# Solid State Electronics (EE113FZ)

## Tutorial 2

## Periodic Table, Atomic Models and Electron Shell Configuration

Answer the following questions.

1. For chromium, Cr, number 24 in the periodic table, calculate the number of protons, neutrons and electrons. Show your work.

2. What does a '-' or '+' sign mean if it is beside an element symbol?

3. How can mass vary among atoms of the same element and what effect does this have?

4. What bond angle does a linear molecule have and what bond angle does a tetrahedral molecule have?

5. An electron in a hydrogen atom jumps from an outer shell ($n$ = 3) to an inner shell ($n$ = 2). It has an energy of -1.51 eV when $n$ = 3 and an energy of -3.4 eV when $n$ = 2. Does it absorb or release electromagnetic (EM) radiation in this process? What is the frequency of this EM radiation? This radiation is a photon but you probably don't know it yet.

6. For an electron at a distance, $r$ = 0.12 nm from the nucleus of an atom where $n$ = 2, calculate its wavelength. Express your answer in both nm and Angstrom, Å (1 Å = 0.1 nm).

7. Explain what the term 'quantisation' refers to in the context of atomic structure.

8. What are the 4 quantum numbers associated with the quantum model of an atom?

9. What is a probability cloud?

10. For the $6^{th}$ electron shell of an atom the maximum number of electrons will be 72. Prove this.

11. What is a subshell? For a shell with $n$ = 5, how many subshells are there?

12. For the principal quantum number $n$ = 2, determine all the possible values of $l$, $m_l$ and $m_s$. Explain why these numbers are possible and what they related to.

13. For an atom whose highest energy electron subshell has a principal quantum number of $n$ = 3 and an angular momentum quantum number of $l$ = 2, calculate the maximum number of electrons it may have.

14. If a snooker ball moving at 20 $m \cdot s^{-1}$ has a relative momentum uncertainty ($\Delta p/p$) of $1 \times 10^{-6}$, calculate the uncertainty in its position. Take the mass of the ball to be 0.5 kg. Comment on whether this makes a practical difference to how you observe it.

15. The de Broglie wavelength of an electron is $\lambda = h/p = h/(mv)$ in which $h$ is Planck's constant, $m$ is the electron mass, and $v$ is its velocity. Apply de Broglie's model to prove that the angular momentum of an electron ($L = mvr$ in which $r$ is the radius of an electron orbital) in an atom can only be integer multiples of the reduced Planck's constant ($\hbar = h/2\pi$).