Nuclear Models and Radioactivity Test

Stage 1 Physics Summative SAT

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| Name: |  | | |
| Marks (out of 50): |  | Grade: |  |

**Time Allowed:** 50 minutes  
**Total Marks:** 50 (one mark per minute)  
**Calculators:** Permitted

**Useful Information:**

* Speed of light: c = 3x108ms-1
* Half Life decay: where is the half-life of the material.
* E=mc2

| **Performance Standards Assessed** | |
| --- | --- |
| **Investigation, Analysis and Evaluation** | **Knowledge and Application** |
| 1. Designs a logical, coherent, and detailed physics investigation. 2. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. 3. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. 4. Critically and logically evaluates procedures and their effect on data. | 1. Demonstrates deep and broad knowledge and understanding of a range of physics concepts. 2. Develops and applies physics concepts highly effectively in new and familiar contexts. 3. Critically explores and understands in depth the interaction between science and society. 4. Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations. |

1. General Multiple Choice (1 mark each)

KA1

* 1. Isotopes are
     1. Atoms with more electrons than protons
     2. Atoms with more protons than electrons
     3. Atoms which have the same number of protons and differing numbers of neutrons
     4. a) and b)
  2. Which force holds the electrons in orbit around the nucleus?
     1. Strong nuclear force
     2. Electrostatic force
     3. Gravitational force
     4. Force due to friction
  3. If a radioactive isotope has a half-life of 10 years, how long will it take for ¾ of the isotope to decay?
     1. 15 years
     2. 17.5 years
     3. 20 years
     4. 13.33 years
  4. Why does nuclear fusion require high temperatures?
     1. The kinetic energy of the atoms needs to be high enough to fling the atoms apart.
     2. The kinetic energy needs to be high enough to overcome the repulsive force of two positively charged nuclei.
     3. At high temperatures, the strong nuclear force breaks down allowing the protons to move freely and stick together to create new elements.
     4. At high temperature, the atoms turn into raw energy and once they cool, they reform into new atoms with excess energy from the mass lost during the fusion process.
  5. What differentiates elements on the periodic table? (not isotopes of elements)
     1. The number of neutrons.
     2. The number of protons.
     3. The number of electrons.
     4. The difference between protons and electrons.
  6. In a fission reaction, the mass of the products is
     1. Less than the original nucleus
     2. Equal to the original nucleus
     3. More than the original nucleus
     4. b) and c)
  7. In alpha decay, the proton number of the parent nuclide
     1. Increases by 2
     2. Increases by 1
     3. Decreases by 2
     4. Decreases by 4
  8. The release of energy from the sun is due to
     1. Nuclear fusion
     2. Nuclear fission
     3. Chemical reaction
     4. Burning of gases
  9. The greatest ionization power is possessed by
     1. Beta particles
     2. Gamma particles
     3. Neutrons
     4. Alpha particles
  10. Gamma radiation are high energy
      1. Electrons
      2. Protons
      3. Photons
      4. Neutrons

(10 marks)

KA4

* 1. Draw and label all parts of a helium atom. Indicate some relative scale and size between the components.

(5 marks)

KA1

* 1. Why don’t the protons in a nucleus fly apart from the strong electrostatic repulsive force they exert on each other?

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1. A small radioactive sample was placed in front of a detector which counts the activity from decay. Measurements of the hourly radioactivity are below.

|  |  |
| --- | --- |
| **Time (Hours)** | **Counts** |
| 0-1 | 150034 |
| 1-2 | 130582 |
| 2-3 | 113678 |
| 3-4 | 98963 |
| 4-5 | 86152 |
| 5-6 | 74931 |
| 6-7 | 65291 |
| 7-8 | 56839 |
| 8-9 | 49481 |
| 9-10 | 43076 |
| 10-11 | 37507 |
| 11-12 | 32645 |
| 12-13 | 28419 |

A2

* 1. Plot a graph of the radioactivity of this material on the grid paper at the end of this test (6 marks)

A3

* 1. What is the half-life for this material? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2 marks)
  2. How would the half-life change if the solid was heated until it changed into a liquid? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2 marks)

KA1

* 1. If there was initially 100g of this material, estimate or calculate how many hours it takes until there is only 35g left? (1 mark)  
     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2 marks)

A3

1. Fill in the blanks

KA1

* 1. In beta minus decay, an unstable nucleus emits \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Beta minus decay occurs when a nucleus has an excess of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and involves the decay of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and antineutrino.   
       
     The nuclear equation for this is shown by:

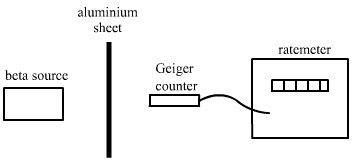
(3 marks)

* 1. In alpha decay, an unstable nucleus emits an alpha particle. An alpha particle is the nucleus of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ atom. The nuclear equation for an alpha decay is shown by:

KA1

(2 marks)

1. Kate's teacher wants to find how much beta radiation passes through different thicknesses of aluminium.



The teacher measures background radiation. It gives a reading of 60 counts per minute on the ratemeter.

KA1

1. Suggest two possible sources of background radiation.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2 marks)
2. Write down two safety precautions to take when using the beta source.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2 marks)

A1

Aluminium is rolled into sheets twenty millimetres thick in a rolling mill. A radioactive source and a detector are used to check the thickness of the sheet as it leaves the rollers.

1. Why is beta radiation not suitable for checking 20-millimetre sheet?   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(1 mark)

KA2

1. Suggest one type of radiation which could be used to check the thickness of 20-millimetre sheet.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(1 mark)

KA2

1. It would be sensible to use, in the rolling mill, a radioactive isotope with a half-life much shorter than 5.3 years. Explain why.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2 marks)

KA2

1. In a nuclear power station, a controlled unclear chain reaction is used to produce energy. Control rods and a moderator are used to ensure that the nuclear reactions proceed at the correct rate.
   1. With the help of a diagram, explain how a nuclear chain reaction takes place.

KA4

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(4 marks)

* 1. What role does the moderator play in a nuclear reactor? Why is it important? Suggest a suitable material.

KA3

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KA2

* 1. Find the energy released in the following fission reaction:

Refer to this table of data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particle |  |  |  |  |
| Mass (x 10-27kg) | 1.675 | 390.173 | 154.248 | 233.927 |

(2 marks)