

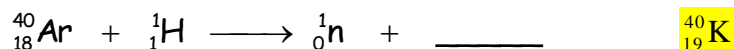
CHM152LL: Nuclear Chemistry Practice Worksheet **Key**

Exercise 1: Complete the following table:

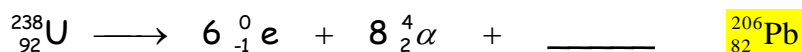
| Isotope | Mass Number | # of Protons | # of Neutrons | # of Electrons |
|-------------------|-------------|--------------|---------------|----------------|
| Strontium - 90 | 90 | 38 | 52 | 38 |
| ^{222}Rn | 222 | 86 | 136 | 86 |

Exercise 1: Identify the unknown element in each to complete the following nuclear equations:

- a. Argon-40 is bombarded with a proton.

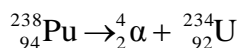


- b. Uranium-238 has a half-life of about 4.5 billion years and is used to date very old rocks.

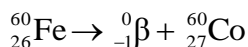


Exercise 2: Write complete nuclear equations for the following processes:

- a. Uranium-234 is produced when a radioactive isotope undergoes alpha decay.

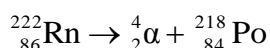


- b. Cobalt-60 is produced when a radioactive isotope undergoes beta decay.

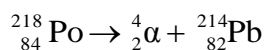


Exercise 3: The inhalation of radon-222 and its decay to form other isotopes poses a health hazard. Write balanced nuclear equations for the decay of radon-222 to lead-206 in eight steps.

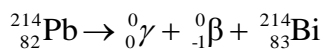
- a. Step 1: Radon-222 decays by alpha emission. (Radon has the element symbol Rn.)



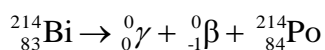
- b. Step 2: The daughter product in part a decays by alpha emission.



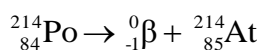
- c. Step 3: The daughter product in part b decays by beta and gamma emissions.



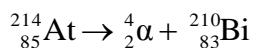
- d. Step 4: The daughter product in part c decays by beta and gamma emissions.



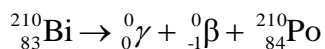
e. Step 5: The daughter product in part d decays by beta emission.



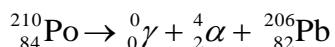
f. Step 6: The daughter product in part e decays by alpha emission.



g. Step 7: The daughter product in part f decays by beta and gamma emissions.



h. Step 8: The daughter product in part g decays by alpha and gamma emissions.



The final stable isotope is **lead-206**.

III. Half-Life and the Amount of Sample Left

Exercise 1: a. What is the half-life for Thorium-230? **8000 y**

b. How many half-lives have passed for Thorium-230 after 32,000 years? **4** half-lives (HL)

c. How much of a 95.6-mg sample of Thorium-230 would remain after 32,000 years?

$$95.6 \text{ mg} \div 2 \div 2 \div 2 \div 2 = \mathbf{5.98 \text{ mg}}$$

$$\text{or Amount remaining} = \text{initial amount} \times (0.5)^n = 95.6 \text{ mg} \times (0.5)^4 = \mathbf{5.98 \text{ mg}}$$

d. What is the value of the rate constant, k, for Th-230?

$$k = 0.693 / 8000 \text{ y} = \mathbf{8.66 \times 10^{-5} \text{ y}^{-1}}$$

e. How much of a 35.8-mg sample of Thorium-230 would remain after 18500 years?

$$\ln [A_t / 35.8] = -(8.66 \times 10^{-5} \text{ y}^{-1}) \cdot 18500 \text{ y}$$

$$[A_t / 35.8] = e^{-1.60256} = 0.2014$$

$$A_t = (0.2014)(35.8) = \mathbf{7.21 \text{ mg}}$$

f. How much time will it take for a 280 mg sample of Thorium-230 to decay to 11.0 mg?

$$\ln [11.0 / 280] = (-8.66 \times 10^{-5} \text{ y}^{-1})t$$

$$t = (-3.237) / (-8.66 \times 10^{-5} \text{ y}^{-1}) = \mathbf{37378 \text{ yrs} = 3.7 \times 10^4 \text{ yrs}}$$