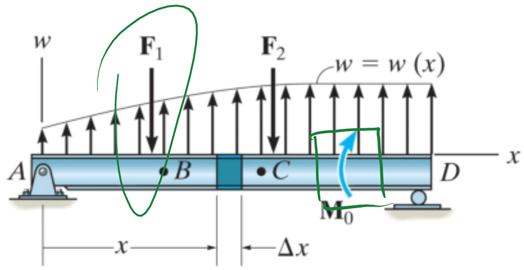
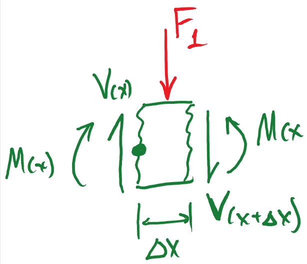
Relations Among Load, Shear and Bending Moments





$$\Sigma F_y = 0 \Rightarrow V(x) - V(x+\Delta x) - F_1 = 0$$

$$V(x+\Delta x) - V(x) = -F_1$$

take $\Delta x \to 0$

$\Rightarrow$ step in $V(x) = |F_1|$ down

$$(\Sigma M)_x = 0$$

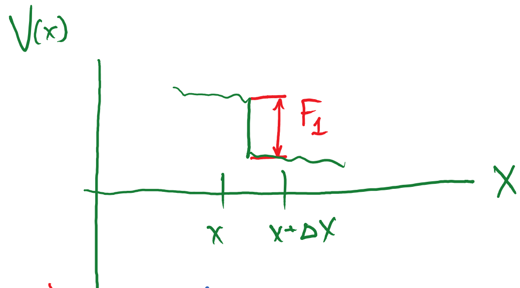
$$\Rightarrow -M(x) + M(x+\Delta x) - F_1 \cdot \frac{\Delta x}{2} - V(x+\Delta x)\cdot \Delta x = 0$$

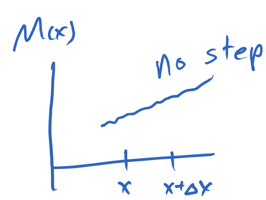
$$M(x+\Delta x) - M(x) = F_1 \cdot \cancelto{0}{\frac{\Delta x}{2}} - V(x+\Delta x)\,\cancelto{0}{\Delta x} = 0$$

take $\Delta x \to 0$

$$\Rightarrow M(x+\Delta x) - M(x) = 0$$

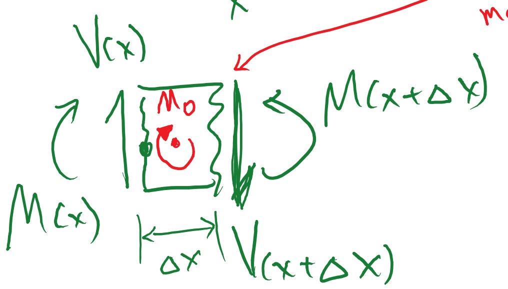
$\boxed{\text{No step!}}$





M_0 is between x and $(x+\Delta x)$

the couple has magnitude M_0, but is in $-\hat{k}$ direction



$$(\Sigma M)_x = 0$$

$$-M(x) + M(x+\Delta x) - M_0 - \Delta x \cdot V(x+\Delta x) = 0$$

$$\underbrace{M(x+\Delta x) - M(x)}_{\text{Value of step}} = M_0 + \cancelto{0}{\Delta x} \cdot V(x+\Delta x)$$

take $\Delta x \to 0$

Value of step

take $\Delta x \to 0$

$\Sigma F_y = 0$

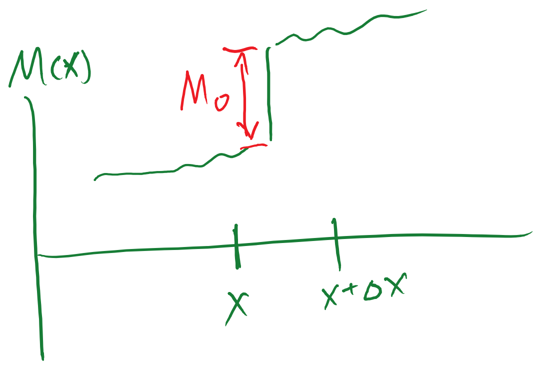
$V(x) - V(x+\Delta x) = 0$

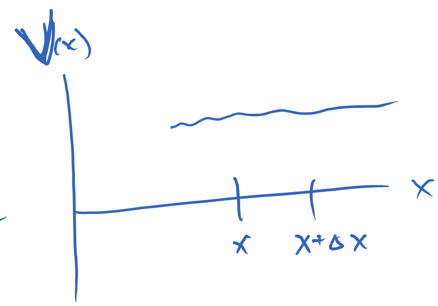
$\Rightarrow V(x+\Delta x) = V(x)$

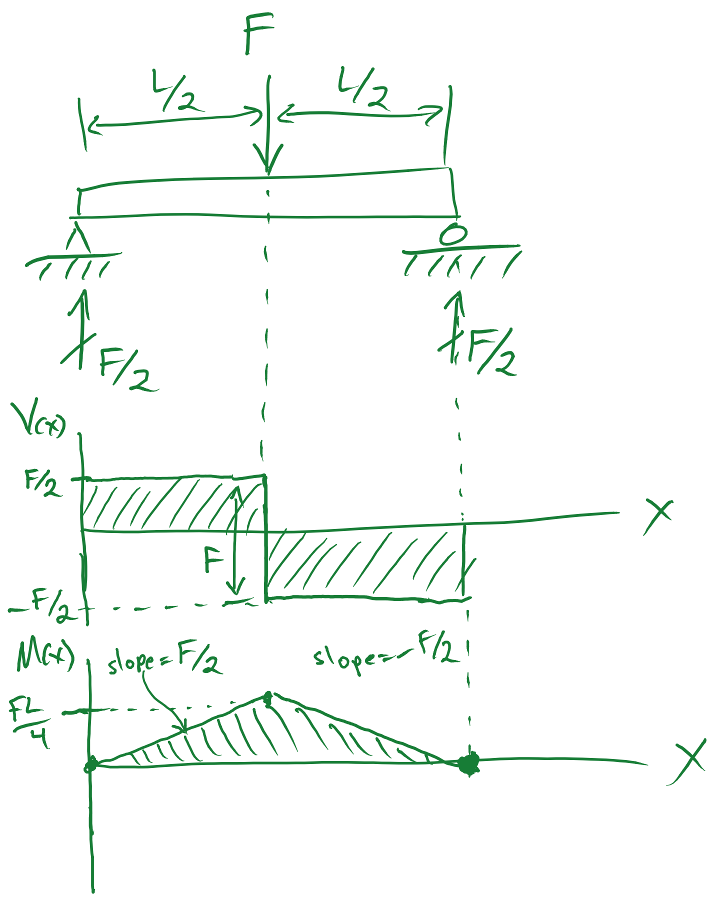
$\Rightarrow$ $\boxed{\text{No step in } V(x)}$

$\Rightarrow$ $\boxed{M(x+\Delta x) - M(x) = M_0}$

step is upward!







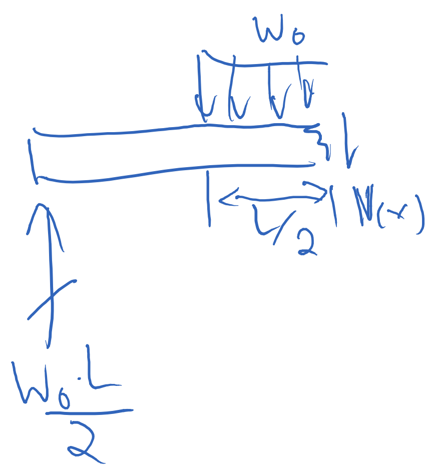
$$\boxed{\frac{dM}{dx} = V(x)\,!}$$

Remember

$$\frac{dM}{dx} = V(x)$$

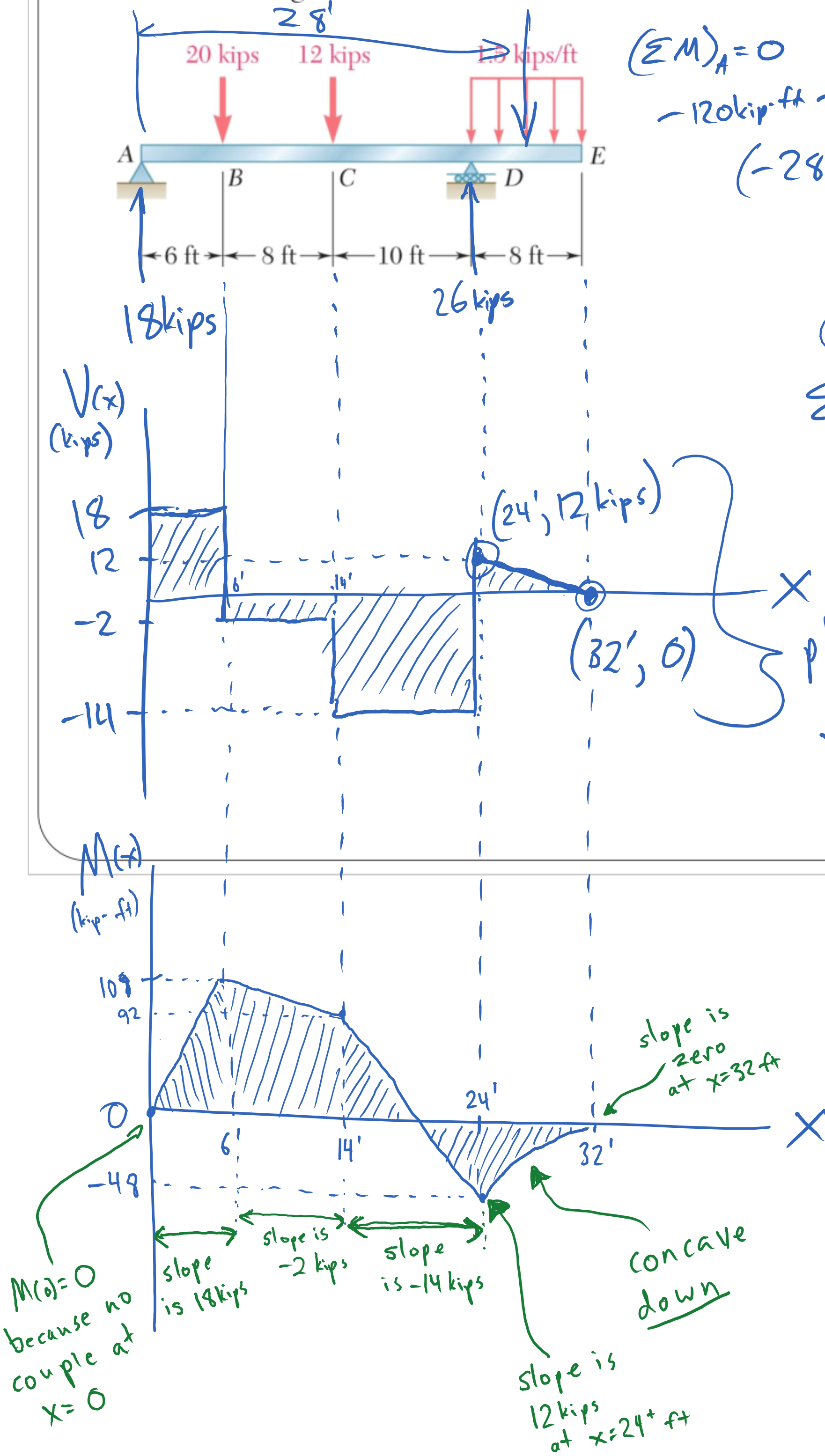
$$\frac{dV}{dx} = \underbrace{w(x)}_{\text{distributed load}}$$

$V(\cancel{x})$ gives slope of $M(x)$



Tuesday, March 7, 2017 7:18 PM

Draw the shear and bending moment diagrams for the beam and loading shown.



$(\Sigma M)_A = 0$

$-120\,\text{kip·ft} - 168\,\text{kip·ft} + 24 D_y - \underbrace{(28')(12\text{ kips})}_{} = 0$

$(-288 - 336)\text{kips} = -24 D_y$

$D_y = \frac{624}{24}$ kips

$D_y = 26$ kips

$\Sigma F_y = A_y + D_y \underbrace{- 20\text{kips} - 12\text{kips} - 12\text{kips}}_{} = 0$

$A_y + 26\text{kips} - 44\text{kips} = 0$

$A_y = 18$ kips

plug into

$y = mx + b$ form

$V(x) = m \cdot x + b$

solve m & b

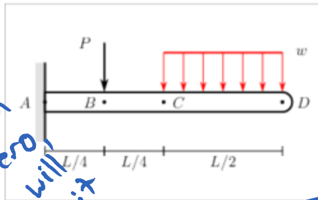
$m = -1.5$ kips/ft

see that $\frac{dM}{dx} = V(x)$

Wednesday, March 22, 2017   9:24 PM

Cantilever beam with distributed load

Consider a cantilever beam subjected to a uniform distributed load w and a point load $P = wL/2$ as indicated below.

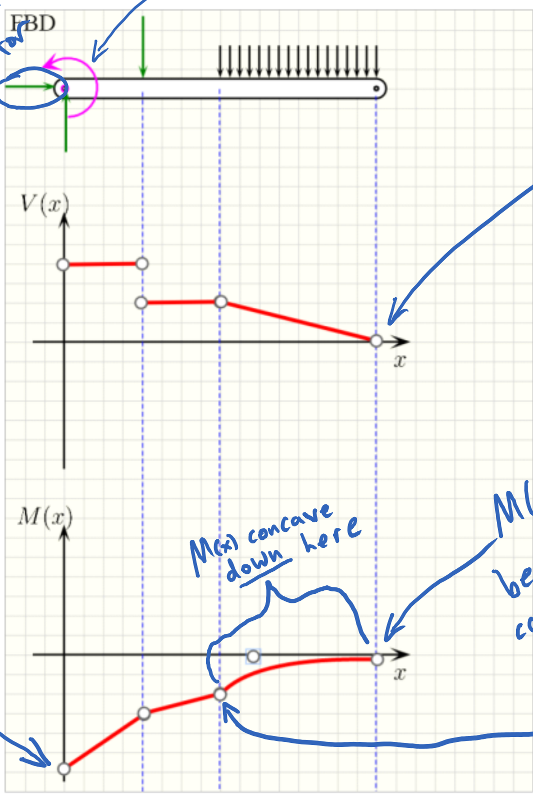


Reaction couple should be positive
Call it M_0

If reaction in x is zero PrairieLearn will allow you to omit the vector

Draw the free-body diagram and corresponding shear force and bending moment diagrams.

To draw the shear force and bending moment diagrams, you MUST use the minimum number of lines (straight or curved), i.e., the minimum number of objects created by clicking the two buttons under "V and M lines".



FBD Concentrated forces:

FBD Distributed loads:

FBD Moments:

V and M lines:

Help buttons (not graded):

$V(L)=0$ because no point load at end of beam

$M(L)=0$ because no couple at end of beam

M(x) concave down here

$M(0)=-M_0$ because positive couples cause a downward step

slope should be continuous here, but PrairieLearn is not picky about that

Tolerance for placement of objects is 1/2 grid size

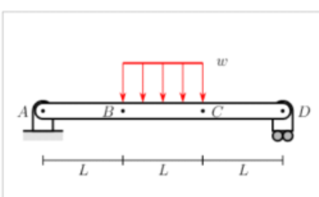
$M(x)<0$ everywhere!

"Frowning" beam

Submit   New variant

SSB with distributed load

Consider a simply-supported beam subjected to a uniform distributed load w as indicated below.

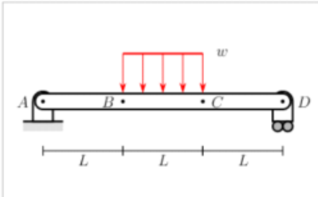


Draw the free-body diagram and corresponding shear force and bending moment diagrams.

To draw the shear force and bending moment diagrams, you MUST use the minimum number of lines (straight or curved), i.e., the minimum number of objects created by clicking the two buttons under "V and M lines".

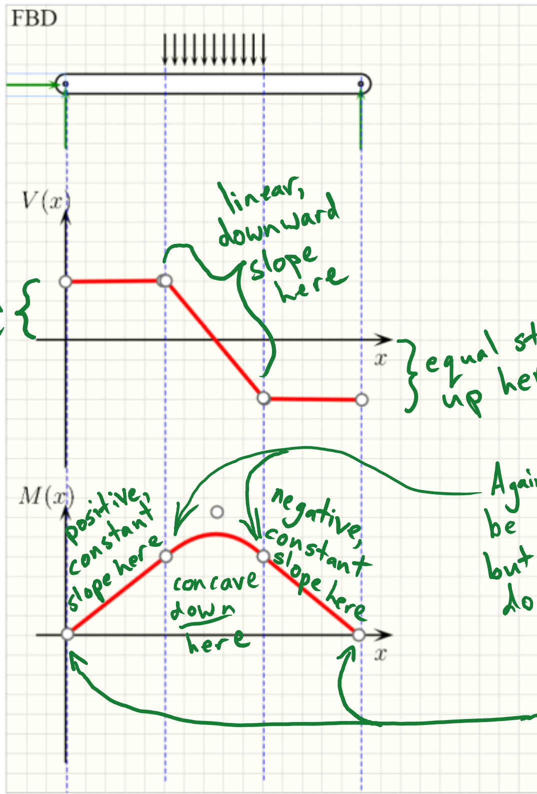
SSB with distributed load

Consider a simply-supported beam subjected to a uniform distributed load w as indicated below.



Draw the free-body diagram and corresponding shear force and bending moment diagrams.

To draw the shear force and bending moment diagrams, you MUST use the minimum number of lines (straight or curved), i.e., the minimum number of objects created by clicking the two buttons under "V and M lines".



Again, slope should be continuous here but PrairieLearn doesn't check for that

M = 0 at ends because no couples at ends

Tolerance for placement of objects is 1/2 grid size

FBD Concentrated forces:

FBD Distributed loads:

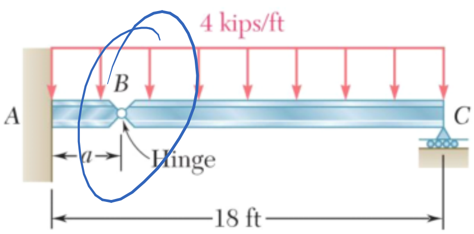
FBD Moments:

V and M lines:

Help buttons (not graded):

Submit | New variant

Draw the shear and bending moment diagrams for the beam and loading shown.



At a hinge, what are M & ΔV?

A) $M>0$
B) $M<0$
C) M unknown
D) $M=0$

ΔV? (step in $V(x)$)

A) 0
B) $V<0$
C) $V>0$
D) $V=?$ (could be either?)