Acceleration Due to Gravity

SPH4C – Unit 3 Motion and Forces

Acceleration Due to Gravity

- Does the mass of an object affect it's acceleration near Earth's surface ?

No, objects fall at the same rate.

Value of g

- Acceleration is a vector quantity (has direction)
- Value is g = 9.8 m/s^2 [down]

Free Fall

- Free Fall
  - Gravity is the only force acting on the object
  - No air resistance (drag)

- Terminal Velocity
  - Occurs when air resistance is present
  - Force of gravity = Drag force (air resistance)
  - Object stops accelerating and travels at a constant speed

Uniform Vertical Acceleration

- A ball is dropped from the top of the CN tower. Determine the velocity of the ball 2.6 seconds after it is released.

Given: $\Delta t = 2.6\ s$

$\vec{a} = 9.8\ m/s^2\ [\downarrow]$

$v_1 = 0\ m/s$

Required: v_2 = velocity at 2.6 s

Steps: $\vec{a} = \dfrac{\vec{v}_2 - \vec{v}_1}{\Delta t}$

$$-9.8\frac{m}{s^2} = \frac{V_2 - 0\,m/s}{2.6s}$$

$$\left(-9.8\frac{m}{s^2}\right)(2.6s) = \left(\frac{V_2 - 0\,m/s}{2.6s}\right)2.6s$$

$$-25.48\frac{m}{s} = V_2$$

$\therefore$ after 2.6s velocity is $25.5\,m/s\,[\downarrow]$

Forces and Free Body Diagrams

SPH4C Unit 3 – Motion and Forces

What is a Force ?

- A push or a pull
- Contact or at a distance
- A vector quantity
- F

Types of Forces

- **Normal** – contact force exerted by a surface on an object
  - direction is perpendicular to and away from the surface
- **Friction** – contact force that acts to oppose sliding motion between surfaces
  - direction is parallel to the surface and opposite the direction of sliding
- **Weight** – long range force due to gravitational attraction between two objects
  - "force of gravity"
  - direction is straight down toward the centre of the earth

Types of Forces

- **Tension** – the pull exerted by a string, rope, or cable when attached to an object and pulled taut

- **Applied** – a push or pull caused by an outside agent

- **Drag** – solid interacts with fluid so as to oppose the motion of the solid through the fluid

Mass vs. Weight

- mass (kg)
  - amount of matter in an object
- weight (N)
  - force of gravity acting on an object

↳ $m \times 9.8\ m/s^2$

- on earth, g=9.8 m/s^2 [down]

  - $1N = 1\ kg \cdot m/s^2$

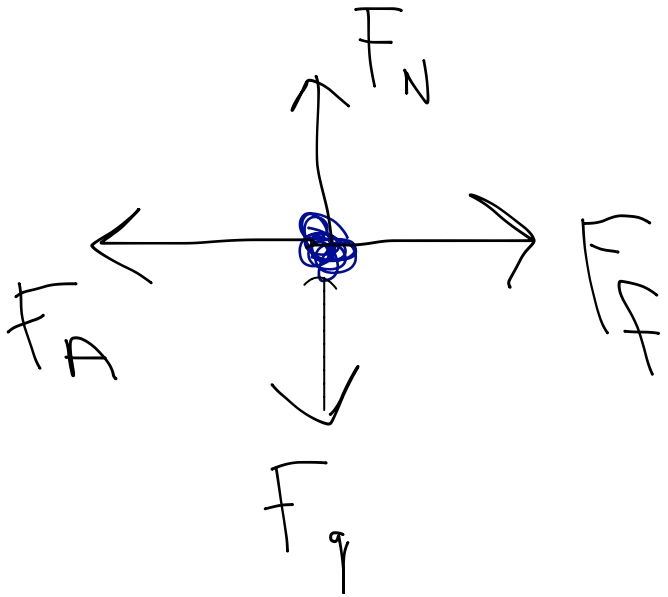
Free Body Diagrams

- Use to analyze forces

- 5 questions:
  1. Is there gravity? (F_g)
  2. Is it sitting on a surface? (F_N)
  3. Is something pushing or pulling on it? (F_A, F_T)
  4. Is there friction? (F_f)
  5. Is it accelerating?

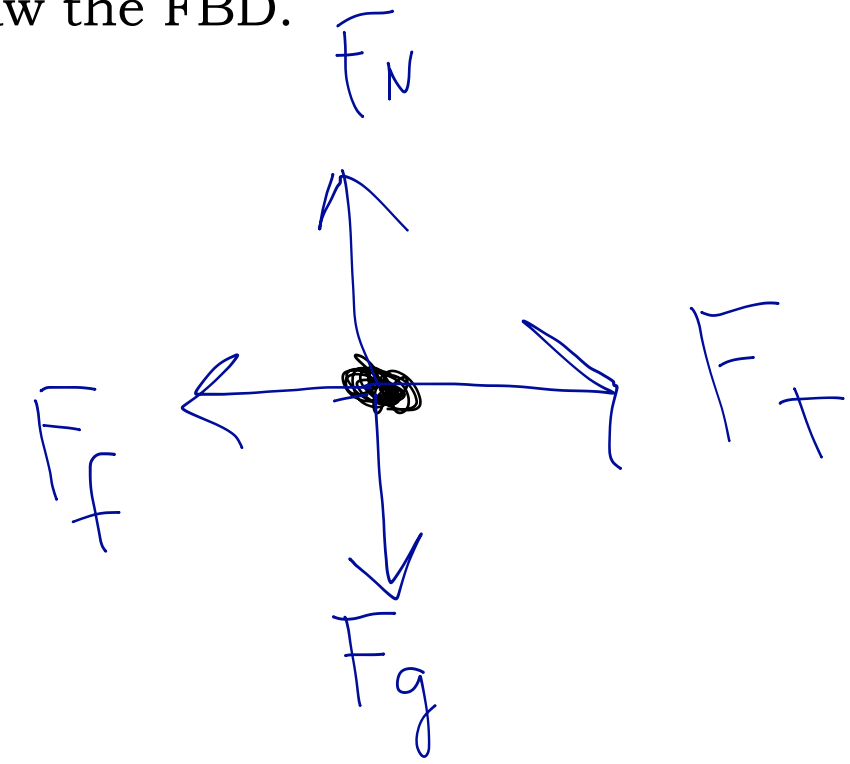
Free Body Diagrams

Example #1: A box is pushed to the left across a rough, horizontal surface. Draw the FBD.



Free Body Diagrams

Example #2: The same box is now pulled to the right with a rope. Draw the FBD.



Net Force

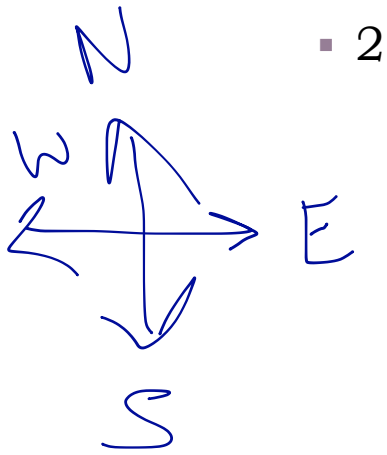
- sum of all forces acting on an object
- = 0 for a stationary object

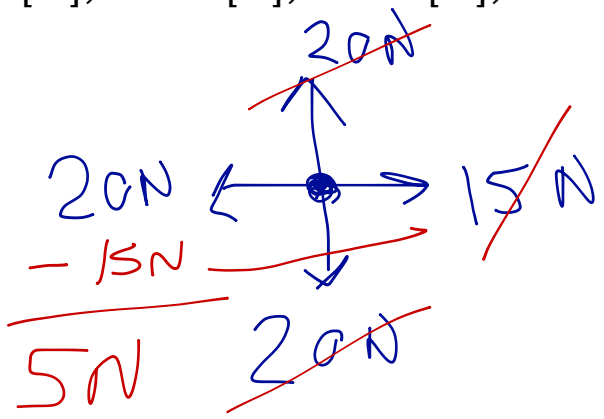
Or moving at a constant velocity

Example

Calculate the net force when the following forces act on an object:

- 20N [N], 20N [S], 15N [E], 20N [W]





$\vec{F}_{Net} = 5\,N\,[W]$

Pg. 27 #3, 4, 5

Pg 29 #6, 7