| AEPHY2024  **Narrogin SHS Year 11 ATAR PHYSICS Name:** | |
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| Task No: | 3b |
| Task Type: | Science Inquiry: Experiment Validation |
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| Content: | Ionising Radiation and Nuclear Reactions |
|  |  |
| Task Description:  Time Allowed | Validation Test (Solutions)  Reading time: 5 minutes  Working time: 45 minutes |
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| Weighting: | 6% (2% for Evaluation and Analysis, 4% for Validation) |
| Materials required | Physics Data Sheet, pens, pencils (including coloured), sharpener, correction fluid, eraser, ruler, highlighters, scientific calculator |
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| --- | --- | --- |
| **Section** | **Mark** | **Percent** |
| Evaluation and Analysis | /10 | \_\_\_\_% |
| Validation test | / 15 | \_\_\_\_% |
|  | | **Total:**  \_\_\_\_% |

**Question 1:**

Within a nuclear reactor, Polonium-209 is bombarded by a neutron to split into two daughter products also emitting two neutrons. Part of the nuclear equation is shown below.

**Palladium**

1. Write the element name for the missing daughter product labelled X. \_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)
2. What is the atomic and mass numbers of the daughter product X:

**116**

1. Mass number \_\_\_\_\_\_\_\_\_\_ (1 mark)

**46**

1. Atomic number \_\_\_\_\_\_\_\_\_\_\_ (1 mark)

**Question 5:**

Calculate the binding energy per nucleon (in MeV) of the Helium-3 atom given the mass of He-3 when using a mass spectrometer measures 4.99 x 10-27 kg . (5 marks)

**He-3 has 2 protons and 1 neutron (total of 3 nucleons)**

**Calculating the mass defect of an atom**

**md = [2 × mp + mn] − M(He – 3)**

**md = [(2 × 1.67 × 10-27 + 1.67 × 10-27] – 4.99 × 10-27**

**md = 2 × 10-29 kg (1 mark)**

**Calculating the binding energy of an atom**

**EJ = mc2**

**EJ = 2 × 10-29 × (3 × 108)2**

**EJ = 1.8 × 10-12 J (1 mark)**

**Converting Joules to electron Volts**

**1 eV = 1.6 × 10-19**

**Hence**

**EeV = (1 mark)**

**EeV = 1.125 × 107 eV**

**EeV = 11.25 MeV (1 mark)**

**Converting to per nucleon**

**EeV = 11.25 ÷ 3**

**= 3.75 MeV per nucleon (1 mark)**

**Question 3:**

When Pu-238 (atomic number 94) is bombarded with a neutron, fission occurs to form Sn-128 (atomic number 50), Ru-108 (atomic number 44) and some neutrons.

1. Complete the nuclear equation showing the number of neutrons released. (1 mark)

3

1. How much binding energy is released per reaction in Joules using the information on your data sheet and the information below? (6 marks)

* Pu-238 = 396.82 × 10-27 kg
* Sn-128 = 212.33 × 10-27 kg
* Ru-108 = 179.13 × 10-27 kg

**Calculating the binding energy of an atom**

**mPu-238 + mn = mSn-128 + mRu-108 + 3 × mn + mbinding energy**

**396.82 × 10-27 + 1.68 × 10-27 = 212.33 × 10-27 +179.13 × 10-27 + 3 × 1.68 × 10-27 +mbinding energy**

**(1 mark) (1 mark)**

**398.5 × 10-27 = 396.5 × 10-27 +mbinding energy (1 mark)**

**Hence mbinding energy =398.5 × 10-27 − 396.5 × 10-27**

**mbinding energy = 2 × 10-27  (1 mark)**

**E = mc2**

**= 2.00 × 10-27 × (3 × 108)2  (1 mark)**

**= 1.80 × 10-10 J (1 mark)**