Name: ______________________________

Exam 03: Chapters 06 and 07

- Select and solve **three** of the following problems to the best of your ability. You must choose **one problem from each column**, and a third problem at your own discretion. *You may not solve all three problems from the same column.*
- Indicate below which three problems you wish to have graded. **If you do not explicitly mark a problem to be scored, it will not be scored. If you have worked on more than three problems, select only three to be graded. I will not choose for you.**

Choose At Least One	Grade this one?	Choose At Least One	Grade this one?
Problem 01		Problem 04	
Problem 02		Problem 05	
Problem 03		Problem 06	

- You may use your **calculator** and the attached **formula sheet**.
- Read and follow the directions carefully.
- *Solve using the method required by the problem statement*. If you are not explicitly required to use a specific technique, please be sure to show sufficient work so that your method is obvious.
- Show all your work. Work as neatly as you can. If you need scratch paper, blank sheets will be provided for you.
- It is permissible to use your calculator to solve a system of equations directly. If you do, state this explicitly.
- Express your answer as directed by the problem statement, using **three significant digits**. Include the **appropriate units**.

Your work will be scored according to the following point structure:

Problem 01: ____________ /34

Problem 02: ____________ /34

Problem 03: ____________ /34

Problem 04: ____________ /34

Problem 05: ____________ /34

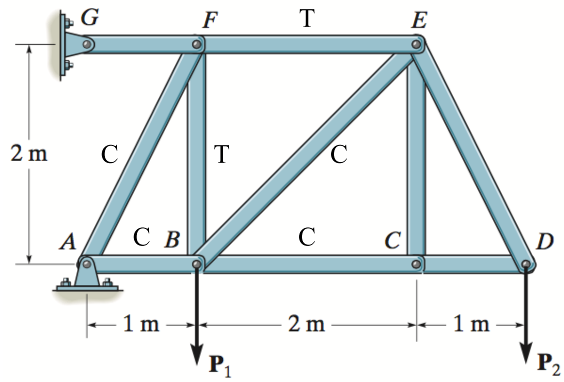
Problem 06: ____________ /34

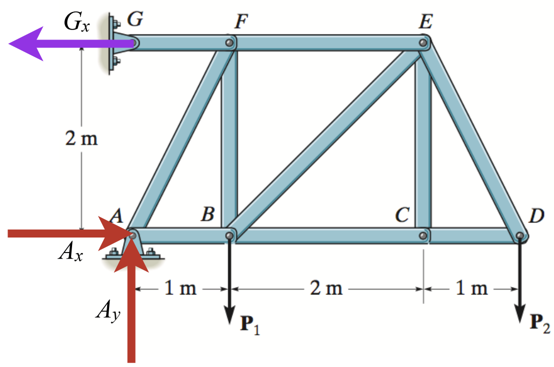
Problem 01

The truss shown is supported by a pins at A and G, and subjected to discrete loads $\mathbf{P_1}$ = 10kN applied at point B, and $\mathbf{P_2}$ = 15kN applied at point D.

A) Determine the reaction forces at A and G. (Hint: $A_x \neq 0$! $G_x \neq 0$!)

B) Use the ***method of joints*** to determine the forces in members ***AB***, ***AF***, ***BF***, ***BE***, and ***BC***. State whether each member is in ***tension*** or ***compression***.





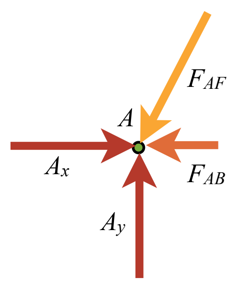
$$\sum M_G = (2\text{m})A_x - (1\text{m})P_1 - (4\text{m})P_2 = 0$$

$$A_x = \frac{(10\text{kN}) + (4)(15\text{kN})}{2} = 35\text{kN}$$

$$\sum F_x = A_x - G_x = 0 \Rightarrow G_x = 35\text{kN}$$

$$\sum F_y = A_y - P_1 - P_2 = 0$$

$$A_y = 10\text{kN} + 15\text{kN} = 25\text{kN}$$

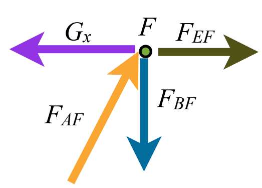


$$\sum F_y = A_y - \left(\frac{2}{\sqrt{5}}\right)F_{AF} = 0$$

$$F_{AF} = \left(\frac{\sqrt{5}}{2}\right)(25\text{kN}) = 27.9\text{kN}$$

$$\sum F_x = A_x - \left(\frac{1}{\sqrt{5}}\right)F_{AF} - F_{AB} = 0$$

$$F_{AB} = 35\text{kN} - \left(\frac{1}{\sqrt{5}}\right)(27.9\text{kN}) = 22.5\text{kN}$$

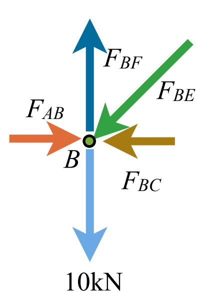


$$\sum F_x = F_{EF} + \left(\frac{1}{\sqrt{5}}\right)F_{AF} - G_x = 0$$

$$F_{EF} = 35\text{kN} - \left(\frac{1}{\sqrt{5}}\right)(27.9\text{kN}) = 22.5\text{kN}$$

$$\sum F_y = \left(\frac{2}{\sqrt{5}}\right)F_{AF} - F_{BF} = 0$$

$$F_{BF} = \left(\frac{2}{\sqrt{5}}\right)(27.9\text{kN}) = 25\text{kN}$$



$$\sum F_y = F_{BF} - \left(\frac{\sqrt{2}}{2}\right)F_{BE} - 10\text{kN} = 0$$

$$F_{BE} = \left(\frac{2}{\sqrt{2}}\right)(25 - 10\text{kN}) = 21.2\text{kN}$$

$$\sum F_x = F_{AB} - \left(\frac{\sqrt{2}}{2}\right)F_{BE} - F_{BC} = 0$$

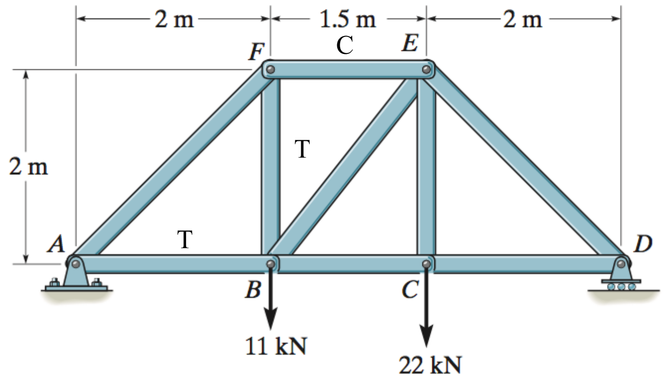
$$F_{BC} = 22.5\text{kN} - \left(\frac{\sqrt{2}}{2}\right)(21.2\text{kN}) = 7.5\text{kN}$$

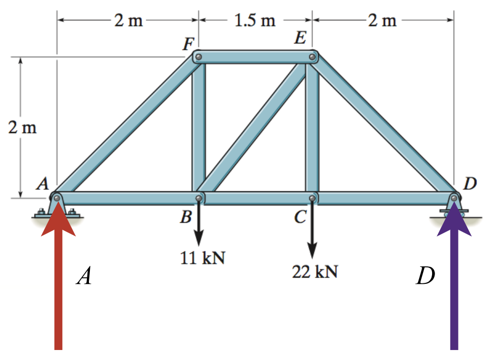
Problem 02

The truss shown is supported by a pin at A and a roller at D. It is subjected to the discrete loads $\mathbf{P_1} = \mathbf{11kN}$ and $\mathbf{P_2} = \mathbf{22kN}$.

A) Determine the reaction forces at A and D.

B) Use the ***method of sections*** to determine the forces in members ***EF***, ***BF***, and ***BA***. State whether each member is in tension of compression.



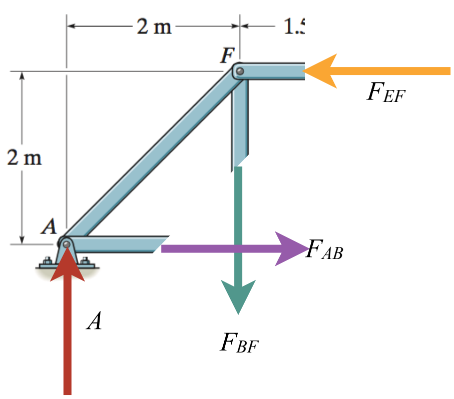


$$\sum M_D = (5.5\text{m})A - (3.5\text{m})(11\text{kN}) - (2\text{m})(22\text{kN}) = 0$$

$$A = \left(\frac{1}{5.5}\right)(38.5+44)\text{kN} = 15\text{kN}$$

$$\sum F_y = A + D - 11\text{kN} - 22\text{kN} = 0$$

$$D = 33\text{kN} - 15\text{kN} = 18\text{kN}$$



$$\sum F_y = A - F_{BF} = 0$$

$$F_{BF} = A = 15\text{kN}$$

$$\sum M_F = (2\text{m})A + (2\text{m})F_{AB} = 0$$

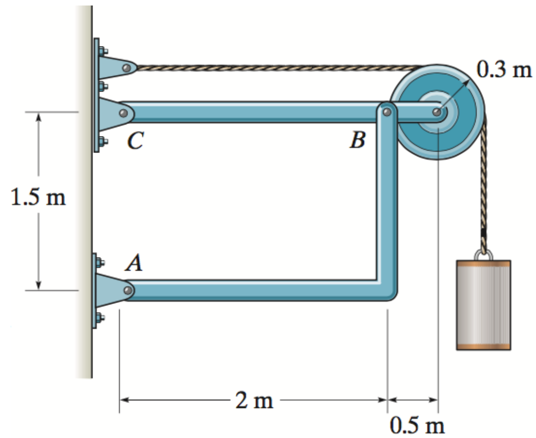
$$F_{AB} = A = 15\text{kN}$$

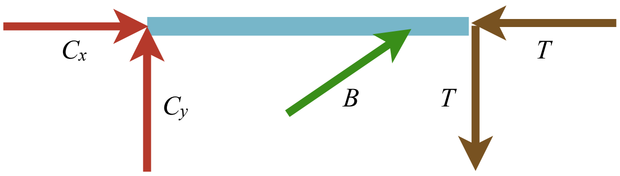
$$\sum F_x = F_{AB} - F_{EF} = 0$$

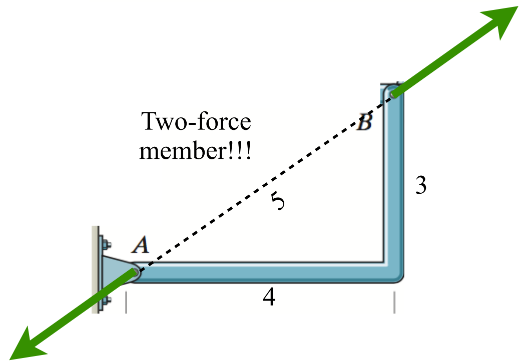
$$F_{EF} = F_{AB} = 15\text{kN}$$

Problem 03

For the frame shown, determine the horizontal and vertical components of the forces at pins *B* and *C*. The suspended cylinder has a **mass** of **75 kg**. (Hint: Notice that *AB* is a two-force member!)







$$\sum M_B = (2m)\,C_y - (0.5m)\,T = 0$$

$$C_y = (0.5)^2 (75\text{kg})(9.81\,\text{m/s}^2) = 184\text{N}$$

$$\sum M_C = (2\text{m})\left(\frac{3}{5}\right)B - (2.5\text{m})\,T = 0$$

$$B = \left(\frac{5}{6}\right)(2.5)(75\text{kg})(9.81\,\text{m/s}^2) = 1533\text{N}$$

$$\sum F_x = C_x + \left(\frac{4}{5}\right)B - T = 0$$

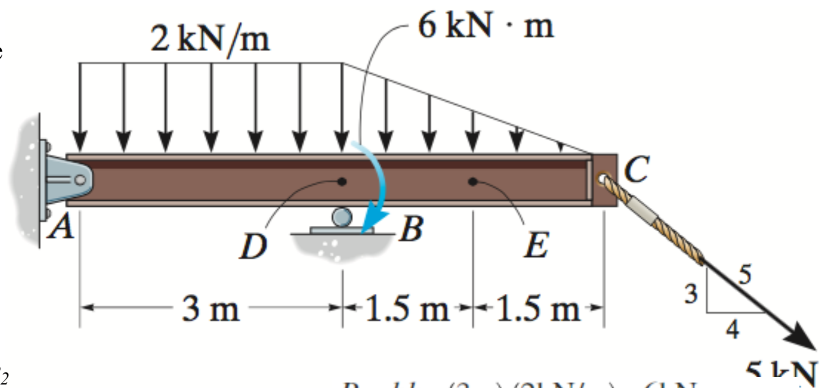
$$C_x = (75kg)(9.81\,\text{m/s}^2) - \left(\frac{4}{5}\right)(1533N) = -491\text{N}$$

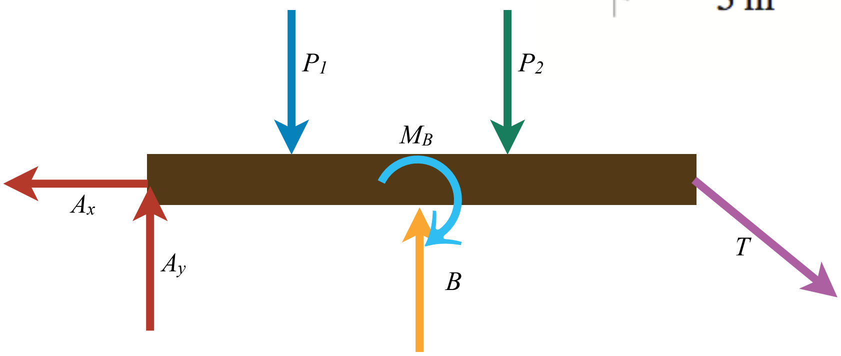
Problem 04

The cantilevered beam on the right is supported by a pin at A and roller at B, then subjected to the distributed and discrete loads shown.

A. Determine the reaction forces at A and B. (Hint: $A_x \neq 0$!)

B. Determine the internal **normal force**, **shear force**, and **bending moment** at points D (located just to the **left** of the roller at B) and E.





$$P_1=bh=(3\text{m})(2\text{kN/m})=6\text{kN}$$

$$x_1=\frac{1}{2}b=\frac{1}{2}(3\text{m})=1.5\text{m} \text{ from A}$$

$$P_2=\frac{1}{2}bh=\frac{1}{2}(3\text{m})(2\text{kN/m})=3\text{kN}$$

$$x_2=\frac{1}{3}b=\frac{1}{3}(3\text{m})=1\text{m} \text{ from B}$$

$$\sum F_x=\left(\frac{4}{5}\right)T-A_x=0$$

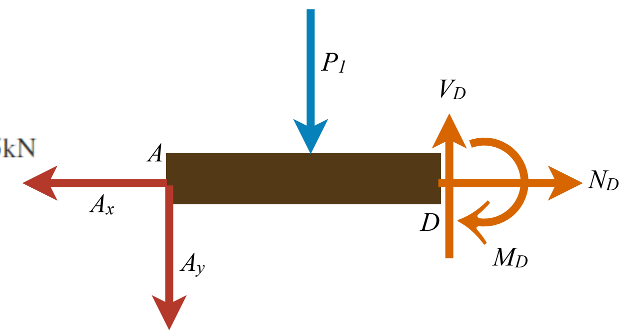
$$A_x=(0.8)(5\text{kN})=4\text{kN}$$

$$\sum M_A=(3\text{m})B-M_B-(1.5\text{m})P_1-(4\text{m})P_2-(6\text{m})(0.6)T=0$$

$$B=\frac{(6\text{kN}\cdot\text{m})+(1.5\text{m})(6\text{kN})+(4\text{m})(3\text{kN})+(6\text{m})(0.6)(5\text{kN})}{(3\text{m})}=15\text{kN}$$

$$\sum F_y=A_y+B-P_1-P_2-\left(\frac{3}{5}\right)T=0$$

$$A_y=6\text{kN}+3\text{kN}+(0.6)(5\text{kN})-15\text{kN}=-3\text{kN}$$



$$\sum F_x=N_D-A_x=0$$

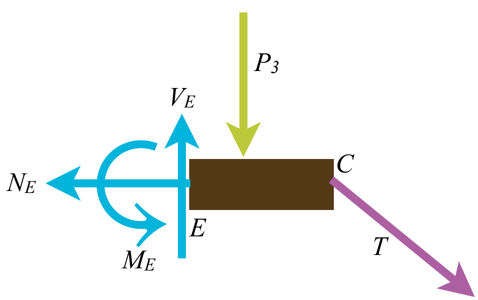
$$N_D=4\text{kN}\rightarrow$$

$$\sum F_y=V_D-A_y-P_1=0$$

$$V_D=6\text{kN}+3\text{kN}=9\text{kN}\uparrow$$

$$\sum M_D=M_D-(3\text{m})A_y-(1.5\text{m})P_1=0$$

$$M_D=(1.5\text{m})(6\text{kN})-(3\text{m})(3\text{kN})=18\text{kN}\cdot\text{m}\curvearrowright$$



$$P_3=\frac{1}{2}bh=\frac{1}{2}(1.5\text{m})(1\text{kN/m})=0.75\text{kN}$$

$$x_3=\frac{1}{3}b=\frac{1}{3}(1.5\text{m})=0.5\text{m} \text{ from E}$$

$$\sum F_x=N_E-\left(\frac{4}{5}\right)T=0$$

$$N_E=(0.8)(5\text{kN})=4\text{kN}\leftarrow$$

$$\sum F_y=V_E-P_3-\left(\frac{3}{5}\right)T=0$$

$$V_E=0.75\text{kN}+(0.6)(5\text{kN})=3.75\text{kN}\uparrow$$

$$\sum M_E=M_E-(1.5\text{m})\left(\frac{3}{5}T\right)-(0.5\text{m})P_3=0$$

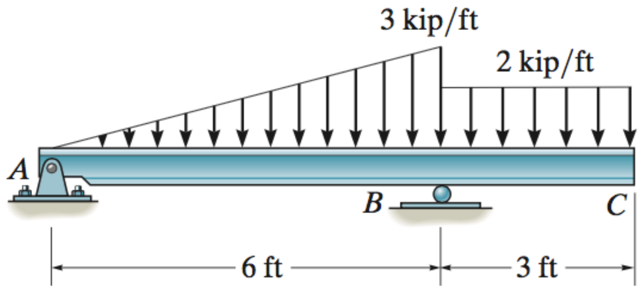
$$M_E=(1.5\text{m})(3\text{kN})+(0.5\text{m})(0.75\text{kN})=4.88\text{kN}\cdot\text{m}\curvearrowleft$$

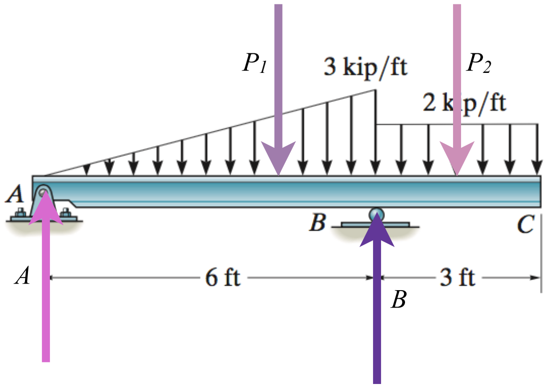
Problem 05

The beam shown is supported by a pin at A and roller at B, then subjected to the distributed loads shown.

A. Determine the reaction forces at A and B.

B. Construct the shear and bending moment diagrams.





$$P_1=\frac{1}{2}bh=\frac{1}{2}(6\,\text{ft})(3\,\text{kip/ft})=9\,\text{kip}$$

$$x_1=\frac{2}{3}b=\frac{2}{3}(6\,\text{ft})=4\,\text{ft from A}$$

$$P_2=bh=(3\,\text{ft})(2\,\text{kip/ft})=6\,\text{kip}$$

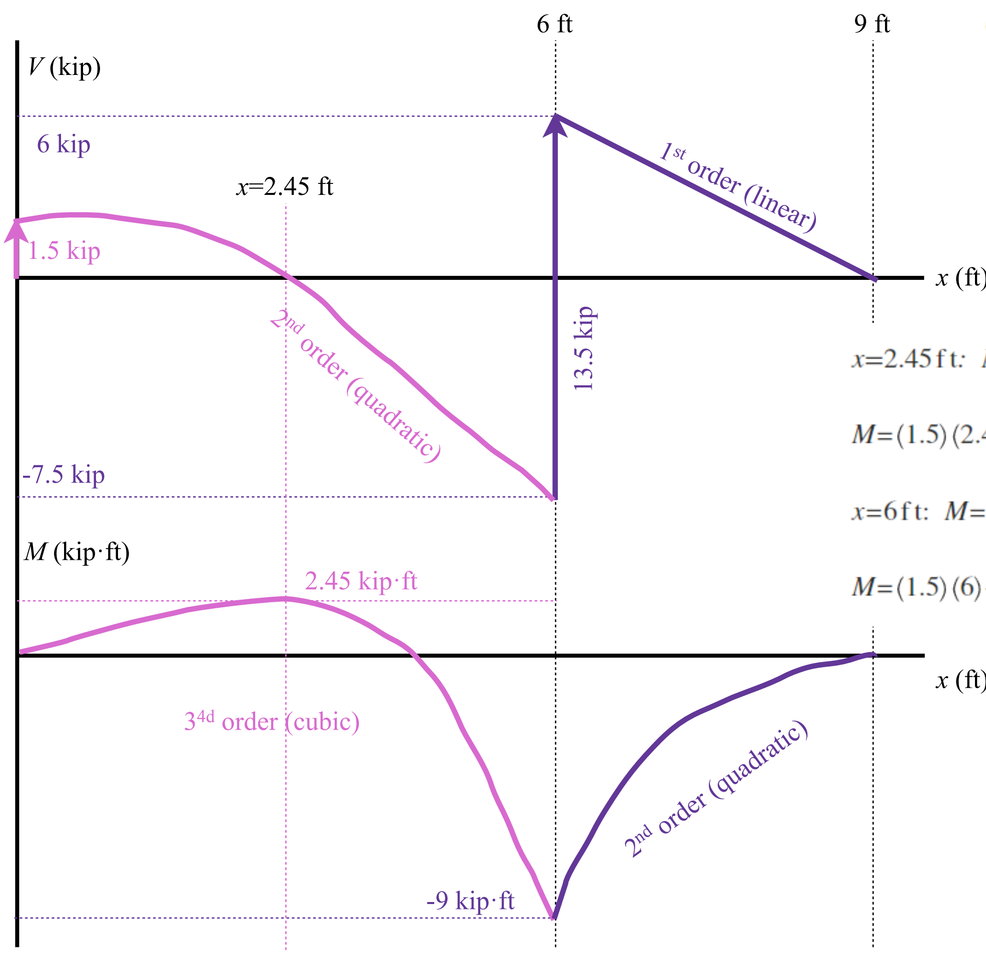
$$x_2=\frac{1}{2}b=\frac{1}{2}(3\,\text{ft})=1.5\,\text{ft from B}$$

$$\sum M_A=(6\,\text{ft})B-(4\,\text{ft})P_1-(7.5\,\text{ft})P_2=0$$

$$B=\frac{(4\,\text{ft})(9\,\text{kip})+(7.5\,\text{ft})(6\,\text{kip})}{(6\,\text{ft})}=13.5\,\text{kip}$$

$$\sum F_y=A+B-P_1-P_2=0$$

$$A=9\,\text{kip}+6\,\text{kip}-13.5\,\text{kip}=1.5\,\text{kip}$$



$$0\le x<6\,\text{ft}:\quad V=A-\frac{1}{2}bh$$

$$V=A-\frac{1}{2}(x)(0.5x)=1.5-0.25x^2$$

$$V=0\ \Rightarrow\ x=\sqrt{\frac{1.5}{0.25}}=2.45\,\text{ft}$$

$$x=2.45\,\text{ft}:\quad M=1.5x-\frac{0.25}{3}x^3$$

$$M=(1.5)(2.45)-\left(\frac{0.25}{3}\right)(2.45)^3=2.45\,\text{kip}\cdot\text{ft}$$

$$x=6\,\text{ft}:\quad M=1.5x-\frac{0.25}{3}x^3$$

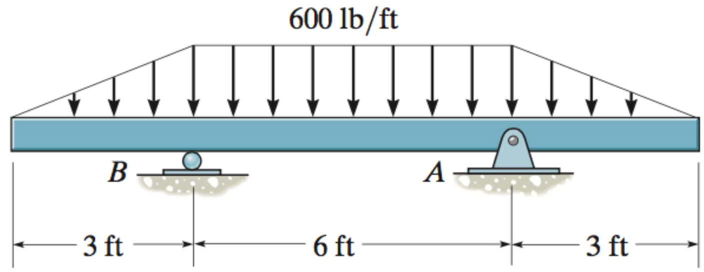
$$M=(1.5)(6)-\left(\frac{0.25}{3}\right)(6)^3=-9\,\text{kip}\cdot\text{ft}$$

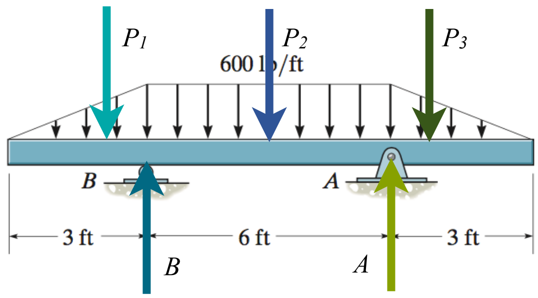
Problem 06

The beam shown is supported by a pin at A and roller at B, then subjected to the distributed loads shown.

A. Determine the reactions at *A* and *B*.

B. Construct the shear and bending moment diagrams.





$$\sum M_B = (6\,\text{ft})A + (1\,\text{ft})P_1 - (3\,\text{ft})P_2 - (7\,\text{ft})P_3 = 0$$

$$A = \frac{-(1\,\text{ft})(900\text{lb}) + (3\,\text{ft})(3600\text{lb}) + (7\,\text{ft})(900\text{lb})}{(6\,\text{ft})} = 2700\text{lb}$$

$$\sum F_y = A + B - P_1 - P_2 - P_3 = 0$$

$$B = 900\text{lb} + 3600\text{lb} + 900\text{lb} - 2700\text{lb} = 2700\text{lb}$$

$$P_1 = \frac{1}{2}bh = \frac{1}{2}(3\,\text{ft})(600\text{lb/ft}) = 900\text{lb}$$

$$x_1 = \frac{1}{3}b = \frac{1}{3}(3\,\text{ft}) = 1\,\text{ft} \text{ from B}$$

$$P_2 = bh = (6\,\text{ft})(600\text{lb/ft}) = 3600\text{lb}$$

$$x_2 = \frac{1}{2}b = \frac{1}{2}(6\,\text{ft}) = 3\,\text{ft} \text{ from B}$$

$$P_3 = \frac{1}{2}bh = \frac{1}{2}(3\,\text{ft})(600\text{lb/ft}) = 900\text{lb}$$

$$x_3 = \frac{1}{3}b = \frac{1}{3}(3\,\text{ft}) = 1\,\text{ft} \text{ from A}$$