

1. Superman stands in the window of a building 90 feet above the street. A baby falls out of a window forty feet higher, passing right in front of the Man of Steel. With what acceleration must he descend to catch the baby just before impact? Please show how your answer is obtained. (You may use the hints below if you find this to be a difficult question, but you shouldn't need them.)
 - a. Draw the baby's speed-time graph. Mark and label the times when he passes Superman and when he would hit the ground if he were not caught.
 - b. Write the definition of acceleration and a formula for the area under the graph.
 - c. Use that pair of simultaneous equations to determine the time and speed at which the baby passes Superman. Also determine any other time intervals that might be useful for solving the problem. *Show how they are obtained.*
 - d. Draw Superman's speed-time graph, assuming that he accelerates uniformly from rest. Write slope and area equations for this graph as you did in part b. Then solve for the unknowns.
 - e. Check the units involved in your calculations. Notice that this problem involves feet, not meters, so the acceleration of the freely-falling baby is ____ *feet* per squared second. (See page 6.)
 - f. After rounding off properly, please draw a **box** around your answer to the original question.
 - g. What will happen to the baby if the Superman catches it just before impact?

2. Two cars accelerate from 0 to 55 mph in 12.0 seconds. Car **A** has a gradually *decreasing* acceleration while car **B** has a gradually *increasing* acceleration:
 - a. Sketch the two speed-time graphs. Superimpose them and label them "A" and "B".
 - b. Which car covers the greater distance during those 12 sec., and how do you know? (Use #2 on RS II as you did in 6d on page 27b.)

3. Imagine standing in an elevator. The cables break and the elevator falls freely:
 - a. What causes it to accelerate? _____
 - b. How much acceleration does the elevator have relative to the earth? _____
 - c. After the cables break, while the elevator is still falling freely, you release a watermelon that you were holding. Gravity then causes the watermelon to accelerate at ____ relative to the ____
 - d. How much acceleration does the watermelon have relative to the *elevator*? _____
 - e. Does the watermelon seem to have any weight in the elevator's frame of reference? _____
 - f. Can you walk around normally in the elevator while it is falling? _____

4. I forgot to mention in #3 that the elevator was moving upward rapidly at the moment when the cables broke. Consequently it coasted upward for some distance before starting downward.
 - a. Does that new information alter any of your answers to #3? _____ (* If so, please explain.)
 - b. Would friction between the elevator and the shaft prolong the upward motion? _____
-Would it help the elevator to stop moving upward? _____
 - c. If the elevator stopped suddenly while moving upward the passengers would hit the _____.
 - d. That means the passengers would momentarily push ____ward on the _____ and the ceiling would simultaneously push _____ward on the passengers, causing them to stop.
 - e. Suppose we make the elevator experience a *slightly* more gradual stop:
The push exerted by the ceiling on the people will then be slightly _____er. (stronger, weaker)
 - * f. **Using** 4d & 4e, what can we conclude about passengers in an elevator which is *coasting* upward *with* friction? (What object pushes on them, and in what direction does it push?)

5. If you are in a vehicle that is moving with perfectly constant velocity can you "feel" the motion? Can you construct an instrument to detect such motion without receiving information from outside? ____ If so, please explain how it will work. Also explain how such an instrument would respond to freely-falling motion. Try not to contradict #3, above.

1. *From Earth To Moon* is a nineteenth-century science fiction novel in which Jules Verne displayed his incredible ignorance. (Perhaps he was merely writing for an ignorant audience, as television writers often do today.) In the story, two men and a dog are placed inside a capsule which is fired from a gigantic cannon aimed at the moon. In the story, they walk around comfortably in the capsule until they cross the invisible boundary between the earth's gravity and the moon's. At that moment they fall painfully to the ceiling of the capsule. If we actually tried such a stunt the experiences of the passengers would be very different. To see why, divide the trip into four parts:
 - a. The moment when the cannon is fired:
 - b. The period of coasting upward through the atmosphere:
 - c. The period of coasting away from the earth after leaving the atmosphere:
 - d. The period of falling toward the moon, *before* impact:
 - Which parts of the trip illustrate the conclusions you made in #3 on page 31b? _____
 - Which part illustrates 4d -4f on p. 31b? ____ -Part "d" of the trip is most similar to # __ on p.31b.
- * 2. Explain what would really happen to you in such a capsule during each part of the trip. (What would you feel if you were still alive? --Could you walk normally? --If not, why not?) Try not to contradict what you said in #3 & 4 on page 31b. Remember that a force can only be exerted by an *object*. *If you mention a force, you must name the object which exerts that force.*
3. The operation that transforms a displacement-time graph into a speed-time graph is called "_____". The operation that transforms a speed-time graph into a displacement-time graph is called "_____". (Review page 29b.) Those facts are on Review Sheet ____ .
4. Sketch a graph describing the equation $y = 5 - 3x$ and give the slope of the graph.
 - a. Sketch a graph of the derivative of that original function.
 - b. Whenever a graph has a _____ shape its derivative is a line parallel to the _____ axis.
 - c. If a graph is a horizontal line below the axis, then its integral is a _____ line with _____ tive slope. (Use #13 on RS II.)
 - d. If a graph is a horizontal line *above* the axis, its integral is a _____ with _____ .
5. Copy the accelerating car's speed-time graph that you sketched on page 27b & 29b and on the back of RS II. That graph suggests that the car's speed *may* be proportional to time with an exponent.
 - a. If that is the case, then the exponent on the time must be between ___ and __ , because an exponent *not* in that range would give a graph with a very different shape. *Please illustrate.*
 - b. Sketch the car's displacement-time graph, as in 8c on page 29b. It suggests that the car's displacement may be proportional to time with a different exponent. That new exponent must be ___ than __. (If it were not, the graph would have a very different shape.)
 - c. The graph in part b was created by integrating the speed-time graph sketched above.
 - d. It seems that integrating a function of this type causes the exponent to __crease.
6. The same car's *acceleration* vs time graph was sketched in #9 on page 29b. *Please illustrate.*
 - a. The shape of that graph suggests an equation with a _____ tive exponent.
 - b. That graph was obtained by _____ ting the car's _____ vs time graph, which seemed to have an exponent between ___ and __. -Does #6b contradict 5a? ____
 - c. It seems that the operation mentioned in 6b causes the exponent in a relation to __crease.
7. On page 29b we concluded that integration and differentiation are _____ operations. We recorded that important discovery in #__ on RS II. Do 5d and 6c on this page support that conclusion? ____
8. Suppose an object slips through your fingers for a few centimeters as it is released. It does not fall freely during the first part of the trip. How is the shape of the displacement vs. time squared graph differ from the ideal one in this case? *Please illustrate your explanation with sketches.*