

1. Which is harder to accelerate: a massive cement truck, or a small motorcycle? _____
 2. Imagine two objects being accelerated separately by equal forces. Object 1 accelerates at 50 cm/sec^2 while object 2 accelerates at 36 cm/sec^2 . Which is the more massive one? ___ *Does #1 agree?* ___
 3. Let's use Newton's law to determine the ratio of the masses of objects 1 and 2 in #2.
 - a. When you solve it for "mass", the law says $\mathbf{m}_1 = \underline{\hspace{2cm}}$, $\mathbf{m}_2 = \underline{\hspace{2cm}}$.
Notice that when you fill in those blanks you don't need to put subscripts on the ___ because those two values are equal. But you must remember to put subscripts on the ___'s.
 - b. Divide the greater mass formula in 3a by the formula for the smaller mass. Simplify (by inverting the divisor and then multiplying) to get a formula for the mass ratio: _____
 - c. Plug in the given data to calculate the mass ratio in *decimal* form: _____ *3b says it must be _____ than 1. -Is it?* ___ Does your answer contradict #2? ___ (If so, it will earn no credit.)
 4. It takes 0.20 seconds to give a 0.70-kilogram hammer a speed of 5.0 m/s. starting from rest at 1:00 PM. Use the given data along with the clues below determine the average propelling force on the hammer.
 - a. We would like to multiply the mass of the hammer by its _____, because that's what Mr. Newton advises us to do. But that acceleration is not given.
 - b. The definition of acceleration on RS I, RS II, and RS III still says that $\mathbf{a} = \underline{\hspace{2cm}}$.
 - c. Using that definition to replace the "a" in Newton's second law, we get $\mathbf{TF} = \mathbf{m}(\underline{\hspace{2cm}})$.
 - d. Insert the given data into 4c: $\mathbf{TF} = (\underline{\hspace{2cm}})(\underline{\hspace{2cm}}) \div (\underline{\hspace{2cm}}) = \underline{\hspace{2cm}}$.
 5. Two identical bricks are pushed by hand on a level surface. One is pushed hard, causing it to accelerate from 0 to 6 m/s westward in only 0.2 sec. The second brick is pushed more gently, so that it takes 0.5 seconds to reach the same westward velocity. Both bricks are released immediately after reaching that speed, and they both slide to a stop. *Review page 24 or 49 if necessary.*
 - a. Sketch the two speed-time graphs. Label the "coasting" section on each graph. Also label the part where the object was pushed. Write "pushed hard" on one graph and "pushed gently" on the other.
 - b. Label the release point on each graph. The speed at the release point on one graph was given as _____ m/sec. The speed at the release point on the other graph was given as _____.
 - c. Write the given time intervals (0.2 s and 0.5 s) on the appropriate sections of the time axes. Mark the endpoints of those segments clearly. Draw dotted lines straight up from those points.
 - d. The "coasting" section on each graph describes an acceleration in the ___ward direction, caused by a _____ force in the ___ward direction. Illustrate with a force diagram.
 - e. Does 5d agree with 4b on RS III? ___ -With 2a on RS V? ___
 - f. Does the sliding friction force depend on speed? ___ -on propelling force? ___
 - g. In this example are the two normal forces different? ___ -Are they equal? ___
 - h. Is there any *other* variable which the sliding friction depends on? _____ (If so, name it.)
 - i. In this example is the sliding friction coefficient a variable? ___ -Is it a constant? ___
 - j. How must the friction forces on the two bricks compare? _____
 - k. During the coasting period how must the accelerations of the two bricks compare? ___
 - l. Are the skidding times given? ___ -Are they unknown? ___
-Are the skidding times equal? ___ If not, which is greater? ___ -Does 5a agree? ___
 - m. How must the two coasting distances compare? _____
 6. Now we glue an identical brick on top of the first one and give the pair the same initial sliding speed:
 - a. A "normal force" is exerted on the double brick by the _____ in the ___ward direction. It prevents the bricks from _____ing.
 - b. The normal force on the double brick is ___ times as great as the original one in #5.
 - c. The friction force on the double brick is ___ times as great as the original one. (See #18 on RS III.)
 - d. Let "M" represent the mass of the single brick. The mass of the double brick is ___ times M.
 - e. According to Mr. Newton, we can predict the acceleration of the coasting double brick by dividing the force mentioned in ___ by the _____ mentioned in 6d. Do it and simplify the result.
 - f. We must conclude that the acceleration of the coasting double brick is _____ the original acceleration of the single brick. (less than, equal to, greater than)
- * g. Experiments show that the double brick slides just as far as the single brick, even though a greater force acts to slow it down. Is that what Newton's second law predicts? *Explain, using 3b on RS V.*

1. Here are three strategies for stopping a car: *Method 1* is to jam on the brakes and skid, using the _____ force exerted on the tires by the _____ to stop the car. (See RS III.) *Method 2* is to press the brake pedal *almost* hard enough to cause a skid, so the braking force is _____ friction. *Method 3* is to release the brakes and re-apply them several times while stopping.
 - a. Sketch speed-time graphs to illustrate the three methods.
 - b. Which method causes you to lose steering ability while stopping? ____
 - c. Which method enables a skilled driver to stop most quickly on dry pavement? ____ See 19 on RS III.
 - d. Which enables an unskilled driver to retain some control of the car even if skidding is silent? ____
2. In each case the car is stopped by a *static* friction force exerted on the tires by the _____.
 - a. On RS III we wrote a formula for the maximum strength of that force: $\mathbf{F} = \underline{\hspace{2cm}}$
 - b. Define the symbols in that formula, using *full names*.
3. The pavement exerts an ____ward normal force on each tire.
 - a. Those normal forces together prevent the car from _____ing toward the center of the earth. Their sum must equal the car's _____, found with the formula _____. (See #9 on RS I or #8 on RS III.)
 - b. Combining 3a with 2a, we conclude that the maximum braking force is _____.
(Answer in terms of m , g , and the friction coefficient.)
 - c. Newton showed us how to predict the car's maximum acceleration: $\mathbf{a} = \underline{\hspace{2cm}}$ (See #2 on RS V)
 - d. Combining 3b with 3c, we see that the maximum braking acceleration is _____.
 - e. Does 3d agree with 7d on page 52? ____ A copy has been saved in #____ on RS ____.
4. When an ordinary car accelerates forward only ____ of its wheels are driven by the engine to propel the car. (Most cars do not have "four-wheel drive".)
 - a. Assuming that the four wheels support the car's weight equally, (as is approximately true for some cars) the maximum forward force cannot be greater than ____ of the force found in 3b, no matter how much engine power it has. (Put a *fraction* into the blank.)
 - b. If the cars designer made the driven wheels support only *one-third* of the car's weight, then the maximum forward acceleration would be roughly ____ of the braking acceleration found in 3d.
5. As a car *coasts* on a level road, its speed gradually decreases from " S_1 " to " S_2 ".
 - a. Name the two forces which cause that negative acceleration.
 - b. Show (with one formula) how the total force on the coasting car can be calculated from the given values of m , Δt , and the two speeds.
 - c. Let $S_1 = 60$ mph and let $S_2 = 50$ mph. Then $\Delta \mathbf{S} = \underline{\hspace{2cm}}$.
 - d. Convert that change in speed to SI units. (Use #1 on RS II.) $\Delta \mathbf{S} = \underline{\hspace{2cm}}$
- * 6. Estimate the time needed for an ordinary 2200-lb car to coast down from 60 to 50 mph on a level road. Use that estimate with 5b and 5d to estimate the sum of the backward forces (air drag and rolling friction) acting on car as it coasts. Show how that result is obtained, writing no numbers except the given ones and the final answer. Use SI units and remember to round off properly.
- * 7. Estimate the amount of time needed to accelerate the same car from 50 to 60 mph. Then show how the forward force which propels the car can be calculated. (Don't confuse the propelling force with the total force. The propelling force is _____er than the backward force found in #6, but the backward force *still exists*.) Again, please don't confuse the reader with unnecessary numbers.
- * 8. Explain two reasons why the forward force estimated in #7 differs from the ones in #4.
- * 9. In #4 we discussed a car with unlimited engine power. Suppose we double the car's mass, keeping the super engine. That will make the car heavier, increasing the "normal force" on the car and making a greater propelling force possible. Will the car's ability to accelerate from rest be affected by that change? If so, explain how much of a change will result. If not, explain why not.
- *10. Suppose you drive the same car on a planet with weaker gravity. Since the car is not so heavy on the new planet you might expect it to accelerate faster. Is that correct? *Explain by using 3 & 4.*