CH5 Randall text Book

Fundamental concept of dynamics is that of force. Force causes change in motion.

Newton's first law of motion : A body in uniform motion remains in uniform motion, and a body at rest remains at rest, unless acted by a non zero net force. Also known as law of Inertia.

Newton's 2nd law of motion: The rate at which a body's momentum changes equals to the net force acting on the body.

$$\vec{p} = m\vec{v} \quad \text{(momentum)}$$

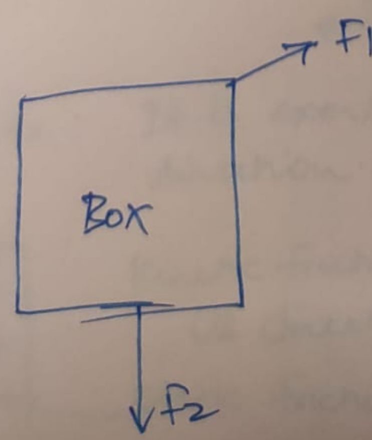
$$\frac{d\vec{p}}{dt} = \vec{F}_{Net} = m \cdot \frac{d\vec{v}}{dt} = m\vec{a}$$

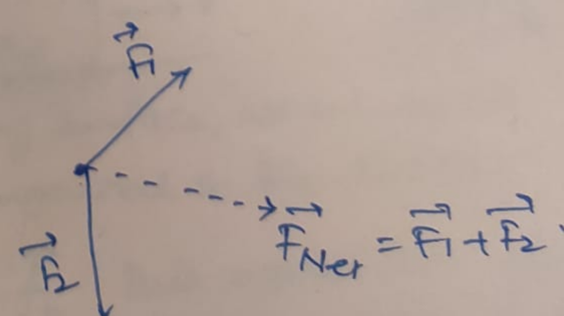
Newton's 3rd law of motion: If object A exerts a force on object B, then object B exerts an oppositely directed force of equal magnitude on A.

Net force: Vector sum of all the forces

$$\vec{F}_{Net} = \vec{F}_1 + \vec{F}_2 + \dots \vec{F}_N$$

example





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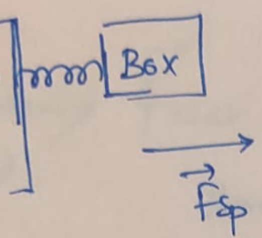
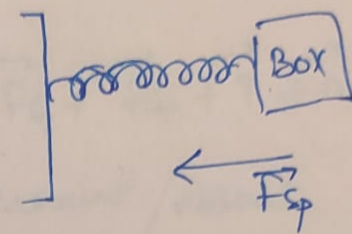
[illegible], Some of these forces are

1. Force due to Gravity : $\vec{F}_G$ Gravitational force. $\vec{F}_G$ vertically downwards

2. Spring force : $\vec{F}_{sp}$

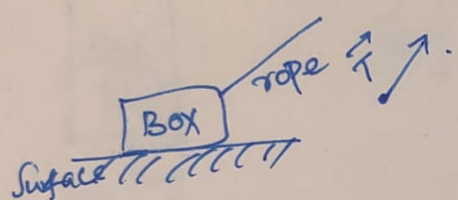
Compressed Spring exerts a pushing force





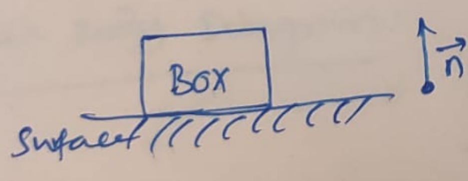
Stretched spring exerts a pulling force

3. Tension force : $\vec{T}$

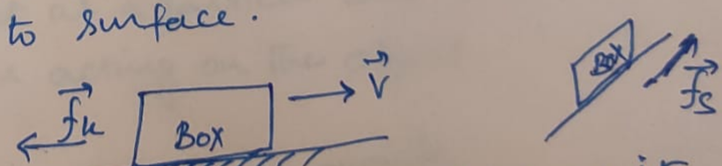


When a string or rope pulls an object it exerts a contact force that we call the Tension force. Direction of Tension force is always the direction of rope or wire.

4. Normal force : $\vec{n}$



Force exerted by a surface against ~~[illegible]~~ an object that is pressing against the surface. Direction is perpendicular to surface.



5. Friction force : It is exerted by surface, where as its direction is tangential to the surface.

Kinetic friction : $\vec{f}_k$ This opposes the motion its direction is opposite to velocity $\vec{v}$

Static friction : $\vec{f}_s$ Keeps an object stuck, and Prevent motion.

points opposite to the direction in which object move if no friction

General force $\vec{f}$

Gravitational force $\vec{F_G}$

Spring force $\vec{F_{sp}}$

Tension $\vec{T}$

Normal force $\vec{n}$

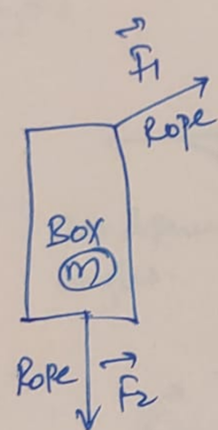
Static friction $\vec{f_s}$

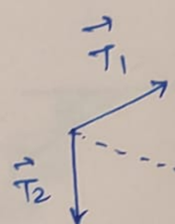
Kinetic friction $\vec{f_k}$

In solving Problems keep in mind

$$\vec{F}_{Net} = \vec{f} + \vec{F_G} + \vec{F_{sp}} + \vec{T} + \vec{n} + \vec{f_s} + \vec{f_k}$$

Some may present / Absent





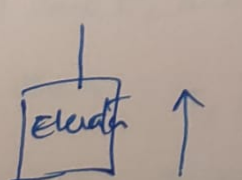
$$\vec{F}_{net} = \vec{T_1} + \vec{T_2}$$

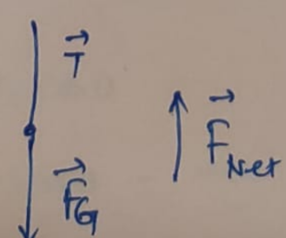
$$\vec{F}_{net} = m\vec{a} = \vec{T_1} + \vec{T_2}$$

$$\vec{a} = \frac{\vec{T_1} + \vec{T_2}}{m}$$

Free Body Diagram: Pictorial representation of a Problem, object as a particle and show all of the forces acting on the object.

Free body diagram of an elevator going upwards

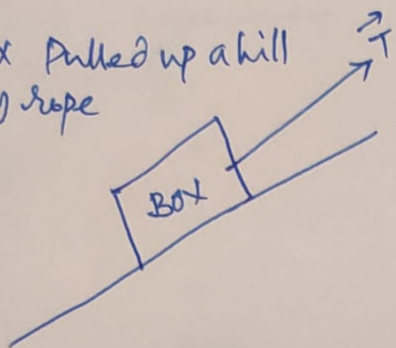




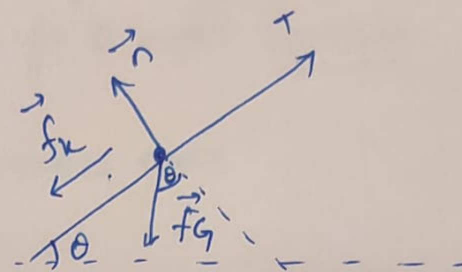
$$\vec{F}_{Net} = \vec{T} + \vec{F_G}$$

$$\boxed{\vec{a} = \frac{\vec{T} + \vec{F_G}}{m}}$$

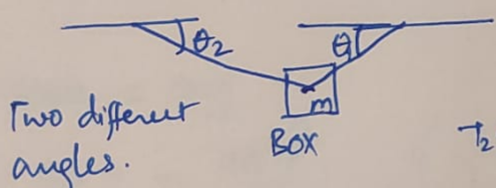
Box Pulled up a hill by rope

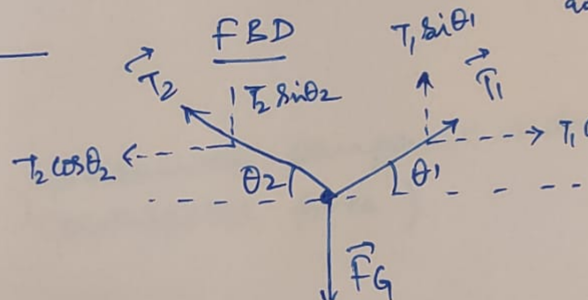


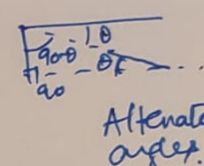
Free Body Diagram



example







$\vec{F}_{Net} = 0 \Rightarrow F_{Net\,x} = 0 = T_1 \cos\theta_1 - T_2 \cos\theta_2$

$F_{Net\,y} = 0 = T_1 \sin\theta_1 + T_2 \sin\theta_2 - \vec{F}_G$ (mg)

$\Rightarrow T_1 \cos\theta_1 = T_2 \cos\theta_2$

$T_1 \sin\theta_1 + T_2 \sin\theta_2 = mg$

If θ_1 and θ_2 are equal and T_1 and T_2 are equal in magnitudes

then $T_1 \cos\theta = T_1 \cos\theta$

$T_1 \sin\theta + T_1 \sin\theta = mg \Rightarrow 2T \sin\theta = mg$

$T = mg/2\sin\theta$

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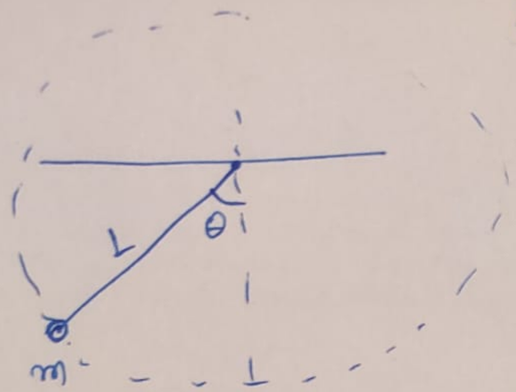
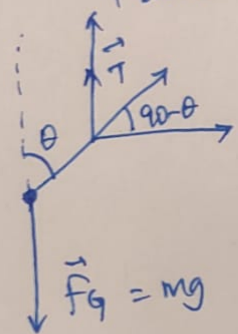
Ques



mass m moving in a circle at the end of a string of length L making angle θ with verticle.

FBD



$$T\cos\theta = mg$$

$$T\sin\theta = \frac{mv^2}{r}$$

(Horizontal component is due to centripetal force)

$$\tan\theta = \frac{v^2}{rg}$$