Nuclear Physics Practice:

1. Which of the following correctly shows the properties of a proton?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Charge | Approximate Mass (u) | Quark Composition | Nucleon number |
| A | +1 | 1 | 2D, 1U | 1 |
| B | +1 | 1 | 2U, 1D | 1 |
| C | +1 | 0 | 2U, 1D | 2 |
| D | +1 | 1 | 2U, 1D | 0 |
| E | +1 | 0 | 2D, 1U | 1 |
| F | 0 | 0 | 2U, 2D | 4 |
| G | 0 | 1 | 1D, 2U | 1 |
| H | 0 | 1 | 2D, 1U | 1 |
| I | 0 | 0 | 2D, 1U | 1 |
| J | -1 | 1 | 2D, 2U | 1 |
| K | -1 | 0 | 2U, 1D | 1 |

2. Which of the following correctly shows the properties of a neutron?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Charge | Approximate Mass (u) | Quark Composition | Nucleon number |
| A | +1 | 1 | 2D, 1U | 1 |
| B | +1 | 1 | 2U, 1D | 1 |
| C | +1 | 0 | 2U, 1D | 2 |
| D | +1 | 1 | 2U, 2D | 0 |
| E | 0 | 0 | 2D, 1U | 2 |
| F | 0 | 0 | 2U, 2D | 4 |
| G | 0 | 1 | 1D, 2U | 1 |
| H | 0 | 1 | 2D, 1U | 1 |
| I | 0 | 0 | 2U, 1D | 1 |
| J | -1 | 1 | 2D, 2U | 1 |
| K | -1 | 0 | 2U, 1D | 1 |

3. Explain why atomic nuclei were/are only formed in the very early universe (10-6s – 3 minutes after the big bang) and in the interior of stars.

4. Which of the following is NOT a difference between chemical reactions and nuclear reactions? Circle all that apply.

A. Nuclear reactions create new elements, chemical reactions do not.

B. The energy involved in nuclear reactions is much greater than the energy involved in chemical reactions.

C. Nuclear reactions conserve mass, while chemical reactions do not.

D. Nuclear reactions conserve charge, while chemical reactions do not.

E. Chemical reactions conserve mass while nuclear reactions do not.

F. Chemical reactions are important for life while nuclear reactions are not.

5. In the fission of 100kg of uranium-253, the mass of the products is 99.87kg (mostly barium-141 and krypton-92).

A. How much energy is released from the fission of 100kg of uranium-235?

B. Given that the energy released from 1 litre of gasoline 3.2x107J, how many litres of gasoline would need to be burned to release the same amount of energy as 100kg of U-235?

6. Consider the following beta decay:

In this decay if the mass of sulfur-35 that reacts is 69.938062mg, the mass of chlorine produced is 69.936606mg and the mass of the emitted beta particles is 0.001098mg.

A. Find the mass defect in this decay in milligrams.

B. Convert the mass from A to kilograms.

C. Find the energy released from this decay.

7. In nuclear physics and in chemistry it is often useful to use a unit of mass called the atomic mass unit (u) because the masses of the atoms and nuclei are so small.

Given: 1u = 1.66x10-27 kg

Consider the following alpha decay:

The mass of an alpha particle is 4.002603u, the mass of a radium-226 nucleus is 226.025402u and the mass of a radon-222 nucleus is 222.017570u.

Find the energy, in Joules, released from the alpha decay of a single radium-226 nucleus.

8. What mass of matter needs to be converted to create 4.0x1013 Joules of energy? This is the amount of electrical energy consumed per day by Vancouver, on average.

9. Write the nuclear equation for the following:

A. The fusion of Lithium-6 and helium-4

B. The alpha decay of Thorium-228

C. The fission of U-235, when struck by a neutron, into rubidium-96 and cesium-137 and \_\_\_\_ neutrons

D. The beta+ decay of a carbon-11 nucleus

E. The beta decay of a neutron

F. The fusion of an Osmium-191 and a Lithium-6

G. The gamma decay of a lead-214

H. The alpha decay of plutonium-242

I. The beta decay of Francium-223

10. What is the main reaction that occurs in the Sun?

11. How many protons and neutrons are in the following?

A. Polonium-212

B. Cerium-140

C. Chlorine-37

D.

E.

F.

12. Write the nuclear symbol for a nucleus containing:

A. 15 protons and 17 neutrons

B. 70 protons and 102 neutrons

C. 8 protons and 8 neutrons

D. 59 protons and 81 neutrons

13. What is the atomic symbol of a nucleus that has a nucleon number of 100 and contains 59 neutrons?

14. What is the atomic symbol of a nucleus that has a charge of +12 and contains 13 neutrons?

15. What parent will become phosphorous-31 via beta-negative decay?

16. Briefly explain why producing electricity by nuclear fusion is not currently viable on Earth.

17. Explain the role of the moderator in a nuclear reactor. Why is it necessary?

18. A nuclear reaction is endothermic. Do the products or reactants have more mass, or are the masses the same?