Topic 7.2 – Nuclear reactions NAME: _____

*THIS IS A PRACTICE ASSESSMENT. Show formulas, substitutions, answers (in spaces provided) and units!*

1. Explain what a transmutation is, and give two examples of artificial transmutations.

   _____

2. Define the concept of *unified atomic mass*.

   _____

3. Define the concept of *mass defect*.

   _____

4. Define the concept of *binding energy*.

   _____

5. Define the concept of *binding energy per nucleon*.

   _____

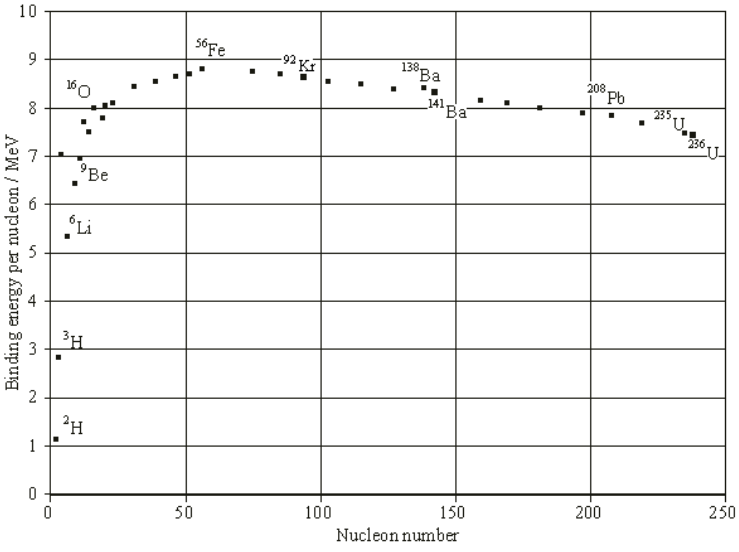
6. A nitrogen atom has a mass of precisely 14.00307 u. How many kilograms is this?

   6. _____

7. How many joules would be released by the complete conversion of 1.250 kg into pure energy?

   7. _____

*The graph shows the binding energy per nucleon vs. number of nucleons. The following questions refer to this graph.*




8. What is the binding energy per nucleon of $^{56}$Fe?

   8. _____

9. What, then, is the total binding energy of $^{56}$Fe?

   9. _____

10. What amount of work would be required to completely disassemble $^{56}$Fe into its constituent nucleons?

    10. _____

11. Find the sum of the binding energies of $^{92}$Kr and $^{141}$Ba. 11. _____

12. Find the binding energy of $^{236}$U. 12. _____

13. From the previous two problems, find the gain in binding energy that occurs when uranium-236 splits into barium-141 and krypton-92. 13. _____

14. Explain which type of reaction this is (fission or fusion) and why it occurs naturally.

_____

*The following questions are about stellar evolution.*

15. For stars more massive than the sun, the "iron catastrophe" occurs just before the star becomes a neutron star. Explain what the iron catastrophe is.

_____

16. From problem 10., you found out that each iron atom required a certain amount of work to be disassembled. During the iron catastrophe, where does the energy for this work come from?

_____

17. Earth has naturally-occurring elements all the way up to $Z$ = 92 on the periodic table. In fact, our bodies contain elements above iron on the periodic table. Given that stars collapse into neutron stars once they have succeeded in fusing elements up to and including iron, explain how the elements beyond iron are produced.

_____

*The following questions refer to the reaction shown below, in which a high-energy alpha particle collides with a nitrogen nucleus. Use the given table as needed.*

| particle | rest mass / *u* |
|---|---|
| He | 4.00260 |
| N | 14.00307 |
| O | 16.99913 |
| p | 1.00783 |

18. Complete the nuclear reaction shown here:

$$^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{O} + {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{p}$$

19. Find the mass in *u* of the reactants. 19. _____

20. Find the mass in *u* of the products. 20. _____

21. Explain why this reaction is an artificial transmutation that is not likely to occur naturally.

_____