1. In the experiments on pages 48 & 49 we discovered a relation between the acceleration of an object and the _______ force acting on it. (See 2b on RS V.) A simple graph describes the relation.
   a. Do you expect such graphs to have different shapes for different objects?____ -Does 5a agree?____
   b. In what ways might these graphs differ from each other? *"Graphs of acceleration vs ________ ________ may have different _________s if the objects have different _______s."*
   c. Please illustrate 1a and 1b with two sketched graphs. Remember to give them titles.
   d. Indicate which graph corresponds to which kind of object.

2. Label the *steeper* graph in #1c as "**A**", and the less-steep graph "**B**":
   a. Which object (A or B) will accelerate more if identical forces act on them? _____
   b. That can happen only if object __ has a greater ______ than object __. -Does 1d agree? ___
   Review pages 37-39 or do an experiment to find the answer to 2b.
   c. Sketch a third graph for a *very* massive object. Label it "C".

3. Now imagine a set of objects with different masses, all experiencing the same total force.
   a. Sketch a graph of *acceleration vs. mass.* Using 2b & c, start with three dots labelled A, B, and C.
   b. Does 3a agree with 1c? ___ -Does it agree with 2a? ____ -with 2b? _____
   c. Graph 3a suggests that _____________ *MAY* be proportional to _________. (See pages 18 & 18R.)
   d. A linear graph of _________ vs ________ would verify that guess. (See 17a on RS II.)

4. Students have found that it is not easy to make the same total force act on several different objects. One reason is that changing the mass of the vehicle changes the friction force, thus changing the total force. If you use a ramp, the propelling force and the friction both depend on the object's _______. If you use pulleys, keeping the suspended weight the same does *not* insure that the forward force will be the same for all runs. On page 50 we found that the string tension *depends* on the suspended object's ___________, as well as its weight. *Check here when you have reviewed 5-8 on page 50:* ___ -Can you think of a way to overcome those difficulties? ___
   If so, please explain your ideas and perform the improved experiment. If not, do #5 & 6 below.

* 5. Answer questions 5a-5e with a short paragraph. *Begin with an opening statement,* so that *any* reader will be able to understand your paragraph. Use simple English. Avoid using slang.
   a. Several different groups did the Acceleration & Force experiment on page 48, using objects with different masses. Do all the resulting graphs of acceleration vs. total force have the same shape?
   b. Do they all have the same slope? -How is such a slope calculated from "a" and "TF"?
   c. What do you expect a graph of slope vs. mass to look like? -Does your sketch agree with #1 & 2?
   d. What type of equation would be your first guess to describe this graph?
   Please use 3c as a model for this answer. Remember to check units and to define your symbols.
   e. What graph can you make to test that guess, and what shape will it have if your guess is correct?

6. Optional: As you know, the procedure described in #5 *was* performed by the groups in your class.
   a. Collect the data from your classmates . See that all of the masses are measured in SI units and that all of the "a/TF" values in your data table are expressed in *range* form, with SI units. (See p. 12.)
   b. Follow the plan that you made in 5e. Use *error bars* to describe the a/TF ranges on your graph.
   c. Write the name of the team next to each error bar on the graph. If a team's result does not fit the pattern, go to that team and politely find out if the accelerations were calculated correctly. Also see if the slope was determined correctly. Help your friends to correct any mistakes that you find.
   d. If the graph does resemble a straight line through the origin, draw two reasonable lines from the origin so that roughly one sixth of the data points lie above the steeper line and one sixth are beneath the lower line, just as we have done in previous experiments.
   e. Using *SI units,* determine the slopes of those two lines and write them on the graph.
   * f. On that same graph, write a conclusion like the ones on pages 17, 18, and 18R. First write an equation relating a/TF to the mass, then define your symbols (including the one representing the constant) and then give the value of the constant as a range with units. You'll get no credit if your conclusion doesn't agree with your graph. You will need a copy of that conclusion for future work.
   g. This new equation is called "Newton's Second Law". A copy has been saved on the back of RS __.

1. One "standard force unit" is enough to accelerate a 1.00-kg object at 1.00 m/s^2 when no other forces act on it. Accelerating the same object at 2.00 m/s^2 would require ___ standard force units.

2. Imagine three blocks identical to the object in #1, placed side-by side. Each one is propelled by a force equal to the one described *in the blank above*. They stay together while accelerating at __ m/s^2.
   a. Suppose we glue them together to form one big block: Using the same units as in #1, the total force on the big block must then be ___ _______ _______ _______.
   b. The mass of the big block is ______ ______. Its acceleration is _____ _____.
   c. If *standard* (SI) units are used, then the numerical value of the force in 2a can be calculated by ___________ing the numerical value of the mass of the big block by the numerical value of its acceleration. (Name the arithmetic operation. Then use the data in # 1 & 2 to *check* your answer.)

3. On RS III you wrote that the "total force" acting on an object is the ________ _____ of all the forces acting on that object. Let "___" represent the total force acting on an object. Let "__" represent the mass of the object. Let "__" represent the object's acceleration. Use those symbols to write the equation that you discovered in 2c: ____ = _______ -This discovery is recorded in # __ on RS V.

4. The equation you wrote in #3 is known as "**Newton's Second Law of Motion**". His first and third laws are on page 31. The same three laws are recorded in #___, ___ & ___ on RS ___.

5. If you had made these discoveries before there was a standard force unit it would have been necessary to invent one, as we did in #1. (Gabriel Fahrenheit invented a temperature unit for similar reasons.)
   a. In #1 and 2 you already had a standard mass unit (______) and an acceleration unit (_______). Therefore the "standard force unit" in #1 was defined as "the amount of force required to accelerate one ____________ of matter at ______ ______ per ____."
   b. The mass of my cart (on page 48) was ______ _____.
   c. The greatest acceleration in that experiment was ______ _______.
   d. #2c above says I should ___________ those two quantities. The result is _______ _______.
   e. The total force on the object (as measured in the experiment on page 48) was ______ pounds or ______ newton. Which one agrees with 5d? ________ _____
   f. Conclusion: One standard unit of force (called a "_________") is one _____ ______ per ________.
   g. Check here ___ when you have copied that definition onto RS V.

* 6. An Amity student once wrote that there *must* be a forward force acting upon a coasting object, since the object continued to move forward after the push. According to this student, "The pushing action continued to exert a force upon the object after the action stopped because it was strong enough to create enough momentum to keep the object moving forward." If you agree with this person, please explain how you could use a spring scale to measure the force exerted by the "pushing action" during the coasting process. If you don't agree, please explain why you don't. *Try not to mystify the reader.*

7. When describing new cars, a consumer magazine always gives the distance required for a full stop from 60 mph. In any issue there are reports on cars weighing anywhere from 1900 to 5000 pounds or more, yet the braking distances are always close to 140 feet. Deviations of more than 10% from this figure are rare. Why are they all nearly the same? One way to answer that question is to create a formula for the stopping distance. The method used in Ch. II still works: (See #13 on RS II.)
   a. First sketch a speed-time graph describing the car's motion while stopping.
   b. Eliminate Δt from the familiar slope and area equations to create a formula for the stopping distance in terms of the initial speed and the deceleration. (See #21 on RS III or #10 on RS II.) **D =** _____
   c. Use your knowlege about friction (#18 on RS III) to create a formula for the total force on the car. (It will involve the friction coefficient and the mass of the car.) *Define your symbols.*
   d. Use 7c with #3 to create formula predicting the car's maximum possible deceleration in terms of m, g, and the friction coefficient. *Remember to simplify it and to check units.* **a =** _____
   e. Equation 7d tells us that doubling the mass of the car will cause the stopping deceleration to ______.
   f. Use equation 7d to eliminate "a" from equation 7b. **D =** _______ *This result is in #___ on RS V.*
   g. Do 7e & 7f agree with the data presented in the magazines? ____
   h. Use the given data with 7b to calculate a car's maximum braking acceleration. *Show how it is done.* (Use #1 on RS II.) Use the result to calculate the friction coefficient for tires on dry pavement. *Show how you do it. Be careful with units. Remember to round off properly.*