8.2 Investigating pendulums

Aims

To investigate what variables affect the period (time of swing) of a pendulum.
Design a pendulum with exactly 1 second period.

Background to Pendulums

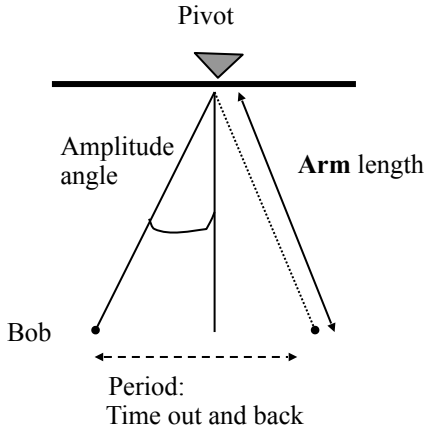
Pendulums show simple periodic motion. That is, they alternate between Potential and Kinetic energy as they constantly repeat their motion in a to and fro swing.
Q. Where in the swing is the energy all potential?
Q. Where in the swing is the potential all kinetic?

Everywhere else its part potential and part kinetic.
If the pendulum never stops then the energy transformation Potential ➔Kinetic is 100% efficient on every swing.
Q. Why is any pendulum even a Grandfather Pendulum Clock not 100% efficient and gradually lose amplitude?

Pendulums have an **Arm, Bob and Pivot** of swing. (see Diagram)
Pendulums swing in constant time if there is little friction at the pivot point.
The time for one oscillation (out and back) of a pendulum is called the period.
Q. What factors affect this time?

There are 3 Important Variables

1. **Arm length** – from pivot to centre of bob
2. **Mass** of the bob
3. **Amplitude angle** from vertical to release



Equipment

retort stand, clamp and boss head
a length of fishing line
bob (use brass hangar and weights)
protractor
ruler
calculator
computer

Prediction

Have you watched a swing or a Grandfather Clock or had a ride on The Claw?

What variables will affect the period (how fast the pendulum swings)?

Details of Experiment variables

Experiment #	**Arm Length**	**Bob mass**	**Amplitude angle**
	0.3m	50g hanger	30º
	0.5m	50g hanger	30º
	0.7m	50g hanger	30º
	0.9m	50g hanger	30º
	0.5m	50g hanger	30º
	0.5m	50g hanger + 50g	30º
	0.5m	50g hanger + 100g	30º
	0.5m	50g hanger + 150g	30º
	0.5m	50g hanger	10º
	0.5m	50g hanger	20º
	0.5m	50g hanger	30º
	0.5m	50g hanger	40°

The table above shows possible fair testing changes that can be done to independently test the 3 variables, length, mass and amplitude angle. If you have a large group of students you can divide up the task.

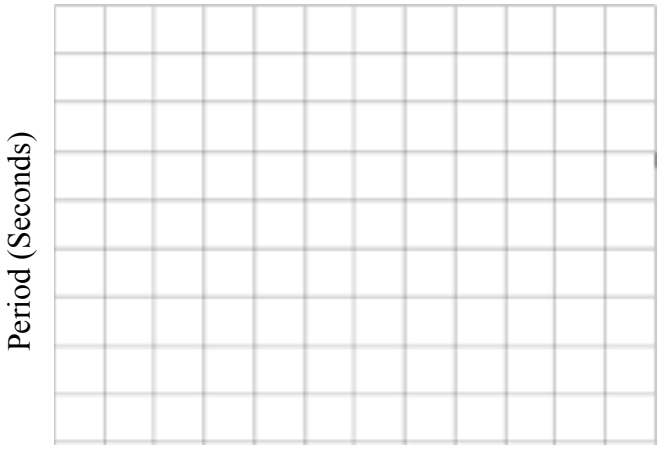
Results

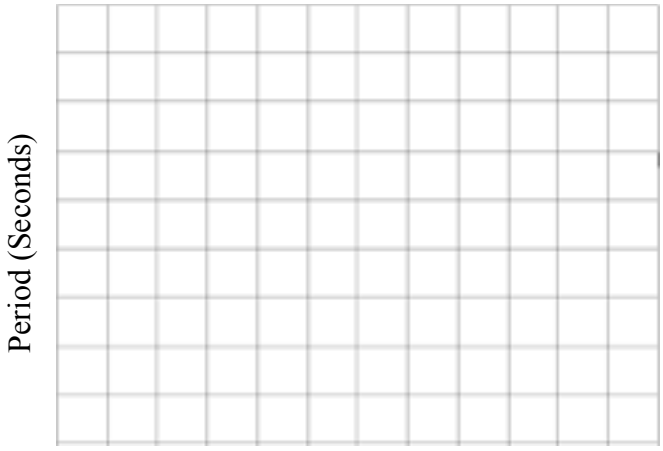
Exp#	Size of variable	Time for 10 swings				Average for 10	Period (1 swing)
		Trial 1	Trial 2	Trial 3	Trial 4		
1	0.3m						
2	0.5m						
3	0.7m						
4	0.9m						
5	50g						
6	100g						

7	150g						
8	200g						
9	10º						
10	20º						
11	30º						
12	40º						

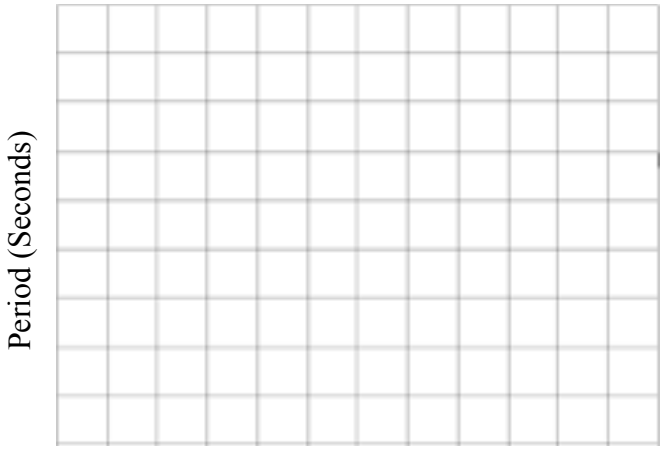
Task

1. For a class; all students work in pairs, each pair will be given a certain experiment/s to measure the period.
2. You will be allocated a group number. Follow that row above for details of your experiment.
3. Construct the pendulum with correct length and bob mass in your experiment.
4. To measure the period hold the bob at the correct amplitude angle for release and measure the time for **10 swings (Note: it works best to count from zero at the time of release and stop after account of 10 swings)**
5. Repeat for 4 trials and put your results in the table below.
6. Determine the average time for 10 swings and then the time for 1 swing using your calculator (this is the period)
7. Give the period to your teacher for a class summary.
8. Get all the results for each variable and using Excel on your computer enter the data.
9. Construct and View line graphs for each variable versus time on x axis. (You can use the graphs below or an Excel Spreadsheet (See 8.2B Sample Pendulum results)





mass of Bob



Amplitude Angle

Analysis

1. Were your measurements very consistent (same for each trial)?

2. Which graphs show that period is affected by the change in variable in a definite pattern.?

Conclusions

What variables definitely affect change in period?
From your graphs what size pendulum would you need for a 1 second period?I
If you have time test this calculation.