LEARNING AS ONE NATION

Expanded Project

SHS LEARNING ACTIVITY

Name: _____ **Score/Mark:** _____

Grade and Section: _____ **Date:** _____

Strand: ☐ STEM ☐ ABM ☐ HUMSS ☐ ICT (*TVL Track*)

Subject: *Physical Science*

Type of Activity: ☑ Concept Notes ☐ Skills: Exercise/Drill ☐ Illustration ☐ Performance Task ☐ Essay/Report ☐ Others: _____

Activity Title: **LA03: Synthesis of Elements – Light and Heavy Elements**

Learning Target: To give evidence for and explain the formation of elements.

References: *(Author, Title, Pages)*
1) Atkins, P. W., *et al.* (2009). *Inorganic Chemistry*, 5th edition, pp. 4–7;
2) Sadudaquil, J. A. *CVIF–DLP Learning Activities*

A few hours after the Big Bang, the elemental composition of matter was mainly 89% H and 11% He. Due to gravity, the clouds of H and He nuclei condensed to form the earliest stars. The more these clouds of atoms compress, the higher their temperature and densities become. A chain of fusion reactions started as these nuclei combined.

Elements with ***Z* < 26** were formed due to a nuclear fusion reaction cycle called **nuclear burning**, which took place inside stars. The following are the types of nuclear reactions that formed the **light elements**:

1) **Proton capture** – a nucleus may capture a proton ($^{1}_{1}p$) and become another element, coupled with the release of a gamma ray photon (γ) or an alpha particle ($^{4}_{2}\alpha$).
   Example: $^{12}_{6}C + ^{1}_{1}p \rightarrow ^{13}_{7}N + \gamma$
2) **Positron decay accompanied by neutrino emission** – a nucleus may release a positron ($^{0}_{+1}\beta$), coupled with neutrino ($^{0}_{0}\nu$) emission, forming an element lighter than the nucleus.
   Example: $^{13}_{7}N \rightarrow ^{13}_{6}C + ^{0}_{+1}\beta + ^{0}_{0}\nu$
3) **Neutron capture accompanied by proton emission** – a nucleus may capture a neutron ($^{1}_{0}n$), forming a lighter element, coupled with the release of a proton.
   Example: $^{14}_{7}N + ^{1}_{0}n \rightarrow ^{14}_{6}C + ^{1}_{1}p$

The most stable nuclei are those near iron (*Z* = 26). The **heavier elements** (***Z* > 26**) are formed by additional types of nuclear reactions:

4) **Neutron capture** – a nucleus may capture a neutron ($^{1}_{0}n$) and become a heavier isotope, coupled with the release of a gamma ray photon (γ).
   Example: $^{98}_{42}Mo + ^{1}_{0}n \rightarrow ^{99}_{42}Mo + \gamma$
5) **Subsequent beta-decay of a neutron capture daughter nuclide with neutrino emission** – a nucleus may eject an electron ($^{0}_{-1}e$) from the nucleus of a neutron capture daughter nuclide as a beta particle, coupled with the release of a neutrino.
   Example: $^{98}_{42}Mo + ^{1}_{0}n \rightarrow ^{99}_{42}Mo + \gamma$
   $^{99}_{42}Mo \rightarrow ^{99}_{43}Tc + ^{0}_{-1}e + ^{0}_{0}\nu$
   The daughter nuclide can capture another neutron and the process continues, gradually forming the heavier elements.