

PRACTICE PROBLEMS: ($E = mc^2$: Recall: $c = 3.00 \times 10^8 \text{ m/sec}$, and $1 \text{ Joule} = 1 \text{ kg} \cdot \text{m}^2 / \text{sec}^2$)

I. Calculate the amount of energy (in kJ) that is released in a nuclear reaction when the mass loss is 3.00 kilograms?

Answers:

$$E = mc^2$$

$$E = (3.00 \text{ kg}) \left(3.00 \times 10^8 \frac{\text{m}}{\text{sec}} \right)^2 = (3.00 \text{ kg}) \left(\frac{9.00 \times 10^{16} \text{ m}^2}{\text{sec}^2} \right)$$

$$E = \frac{2.70 \times 10^{17} \frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2}}{1 \left(\frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2} \right)} \times \frac{1 \text{ Joule}}{1000 \text{ J}} = 2.70 \times 10^{14} \text{ kJ}$$

II. Calculate the mass (in grams) of nuclei that was lost when 3.33×10^{15} kilojoules are released.

Answers:

$$E = mc^2 \quad ; \quad m = \frac{E}{c^2}$$

$$\frac{3.33 \times 10^{15} \text{ kJ}}{1 \text{ kJ}} \times \frac{1000 \text{ J}}{1 \text{ Joule}} \frac{1 \left(\frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2} \right)}{1 \text{ Joule}} = 3.33 \times 10^{18} \frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2}$$

$$m = \frac{3.33 \times 10^{18} \frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2}}{\left(3.00 \times 10^8 \frac{\text{m}}{\text{sec}} \right)^2} \times \frac{3.33 \times 10^{18} \text{ kg} \cdot \text{m}^2 (\text{sec}^2)}{9.00 \times 10^{16} \text{ m}^2 (\text{sec}^2)} = 37.0 \text{ kg}$$