 Establish the simple growth model $\frac{dN}{dt}=kN$

Resources required:

* Projector for the geogebra applet or individual computers for each student.

Setup:

* Open the supporting geogebra resource: geogebra-applet-establish-the-simple-model.GGB
* Model how to use the geogebra applet:
	+ The sliders A and k will change the curve
	+ The slider n will set the y-coordinate of the given point (the quantity or size of the population)
	+ The tick-a-boxes will display the tangent and gradient of the tangent,

$$\frac{dN}{dt}$$

Activity:

This activity will examine the rate of change $\frac{dN}{dt}$, for a given physical quantity (current population size), $N=N(t)$

$\frac{dN}{dt}$ is the instantaneous rate of change in the size of the quantity at the given time t and is equal to the gradient of the tangent at the given point.

1. Decide on which specific curve you wish to examine by setting the values of sliders A and k. Once these are set, do not adjust them unless you decide to repeat the activity from the beginning. Do not set k = 0.
2. Use the slider, N, to complete the first two columns of the table by adjusting the position of the point and using the tick-a-boxes to display the gradient of the tangent at the given point.

| Physical quantity | Rate of change $\frac{dN}{dt}$ | $$\frac{dN}{dt}÷N$$ |
| --- | --- | --- |
| 1 |       |       |
| 2 |       |       |
| 3 |       |       |
| 4 |       |       |
| 5 |       |       |
| 6 |       |       |

1. Get students to complete the third column. Examine these values. What have you discovered? Write the relationship as an equation.
2. Make $\frac{dN}{dt}$the subject of the formula
3. What does this mean?
4. Since the quantities vary directly, if we double the value of N then the rate of change $\frac{dN}{dt}$ should also double. Verify this with reference to your table of values.
5. Given you know that k value, what will be the rate of change $\frac{dN}{dt}$ when N=8? Verify your result with the geogebra applet.

Sample responses for the activity:

1. A=2, k=0.8

| Physical quantity N | Rate of change $\frac{dN}{dt}$ | $$\frac{dN}{dt}÷N$$ |
| --- | --- | --- |
| 1 | 0.8 | $$0.8÷1=0.8$$ |
| 2 | 1.6 | $$1.6÷2=0.8$$ |
| 3 | 2.4 | 0.8 |
| 4 | 3.2 | 0.8 |
| 5 | 4 | 0.8 |
| 6 | 4.8 | 0.8 |

1. Get students to complete the third column. Examine these values. What have you discovered? Write the relationship as an equation.

$\frac{dN}{dt}÷N=k$ and in this case $\frac{dN}{dt}÷N=0.8$

1. Make $\frac{dN}{dt}$ the subject of the formula: $\frac{dN}{dt}=kN$ or with k = 0.8, $\frac{dN}{dt}=0.8N$
2. What does this mean? The rate of change varies directly with the size of the quantity, N, at any given instant.
3. 6. Since the quantities vary directly, if we double the value of N then the rate of change $\frac{dN}{dt}$ should also triple. Verify this with reference to your table of values.

N=2, $\frac{dN}{dt}=1.6$

Tripling N

N=4, $\frac{dN}{dt}=3.2$

$\frac{dN}{dt}$ also doubles in value.

1. 7. Since the quantities vary directly, if we triple the value of N then the rate of change $\frac{dN}{dt}$ should be also triple. Verify this with reference to your table of values.

N=2, $\frac{dN}{dt}=1.6$

Tripling N

N=6, $\frac{dN}{dt}=4.8$

$\frac{dN}{dt}$ also triples in value.

1. Given you know the k value, what will be the rate of change $\frac{dN}{dt}$, when N=8? Verify your result with the geogebra applet.

$$\frac{dN}{dt}=0.8×8=6.4$$

From the graph: m=6.4

