

## 2 Functions

### Activity: Big wheel (Teacher version)

A big wheel (like, for example, the Singapore Flyer) has a diameter of 40 metres and rotates around an axle that is 30 metres above the ground. It takes 3 minutes to complete one full rotation.

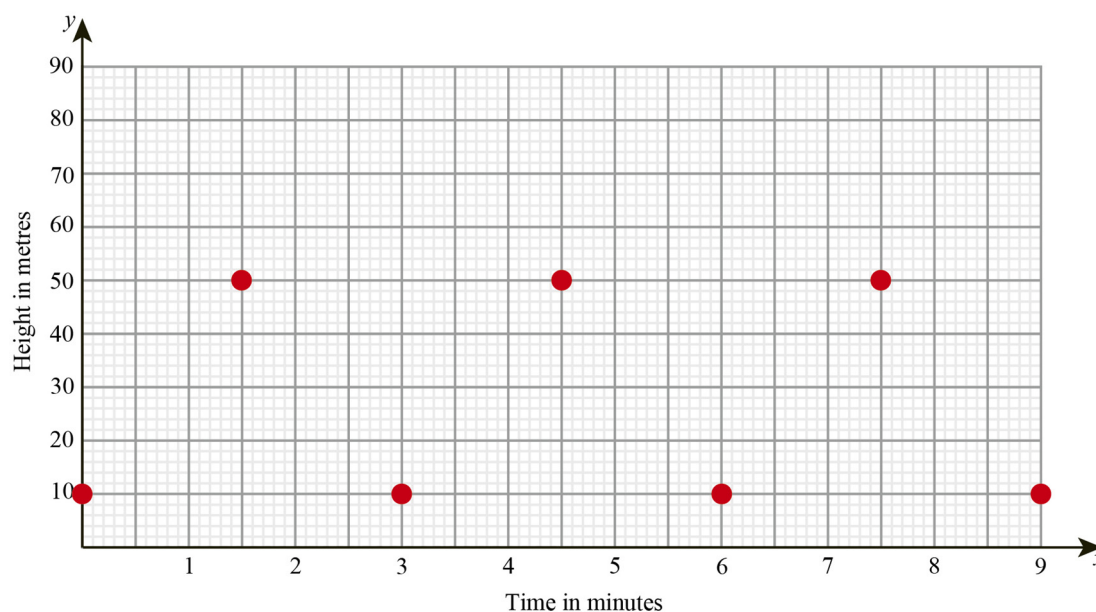
You decide to ride the big wheel and get into one of the cars when it is at its lowest point.



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### Questions

- Using the axes below, sketch a graph to show how your height varies over time.



- Your motion can be modelled using the formula

$$h = a + b \cos ct$$

where  $h$  is the height of the car in metres,  $t$  is the time that has elapsed in minutes and  $a$ ,  $b$  and  $c$  are constants.

Find values for  $a$ ,  $b$  and  $c$  that will effectively model your motion on the big wheel.

$a$  = principal axis (axle height) = 30

$|b|$  = amplitude = 20

$$c = \text{rate of turn in degrees per minute} = \frac{360}{3} = 120$$

$$h = 30 - 20 \cos 120t$$

- 3 Create a cosine function for a big wheel with any diameter, rotational speed and central axle height. Be sure to do the following:

- Fully **explain** your formula (describe what and why). This may require graphs, tables, etc.
- **Define** and describe all variables as needed.
- **Describe** the *realistic* scope and limitations of the variables ( $h, t$ ) and parameters ( $a, b, c$ ) – in other words, **describe** real-world limitations on your model variables and parameters and how these would affect your model – what would the real-life model look like?
- Be clear, concise and complete.

$$h = a + b \cos ct$$

where

$a$  = axle height

$b$  = radius

$$c = \text{rate of turn in degrees per minute} = \frac{360}{\text{time in minutes for one rotation}}$$

#### 4 Optional extension question

Huw is on the original big wheel from Question 1. He becomes scared and starts screaming when he is 45 metres or more above the ground.

- When will Huw first start screaming?
- How long will he scream for in one rotation?

Students should explore the use of horizontal lines on the graph to identify the solutions to the equation:  $45 = 30 - 20 \cos 120t$

This will give the answers:

- after 1.16 minutes
- 0.69 minutes  $\approx$  41 seconds