Wheels

Question:

- You are in a tremendous hurry and you want your car to accelerate as quickly as possible when the light turns green. Tire damage is not an issue. Will you accelerate faster if you “burn rubber” (skid your wheels) or if you just barely avoid skidding your wheels?

Observations About Wheels

- Without wheels, objects slide to a stop
- Friction is responsible for stopping effect
- Friction seems to make energy disappear
- Wheels eliminate friction, or so it seems
- Wheels can also propel vehicles, but how?

Friction

- Opposes relative motion of two surfaces
- Acts to bring two surfaces to one velocity
- Consists of a matched pair of forces:
  - Object 1 pushes on object 2
  - Object 2 pushes on object 1
  - Equal magnitudes, opposite directions
- Comes in two types: static and sliding

Types of Friction

- Static Friction
  - Acts to prevent objects from starting to slide
  - Forces can vary from zero to an upper limit
- Sliding Friction
  - Acts to stop objects that are already sliding
  - Forces have fixed magnitudes

Frictional Forces

- Increase when you:
  - push the surfaces more tightly together
  - roughen the surfaces
- Peak static force greater than sliding force
  - Surface features can interpenetrate better
  - Friction force drops when sliding begins

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Friction and Wear

- Static friction
  - No work is done (no distance)
  - No wear occurs
- Sliding friction
  - Work is done (distance in direction of force)
  - Wear occurs
  - Work is turned into thermal energy

Conserved Quantity

- Energy
  - A directionless (scalar) quantity
  - Can’t be created or destroyed
  - Transferable between objects via work
  - Can be converted from one form to another

Forms of Energy

- Kinetic: energy of motion
- Potential: stored in forces between objects
  - Gravitational
  - Elastic
  - Magnetic
  - Electric
  - Electrochemical
  - Chemical
  - Nuclear

Types of Energy

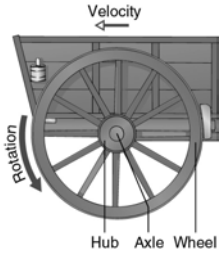
- Ordered Energy
  - Organized in chunks (e.g. work)
- Disordered Energy
  - Fragmented (e.g. thermal energy)
- Sliding friction disorders energy
  - Converts work into thermal energy

Rollers

- Eliminate sliding friction at roadway
- Are inconvenient because they keep popping out from under the object

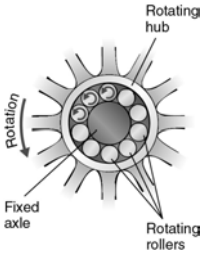
Wheels

- Eliminate sliding friction at roadway
- Are convenient because they don't pop out
- Wheel hubs still have sliding friction



Bearings

- Eliminate sliding friction in wheel hub
- Behave like automatically recycling rollers



Summary about Wheels

- Sliding friction wastes energy
  - Wheels eliminate sliding friction
  - 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