Referring to **Table N**

Nuclide: Au-198 **Decay mode**: β⁻eta

Write the nuclear equation for the radioactive decay of Au-198.

$$^{198}_{79}Au \dashrightarrow \boxed{^{0}_{-1}e} + {}^{198}_{80}Hg$$

Half-life: 2.695 days

Aim: How do we solve half life problems?

1) <u>Half-life</u> – the time it takes for half the mass of a radioactive sample to decay

(*There is no way to predict when a single atom (nucleus) of a radio isotope will decay. However, it is possible to determine what fraction of nuclei in a sample will decay within any given time. The number of atoms that disintegrate is a constant fraction (1/2) of the total number of atoms.)*

- Half life isn't affected by changes in temperature, pressure, etc…
- Different radioisotopes have different half lives.

2) **"Just keep halving what you have."**

Again, for Au-198, half-life = 2.695 d. Therefore,

$$100g \xrightarrow{2.695\ d} 50g \xrightarrow{2.695\ d} 25g$$

The # times you chop it in half depends on the total time it decays.

Problem: Starting with 100 grams radioactive gold, how much will remain after 13.475 days?

$$\# = \frac{t}{T}$$

# = number of half life periods T = half life time
t = total time elapsed

$$\# = \frac{13.475\ d}{2.695\ d}$$

$$\# = 5$$

This means "chop" the given mass five times in half.

100g → 50g → 25g → 12.5 g → 6.25g → 3.125 g

GO TO HANDOUT FOR MORE EXAMPLES

KEEP HALVING IT!!

1) What will happen to the half-life of Fr-220 if its temperature is raised?

Nothing happens; Half-life is a constant.

2) What is the number of years required for Sr-90 to undergo two half-life periods? (# → two)

Sr-90 $T = 28.1$ y $\quad 28.1\text{ y} \times 2 = 56.2\text{ y}$

3) How much of a 64.0 gram sample of K-42 will remain unchanged after 37.08 hours? (starting → 64.0 g; $T = 12.36$ h; t → 37.08 hours)

$64.0\text{ g} \rightarrow 32 \rightarrow 16 \rightarrow 8\text{ g}$

$\frac{t}{T} = \#$ $\quad \frac{37.08\text{ h}}{12.36\text{ h}} = 3$

4) If 48.0 grams of Na-24 decays to 3.00 grams in 60.0 hours, what is the half-life of Na-24? (starting → 48.0 g; remaining → 3.00 g; t → 60.0 hours)

$48.0\text{ g} \rightarrow 24 \rightarrow 12 \rightarrow 6 \rightarrow 3\text{ g}$

$\frac{t}{T} = \#$ $\quad \frac{60.0\text{ h}}{T} = 4$ $\quad \frac{60.0}{4} = 15\text{ h}$

5) What fraction of I-131 sample will remain unchanged after 3 half-life periods? (HINT: start with any amount you like) ($\frac{t}{T}$ → 3 half-life)

$1\text{ g} \rightarrow \frac{1}{2}\text{ g} \rightarrow \frac{1}{4}\text{ g} \rightarrow \frac{1}{8}\text{ g}$

OR

$\text{fraction remaining} = \left(\frac{1}{2}\right)^{t/T}$ $\quad \left(\frac{1}{2}\right)^3 = \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{8}$