

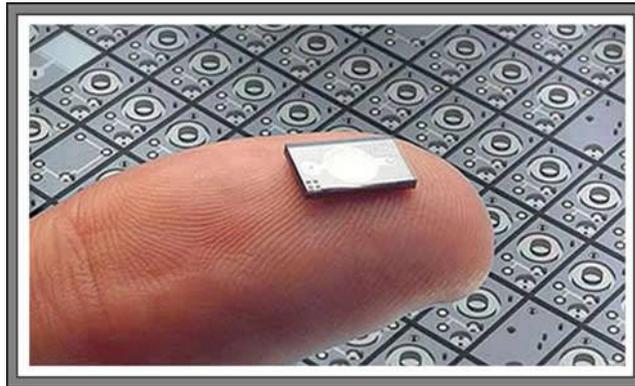
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# Scale Inquiry Activity: Cut To Size

## Participant Guide

### Introduction

To understand microsystems, their applications and fabrication, you need to have a good understanding of size and scale. This leads to a better understanding of the function of micro-sized objects and the applications in which they are used.



*Microchip containing a nano-sized insulin pump  
[Printed with permission from Debiotech S.]*

For example, this picture shows a microchip of a nano-sized pump used to supply a continuous infusion of insulin to a diabetic. This device is small enough to be mounted on a disposable skin patch. The nanopump inside the micro-size chip is able to control delivery at the nanoliter level, the amount very close to the physiological delivery of insulin<sup>(1)</sup>. This pump is constructed using MEMS technology fabrication techniques.

In this activity you will discover similar devices in the macro, micro, and nano-scales. You will identify objects that exist in each of these scales given a specific length. You will be asked to think of ways that these objects can be used to perform a necessary task.

### Description and Estimated Time to Complete

This activity allows you to explore the macro, micro and nano- scales and to begin thinking about the types of objects found in these scales. In this activity you will cut a 20 cm paper ruler in half, then continue to cut each new piece in half until it becomes too small to cut. For each cut, you will identify an object that has the length of the remaining size. Even after the ruler becomes too small to cut, you will continue to identify objects for several lengths all the way down into the nano-scale.

#### Estimated Time to Complete

Allow approximately 60 minutes to complete this activity.

## **Activity Objectives and Outcomes**

### Activity Objectives

- Demonstrate your knowledge of metric scales by identifying at least 15 objects that range in size from the nano-scale to the macro-scale.
- Identify at least 3 macro-size objects that perform the same tasks but in the micro-scale.

### Activity Outcomes

For each cut of the ruler you will indicate on a chart the length of the new ruler and at least one object that measures that length. When you are no longer able to cut the ruler in half, you will continue to identify objects that measure specific micro and nano lengths as indicated on the activity chart. By the end of this activity you should be able to answer the following questions:

- How many cuts would it take to get to the size of a water molecule (approximately 1 nm)?
- How do you denote lengths using the metric system?
- What are some objects that overlap the micro and nano-scales?
- What is an object in the micro or nano-scale that performs the same function or task as a macro-sized object?
- What are some tasks that micro or nano-sized objects perform that affect your life?

### **Team**

It is recommended that you complete this activity with one or two other participants. Working with others will promote more discussion and ideas.

### **Supplies**

- One 20 cm long strip of ruled paper. (One is provided on the Cut to Size Activity Chart at the end of this activity).
- One piece of stock paper (or thick printer paper) – if available
- One pair of scissors
- One Cut to Size Activity chart (last 2 pages of this activity)
- One pencil
- Computer with Internet access
- Computer with PowerPoint or Adobe Reader

## **Documentation**

- Record your observations during this activity.
- Complete the Cut to Size Activity Chart.
- Record the results for each step of the activity.
- Revise your hypothesis to reflect the results.
- Summarize your discussions with other participants.
- Answer the Post-activity questions.

## **Think About the Outcome**

Answer the following based on what you think will be the outcome of this activity.

### Expectations:

- You will discover functional objects that range from the nano-scale to the macro-scale.
- You will identify micro and nano-sized objects that work as efficiently as macro-sized objects with equivalent functions.

### Observations:

- What is the difference between a micro-sized object and a nano-sized object?
- Describe any previous experience or observations that you have had relating to micro and nano-sized objects.
- What types of objects do you think of when you think "micro"?
- What types of objects do you think of when you think "nano"?

### Hypothesis:

- Write a statement on what you expect to discover in fulfilling the expectations.

### Predictions:

- What types of objects will you find in the micro and nano-scales that perform the same functions as objects macro-scales (> 100 microns)?
- What types of objects will you find in the micro-scale?
- What types of objects will you find in the nano-scale?

## **Inquiry Activity: Cut To Size**

### **Description**

This activity allows you to explore the macro, micro and nano- scales. You will cut a 20 cm long paper ruler as small as you can get it and identify an object that has the length of each cut size. This activity will help you begin to think about objects in the micro and nano-scales.

1. View the Presentation: "Macro, Micro, or Nano?"

**Description** View either the PowerPoint or Flash version of the presentation "Macro, Micro, or Nano?"

- How did you do?
- How many did you get correct?

2. Print out the Cut to Size Activity Chart

**Description**

- Print out the Cut to Size Activity Chart at the end of this handout.
- Print page 2 of the chart on stock paper, if available.
- Cut out the metric ruler along the red line.

3. Cut the ruler in half.

**Description** Cut the ruler in half.  
Discard one half of the ruler.  
Answer the following questions:

- a. What is the new length of the ruler? Record the length on the activity chart. (Be sure to use metric notation).
- b. Give an example of an object of this size. (You are welcome to Google images for ideas)
- c. What is the function (task) of this object? (i.e. red blood cells (6 to 8  $\mu\text{m}$  in diameter) carry oxygen from the lungs to the body)
- d. Is this object macro, micro, or nano in length? Refer back to the presentation if you need to.
- e. Record your answers to these questions on the chart.

4. Repeat Step 3

**Description** Repeat step 3 until the ruler gets too small to cut in half.  
Use the activity chart to keep track of the number of times you cut.

5. How many cuts did you get?

**Description** How many cuts did you get before the ruler got too small to cut?  
  
On the activity chart, highlight the number of cuts you were able to do before the last piece was too small to cut.

6. Complete the Activity Chart

**Description** For the remaining cuts indicated on the chart, answer the following.

- Give an example of an object of this size?
- What is the function of this object?
- Is it macro, micro, or nano?

7. How many cuts to 1 nm?

**Description**

- Determine how many cuts it would take to get to 1 nanometer.
- How many cuts? \_\_\_\_\_
- What are two objects that are 1 nm in length or diameter?

8. Revisit your hypothesis and predictions

**Description**

- Revise your hypothesis to reflect your results.
- How well did your results match your predictions? (Be specific)

9. Answer the Post-Activity Questions

**Description** Answer the Post-Activity Questions at the end of this procedure.

10. Discuss results with other participants

**Description** Discuss your activity results with other participants.

11. Write up your documentation

**Description** See the Documentation section and complete your documentation for this activity.  
Submit your documentation as required.

## Post-Activity Questions

1. How many cuts would it take to get to the size of a molecule approximately 1 nm in diameter?
2. What types of objects did you find in the micro-scale? Nano-scale?
3. Based on the types of objects that you found in the micro and nano-scales, what types of professions do you think directly utilize the functional capabilities of these objects? (Be specific)
4. What are some objects that overlap the micro and nano-scales?
5. What is an object in the micro-scale that performs the same function or task as a macro-sized object?
6. What are some functions that micro and nano-sized object perform that affect your life?

## Summary

This activity allowed you to explore objects in three different scales – macro, micro, and nano. Even though nano, and most micro-sized objects cannot be seen with the naked eye, you should have found that there still exists billions and billions of functional objects within these scales.

It is important that you get a sense of relative size and develop a good understanding of scale and units. This understanding will assist in all aspects of your life.

## References

- 1 "Debiotech's Insulin Nanopump™". MedGadget. April 23, 2007.

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## Cut to Size Activity Chart

Cut #	Length of Paper (as power of 10)	Length of Paper (using metric prefix)	Object	Function of Object	Macro, Micro, Nano
Cut 1	$10 \times 10^{-2} \text{ m}$	10 cm	Coaster	To protect a table top from drips	Macro
Cut 2	$5 \times 10^{-2} \text{ m}$	5 cm	The diameter of a drinking glass	To hold liquids	Macro
Cut 3					
Cut 4					
Cut 5					
Cut 6					
Cut 7					
Cut 8					
Cut 9					
Cut 10					
Cut 11					
Cut 12					
Cut 13					
Cut 14					
<b>Notice we start skipping cuts at this point. So keep track!</b>					
Cut 17					
Cut 19					
Cut 22					

<b>Cut 25</b>						
<b>Cut 27</b>						
<b>Cut 28</b>						

