07.04 Virtual Lecture Notes
Refresher: Mass vs. Weight

There are several more precise definitions of mass, but roughly speaking mass is how much "stuff" (i.e. matter) there is in an object. Is there any *more* of you on Earth than there would be on Jupiter? No, it doesn't *matter* which planet you are on…your mass doesn't change, but your weight does.

Your weight is determined by how strongly your mass is attracted to the Earth by the force of gravity. Step on a scale and you know your weight.

weight = (mass) x (surface gravity)

Since we can measure our weight, and Earth's surface gravity is a known constant (1.0), for all practical purposes your Earth weight is your mass. However, mass is measured in metric units, so we first have to convert pounds to grams (1 pound = 433.59237 grams).

After re-arranging the terms and applying a conversion factor for pounds to grams, the equation for mass is the following. (Notice how closely this resembles a Java arithmetic expression.)

mass = (weight) * (433.59237) / (surface gravity)

If a person weighs 150 pounds on Earth, and Earth's surface gravity is 1.0, what is the person's mass in grams.

mass = (150) * (433.59237) / (1.0)
= 65038.8555 grams

In essence, your weight on Earth equals your mass, but this is not the case on other planets because each has a different surface gravity. You would be much more strongly attracted by gravity on Jupiter than you would be on Mars. Therefore, you (actually your mass) would weigh more on Jupiter than Mars.

weight = (mass) x (surface gravity)

Note: If you used this equation in the assignment as it is written, weights will be off by a factor of 10. The reason for this is well beyond the scope of this course, but has to do with the complicated units of some of the numbers. Consequently, to the surface gravity quantity ($G * M / r^2$) must be divided by 10 for accurate results. An explanation for this adjustment can be found the Astronomy Answer Book web site. But, it is just Algebra, so divide by 10 and your answers will be correct.

If we know the surface gravity of each planet, then we can use the first equation again to find our weight in grams on any planet, asteroid, moon, etc. for which we know the surface gravity. For example, the surface gravity of Mercury is .38 grams. Using the first equation again we can find our weight in grams, and then convert that back to pounds.

weight = (mass) x (surface gravity)
= 65038.8555 * .38
= 24714.8 / 433.59237
= 57 pounds

With this brief physics refresher, you should now be able to write a program in Java to find out how much you weigh on each planet.

Physics Lite

It may increase your comfort level to know more about the terms and units used in this equation. (Consult a physics book or web site for a detailed explanation.) The following does not do justice to the science behind the math, but it should be understandable.

In simple terms, mass is how much "stuff" an object contains. A bowling ball has more mass than a basketball. The Universal Gravitational Constant (G) is an indicator of the strength of gravity; this constant is the same everywhere in the universe.

Earth's surface gravity (g), or acceleration due to gravity, is 9.8 meters/second^2 and indicates the rate at which an object gains speed while falling. An object dropped near the Earth's surface would accelerate to a velocity of 9.81 meters/second after one second, 19.6 meters/second after two seconds, 29.4 meters/second after three seconds, etc.

Putting 9.8 m/sec^2 into Perspective

You have some experience with another kind of acceleration. Imagine that you set the speed control on your car to travel along the Interstate at 70 miles per hour. At any given point in time, your speed is constant; therefore you are neither accelerating nor decelerating. If your speed is constant, acceleration is 0.

Now consider what happens if you stop at a toll booth to pay with cash. You are at a complete stop and you need to get back up to 70 mph to fit into the flow of traffic. If you accelerated at 9.8 meters/second^2, how long would it take you to get back up to 70 mph? Would you believe 3.2 seconds? Hopefully, that puts things in perspective…and please remember to buckle up!