1. Things which are measurable and which have direction are called **"vectors"**. Measurable quantities which have no direction are called **"scalars"**. For example, *mass* is a scalar, but *forces* are vectors.
   a. Is a velocity a vector? ___ Is velocity a scalar? ____ Temperature is a _______.
   b. Another example of a **vector** is_________. --Another **scalar** is ________.

2. On page 30 you were asked to predict the final displacement of a person who walked four meters north, turned right, and then walked four meters east. One method is to pretend that your paper is a map. Let's pretend that "north" is toward the top of the paper, and that "east" is toward the right side of the map. Sketch that map in the space at the right:
   a. The *magnitude* of the person's final displacement (in *decimal* form) was about ______ meters.
   b. The *direction* of that final displacement was described with one word as "___________".

3. Several different directions are described below. *None* of them are horizontal. Some of them are not described clearly. Cross out the ones which are not clear. (See #2 on page 34R if necessary.)

36.4 degrees down from east	89.95 degrees west from down
0.05 degrees down from west	95.2 degrees from north
95.2 degrees clockwise from north	95.5 degrees south from north

   * a. Explain what is wrong with the ones which are not clear. (Use 2 & 4 on page 34R)
   b. Which two examples describe the same direction? ________________ and ________________
   c. Both of those descriptions are rounded to the nearest __________th of a degree, yet one description is longer than the other. Which one do you prefer, and why? (See page 34R)

4. Make a map like #2 to describe the path of a person who walks four miles north, turns left, and then walks another *three* miles. Choose a scale intelligently so that your diagram will have one-percent precision or better. (Use #12 on RS III. Make it cover almost half a sheet of paper.)
   a. Describe the "scale" of this map: ***"One ____ represents ____ mile."***
   b. Make a dotted arrow to indicate the person's final displacement. (We call it the "resultant", or "vector sum" of the two given displacements.)
   c. The **magnitude** of the person's final displacement is "___ miles".
   d. Place the center of a protractor at the vertex of the angle formed by the northward vector and the resultant. (See 4b.) Trace an arc from the former to the latter, and measure that arc in degrees: __
   * e. Using 4d, describe the *direction* of the final displacement. (See page 31R or #2 on page 34R.)
   * f. Using similar language, describe the direction of the resultant *in #2*. (Use "from", as in #3 & 4e.)
   * g. A *single word* described the direction of the resultant in #2b. Why would a similar word be *incorrect* in #4e?

5. Suppose a person tries to swim east at 3.0 mph in a river that flows north at 4.0 mph.
   a. The velocity of the person relative to the water is given: $\boldsymbol{V_{pw}}$ **= *3.0 mph east.***
   b. We also know that ***4.0 mph north*** is the velocity of the ______ relative to the ______ = $\boldsymbol{V_{wg}}$.
   c. From #14 on RS II we know that $\boldsymbol{V_{pg} = V_{pw}} +$ _____.
   d. Since velocities are vectors, I must use *vector addition* to find the unknown $\mathbf{V_{pg}}$. So I must set up a scale diagram. To make the diagram reasonably precise it must be big enough to cover almost _____ of a sheet of paper. Thus I choose to let ___ cm. in the diagram represent ___ mph.
   e. $\mathbf{V}_{pw}$ will be represented by an arrow ___ cm. long pointing toward the ____ side of the paper.
   f. $\mathbf{V}_{wg}$ will be represented by a ___-centimeter arrow drawn from the _______ end of the $\mathbf{V}_{pw}$ arrow, pointing toward the ________ of the paper, i.e. _____ward. *Where is that diagram?* _______
   g. $\mathbf{V}_{pg}$ will be represented by a third arrow drawn from the ____ end of ____ to the ____ of ___. We find that this arrow is _____cm. long, indicating that V_{pg} is about ____mph.
   h. With a protractor we find that the *direction* of V_{pg} is about ____degrees ____ from ___.
   i. Does this result agree with #5 on page 31R? ___ -Does it agree with #5c on page 34R? ___

1. **Standard Directions:** On a conventional map of the USA we find the northern part of the country near the ___ of the paper and the ________ern part of the country near the right side. On the back of this paper draw and label four arrows pointing north, south, east, and west as you would on such a map. (These are four of the six **"standard"** directions. The others are "___" and "____".)

2. **To Practice Describing Other Directions:** On the back of this paper draw a new arrow in a randomly-chosen direction, not parallel to any of the first four. *Use a ruler.* Label it "A".
   a. Write the name of the nearest *standard* direction into the *third* blank in 2e, below.
   b. Starting at the tail end of A, draw an arrow in that standard direction. Call it "B".
   c. Use a protractor to measure the angle between arrows A and B. If it is less than 45 degrees, write it into the first blank in 2e. If it is greater than 45º, check your measurement. Make sure that the center of the protractor is at the vertex of the angle and that the zero-degree mark is on one of the arrows. *If it is still greater than 45º then go back to step 2a and guess again.*
   d. Lay a pencil along arrow B. While holding its erasor on the tail end of B, push the pointed end to make the pencil turn like the hand of a clock until it lies along arrow A. (You may turn it clockwise *or* counterclockwise, whichever is shorter.) Using #1, decide what standard direction you pushed the tip of the pencil, and write it into the *second* blank in 2e.
   e. Conclusion: ***The direction of arrow A is ____ degrees _____ from ______.***

3. **How To Practice Drawing a Vector in a Given Direction:** Choose any number between 0 and 45 and any two standard directions which form a right angle. Use those choices to fill in the blanks in this statement: "Vector **C** points ____ degrees _____ from _______."
   Then use the instructions below to draw an arrow pointing in the direction that you just described. (Again, please use the back of this paper.)
   a. Lightly draw an arrow in the standard direction that you named in the **third** blank. Call it "E".
   b. Place the *center* of your protractor on the tail end of E. Trace an arc intersecting that arrow.
   c. Starting at the intersection point, move along the arc in the direction that you named in the second blank. Stop when you have covered the number of degrees indicated in the first blank, and make a mark at that point. Draw an arrow from the tail of E through that new mark. Label it "C".

4. **Describing Directions Which Are Not Horizontal:** In the real world there are not just four standard directions, there are *six*. The directions that we call "up" and "down" are perpendicular to all four of the standard directions mentioned above. Have you ever tried to squirt as far as possible with a hose or a water pistol? If so, you probably noticed that you don't get maximum distance by aiming horizontally. You have to aim a certain number of degrees "up from horizontal." As you know, "north" is a *horizontal* direction. If you want the water to reach a target that is north of you, you must aim a certain number of degrees ___ from _______. *Please draw a picture of the hose and the curved stream of water to show that you understand this idea.* (See #7 on page 29.)

5. **Familiar Triangles:** (This information comes from page 31R. It should *already* be on RS III.)
   a. In a **45-45-90** triangle the "hypotenuse" (longest side) is always ____ times longer than the other two. *Please illustrate. For extra help, see page 31R.*
   b. In a **30-60-90** triangle the *short* side is always ______ times as long as the hypotenuse, and the length of the third side is _____ times the length of the hypotenuse. (Use *decimal* form.)
   c. In a **3-4-5** triangle the *smallest* angle is always about ___ degrees and the other two are about ___ and exactly ____ degrees. *Round off to the nearest degree (or to the nearest tenth) and illustrate.*

6. **How to Add Vectors:** Without changing their sizes or directions, draw the vectors *tail-to-head*, forming a "chain of arrows". Then draw a dotted arrow from the tail of the first to the head of the last arrow in that chain. The dotted arrow describes the vector sum.