1. One day I drove 100 miles between 3 PM and 5 PM. Calculate my average speed. ____ ____

2. It takes 2.00 seconds for a rock to fall 32.2 feet. Calculate its average speed. ___ ___

3. Suppose I am 12 miles from home at two o'clock.
* a. Why can't I use that time and that distance to determine my average speed?
* b. Is it correct to say that average speed equals distance divided by time?
* c. Show how we must modify that statement to make it correct and clear. *Save a copy* on RS I.

4. When you calculate a speed (as you did in #1 and #2) you always divide one number by another number. Both numbers always have units.
a. One of the numbers always is a distance, so it always has *distance* units such as ____ or ____.
b. The other number is always a time interval, so it always has *time* units such as ____or ____.
c. When you divide the numbers, what do you do with the units? __________________
d. According to 4c, a speed unit is always a _______ unit divided by a _____ unit. -Does #2 agree? __
e. Some of the following are not speed units. *Cross them out. Circle* the ones that are speed units.
ft per min cm/sec hour/meter swings per sec.

5. A "**ticker**" (recording timer) is a device that makes dots at a steady rate on a paper tape.
a. Imagine a ticker clamped to a table. Suppose a tape is pulled through the ticker slowly. Another tape is pulled through the same ticker at a higher speed. Sketch the dot patterns that you expect on the two tapes, showing how they will differ from each other. Label them "fast" and "slow".
b. Another tape is pulled through the same ticker with gradually increasing speed. Sketch the pattern of dots that you expect. Label the first and last dots, and *indicate the direction of the tape's motion*.

6. Another motion is recorded with a different ticker. This time the distance from the first to the third dot is 1.5 centimeters and the distance from the third to the fifth dot is 3.3 cm. The amount of time between one dot and the next is called a "tick". Remember that we are now using centimeters and ticks instead of miles and hours. *Keep a copy the information below for use on page 9.*
a. What non-standard speed units will we obtain, according to 4d? _____ per ____
b. Using 3c and 6a, the average speed for the first two-tick interval is _____ _____
c. Show how the average speed in the next two-tick interval is found: (___ __) ÷ (___ ___) = ___ __
d. Did this tape's speed *increase*, as in 5b? __ Did it *remain constant* as in 5a? __ -Did it *decrease*? __

7. Drop a book onto your lap from a height of about one foot. Then drop the same book onto your lap from about two or three feet. Can you feel the difference? ____ Those impacts tell you that the speed of a freely falling object _____________ as in #___. (increases, decreases, remains constant)

8. Observe the motions of several small falling objects. Decide if their motions are affected significantly by the air. (Air causes a feather to flutter as it falls.) Find a pair of objects with unequal masses which are *unaffected* by the air as they fall. (Such objects are said to fall "*freely*".) Hold them together and release them simultaneously. Compare their falling *motions* and describe what you see.

9. Experiment: Record the motion of a freely-falling object. *Use the advice below.*
a. The object's mass must be at least half a kilogram, so that the motion will not be affected significantly by the friction between the ticker and the paper tape.
b. The falling distance must be more than one meter, so that you will have enough data to see a pattern.
c. The length of the tape does not need to be any greater than the falling distance.
d. To protect the floor, place a stack of scrap paper or an old catalog on the landing area.
e. The tape must begin moving through the ticker at the moment when the object begins to fall, not later. *There must be no slack in the tape between the object and the ticker before release.*
f. The release must be sudden. *Keep the tapes for page 9.*
g. Each student must make at least one good tape. Each team should make some some extras.

10. The tape shows that the object's speed __creased as it fell. What *caused* that speed to change? ______

11. Suppose you recorded the falling motion of a more massive object: Would the tape show a different pattern? _____ If so, please describe the difference. In either case, please explain how you know.