevels, the s , p , and d sublevels
9. Sketch the shape and orientation of the following types of orbitals:
- a) s
- b) p_z
- c) $d_{x^2-y^2}$
10. Subshells half-filled and fully-filled with electrons are particularly stable. Can you suggest a possible physical basis for this claim?
11. Which of the following sets of quantum numbers are not allowed? For each incorrect set, state why it is incorrect.
- a) $n = 3, \ell = 3, m_\ell = 0, m_s = -\frac{1}{2}$
- b) $n = 4, \ell = 3, m_\ell = 2, m_s = -\frac{1}{2}$
- c) $n = 2, \ell = 1, m_\ell = -1, m_s = -1$
12. Explain the observed discontinuities in the ionisation energy periodicities.
13. The four successive ionization energies for an unknown element are;

$$I_1 = 896 \text{ kJ/mol}$$

$$I_2 = 1752 \text{ kJ/mol}$$

$$I_3 = 14,807 \text{ kJ/mol}$$

$$I_4 = 17,948 \text{ kJ/mol}$$

To which family in the periodic table does the unknown element most likely belong?

14. Provide a brief explanation why the ionic radii for:
- a) S^{2-} is larger than O^{2-} .
- b) K^+ is larger than Ca^{2+}
15. Briefly explain why electron affinity decreases down the group?