Unit 7B
Nuclear Fission
Practice Problems TEACHER

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Work each of the following problems. SHOW ALL WORK.

1. **Nuclear fission that is not spontaneous starts by a neutron being captured by an unstable nucleus. Protons have nearly identical masses to neutrons. Protons and neutrons have nearly identical masses.**

   Neutrons have no charge and, unlike a proton, would not be repelled by a positively charged nucleus.

2. **When heavy nuclei undergo fission, mass is lost. Where does this mass go?**

   The mass turns into energy that is released in a nuclear fission reaction.

3. **One ton of TNT releases 4.18 gigajoules of energy. The metric prefix giga means billion. How much mass could be converted to energy to release this much energy?**

$$E = \Delta mc^2$$
$$4.18 \times 10^9 \, J = m(3 \times 10^8 \, m/s)^2$$
$$4.18 \times 10^9 \, J = m(9 \times 10^{16} \, m^2/s^2)$$
$$4.64 \times 10^{-8} \, kg = m$$

4. **How much energy is equivalent to 1 kilogram of mass?**

$$E = \Delta mc^2$$
$$E = (1 kg)(3 \times 10^8 \, m/s)^2$$
$$E = (1 kg)(9 \times 10^{16} \, m^2/s^2)$$
$$E = 9 \times 10^{16} \, J$$

5. **If the mass lost in a nuclear fission reaction is 0.50 grams, how much energy is released?**

$$E = \Delta mc^2$$
$$E = (5 \times 10^{-4} \, kg)(3 \times 10^8 \, m/s)^2$$
$$E = (5 \times 10^{-4} \, kg)(9 \times 10^{16} \, m^2/s^2)$$
$$E = 4.5 \times 10^{13} \, J$$

questions continued on next page

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Work each of the following problems. SHOW ALL WORK.

6. **An electron has a mass of 9.12×10^{-31} kilograms. How much energy would be released if the mass of one electron was lost in a nuclear fission reaction?**

$$E = \Delta mc^2$$
$$E = (9.12 \times 10^{-31}\ kg)(3 \times 10^{8}\ m/s)^2$$
$$E = (9.12 \times 10^{-31}\ kg)(9 \times 10^{16}\ m^2/s^2)$$
$$E = 8.21 \times 10^{-14}\ J$$

7. **The Little Boy atomic bomb released 63 terajoules of energy when it was dropped on Hiroshima, Japan. The metric prefix tera means 10^{12} times the base unit. How much mass was converted to energy during this explosion?**

$$E = \Delta mc^2$$
$$6.3 \times 10^{13}\ J = m(3 \times 10^{8}\ m/s)^2$$
$$6.3 \times 10^{13}\ J = m(9 \times 10^{16}\ m^2/s^2)$$
$$m = 7.0 \times 10^{-4}\ kg$$

8. **The efficiency of nuclear reactors is 45%, meaning 45% of the energy created by nuclear fission turns into electricity. The highest producing nuclear power plant in 2015 created 11.63 billion kilowatt hours, which is equal to 4.18×10^{16} joules of energy. How much mass was converted at 45% efficiency to create this much energy?**

$$E = \Delta mc^2$$
$$4.18 \times 10^{16}\ J = m(3 \times 10^{8}\ m/s)^2$$
$$4.18 \times 10^{16}\ J = m(9 \times 10^{16}\ m^2/s^2)$$
$$m = 0.464\ kg$$

This 0.464 kg is 45% of the actual amount of mass lost in the nuclear reactor. So, this mass must be divided by 0.45 (45% as a decimal) to get the total amount of mass lost in the nuclear reactor.

$$mass_{total} = \frac{0.464\ kg}{0.45} = 1.031\ kg$$