Inertia and Newton's First Law

NEWTON'S LAWS OF MOTION

Video

- Bill nye

Inertia

- a property of matter that causes an object to resist changes in its state of motion
- it is directly proportional to the mass of the object

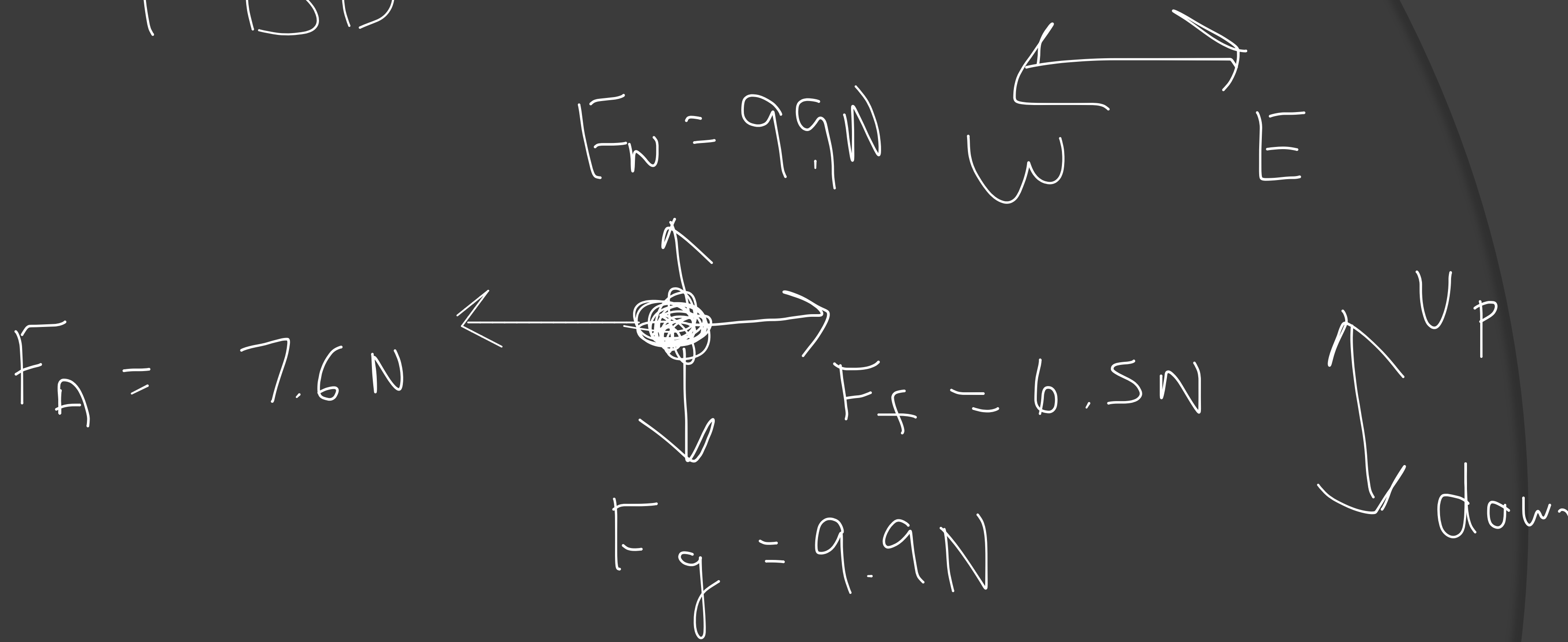
Net Forces

- Net Force:
  - the vector sum of all the forces acting on an object
  - also called the resultant force
  - symbol F_{Net}

Example #1

- A store clerk pushes a parcel on a counter with a force of 7.6N [W]. The kinetic friction on the parcel is 6.5N [E]. Both the force of gravity and the normal force have a magnitude of 9.9N. Draw an FBD of the parcel and determine the net force acting on it.

FBD



$$F_{NET} = F_A - F_f$$
$$= 7.6N - 6.5N$$
$$F_{NET} = 1.1N\ [W]$$

Newton's First Law of Motion: The Law of Inertia

- If the net force acting on an object is zero, the object will maintain its state of rest or constant velocity.
  - objects at rest remain at rest unless acted upon by a net force
  - objects in motion remain in motion unless acted upon by a net force
  - if the velocity of an object is constant (or zero), the net external force acting on it is zero
  - if the velocity of an object is changing either in magnitude, direction, or both, the change must be caused by a net external force acting on the object

Newton’s Second Law of Motion and Weight

NEWTON’S LAWS OF MOTION

What is a Newton ?

- Newton:
  - the magnitude of the net force needed to give a 1-kg object an acceleration of 1 m/s^2
  - $1\ N = 1\ kg \times m/s^2$

$F_{orce} = \text{mass} \times \text{acceleration}$

$\vec{F} = m\vec{a}$

Newton's Second Law of Motion

- If the external net force on an object is not zero, the object accelerates in the direction of the net force. The magnitude of the acceleration is directly proportional to the net force and inversely proportional to the object's mass.

$$\vec{a} = \frac{\vec{F}_{Net}}{m} \qquad \vec{F}_{Net} = m\vec{a}$$

Example #2

- Calculate the acceleration when a bowler exerts a net force of 18N [forward] on a 7.5 kg bowling ball

$1\ N = 1\ kg \cdot \frac{m}{s^2}$

Given: $m = 7.5\ kg$

$\vec{F}_{NET} = 18\ N$ [Forward]

Required: $\vec{a}$

Analysis

$\vec{a} = \frac{\vec{F}_{NET}}{m}$

Steps:

$\vec{a} = \frac{18\ kg \cdot \frac{m}{s^2}}{7.5\ kg}$ [F]

$\vec{a} = 2.4\ m/s^2$ [F]

Example #3

$m = kg$ $F = N$
$a = m/s^2$

- Calculate the net force given that a 28-g arrow has an acceleration of $2.4 \times 10^3\ m/s^2$

Given: $a = 2.4 \times 10^3 \frac{m}{s^2}$

$m = 28g$

Required: F = Net Force

Analysis: $F_{NET} = ma$

Steps

$m = 28g$

$= 0.028 kg$

$a = 2.4 \times 10^3\ m/s^2$

$= 2400\ m/s^2$

$F_{NET} = (0.028 kg)(2400 \frac{m}{s^2})$

$F_{NET} = 67 N$

Example #4

- Calculate the net force needed to cause a 1310 kg sports car to accelerate from 0 to 28.6 m/s [forward] in 5.60 s.

Given:
$m = 1310\ kg$
$v_1 = 0\ m/s$
$v_2 = 28.6\ m/s\ [F]$
$\Delta t = 5.60\ s$

Required: $\vec{F}_{NET}$

Analysis: $\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$, $\vec{F}_{NET} = m\vec{a}$

Steps:
$\vec{a} = \frac{28.6\frac{m}{s}[F] - 0}{5.60\ s}$

$\vec{a} = 5.107\ m/s^2\ [F]$

$\vec{F}_{NET} = (1310\ kg)(5.107\frac{m}{s^2}[F])$

$\vec{F}_{NET} = 6690\ N\ [F]$

Class / Home Work

- Pg. 129 #2-6,8
- Pg. 133 #1-6