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

(a) Write a balanced nuclear equation for the decay of I-131.

\[
\frac{^{131}_{53}I}{\rightarrow} \frac{^{131}_{54}Xe}{+} \frac{^0_{-1}e}{1 \text{ point for correct equation}}
\]

*Note: “β” for $^0_{-1}e$ 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

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
(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

(ii) What are the units of the rate constant, \( k \), for the decay reaction?

From the graph, the units on the rate constant are \( \text{days}^{-1} \)
(Units of \( \text{time}^{-1} \) is acceptable)

1 point for correct units

(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

(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