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Date: _____

Honors Physical Science

$$E=mc^2$$

E = energy released

m = mass changed into energy in kg

c = speed of light

$$1g = 6.022 \times 10^{23} \text{ amu}$$

$$1 \text{ kg} = 1000 \text{ g}$$

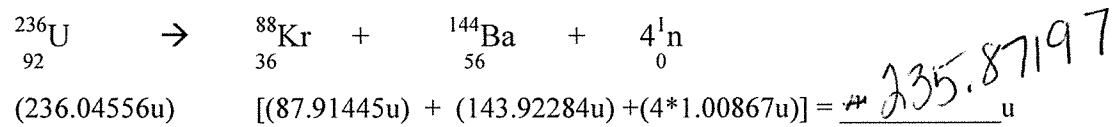
$$1 \text{ amu} = 1 \text{ u}$$

1. What is the energy generated when the change in mass in a nuclear reaction = 1g?
Step 1 convert mass into kg - $1g \cdot (1\text{kg}/1000\text{g}) = 0.001\text{kg}$
Step 2 insert variables into the equation $E = mc^2$

$$E = \cancel{0.001} \text{ kg} \cdot (3 \times 10^8 \text{ m/s})^2 \rightarrow E = (0.001)(3 \times 10^8 \text{ m/s})^2 = 9 \times 10^{13} \text{ J}$$

Step 3: Convert to Joules using $1 \text{ kgm}^2/\text{s}^2 = 1 \text{ J}$

2. Calculate the mass defect and the corresponding energy released during this fission reaction.



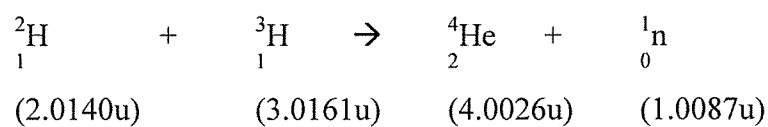
Mass Defect = (sum of mass of products) - (sum of mass of reactants)

$$\text{Mass defect} = 235.87197 - 236.04556 = -0.17359$$

$$\text{Convert to kg} = -0.17359 \text{ amu} \cdot (1\text{g}/6.022 \times 10^{23}\text{amu}) \cdot (1\text{kg}/1000\text{g}) = -2.883 \times 10^{-28}$$

$$E = mc^2 = (2.883 \times 10^{-28}) (3 \times 10^8)^2 = 2.59 \times 10^{-11} \text{ J}$$

3. Calculate the mass defect and the corresponding energy released during this fusion reaction.

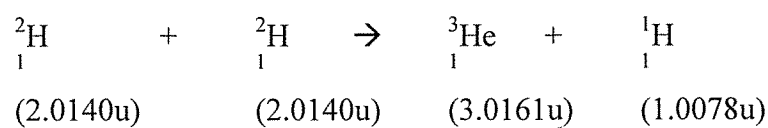


Mass = products - reactants

$$= (4.0026 + 1.0087) - (3.0161 + 2.0140) = -0.0188 \text{ amu}$$

$$\frac{-0.0188 \text{ amu}}{6.022 \times 10^{23} \text{ amu}} \cdot \frac{1 \text{ kg}}{1000 \text{ g}} = 3.1219 \times 10^{-29} \text{ kg} \cdot (3 \times 10^8)^2 = 2.81 \times 10^{-12} \text{ J}$$

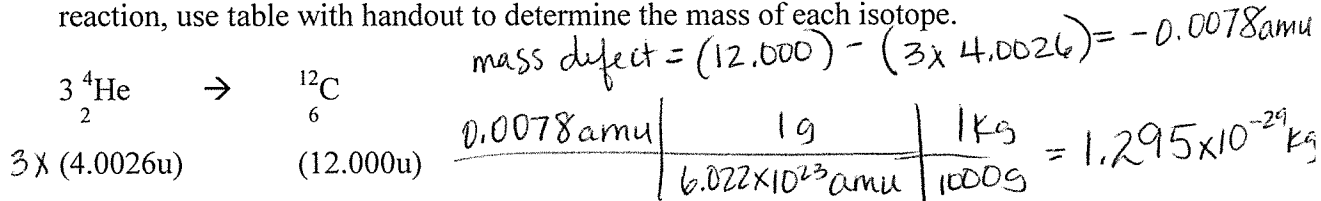
4. Calculate the mass defect and the corresponding energy released during this fusion reaction.



Mass = products - reactants = (3.0161 + 1.0078) - (2.0140 + 2.0140) = -0.0041

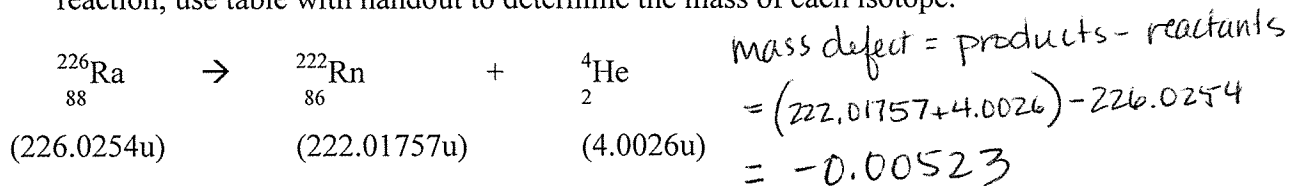
$$\frac{0.0041 \text{ amu}}{6.022 \times 10^{23} \text{ amu}} \cdot \frac{1 \text{ kg}}{1000 \text{ g}} = (6.81 \times 10^{-30} \text{ kg}) \cdot (3 \times 10^8)^2 = 6.13 \times 10^{-13} \text{ J}$$

5. Calculate the mass defect and the corresponding energy released during this fusion reaction, use table with handout to determine the mass of each isotope.



$$E = mc^2 = (1.295 \times 10^{-29}\text{kg})(3 \times 10^8\text{m/s})^2 = 1.17 \times 10^{-12}\text{J}$$

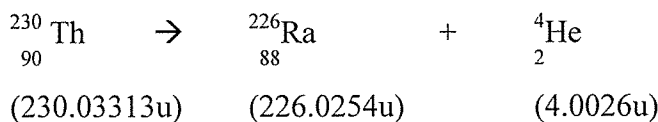
6. Calculate the mass defect and the corresponding energy released during the following reaction, use table with handout to determine the mass of each isotope.



$$\frac{0.00523\text{amu}}{6.022 \times 10^{23}\text{amu}} \left| \frac{1\text{g}}{1000\text{g}} \right| \frac{1\text{kg}}{1000\text{g}} = 8.68 \times 10^{-30}\text{kg}$$

$$E = mc^2 = (8.68 \times 10^{-30})(3 \times 10^8)^2 = 7.816 \times 10^{-13}\text{J}$$

7. Calculate the mass defect and the corresponding energy released during the following reaction, use table with handout to determine the mass of each isotope.



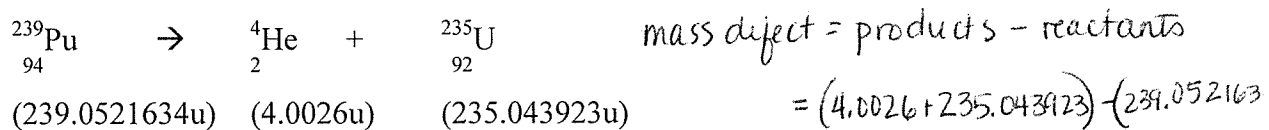
mass defect = products - reactants

$$(4.0026 + 226.0254) - (230.03313) = 0.00513\text{amu}$$

$$\frac{0.00513\text{amu}}{6.022 \times 10^{23}\text{amu}} \left| \frac{1\text{g}}{1000\text{g}} \right| \frac{1\text{kg}}{1000\text{g}} = 8.52 \times 10^{-30}\text{kg}$$

$$E = mc^2 = (8.52 \times 10^{-30})(3 \times 10^8)^2 = 5.11 \times 10^{-21}\text{J}$$

8. Calculate the mass defect and the corresponding energy released during the following reaction, use table with handout to determine the mass of each isotope.



$$\frac{0.0056404\text{amu}}{6.022 \times 10^{23}\text{amu}} \left| \frac{1\text{g}}{1000\text{g}} \right| \frac{1\text{kg}}{1000\text{g}} = 9.37 \times 10^{-30}\text{kg}$$

$$E = mc^2 = (9.37 \times 10^{-30}\text{kg})(3 \times 10^8\text{m/s})^2 = 8.43 \times 10^{-13}\text{J}$$