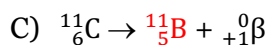
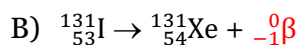
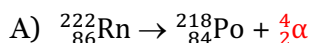
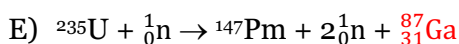
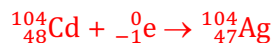


Particle	Symbol	Description
Neutron	${}^1_0\text{n}$	Mass approximately equal to proton, but no charge
Proton	${}^1_1\text{H}$ or ${}^1_1\text{p}$	Nuclei of a hydrogen atom
Deuteron	${}^2_1\text{H}$ or ${}^2_1\text{D}$	Nuclei of a hydrogen atom with 2 neutrons
Electron (β particle)	${}^0_{-1}\beta$ or ${}^0_{-1}\text{e}$	(High-energy) electrons
Positron α particle	${}^0_{+1}\beta$ or ${}^0_{+1}\text{e}$ ${}^4_2\alpha$ or ${}^4_2\text{He}$	Same mass as electron, but positive charge (High-energy) helium nuclei (2 protons + 2 neutrons)

1. Complete each nuclear reaction given below.



D) Electron capture by cadmium-104 (${}^{104}_{48}\text{Cd}$)



2. Mercury-197 has a half-life of 65 hours. What fraction of a mercury sample remains after 6 days?

$$\text{Rate} = kN \quad t_{1/2} = \frac{\ln 2}{k} \quad t = -\frac{1}{k} \ln \frac{N_t}{N_0}$$

$$t = -\frac{1}{k} \ln \frac{N_t}{N_0}$$

$$6 \text{ days} \times \frac{24 \text{ hr}}{1 \text{ day}} = -\frac{65 \text{ hr}}{\ln 2} \ln \frac{N_t}{N_0}$$

$$\ln \frac{N_t}{N_0} = -1.53_6$$

$$\frac{N_t}{N_0} = 0.22 \text{ (22 \%)}$$

3. Both carbon-14 and potassium-40 can be used for radiometric dating. The half-life of ^{14}C is 5730 years and the half-life of ^{40}K is 1.28×10^9 years.

$$\text{Rate} = kN \quad t_{1/2} = \frac{\ln 2}{k} \quad t = -\frac{1}{k} \ln \frac{N_t}{N_0}$$

- A) If a rock is predicted to be 20,000 years old, which form of radio dating is preferred? Why?

Answer: ^{14}C because it has a shorter half-life, so there is a more appreciable (measurable) decay

Carbon-14	Potassium-40
$\frac{N_t}{N_0} = 0.5^{\frac{t}{t_{1/2}}}$	$\frac{N_t}{N_0} = 0.5^{\frac{t}{t_{1/2}}}$
$= 0.5^{\frac{20000 \text{ yr}}{5730 \text{ yr}}}$	$= 0.5^{\frac{20000 \text{ yr}}{1.28 \times 10^9 \text{ yr}}}$
$\frac{N_t}{N_0} = 0.0890$ (8.90 %)	$\frac{N_t}{N_0} = 0.999$ (99.9 %)

- B) If a rock is predicted to be 200,000 years old, neither method is preferred. Why?

Answer: Too many half-lives have passed for ^{14}C and too few for ^{40}K , so both not measurable.

Carbon-14	Potassium-40
$\frac{N_t}{N_0} = 0.5^{\frac{t}{t_{1/2}}}$	$\frac{N_t}{N_0} = 0.5^{\frac{t}{t_{1/2}}}$
$= 0.5^{\frac{200000 \text{ yr}}{5730 \text{ yr}}}$	$= 0.5^{\frac{200000 \text{ yr}}{1.28 \times 10^9 \text{ yr}}}$
$\frac{N_t}{N_0} = 3.11 \times 10^{-11}$ (3.11×10^{-9} %)	$\frac{N_t}{N_0} = 0.999$ (99.9 %)

4. Silicon-28 can be made by many different nuclear fusion reactions.

- A) Which of the two fusion reactions releases the greater amount of energy?

Recall $\Delta E = \Delta mc^2$ where $c = 3.00 \times 10^8 \text{ m/s}$ and $1 \text{ J} = 1 \text{ kg} \cdot \text{m}^2/\text{s}^2$.

- i. $^{14}\text{N} + ^{14}\text{N} \rightarrow ^{28}\text{Si}$ $^{14}\text{N} = 14.00307 \text{ amu}$ $^{28}\text{Si} = 27.97693 \text{ amu}$
 ii. $^{16}\text{O} + ^{12}\text{C} \rightarrow ^{28}\text{Si}$ $^{16}\text{O} = 15.99491 \text{ amu}$ $^{12}\text{C} = 12.00000 \text{ amu}$

Answer: Fusion reaction (i)

$^{14}\text{N} + ^{14}\text{N} \rightarrow ^{28}\text{Si}$	$^{16}\text{O} + ^{12}\text{C} \rightarrow ^{28}\text{Si}$
$\Delta m = m_{\text{Si}} - 2m_{\text{N}}$	$\Delta m = m_{\text{Si}} - m_{\text{O}} - m_{\text{C}}$
$= (27.97693 - 2 \times 14.00307) \text{ amu}$	$= (27.97693 - 15.99491 - 12.00000) \text{ amu}$
$\Delta m = -0.02921 \text{ amu}$ ($-4.850 \times 10^{-29} \text{ kg}$)	$\Delta m = -0.01798 \text{ amu}$ ($-2.986 \times 10^{-29} \text{ kg}$)
$E = 4.850 \times 10^{-29} \text{ kg} \times \left(3.00 \times 10^8 \frac{\text{m}}{\text{s}}\right)^2$	$E = 2.986 \times 10^{-29} \text{ kg} \times \left(3.00 \times 10^8 \frac{\text{m}}{\text{s}}\right)^2$
$E = 4.37 \times 10^{-12} \text{ J}$	$E = 2.69 \times 10^{-12} \text{ J}$

- B) Propose a nuclear reaction that could produce an isotope of Si.

Example: $^{24}\text{Mg} + ^4\text{He} \rightarrow ^{28}\text{Si}$