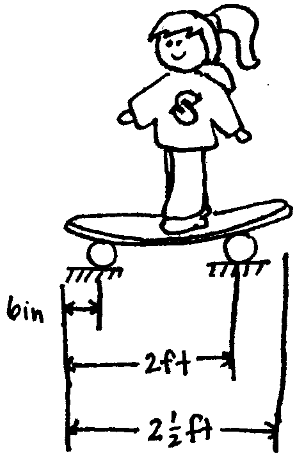
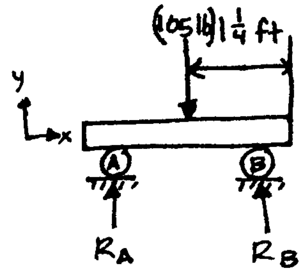
LESSON 1: SHEAR and MOMENT DIAGRAMS

Mary needs to get to class fast, so she decides to take her skateboard. If we know Mary weighs 105 lbs. and assume the skateboard is massless, draw the shear and moment diagrams for the instant when she is standing on her board.



use a simply supported beam model $\Longrightarrow$

draw in the $\boxed{\text{external}}$ forces



STEP 1: Solve for R_A and R_B

$$+\uparrow \Sigma F_y = 0 \rightarrow R_A + R_B - 105\,lb = 0$$

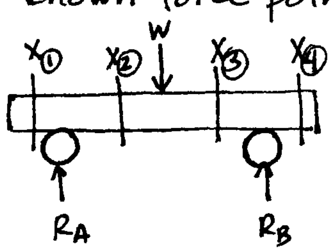
$$R_A + R_B = 105\,lb$$

$$+\circlearrowleft \Sigma M_A = 0 : (-105\,lb)(\tfrac{3}{4}\,ft) + R_B(1\tfrac{1}{2}\,ft) = 0$$

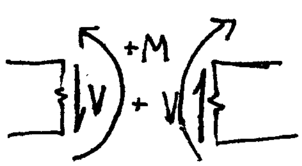
$$R_B = 52.5\,lb \uparrow$$

$$\text{so... } R_A = 52.5\,lb \uparrow$$

STEP 2: Divide beam between known force points...

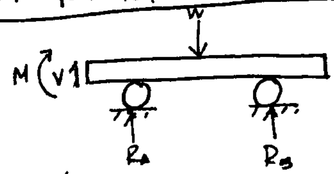


STEP 3: Look at each section closely using your understanding of external forces.



STEP 4: To help you understand the concept of moment-shear diagrams we will look at points ①, ②, ③, ④ as well as the end points and load points so, here we go...

At far left end of the beam:



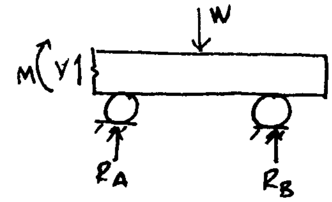
$+\uparrow \Sigma F_y: 0 = V + R_A + R_B - W$

$\therefore V = 0$ lb

$\circlearrowleft + \Sigma M: 0 = M + (W)(\frac{5}{4}) - R_A(.5) - R_B(2)$

$\therefore M = 0$ lb·ft

at point $x_①$



$+\uparrow \Sigma F_y: 0 = R_A + R_B - W + V$

$\therefore V = 0$ lb

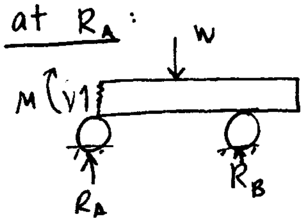
$\circlearrowleft + \Sigma M: 0 = M + W(\frac{5}{4} - x_1) - R_A(\frac{1}{2} - x_1) - R_B(2 - x_1)$

plugging in values

$0 = M + 131.25 - 105x_1 - 26.25 + 52.5x_1 - 105 + 52.5$

$\therefore M = 0$ lb·ft

at R_A:



$+\uparrow \Sigma F_y: 0 = R_A + R_B - W + V$

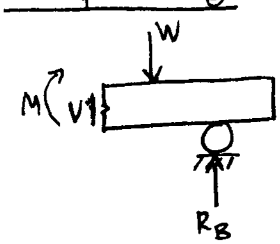
$\therefore V = 0$ lb

$\circlearrowleft + \Sigma M: 0 = M + W(\frac{3}{4}) - R_A(0) - R_B(1.5)$

$0 = M + 78.75 - 78.75$

$\therefore M = 0$ lb·ft

at point $x_②$



$+\uparrow \Sigma F_y: 0 = R_B - W + V$

$\therefore V = 52.5$ lb $\uparrow$

$\circlearrowleft + \Sigma M: 0 = M + W(\frac{5}{4} - x_2) - R_B(2 - x_2)$

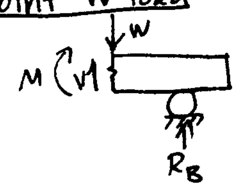
$0 = M + 131.25 - 105x_2 - 105 + 52.5x_2$

$0 = M + 26.25 - 52.5x_2$

$\therefore M = 52.5x_2 - 26.25$ [lb·ft]

for $\frac{1}{2}$ ft $< x_2 < \frac{5}{4}$ ft

at point W load



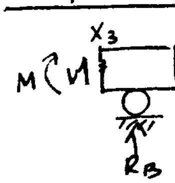
$+\uparrow \Sigma F_y: 0 = V - W + R_B$

$\therefore V = 52.5$ lb $\uparrow$

$\circlearrowleft + \Sigma M: M - R_B(\frac{3}{4}) = 0$

$\therefore M = 39.375$ lb·ft

at point $x_③$



$+\uparrow \Sigma F_y: 0 = V + R_B \rightarrow \therefore V = 5$

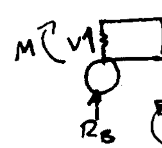
$\circlearrowleft + \Sigma M: M - R_B(2 - x_3) = 0$

$M - 105 + 52.5x_3 = 0$

$\therefore M = 105 - 52.5x_3$

for $\frac{5}{4}$ ft $< x_3 < 2$ ft

at R_B



$+\uparrow \Sigma F_y: 0 = V + R_B$

$\therefore V = 52.5$ lb $\downarrow$

$\circlearrowleft + \Sigma M: M + 0 = 0$

$\therefore M = 0$

at point $x_④$

$+\uparrow \Sigma F_y: V + 0 = 0$

$\therefore V = 0$

$\circlearrowleft + \Sigma M: M + 0 = 0$

$\therefore M = 0$

at end of beam

$V = 0$

$M = 0$

② * use the eqns to plot M vs. x and V vs. x *