

NEWTON'S LAWS

1st) DEFINES EQUILIBRIUM

- AN OBJECT MOVING WITH A CONSTANT VELOCITY WILL CONTINUE TO MOVE WITH THE SAME SPEED AND IN THE SAME DIRECTION UNLESS AN INTERACTION WITH ANOTHER OBJECT(S) PRODUCES A NET EXTERNAL FORCE.

2nd) CAUSE/EFFECT DESCRIPTION FOR DEPARTURES FROM EQUILIBRIUM

$$\sum \vec{F}_{\text{EXTERNAL ON SYSTEM}} = M_{\text{SYSTEM}} \vec{a}_{\text{COM}}$$

3rd) OBJECTS INTERACT (FORCE PAIRS)

- $|\vec{F}_{12}| = |\vec{F}_{21}|$
- IF COORDINATE SYSTEM SAME FOR BOTH OBSS.

$$\vec{F}_{12} = -\vec{F}_{21}$$

FREE BODY DIAGRAMS

- DEFINE SYSTEM
- DRAW NON-CONTACT FORCES
- DRAW CONTACT FORCES

$$|\vec{F}_{E1}^g| = M_1 g$$

$$\vec{F}_T, \vec{F}_N, \vec{F}_{fk}, \dots$$

* DEFINE COORDINATE SYSTEM

- USUALLY HELPFUL IF ALIGN ONE AXIS ALONG DIRECTION OF ACCELERATION

• APPLY 2nd LAW

FORCES

FRICTION

$$|\vec{F}_{12}^f| \leq \mu_s |\vec{F}_{12}^N|$$

$$|\vec{F}_{fmax}| = \mu_s |\vec{F}_{12}^N|$$

$$|\vec{F}_{fk}| = \mu_k |\vec{F}_{12}^N|$$

* OPPOSES RELATIVE DIRECTION OF MOTION BETWEEN THE TWO SURFACES

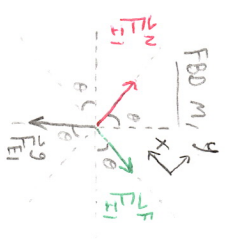
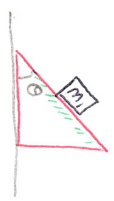


OBJECT NOT MOVING RELATIVE TO SURFACE

OBJECT MOVING RELATIVE TO SURFACE

INCLINED PLANES

EXAMPLE PROBLEM:



- \vec{F}_N IS \perp TO SURFACE OF INCLINE
- \vec{F}_f IS \parallel TO SURFACE OF INCLINE

COUPLED SYSTEMS

- MASSLESS ROPE, MASSLESS + FRICTIONLESS PULLEY...
- ... $|\vec{F}_T|$ IS CONSTANT ALONG ALL PARTS OF THE ROPE

MECHANICAL ADVANTAGE (MA)

$$MA \equiv \frac{|\vec{F}|_{\text{WITHOUT}}}{|\vec{F}|_{\text{WITH}}}$$

UNIFORM CIRCULAR MOTION (UCM)

- BY DEFINITION, SPEED IS CONSTANT...
- ... $V_t = \text{CONSTANT}$
- ACCELERATION POINTS TOWARDS CENTER OF CIRCLE
- RADIAL COMPONENT OF ACCELERATION IS...
- ... $a_r = \frac{V_t^2}{r}$