2-2014 APPLYING NEWTON'S LAWS OF MOTION

START WITH A PICTURE OF THE OBJECT OF INTEREST. IDENTIFY THE FORCES THAT ACT ON THE OBJECT. ADD UP THE FORCES KEEPING THEIR DIRECTION IN MIND. THIS IS THE NET FORCE THAT CAUSES ACCELERATION

ACCEL → VELOCITY → POSITION OVER TIME.

EXAMPLE: DROPPED OBJECT

m = MASS

$F_G = m \cdot g$

NEWTON'S 2nd LAW

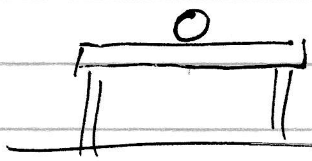
$\vec{F}_{NET} = m\vec{a}$

$mg\downarrow = ma\downarrow$ ACCEL. $= g = 9.8\,m/s^2$ DOWN

MORE MASSIVE OBJECTS EXPERIENCE MORE GRAVITATIONAL FORCE, BUT THEY ALSO HAVE MORE INERTIA.

ALL OBJECTS HAVE $a = g$

EXAMPLE: BALL ON A TABLE



$F_{\text{TABLE ON BALL}} = ?$

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

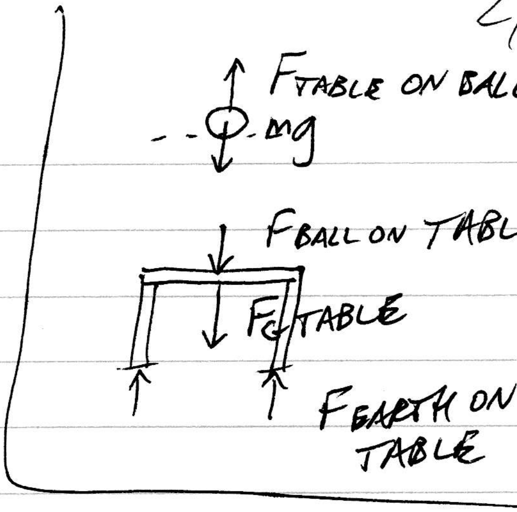
F_{TABLE}

$\uparrow +$

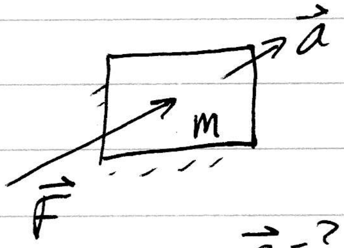
$a = 0$

$F_G = mg$

$-mg + F_{TABLE} = 0$ $\boxed{F_{TABLE} = F_G}$



EXAMPLE: BOX IN SPACE



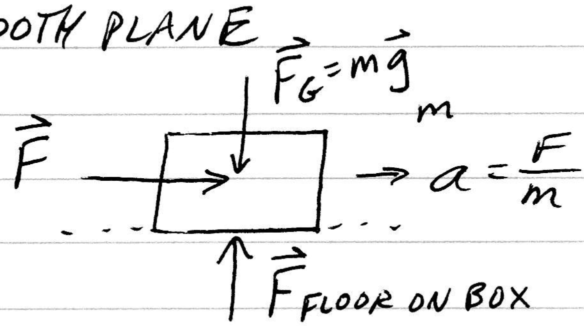
$$\vec{a} = ? = \frac{\vec{F}}{m}$$

IF F DOUBLES, a DOUBLE

IF m DOUBLES, a HALVES

EXAMPLE: BOX ON A SMOOTH PLANE

WHAT IS THE ACCELERATION?



VERTICALLY,

$$-\vec{F}_G + \vec{F}_{FLOOR} = 0 \qquad F_{FLOOR} = F_G = mg$$

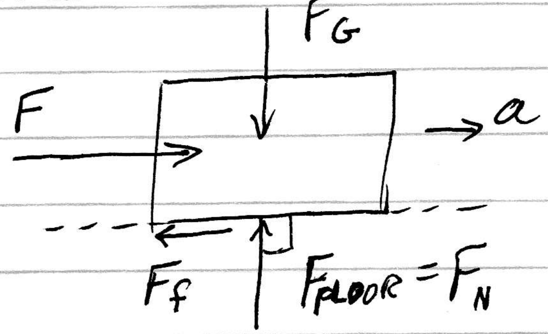
HORIZONTALLY,

$$F = ma \qquad \underrightarrow{a} = \frac{F}{m}$$

SEPERABLE INTO VERTICAL AND HORIZONAL MOTION

EXAMPLE:

BOX ON A ROUGH SURFACE



FRICTION FORCE
ACTS ON THE BOX
OPPOSITE THE MOTION
(OR IMPENDING MOTION)

F_f IS PARALLEL TO SURFACES IN CONTACT

$F_{FLOOR} = F_N$ IS PERPENDICULAR OR 'NORMAL' TO SURFACES

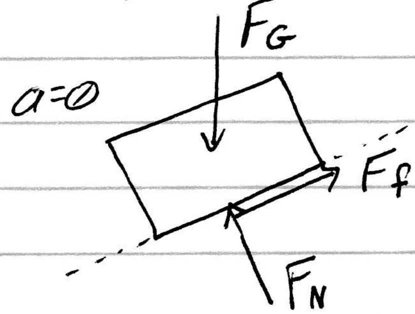
VERTICALLY, AGAIN, $F_N = F_G$

HORIZONTALLY, $F_{(RIGHT)} - F_{f\,LEFT} = F_{NET} = ma$

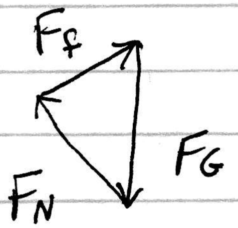
$$\text{ACCELERATION} = \frac{F - F_f}{m}$$

EXAMPLE: BOX ON A ROUGH, INCLINED PLANE
(ASSUME THE BOX IS STATIONARY)

$$\vec{a} = \frac{\vec{F}_{NET}}{m} = 0$$



SUM OF ALL FORCES IS 0

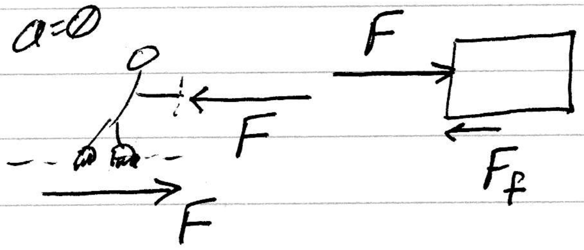


(CLOSED TRIANGLE)

m

ROUGH SURFACE

$a=0$



$\rightarrow a = \left(\frac{F-F_f}{m}\right)$ (IGNORE VERTICAL FORCES)

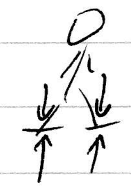
$$a = \frac{F-F_f}{m} \quad \text{OR} \quad ma = F - F_f$$

$$\underline{F} = \underbrace{ma}_{\text{INERTIAL FORCE}} + \underbrace{F_f}_{\text{FRICTION}}$$

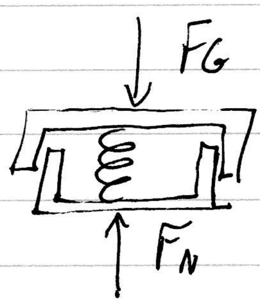
HOW DO WE SENSE WEIGHT?

WE SENSE THE NORMAL FORCE ~~...~~ COUNTERACTING GRAVITY FORCE AS A PRESSURE

IF IN ~~...~~ A NON-ACCELERATING FRAME, WE CALL THIS YOUR WEIGHT



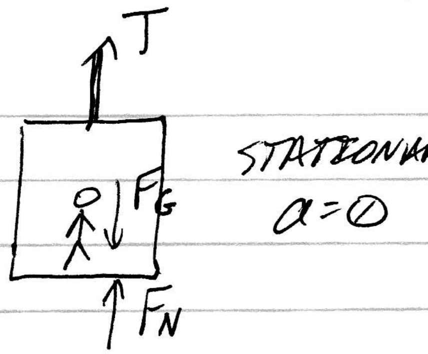
TO MEASURE, USE A SCALE

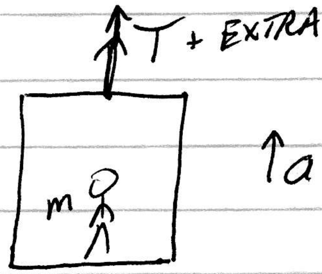


$F_G = F_N$

EXAMPLE: ELEVATOR

WEIGHT = mg

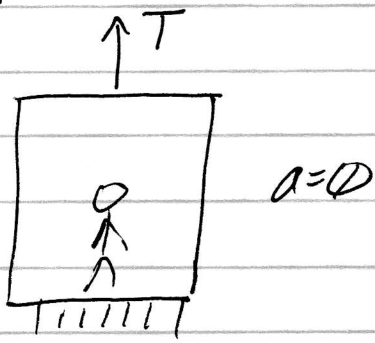




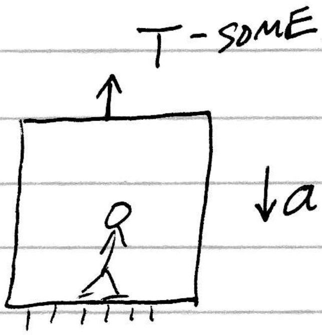
$$F_{NET} = ma$$

$$-mg + W_{APPARENT} = ma$$

$$W_{APPARENT} = \underbrace{ma}_{\text{DUE TO INERTIA}} + \underbrace{mg}_{\text{NORMAL WEIGHT}}$$



$$W_{APPARENT} = 0 + mg \text{ (= NORMAL)}$$



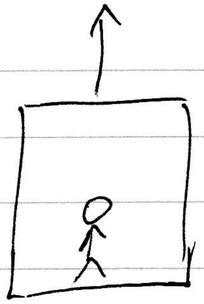
$$W_{APPARENT} = \underbrace{m(-a)}_{\text{DUE TO INERTIA}} + \underbrace{mg}_{\text{NORMAL WEIGHT}}$$

= LESS THAN NORMAL WEIGHT

EXTREME ELEVATORS

$$W_{APP} = mg + mg$$
$$= 2(mg)$$ 2* NORMAL WEIGHT

2 "GEES"

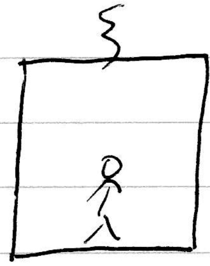


$\uparrow a = 9.81\ m/s^2$ $(=g)$

$a = 2g$ or $a = 3g$

$W_{APP} =$ 3 'GEES' $\quad W_{APP} =$ 4 'GEES'

$$W_{APP} = m(-g) + mg$$
$$= 0$$



$\downarrow a = 9.81 = g$

$$W_{APP} = m(-2g) + mg$$
$$= -mg$$ APPARENT WEIGHT IS UP!

$\downarrow a = 2*(9.81)$