

## 2APHY: Nuclear Physics Mid Unit Test

Name: \_\_\_\_\_ (33 marks + overall = 34 marks)

**OVERALL: Additional 1 mark for units and significant figures.**

1. Complete the table below: (2 marks)

Element	Nuclide	Atomic Number	Number of Neutrons	Mass Number
Nitrogen - 14	$^{14}_7\text{N}$	7		
		2	2	
	$^{14}_6\text{C}$	6		14

2. Fully explain what an isotope is using examples. (3 marks) \_\_\_\_\_

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3. For each of the following, name the radiation emitted, its symbol and what the radiation is and what will stop it. [Level 4] (3 marks)

Nuclear Equation	Nuclide	Radiation name	Symbol	What is the radiation made of?
$^{234}_{90}\text{Th} \rightarrow ^{234}_{91}\text{Pa} + ?$				
$^{137m}_{56}\text{Ba} \rightarrow ^{137}_{56}\text{Ba} + ?$				
$^{238}_{92}\text{U} \rightarrow ^{234}_{90}\text{Th} + ?$				

4. A radiographer wants to investigate blood circulation in a patient. There are a number of radioisotopes available. What properties would you look for to select one? Give three reasons. (3 marks)

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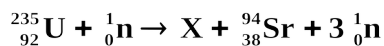


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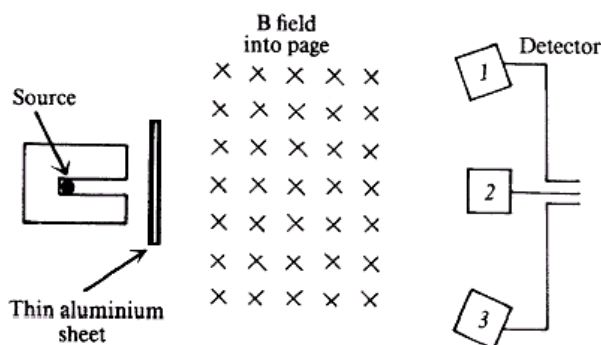
5. Within a nuclear reactor, uranium-235 is bombarded by a neutron to split into two daughter products also emitting three neutrons. Part of the nuclear equation is shown below.



- a. Write the nuclide for the missing daughter product labelled X. \_\_\_\_\_ (1 mark)
- b. What are the atomic and mass numbers of the daughter product X:

Mass no. \_\_\_\_\_ (1 mark)      Atomic no. \_\_\_\_\_ (1 mark)

6. A physics student has three radioactive sources, X, Y and Z. One is a pure  $\alpha$  emitter, one is a pure  $\beta$  emitter and one is a pure  $\gamma$  emitter. He uses the following apparatus to decide which is which. The apparatus consists of a holder for the source, a sheet of thin aluminium foil placed in front of the source, a region of magnetic field directed into the page, and three detectors, 1, 2 and 3, arranged as shown below. The student is also told that charged particles will be deflected to the left or to the right when passing through a magnetic field.



With source X there is no signal from any detector. With source Y there is a signal from detector 3 only. With source Z there is a signal from detector 2 only.

- a. Which source (X, Y or Z) is the  $\beta$  emitter? (1 mark) \_\_\_\_\_
- b. Which source (X, Y or Z) is the  $\alpha$  emitter? (1 mark) \_\_\_\_\_
- c. Which detector (1, 2 or 3) would most likely detect  $\gamma$  radiation? (1 mark) \_\_\_\_\_
5. A student is measuring the decay of a nuclear source. She finds that the source has a count of  $8.30 \times 10^3$  decays in a one hour period. Calculate the activity of the source. (2 marks)

7. The forming of a new element during radioactive decay is called transmutation. Explain why

emitting alpha and beta radiation causes a transmutation but emitting gamma radiation does not. (3 marks)

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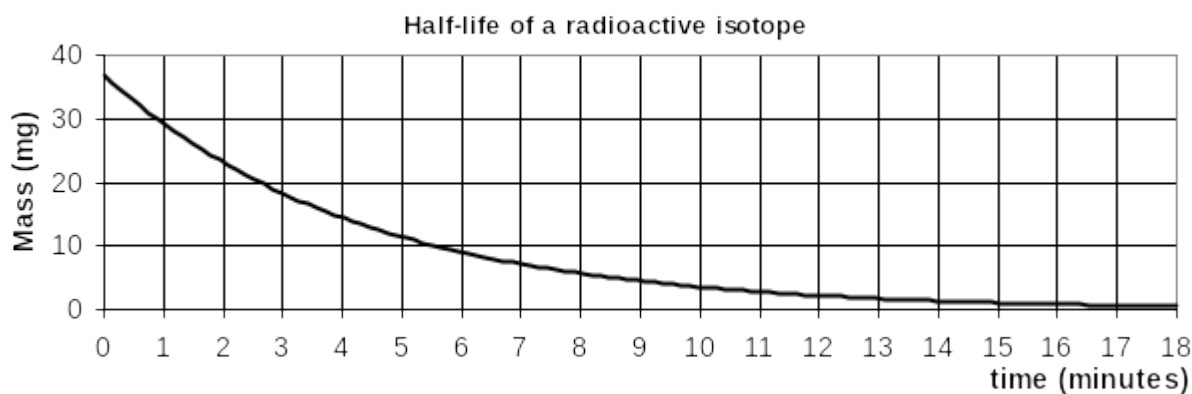
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4. From the graph, determine the half life of the radioactive isotope. (1 mark)  
Show on the graph how you did this. (1 mark)



Half-life = \_\_\_\_\_

5. In the following reaction  ${}^{212}_{84}\text{Po} \rightarrow \text{X} + \text{an } \alpha \text{ particle}$ ; the nuclide X is: (1 mark)
- A.  ${}^{212}_{80}\text{Hg}$       B.  ${}^{210}_{80}\text{Hg}$       C.  ${}^{210}_{82}\text{Pb}$       D.  ${}^{208}_{82}\text{Pb}$       E.  ${}^{212}_{82}\text{Pb}$

Answer: \_\_\_\_\_

6. If a radioactive sample has a half-life of 1.50 hours. If the activity of the sample was originally 15.0 kBq, what would the activity be exactly one day later? (2 marks)

7. The radio isotope  ${}^{60}_{24}\text{Co}$  has a half-life of approximately 5.00 years. Gamma radiation from a  ${}^{60}_{24}\text{Co}$  source is used to treat cancer. Hospitals using such sources for therapy usually replace the source

when its activity has fallen to 25% of its original value. After how many years must a source be replaced? All working must be shown. (2 marks)

8. Household smoke detectors contain a radioactive Americium-241 source. Emitted radiation ionizes air inside a chamber that allows a small current to flow. Smoke particles entering the chamber interrupt the current flow, which sets off the alarm. Americium-241 is an  $\alpha$  emitter with a half life of 433 years.

- a. Using the information above, briefly discuss why  ${}^{241}_{95}\text{Am}$  is ideal for use in smoke detectors.

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(2 marks)

- b. What would you say to a person who is anxious about having a smoke detector containing a radiation source in their home? (2 marks)

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