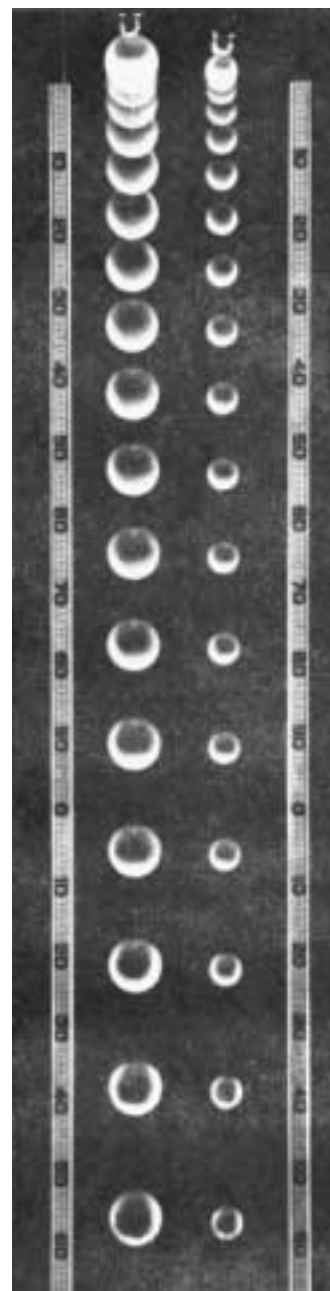


WORKSHEET 2

1. The figure on the right shows a multiflash photograph of two balls falling after being released from rest. The rulers in the figure are marked in centimeters. The formula for free fall near the Earth's surface is $s = 4.9t^2$, where s is distance fallen (in meters) and t is the time elapsed (in seconds).
 - a) How long did it take the balls to fall the first 160 cm? What was their average velocity for this period?
 - b) How long was the time between consecutive flashes?
 - c) Estimate the velocity of the balls after they had fallen 50 cm and also after they had fallen 160 cm.
 - d) How could the experiment be changed so that the estimates in part c) would be more accurate? Is there a limit to the accuracy you could obtain in this way?



2. *Rectilinear motion* is motion of an object along a straight line. Examples of such motion are objects falling under the pull of gravity, a dragster racing along a straight line course, or an airplane flying at level flight along a straight line path. Suppose we have an equation which gives the position of a moving object along a straight line with respect to some reference point labeled 0. Let

$$s(t) = 16t^2$$
 denote the number of feet an object has fallen under the pull of gravity after t seconds has passed from the first moment it was first let go.
 - a) Make a chart giving the distance that the object has fallen after t seconds for values $t = 0, \frac{1}{2}, 1, 1\frac{1}{2},$ and 2 . Determine the *average velocities* for the first four half-second intervals. From the chart alone, can you determine the *instantaneous velocity* at any time, say at $t = 1$?
 - b) Write a formula for the average velocity of the object starting at an arbitrary time t and lasting for h seconds. From this formula, can you determine the instantaneous velocity at any time?
 - c) Define the term *instantaneous velocity*.

3. When a chemical reaction was allowed to run for t minutes, it produced the amounts $A(t)$ of substance shown in the following table

t (in min)	10	15	20	25	30	35	40
$A(t)$ (in moles)	26.5	36.5	44.8	52.1	57.1	61.3	64.4

- a) Find the average rate of the reaction for the interval from $t = 20$ to $t = 30$.
- b) Plot the data points from the table, draw a smooth curve through them, and estimate the instantaneous rate of the reaction at $t = 25$.

4. Use a calculator to fill in the table given and then make a guess at the given limit.

a)	$\frac{\sqrt{x} - \sqrt{3}}{x - 3}$...	
	x	2	2.5	2.75	2.9	2.99	... limit

b)	$\frac{1}{x^2}$...	
	x	1	0.5	0.25	0.1	0.001	... limit

c)	$(1+x)^{1/x}$...	
	x	1	0.1	0.01	0.001	0.0001	... limit

d)	$\frac{\sin 6x}{\sin 2x}$...	
	x	1	0.25	0.1	0.001	0.0001	... limit

5. The number of gallons of water in a tank t minutes after the tank has started to drain is $Q(t) = 200(30 - t)^2$.

- What is the average rate at which the water flows out during the first ten minutes?
 during the five minutes from $t = 5$ to $t = 10$?
 during the two minutes from $t = 8$ to $t = 10$?
 during the minute from $t = 9$ to $t = 10$?
- Estimate how fast the water is running out of the tank at the end of ten minutes.
- Draw a graph of the function Q for $0 \leq t \leq 20$. Draw the secant lines for the four time intervals used in part a). What are their slopes?

6. Define *slope* for the following cases:

- for two points
- for a line
- for an arbitrary curve in the plane