1. Why is $\dfrac{a}{0}$ "undefined" for $a \neq 0$?

2. The volume of a cylinder is the area of the base circle times the height: $V = \pi r^2 h$.

   (a) Assume the radius of the cylinder is constant, but the height can change.

      i. Write an equation for $V(h)$, volume as a function of the height.

      ii. Sketch a graph.

      iii. Find an expression for $\dfrac{dV}{dh}$ and describe its meaning in words.

   (b) Now assume the height of the cylinder is constant, but the radius can change.

      i. Write an equation for $V(r)$, volume as a function of the radius.

      ii. Sketch a graph.

      iii. Find an expression for $\dfrac{dV}{dr}$ and describe its meaning in words.

3. $y = \sin(2x)$

   (a) Find $\dfrac{dy}{dx}$. [Hint: Use the cheer.]

   (b) Draw a function machine diagram showing y as a composition of two functions.

4. Read this multiple choice choice question and get quick response from from each member of your group.

   Imagine that there is a rope around the equator of the earth. Add a 20 meter segment of rope to it. The new rope is held in a circular shape centered about the earth. Then which of the following is the largest living creature that can walk (or otherwise move in an upright position) beneath the rope without touching it:

   (a) an amoeba

   (b) an ant

   (c) you (the student)

   (d) a giraffe

5. Revisit the previous question with some careful thinking. The circumference of the Earth is approximately 4×10^7 meters. How far is the new rope above the Earth?

6. **Practice**

Assume that $f(x)$ and $g(x)$ are differentiable functions about which we know very little. In fact, assume that all we know about these functions is the following table of data:

x	$f(x)$	$f'(x)$	$g(x)$	$g'(x)$
-2	3	1	-5	8
-1	-9	7	4	1
0	5	9	9	-3
1	3	-3	2	6
2	-5	3	8	?

This isn't a lot of information. For example, we can't compute $f'(3)$ with any degree of accuracy. But we are still able to figure some things out, using the rules of differentiation.

1. Let $h(x) = e^x f(x)$. What is $h'(0)$?
2. Let $j(x) = -4f(x)g(x)$. What is $j'(1)$?
3. Let $k(x) = \dfrac{xf(x)}{g(x)}$. What is $k'(-2)$?
4. Let $l(x) = x^3 g(x)$. If $l'(2) = -48$, what is $g'(2)$?
5. Let $n(x) = x^2 f(x)g(x)$. What is $n'(1)$?

7. The *intermediate value theorem* states:

> If f is a real-valued continuous function on the interval $[a, b]$, and u is a number between $f(a)$ and $f(b)$, then there is a $c \in [a, b]$ such that $f(c) = u$.

Right now (and until you take a math course called *Real Analysis*), take the IVT as a postulate.

(a) Explain what the IVT means. Be sure to draw at least one picture.

(b) Recall there is no *rational number* whose square is 2. Explain how the IVT shows that there is a *real* number whose square is 2.

8. A hiker sets out at dawn to walk over a mountain and down the other side to a lake, a distance of x kilometers, and she reaches her destination exactly 12 hours later. She camps, then leaves at the same time the next morning and travels the same trail back, arriving at her starting place exactly 12 hours later. Use the *Intermediate Value Theorem* to show that at some specific time, she was at the same place on her hike on both days.