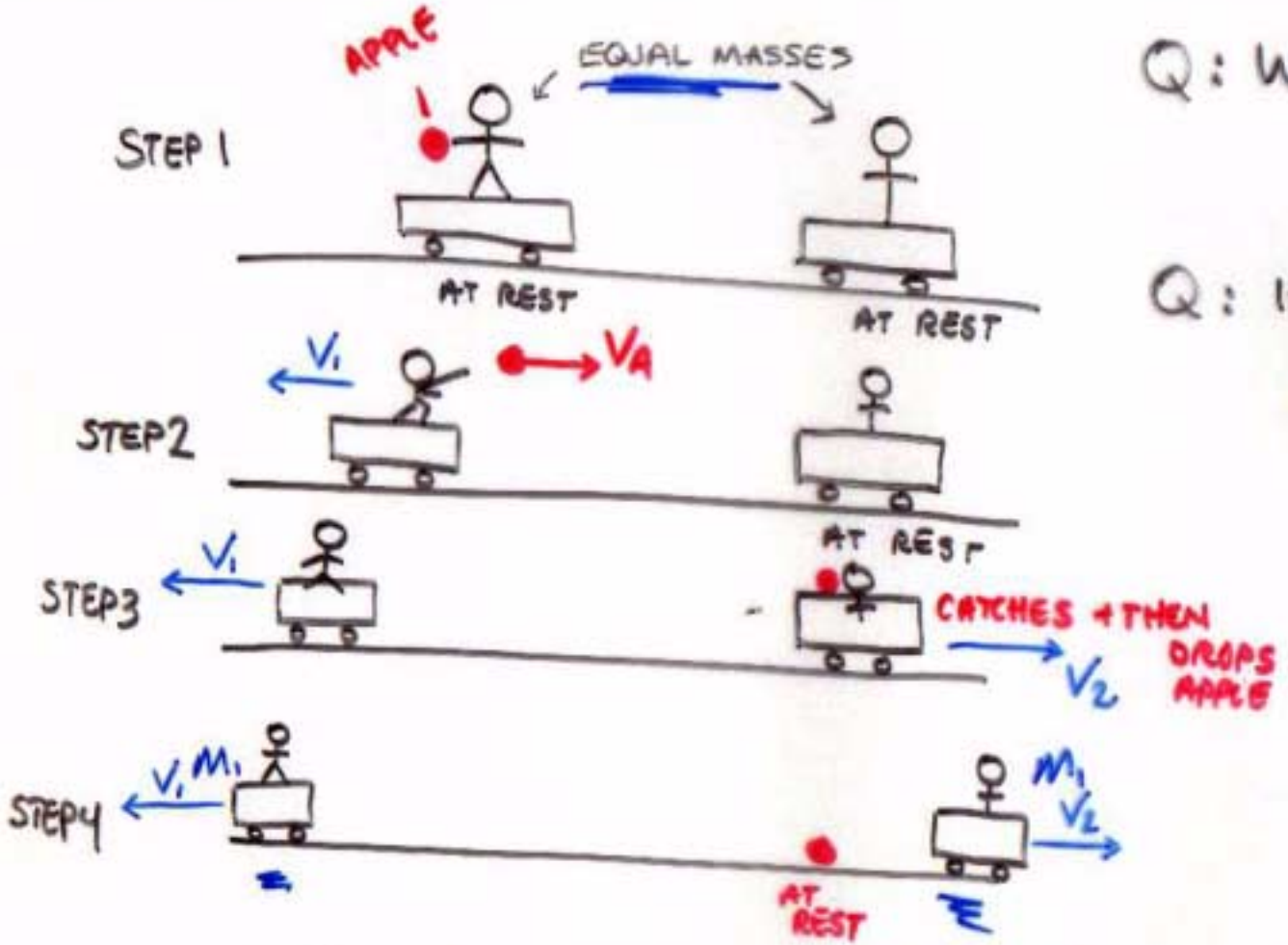
☐ NEWTON'S LAWS WHAT DO YOU NEED TO KNOW

$\approx \frac{1}{3} - \frac{1}{2}$ OF THE EXAM DEPENDS ON NEWTON'S 1ST + 2ND LAWS:

IF A BODY IS STANDING STILL ($\vec{v} = 0$)
OR IS NOT ACCELERATING ($\vec{v} = \text{CONST.}$)
THEN THE **TOTAL FORCE VANISHES**

ONE TYPE OF PROBLEM: FIND "MISSING FORCES" THIS WAY

PLAYING CATCH



Q: WHAT IS INITIAL MOMENTUM OF THE ENTIRE SYSTEM?

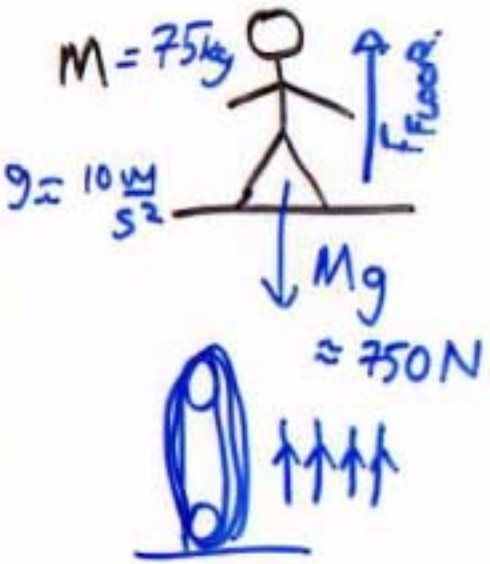
MOM = 0.

Q: IN STEP 2 WHICH DIRECTION IS THE MOMENTUM OF APPLE? OF FRIEND 1?

Q: WHICH IS LARGER V_1 OR V_2?

Q: IF ~~YOU~~ THE APPLE WERE INVISIBLE, + TRAVELED FAST WOULD THIS PROCESS LOOK LIKE FRIEND 1 PUSHING ON FRIEND 2 THROUGH AN "ACTION-AT-A DISTANCE"?

☐ CLASSIC "GUY STANDING BY THE ROAD" - "WOMAN ON A SWING"



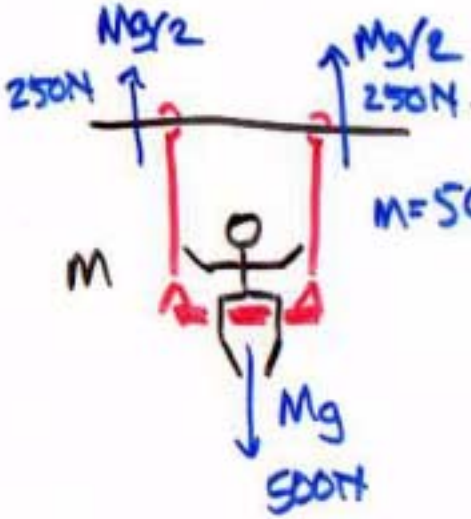
Q: WHAT IS GRAVITY FORCE ON THE GUY?
DIRECTION + MAGNITUDE. Mg DOWNWARD
750 N DOWNWARD

Q: WHAT IS THE TOTAL FORCE ACTING ON THE GUY? 0 ✓ Δ(MV) = 0 = FΔt

Q: IS THERE A FORCE OTHER THAN GRAVITY ACTING ON THE GUY?
WHAT IS ITS MAGNITUDE + DIRECTION
↑ Mg

Q: WHERE DOES THIS FORCE COME FROM?
FLOOR
ELECTROSTATIC EFFECT.

WOMAN MOTIONLESS ON A SWING.



Q: GRAVITY? ↓ Mg = 500N

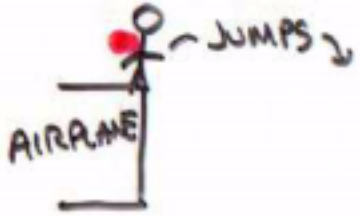
Q: OTHER FORCES? Y ↑ Mg 500N ↑

Q: 2 ROPES HOLDING THE WHOLE THING UP. WHAT IS THE FORCE SUPPLIED BY JUST 1 OF THESE ROPES? ½ Mg ↑

☐ "IF A BODY IS AT REST, OR $\vec{V}$ = CONST. THEN TOTAL FORCE = 0

EXAMPLES:

PARACHUTE



JUST AFTER HE JUMPS, HE ACCELERATES DOWNWARD AT $10\ m/s^2 = g$.

Q: WHAT ARE ALL THE FORCES ACTING?

A: GRAVITY ALONE: $\downarrow Mg$ ONE FORCE, PRODUCES AN ACCELERATION g DOWNWARD.

AFTER FALLING FOR A BIT, OPENS HIS PARACHUTE + BEGINS TO DRIFT DOWNWARDS WITH A CONSTANT VELOCITY $V = -3\ \frac{m}{s}$ TERMINAL VELOCITY!

Q: WHAT IS THE TOTAL FORCE ACTING?

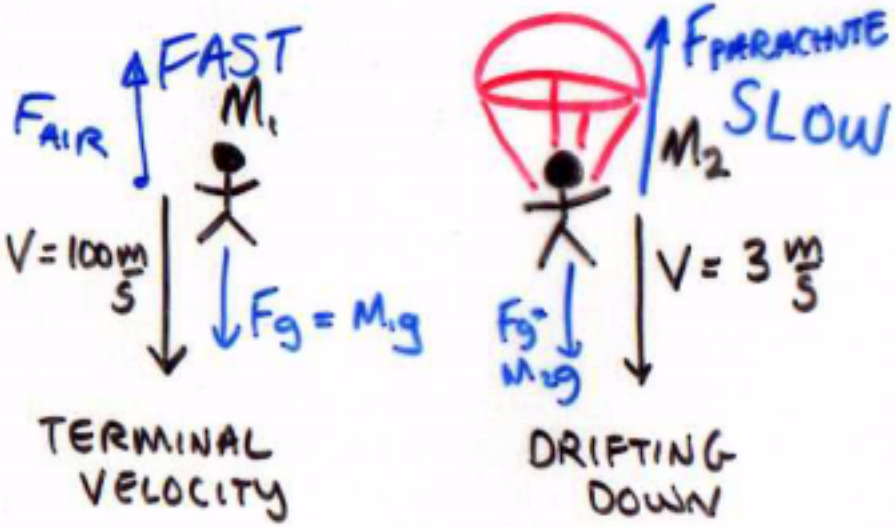
A: GRAVITY STILL ACTS, BUT SINCE V = CONSTANT THERE IS ANOTHER FORCE FROM THE PARACHUTE:

AND $F_p = Mg$ ... PARACHUTE CANCELS THE WEIGHT.

NET, TOTAL FORCE VANISHES

☐ LETS GET CONFUSING:

2 PEOPLE JUMP FROM A PLANE - ONE WITH A PARACHUTE ONE WITHOUT " "



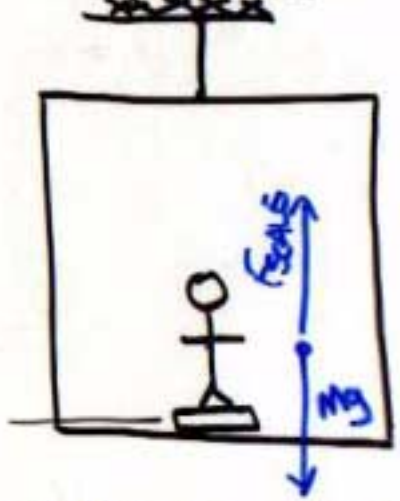
Q: SUPPOSE $M_1 = M_2$ (AND ASSUME PARACHUTE HAS NO MASS!)
IS THE FORCE DUE TO GRAVITY BIGGER FOR 1, OR FOR 2, OR ARE THEY EQUAL.

Q: FOR M_1, IS THERE AN UPWARD FORCE FROM THE AIR? Y

Q: WHICH IS BIGGER: F^1_{AIR} OR $F^2_{PARACHUTE}$?

☐ GRAVITY IN AN ELEVATOR:

ELEVATOR STOPPED ON THE 20TH FLOOR



Q: WHAT ARE THE FORCES ACTING ON YOU?

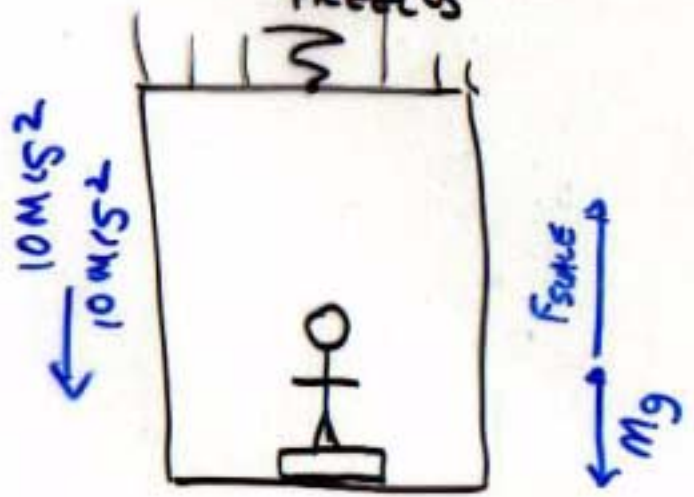
Q: IF YOUR MASS IS 75 kg, WHAT DOES THE SCALE READ IN NEWTONS

$\Delta(mv) = 0 = F \cdot \Delta t = 0$

$F = 0 = F_{SCALE} - mg$

$F_{SCALE} = mg = 75\,kg \cdot 10\,\frac{m}{s^2} = 750\,N$

BROKEN CABLE, ELEVATOR + YOU DROPPING FREELY



Q: WHAT ARE FORCES ACTING ON YOU?

Q: NOW WHAT DOES THE SCALE READ IN NEWTONS?

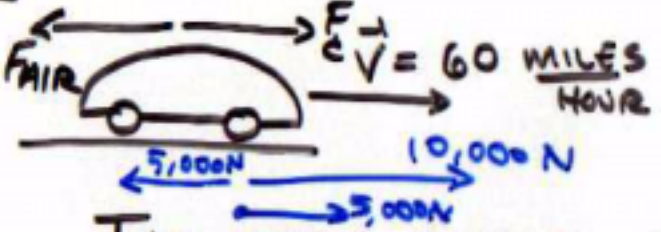
$\Delta(mv) = mg\Delta t$

$= (F_{SCALE} - mg)\Delta t$

$-mg\Delta t = F_{SCALE}\Delta t - mg\Delta t$

$F_{SCALE} = 0$

☐ ONE MORE... A CAR ON A STRAIGHT SECTION OF HIGHWAY



— CONSTANT.

THE CAR'S ENGINE PUSHES THE WHEELS, + THE WHEELS PUSH THE CAR ALONG WITH A TOTAL FORCE = ~~100,000N~~ 10,000 N.

Q: THE AIR RUSHING BY THE CAR EXERTS A FORCE. WHICH DIRECTION? ←

Q: HOW BIG IS THE FORCE FROM THE AIR?
-10,000N OR 10,000N LEFT.

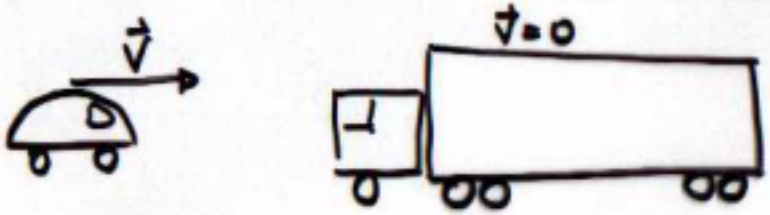
Q: SUPPOSE YOU SUDDENLY TURN OFF THE IGNITION, + LET THE CAR "COAST". WILL THE CAR ACCELERATE? (CHANGE ITS VELOCITY VECTOR?)
WHICH DIRECTION WILL ~~the~~? ←

UNBALANCED FORCE

~~3RD LAW?~~ 2ND

☐ 3RD LAW AND NOT 3RD LAW:

A VW BUG RAMS INTO A SEMI TRUCK:



WHICH IS LARGER: THE FORCE THE CAR EXERTS ON THE TRUCK
EQUAL! OR THE FORCE THE TRUCK EXERTS ON THE CAR?

COMPARING BEFORE THE COLLISION TO AFTER THE COLLISION,
WHICH CHANGES MOST: THE MOMENTUM OF THE CAR
$\Delta(mv) = F\Delta t$ (EQUAL.) THE MOMENTUM OF THE TRUCK?

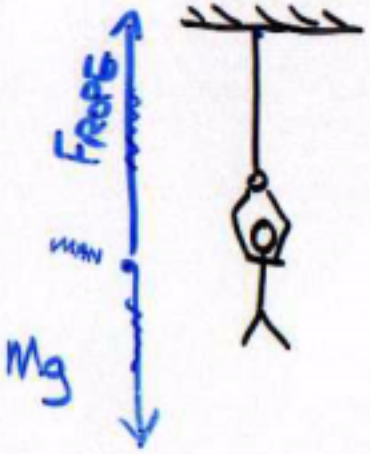
IS MOMENTUM CONSERVED HERE?

↑ YES ↑

WHAT ABOUT $\vec{v}$ (NOT $m\vec{v}$).

☐ NOT 3RD LAW

MAN IS HOLDING ONTO A ROPE:



Q: WHAT FORCES ACT ON THE MAN?

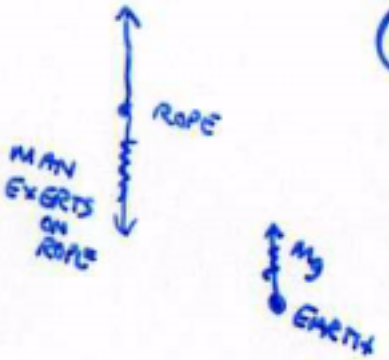
F ROPE + WEIGHT (FORCE FROM GRAVITY)

Q: IF THE MAN IS STATIONARY, WHAT CAN YOU SAY ABOUT THOSE FORCES?

2ND: $\Delta(MV) = F\Delta t$ $\vec{F}=0$ $F_{ROPE} = Mg$

T/F Q: THESE FORCES ARE EQUAL AND OPPOSITE.

T/F: THIS IS AN EXAMPLE OF NEWTON'S 3RD LAW.



☐ ENERGY AND MOMENTUM

$\frac{1}{4} - \frac{1}{2}$ OF THE EXAM FOCUSES ON THESE QUANTITIES

FOR AN ISOLATED SYSTEM

VECTOR MOMENTUM OF THE <u>WHOLE SYSTEM</u> DOESN'T CHANGE

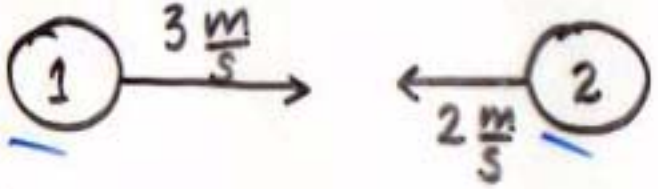
ENERGY OF THE SYSTEM DOESN'T CHANGE

- BUT IF THERE IS <u>FRICTION</u> OF <u>ANY SORT</u> YOU MAY HAVE TO LOOK FOR THE ENERGY IN HEAT.

THESE STATEMENTS ARE FOUNDATION OF MODERN PHYSICS - PARTICALS, FIELDS, ETC. <u>EXTREMELY IMPORTANT</u>

☐ MOMENTUM IS CONSERVED AS A VECTOR: COLLISION.

2 OBJECTS, EACH HAS A MASS OF 5 kg, MOVING AS SHOWN:



MASS × $\vec{V}$

THEY COLLIDE AND STICK TOGETHER. →

Q: AFTER COLLISION, WHICH WAY DOES THE OBJECT GO?

Q: WHAT IS THE INITIAL MOMENTUM OF OBJECT 1? +15 kg m/s

Q: WHAT IS THE INITIAL MOMENTUM OF OBJECT 2? −10 kg m/s

Q: WHAT IS THE TOTAL INITIAL MOMENTUM? +5 kg m/s

Q: AFTER THE COLLISION, WHAT IS THE TOTAL MOMENTUM? +5 kg m/s

MOM = (10 kg) V_F = 5 kg m/s

Q: GIVEN THAT OBJECT 1 + OBJECT 2 TOGETHER HAVE A TOTAL MASS = 10 kg, WHAT IS THEIR FINAL VELOCITY? ½ m/s

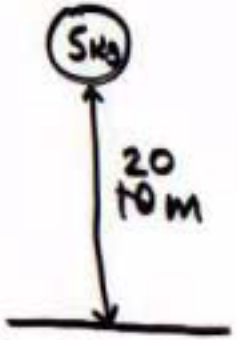
$V_F = \frac{5}{10}\ \frac{m}{s} = \frac{1}{2}\ m/s$

☐ ENERGY CONSERVATION:

$KE = \frac{1}{2}MV^2$ $\quad PE = Mgh$

$5\,kg \cdot 10\frac{m}{s^2} \cdot 20\,m = 1000\,J$

DROP A 5 Kg MASS 20 METERS: $5\,kg \cdot 10\frac{m}{s^2}\,20\,m$ $\quad V=0$



Q: WHAT IS THE INITIAL ENERGY? $\frac{0}{KE} + \frac{1000}{PE}$ J

Q: WHAT IS THE FINAL ENERGY HITTING THE GROUND $\frac{1000}{KE} + \frac{0}{PE}$ J

Q: GIVEN THAT $KE = \frac{1}{2}mV^2$, WHAT IS THE SPEED OF THE MASS WHEN IT HITS THE GROUND? $1000 = \frac{1}{2} \cdot 5kg \cdot V^2$

$\frac{2000}{5}\frac{m^2}{s^2} = V^2 = 400\frac{m^2}{s^2}$

$V = 20\frac{m}{s}$

DROP A 1 Kg MASS 20 METERS:

$PE = M \cdot g \cdot h$
$= 1kg \cdot 10\frac{m}{s^2} \cdot 20m$
$= 200\,J$

Q: WHAT IS THE INITIAL ENERGY? $\frac{0}{KE} + \frac{200}{PE}$ J

Q: WHAT IS THE FINAL ENERGY? $\frac{200}{KE} + \frac{0}{PE}$ J

Q: WHAT IS THE SPEED OF THE OBJECT WHEN IT HITS THE GROUND? $200\,J = \frac{1}{2} \cdot 1kg \cdot V^2$

$\frac{400\,J}{kg} = V^2 \rightarrow V = 20\frac{m}{s}$

Q: WHICH OBJECT HAS MORE ENERGY? $M = 5kg$

Q: DOES THIS REMIND YOU OF A FAMOUS EXPERIMENT?