



## student activity



### Mathematics B Education Program

Name: \_\_\_\_\_

Teacher: \_\_\_\_\_

School: \_\_\_\_\_

Ever wondered why some riders take longer to get sucked into The Rip than others? Here's your chance to find out why! In this activity you'll investigate the effect of the mass of the riders on the time that they spend in The Rip. You'll discover just how much difference it makes.

This Mathematical modelling activity is similar in structure to that of The Green Room, but here the data-gathering process is simpler and the distinct data associated with each will ensure that the solutions and analysis involved are unique.

### Syllabus Links

#### Modelling and problem solving

The objectives of this category involve the uses of mathematics in which the students will model mathematical situations and constructs, solve problems and investigate situations mathematically within the contexts of Application, Technology, Initiative and Complexity.

By the conclusion of the course, students should be able to demonstrate the category of modelling and problem solving through:

- understanding that a mathematical model is a mathematical representation of a situation
- identifying the assumptions and variables of a simple mathematical model of a situation
- forming a mathematical model of a life-related situation
- deriving results from consideration of the mathematical model chosen for a particular situation
- interpreting results from the mathematical model in terms of the given situation
- exploring the strengths and limitations of a mathematical model.

### Equipment

Student activity sheets, pens/pencils, graphics calculators, stopwatches

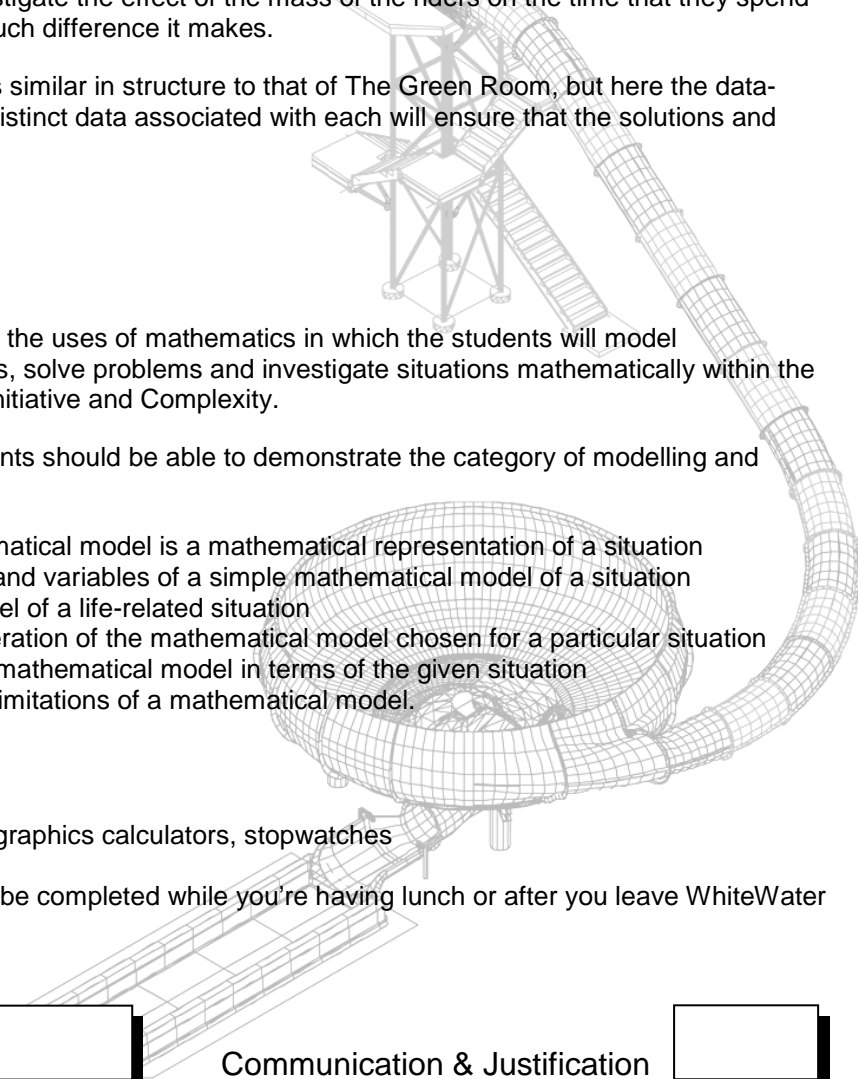


Activities with this symbol may be completed while you're having lunch or after you leave WhiteWater World.

### Standard Achieved

Modelling & Problem Solving

Communication & Justification



## Mathematical modelling

Mathematical modelling is the process of using mathematics to help to understand a situation. Four steps are involved:

1. Identify the situation
2. Simplify the situation
3. Build the model
4. Evaluate and revise the model

### Set up the Mathematical Model

Identifying the situation (Step 1) means posing a well-defined question to indicate exactly what you are investigating. In this activity your goal is to develop a mathematical model for the time that a raft spends in The Rip. We first need to define the question more specifically by simplifying the situation (Step 2).

#### Question 1

To simplify the situation, first determine the assumptions on which your model will rest. Make a list of the variables that might affect the time that a raft spends in The Rip. List as many as you can think of.

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
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To model a situation mathematically, we need to simplify it by choosing to ignore some of the key features and relationships. We'll keep the model as simple as possible to start with, and we can always add complexities later if necessary. In this activity, we will consider only the variable of the effect of the mass of the riders on the time that the raft spends in The Rip.

Building the model (Step 3) is the most important part of the process.

#### Question 2

Assign variables to the two quantities that you will measure in this model. If you do not have a means for measuring or asking the mass of the riders on multiple rafts, you may choose to simply use the number of riders per raft instead of the total mass of the riders.

First variable:      Name of quantity: \_\_\_\_\_      Symbol: \_\_\_\_\_      Units: \_\_\_\_\_

Second variable:      Name of quantity: \_\_\_\_\_      Symbol: \_\_\_\_\_      Units: \_\_\_\_\_

**Question 3**

Describe what you predict to be the effect of the mass of the riders on the time spent by the rafts in The Rip. To stay in for the longest, should you ride with your heaviest friends?

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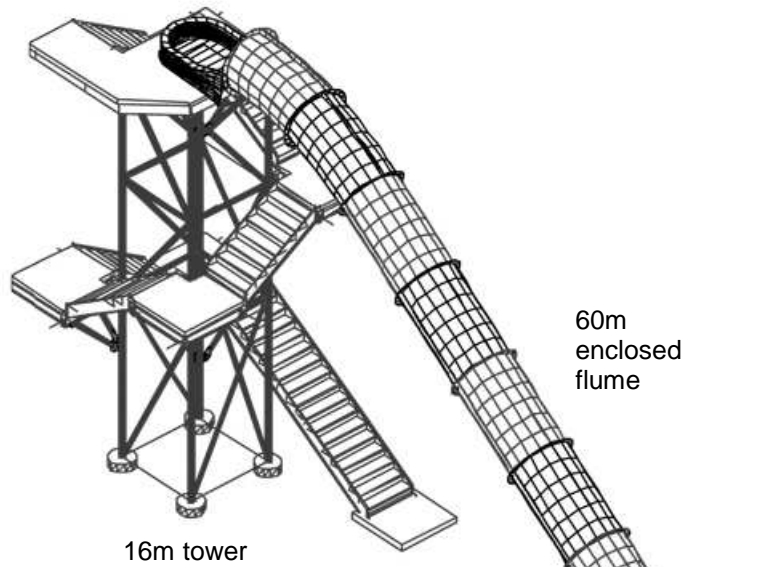
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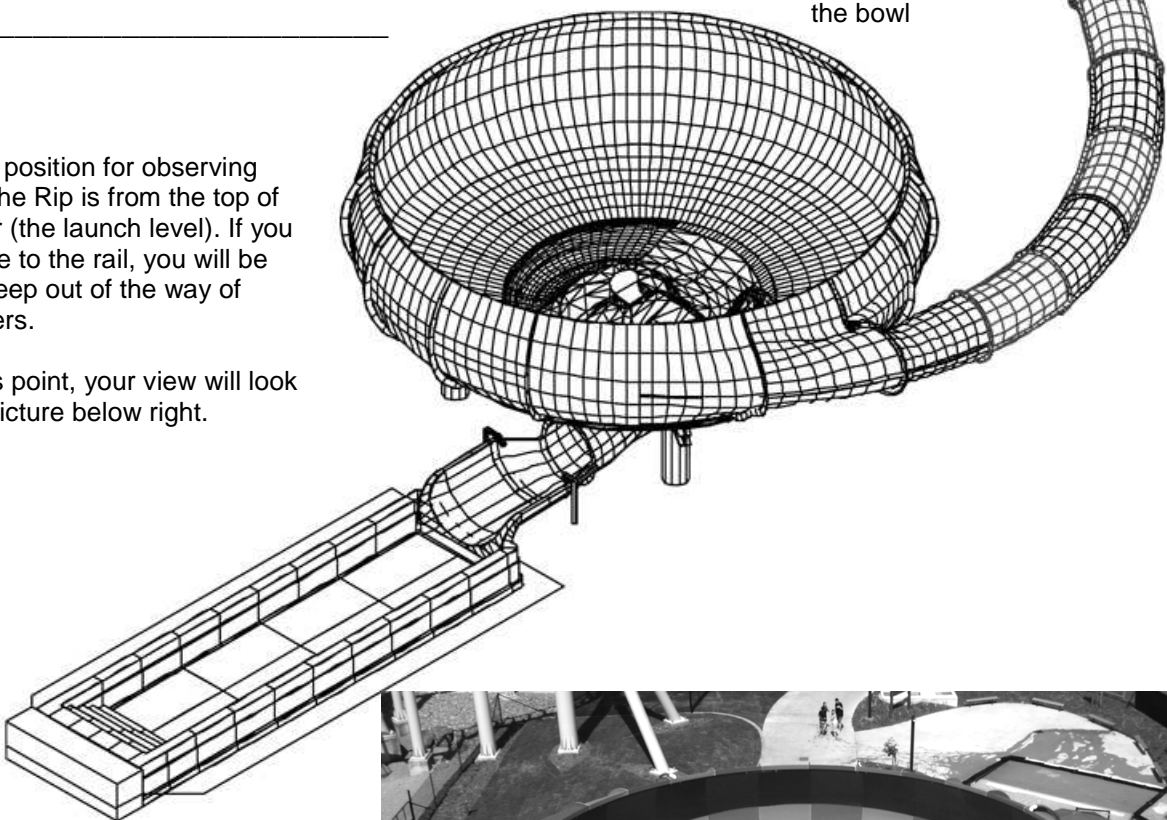
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The top of the tower is 19m above the bowl

The best position for observing rafts in The Rip is from the top of the tower (the launch level). If you stay close to the rail, you will be able to keep out of the way of other riders.

From this point, your view will look like the picture below right.



**Measure Times that the Rafts spend in The Rip**

From your observation point (see previous page), it's time to make your measurements. Allow at least 30 minutes for this.

**Tip:** You will see the water stream from the flume into the bowl lose pressure a moment before the raft appears. This will help you to start the stopwatch at exactly the right moment.

**Question 4**

For each raft, record the total combined mass of the riders in kilograms as **Variable 1**. If you don't have a means for measuring this (or if they're not comfortable to tell you!), instead record the number of riders per raft (2, 3 or 4) as your variable. If you choose this method, note whether they are kid (k), youth (y) or adult (a) size riders. Also record the number of full revolutions of the bowl that each raft completes.

Use a stopwatch to time how long each raft spends in The Rip. Start timing the instant you see the raft appear in The Rip and stop it when it reaches the purple section in the exit tube. You should be able to accurately record times to the nearest 0.01s. Record your data in the table below for 50 rafts.

	<b>Variable 1</b>	<b>Time spent in The Rip</b>		<b>Variable 1</b>	<b>Time spent in The Rip</b>
Raft 1	_____	_____ s	Raft 26	_____	_____ s
Raft 2	_____	_____ s	Raft 27	_____	_____ s
Raft 3	_____	_____ s	Raft 28	_____	_____ s
Raft 4	_____	_____ s	Raft 29	_____	_____ s
Raft 5	_____	_____ s	Raft 30	_____	_____ s
Raft 6	_____	_____ s	Raft 31	_____	_____ s
Raft 7	_____	_____ s	Raft 32	_____	_____ s
Raft 8	_____	_____ s	Raft 33	_____	_____ s
Raft 9	_____	_____ s	Raft 34	_____	_____ s
Raft 10	_____	_____ s	Raft 35	_____	_____ s
Raft 11	_____	_____ s	Raft 36	_____	_____ s
Raft 12	_____	_____ s	Raft 37	_____	_____ s
Raft 13	_____	_____ s	Raft 38	_____	_____ s
Raft 14	_____	_____ s	Raft 39	_____	_____ s
Raft 15	_____	_____ s	Raft 40	_____	_____ s
Raft 16	_____	_____ s	Raft 41	_____	_____ s
Raft 17	_____	_____ s	Raft 42	_____	_____ s
Raft 18	_____	_____ s	Raft 43	_____	_____ s
Raft 19	_____	_____ s	Raft 44	_____	_____ s
Raft 20	_____	_____ s	Raft 45	_____	_____ s
Raft 21	_____	_____ s	Raft 46	_____	_____ s
Raft 22	_____	_____ s	Raft 47	_____	_____ s
Raft 23	_____	_____ s	Raft 48	_____	_____ s
Raft 24	_____	_____ s	Raft 49	_____	_____ s
Raft 25	_____	_____ s	Raft 50	_____	_____ s

**Determine the Mathematical Relationship between the Variables**

 **Question 5**

Use the data you have gathered to develop a mathematical relationship between the combined mass of the riders (or number of riders) and the time spent by the raft in The Rip.

Using statistics mode in your graphics calculator, enter your data into a table, plot a scatter graph and calculate the line of best fit. If you are using masses rather than number of riders you may need to experiment with polynomial, logarithmic, exponential or power functions to obtain the best fit.

Equation of line of best fit: \_\_\_\_\_

$r^2$  value for line of best fit: \_\_\_\_\_

 **Question 6**

If you have used the mass of the riders as your variable, use your equation to determine the time that the raft should spend in The Rip for riders with a total mass of:

a. 50kg \_\_\_\_\_ s

b. 450kg \_\_\_\_\_ s

If you have used the number of riders as your variable, use your equation to determine the time that the raft should spend in The Rip for:

a. 1 rider \_\_\_\_\_ s

b. 5 riders \_\_\_\_\_ s

**Evaluate the Model**

The fourth and final stage of the mathematical modelling process involves evaluating and revising the model.

 **Question 7**

Write a detailed discussion to evaluate the mathematical model, with reference to:

- The original question and the assumptions made.
- Your prediction in Question 3.
- The reliability of your results and whether or not they make sense.
- The meaning of the  $r^2$  value for your line of best fit.

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