09	**6b**	Radium decays at a rate proportional to the amount of radium present. That is, if $Q(t)$ is the amount of radium present at time t, then $Q = Ae^{-kt}$, where k is a positive constant and A is the amount present at $t = 0$. It takes 1600 years for an amount of radium to reduce by half. (i) Find the value of k. (ii) A factory site is contaminated with radium. The amount of radium on the site is currently three times the safe level. How many years will it be before the amount of radium reaches the safe level?	**2** **2**

(i) Let $Q = 0.5$, $A = 1$, $t = 1600$:

$$\frac{1}{2} = 1e^{-k(1600)}$$

$$e^{-1600k} = \frac{1}{2}$$

Taking logs of both sides:

$$-1600k = \log_e \frac{1}{2}$$

$$k = \frac{-1}{1600} \log_e \frac{1}{2}$$

$$= \frac{1}{1600} \log_e 2$$

$$= 0.000433216 \ldots$$

$$= 0.0004 \quad \text{(corr. to 4 dec pl)}$$

(ii) Let $Q = \frac{1}{3}$:

$$\frac{1}{3} = 1e^{-kt}$$

$$e^{-kt} = \frac{1}{3}$$

Taking logs of both sides:

$$-kt = \log_e \frac{1}{3}$$

$$t = \log_e \frac{1}{3} \div -k$$

$$= \log_e \frac{1}{3} \div -\frac{1}{1600} \log_e 2$$

$$= 2535.940001 \ldots$$

$$= 2536 \text{ (nearest whole)}$$

$\therefore$ will take 2536 years to reach safe level.

Board of Studies: Notes from the Marking Centre

(i) A significant number of candidates seemed confused with the concept of half-life, not sure where to put $\frac{1}{2}$, or alternatively 2. Fewer candidates substituted 1600 in the correct position. Most correctly took the log of both sides of the exponential equation they had created. As in the previous part, a significant number of candidates were careless with negative signs, often ignoring them in order to achieve the positive value of k as stated in the question. A small number of candidates experienced difficulty dealing with the $A = 2A$ or $A = \frac{1}{2}A$ part of their equation.

(ii) The responses to this part were very similar to responses in the previous part, although fewer candidates were successful here. Candidates are reminded that setting out their work in a neat, organised manner not only assists the marker to follow their working, but also helps them keep their ideas clear in their own mind.

Source: http://www.boardofstudies.nsw.edu.au/hsc_exams/