Physics Education Program

Teacher Overview

an introduction to Dreamworld's Physics Education Program

Amusement parks offer some of the most thrilling examples of real physics in action!

Centripetal forces fling riders high into the sky, gravity pulls them into freefall trajectories and simple harmonic motion throws them back and forth. The wonders of electricity and magnetism power the whole process, while friction and inertia work to resist their every movement. The result is a dizzying, adrenaline-pumping, stomach-losing experience like nothing else on the planet!

The Queensland Senior Physics syllabus, with its emphasis on "in-context" learning, takes Amusement Park Physics from an interesting add-on in Physics courses of the past to an integral context. There has never been a better time for Physics classes to take full advantage of the dynamic and exciting opportunities offered by Dreamworld.

This program has been fully revised, updated and extended in 2009 in line with the 2007 Queensland Senior Physics Syllabus

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Student Worksheets

Provided separately as loose sheets

1. The Claw Student Activity
2. The Cyclone Student Activity
3. The Giant Drop Student Activity
4. Horizontal Accelerometer Student Activity
5. The Reef Diver Student Activity
6. The Tower of Terror Student Activity
7. Triangulation Device Student Activity
8. Vertical Accelerometer Student Activity
9. The Vortex Student Activity
10. Mick Doohan's Motocoaster Student Activity

Teacher Guides

Provided separately as loose sheets

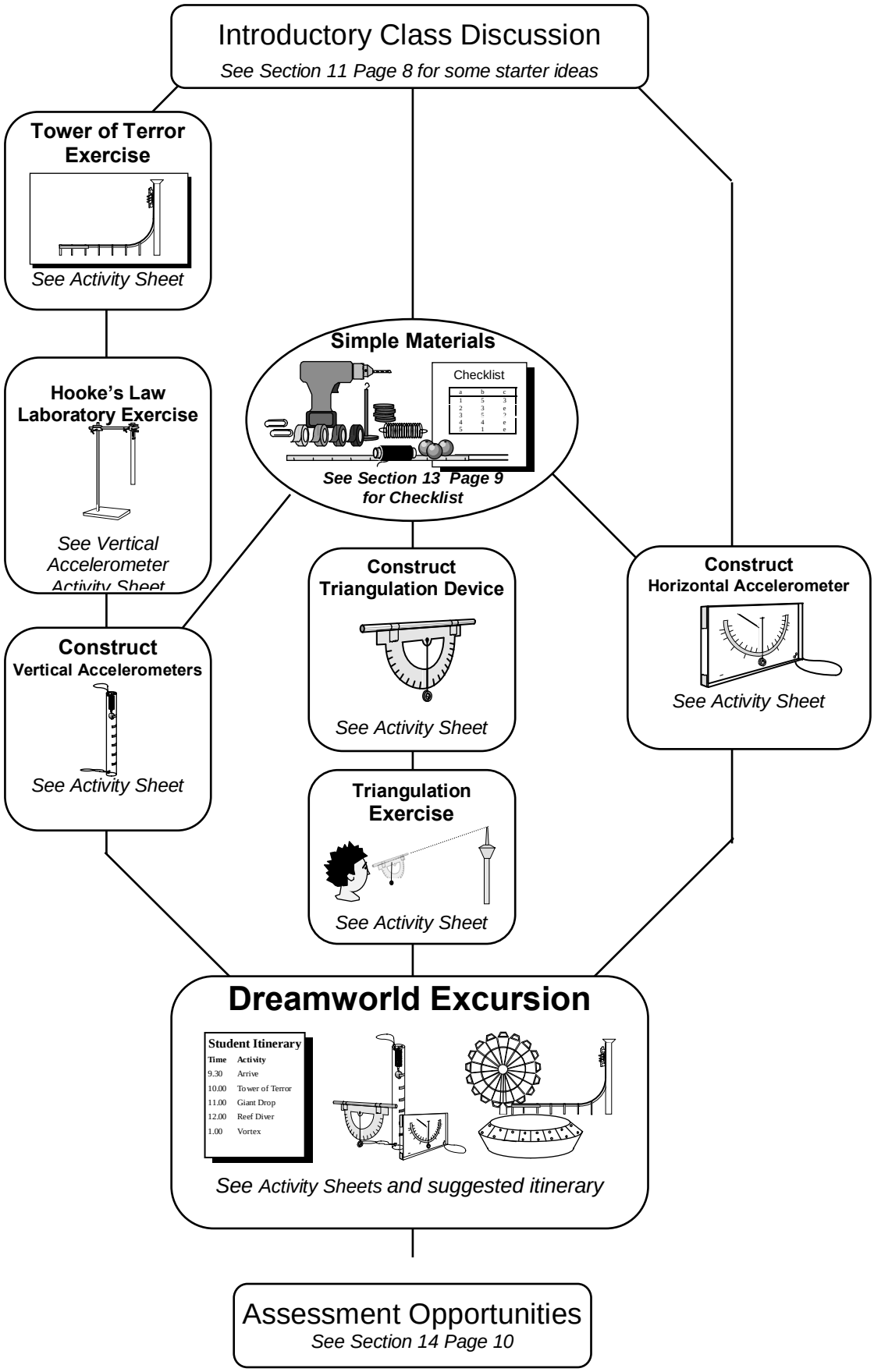
1. The Claw Teacher Guide
2. The Cyclone Teacher Guide
3. The Giant Drop Teacher Guide
4. Horizontal Accelerometer Teacher Guide
5. The Reef Diver Teacher Guide
6. The Tower of Terror Teacher Guide
7. Triangulation Device Teacher Guide
8. Vertical Accelerometer Teacher Guide
9. The Vortex Teacher Guide
10. Mick Doohan's Motocoaster Teacher Guide

Other Documentation

Provided separately as loose sheets

1. Formulae and Constants
2. Ride Specifications

1. Activities Overview



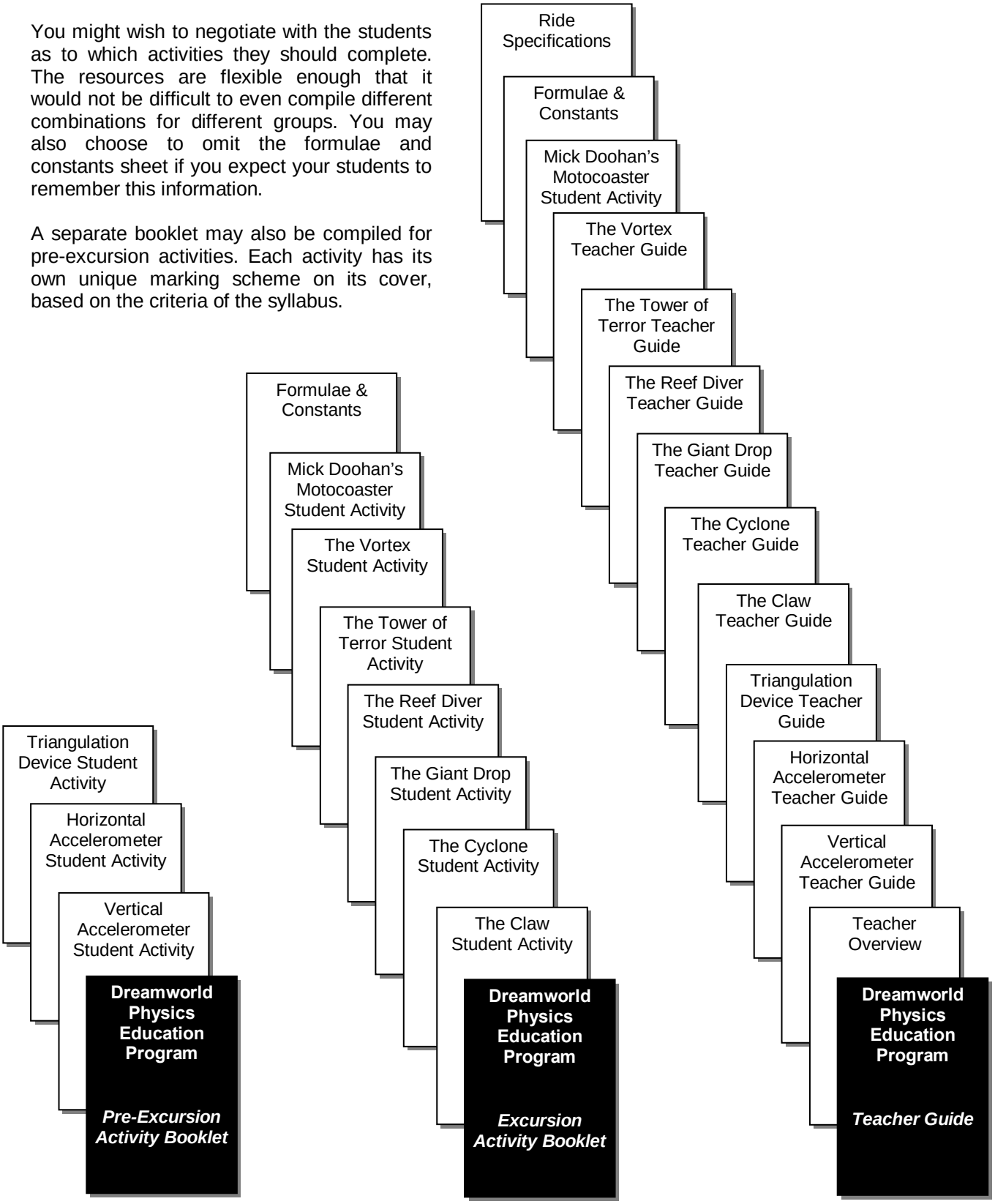
2. Compiling Student and Teacher Booklets

Dreamworld's Physics Education Program has been designed for optimum flexibility, allowing you as the teacher to customise the activities for your students. For this reason, all student activities are provided in a downloadable format to allow you to add or remove questions according to the needs of your program.

Student activity sheets for each ride are provided separately, to enable you to create your own student activity booklet containing only the activities which your students are to complete. It's as simple as printing the required activities, running them through a photocopier and stapling them into booklets.

You might wish to negotiate with the students as to which activities they should complete. The resources are flexible enough that it would not be difficult to even compile different combinations for different groups. You may also choose to omit the formulae and constants sheet if you expect your students to remember this information.

A separate booklet may also be compiled for pre-excursion activities. Each activity has its own unique marking scheme on its cover, based on the criteria of the syllabus.



3. Key Concepts and Key Ideas Tracking (2007 Syllabus)

Organiser →	**Forces**				**Energy**			**Motion**		
Key Concept →	**F1**	**F2**	**F3**	**F4**	**E1**	**E2**	**E3**	**M1**	**M2**	**M3**
Activity↓										
The Claw					E1.2 E1.3	E2.1 E2.2 E2.5	E3.4	M1.3	M2.3	
The Cyclone					E1.2 E1.3	E2.1 E2.2 E2.5	E3.4	M1.3	M2.3 M2.4	
The Giant Drop								M1.2 M1.3 M1.4	M2.5	
Horizontal Accelerometer	F1.1	F2.4	F3.1					M1.2 M1.3		
The Reef Diver	F1.3							M1.2 M1.3	M2.1	
The Tower of Terror	F1.3				E1.2 E1.3	E2.1 E2.2 E2.5	E3.4	M1.3 M1.4	M2.3	
Triangulation Device								M1.3		
Vertical Accelerometer	F1.1	F2.4	F3.1					M1.3 M1.4	M2.1	
The Vortex								M1.3	M2.1	
Mick Doohan's Motocoaster	F1.3 F1.4	F2.1 F2.4	F3.1					M1.1 M1.3	M2.1 M2.2	

4. Topics covered by each activity

The Claw Acceleration, Centripetal acceleration, Circular motion, Conservation of energy, Free fall, Gravitational potential energy, Gravity, Kinetic energy, Pendulum, Period, Simple harmonic motion, Velocity

The Cyclone Acceleration, Circular motion, Centripetal acceleration, Conservation of energy, Gravitational potential energy, Gravity, Kinetic energy, Velocity

The Giant Drop Acceleration, Equations of motion, Free fall, Graphing, Gravity, Terminal Velocity, Velocity

Horizontal Accelerometer Acceleration, Gravity, Resolving vectors

The Reef Diver Acceleration, Centripetal acceleration, Force, Graphing, Gravity, Period, Vectors

The Tower of Terror Acceleration, Centripetal Acceleration, Conservation of energy, Forces, Free fall, Kinetic energy, Potential energy, Velocity

Triangulation Device Mathematical background and trigonometry

Vertical Accelerometer Acceleration, Accelerometer, Force, Graphing, Gravity, Hooke's Law, Mass, Spring constant, Weight

The Vortex Acceleration, Centripetal Acceleration, Circular motion, Period, Velocity

Mick Doohan's Motocoaster Circular motion, Centripetal acceleration, Centripetal force, Free-body diagrams, banking, Resolution of vectors, Inclined plane problems

5. Recommended Number of Activities

How many activities can you expect your students to realistically complete in a day at Dreamworld? Take these considerations into account:

- Fewer activities completed well give a better indication of student ability than a larger number of rushed activities.
- Student ability and experience in measuring and recording data, and in their understanding of the concepts encountered will dramatically affect the amount of time it takes them to complete a task.
- Acceleration readings take some time to gather and will often need to be repeated. Returning to a laptop in a central location to upload accelerometer data is time-consuming.
- Allow time for students to enjoy the rides and encourage them to take note of the sensations of force and acceleration which they experience.
- **It is suggested that students complete the activities associated with two, three or four rides per day at Dreamworld.**

6. Preparing for the Excursion

Before planning your excursion, it is recommended that you take some time to study the student activity sheets. You may wish your students to undertake the pre-visit activities in class time, or set some of these activities for homework prior to the excursion. We recommend that you prepare an itinerary of activities to be completed as a student booklet. Visitor numbers in the park vary and affect the waiting time in queues. For this reason, we discourage the setting of time limits on each activity within the park. By prioritising the activities, you will maximise the students' experiences without introducing a fear of failing to complete the tasks.

Pre-Visit Activities

For a broad overview of the learning experiences offered in this book, see page 4.

1. Class discussions and practise problems	*See page 7 (Pre-visit class discussion suggestions)*
2. Hooke's Law Laboratory Exercise	*See Vertical Accelerometer Student Activity*
4. Construct the vertical accelerometer	*See Vertical Accelerometer Student Activity*
5. Construct the horizontal accelerometer	*See Horizontal Accelerometer Student Activity*
6. Construct the triangulation device	*See Triangulation Device Student Activity*
7. Practice triangulation measurements	*See Triangulation Device Student Activity*

Activities at Dreamworld

1. The Claw Student Activity	*See Student Activity Sheets and Teacher Guides*
2. The Cyclone Student Activity	*See Student Activity Sheets and Teacher Guides*
3. The Giant Drop Student Activity	*See Student Activity Sheets and Teacher Guides*
4. The Reef Diver Student Activity	*See Student Activity Sheets and Teacher Guides*
5. The Tower of Terror Student Activity	*See Student Activity Sheets and Teacher Guides*
6. The Vortex Student Activity	*See Student Activity Sheets and Teacher Guides*
7. Mick Doohan's Motocoaster	*See Student Activity Sheets and Teacher Guides*

Post-Visit Activities

1. Assess students' work	*See Teacher Guides for marking schemes*
2. Complete unfinished questions on worksheets	
3. Assessment opportunities	*See section 14, page 10*

7. Learning Goals and Objectives

Concepts and Process Skills

Triangulation

Students will construct and use a simple triangulation device and exploit the triangulation method to determine the height of rides and structures at Dreamworld using the equation

$$H = D \tan \theta$$

Kinematics

Students will become familiar with and use the equations contained on the *Formulae and Constants* sheet and apply them to free falling and linearly accelerated rides

Students measure heights, accelerations and the duration of accelerations and apply them to finding unknown quantities by substituting and rearranging equations

Rotational Mechanics

Students will become familiar with and use the equations contained on the *Formulae and Constants* sheet and apply them to rotating rides.

8. Positive Attitudes

At Dreamworld, students safely encounter large and exhilarating accelerations, making the learning of kinematics and rotational mechanics an exciting experience. This also affords them the valuable opportunity of feeling the effects of large forces and accelerations on their bodies. Experiencing is an important step toward understanding.

Students' experiences, measurements, and observations are combined and applied with mathematical formulae demonstrating the applied and fundamental nature of physics.

Students work in small groups and cooperate to complete tasks in a unique and exciting experience.

9. Tips for a successful day

In order to enjoy a successful day, the following instructions must be adhered to:

- Stopwatches are not permitted on any ride. When arranging student groups, ensure that at least one student has a wristwatch with a stopwatch function.
- Notify the Dreamworld Education staff of your impending visit. If you have not made it clear to Dreamworld Education staff that you will be using accelerometers on the rides there will be no prior notification and authorization to the ride attendants and your students will be refused entry to the ride.
- It is preferable that a teacher accompany the students onto the rides so as to notify the ride attendants that the students will be using accelerometers.
- If there are any problems during your day please ask a ride attendant to notify the Dreamworld Education Executive so that the problem can be resolved quickly.

10. Safety precautions at the park

In order to maintain our high health and safety standards, we ask that you follow some simple guidelines when constructing the accelerometers. By ensuring all moving parts are enclosed and that accelerometers are securely sealed, the safety of your students and other visitors is maintained. Strong elastic straps need to be secured to the accelerometers to prevent loss of the device while riding. A brief safety inspection of the accelerometers will be conducted upon your arrival at Dreamworld. Accelerometers will receive an approval sticker to inform our ride attendants that the safety inspection has been conducted. It is important that teachers accompany students onto the rides so as to notify the ride attendants that the students will be using accelerometers. Accelerometers which could pose a hazard may be rejected, but this is easily avoided by ensuring that the safety precautions described in the instructions are adhered to.

11. Pre-Visit Class Discussion Suggestions

1. A good discussion starter is to ask students to draw a concept map of the rides and physics within a typical theme park (you may wish to provide students with a map of Dreamworld to assist in drawing out the responses).

2. To begin a review of kinematics and dynamics, provide students with the *Tower of Terror ride information brochure* and the first page of *The Tower of Terror Student Activity*. Ask the students to determine where riders would most likely experience the 4.5 **g** acceleration. Once they have discovered that the 4.5 **g** is a centripetal acceleration experienced in the curved part of the track, they can determine the linear acceleration of the car using the information in the brochure.

3. Prompt students to suggest methods they might use to measure the linear and centripetal acceleration of the Tower of Terror car, both as a rider and as an observer. Ask them if there is a method with which they can directly measure linear velocity. If necessary, lead the discussion to include the use of accelerometers and their theory of operation.

4. Provide students with a map of Dreamworld and have them continue proposing activities for their excursion and the measurements they might make. You may wish to have students produce concept maps in small groups to allow for free discussions which can be reported back to the class on the white-board to construct a class concept map of ideas for the excursion.

5. Model rides with simple constructions using an old record player or children's toys to investigate principles of operation. Students can be prompted further to suggest potential activities for their excursion to Dreamworld.

6. Practice measurements of the heights of structures can be made within the school grounds using the triangulation method outlined in the *Triangulation Device Student Activity*. Familiarity with the worksheets and calculations prior to the day of the excursion will maximise the students' time for riding the attractions while at Dreamworld.

7. If possible, plan the itinerary with your students. Provide a map of Dreamworld to assist in the planning and prioritise the activities to allow for queue times. Allow students to suggest activities and ground-rules for the excursion so that the sense of ownership of the learning experience is maintained. Times and places to meet throughout the day can be discussed at this time, and recorded for inclusion on your itinerary as well as guidelines in the event of illness.

8. Allow students to study the worksheets and discuss any queries prior to the excursion.

12. Acceleration measurement techniques

Detailed student activity sheets are provided to guide in the construction and operation of both vertical and horizontal accelerometers. However, these are intended as a last resort when electronic accelerometers and data loggers are not available.

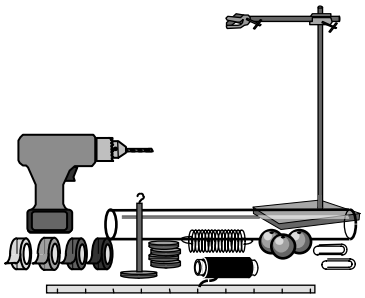
There are a number of advantages of using data loggers:

1. Electronic accelerometers afford the measurement of rapid spikes in acceleration, such as the 4.5G deceleration of *The Giant Drop*, which hand-made accelerometers are not able to register.
2. Electronic accelerometers enable accurate acceleration readings to be obtained throughout the ride.
3. Electronic accelerometers may be used on *The Giant Drop,* while hand-made accelerometers are not permitted on this ride.
4. The use of electronic accelerometers affords students the opportunity to demonstrate the scientific technique of "applying technology to gather and record valid data and information with discrimination", as mandated in the physics syllabus.

For information on loaning sets of accelerometers and the training associated with their use, please contact Dreamworld's Education Executive on telephone 07 5588 1184 or email education@dreamworld.com.au.

13. Checklist of Materials Required

This list covers all the equipment you will require for the pre-visit activities and construction of accelerometers and triangulation devices. In addition to these, students will require wristwatches with stopwatch function, writing implements and calculators on the day of the excursion. It is advised that students carry these materials in a strong, labelled bag at Dreamworld.



Vertical Accelerometer Construction

	Item	*Suggested Supplier*	*Quantity per Accelerometer*
o	Clear plastic tubes (about 40 cm long)	*Hardware stores*	1
o	Sinkers	*Fishing Tackle Shop*	1[2]
o	Small springs[1]	*Maintenance Engineering Suppliers or Auto parts suppliers*	1
o	Braided elastic *for wrist and elbow strap*	*Haberdashery/Craft shop*	approx. 30 cm
o	Electrical tape [2] (or permanent marker pens)	*Hardware store/Auto parts suppliers* (different colours)	5 rolls
o	Paper clips	*Stationary supplier*	2
o	Braided elastic[3]	*Haberdashery/Craft shop*	approx. 10cm

[1] You will need very low tension 'extension' springs approximately 50 mm in length and 15 - 30 mm in diameter ('compression' springs are not suitable). As a guide, the spring should sag a little under its own weight.

[2] plus 5 extras per class extra sinkers for calibration

[3] alternative for spring if unavailable or difficult to obtain

Horizontal Accelerometers and Triangulation Device Construction

	Item	*Suggested Supplier*	*Quantity*
o	Stiff white card	*Stationery supplier*	1 A4 sheet per accelerometer and triangulator
o	Protractors	*Stationery supplier*	1 per group
o	A4 Plastic protectors	*Stationery supplier*	1 per accelerometer
o	Small steel washers	*Hardware store*	1 per accelerometer and triangulator
o	Plastic drinking straws	*Grocery store*	1 per triangulator
o	Braided elastic *for wrist strap*	*Haberdashery/Craft shop/*	approx. 10cm per accelerometer

Standard Equipment Required

	Item	
o	Electric Drill with a 2 or 3 mm diameter drill bit	
o	Lab stands and clamps	*2 per group*
o	Standard weights and caddies	*1 caddie per group*
o	1 Metre ruler *(1mm increments)*	*1 per group*
o	Clear sticky tape	*1 small roll per group*
o	Stanley knife	*1 per group*

14. Assessment Opportunities

Dreamworld Student Activity Booklets do not fit neatly under a single assessment task category in the 2007 Queensland Physics Syllabus. They contain aspects of Extended Experimental Investigations, Extended Response Tasks and Supervised Assessment.

However, these activities effectively lead into a wide range of assessment tasks which fall neatly under the three assessment categories in the syllabus. The following list is far from exhaustive, but is intended to provide some suggestions.

Extended Experimental Investigation (EEI)

Visit a theme park and devise an experiment to test a hypothesis relating to a ride. Take measurements to test your hypothesis.

Extended Response Task (ERT)

Design an original amusement park ride. Your design should take into consideration the maximum forces and accelerations experienced by the riders, and contain a detailed account of what the riders will experience during the course of the ride.

Analyse an existing theme park rider in detail, calculating the forces and accelerations experienced by the riders. Take measurements on the ride and compare these with calculated predictions.

Supervised Assessment (SA)

Questions similar to those contained in the Dreamworld Student Activities could be completed under supervised conditions as a written task.

Compiled by Tyson Stelzer
BSc, BA, Dip Ed, Grad Cert Ed Leadership
Author, Head of Senior Science and Physics teacher
Trinity Lutheran College
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