

Lesson Plan 8 – Drawing to Scale

Background

Drawing to scale is a tool that Engineers use for many different tasks, including designing roller coasters. One key part of every scale drawing is the scaling factor. This number represents the degree to which your scale drawing or scale model has been reduced in size when compared to the original. Maintaining as constant a scaling factor throughout their sketches will be one of the most difficult parts of the activity for the students. But it is something they should strive for as a uniform scaling factor will provide the most useful information and results.

Student Learning Objectives	NYS Standards
Students will be able to read a scale drawing	
Students will be able to find a scaling factor when scaling an object.	
Students will be able to create a scale drawing.	
Students will be able to understand the challenges in technical drawing.	
Students will be able to create a set of 2-D scale drawing from a real object to represent its 3-D shape.	

Key Terms

Term	Definition
Scale	A defined ratio of a model's size relative to the actual object that the model represents.
Ratio	Essentially a comparison between two numbers equal to one divided by the other.
Model	Simplified representation of a physical system intended to allow one to more easily analyze and understand the system.
Scale Factor	The number by which each dimension of the model is multiplied to modeled objects actual size.

This lesson can be a 1-3 day activity. The second and thirds day options included below (practice scale drawings of roller coaster track and 3-D sketches are optional)

2-D Activities (1 day)

- Introduce the concept of scaled drawings. A drawing on a transparency blown up on screen is an effective way. Measuring the length of a line on each can be used to define the scaling factor. Show other examples (e.g., simple blue print) and review scaling factors and how information can be used.
- Scaled drawings are a means of communication between the contractor and the designer of a structure, in this case a roller coaster. Scaled drawings are used because they allow the designer to put a large amount of information into a relatively small and easily read package. Introduce key terms and have students copy them down in their notes after you have worked out the definitions with the class and written them on the board. (10 mins)
- Have a single student come to the front of the class and draw a 2-D (X-Z plane) roller coaster on the board. Inquire with the class what you would have to know in order to build this roller coaster. Bring in the concepts of scale factor. You have to know how high the tallest point is, how big the loops are... before you can do anything you have to have some idea of scale (5 mins)
- Hand out the worksheet on scaled drawings, have the students read through the instructions and measure the scale drawings on the worksheets. (20 mins)
- Close lesson by briefly going over the worksheet and handing out the HW assignment on having the students draw their own scale coasters. Review Key terms and objectives of the class. Introduce tomorrow's lesson – 2-D graphical representation not sufficient. Need to determine how to represent the 3-D aspects of the system also in order to construct. (5 mins)

2-D drawings – practice (optional 1 day)

- Have simple model roller coaster in class room and have students draw scale models of the track. (students will also have to do this later with their own project)
- Have extra tracks available and have students draw a model roller coaster first and then see if they can build the track according to their drawing.

3-D Activities (1 day)

- Call students to order, and collect anything that is due. (5 mins)
- Introduce the lesson, detailing that the students will be making drawings of a number of different objects with the goal of making accurate scale drawings of the item from front, side and top views. (5 mins)
- Hand out paper and rulers to the students, allow them to work in pairs, each student must hand in his/her own drawing, however two students can work on the same object at the same time. The students may select the objects they want to draw themselves from the bin. (20 mins)
- Assess student work throughout class to make sure they understand the principles and generate accurate drawings.
- Collect the drawings from the students and show them the actual drawings that were made of the items by the instructor (you are probably going to have to make

these each time, as the objects will probably change from year to year.) (rest of class time).

Supply list

Scaled drawings 2d worksheet

Scaled drawings 2d HW

Rulers, compasses, protractor, French curves and other drawing tools

Model roller coaster sets

Graph Paper (preferably with lines in metric distances)

Simple 3-D objects (plastic egg, tape dispenser, battery, coffee mug)

Transparencies/handouts of actual drawings of the items.

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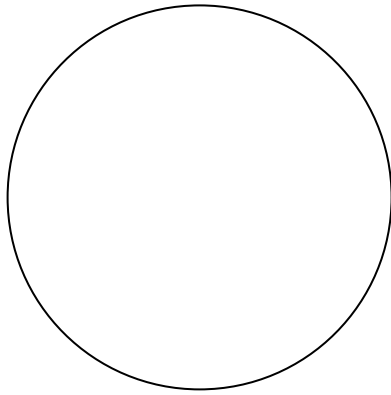
DATE: _____

2D Scale Drawing Activity Sheet

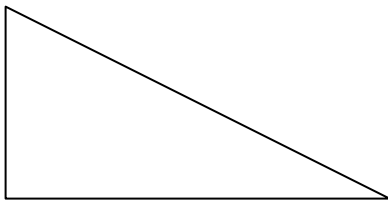
- 1) The scaled down representation of a Box below is given to you in $1/16$ scale, what are the length and width of the box at full scale? Give dimensions in cm.



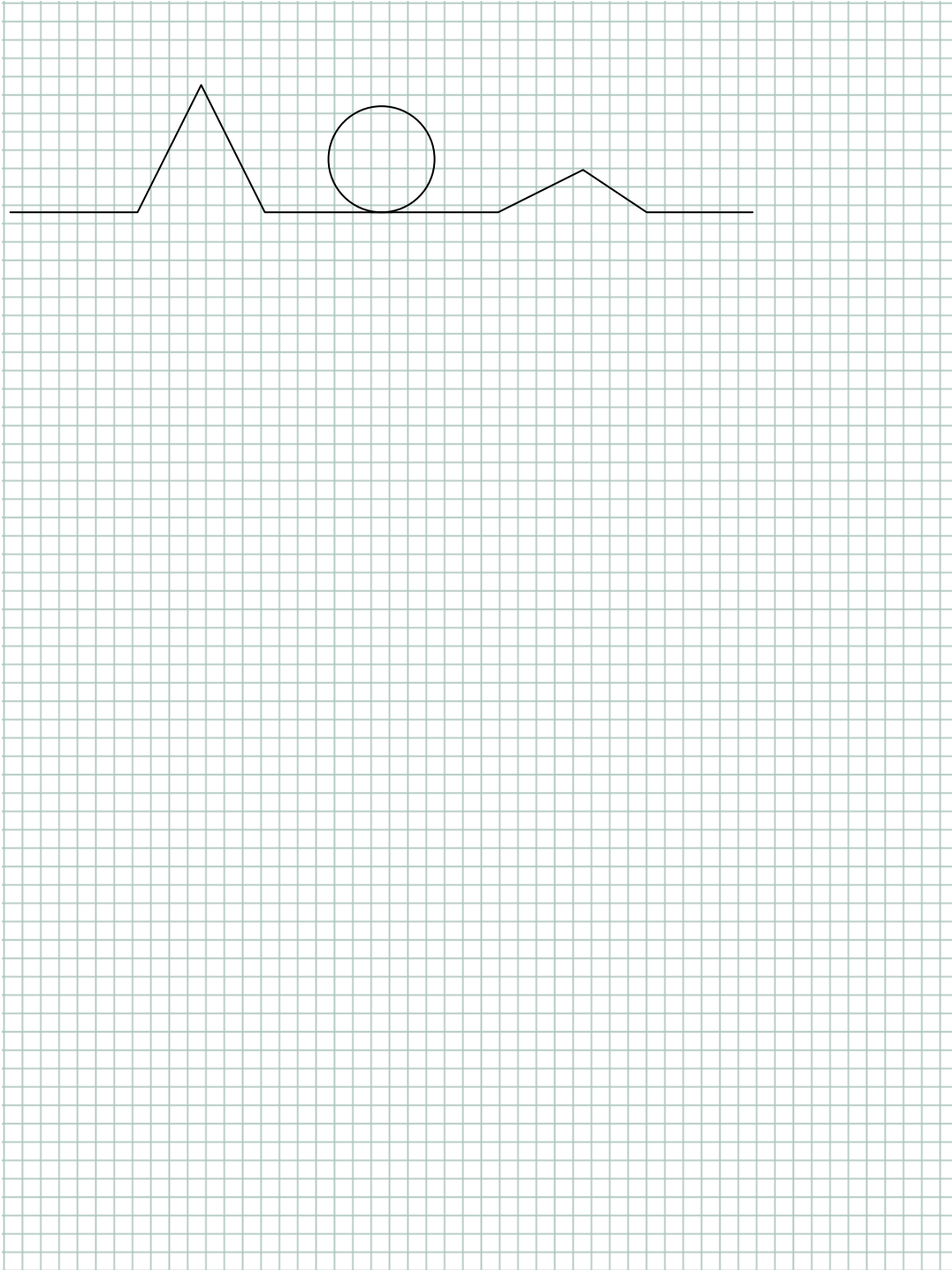
- 2) The circle below is given in 4:1 scale, what is the diameter of the circle at full scale? Give dimensions in cm.



- 3) Find the slope of the longest side of the triangle below and find its height at full scale. The scale factor is $1/32$; give dimensions in cm.



- 4) Below is a simplified model of a roller coaster, it is drawn at $1/32$ scale. Draw two new scale models of this roller coaster – one at $1/16$ scale and one at $1/64$ scale. Which scale factor would you recommend using? Why? Consider both accuracy of drawing and capacity to draw the model in a reasonable overall size of graph paper. What can you note about the slope of the angled lines when you scale up and scale down?



NAME: _____

DATE: _____

2D Scale Drawing HW

- 1) You are to draw a 2-D model of a roller coaster with the following dimensions. Your drawing should be a 1/32 scale of the model on the grid below from left to right (you can turn the page sideways to make it fit)
 - a. Start with a 96 cm vertical drop
 - b. Then a 80 cm 45 degree downward slope
 - c. Next a 360 cm level area with a 64 cm loop in the middle of the 360 cm length.
 - d. Finish with a 30 degree upward slope that is 264 cm long.Remember to include title and scale factor on your drawing. Use of a ruler and other measuring/drawing devices is expected.

- 2) Determine the full scale dimensions of this roller coaster if the model is a 1/100 scale of a full scale roller coaster

