

# NUCLEAR CHEMISTRY WORKSHEET

Name \_\_\_\_\_ Date \_\_\_\_\_ Block \_\_\_\_\_

Most nuclear reactions involve changes in the number of protons and/or neutrons in the nucleus of an atom. These changes are called *transmutations* because an atom of one element is changed into an atom of a different element. During these changes, nuclear particles may be absorbed and/or emitted along with a release of energy.

There are four types of nuclear reactions:

- 1) *natural radioactive decay*: transmutations occur by natural radioactivity (the ability of a nucleus to emit a nuclear particle and energy without external stimulation);
- 2) *artificial transmutation*: transmutations occur by nuclear disintegration caused by external stimulation as a scientist bombards a nucleus with a particle (the addition of another nuclear particle makes the nucleus unstable);
- 3) *fission*: certain nuclei having a large mass are bombarded with special particles that cause the nuclei to split into two nuclei each having a smaller mass;
- 4) *fusion*: nuclei of light elements are combined to form heavier nuclei.

Nuclear reactions are written using symbols in the  ${}^A_ZX$  notation. The symbols for the major nuclear particles involved in nuclear reactions are given below.

|                |                                                                       |
|----------------|-----------------------------------------------------------------------|
| Alpha particle | ${}^4_2\text{He}$ (an alpha particle is a helium nucleus)             |
| Proton         | ${}^1_1\text{H}$ (the most common hydrogen nucleus is a proton)       |
| Neutron        | ${}^1_0\text{n}$                                                      |
| Electron       | ${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$ (also called a beta particle) |
| Positron       | ${}^0_1\text{e}$ or ${}^0_1\beta$                                     |
| Gamma ray      | ${}^0_0\gamma$                                                        |

The table below contains information about nuclear reactions involving the emission of radiation.

| Type of Reaction                | NUCLEAR CHANGES                         |                             |                           |
|---------------------------------|-----------------------------------------|-----------------------------|---------------------------|
|                                 | Radiation (Particle)                    | Effect on the Atomic Number | Effect on the Atomic Mass |
| Alpha emission ( $\alpha$ )     | ${}^4_2\text{He}$                       | decrease by 2               | decrease by 4             |
| Beta emission ( $\beta$ )       | ${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$ | increase by 1               | no change                 |
| Positron emission ( $\beta^+$ ) | ${}^0_1\text{e}$ or ${}^0_1\beta$       | decrease by 1               | no change                 |
| Gamma emission                  | ${}^0_0\gamma$                          | no change                   | no change                 |
| Electron capture (EC)           | ${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$ | decrease by 1               | no change                 |

# Answer Key Nuclear Chemistry

**Jianjun Gao**



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