05-2014 IMPULSE AND MOMENTUM

(AT AN INSTANT) NEWTON'S LAW: $F = ma$ $a \to v \to x$

ENERGY METHODS: F CAUSE WORK

(DISTANCES) WORK CHANGES THE FORM OF ENERGY,

SOME COULD TURN TO/FROM KINETIC $= \frac{1}{2}mv^2$

~~M~~ MOMENTUM METHODS: F CAUSES IMPULSE

(TIME) IMPULSE CHANGES MOMENTUM

$\vec{p} = m\vec{v}$

MOMENTUM IS A VECTOR

$\vec{p} = m \cdot \vec{v}$ (MASS)*(VELOCITY)

(DIRECTION IS IMPORTANT)

UNITS: $\frac{kg\,m}{s}$ (NO SPECIAL NAME)

VALUE DEPENDS ON THE OBSERVER

CHANGE IN MOMENTUM = IMPULSE

(DOESN'T DEPEND ON OBSERVER)

IMPULSE = $\vec{I} = \vec{p}_2 - \vec{p}_1 = m\vec{v}_2 - m\vec{v}_1$

$= m\Delta\vec{v}$

IMPULSE : MOMENTUM :: WORK : ENERGY

ANOTHER WAY TO CALCULATE IMPULSE:

$\vec{I}$ = FORCE ACTING OVER SOME TIME INTERV

UNITS: $\vec{F}\cdot t = N\cdot s = \frac{kg\,m}{s^2}\cdot s = \frac{kg\,m}{s}$

(MOMENTU
UNITS

$\vec{I}$ = $\underbrace{\text{SUM}}_{\Sigma}$ OF $\vec{F}\cdot t$

COULD CHANGE
WITH TIME

$\vec{p}_2 - \vec{p}_1 = \vec{I} = \Sigma(\vec{F}_{NET}\cdot t)$

$$\boxed{\underbrace{\vec{p}_2}_{\text{FINAL MOMENTUM}} = \underbrace{\vec{p}_1}_{\text{INITIAL MOMENTUM}} + \underbrace{\Sigma\vec{F}\cdot t}_{\text{CHANGE IN MOMENTUM}}}$$

PRINCIPLE OF
IMPULSE AN
MOMENTUM

SOME SPECIAL CASES

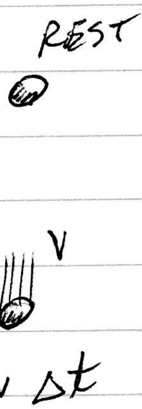
IF $\vec{F}_{NET} = 0$, $\vec{p}_2 = \vec{p}_1$ $\quad \cancel{m}\vec{v}_2 = \cancel{m}\vec{v}_1$

$\vec{v}$ IS CONSTANT

IF $\vec{F}$ IS CONSTANT

$$\vec{p}_2 = \vec{p}_1 + \vec{F}\cdot\Delta t$$

DROPPED BALL EXAMPLE



NEWTON

$$F = ma$$
$$mg = ma$$
$$v = gt$$
$$x = -\tfrac{1}{2}gt^2$$

ENERGY

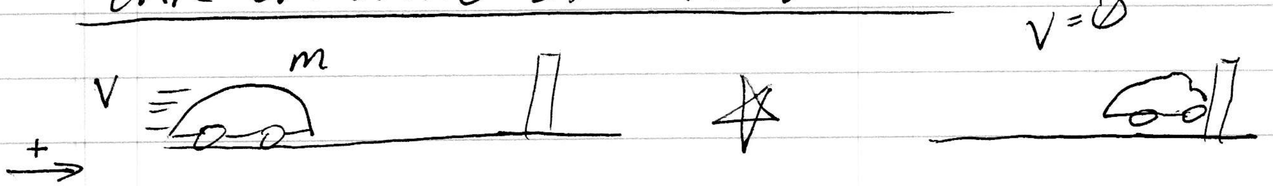
CONSERVATION OF ENERGY

$$K_{TOP} + P_{TOP} = \text{CONST}$$
$$= K_{BOTTOM} + P_{BOTTOM}$$
$$\cancel{m}gh = \tfrac{1}{2}\cancel{m}v^2$$
$$v = \sqrt{2gh}$$

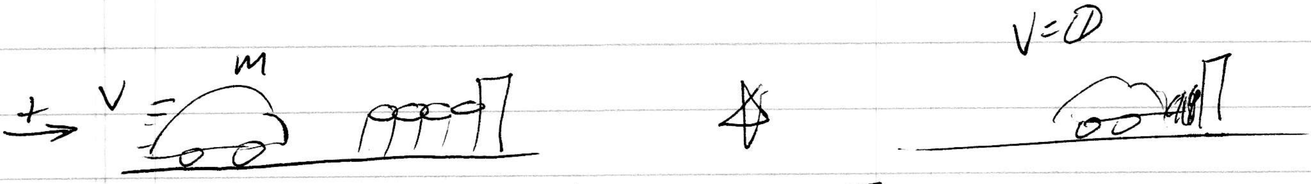
MOMENTUM

$$F_G = \text{CONSTANT} = mg$$
$$\vec{P}_{BOTTOM} = \underbrace{\vec{P}_{TOP}}_{=0} + F_G \cdot$$
$$\cancel{m}v = \cancel{m}g\cdot\Delta t$$
$$v = -g\cdot t$$

CAR CRASHING INTO A WALL



$$0 = mv - \Sigma\big(F_{WALL}\underbrace{\Delta t}_{\text{COLLISION TIME}}\big)$$



Δt IS BIG, F_{WALL} IS SMALL