Unit 21 · Nuclear Chemistry and Applications of Radioactivity

WORKSHEET

Full marks 36

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 36

1 Key words [3]

Write True or False in the box beside each sentence. Correct each false sentence. Each carries 0.5 mark.

i. In every nuclear equation both the mass numbers and the atomic numbers balance. ☐

ii. One fusion of deuterium with tritium releases more energy than one fission of uranium-235. ☐

iii. A γ ray has no charge and travels at the speed of light. ☐

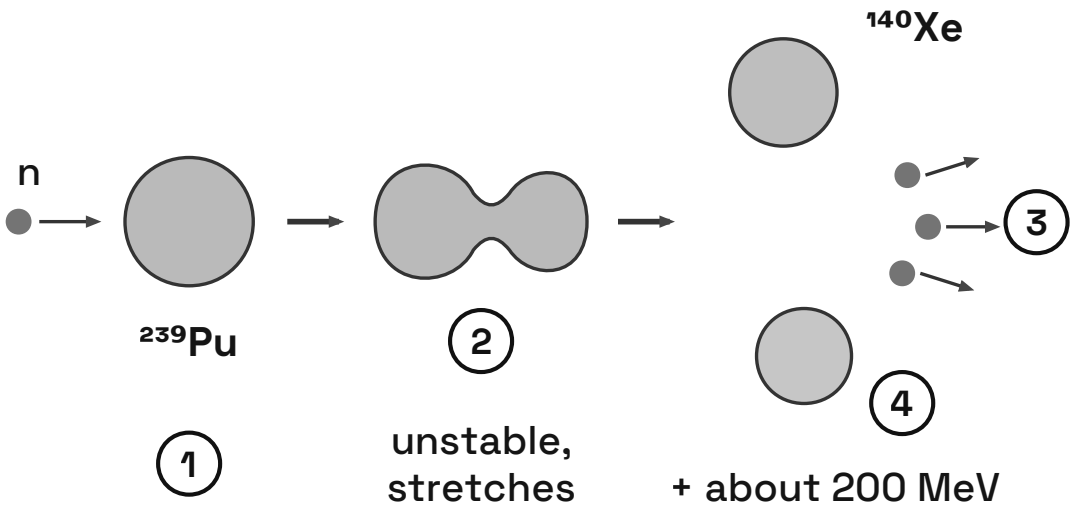
iv. Nitrogen-14 bombarded with α particles, giving oxygen-17 and a proton, is an example of artificial radioactivity. ☐

v. Radiocarbon dating can find the age of a rock two billion years old. ☐

vi. Every element beyond lead (Z = 82) is radioactive. ☐

2 Label the diagram [2]

The diagram shows the fission of plutonium-239: it absorbs a slow neutron and splits into xenon-140, another nucleus and some neutrons. Write what belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. When a nucleus gives out a β^- particle, its mass number and atomic number change by: [1]

a. -4 and -2 **b.** 0 and $+1$

c. 0 and -1 **d.** 0 and 0

ii. Polonium-210, $^{210}_{84}\text{Po}$, decays by giving out an α particle. The nucleus formed has: [1]

a. A = 210, Z = 85 **b.** A = 206, Z = 84

c. A = 206, Z = 82 **d.** A = 208, Z = 82

iii. A radioactive source has an activity of 7.4×10^{10} Bq. In curies this is: [1]

a. 0.5 Ci **b.** 1 Ci

c. 2 Ci **d.** 7.4 Ci

iv. In a nuclear power reactor, the extra neutrons are absorbed by control rods made of: [1]

a. graphite **b.** water

c. boron or cadmium **d.** lead

v. A PET scan uses isotopes such as fluorine-18 that give out: [1]

a. α particles **b.** β^- particles

c. positrons **d.** neutrons

4 Short answers [11]

Write short answers to the following questions.

a. Aluminium-27 bombarded with α particles gives phosphorus-30 and a neutron; phosphorus-30 then gives out a positron. Write balanced nuclear equations for both changes. [2]

b. What is the difference between controlled and uncontrolled nuclear fission? Where is each used? [2]

c. Why is iodine-131 used to treat an overactive thyroid gland? [2]

d. Give two differences between α particles and γ rays. **[2]**

e. How does an ionization smoke detector work? Why is it safe to keep one in a house? **[3]**

5 Long answer **[4]**

Write a long answer to the following question.

What is nuclear fission? Write the equation for the fission of uranium-235 into barium-141 and krypton-92, explain how a chain reaction arises, and state two advantages and two disadvantages of nuclear power.

6 Numerical problems **[8]**

Solve the following problems. Show your working. Take the half-life of carbon-14 as 5,730 years, of sodium-24 as 15.0 hours, $\log 2 = 0.3010$, and $1\ \text{Ci} = 3.7 \times 10^{10}$ Bq.

a. Carbon from a wooden beam in an old temple gives 9.6 counts per minute per gram, and carbon from fresh wood 15.3 counts per minute per gram. i. Find the age of the beam. ii. What count will the beam's carbon give 5,730 years from now? iii. Why can't this method date a piece of wood 200,000 years old? **[4]**

Answer:

b. Sodium-24, made from aluminium-27 and neutrons, is added to the water in a buried pipe to find a leak. The sample added has an activity of 8.0×10^6 Bq. i. Write the nuclear equation for the β^- decay of sodium-24. ii. Find its activity 60 hours later. iii. Express the starting activity in curies. iv. How long after it is added does the activity fall to 1% of its starting value? **[4]**

Answer: _____

7 Think **[3]**

One fission of uranium-235 releases about 200 MeV and one fusion of deuterium with tritium only 17.6 MeV, yet a kilogram of deuterium–tritium fuel gives about four times as much energy as a kilogram of uranium-235. Explain, with a rough calculation.

8 Activity: Half-lives with coins (not marked)

You need: 64 coins (or bottle caps marked on one side) and a tray. Each coin is a nucleus. Shake the coins in the tray and tip them out: every coin that lands heads has "decayed"; take it out. Count the coins left, and repeat until none is left.

Throw	0	1	2	3	4	5	6
Coins left	64						

Plot coins left against the number of throws. How many throws is one "half-life"? Can you say which coin will decay next?