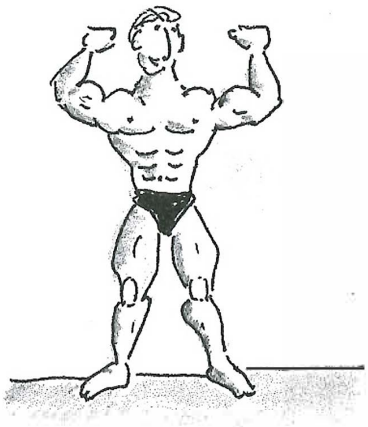
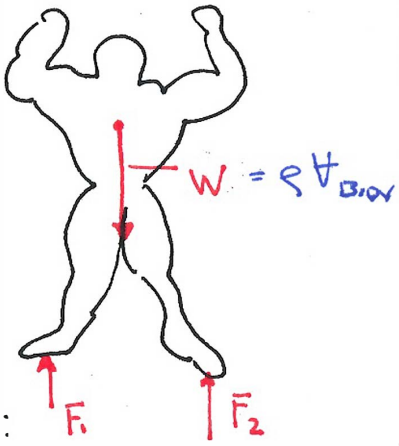
DRAW A FREE BODY (-BUILDER) DIAGRAM of OUR FRIEND:

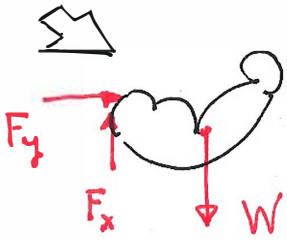


F.B.D. ⇨



NOW DRAW A F.B.D. OF ONLY HIS LEFT ARM:

F.B.D.



IS THERE NO WEIGHT? DID THE WEIGHT MOVE? IS IT THE SAME WEIGHT?

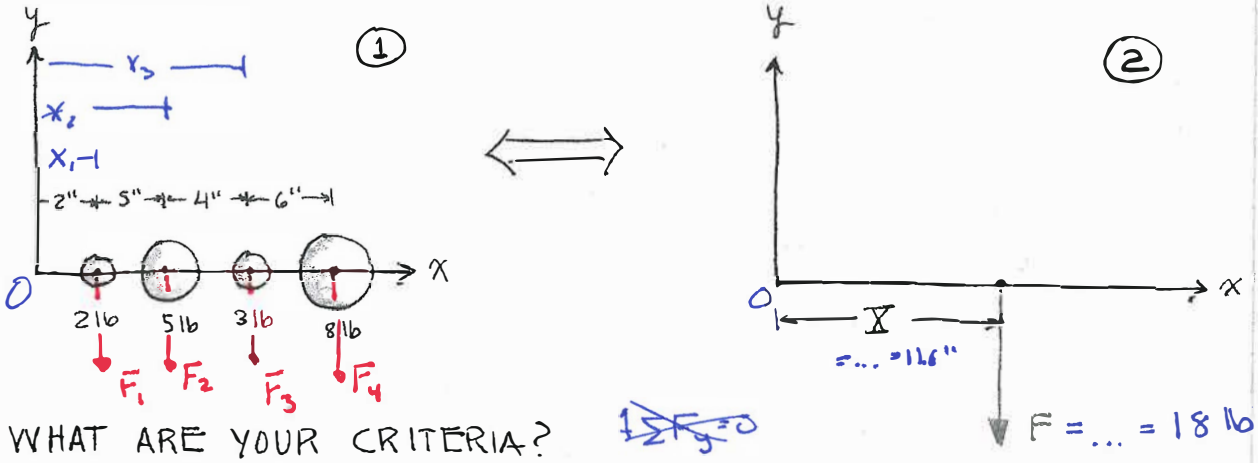
DISCUSS HOW YOU HANDLED THE FORCE DUE TO GRAVITY IN EACH F.B.D.

- REPRESENTED AS A SINGLE FORCE.
- PUT IT AT ONE POINT
- MAGNITUDE IS FUNCTION of VOLUME (IMPLICITLY, @ LEAST)
- WAVED MY HANDS A LOT.

WE *PRETEND* LIKE WEIGHT IS CONCENTRATED AT ONE POINT. HOW CAN WE DO THIS? AND WHICH POINT DO WE USE?

example

REPLACE THE FOUR MASSES WITH A SINGLE FORCE AND SPECIFY ITS LOCATION.



WHAT ARE YOUR CRITERIA?

1. $\sum \vec{F}_{①} = \sum \vec{F}_{②}$
2. $\sum \vec{M}_{①P} = \sum \vec{M}_{②P}$

$\sum F_y = 0$

$-F_1 - F_2 - F_3 - F_4 = -F$

$F = F_1 + F_2 + F_3 + F_4$

$= \sum F$

(4) $\sum M_{O①} = \sum M_{O②}$

$-x_1 F_1 - x_2 F_2 - x_3 F_3 - x_4 F_4 = -\bar{x} F_R$

$= -\bar{x} \sum F_i$

$$\bar{x} = \frac{\sum_i x_i F_i}{\sum_i F} = \frac{(2")(5lb) + (7")(5lb) + (11")(3lb) + (17")(8lb)}{(2+5+3+8)lb}$$

$= 11.6"$

GENERALING: IF FORCE IS WEIGHT

$$\bar{X} = x_G = \frac{\sum x_i W_i}{\sum W_i} = \frac{\int \tilde{x}\, dW}{\int dW} = \frac{\int_V \tilde{x}\, \rho g\, dV}{\int_V \rho g\, dV}$$

CENTER of GRAVITY

LET NUMBER of WEIGHTS BECOME INFINITE & CONTINUOUS

$dV = w\, dA$

IN 2-D:

$$x_G = \frac{\int \tilde{x}\, \rho g \cdot w\, dA}{\int \rho g\, w\, dA} = \frac{\rho g w \int_A x\, dA}{\rho g w \int_A dA}$$

WIDTH

LET DENSITY & GRAVITY BE CONSTANT.

CENTROID of dA

$$x_c = \frac{\int_A \tilde{x}\, dA}{\int_A dA}$$

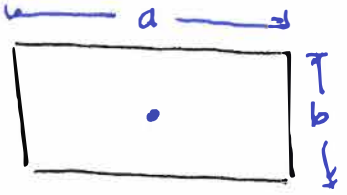
CENTROID (GEOMETRIC CENTER)

CAN DO THE SAME FOR y-DIRECTION.

$$y_c = \frac{\int_A \tilde{y}\, dA}{\int_A dA}$$

WHERE'S x_c & y_c?

e.g.



STEPS IN FINDING CENTROIDS

STEP 1: CHOOSE AN ELEMENTAL AREA, dA.

WHAT INFLUENCES CHOICE?

$y = f(x)$? $x = f(y)$? LOOKING FOR x_c or y_c, etc.

STEP 2: IDENTIFY VARIABLE of INTEGRATION

~~WRITE dA IN TERMS of~~

i.e. (width) dx or (width) dy

STEP 3: WRITE dA IN TERMS OF VARIABLE of INTEGRATION.

i.e. $y\,dx = f(x)\,dx$ IF $y = f(x)$

STEP 4: IDENTIFY CENTROID of ELEMENT dA.

($\tilde{x}$ or $\tilde{y}$)

STEP 5: SUB INTO

$$X_c = \frac{\int \tilde{x}\,dA}{\int dA}$$

& FIND CORRECT LIMITS

STEP 6: EVALUATE!