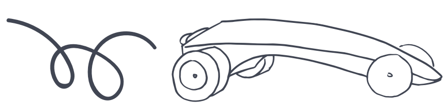
THE MATH OF GOING FAST



When you see a CO_2 dragster fly down a track in a second, it's hard to imagine that there's actually math involved in the process. But as in many things in life, math concepts hide quite well in the dragster activity.

The following are a just a few math concepts that are easy to understand and apply: working with specifications and tolerances, calculating speed, and more.

PITSCO EDUCATION

SPECIFICATIONS AND TOLERANCES

Students designing and building CO_2 race cars experience the same challenge faced by many engineers: working with specifications and tolerances.

Specifications

Specifications are a detailed list of requirements that can include measurements, capabilities, or limitations on a project's size, weight, or functionality. Often a designer is handed a set of specifications before beginning a project. Whatever is being designed must be able to do this, go this fast, and be roughly this size. The challenge for the designer is to be creative and develop an innovative, effective solution while working within the established parameters.

For the dragster activity, giving students a set of specifications is a good idea even if they aren't aiming for a competition such as TSA's Dragster Design event. Designing to specifications is a real-world skill that will come in handy later. It also gives you an opportunity to have them apply measuring skills to a project that excites them.

Tolerances

Nothing is perfect – there's always going to be the smallest of differences (even if a few ten-thousandths of an inch) between two things that are made the same way. This is where tolerances come into play – they determine how much difference is allowed so that the object will work as intended.

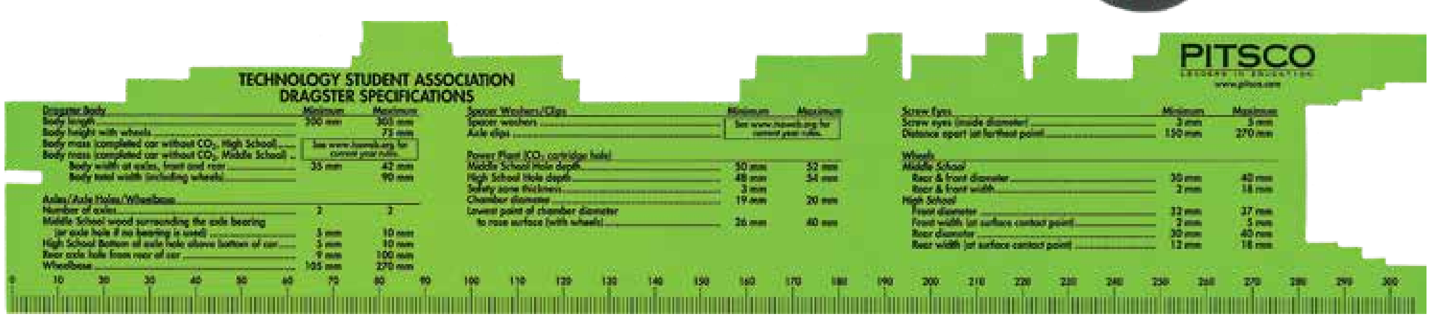
Many times, specifications include a tolerance. If so, the tolerance has a number for the measurement, followed by a ± symbol, which means plus or minus. For example, the length of a part is listed as 26.5 mm ± 1 mm. This means that the length of the part could be as small as 25.5 mm or as large as 27.5 mm.

Sometimes, a tolerance might only have a + sign (or a plus tolerance) or a – sign (or a minus tolerance). Tolerances can also be shown as a percent. So, a part might have a thickness of 40 mm ± 10 percent. Here, 10 percent of the 40 mm would be 4 mm, so it would be the same as 40 mm ± 4 mm, or a thickness of 36 mm to 44 mm. When it comes to percentage tolerances, the lower the percentage, the tighter the tolerance.

Specifications might have maximums and minimums. For instance, the diameter of a hole might have a specification of a minimum diameter of 2 mm or a maximum diameter of 3 mm. If the measurement of the diameter of the hole falls outside of those two measurements (it is less than 2 mm or greater than 3 mm), then the hole diameter does not meet the specification.

In competitions, specifications are part of the rules of a game – they make the playing field equal for everyone. In the CO_2 dragster activity, if any of the specs are not met by a dragster, it cannot be a part of the race – it is disqualified from racing. However, specifications are different from rules in that specifications refer to objects that have measurable properties. Rules may include specifications but may also indicate how a competition is run. Rules are more about conduct and actions; specifications are more about measurements.

CHECK OUT: Metric Dragster Go/No Go Gauge



CALCULATING SPEED

How fast is your car going? Calculating the speed (average speed) of a race car is pretty simple. The formula is:

Average Speed = Distance / Time

To plug in some numbers, our distance will be 65.625 feet (ft) (official distance) and our time will be 1.22 seconds (s) (a pretty fast race time).

$$65.625 \text{ ft} / 1.22 \text{ s} = 53.791 \text{ ft} / \text{s}$$

To convert your speed to miles per hour (mph) we have to know a few things. There are:

- 5,280 feet in a mile
- 3,600 seconds in an hour

Plug in those numbers and we can figure out the speed in mph.

$$53.791 \text{ ft/s} \cdot 3{,}600 \text{ s} / 5{,}280 \text{ ft} = 36.676 \text{ mph}$$

LEARN MORE

Our dragster is roughly 1/20th the size of a top-fuel dragster. If it were full size, it would be going almost 734 mph! (20 • 36.676 mph)

SPEED AND VELOCITY

Speed is simply a measure of how fast something is moving. When you are in a car, the speedometer displays the speed at which the car is moving. So, if the speedometer reads 65 miles per hour (mph), this is the car's speed.

Speed is found by dividing the distance traveled by the time required to travel that distance.

$$S = D \div T$$

Engineers and scientists use the term *velocity* to refer to how fast an object moves in a certain direction. This means that the velocity of a car would be its speed in a specific direction. For example, the same car mentioned above is moving at a speed of 65 mph. If we determine that the car is moving west at 65 mph, this is the car's velocity.

The formula used to calculate velocity is the distance traveled divided by the time required to travel that distance.

$$V = D \div T$$

So, if a car is moving south and goes 100 miles in 2 hours, the velocity of the car is south at 50 mph.

Mathematically speaking, speed and velocity are calculated using the same values. However, the difference between the two is the component of direction. This means that speed is a scalar quantity while velocity is a vector quantity.

Scalar quantities represent only size. For example, height, length, width, and volume would all be examples of scalar quantities. Vector quantities represent both size and direction.