CONCEPTUAL *Physics* PRACTICE PAGE

Chapter 12 Solids
Scaling

1. Consider a cube, say 1 cm × 1 cm × 1 cm (a very small sugar cube). Its volume is 1 cm^3. The surface area of one of its faces is 1 cm^2. The total surface area of the cube is 6 cm^2, because it has six sides. Now consider a second cube, scaled up by a factor of 2 so it is 2 cm × 2 cm × 2 cm.

   a. What is the total surface area of each cube?

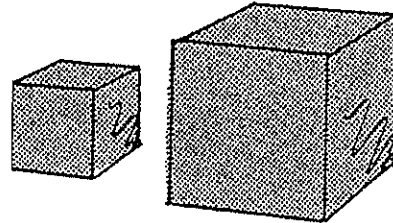   1st cube _____ cm^2; 2nd cube _____ cm^2

   b. What are the volumes of each cube?

   1st cube _____ cm^3; 2nd cube _____ cm^3

   c. Compare the surface-area-to-volume ratio for

   1st cube of $\dfrac{\text{surface area}}{\text{volume}}$ = ___; 2nd cube of $\dfrac{\text{surface area}}{\text{volume}}$ = ___
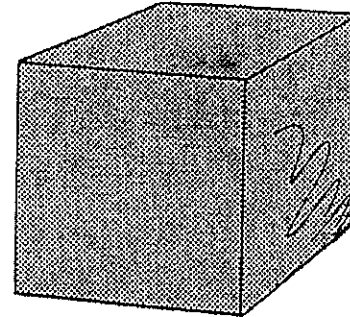
2. Now consider a third cube, scaled up by a factor of 3 so it is 3 cm × 3 cm × 3 cm.

   a. What is its total surface area? _____ cm^2

   b. What is its volume? _____ cm^3

   c. What is its surface-area-to-volume ratio?

   $\dfrac{\text{surface area}}{\text{volume}}$ = ___

3. When the size of a cube is scaled up by a certain factor

   (2 and then 3 for the above examples), the area increases as the _____

   of the factor, and the volume increases as the _____ of the factor.

4. Does the surface-area-to-volume ratio increase or decrease as things are scaled up?

   _____

5. Does the rule for the scaling up of cubes also apply to other shapes? _____
   Would your answers have been different if we started with a sphere of
   diameter 1 cm and scaled it up to a sphere of diameter 2 cm, and then 3 cm? _____

6. The effects of scaling are beneficial to some creatures and detrimental to others. Write either beneficial (B) or detrimental (D) for each of the following:

   a. an insect falling from a tree _____   d. a big fish chasing a small fish _____
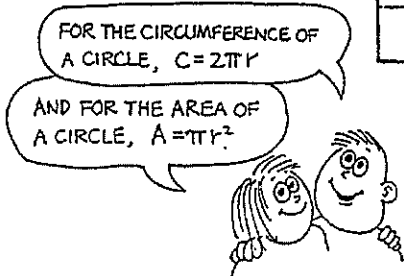
   b. an elephant falling from the same tree _____   e. a hungry mouse _____

   c. a small fish trying to flee from a big fish _____   f. an insect that falls in the water _____

Chapter 12 Solids
### Scaling Circles

1. *Complete the table.*

CIRCLES		
RADIUS	CIRCUMFERENCE	AREA
1 cm	$2\pi(1\,cm) = 2\pi$ cm	$\pi(1\,cm)^2 = \pi\,cm^2$
2 cm		
3 cm		
10 cm		

FOR THE CIRCUMFERENCE OF A CIRCLE, $C = 2\pi r$

AND FOR THE AREA OF A CIRCLE, $A = \pi r^2$

2. From your completed table, when the radius of a circle is doubled,

   its area increases by a factor of _____.

   When the radius is increased by a factor of 10, the area increases

   by a factor of _____.

3. Consider a round pizza that costs $5.00. Another pizza of the same thickness has twice the diameter. How much should the larger pizza cost?
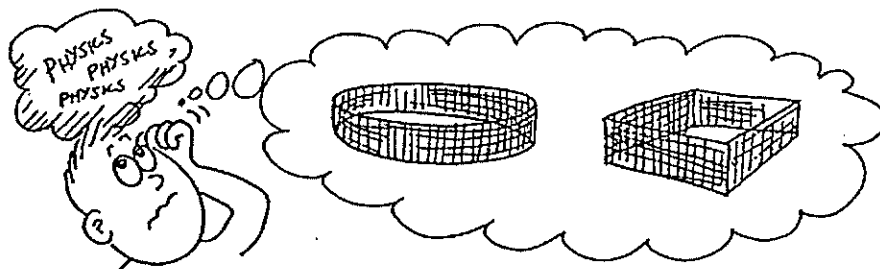
   _____
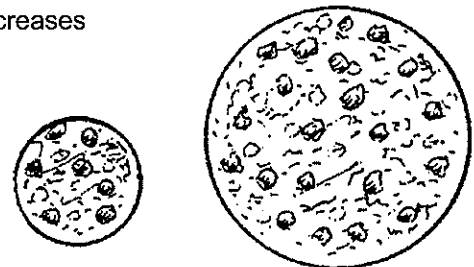
4. [True]   [False]   If the radius of a circle is increased by a certain factor, say 5, then the area increases by the *square* of the factor, in this case 5^2 or 25.

   So if you scale up the radius of a circle by a factor of 10, its area will increase by _____.

Application:
5. Suppose you raise chickens and spend $50 to buy wire for a chicken pen. The shape of the pen that will hold the most chickens inside will be

   [square]   [circular]   [either, for both provide the same area]