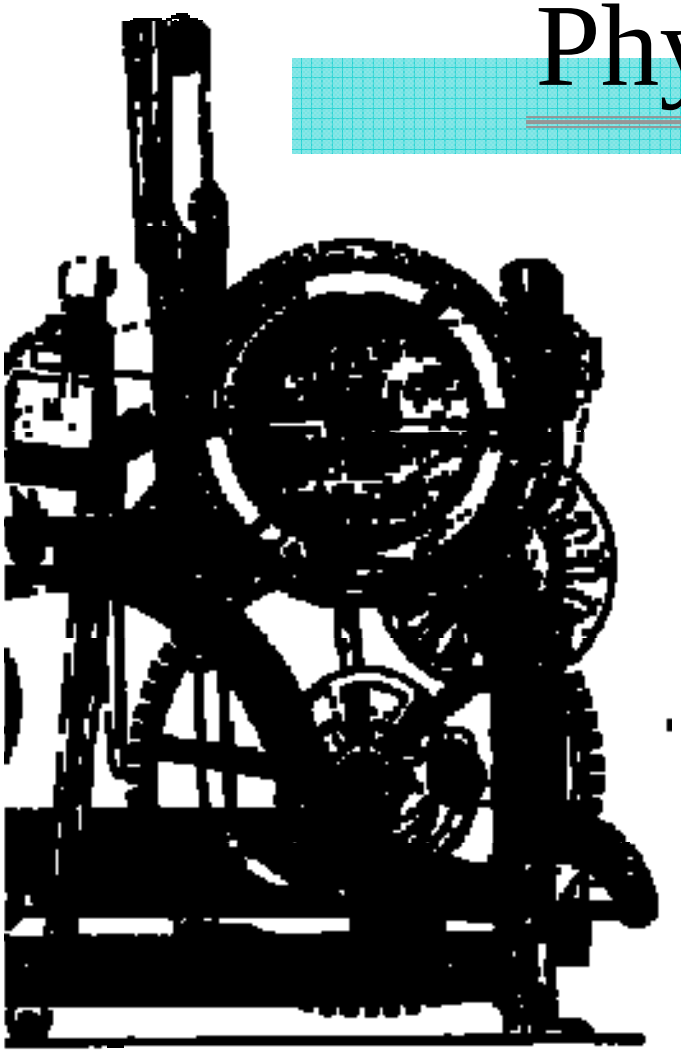
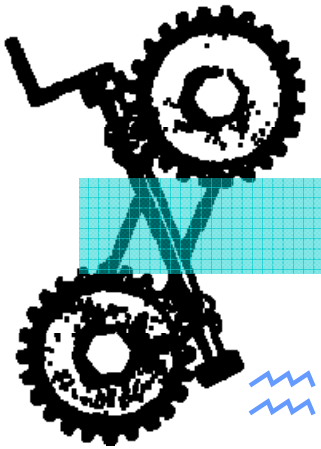
Physics Review



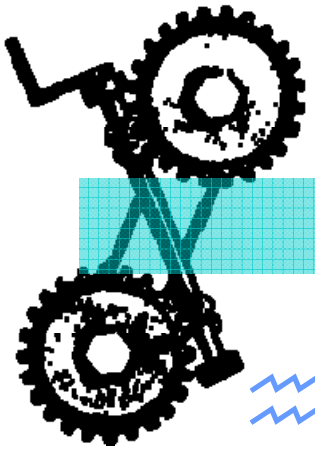
What Are Newton's Laws of Motion?



Forces

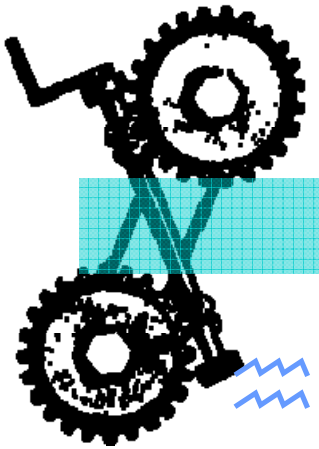
- "Push or Pull" that acts between two bodies
  - Tension
  - Gravitational force
  - Frictional force
  - Air resistance
  - Electrostatic force
  - Strong nuclear force
  - Weak nuclear force

The SI unit for force is the Newton (N). This unit is equivalent to $1\frac{kgm}{s^2}$



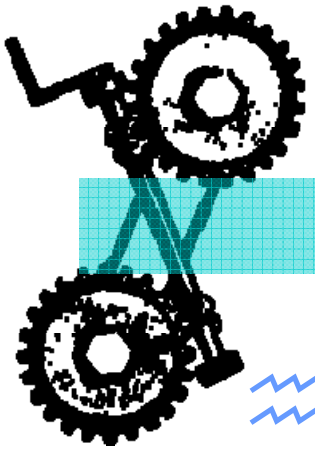
Newton's First Law

- "Law of Inertia"
- An object will continue in its state of motion unless compelled to change by a force impressed upon it.
- What net force is required to maintain a 5000 kg object moving at a constant velocity of magnitude 7500 m/s?
  - Net force of 0 $\Rightarrow$ constant motion



Newton's Third Law

- For every action, there is an equal, but opposite, reaction.



Weight

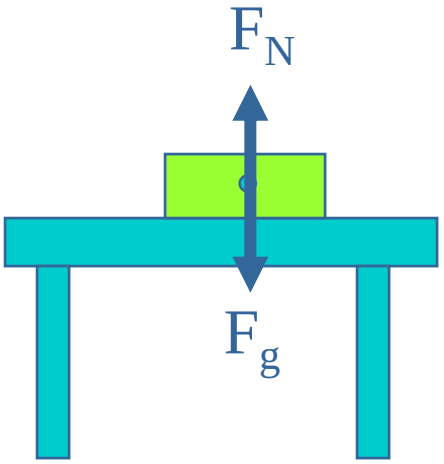
- The weight of an object is the gravitational force exerted on it by Earth (or whatever planetary mass the object is on).
- What is the mass of an object that weighs 500 N?

$$F_w = mg$$

$$m = \frac{F_w}{g} = \frac{500\ N}{9.8\ \frac{m}{s^2}} = 51\ kg$$

Other Examples

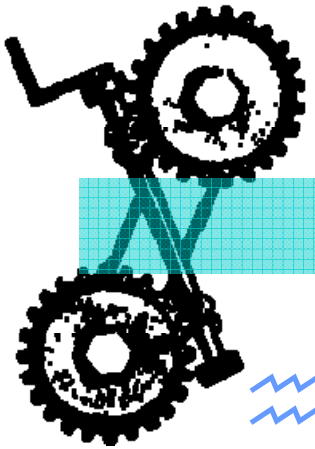
- A book with a mass of 2 kg rests on a table. Find the magnitude of the force exerted by the table on the book.



$$F_g = mg = F_N$$

$$F_g = (2\ kg)\left(9.8\ \frac{m}{s^2}\right) = 20N = F_N$$

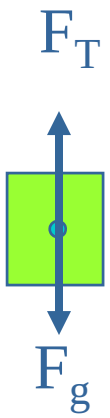
Note: This force is called the *Normal* force because it acts *perpendicular* to the contact surface of the object.



Other Examples

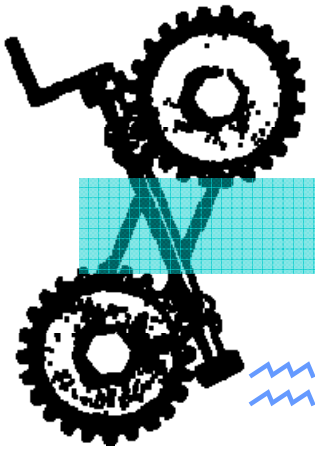
A can of paint with a mass of 6 kg hangs from a rope. If the can is to be pulled up to a rooftop with a constant velocity of 1 m/s, what must the tension in the rope be?

+
direction



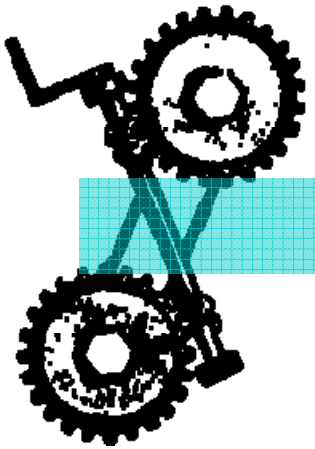
$$F_T = F_g = mg$$

$$F_T = 6\,kg\left(9.8\,\frac{m}{s^2}\right) = \boxed{59\,N}$$



Friction

- *Friction* is a contact force that is **parallel** to the contact surface and **perpendicular** to the *normal* force.
- Static friction (F_s) occurs when a force tries unsuccessfully to set a body in motion.
- Kinetic (sliding) friction (F_k) occurs when a force acts on a body in motion.
- Generally $F_s > F_k$

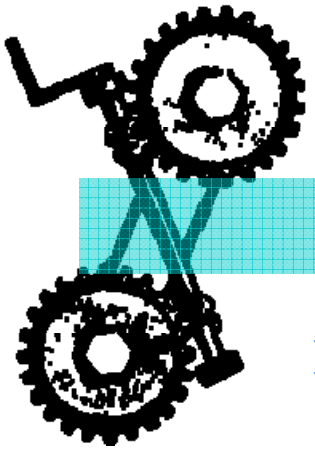


Friction Equations

$$F_{s\ (\max)} = \mu_s F_N$$

$$F_k = \mu_k F_N$$

- μ represents the *coefficient of friction* - a number that is related to the nature of the surfaces in contact with each other.
- F_s has a range of values dependent on the magnitude of the horizontal force being applied.

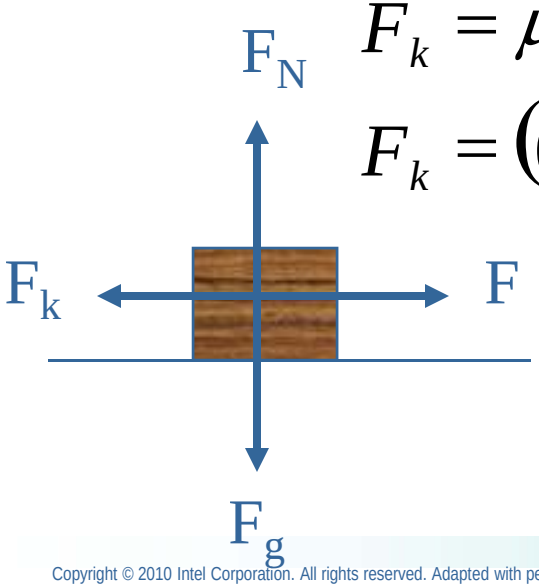


Friction Problems

- A crate of mass 20 kg is sliding across a wooden floor. μ_k between the crate and the floor is 0.3. Determine the strength of the force acting on the crate.

$$F_k = \mu_k F_N = \mu_k mg$$

$$F_k = (0.3)(20kg)\left(9.8\frac{m}{s^2}\right) = \boxed{59N}$$



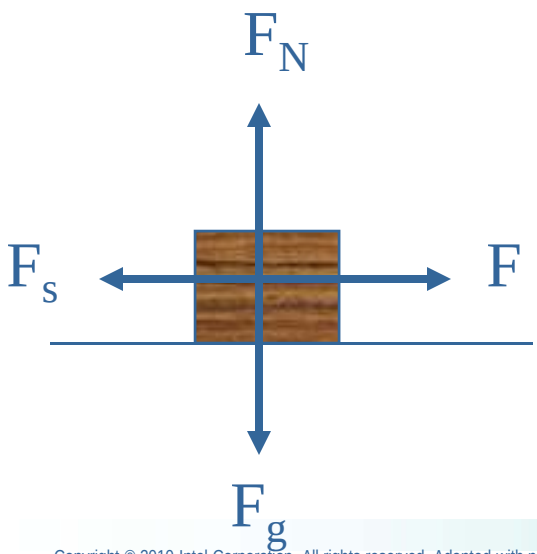
If the crate is being pulled by a force of 90 N (parallel to the floor), find the acceleration of the crate.

$$F_{net} = F - F_f = 90N - 59N = 31N$$

$$F_{net} = ma \quad a = \frac{F_{net}}{m} = \frac{31N}{20kg} = \boxed{1.6\frac{m}{s^2}}$$

Friction Problems

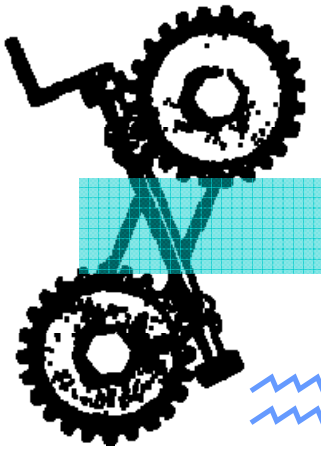
- A crate of mass 100 kg rests on the floor. μ_s is 0.4. If a force of 250 N (parallel to the floor) is applied to the crate, what is the magnitude of F_s on the crate?



$$F_{s,\,max} = \mu_s F_N = \mu_s mg$$

$$F_{s,\,max} = (0.4)(100kg)\left(9.8\ \frac{m}{s^2}\right) = 390\ N$$

NOTE: Remember that F_s represents a range of values. In this case, the applied force of 250N is less than the maximum F_s so the actual magnitude of F_s is 250N.

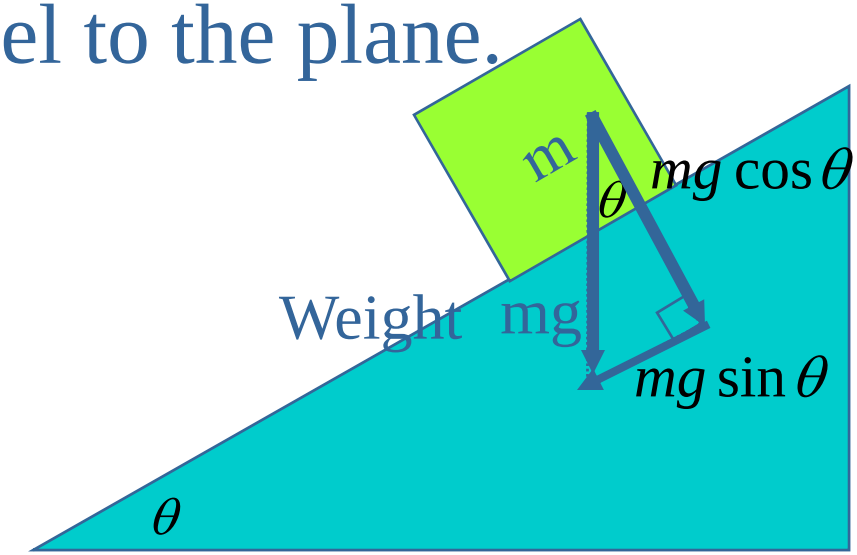


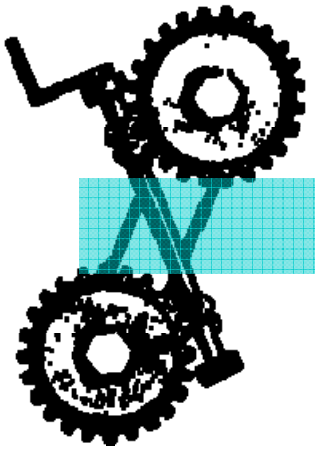
Pulleys

- Pulleys are devices that change the direction of the tension force in cords that slide over them.
- In problems, we generally ignore the mass and friction associated with pulleys.

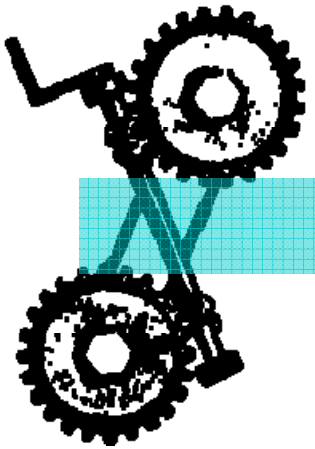
Inclined Planes

- When a mass sits on an inclined plane, its weight has two components: normal and parallel to the plane.





How do the laws of motion describe everyday events?



Can the motion of any object be predicted? How?