A simple test must be done, materials include

1) Sturdy material such as a sheet of plywood .500″ or larger
2) Robot with no motors attached to wheels
3) Field tile (if you are not making a competition robot, use a sample of the primary surface you will be driving on.)
4) Square bars to lock your wheels into place.
5) Protractor

Testing

1) Place a game tile onto the piece of plywood or your substitute material
2) Place robot onto surface. With the wheels locked, begin to lift one side of the material. Lift until the robot begins to slide back.
3) Once the robot slides back, measure the angle at which it slid with your protractor, document this angle in your engineering notebook or engineers log.

This test is now done. You may do a couple more and take the average angle if you want more precise values. Or try it out with different wheel combinations to find your best fit.

Calculations

The formula we will be using to calculate this is **F=UMG**

F= Friction Force

U= Static Friction

M= Mass of the robot (Kilograms)

G= Gravity (9.8 $^{m}/_{s^2}$)

F is what we are searching for, this will determine our maximum gear ratio.

To find "**U**", we simply need to take the Tangent of X. X being the angle at which your robot began to slide.

If you are in the United States, chances are you do not use the metric system too often. A conversion needs to take place. To convert from pounds to kilograms, you multiply the weight (in lbs) by **.4536**. This will give you your robots weight in kilograms.

Gravity is a constant. It is always **9.8** $^{m}/_{s^2}$

Once you have determined this, just fill in the equation F=(U)*(M)*(G) and you should get an absolute number (positive number)

You may already know what motors you want to use, but many of us do not know the available torque for these or some may not know what torque even is. Luckily for you I have supplied a chart with the torque values for all the motors.

Motor	Torque
3-wire	6.5 in LBS
269 (2-wire)	8.6 in LBS
393 w/ internal speed ratio	8.4 in LBS
393 w/ internal torque ratio	13.5 in LBS

Multiply the torque of the motor and the quantity you want to use. For example, I want my robot to use 4 of the 393 motors geared at a torque setting my math would look like this.

(Available torque)=(torque of motor)*(quantity of that specific motor)

(Available Torque) =(13.5 in LBS)*(4)

=54 in LBS

Next you will be dividing this number by F. We are going to name our answer as "I"

$$I = F / (\text{Available Torque})$$

Now take "I" and multiply it by the radius of your wheels ($^1/_2$ the diameter)

This number is the maximum ratio you can use on your application. Normally reduce this number by 30-40% to account for friction, motor wear, stalling, etc. The number you receive is your driven gear.