Wheels

Question

The light turns green and you're in a hurry. Will your car accelerate faster if you skid your wheels and "burn rubber" or if you just barely avoid skidding your wheels?

A. Skid your wheels
B. Barely avoid skidding

Why does a wagon need wheels?

Why do sleds work well only on snow or ice?

Friction!

Contact Forces

Objects in contact can push on each other.

Consider a block resting on a ramp.

Support force
- prevents the block from penetrating the ramp's surface
- points directly away (perpendicular) from the ramps surface

Frictional force
- Prevents the block from sliding down the ramp
- Pushes along the direction (parallel) of the ramps surface

Frictional Forces

A frictional force
- Opposes relative sliding motion of two surfaces
- Pushes along the direction of the surface
- Acts to bring the two surfaces to one velocity

Frictional forces come in third law pairs. As I push my book across the desk,
- The desk's frictional force pushes backward on my book
- The book's frictional force pushes forward on the desk

Friction comes in two types

Static friction
- Acts to prevent objects from starting to slide
- Can vary in amount from zero to some upper limit

Sliding friction
- Acts to bring objects that are moving relative to each other to the same velocity
- Pushes with a strength that is independent of the relative speed of the objects

Frictional forces

Increase when you

- Push the surfaces together more tightly
- Make the surfaces rougher

Decrease when

- Sliding begins – peak static force is greater that sliding force

Question

An object is held in place by friction on an inclined surface. The angle of inclination is increased until the object starts moving. If the surface is kept at this angle, the object

1. slows down.
2. moves at uniform speed.
3. speeds up.
4. leaps off of the ramp and does a triple back flip.

Question

The light turns green and you're in a hurry. Will your car accelerate faster if you skid your wheels and "burn rubber" or if you just barely avoid skidding your wheels?

A. Skid your wheels
B. Barely avoid skidding

Forms of Energy

Kinetic Energy – energy of motion

Potential Energy – stored in forces between objects
- Gravitational
- Elastic
- Electric
- Magnetic
- Electrochemical
- Chemical
- Nuclear

Thermal Energy – kinetic and potential energy, but divided up into countless tiny fragments

Friction and Thermal Energy

Consider a heavy object resting on the table

Static friction – If you don't push too hard static friction will keep the object at rest. While the table is pushing on the object, the object isn't moving – no work is done.

Sliding friction – If you push hard enough the object will move. When you stop pushing the object will slow down and come to rest. As the object moves forward, friction pushes back on it. Friction does a negative amount of work on the object – kinetic energy is removed. The object warms up – individual pieces of the object move more rapidly in a disordered way – thermal energy increases.

Observations about Wheels

Without wheels, objects slide to a stop
- Friction is responsible for stopping
- Friction seems to make energy disappear
- Sliding friction wastes energy

Wheels eliminate sliding friction (or at least minimize it)

A vehicle with wheels coasts well

Free wheels are turned by static friction with the ground

Powered Wheels use static friction with the ground
- to propel the vehicle

Question

You are riding your bike along a flat country road. Both the brake and the pedals work on the rear wheel; there is no brake on the front wheel.

Indicate the direction and relative magnitude of the frictional forces on the front and rear tires in the following situations:

(a) You are accelerating
(b) You are pedaling along at a steady pace
(c) You are breaking