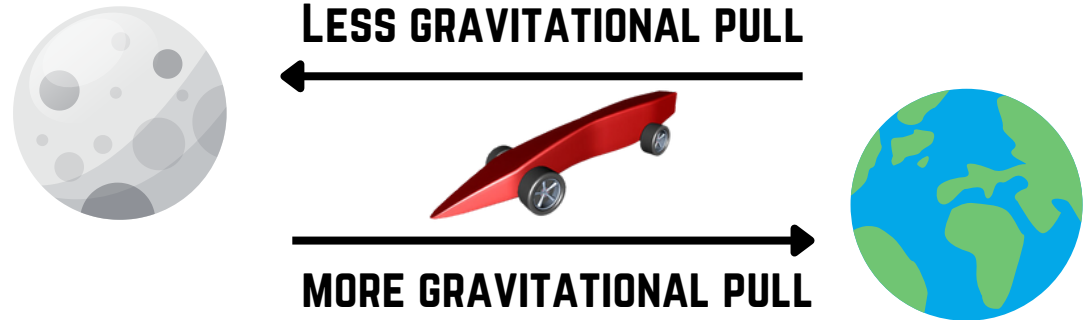


MASS

MASS IS RELATED TO THE WEIGHT OF THE VEHICLE. THERE IS A DIFFERENCE BETWEEN THE MASS OF AN OBJECT AND HOW MUCH IT WEIGHS. MASS IS A MEASURE OF THE AMOUNT OF MATTER OR MATERIAL AN OBJECT CONTAINS. WEIGHT TAKES INTO ACCOUNT GRAVITATIONAL PULL.



YOUR CAR WOULD WEIGH LESS ON THE MOON BUT THE MASS WOULD BE THE SAME. SINCE ALL RACES OCCUR ON EARTH, THE DIFFERENCE BETWEEN MASS AND WEIGHT FACTORS OUT. IF YOUR CAR WEIGHS LESS THAN YOUR CLASSMATE'S CAR, IT HAS LESS MASS.

$$\text{MASS (M)} = \text{DENSITY (P)} \times \text{VOLUME (V)}$$

This equation shows that the mass of an object depends on a variable called density and the volume of an object. All materials have a unique density.

Lighter materials are not as strong as heavier materials. From our table, we can see that basswood is more than twice as heavy as balsa wood, but it is also more than twice as strong.

To put things into perspective, if you designed a dragster made of steel, it would have to be about the size of your thumb to have the same mass as the other balsa wood cars.

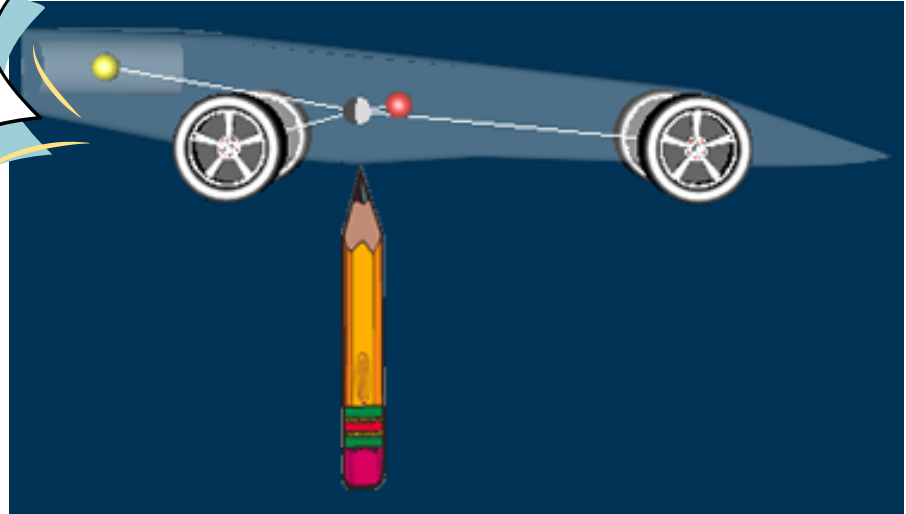
(Tensile strength refers to the amount of force a material can withstand before it fails or breaks, measured in force per unit area.)



Material	Density	Tensile Strength
Brass	8.55	45,700
Steel	7.84	4,800
Aluminum	2.64	3,800
Kevlar	1.44	43,500
Plastic	1.00	4,000
Pine	0.54	406
Basswood	0.41	384
Balsa	0.17	150

BODY DESIGN IS NOT THE ONLY THING TO CONSIDER WHEN IT COMES TO MASS. THE TOTAL MASS OF YOUR CAR INCLUDES THE MASS OF THE WHEELS, AXLES, BEARINGS, AND THE CO2 CARTRIDGE.

Kevlar is a material used in products from bike frames to bulletproof vests. You can see from the table that its tensile strength is extremely high for a material with a density of 1.44 g/cm³. Kevlar is used in race cars to reduce the mass of structural components. Mass vs. strength is a classic engineering trade-off.



Center of Mass

The total mass of the vehicle is important. How this mass is distributed is also important. Your car's behavior as it runs down the track depends on its center of mass

The center of mass is an object's "balance point." For example, if you could balance a CO2 car on the tip of a pencil, the pencil would be just below the center of mass. This literally means that half of the car's mass is on either side of the pencil.



Stability

The center of mass helps us understand how an object will behave when external forces are applied. In an automobile, if the center of mass is high, the vehicle will tend to flip when going around a corner. SUVs and vans have a higher center of mass than sedans, which is why we sometimes hear about "rollover" problems with these vehicles.

The stability of a CO2 car depends on the location of the center of mass. Also important is the contact width of the car. A wider car is less likely to flip when raced.