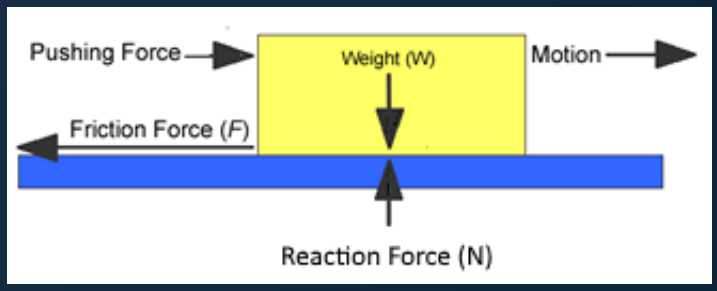
FRICTION FORCE

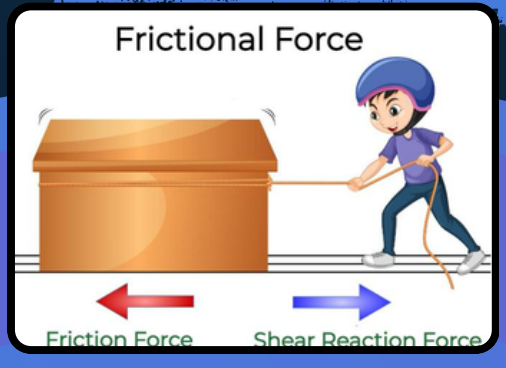
FRICTION FORCE IS A RESISTIVE FORCE THAT MUST BE OVERCOME TO MOVE YOUR DRAGSTER FORWARD. ONCE IN MOTION, FRICTION ALSO SLOWS YOUR CAR DOWN. IF THERE WERE NO RESISTIVE FORCES, YOUR DRAGSTER WOULD CONTINUE TO TRAVEL AT ITS MAXIMUM VELOCITY FOREVER. IF YOU STOP PEDALING A BICYCLE, THE BIKE SLOWS DOWN. LIKEWISE, WHEN THE POWER FROM THE CO2 CARTRIDGE STOPS, THE DRAGSTER SLOWS DOWN. IN BOTH EXAMPLES, FRICTION PLAYS A MAJOR ROLE IN SLOWING THE VEHICLE.

Friction occurs when two surfaces are in contact and a force is moving one surface over the other. For example, if you push a wood block across your desk, friction will resist the motion of the block and bring it to a stop. Friction is caused by the roughness of the two objects in contact. Even two materials that seem very smooth have some degree of roughness. Viewing surfaces under a microscope can be very revealing.



We can calculate the force of friction between two surfaces if we know the reaction force between them (R) and a number called the coefficient of friction (k)

FRICTION FORCE (F)= COEFFICIENT OF FRICTION (K) X REACTION FORCE (R)



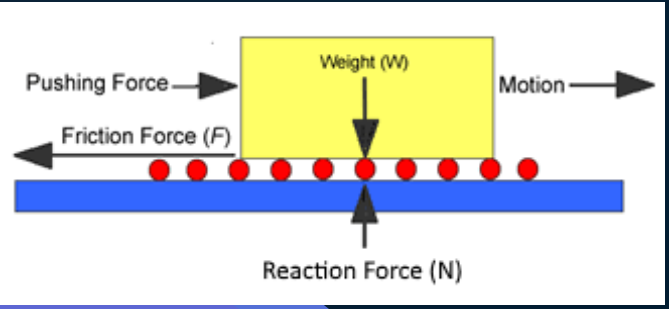
IN THE CASE OF OUR BLOCK SLIDING OVER THE DESKTOP, THE *REACTION FORCE* IS SIMPLY THE WEIGHT OF THE BLOCK. WE CALL THIS A REACTION FORCE BECAUSE THE TABLE HAS TO REACT TO THE BLOCK WITH AN EQUAL AND OPPOSITE FORCE TO ENSURE THAT THE BLOCK DOES NOT CRASH THROUGH THE TABLE. THIS IS AN EXAMPLE OF NEWTON'S 3RD LAW OF MOTION. THE COEFFICIENT OF FRICTION IS A UNIQUE VARIABLE REPRESENTING THE TWO SURFACES IN CONTACT. THE FOLLOWING TABLE LISTS THE FRICTION COEFFICIENTS FOR SEVERAL COMMON MATERIALS.

Material 1	Material 2	Friction Coefficient
Copper	Steel	0.53
Graphite	Steel	0.10
Polystyrene	Steel	0.35
Steel	Brass	0.51
Wood	Metal	0.60

What would you expect would happen with the force of friction if two identical wood blocks were stacked on top of each other so the total weight was 1.0 N? Would you expect the wood blocks to slide as far?

Rolling Friction

Rolling friction is a force that resists the motion of wheels. Rolling friction will slow your vehicle but it is much less than sliding friction. Think about it. Place a wheel and wood block on a board, and slowly raise one end of the board. Which object would you expect to move first? Intuitively, we would expect the wheel to move first and continue to roll much further once it has left the ramp. This is because rolling friction is much smaller than sliding friction.

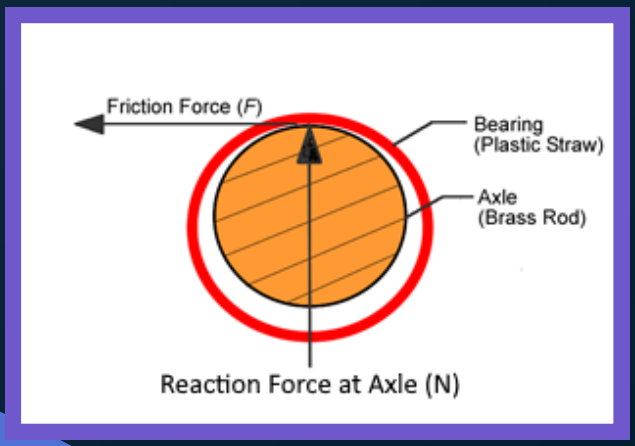


Friction Forces on Your Dragster

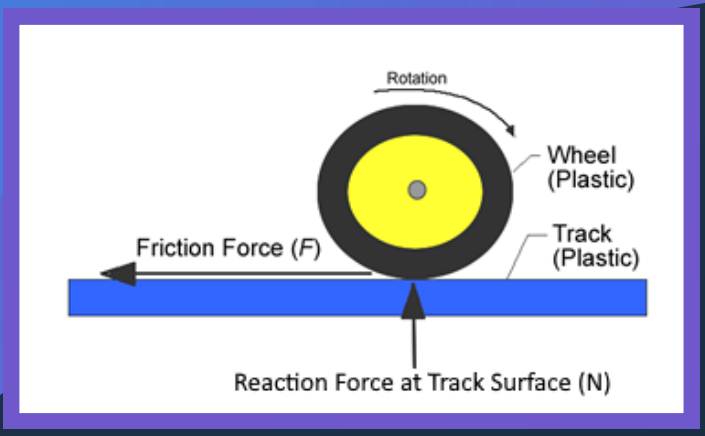
On a CO2 dragster, surface friction occurs between the wheels and track surface and between each axle and bearing surface. The bearing is whatever surface the axle is in contact with. This may be the car's body if no explicit bearing is selected or any number of other options from a plastic straw to premium bushings. On a dragster, the four locations producing friction force:

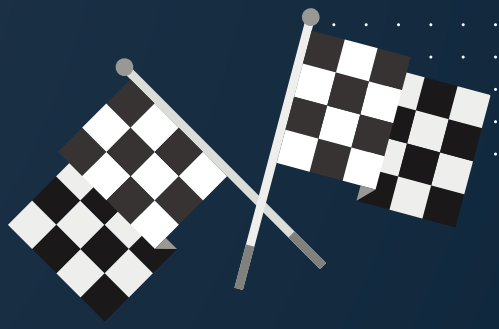
1. Front wheel and track (Ffw)
2. Rear wheel and track (Frw)
3. Front Axle and Bearing (Ffa)
4. Rear Axle and Bearing (Fra)

The friction on the axle is caused by the axle material (brass in the illustration) and bearing (a plastic straw in the illustration) rubbing together. There are many different kinds of material that can be used for axles and bearings. The coefficient of friction for axles and bearings depends on the materials used for each of these parts.



The wheel rolling on the track also produces a friction force. The table below shows the coefficient of friction for manufactured wheels available in the engineering application rolling on a common track surface — plastic.





The wheel coefficients are low compared to axle and bearing coefficients. This should not be surprising. Wheels roll over the track surface (rolling friction), while axles turn or slide inside the bearing (sliding friction). But, the friction force of the wheel does add to the total force.

What is the best combination? Working with those that have the lowest fiction coefficient would be the first choice. But, engineers must always design with constraints. You have to work with what is available (the parts you teacher gives you) and cost is always an important limitation.

The total friction force is a sum of the friction forces of the front and rear wheels/track surface plus the front and rear axle/bearing surfaces. To find the friction force between the front and rear wheels and the track, we first need to know the reaction force. The reaction force on both wheels combined is the weight of the car. But how much of the reaction force is on just the front wheels or just the rear wheels? This is where the center of mass comes into play. If the center of mass is closer to the rear wheels, then the reaction force on the rear wheels would be greater than the reaction force on the front wheels.