Nuclear Reactions Practice:

For the following, simply write the reaction using proper nuclear notation. For each confirm that charge and nucleon number are conserved.:

1. Hydrogen-1 and 1 neutron form hydrogen-2.

$$^{1}_{1}H + ^{1}_{0}n \rightarrow ^{2}_{1}H$$

2. Hydrogen-2 and 1 neutron from hydrogen-3.

$$^{2}_{1}H + ^{1}_{0}n \rightarrow ^{3}_{1}H$$

3. Hydrogen-2 and hydrogen-3 form helium-5.

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{5}_{2}He$$

4. Calcium-41 and hydrogen-3 form scandium-44.

$$^{41}_{20}Ca + ^{3}_{1}H \rightarrow ^{44}_{21}Sc$$

5. Helium-3 and phosphorous-32 form chlorine-35.

$$^{3}_{2}He + ^{32}_{15}P \rightarrow ^{35}_{17}Cl$$

For the following, use the Law of Conservation of Charge and the Law of Conservation of Nucleon Number to complete the nuclear reactions. Write the reactions with proper nuclear notation.

6. Hydrogen-2 and Osmium-192 combine to form Iridium-194.

$$^{2}_{1}H + ^{192}_{76}Os \rightarrow ^{194}_{77}Ir$$

7. Beryllium-9 and silver-110 combine to form Antimony-119.

$$^{9}_{4}Be + ^{110}_{47}Ag \rightarrow ^{119}_{51}Sb$$

8. Boron-12 and Helium-5 combine to form Nitrogen-13 and 4 neutron(s).

$$^{12}_{5}B + ^{5}_{2}He \rightarrow ^{13}_{7}N + 4\,^{1}_{0}n$$

9. Uranium-235 is hit by a neutron. This forms a Uranium-236 nucleus. U-236 then splits into cesium-140, Rubidium-94 and 2 neutrons.

$${}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{236}_{92}U \rightarrow {}^{140}_{55}Cs + {}^{94}_{37}Rb + 2{}^{1}_{0}n$$

10. Plutonium-240 absorbs a neutron to become Plutonium-241. This nucleus then splits into Radon-222, Oxygen-15 and 4 neutron(s).

$${}^{240}_{94}Pu + {}^{1}_{0}n \rightarrow {}^{241}_{94}Pu \rightarrow {}^{222}_{86}Rn + {}^{15}_{8}O + 4{}^{1}_{0}n$$

Use the equation $E=mc^2$ to calculate the energy produced from the following masses.

- $c=3.00\times10^{8}$m/s
- mass must be in KILOGRAMS.
- 1 tonne (1000kg) of coal produces 2.0×10^{10} Joules of energy.

11. How much energy is released from 1.0mg of matter converted to energy?

$$1.0mg \times \left(\frac{1g}{1000mg}\right) \times \left(\frac{1kg}{1000g}\right) = 1.0\times10^{-6}kg$$

$$E = mc^2 = 1.0\times10^{-6}kg\,(3\times10^{8}m/s)^2 = 9\times10^{10}J$$

12. How much energy is produced if 0.000354kg is converted to energy?

$$E = mc^2 = 0.000354kg\,(3\times10^{8}m/s)^2 = 3.186\times10^{13}J$$

13. How much energy is released if 1.0g of matter is converted to energy in a nuclear reaction? How much coal would need to be burned to release the same amount of energy?

$$m = 1.0g \times \left(\frac{1kg}{1000g}\right) = 1\times10^{-3}kg$$

$$E = mc^2 = 1\times10^{-3}kg\,(3\times10^{8})^2 = 9\times10^{13}J$$

$$9\times10^{13}J \times \left(\frac{1\text{ tonne coal}}{2\times10^{10}J}\right) = 4500\text{ tonnes}$$

14. In the fission of 1.0kg of Uranium-235, the mass defect is 0.763g. How much energy is released from the fission of 1.0kg of U235? How much coal would need to be burned to produce the equivalent amount of energy?

$$0.763g \times \left(\frac{1kg}{1000g}\right) = 7.63\times10^{-4}kg$$

$$E = mc^2 = 7.63\times10^{-4}kg\,(3\times10^{8}m/s)^2$$

$$E = 6.867\times10^{13}J$$

$$6.867\times10^{13}J \times \left(\frac{1\text{ tonne coal}}{2.0\times10^{10}J}\right) = 3433.5\text{ tonnes of coal}$$