



AP[®] Chemistry 2003 Sample Student Responses Form B

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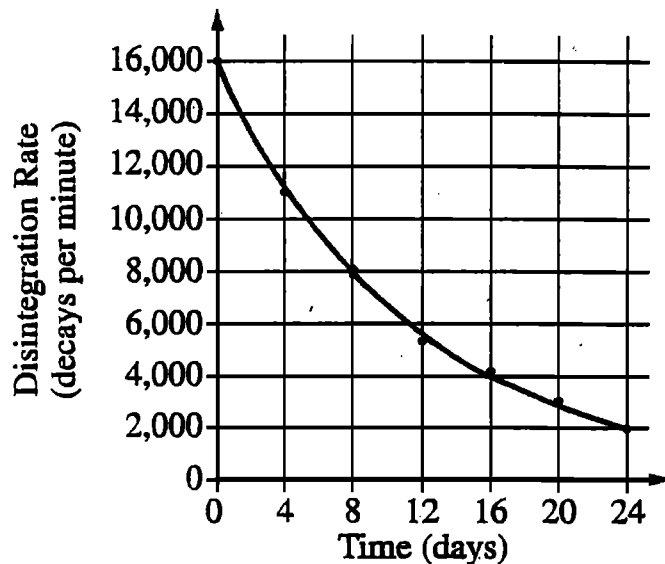
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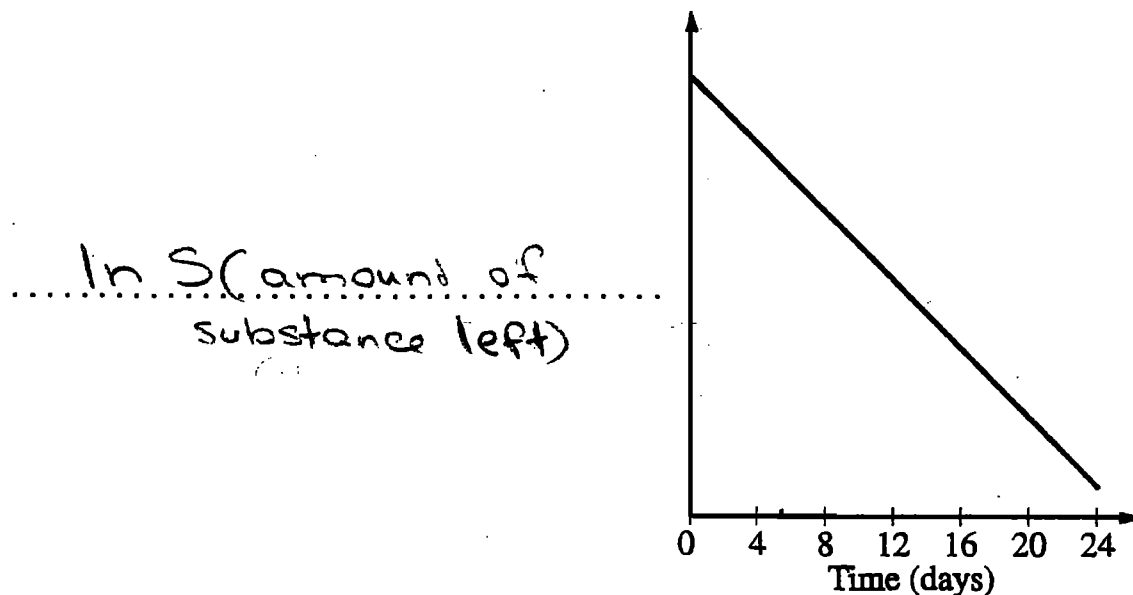
8. The decay of the radioisotope I-131 was studied in a laboratory. I-131 is known to decay by beta (${}_{-1}^0e$) emission.

- (a) Write a balanced nuclear equation for the decay of I-131.
- (b) What is the source of the beta particle emitted from the nucleus?

The radioactivity of a sample of I-131 was measured. The data collected are plotted on the graph below.



- (c) Determine the half-life, $t_{1/2}$, of I-131 using the graph above.
- (d) The data can be used to show that the decay of I-131 is a first-order reaction, as indicated on the graph below.



- (i) Label the vertical axis of the graph above.
 - (ii) What are the units of the rate constant, k , for the decay reaction?
 - (iii) Explain how the half-life of I-131 can be calculated using the slope of the line plotted on the graph.
- (e) Compare the value of the half-life of I-131 at 25°C to its value at 50°C.

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(b) When a beta particle is emitted a neutron emits an electron and becomes a proton. The neutron is the source.

(c) $t_{1/2}$ → time for half the given sample to decay

$$t_{1/2} = 8 \text{ days}$$

$$(d) (ii) \ln S = -kt + \ln S_0$$

$$\text{Half-life} = \frac{\ln 2}{k}$$

k is in days^{-1}

(iii) The slope of this graph is $-k$.

Half-life can be calculated by dividing

$\ln 2$ by the negative of the slope.

$$\text{Half-life} = \frac{\ln 2}{k}$$

(e) It is the same. Radioactive decay is not a chemical process and does not depend on temperature. The rate of decay depends on the nature of substance (thermodynamic considerations) and the amount of substance left.

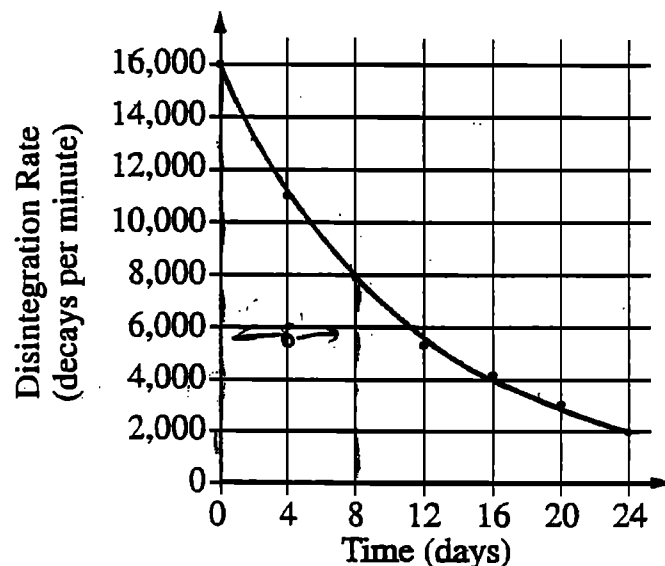
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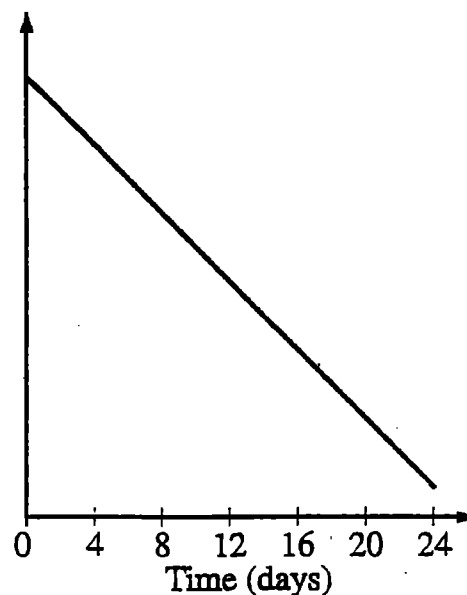
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In [Degredation rate].....

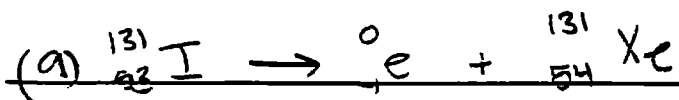


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(b) A neutron in the nucleus of I

(c) $\frac{1}{2}$ life \Rightarrow time required for $\frac{1}{2}$ material to decay.
taking time difference from 16000 \rightarrow 8,000
we find that the half life is 8 days.

d) (i) 1st order $\Rightarrow \ln[k]$ vs t

\Rightarrow axis label is $\ln[\text{degradation rate}]$

$$\text{ii) } \ln[A] = -kt + \ln[A_0]$$

$$\Rightarrow k = -\text{slope} = -\frac{\text{no units}}{\text{days}}$$

\Rightarrow units for k are days^{-1}

$$\text{iii) } \frac{1}{2} \text{ life } \Rightarrow [A] = \frac{1}{2} [A_0]$$

$$\ln[A_{0/2}] = -kt_{1/2} + \ln[A_0]$$

$$\ln\left[\frac{1}{2}\right] = -kt_{1/2}$$

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

The slope of the graph = $-k$

$$\Rightarrow k = -\text{slope}$$

$\Rightarrow t_{1/2}$ can be calculated by dividing $\ln 2$ with $-\text{slope}$.

$$\text{i.e. } t_{1/2} = \frac{\ln 2}{-\text{slope}}$$

(e) At a higher temperature (i.e. 50°C) the components

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of the atom would be at a more excited state.

Consequently, since systems tend to lower energy, the rate of emission of these particles would increase, i.e. k increases.

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

The half-life of a radioactive particle & the rate constant k are inversely proportional. This means that as k increases, $t_{1/2}$ would decrease.

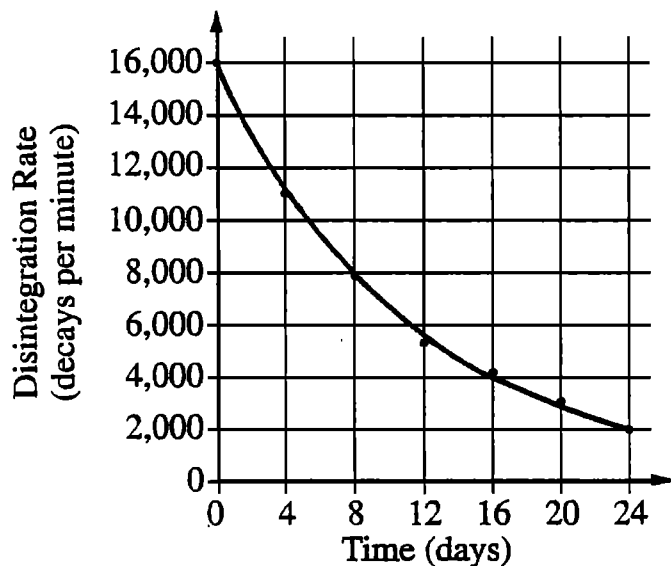
$$\therefore t_{1/2} \text{ at } 50^\circ\text{C} < t_{1/2} \text{ at } 25^\circ\text{C}$$

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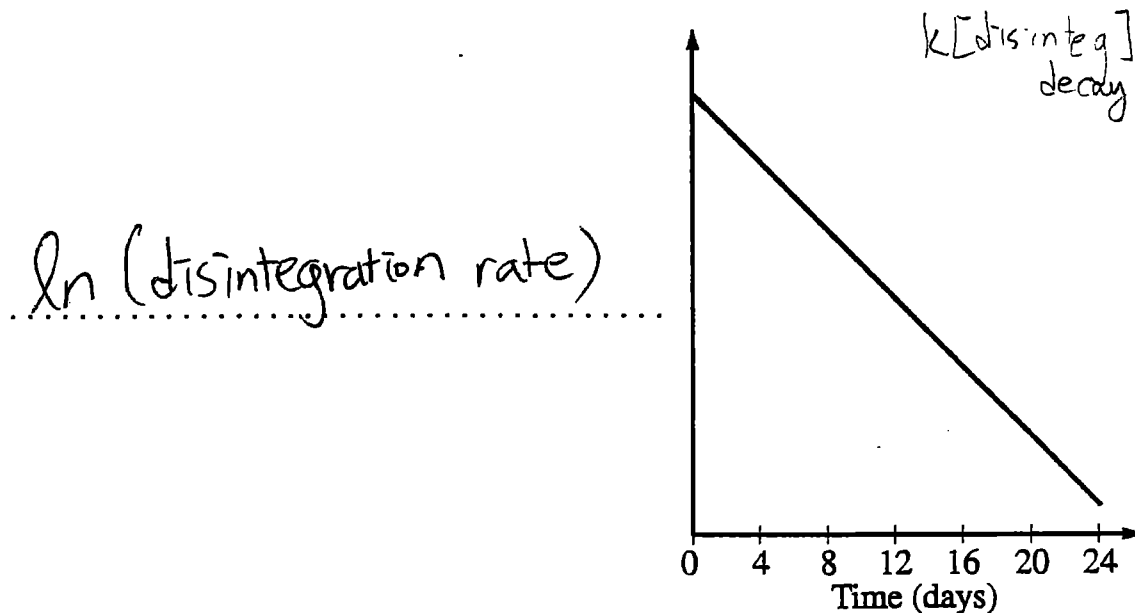
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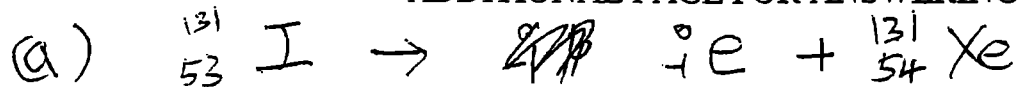
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(b) It is the radioactivity that results in the detachment of an electron.

(c) The disintegration rate halves every 8 ~~minutes~~ ^{days}.
 $\therefore t_{1/2} = 8 \text{ days}$

(d) (i) <on the diagram>

(ii) $t_{1/2} = \frac{0.693}{k}$ $k = \frac{0.693}{t_{1/2}}$

$k = \frac{0.693}{8 \text{ days}} = 0.0853 \text{ days}^{-1}$ so,

the unit is days^{-1} or (time^{-1})

(iii) the slope of the graph yields the half-life value

(e) The ~~real~~ half-life value decreases as the rate is faster as the Temperature increases. ~~which~~ There are more collisions hence more vibrant reactions.