



student activity



Mathematics B Education Program

Name: _____

Teacher: _____

School: _____

Everyone wants to go as high as possible into the upper hemisphere of The Green Room, but there's only one thing you can do that will make any difference: choose your co-riders carefully! In this activity you will investigate the effect of the mass of the riders on the height that the raft achieves in The Green Room. What you discover might come as quite a surprise!

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, clinometers, pens/pencils, graphics calculators



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 height that a raft achieves in The Green Room. 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 height that a raft achieves in The Green Room. List as many as you can think of.

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

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 height that the raft achieves.

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: _____

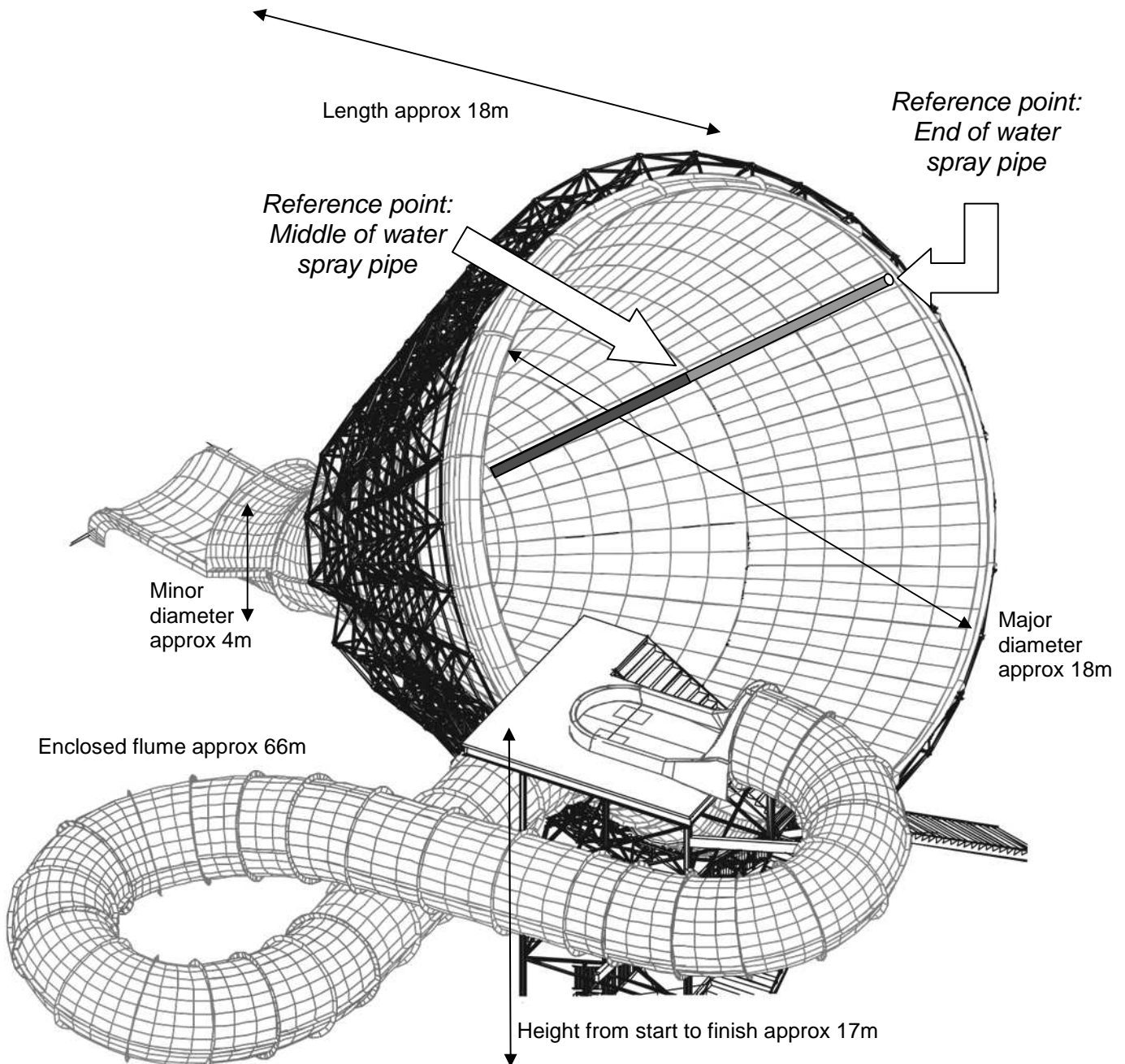
Question 3

Describe what you predict to be the effect of the mass of the riders on the height achieved by the rafts in The Green Room. To go the highest, should you ride with your heaviest friends?

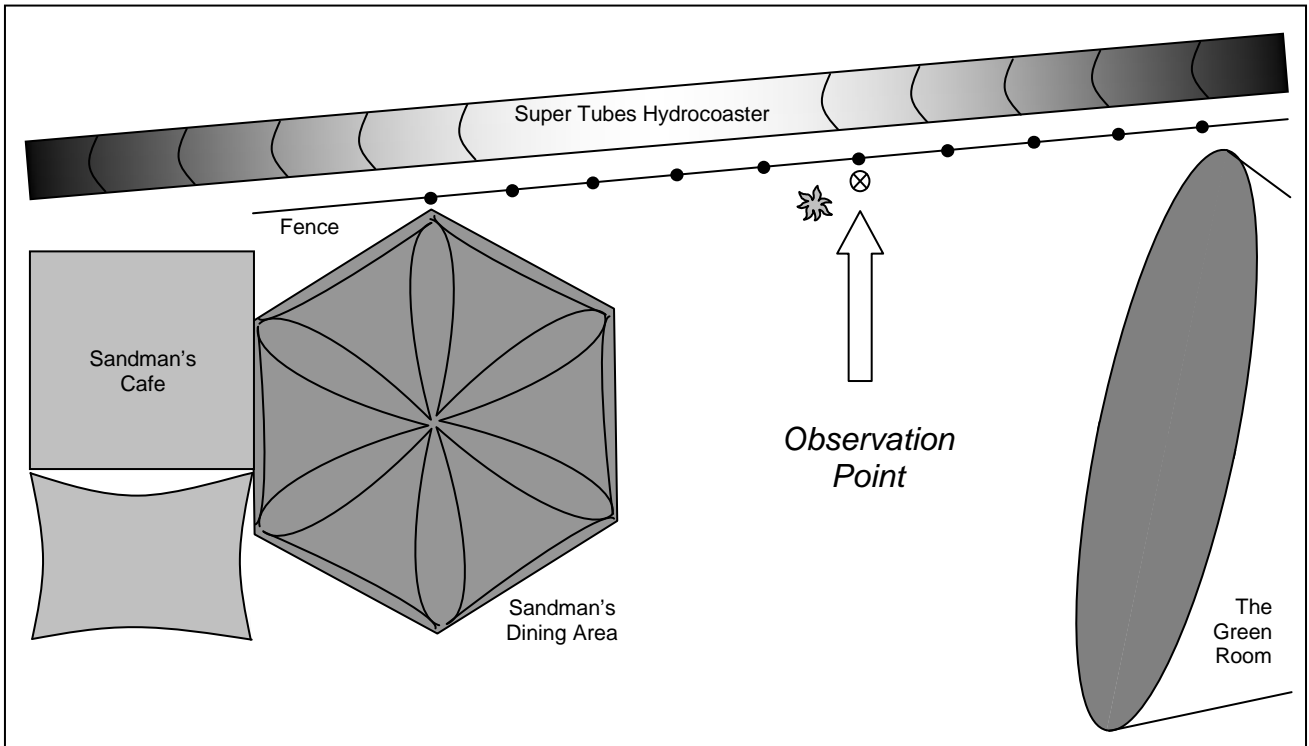
Create a grid for estimating heights

This model is based around your ability to accurately determine the height that a raft reaches in the upper hemisphere of The Green Room. However, you can't exactly scale the side of the structure, ruler in hand, to make your measurements! You'll need to be a little more clever than that. You need some precise reference points against which to make accurate estimates.

WhiteWater World engineers have provided the dimensions of The Green Room, as shown in the diagram below, but these are only approximate. We need to be more precise. The end of the water spray pipe inside The Green Room provides a good reference point.



To determine the height of the end of the water spray pipe above ground level, go to Sandman's Snack Shack & T-Bar and locate the fence near the Super Tubes Hydrocoaster, as shown in the diagram. Find the **sixth fence post** from Sandman's (the first one past the palm tree), as shown below.



From this point, you should be able to make out the top of the water spray pipe in The Green Room as well as the point along it where it changes to a darker green colour (see diagram on previous page).

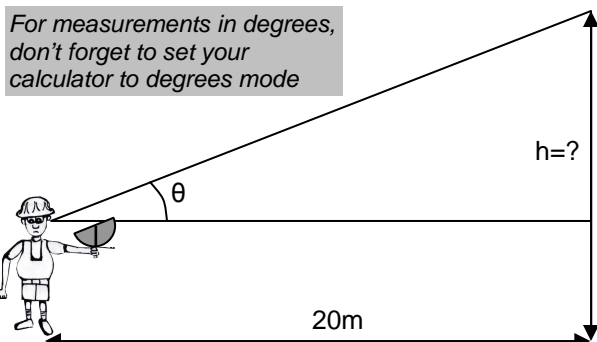
Question 4

Using a clinometer, measure the altitude (angle of elevation) to the top of the water spray pipe. Repeat your measurement three times and take an average.

	Altitude to top of pipe
Trial 1	_____ °
Trial 2	_____ °
Trial 3	_____ °
Average	_____ °

Question 5

From your observation point, the horizontal distance to the top of the water spray pipe is approximately 20m. Take your position as ground level. Using your skills in trigonometry, calculate the height of the top of the water spray pipe above ground level. Don't forget to add your height (to eye level).



Working space

Height of top of water spray pipe = _____ m

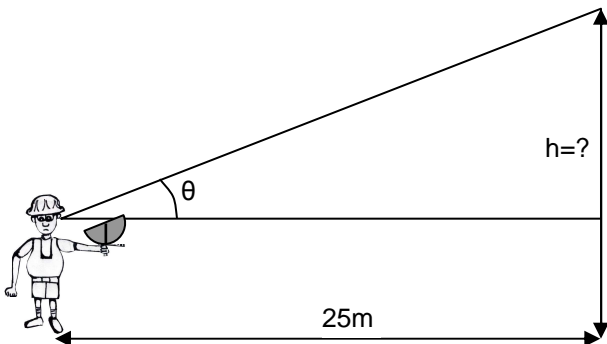
Question 6

Repeat these procedures to find the altitude of the point part way along the spray pipe where it changes in colour to a darker green.

	Altitude to top of pipe
Trial 1	_____ °
Trial 2	_____ °
Trial 3	_____ °
Average	_____ °

Question 7

From where you are standing, the horizontal distance to the point where the water spray pipe changes colour is approximately 25m. Calculate the height of this point above ground level.



Working space

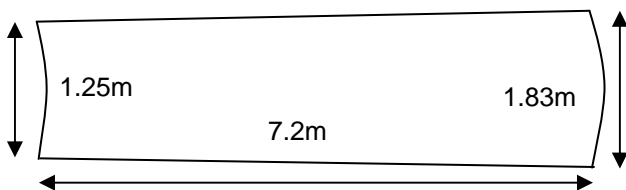
Height of middle of water spray pipe = _____ m

Now that you have determined the height of your reference points in The Green Room, you need to identify other points so as to make your estimates more accurate.

To get a good view of the heights that the rafts achieve in The Green Room, walk around to the base of the stairs to The Green Room (near the sign). Make sure you stay out of the way of people accessing the stairs.

From this point, you should be able to make out the panels that make up the sides of the green room. You should be able to count 7 or 8 of them on the inside wall of The Green Room below the water pipe. Your view should look like the picture to the right.

Each of the panels that you can see is 7.2m in length, with a width of 1.83m at the mouth and 1.25m where it meets the darker green panels.



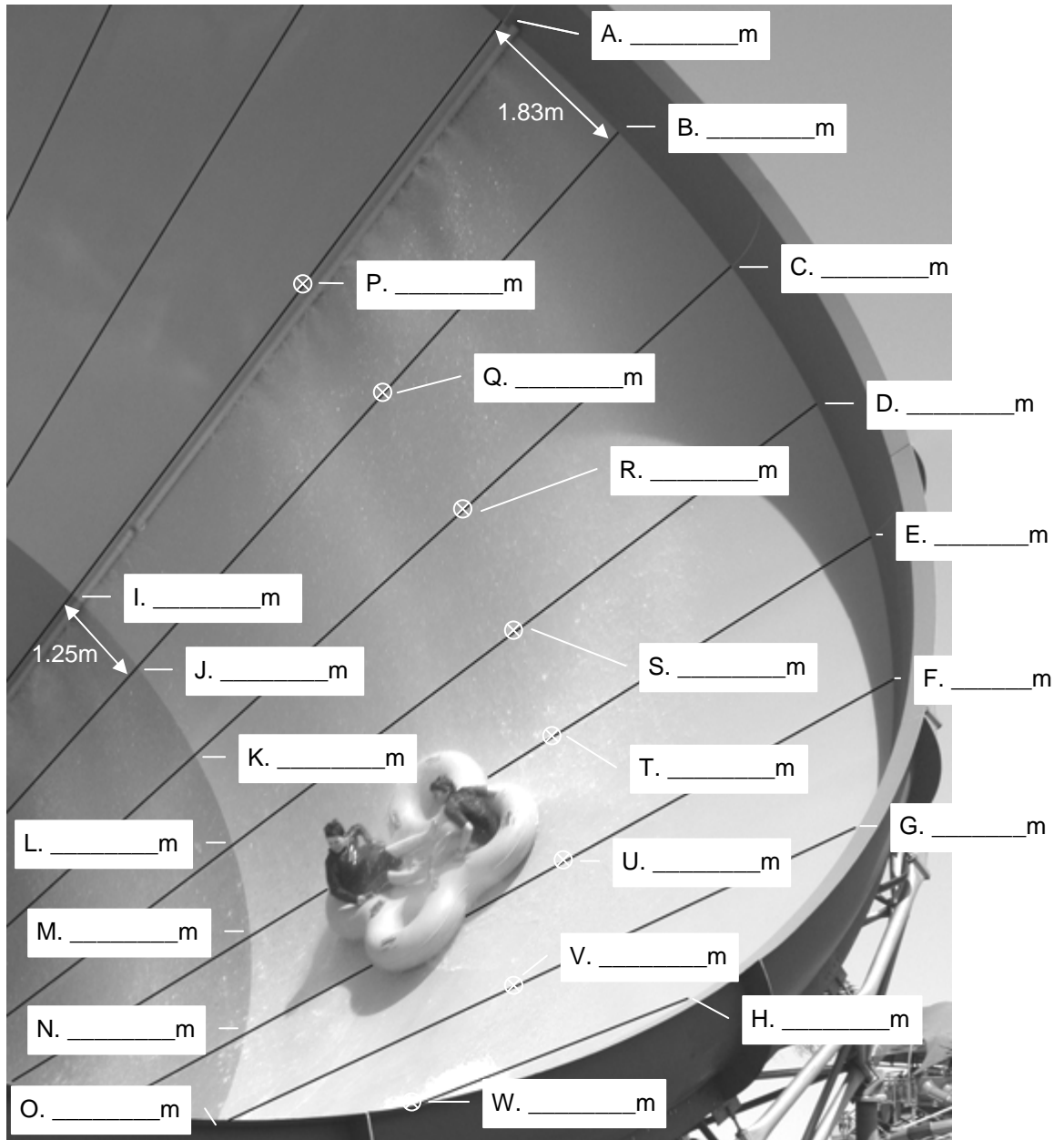
Question 8

Use the diagram on the right to build up a grid of reference heights against which to estimate the heights that the rafts achieve.

First fill in Point A from your answer to Question 5 above. Then complete points B through H using the fact that each panel is 1.83m wide. For simplicity, assume that each point lies directly below the previous one.

Then complete Point I from your answer to Question 7 above, and fill in Points J through O accordingly.

Points P through W lie midway along each line and their heights can be determined by averaging the heights of their endpoints. For instance, the height of P is half way between the heights of A and I.



Measure Heights Achieved by the Rafts

Now that you have a grid of heights against which to estimate the heights that the rafts achieve, it is time to make your measurements. The best position from which to do so is right where you are, at the base of the stairs to The Green Room.

Question 9

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. It will be useful to have a friend with you to note k, y and a for each raft while you note heights.

To estimate the height, put a dot on the diagram above to indicate the highest height reached by the uppermost point of the raft. Then later, or while you are waiting for the next raft, use the nearest reference points to estimate the height as accurately as possible. You should be able to accurately estimate it to the nearest 0.1m. Record your data in the table below for 50 rafts.

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

Determine the Mathematical Relationship between the Variables

 **Question 10**

Use the data you have gathered to develop a mathematical relationship between the combined mass of the riders (or number of riders) and the height reached by the raft in The Green Room.

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 11**

If you have used the mass of the riders as your variable, use your equation to determine the height that the raft should reach for riders with a total mass of:

a. 50kg _____ m

b. 450kg _____ m

If you have used the number of riders as your variable, use your equation to determine the height that the raft should reach for:

a. 1 rider _____ m

b. 5 riders _____ m

Evaluate the Model

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

 **Question 12**

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.
