

Exponential growth and decay

1. The number of bacteria of a particular strain is given by $B(t) = 60e^{1.5t}$, where t is the time in hours.
 - (a) How many bacteria are there at time zero?
 - (b) How long will it take for the number of bacteria to treble?
2. A radioactive material has mass m , at time t years, given by $m = m_0e^{-0.03t}$, where m_0 is the original mass.
 - a. If the original mass is 600g, find the mass after 20 years.
 - b. Find the percentage of the material left after 10 years.
3. For a radioactive substance $A = A_0e^{-kt}$, where A_0 is the original mass and t is the time in minutes. In 5 minutes, 40g of this substance is reduced to 32g.
 - a. Find k to 2 significant figures.
 - b. Find the half life of this substance (the time taken for the amount of the substance to fall by half).
4. For a radioactive substance the mass at time t years is given by $m = m_0e^{-0.02t}$ where m_0 is the original mass.
 - a. If the original mass is 800g find the mass after 40 years.
 - b. Find the half life of this substance.
5. A radioactive substance is defined by $M = M_0e^{-kt}$, where M_0 is the original mass and M is the mass after t years. Experiments have shown that $M = 0.8M_0$ after 3 years.
 - (a) Find the value of k .
 - (b) Find the percentage reduction in mass after 20 years.
6. The value, V (£million), of an aeroplane is given by the formula $V = 3.5e^{-0.095t}$ where t is the number of years after the aeroplane is put into service..
 - (a) Calculate the value of the aeroplane when it was built.
 - (b) How long, to the nearest year, will it take for the aeroplane to fall to 40% of its original value?
7. The size of the human population, N , can be modelled using the equation $N = N_0e^{rt}$ where N_0 is the population in 2006, t is the time in years since 2006, and r is the annual rate of increase in the population.
 - (a) In 2006 the population of the United Kingdom was approximately 61 million, with an annual rate of increase of 1.6%. Assuming this growth rate remains constant, what would be the population in 2020?
 - (b) In 2006 the population of Scotland was approximately 5.1 million, with an annual rate of increase of 0.43%. Assuming this growth rate remains constant, how long would it take for Scotland's population to double in size?