

The population of a species of plant in a field is modelled using the formula $P = 50e^{0.1t}$
Where t is the number of weeks since the population was first recorded.

- (a) Write down the number of the plants when the population was first recorded. (1)
- (b) Find the rate of increase in the population 10 weeks after the population was first recorded. (2)
- (c) Find how many weeks it takes for the number of plants to exceed 300. (4)

The decay of a radioactive substance is modelled using the formula $N = 1000e^{-kt}$
Where N is the number of atoms after t years and k is a positive constant.

(a) Write down the number of atoms when the substance started to decay. (1)

Given it takes 14.4 years for half of the substance to decay.

(b) Find the value of k to three significant figures. (4)

(c) Calculate the number of atoms left when $t=30$. (1)

Find the set of values of x for which

$$(x + 5)(x + 1) < 32$$

Solve the inequality

$$x(x + 1) \leq 12$$

$$2(13 + 2x) < (6 + x)(1 - x)$$

The temperature of water in a kettle is modelled using the formula $T = 75e^{-kt} + 22$

Where T is the temperature t minutes after the kettle is turned off and k is a positive constant.

(a) Find the rate of change of the temperature in terms of k (2)

After 5 minutes the temperature of the water is 70°C

(b) Find the value of k (3)

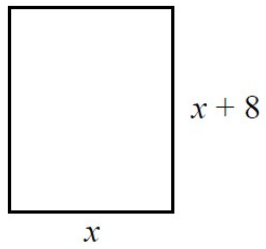
(c) Find how many minutes it takes for the water to cool to 55°C (4)

A quantity N is decreasing such that at time t

$$N = N_0 e^{kt}.$$

Given that at time $t = 10$, $N = 300$ and that at time $t = 20$, $N = 225$, find

- a** the values of the constants N_0 and k ,
- b** the value of t when $N = 150$.



The diagram shows a rectangular birthday card which is x cm wide and $(x + 8)$ cm tall.
Given that the height of the card is to be at least 50% more than its width,

a show that $x \leq 16$.

Given also that the area of the front of the card is to be at least 180 cm^2 ,

b find the set of possible values of x .

Given that $x - y = 8$,

and that $xy \leq 240$,

find the maximum value of $(x + y)$.

A bead is projected vertically upwards in a jar of liquid with a velocity of 13 m s^{-1} . Its velocity, $v \text{ m s}^{-1}$, at time t seconds after projection, is given by

$$v = ce^{-kt} - 2.$$

a Find the value of c . **(2)**

Given that the bead has a velocity of 7 m s^{-1} after 5.1 seconds, find

b the value of k correct to 4 decimal places, **(3)**

c the time taken for its velocity to decrease from 10 m s^{-1} to 4 m s^{-1} . **(5)**

A colony of fast-breeding fish is introduced into a large, newly-built pond. The number of fish in the pond, n , after t weeks is modelled by

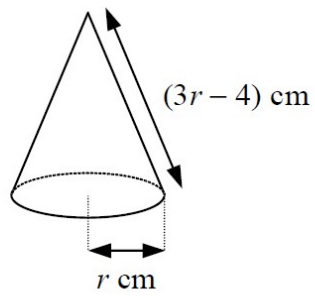
$$n = \frac{18000}{1 + 8c^{-t}}.$$

a Find the initial number of fish in the pond. (2)

Given that there are 3600 fish in the pond after 3 weeks, use this model to

b show that $c = \sqrt[3]{2}$, (3)

c find the time taken for the initial population of fish to double in size, giving your answer to the nearest day. (4)



A party hat is designed in the shape of a right circular cone of base radius r cm and slant height $(3r - 4)$ cm.

Given that the height of the cone must not be more than 24 cm, find the maximum value of r .

Find the set of values of x for which

$$(3x - 1)^2 < 5x - 1.$$