N5 Chemistry: Unit 3 – Chemistry in Society

Part B – Fertilisers, Nuclear and Chemical Analysis

Lesson 2 – Nuclear Equations

Learning Outcomes

By the end of this lesson you should know:

1. How to identify and write nuclear equations for alpha and beta decay.

Success Criteria

You will have been successful in this lesson if you:

1. Read and learn the notes given. Use them to fill in the blanks in your printed notes
2. Watch the links provided
3. Complete revision questions provided
4. Complete and submit homework assigned (Revision HW and HW 14: Radiation)

There is also a further reading section to help you gain more depth of understanding for this section.

If you have any questions about the content of this lesson, you should ask your class teacher either through your class MS team or via email. MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge

You may wish to revise the following to help you understand this lesson:

- N5 Unit 1: Nuclide notation and Isotopes

3. Nuclear Equations	Unit 3 – Nuclear	https://youtu.be/3CwYXKYwrdU

Words written in italics do not need to be copied and are there to provide instruction.

Nuclear Reactions

When radioactive atoms disintegrate (decay) it is the nuclei which are involved. The changes which take place in these nuclei depend on the type of radiation emitted.

Balanced nuclear equations can be written using nuclide notation.

Species	Nuclide Notation
Alpha particle	$^{4}_{2}He$
Beta particle	$^{0}_{-1}e$
Proton	$^{1}_{1}p$
Neutron	$^{1}_{0}n$

Writing a nuclear equation is similar to any other balanced equation - always check the mass numbers and atomic numbers add up to the same number on each side of the arrow.

The name of the radioisotope indicates its mass number i.e. Lawrencium-257 is the isotope of Lawrencium that has a mass number of 257. The atomic number is always 103 for all isotopes of Lawrencium.

Alpha Decay

During alpha decay a nucleus will emit 2 protons and 2 neutrons (an alpha particle/Helium nucleus). This means the atomic mass number of the nucleus would decrease by 2 and the mass number decrease by 4.

E.g. Thorium-232 emitting an alpha particle

$$^{232}_{90}Th \longrightarrow {}^{228}_{88}Ra + {}^{4}_{2}He$$

Beta Decay

During beta decay a high energy electron is emitted from the nucleus of an atom. This results in the atomic number of the nucleus increasing by 1 but the mass number does not change.

e.g. Bismuth-212 emitting a beta particle.

$$^{212}_{83}Bi \longrightarrow {}^{212}_{84}Po + {}^{0}_{-1}e$$

Gamma Decay

Since gamma rays have no mass and no charge, their emission will have no effect on the mass number or the atomic number of the radioisotope.

Watch the following video to help understand how to write a nuclear equation: https://www.youtube.com/watch?v=9SQvpsUP4rE

Other Nuclear Reactions

Nuclear equations can also be written for other nuclear reactions. We must still remember to check that the total mass numbers on the left hand side of the equation are equal to the total mass numbers on the right hand side of the equation. This also applies to the atomic numbers – they must add up to the same number on both sides of the equation.

E.g. 1. Argon-37 undergoing electron capture

$$^{37}_{18}Ar + ^{0}_{-1}e \longrightarrow ^{37}_{17}Cl$$

E.g. 2. Lead-214 absorbing a proton and emitting an alpha particle producing a new isotope.

$$^{214}_{82}Pb + ^{1}_{1}p \longrightarrow ^{211}_{81}Tl + ^{4}_{2}He^{2+}$$

Using the equation and information in a question, you should be able to complete nuclear equations.

Further Reading

To learn more about types of radiation, try the following online resources:

BBC Bitesize: https://www.bbc.co.uk/bitesize/guides/zxxrng8/revision/4

Scholar: Log in through GLOW

National 5 Chemistry → Chemistry in Society → Nuclear Chemistry → read content 7.4

Evans2 chem web: https://www.evans2chemweb.co.uk/

Username: snhs password: giffnock

Select any teacher → revision → National 5 → Unit 3: Chemistry in Society → Nuclear Chemistry

Complete self-check exercises in your class work jotter and use the answers at the end of this document to mark.

Self Check 7

1. Balanced nuclear equations can be written using nuclide notation, for example;

$^{3}_{1}H$ emits a β particle can be written as:

$$^{3}_{1}H \longrightarrow {}^{3}_{2}He + {}^{0}_{-1}e$$

Write nuclear equations for the following changes:

(a) $^{236}_{92}U$ emits an α particle

(b) $^{60}_{27}Co$ emits a β particle

(c) $^{210}_{83}Bi$ emits an α particle

(d) $^{10}_{4}Be$ emits an α particle

(e) $^{17}_{8}O$ emits a β particle

(f) $^{14}_{6}C$ emits a β particle

(g) $^{210}_{84}Po$ emits an α particle

Self Check 7 (continued)

2. Write the nuclide notation for the unknown substances in the following nuclear equations:

(a) $^{238}_{92}U \longrightarrow ^{234}_{90}Th + ?$

(b) $^{235}_{92}U \longrightarrow ^{0}_{-1}e + ?$

(c) $^{226}_{88}Ra \rightarrow ^{4}_{2}\alpha + ?$

(d) $^{87}_{37}Rb \rightarrow ? + ^{87}_{38}Sr$

(e) $^{55}_{26}Fe + ^{0}_{-1}e \rightarrow ?$

(f) $^{32}_{15}P \rightarrow ^{4}_{2}He + ?$

(g) $^{14}_{6}C \rightarrow ? + ^{14}_{7}N$

(h) $^{73}_{30}Zn \rightarrow ^{0}_{-1}\beta + ?$

(i) $^{196}_{82}Pb + ^{0}_{-1}e \rightarrow ?$

Self Check 7 ANSWERS

1. (a) $^{236}_{92}U \rightarrow ^{232}_{90}Th + ^{4}_{2}He$

(b) $^{60}_{27}Co \rightarrow ^{60}_{28}Ni + ^{0}_{-1}e$

(c) $^{210}_{83}Bi \rightarrow ^{206}_{81}Tl + ^{4}_{2}He$

(d) $^{10}_{4}Be \rightarrow ^{6}_{2}He + ^{4}_{2}He$

(e) $^{17}_{8}O \rightarrow ^{17}_{9}F + ^{0}_{-1}e$

(f) $^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e$

(g) $^{210}_{84}Po \rightarrow ^{206}_{82}Pb + ^{4}_{2}He$

2. (a) $^{4}_{2}He$

(b) $^{235}_{93}Np$

(c) $^{222}_{86}Rn$

(d) $^{0}_{-1}e$

(e) $^{55}_{25}Mn$

(f) $^{28}_{13}Al$

(g) $^{0}_{-1}e$

(h) $^{73}_{31}Ga$

(i) $^{196}_{81}Tl$