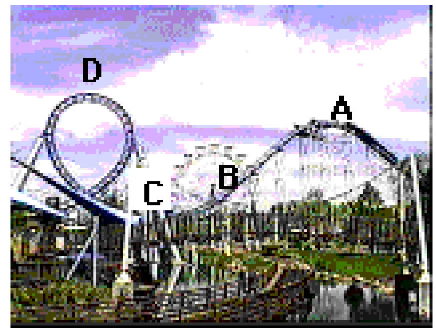
Corkscrew

Objective 1 (E1): *To calculate the speed of the train from distance and time measurements.*

SUGGESTED PROCEDURE: Estimate the length of the train and time the passage of the train at indicated points along the path in order to calculate speeds.

APPARATUS: Stopwatch



Corkscrew with points A, B, C, and D identified (perspective of picture incorrectly implies D is higher than A)

DATA: Length of train: __________ m

Time for train to pass Point A: __________ s

Point B: __________ s

Point C: __________ s

Point D: __________ s

RESULTS: Speed at Point A: __________m/s

Point B: __________m/s

Point C: __________m/s

Point D: __________m/s

Objective 2 (E12, E13, E14): *To predict the speed of the train at points C and D using the principle of conservation of energy.*

SUGGESTED PROCEDURE: Either by measuring angles at a known distance or by making estimates using multiples of some known dimension, determine the indicated heights. Assuming the mechanical energy is conserved and knowing the heights of points A and D above point C, calculate the speed of the train at points C and D.

APPARATUS: Triangulation device

DATA: Height CA: ___________ m Height AD: ___________ m

RESULTS: Speed at C: ___________ m/s Speed at D: ___________ m/s

How do these predicted speeds compare with the calculated speeds found in OBJECTIVE 1? Explain any differences.

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Objective 3 (E2, E7, E18): *to <u>calculate</u> the acceleration of the train at various points and compare them with those <u>measured</u> with an accelerometer.*

SUGGESTED PROCEDURE: a) Using the speed at points A and B from OBJECTIVE 1 and the time of travel from A to B, calculate the acceleration of the train down the incline.
b) To calculate the acceleration upon entering the loop at point C, calculate the centripetal acceleration at C using the speed from OBJECTIVE 1.
c) Calculate the centripetal acceleration at point D in the same way.

APPARATUS: A vertical accelerometer and stopwatch

DATA:	Time of travel from point A to point B:	___________ s
	Chord length "L" at bottom of first hill (point C):	___________ m
	Altitude "h" for this chord:	___________ m
	Chord length at top of loop (point D):	___________ m
	Altitude for this chord:	___________ m
RESULTS:	Calculated acceleration from A to B:	___________ m/s^2
	Calculated radius for point C:	___________ m
	Calculated centripetal acceleration at C:	___________ m/s^2
	Calculated radius for point D:	___________ m
	Calculated centripetal acceleration at D:	___________ m/s^2
	Measured accelerometer reading at C:	___________ m/s^2
	Measured accelerometer reading at D:	___________ m/s^2

CONCLUSION: How do the calculated accelerations compare with the measured accelerometer reading? Explain any differences.

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Objective 4: *to calculate the minimum speed at D required to have a net force of zero (0), i.e., to just stay in your seat without the harness. Compare this speed with the speed measured at D in Objective 1.*

SUGGESTED PROCEDURE: Estimate or calculate the radius of the track at the top of the loop. Set centripetal acceleration equal to gravity (v2/R = g = 9.8 m/s2) and solve for v.

DATA: Radius at D: ___________ m Speed at D:___________ m/s from OBJECTIVE 1

RESULTS: Required speed: __________ m/s for zero net force

CONCLUSION: Why is it important that the speed at D determined in OBJECTIVE 1 is not equal to the minimum speed required to have a net force of zero as determined above?
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Objective 5 (E12, E13): *To calculate energies lost due to frictional forces during various parts of the ride.*

SUGGESTED PROCEDURE: Assume the train is loaded with passengers with the same mass as yourself. Use data from OBJECTIVE 2, assume the speed of the train at point A will be negligible and that point C is the zero reference for height. Calculate the potential energy of the train at point A, at point D, and at the final approach to the station. Calculate the kinetic energies at point C, at point D, and just before the brakes are applied as the train approaches the station. Calculate the energy lost to friction from point A to point C, from point C to point D, and the total from point A to the final approach to the station.

APPARATUS: Stopwatch, Triangulation device for measuring heights.

DATA:	Height of first hill (CA):	___________ m
	Height of vertical loop (CD):	___________ m
	Height of station approach relative to bottom of tow-hill:	___________ m
	Mass of 6-car train (mass of car 680 kg):	___________ kg
	Your mass _____ X number of passengers ______ =	
	Mass of riders:	___________ kg
RESULTS:	Mass of train and passengers:	___________ kg
	Potential Energy CA:	___________ J
	Kinetic Energy at C:	___________ J
	Energy lost between A and C:	___________ J
	Potential Energy CD:	___________ J
	Kinetic Energy at D:	___________ J
	Energy lost going up loop:	___________ J
	Potential Energy approaching station:	___________ J
	Kinetic Energy approaching station:	___________ J
	Energy lost from A to station approach:	___________ J

Objective 6 (E10): *To calculate the required elevation angle for the turn at the farthest point from the loading station and compare to the actual elevation angle in this turn.*

SUGGESTED PROCEDURE: Calculate the speed of the train in the turn at the farthest point from the loading station. Estimate the radius of the turn. Calculate the "required banking" angle for the train to go through the turn with the rider feeling only forces into the seat, not to the side (as in the flying trapeze).

APPARATUS: Measured pace, stopwatch, protractor

DATA:	Speed of train through turn:	___________ m/s
	Radius of turn:	___________ m
	Measured elevation angle:	___________ degrees
RESULTS:	Calculated required angle:	___________ degrees
	This angle is ___________ (larger/smaller) than the actual measured angle.	

CONCLUSION:

Objective 7: *To gather subjective data about the ride to compare with the direct data and calculations.*

SUGGESTED PROCEDURE: During the ride concentrate only on how forceful you are "pushed" down into the seat or "lifted" against the retaining bar. If you can, try this with your eyes closed for the duration of the ride!

APPARATUS: Clear head, relatively empty stomach, no distractions.

DATA: Rate the relative magnitude of the force at the points indicated using the rest position before the ride starts as the neutral (N) reference force. Circle the appropriate letter.

Were you pushed		INTO THE SEAT		or	AGAINST THE BAR		
	Large	Medium	Small	Neutral	Small	Medium	Large
Point C	L	M	S	N	S	M	L
Point D	L	M	S	N	S	M	L
At upright points during helix	L	M	S	N	S	M	L
At upside down points during helix	L	M	S	N	S	M	L