Applied Exponential Growth and Decay : Radioactive Half Life and More…

The half-life of carbon-11 is 20 minutes.

a A sample of carbon-11 has 10 000 nuclei. Make a table of values for five 20-minute intervals, and write down a function for the number of nuclei after x number of 20 minute intervals.

b Find the number of nuclei after 3 hours.

c Determine how long it takes for the number of nuclei to reduce to less than 10% of the original number.

t (in 20 minute intervals)	N (number of nuclei remaining)
0	
1	
2	
3	
4	
5	

Carbon dating of fossils is based upon the decay of ^{14}C, a radioactive isotope of carbon with a relatively long half-life of about 5700 years.

All living organisms get ^{14}C from the atmosphere. When an organism dies, it stops absorbing ^{14}C, which begins to decay exponentially. Carbon dating compares the amount of ^{14}C in fossil remains with the amount in the atmosphere, to work out how much has decayed, and therefore how long ago the organism died.

1 Let N_0 = the initial amount of ^{14}C at the time of death.

Let x = the number of half-lives, where each half-life is 5700 years.

Let N = the amount present after x number of half-lives.

Write an exponential function relating N_0, x, and N.

2 When it dies, an organism contains 30 000 nuclei of ^{14}C. **Calculate** the number of ^{14}C nuclei in the organism after 11 400 years.

3 The amount of ^{14}C in a fossil is calculated to be 0.25 times the amount when the organism died. **Calculate** the approximate age of the fossil.

4 A fossil bone is approximately 16 500 years old. **Estimate** the fraction of ^{14}C still in the fossil.

5 Only 6% of the original amount of ^{14}C remains in a fossil bone. **Estimate** how many years ago it died.

The population of a town in 2010 was 38 720. It was estimated that its population will grow at an annual rate of 2.68%. **Determine** the population size in the year 2025, to the nearest 100 people.

Xixi bought a car five years ago for $18 000. It depreciates approximately 15% every year.

a **Write down** the depreciation (decay) factor for this problem.

b **Write down** a function to model the depreciation of the car over time.

c **Find** the value of her car now, to the nearest $100.

Gina invests $400 in a savings account that pays 1.4% interest compounded annually.

a **State** the growth factor on this investment.

b **Write down** a function to model the growth of her savings.

c **Determine** how many years it will take for her savings to double.

Drug testing trials show that the amount of a pain-relieving medicine in a person's body reduces by one quarter every hour. It is safe to take another dose of the medicine when there is less than 200 mg in the body.

Determine how long after a dose of 400 mg it will be safe to take another dose.

One bacterium cell divides to produce two cells every minute.

a. Fill the table.
b. Find the ratio, r.
c. Using the exponential model given, create an equation for this growth.

d. Find the number of cells after 15 minutes.

e. Find after how many minutes there will be 1 million cells.

t (time in minutes)	**C (number of cells)**
0	
1	
2	
3	
4	
5	

$$r = \frac{C_1}{C_0}$$

$$C = C_0 \cdot r^t$$