CONCEPT: RADIOACTIVE HALF-LIFE

● **Radioactive Half-Life (_____):** The amount of time required for _____ of a *radioisotope* to decay.

   □ **Radioisotope (nuclide):** An isotope that has an unstable _____ and emits radiation as it decays.

EXAMPLE: What is the half-life of the radioisotope that shows the following data of remaining percentage vs. time?

Radioisotope % vs Time	
% Remaining	Days
100	0
80.0	1
60.0	2
50.0	3
40.0	4
33.0	5
25.0	6
20.7	7
16.4	8
12.5	9
9.90	10

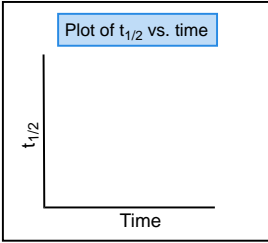## Method 1: Direct Calculation of Half-life or Rate Constant

● In Method 1, use the Radioactive Half-Life Equation when dealing with only _____ and the decay constant, k.

Radioactive Half-Life

$$t_{1/2} = \frac{\ln 2}{k}$$

   □ ln2 = Constant

   □ k = Decay Constant in _____

   □ t = time

Plot of $t_{1/2}$ vs. time

$t_{1/2}$ vs. Time

   □ Half-Life does _____ depend on the initial concentration and is _____ throughout the whole reaction.

EXAMPLE: If the decay constant of plutonium-244 is 8.66 x 10^{-9} years^{-1} at 25ºC, what is its half-life?

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<u>**Method 2: Radioactive Nuclei Concentrations**</u>

● In Method 2, we utilize both the Radioactive Half-life Equation and the Radioactive Integrated Rate Law.

    □ In this case the questions will involve the half-life, time, _____ and/or _____ radioactive nuclei concentrations.

> **EXAMPLE:** A sample of radon-222 has an initial α particle activity (A_0) of 8.5 x10^4 dps (disintegrations per second). After 7.3 days, its activity (A) is 3.7 x 10^4 dps. What is the half-life of radon-222?

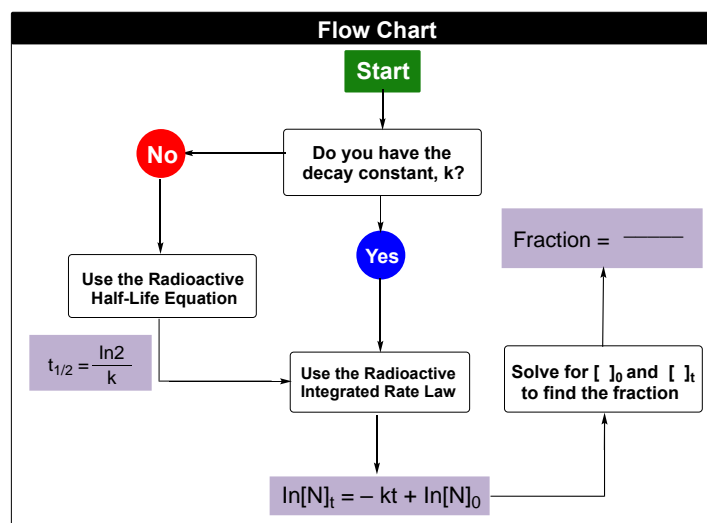**Radioactive Decay Formulas**

$$\ln[N]_t = -kt + \ln[N]_0$$

$$t_{1/2} = \frac{\ln 2}{k}$$

<u>**Method 3: Fractions and Percentages**</u>

● In Method 3, we also utilize both the Radioactive Half-life Equation and the Radioactive Integrated Rate Law.

    □ In this case the questions will ask for the fraction or percentage _____ while involving $t_{1/2}$.

    □ The fraction of a radioisotope is equal to its _____ concentration divided by its _____ concentration.

        - Multiplying the fraction remaining value by _____ gives the percentage remaining of the radioisotope

> **EXAMPLE:** The half-life of iodine-131, an isotope used in thyroid therapy, is 8.021 days. What fraction of iodine-131 remains in a sample that is estimated to be 6.25 months old?

Flow Chart

Start

Do you have the decay constant, k?

No

Yes

Use the Radioactive Half-Life Equation

$$t_{1/2} = \frac{\ln 2}{k}$$

Use the Radioactive Integrated Rate Law

Solve for [ ]$_0$ and [ ]$_t$ to find the fraction

Fraction = ————

$$\ln[N]_t = -kt + \ln[N]_0$$

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PRACTICE: The half-life of arsenic-74 is about 18 days. If a sample initially contains 5.13×10^4 mg arsenic-74, what mass (in mg) would be left after 80 days?

PRACTICE: What percentage of carbon – 14 ($t_{1/2}$ = 5715 years) remains in a sample estimated to be 18,315 years old?