

# Advanced Diploma of Civil and Structural Engineering

Use Physics in Engineering

Practical Assignment

V5.1

Student Name:			
Assessed By:		Date:	Click here to enter a date.

Element	Satisfactory	Not Satisfactory	Assessor Feedback:
8	<input type="checkbox"/>	<input type="checkbox"/>	
<b>RESULT</b>	<input type="checkbox"/>	<input type="checkbox"/>	

Created By:		Date:	
Reviewed By:		Date:	

# Use Physics in Engineering

## Practical Assignment

### Questions

#### Element 8: Perform, report and assess laboratory experiments.

##### Part 1: Measurements and Uncertainties in Physics

##### Topics Covered

- Measurements
- Uncertainties
- Data analysis

##### Objectives

The purpose of this exercise is to understand how to take accurate measurements and understand experimental uncertainties. This laboratory task will require you to take measurements of an A4 sheet of paper to determine the perimeter, area and respective uncertainties.

##### Procedure

1. Measure the length of the A4 paper
2. Determine the uncertainty of the measurement
3. Measure the width of the A4 paper
4. Determine the uncertainty of the measurement
5. Calculate the perimeter
6. Calculate the uncertainty in the perimeter
7. Calculate the area
8. Calculate the uncertainty in the area

##### Hints

**The formula for perimeter:**  $P = 2L + 2W$

**The formula for area:**  $A = LW$

**Uncertainty of the addition and subtraction of measurements:**  $z = a \pm b \rightarrow U(z) = U(a) + U(b)$

**Uncertainty of the product and quotient of measurements:**  $z = ab \rightarrow \frac{U(z)}{z} = \frac{U(a)}{a} + \frac{U(b)}{b}$



**Q1 Submission Requirements:**

A short report will be required for this exercise.

The elements to consider when writing this short report are:

- Summary of results
- Calculation of perimeter and area
- Calculation of the uncertainties

You may use the following table to present your results:

<b>Length (mm)</b>	<b>297</b>
<b>Uncertainty in Length (mm)</b>	<b>1</b>
<b>Width (mm)</b>	<b>210</b>
<b>Uncertainty in Width (mm)</b>	<b>1</b>

**At the end of the report provide a quick discussion/conclusion highlighting the following points:**

- What are experimental uncertainties?
- How can uncertainties impact experimental results?
- From your measurements, what percentages of the perimeter and area are the uncertainties?
- Are the measurements precise?
- How can the uncertainties in the exercise be improved?

**A1 Student Answer**

After measuring the length and breadth of the A4 paper with ruler, we get the following measurements:-

<b>Length (mm)</b>	<b>297 mm</b>
<b>Uncertainty in Length (mm)</b>	<b>0.5 mm</b>
<b>Width (mm)</b>	<b>210 mm</b>
<b>Uncertainty in Width (mm)</b>	<b>0.5 mm</b>

The uncertainty in the measurements is equal to the least count of the instrument being used.

The perimeter of the paper can be calculated using the formula

$$Perimeter = 2 * (length + breadth)$$

Hence  $Perimeter = 2 * (297 + 210) = 1014 \text{ mm}$ .

Area of the paper can be found out using the formula

$$Area = length * breadth$$

Hence  $Area = 297 * 210 = 62370 \text{ mm}^2$  (62400 using appropriate number of significant digits).

Uncertainty in perimeter can be found using the formula  $U(Perimeter) = 2(U(length) + U(breadth)) = 2 * (0.5 + 0.5) = 2 \text{ mm}$ .

Uncertainty in area can be found out by using the formula  $\frac{U(area)}{area} = \frac{U(length)}{length} + \frac{U(breadth)}{breadth} \Rightarrow$

$$U(area) = 62370 * \left( \frac{0.5}{297} + \frac{0.5}{210} \right) = \frac{1}{2} * (210 + 297) = 254 \text{ mm}^2.$$

Experimental uncertainty is the estimated amount by which a measurement might be in error. Uncertainties in measurement adversely affect the credibility of the data. Large uncertainties

are highly undesirable in an experiment because then we will get inaccurate results. Now as we calculated, uncertainty in perimeter= $2/1014*100=0.197\%$  and uncertainty in area= $254/62370*1000.407\%$ .

The measurements are precise to 0.5 mm precision.

We can reduce manual errors here, which consist mainly of parallax error. Also we could take many readings of the dimensions and then take the mean. This would also reduce the uncertainty to some extent.

<b>F1</b> Assessor Feedback	Satisfactory	<input type="checkbox"/>
	Not Satisfactory	<input type="checkbox"/>

## Part 2: Conservation of Energy & Circuits

### Lab Submission Guide

The purpose of these laboratories is to present your results and findings in a short report. The objective is to understand the underlying physics concepts whilst effectively communicating your findings. The dot points below provide a set of guidelines regarding what to include in your report.

### Presentation of Reports

Each lab report shall include the following:

- Cover sheet
  - Unit name
  - Student name
  - Dates performed
- Introduction
  - Purpose of the laboratory exercise (in your own words)
  - Any relevant theory (include mathematical formulas that are relevant)
- Laboratory tabulated results
  - Clear comparison between and measured results and theoretical results
  - Each section or table is clearly titled
- Graphs (if required)
  - Graph title
  - Axis titles
  - Horizontal and vertical grid lines on graph
- Discussion
  - Answer to questions
  - Referencing to appendices (if any) for any derivations
  - Reasons for variations between theoretical and measured results
- Conclusions
  - Deductions and inferences
  - Significant points
- General
  - Each title has to be bolded
  - Each lab is to start as a new page
  - A caption is required for any figures and/or graphs

## A: Work and Energy

### Topics Covered

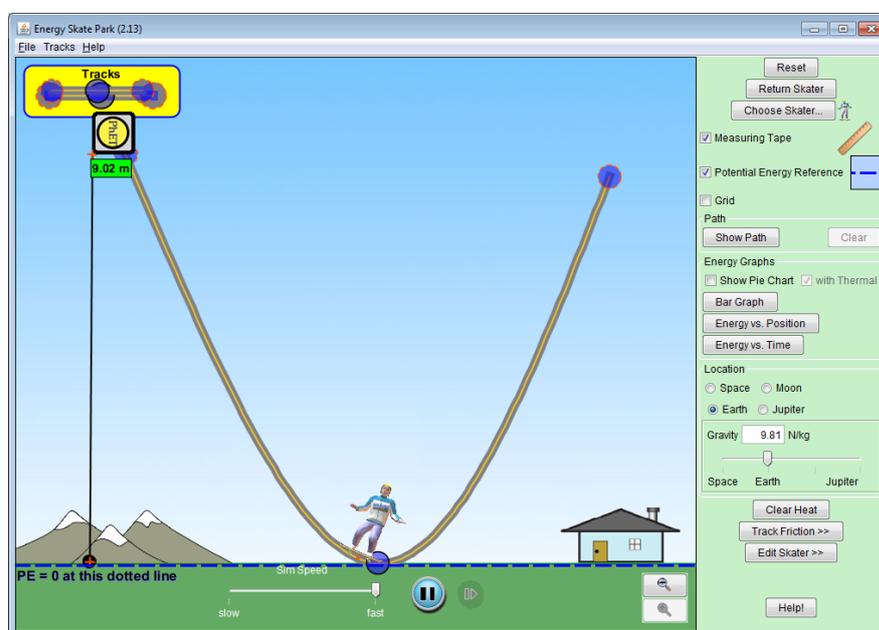
- Energy
- Conservation of mechanical energy
- Potential energy
- Kinetic energy

### Objectives

The purpose of this simulation exercise is to investigate the conservation of mechanical energy. Various scenarios will be constructed using the 'energy skate park' simulation package to validate the law of conservation of energy.

### Q2 Procedure:

1. To access the interactive lab, open up a search engine and go to this link:  
<http://phet.colorado.edu/en/simulations/category/physics>  
(We acknowledge that the software used here is attributed to PhET Interactive Simulations University. of Colorado <http://phet.colorado.edu> ).
2. Once PhET is up, click on the title 'Energy Skate Park'
3. Click 'Download' save then run the '.jar' file.
4. Open the 'energy skate park' simulation package and set up the skate ramp as seen in the figure below. Ensure that the height of the ramp is set to 9 meters.

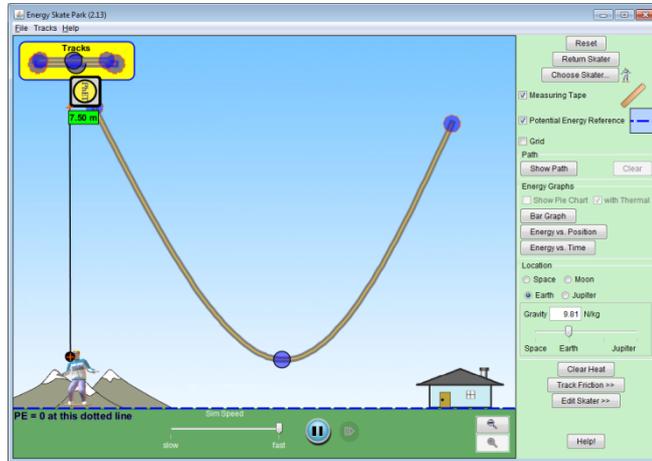


5. Drag the skater to the top of the ramp you have built and release him. Open the 'energy versus time' graph and let the skater complete one full cycle to obtain a full plot.
6. Take a print screen of the 'energy versus position' plot and fill in the information below:

Maximum Potential Energy	
Maximum Kinetic Energy	

Total Energy

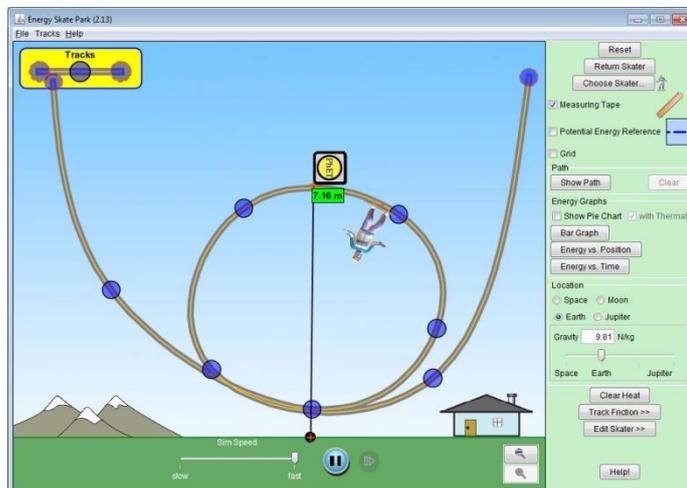
7. Repeat the procedure, except this time make the base of the ramp 1.5m above the ground as seen in the figure below.



8. Take a print screen of the 'energy versus position' plot and fill in the information below:

Maximum Potential Energy	6000 J
Maximum Kinetic Energy	5000 J
Minimum Potential Energy	1000 J
Total Energy	6000 J

9. Set up a skate ramp similar to the one in the Figure below:



10. Record the maximum height, minimum height and height of the loop and record them in the table below:

Maximum Height (m)	
Minimum Height (m)	
Height of the loop (m)	

11. Take a print screen of the energy versus time graph of the skater.  
12. Use the total energy value provided on the energy versus time graph where necessary to calculate the following. Show all your calculations. Note that the mass of the skater is

75 kg.

- Maximum potential energy
- Maximum kinetic energy
- Minimum potential energy
- Kinetic energy at the top of the loop
- Velocity of the skater at the bottom and top of the loop.

13. Comment on whether or not these values are consistent with the energy verses time graph.

**A2** Student Answer

**F2** Assessor Feedback

Satisfactory

Not Satisfactory

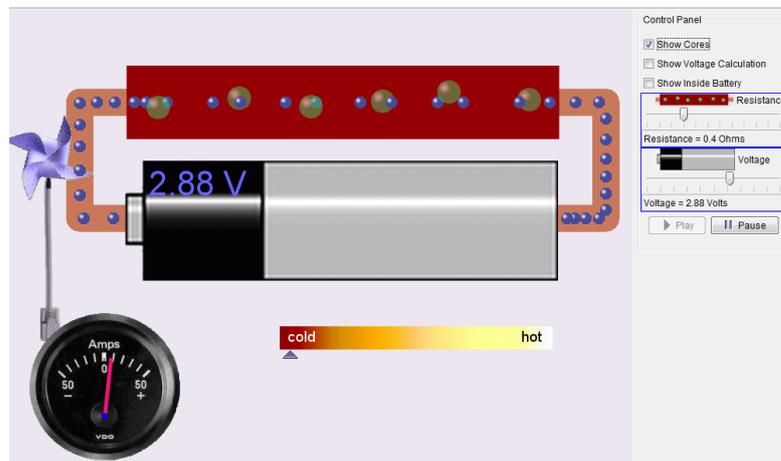
## B: Circuits

### Purpose:

The purpose of this investigation is to understand the physical characteristics of a battery resistor circuit.

### Experimental Procedure:

1. To access the interactive lab, open up a search engine and go to this link:  
<http://phet.colorado.edu/en/simulations/category/physics>.
2. Once PhET is up, click on the title 'Battery-Resistor Circuit'.
3. Click 'Download' save then run the '.jar' file.
4. The following window should appear



5. Explain what is happening (Action 1)
6. Vary the voltage slider on the top right corner and record what you see (Action 2)
7. Vary the resistance slider on the top right corner and record what you see (Action 3)
8. What makes the filament become hot? Explain this in terms of what is happening within the filament (Action 4)

**Q3 Results:**

Action	Observation
1	
2	
3	
4	

**Discussion**

1. What parameter(s) affect(s) a resistor?

The parameters that affect the resistor are thickness of the wire, length of the wire and the resistivity of the material of the wire used. Also while current is passing through it, it may get heated up and the resistance may change with the temperature.

2. A resistor is said to be linear. What does this mean?

A resistor is said to be linear when the current passing through it is directly proportional to the potential difference between its ends.

3. When is a resistor nonlinear?

A resistor is said to be non-linear when the current passing through it isn't directly proportional to the applied voltage across its ends. For example, zener diode.

4. If there are 5 resistors in parallel, such that  $R_1 < R_2 < R_3 < R_4 < R_5$ . What can you say about the equivalent resistance?

We know that for a parallel setup, equivalent resistance is given by the formula

$$\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$$

So, we have  $\frac{1}{R_{eff}} > \frac{1}{R_1}$ . Therefore  $R_{eff} < R_1$ . Hence the effective resistance is smaller than the resistance of the smallest individual resistance used.

**A3** Student Answer

**F3** Assessor Feedback

Satisfactory

Not Satisfactory