ST. STEPHEN’S SCHOOL

PHYSICS 2A

END TOPIC TEST

NUCLEAR PHYSICS

Name:

Teacher:

**INSTRUCTIONS**

* You have 1 hour to complete the test.
* It is recommended that you take a few minutes to read the paper through carefully.
* Answer all questions in the space provided.
* Use BLACK or BLUE pen only.
* Scientific calculators are permitted for this test (NO GRAPHICS CALCULATORS).
* Unmarked physics constant sheets are permitted for this test

Test Score:

60

Percentage:

**This test is divided into three sections:**

**SECTION A: Short Answer 18 marks**

**SECTION B: Problem Solving 30 marks**

**SECTION C: Interpretation & Comprehension 12 marks**

**SECTION A: Short Answer (18 marks)**

1. Radon- 222 (222Rn86) is a naturally occurring radioisotope which exists as a gas. It decays by alpha emission.
2. Write the nuclear equation of this radioactive decay of radon- 222.

**( 2 marks)**

1. Use the periodic table to identify the product formed in the reaction.

**(1 mark)**

1. The symbols for four different nuclei follow. Determine the number of protons and neutrons in each nucleus and determine the element the symbol represents.
2. 17O8 - \_\_\_\_\_ protons \_\_\_\_\_\_\_\_ neutrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ element
3. 40K19  - \_\_\_\_\_ protons \_\_\_\_\_\_\_\_ neutrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ element
4. 234U92- \_\_\_\_\_ protons \_\_\_\_\_\_\_\_ neutrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ element
5. 241Am95 \_\_\_\_\_ protons \_\_\_\_\_\_\_\_ neutrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ element

**(4 marks)**

1. Complete the following nuclear equations.
2. 23Na11 + 4He2 26Mg12 + \_\_\_\_\_\_\_\_
3. 239Np93  0e-1 + \_\_\_\_\_\_\_\_
4. 22Na 22Ne10 + \_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_ 131I53 + 0γ0
6. **marks)**
7. Explain the principle of a neutron induced chain reaction.
8. **marks)**
9. Fission reactions using Uranium-235 form the basis of both the nuclear reactor and the nuclear bomb. What is the essential difference between a reactor and a bomb?
10. **marks)**
11. Why does a thermal nuclear reactor use a moderator to slow down neutrons?

**(1 mark)**

1. Fast breeder reactors do not have moderators. Explain why this is so.

**(1 mark)**

1. Plutonium does not naturally exist on the Earth. Explain how the plutonium that is used in fast breeder reactors is formed.

**(2 marks)**

**SECTION B: Problem Solving (30 marks)**

1. Radio carbon dating is possible because of the presence of radioactive carbon-14 which is produced when neutrons collide with nitrogen-14 in the upper atmosphere. This reaction also produced the emission of a positron.

A sample of wood containing carbon-14 from a tree which has recently been chopped down had an activity of 0.800 Bq. A sample of similar size from an ancient boat had an activity of 0.300 Bq.

The half-life of carbon-14 is 5.7 x 103 years.

1. Sketch below, labelling the relevant axes, a graph to show how the sample having an initial activity of 0.800 Bq will vary with time over a period of three half-lives.

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**(5 marks)**

1. Use the graph to determine the age of the boat.

**(1 mark)**

1. Radiation is often used to attempt to cure cancers.
2. How is damage to healthy cells minimised in such procedures?

**(2 marks)**

1. How does radiation affect the cancerous cells?

**(2 marks)**

1. A common side-effect of patients undergoing radiation therapy is local hair loss. Explain this observation.

**(2 marks)**

1. A film badge worn by a hospital laboratory technician indicates the following monthly exposure:

Gamma radiation = 0.2 Sv

Beta-particles = 0.4 Sv

1. What is the technician’s absorbed does for each radiation type?

**(2 marks)**

1. If the technician’s body mass is 70 kg, how much energy did his body absorb from the radiation in total?

**(3 marks)**

1. If the technician’s son, who has a mass of 25 kg was exposed to this radiation instead of the technician, what would have been the results of the monthly exposure given in part a have been?

**(3 marks)**

1. Pu-239 is an alpha particle emitter according to the equation

239Pu92 235U92 + 4He2 + energy

Nuclear mass of Pu-239 = 3.968266 x 10-25 kg

Nuclear mass of U-235 = 3.901729 x 10-25 kg

1. Find the energy released per decay (in Joules).

**(4 marks)**

1. If a sample of Pu-239 has an activity of 5 x 109 Bq then how much energy (in J) is released in one minute?
2. **marks)**
3. Tiahne was investigating the activity of 15.00 g of an unknown radioisotope. The original activity of the sample was 8.00 kBq and Tiahne had already determined that its half-life was four days.
4. What would its activity be 12 days later?

**(2 marks)**

1. Tiahne also had another 100 g sample of the same radioisotope. Would this second sample have a greater, equal or smaller half-life than the original 15.00 g sample of the radioisotope?

Circle the correct answer: GREATER EQUAL SMALLER

**(1 mark)**

1. Explain your answer to part b.

**(1 mark)**

**SECTION C: Interpretation & Comprehension (12 marks)**

The graph below shows the amount of radiation received by the body when different parts of the body are X-rayed. This data was collected from a population of 200 patients.

* 1. State the independent and dependent variables for this experiment

**(2 marks)**

* + 1. Independent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. Dependent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  1. State two variables that would need to be controlled when collecting this data.

**(2 marks)**

* 1. What would be an appropriate title for the graph?

**(2 marks)**

* 1. List one way in which the data collected could be more reliable.

1. **mark)**
   1. What unit of measurement would you choose to place on the y-axis? Explain your choice.

**(3 marks)**

* 1. Suggest a reason why the total radiation received by the patient’s body is high when the spine is being imaged and small when the patient’s teeth are being imaged.

**(2 marks)**

**END OF TEST**