

AP[®] CHEMISTRY
2003 SCORING GUIDELINES (Form B)

Question 8

Total Score 8 points

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.

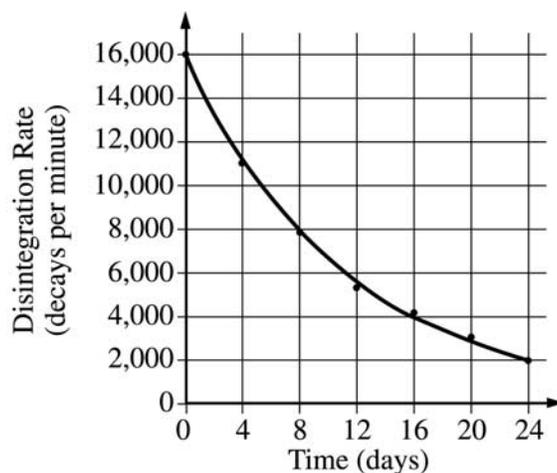
${}_{53}^{131}\text{I} \rightarrow {}_{54}^{131}\text{Xe} + {}_{-1}^0e$	1 point for correct equation
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Note: “β” for ${}_{-1}^0e$ is acceptable

(b) What is the source of the beta particle emitted from the nucleus?

A neutron spontaneously decays to an electron and a proton.	1 point for identifying a neutron as the source of the beta emission
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The radioactivity of a sample of I-131 was measured. The data collected are plotted on the graph below.



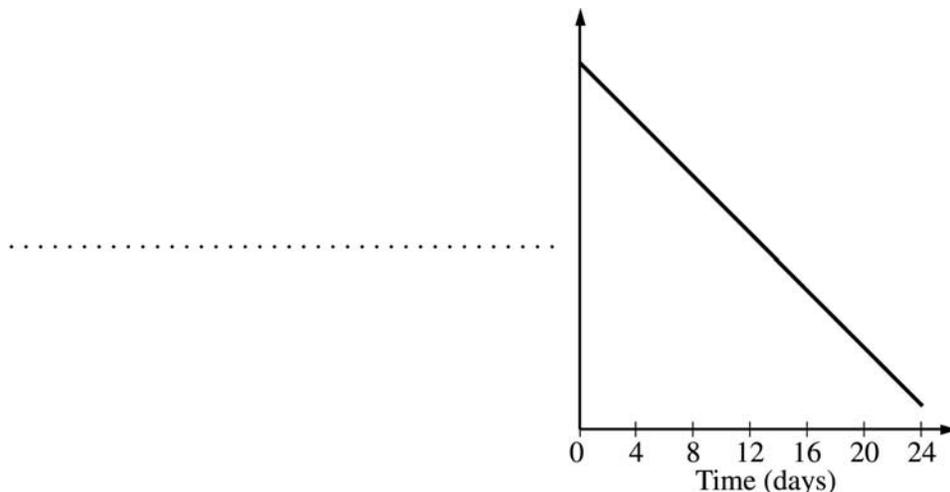
(c) Determine the half-life, $t_{1/2}$, of I-131 using the graph above.

The half-life is 8 days. That is the time required for the disintegration rate to fall from 16,000 to one-half its initial value, 8,000.	1 point for half-life
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Question 8 (cont'd.)

- (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.

The label on the y -axis should be \ln or \log one of the following: disintegrations or moles or atoms or [I-131] or disintegration rate.	1 point for correct label on y -axis
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- (ii) What are the units of the rate constant, k , for the decay reaction?

From the graph, the units on the rate constant are days^{-1} (Units of time^{-1} is acceptable)	1 point for correct units
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- (iii) Explain how the half-life of I-131 can be calculated using the slope of the line plotted on the graph.

The slope of the line is $-k$. The slope is negative, so k is a positive number. The half-life can then be calculated using the relationship $t_{1/2} = \frac{0.693}{k}$.	1 point for indicating slope is k 1 point for half-life equation
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- (d) Compare the value of the half-life of I-131 at 25°C to its value at 50°C.

The half-life will be the same at the different temperatures. The half-life of a nuclear decay process is independent of temperature.	1 point
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