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	$^{14}_{7}\mathrm{N}$	7		
		2	2	
	$^{14}_{6}\mathrm{C}$	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?
$^{234}_{90}\mathrm{Th} \rightarrow {}^{234}_{91}\mathrm{Pa} + ?$				
$^{137m}_{56}\mathrm{Ba} \rightarrow {}^{137}_{56}\mathrm{Ba} + ?$				
$^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + ?$				

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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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.

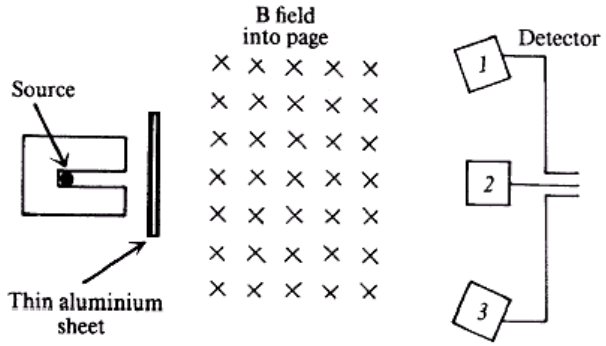
$$^{235}_{92}\mathbf{U} + ^{1}_{0}\mathbf{n} \rightarrow \mathbf{X} + ^{94}_{38}\mathbf{Sr} + \mathbf{3}\ ^{1}_{0}\mathbf{n}$$

a. Write the nuclide for the missing daughter product labelled X. _____ (1 mark)

b. What is 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 α emitter, one is a pure β emitter and one is a pure γ 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 β emitter? (1 mark) _____

b. Which source (X, Y or Z) is the α emitter? (1 mark) _____

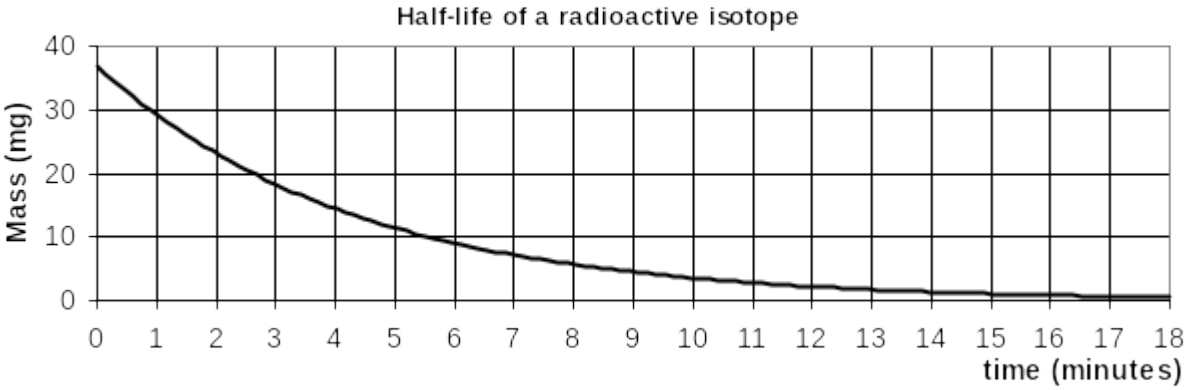
c. Which detector (1, 2 or 3) would most likely detect γ radiation? (1 mark) _____

5. A student is measuring the decay of a nuclear source. She finds that the source has a count of 8.30×10^3 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)

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 $^{212}_{84}Po \rightarrow$ X + an α particle; the nuclide X is: (1 mark)

A. $^{212}_{80}Hg$ B. $^{210}_{80}Hg$ C. $^{210}_{82}Pb$ D. $^{208}_{82}Pb$ E. $^{212}_{82}Pb$

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 $^{60}_{24}\mathrm{Co}$ has a half-life of approximately 5.00 years. Gamma radiation from a $^{60}_{24}\mathrm{Co}$ 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 α emitter with a half life of 433 years.

   a. Using the information above, briefly discuss why $^{241}_{95}\mathrm{Am}$ 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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