The History of Motion and Forces

Life before Sir Isaac Newton

History intro summarized from Michael Fowlers Galileo and Einstein Course at UVa

Aristotle

- Objects always try to go to their natural place
- Two Classifications of motion
  - Natural Motion
  - Violent Motion
- Laws of Motion:
  - Heavier things fall faster, the speed being proportional to the weight.
  - The speed of fall of a given object depends *inversely* on the density of the medium it is falling through, so, for example, the same body will fall twice as fast through a medium of half the density.
- **Aristotle's rule for horizontal motion** is: *velocity is proportional to applied force*.
- Rules of motion in the heaven are different than the rules of motion on earth
- Unfortunately….

History intro summarized from Michael Fowlers Galileo and Einstein Course at UVa

Galileo

- Developed the refracting telescope.
- Was far more interested in Astronomy than motion.
- Studied motion on earth to help him understand the motion of the heavens.
- Acceleration Hypothesis:
  - *"A falling body accelerates uniformly: it picks up equal amounts of speed in equal time intervals, so that, if it falls from rest, it is moving twice as fast after two seconds as it was moving after one second, and moving three times as fast after three seconds as it was after one second. "*

History intro summarized from Michael Fowlers Galileo and Einstein Course at UVa

Galileo (Continued)

- *Galileo's law of horizontal motion*
  - *"Imagine any particle projected along a horizontal plane without friction; then we know … that this particle will move along this same plane with a motion which is uniform and perpetual, provided the plane has no limits. "*
- Galileo's Law of Vertical Motion is:
  - For **vertical motion**: acceleration = constant (neglecting air resistance, etc.)
- Did not publish any of his research on motion until after he was sentenced to house arrest.
- Galileo's Principal of Inertia
  - "A body moving on a level surface will continue in the same direction at constant speed unless disturbed."

History intro summarized from Michael Fowlers Galileo and Einstein Course at UVa

Sir Isaac Newton Laws of Motion

- Law of Inertia – An object will continue at a constant velocity unless acted upon by an outside force.
- The acceleration of. an object is directly proportional to and in the same direction as the applied NET force and inversely proportional to the mass of the object.

$$a=F/m$$

- If Object A exerts a force on Object B, Object B will exert a force equal in magnitude but opposite in direction on Object A.

$$F_A=-F_B$$

Forces

- A Force is a push or a pull.
- Forces have a unit of Newtons ($1N=1kg\cdot m/s^2$)
- Pushing Force – Compress or Compression
- Pulling force – Tensile or Tension

Forces

- A Force is a push or a pull.
- Forces have a unit of Newtons ($1N=1kg\cdot m/s^2$)
- Pushing Force – Compress or Compression
- Pulling force – Tensile or Tension
- Different materials have different force constraints

Net Force

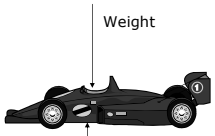
- Sum of all forces
- Forces are vectors so you can work with vertical and horizontal forces independently.
- A way to remember Net Force:
- "Forces that go – Forces that slow"
- $F_{go} - F_{slow}=F_{net}$

Free Body Diagram

1. Draw a picture of the object
2. Draw an arrow and label it for each force that is acting on the object.

Free Body Diagram Vertical Forces

If object is not falling through the floor – net vertical force must be equal to zero.



$\Sigma F_{vertical}=0$

Normal Force
Support Force

Weight – Normal=0
Normal=Weight

Net Force

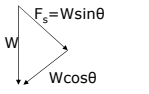
$\Sigma F_{horizontal}=0$ $\quad F_{engine}-(F_{friction}+F_{air\ resistance})=0$
$F_{engine}=(F_{friction}+F_{air\ resistance})$

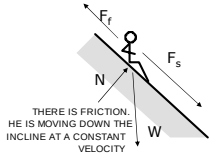
$\Sigma F_{horizontal}\neq 0$ $\quad F_{engine}-(F_{friction}+F_{air\ resistance})=ma$

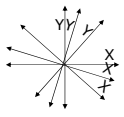
$F_{engine}=F_{road}$

Free body Diagram
Horizontal Forces

Non Horizontal Free Body







$\Sigma Fx = F_s-F_f=Wsin\theta-F_f$

$\Sigma Fy = Wcos\theta-N$