5062 - Forces & Energy

Forces - Different types

Constant Forces

F_{app} - Applied Force

F_{fr} - Friction Force

F_n - Normal Force

F_{spring} - Spring Force

Forces At A Distance

F_g - Force of Gravity

Other Forces

- Magnetic Force
- Electromagnetic Forces
- Electrical Forces
- Nuclear Forces
- Buoyant Forces
- Centripetal Forces

Jedi Forces

Newton's Laws of Motion

1.) Inertia - An object rest remains at rest unless acted on by an external unbalanced force.

2.) Acceleration - Acceleration is directly proportional to the force applied by an object and indirectly proportional to its mass.

$$a \propto \frac{F}{M}$$

$$F = M \cdot a$$

Units: $\left(kg \cdot M/s^2\right)$

Newton (N)

3.) Action/Reaction - For every action there is an equal & opposite reaction.

Universal Gravitation

$$F \propto \frac{M_1 M_2}{d^2}$$

$$F = \frac{G M_1 M_2}{d^2}$$

Universal Gravitational Constant

$G = 6.67 \times 10^{-11} \frac{N m^2}{kg^2}$

Ex. Calculate the force of attraction between a 2000kg rhino and a 5000kg elephant if they are 3m apart.

$m_1 = 2000kg$
$m_2 = 5000kg$
$d = 3m$

$$F = \frac{G M_1 M_2}{d^2}$$

$$F = \frac{(6.67 \times 10^{-11})(2000)(5000)}{3^2}$$

$$F = 7.41 \times 10^{-5} N$$

Ex. Mass of Earth: $5.972 \times 10^{24} kg$
Mass of Sun: $1.989 \times 10^{30} kg$
Distance Earth to Sun: 149597870 km
What is force of attraction?

$$F = \frac{G M_1 M_2}{d^2} = \frac{(6.67 \times 10^{-11})(5.972 \times 10^{24})(1.989 \times 10^{30})}{(149597870000 m)^2}$$

$$F = 3.54 \times 10^{22} N$$

Ex. What is the force of attraction between Marc & the earth

Marc's mass: 79.18 kg
Mass of Earth: $5.98 \times 10^{24} kg$
Distance to centre of Earth: $6.37 \times 10^6 m$

$$F = \frac{G M_1 M_2}{d^2} = \frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})(79.18)}{(6.37 \times 10^6 m)^2}$$

(Mass of Marc)

$F = 778 N$

Weight of Marc

$9.8 m/s^2$

Note: On Earth: mass = 79kg Weight = 778N
On Moon: mass = 79kg Weight < 778N
In space: mass = 79kg Weight = 0 N

Free Body Diagrams

- Way to visualize all forces acting on an object.

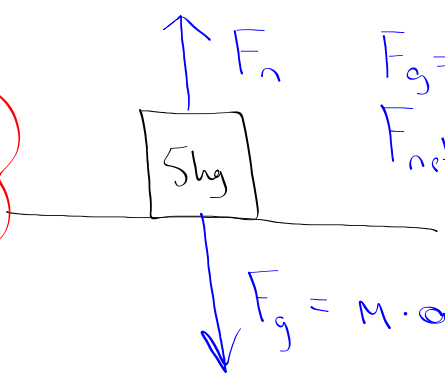
If an object is not moving:

Note:

$F_g = m \cdot a$

on earth:

$F_g = m \cdot g$



$F_g = F_n$

$F_{net} = 0\ N$

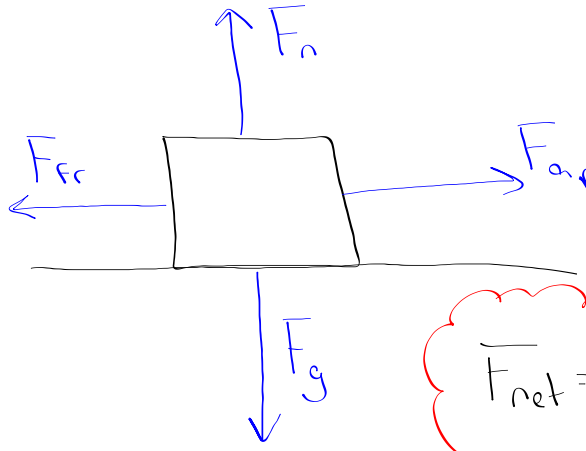
$F_g = m \cdot g$

$= (5kg)(9.8\ m/s^2)$

$F_g = 49\ N$

$F_{fr} = F_n \cdot \mu$

μ = friction coefficient



$F_{net} = F_{app} - F_{fr}$

Note:

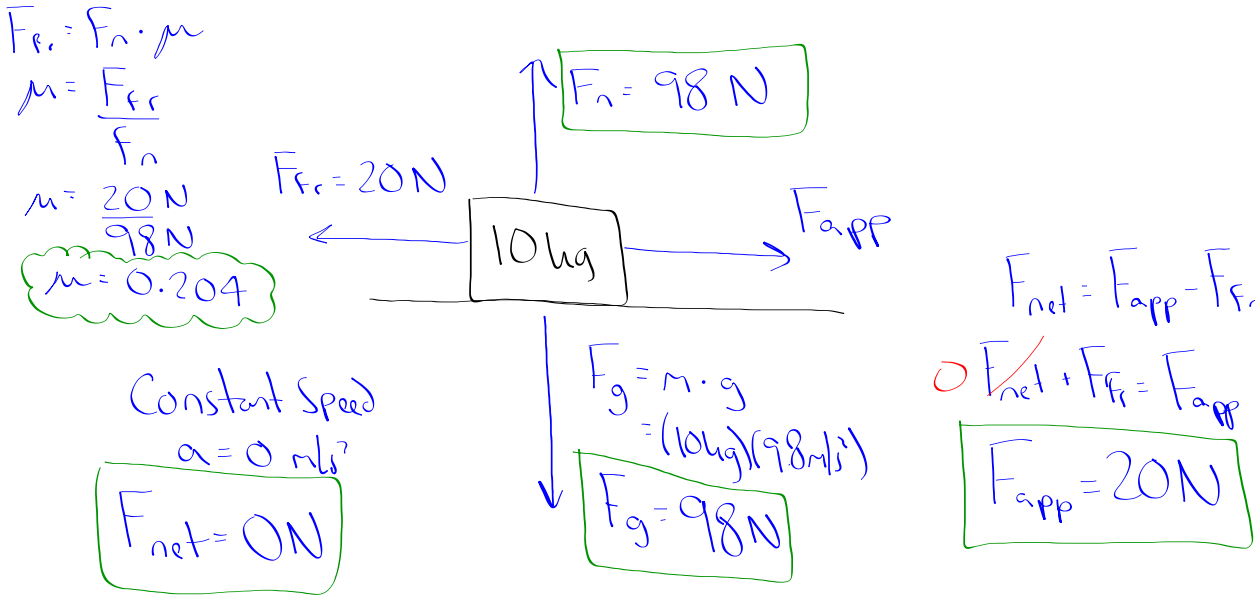
If an object is at constant speed

$a = 0\ m/s^2$

$\therefore F_{net} = 0\ N$

Once we have F_{net}, we can also find acceleration because $F_{net} = m \cdot a$

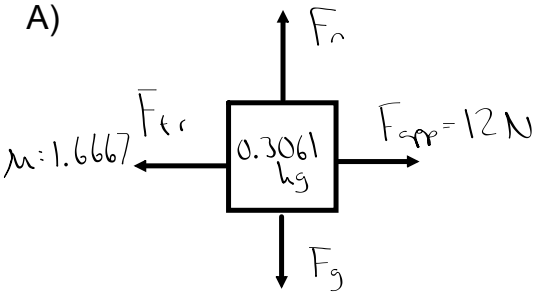
Ex. A 10kg container is moving to the right at a constant velocity of 4m/s. It encounters a frictional force of 20N. Analyze all the forces on the object. (Draw a free body diagram)



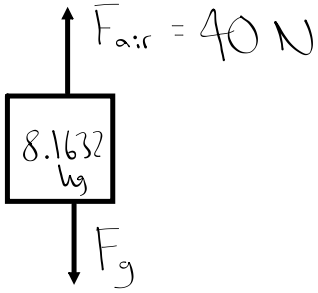
Ex. A 15kg object is accelerating to the left at 4 m/s^2. There is a friction coefficient of 0.15. Analyze all the forces on the object.

Ex. 1) For each of the situations determine the net force.

A)



B)



2) A rightward force is applied to a 6kg object to move it across a surface at constant velocity. The object encounters 15N of friction. Analyze all properties on the object.