The law of radioactive decay and the decay constant

Apart from half-lives (see topic 7), the activity of radioactive decay can also be shown exponentially by the law of radioactive decay.

$$R(t) = R_0 e^{-\lambda t}$$

where:
R(t) is the decay rate at time *t*
R_0 is the initial decay rate (at time zero)
e is the base of the Naperian logarithms
λ is the decay constant of the radioactive isotope

decay constant (≈ probability per time) $\lambda = \frac{1}{\tau}$

time constant (≈ average lifetime) $\tau = \frac{1}{\lambda}$

The decay constant (λ) represents the probability of decay of a nucleus per unit time and is dependent on the type of element.

On both Paper 1 and Paper 2, you can be expected to work in detail with the decay equations (exponentials) to solve for time. That requires you to be able to solve mathematically an equation with an exponential function (e^something). The trick, remember, is to take the natural log of both sides.

Isotope	Half life	Decay constant (s^{-1})
Uranium 238	4.5×10^{9} years	5.0×10^{-18}
Plutonium 239	2.4×10^{4} years	9.2×10^{-13}
Carbon 14	5570 years	3.9×10^{-12}
Radium 226	1622 years	1.35×10^{-11}
Free neutron 239	15 minutes	1.1×10^{-3}
Radon 220	52 seconds	1.33×10^{-2}
Lithium 8	0.84 seconds	0.825
Bismuth 214	1.6×10^{-4} seconds	4.33×10^{3}
Lithium 8	6×10^{-20} seconds	1.2×10^{19}