1. If the price of an item was $10 yesterday but it is $11 today then its *change* in price was ____ ___.
   a. As on p. 0, that change is calculated by ________ing its ____ price from its ____ price. (new, old)
   b. Similarly, a change in *velocity* is found by ________ing a _____ velocity from a ______ one.
   c. Let "$\mathbf{V_o}$" represent the old velocity, let "$\mathbf{V_n}$" represent the new velocity, and let "**ΔV**" represent the *change* in velocity. Use those symbols to write eq. 1b: ___ = ___ - ___ Does 1c contradict 1a or b?

2. If we choose to let upward vectors be represented by positive numbers then downward vectors must be _____tive. Suppose that in 2.0 seconds the velocity of an elevator changes from -1.0 m/s to +3.0 m/s:
   a. To find the elevator's change in velocity we must subtract ____m/s from ____m/s.
   b. Write 2a as a "number sentence". Don't contradict #1 or 2a. **ΔV = (___ m/s) - (___ m/s)**.
   c. The rule for subtracting signed numbers says that in this case we must reverse the sign (direction) of the _____ velocity (old, new) and then _____ it to the ____ velocity.
   d. We get **ΔV = (___ m/s) + (___ m/s) = ____ m/s.** *Does 1c agree?* ____
   e. The sign of that result indicates that **ΔV** is a vector pointing _____ward.
   f. To determine this elevator's average *acceleration* you must divide that **ΔV** by ___ seconds.
   g. The sign of that quotient indicates that the elevator's acceleration was ____ward.
   h. Sketch a linear graph of *velocity vs time* describing the elevator's motion during the 2 seconds.
   i. That graph has a _____tive slope, indicating that the elevator's ___________ was in the ____ward direction during the entire ___-second interval. -Does 2i agree with 2g? ___ -with 2e? ___

3. Two forces act on a person who is riding in an elevator:
   a. There is a _____ward gravitational force exerted on the person by the ______. (See #6 on p. 35.)
   b. There is also an ____ward force exerted on the person by the floor of the elevator.
   c. Whenever the elevator begins to accelerate or decelerate the ____ward force must change.
   d. The _____ward force *cannot* change unless you alter the mass of the earth or the mass of the ______.
   e. When the acceleration is *upward*, the ___ward force is stronger than the _____ward one.
   f. If the acceleration is *downward* then the downward force is ______er than the upward one.

4. On page 0 and again on page 31 you observed that elevator passengers feel lighter than normal when the acceleration is ______ward, and heavier than normal when the elevator is __________ing upward.
   -Is the direction of the elevator's *velocity* important for this question, or is it irrelevant? ___________.

5. When you are stopping a downward motion *or* starting an upward motion in an elevator you feel _______er than normal because your ____________ is _____tive, meaning _____ward.
   Do 2g, 2i, & 4 above all agree with that fact? ____

6. Set up a long pendulum with a spring scale measuring the string tension. Measure the tension when it is just hanging. Then watch the scale while the pendulum is swinging with a large amplitude. Does the string tension remain constant while the pendulum is swinging? _____
   a. When the bob is near either endpoint of its curved path the string pulls diagonally on it with a force that is ________ ____ the gravitational force on the bob. (stronger than, weaker than, equal to)
   b. When the bob is passing through the *lowest* point of its swing, the string pulls _____ward on it with a force that is ________ ____ the gravitational force on the bob. (stronger than, weaker than, equal to)
   c. When the bob is passing through the midpoint of its swing the *total force* on it is ____ward.
   d. According to 4b on RS III, an object's acceleration is always in the same direction as the _____ force acting on it. Therefore the bob must be accelerating ____ward as it passes through the midpoint.
   e. Does 6c contradict 6b? ___ Does 6d contradict 6c? ___ *If so, explain why this doesn't bother you.*
   f. The discovery in 6d has been recorded in #__ on RS IV. Will it still be there when you need it? __

7. To understand that strange conclusion we must look closely at the definition: "**Acceleration**" is the ***rate*** *at which* ***velocity*** *changes.* In other words, it's the ***change*** in _________ divided by the corresponding time ***interval***. In algebraic language, **a = Δv/Δt**. (Recorded on RS __.) To calculate the "ΔV" in that fraction we must _____________ two velocities. *To be continued...*

1. Sometimes it is convenient to pretend that a vector is the sum of two other vectors in different directions. Those two imaginary vectors are called “**components”** of the original vector. For example, I could throw a ball "with a vertical velocity of 3.0 m/sec and a horizontal velocity of 4.0 m/sec northward". That is equivalent to throwing it with a velocity of "___ m/sec, ___ degrees up from ______", as you can see by *vector addition*. (See pages 35 & 35R.) *Please illustrate your answer.*

2. You can describe a vector by giving its magnitude and direction, as we did on page 35, **or** by listing the magnitudes of its *components* as we did in the example above. The procedure you use to find the magnitude and direction of the vector when you are given only its components is called **composition**.
   a. You already know the process by the more familiar name underlined above: ________ ________
   b. The reverse procedure is called **resolution.** To "resolve a vector into components" means to find two new vectors in two previously-chosen directions so that their vector sum is equivalent to the original vector. For example, in #1 you could have been given the hypotenuse of the triangle and you could have determined the lengths of the other two sides. In doing so you would have "_________ed" the original velocity into horizontal and vertical "_______________s".

3. As an example, think about a 2.5-kg brick resting on a board inclined at 15 degrees from horizontal:
   a. The fact that it is not accelerating tells us that the total force on it must be _____. (See #3 on RS III.)
   b. We know that the downward gravitational force on the brick is ____ N. (Use #8 & #9 on RS III.)
   c. We conclude that the upward force exerted on the brick by the board is ____ N, since the board is the only other thing that could be exerting a force on the brick.
   d. Another way to look at it is to say that the board simultaneously exerts *two* forces on the brick: One of them is in the **normal** direction, (perpendicular to the board) and the other is in the ***uphill*** direction, *parallel* to the board. On pages 39 & 40 the first of those was called the "normal force" exerted on the brick by the________; the other was called a "_______ ________ force". (See RS III.) *Those two forces are actually "components" of the single upward force described in 3c.*

4. Here is a foolproof, non-thinker's method for resolving any vector into components:
   a. Decide on the desired directions for the two components. (They must not be parallel.)
   b. Draw a dotted line through the tail of the original vector in one of those directions.
   c. Draw a dotted line through the head of the original vector in the other chosen direction.
   d. Extend the two dotted lines until they intersect, and draw an arrow along the dotted line from the tail of the original vector to the point of intersection. That's the first component.
   e. The other component is an arrow from the intersection point to the _____ of the _______ vector.

* 5. Use that procedure to calculate the force components mentioned in #3d on this page. First sketch and label a diagram. Then use trigonometry or a scale drawing large enough for 1% accuracy. Name the two components as in #3 and describe their magnitudes and directions in the manner that was explained on pages 35 and 35R. Here is a *trigonometric* method for solving right triangle problems:
   a. Draw triangle. Label the sides. Label the given angle and the right angle.
   b. Decide which two sides are involved in the question. (Opposite, adjacent, hypotenuse)
   c. Write the definition of the appropriate trig function (sin, cos or tan) using the symbols defined in 5a.
   d. Solve for the unknown and then plug in the given data.

6. The motion of a ping-pong ball in flight is recorded with a movie camera at 15 frames per second. Between the 5th and 16th frames the ball's average velocity was 18.27 m/s, 37 deg up from north. Between the 16th and 27th frames its average velocity was 6.06 m/sec, 2.6 deg down from north.
   a. The ball had an instantaneous velocity equal to the first one given above at a time roughly midway between the 5th and 16th frame: (10.5 fr) ÷ (15 fr/sec) = ____ sec. after frame zero.
   b. At approximately what time did the ball have an instantaneous velocity equal to the *second* one mentioned in #6? (________) ÷ (________) = _____ sec. after _____________ ________.
   c. The ball's average velocity for the interval between those two times can be found by adding the two _____s and then dividing by 2. (Show how.) Describe its direction as on page 35R:
   d. The ball's *change* in velocity for that interval is about ____ m/s, ___ degrees from down.
   e. Show how the average acceleration of the ball during that interval is calculated.
   f. Resolve that acceleration into components so that one component is vertical and the other is parallel to the average velocity mentioned in part c. (Use #4)
   g. Those acceleration components must have been caused by something. Name the two causes.