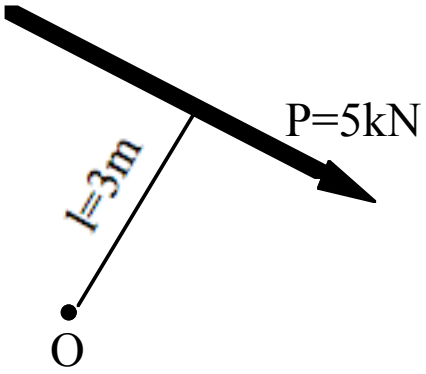
学生番号＿＿＿＿＿＿＿＿　氏　名　＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

演習問題：モーメント，数力の合力，部材力

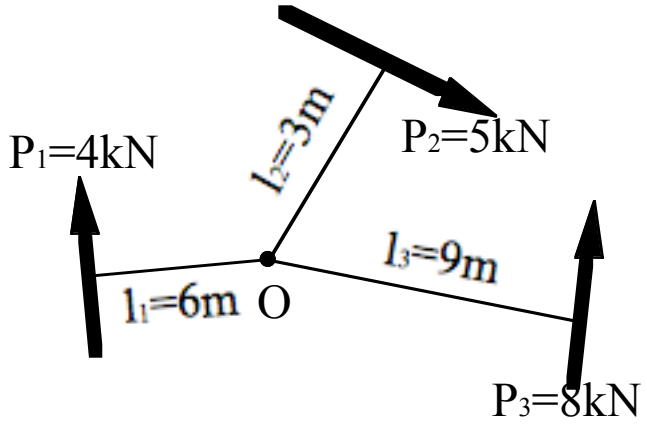
１．　O 点回りのモーメント力を求めよ．

(1)



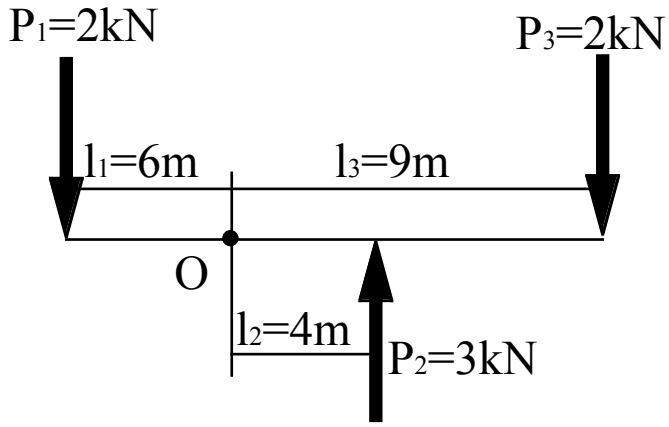
$$M = P \cdot l = 5kN \times 3m = 15kN \cdot m$$

(2)



$$\begin{aligned} M &= P_1 \cdot l_1 + P_2 \cdot l_2 - P_3 \cdot l_3 \\ &= 4kN \times 6m + 5kN \times 3m - 8kN \times 9m \\ &= -33kN \cdot m \end{aligned}$$

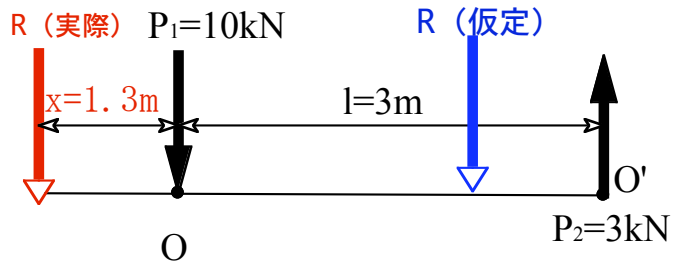
(3)



$$\begin{aligned} M &= -P_1 \cdot l_1 - P_2 \cdot l_2 + P_3 \cdot l_3 \\ &= -2kN \times 6m - 3kN \times 4m + 2kN \times 9m \\ &= -6kN \cdot m \end{aligned}$$

２．　合力 R とその作用位置を求め，図示せよ．

(1)

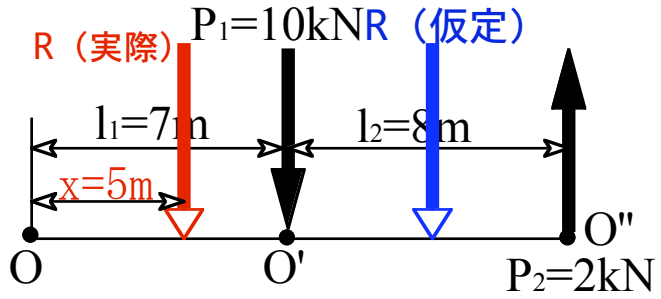


$$R = -P_1 + P_2 = -10kN + 3kN = -7kN(\text{下向き})$$

$$M_o = -P_2 \cdot l = 7kN \cdot x$$

$$x = \frac{-P_2 \cdot l}{7kN} = \frac{-3kN \cdot 3m}{7kN} = -1.3m$$

(2)

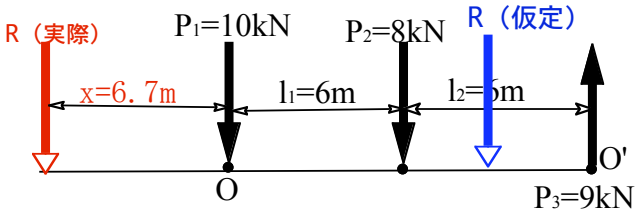


$$R = -P_1 + P_2 = -10kN + 2kN = -8kN(\text{下向き})$$

$$M_o = P_1 \cdot l_1 - P_2 \cdot (l_1 + l_2) = 8kN \cdot x$$

$$x = \frac{P_1 \cdot l_1 - P_2 \cdot (l_1 + l_2)}{8kN} = \frac{10 \cdot 7 - 2 \cdot (7+8)}{8} = 5m$$

(3)



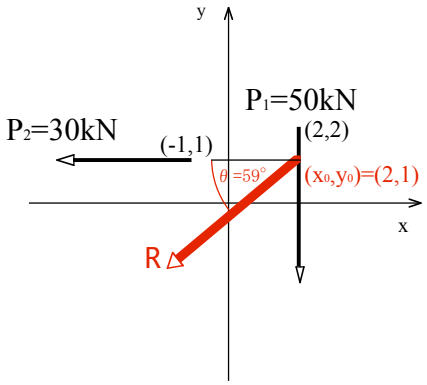
$$R = -P_1 - P_2 + P_3 = -9kN(\text{下向き})$$

$$M_o = P_2 \cdot l_1 - P_3 \cdot (l_1 + l_2) = 9kN \cdot x$$

$$x = \frac{P_2 \cdot l_1 - P_3 \cdot (l_1 + l_2)}{9kN} = \frac{8 \cdot 6 - 9 \cdot (6+6)}{9} = -6.7n$$

３．　１点に作用していない数力の合力 R とその作用位置を求め，図示せよ．

(1)



	→H	↑V	H•y	V•x
P_1	0kN	-50kN	0×2m=0	50kN×2m =100kN•m
P_2	-30kN	0kN	-30kN×1m =-30kN•m	0×1m=0
Σ	-30kN	-50kN	-30kN•m	100kN•m

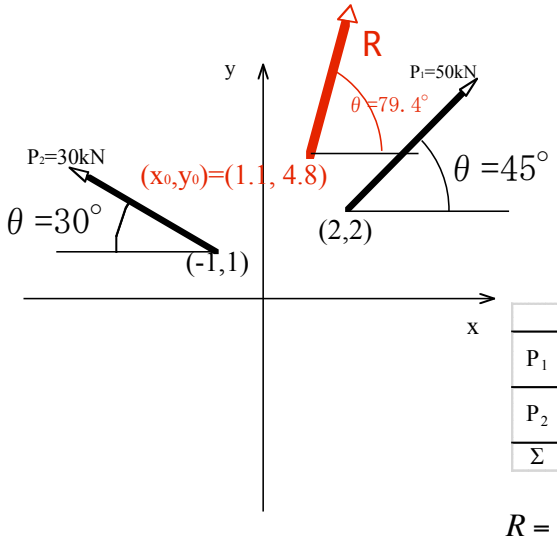
$$R=\sqrt{(\Sigma H)^2+(\Sigma V)^2}=\sqrt{(-30)^2+(-50)^2}=58.3kN$$

$$\theta=\tan^{-1}\left(\frac{\Sigma V}{\Sigma H}\right)=\tan^{-1}\left(\frac{-50}{-30}\right)=59^\circ$$

$$-|\Sigma H|\cdot y_0=\Sigma(H\cdot y)$$
$$-30\times y_0=-30$$
$$y_0=1m$$

$$|\Sigma V|\cdot x_0=\Sigma(V\cdot x)$$
$$50\times x_0=100$$
$$x_0=2m$$

(2)



	→H	↑V	H•y	V•x
P_1	$P_1 cos45°$=35.4kN	$P_1 sin45°$=35.4kN	35.4kN×2m =70.8kN•m	-35.4kN×2m =-70.8kN•m
P_2	$-P_2 cos30°$=-26kN	$P_2 sin30°$=15kN	-26kN×1m =-26kN•m	15kN×1m =15kN•m
Σ	9.4kN	50.4kN	44.8kN•m	−55.8kN•m

$$R=\sqrt{(\Sigma H)^2+(\Sigma V)^2}=\sqrt{(9.4)^2+(50.4)^2}=51.3kN$$

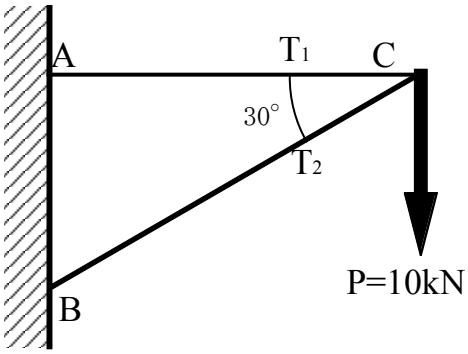
$$\theta=\tan^{-1}\left(\frac{\Sigma V}{\Sigma H}\right)=\tan^{-1}\left(\frac{50.4}{9.4}\right)=79.4^\circ$$

$$|\Sigma H|\cdot y_0=\Sigma(H\cdot y)$$
$$9.4\times y_0=44.8$$
$$y_0=4.8m$$

$$-|\Sigma V|\cdot x_0=\Sigma(V\cdot x)$$
$$-50.4\times x_0=-55.8$$
$$x_0=1.1m$$

４．　部材力 T_1，T_2 を求めよ．

(1)



鉛直方向と水平方向の釣り合いより

$$\Sigma V = -T_2 \sin 30° - P = 0$$

$$T_2 = -\frac{P}{\sin 30°} = -\frac{10kN}{\sin 30°} = -20kN$$

$$\Sigma H = -T_1 - T_2 \cos 30° = 0$$

$$T_1 = -T_2 \cos 30° = -(-20kN) \times \cos 30°$$

$$= 17.3kN$$

モーメントの釣り合いより

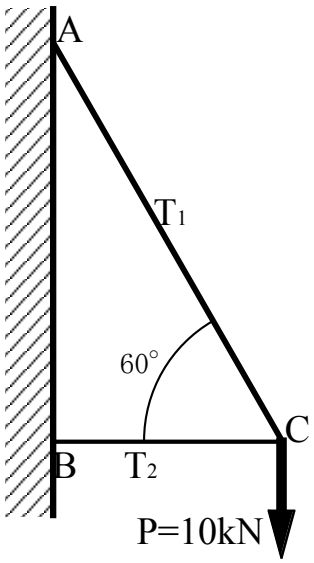
$$\Sigma M_A = P \times \ell_{AC} + T_2 \cdot \ell_{AC} \sin 30° = 0$$

$$T_2 = -\frac{P}{\sin 30°} = -\frac{10kN}{\sin 30°} = -20kN$$

$$\Sigma M_B = P \cdot \ell_{BC} \cos 30° - T_1 \cdot \ell_{BC} \sin 30° = 0$$

$$T_1 = \frac{P \cdot \cos 30°}{\sin 30°} = \frac{10kN \cdot \cos 30°}{\sin 30°} = 17.3kN$$

(2)



鉛直方向と水平方向の釣り合いより

$$\Sigma V = T_1 \sin 60° - P = 0$$

$$T_1 = \frac{P}{\sin 60°} = \frac{10kN}{\sin 60°} = 11.5kN$$

$$\Sigma H = -T_1 \cos 60° - T_2 = 0$$

$$T_2 = -T_1 \cos 60° = -(11.5kN) \times \cos 60°$$

$$= -5.8kN$$

モーメントの釣り合いより

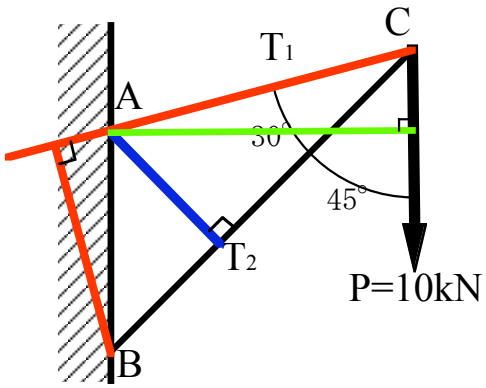
$$\Sigma M_A = P \times \ell_{AC} \cos 60° + T_2 \cdot \ell_{AC} \sin 60° = 0$$

$$T_2 = -\frac{P \cdot \cos 60°}{\sin 60°} = -\frac{10kN \cdot \cos 60°}{\sin 60°} = -5.8kN$$

$$\Sigma M_B = P \times \ell_{BC} - T_1 \cdot \ell_{BC} \sin 60° = 0$$

$$T_1 = \frac{P}{\sin 60°} = \frac{10kN}{\sin 60°} = 11.5kN$$

(3)



モーメントの釣り合いより

$$\Sigma M_A = P \times \ell_{AC} \cos 15° + T_2 \cdot \ell_{AC} \sin 30° = 0$$

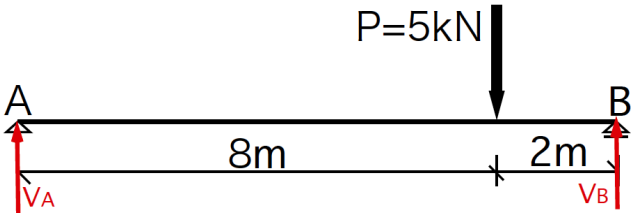
$$T_2 = -\frac{P \cdot \cos 15°}{\sin 30°} = -\frac{10kN \cdot \cos 15°}{\sin 30°} = -19.3kN$$

$$\Sigma M_B = P \cdot \ell_{BC} \sin 45° - T_1 \cdot \ell_{BC} \sin 30° = 0$$

$$T_1 = \frac{P \cdot \sin 45°}{\sin 30°} = \frac{10kN \cdot \sin 45°}{\sin 30°} = 14.1kN$$

５．　はりの反力を求めよ．

(1)



$$\Sigma H = H_A = 0$$

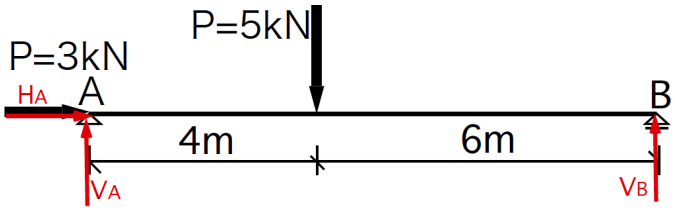
$$\Sigma M_A = 5kN \times 8m - V_B \times 10m = 0$$

$$V_B = \frac{5kN \times 8m}{10m} = 4kN$$

$$\Sigma M_B = -5kN \times 2m + V_A \times 10m = 0$$

$$VA = \frac{5kN \times 2m}{10m} = 1kN$$

(2)



$$\Sigma H = H_A + 3kN = 0$$

$$H_A = -3kN$$

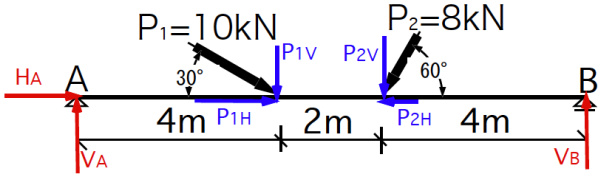
$$\Sigma M_A = 5kN \times 4m - V_B \times 10m = 0$$

$$V_B = \frac{5kN \times 4m}{10m} = 2kN$$

$$\Sigma M_B = -5kN \times 6m + V_A \times 10m = 0$$

$$V_A = \frac{5kN \times 6m}{10m} = 3kN$$

(3)



$P_{1V} = P_1 \times \sin 30^\circ = 5.0kN$ ，$P_{1H} = P_1 \times \cos 30^\circ = 8.66kN$

$P_{2V} = P_2 \times \sin 60^\circ = 6.93kN$ ，$P_{2H} = P_2 \times \cos 60^\circ = 4.0kN$

$$\Sigma H = H_A + 8.66kN - 4.0kN = 0$$

$$H_A = -4.66kN$$

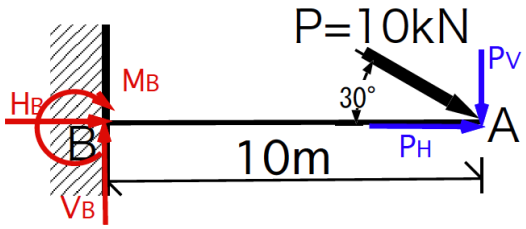
$$\Sigma M_A = 5.0kN \times 4m + 6.93kN \times 6m - V_B \times 10m = 0$$

$$V_B = \frac{5.0kN \times 4m + 6.93kN \times 6m}{10m} = 6.16kN$$

$$\Sigma M_B = -6.93kN \times 4m - 5.0kN \times 6m + V_A \times 10m = 0$$

$$VA = \frac{6.93kN \times 4m + 5.0kN \times 6m}{10m} = 5.77kN$$

(4)



$$P_V = P \times \sin 30^\circ = 5.0kN \quad , \quad P_H = P \times \cos 30^\circ = 8.66kN$$

$$\Sigma H = H_B + 8.66kN = 0$$

$$H_B = -8.66kN$$

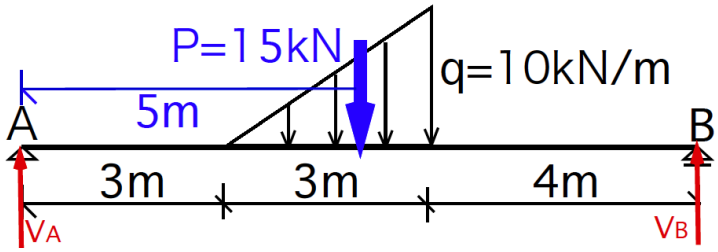
$$\Sigma V = V_B - 5.0kN = 0$$

$$V_B = 5.0kN$$

$$\Sigma M = M_B + 5kN \times 10m = 0$$

$$M_B = -50kN \cdot m$$

(5)



$$P = \frac{10kN/m \times 3m}{2} = 15kN$$

$$\Sigma M_A = 15kN \times 5m - V_B \times 10m = 0$$

$$V_B = \frac{15kN \times 5m}{10m} = 7.5kN$$

$$\Sigma M_B = -15kN \times 5m + V_A \times 10m = 0$$

$$VA = \frac{15kN \times 5m}{10m} = 7.5kN$$