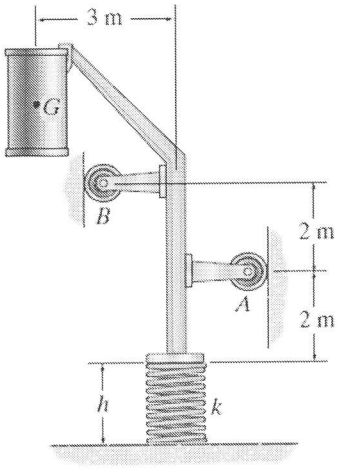
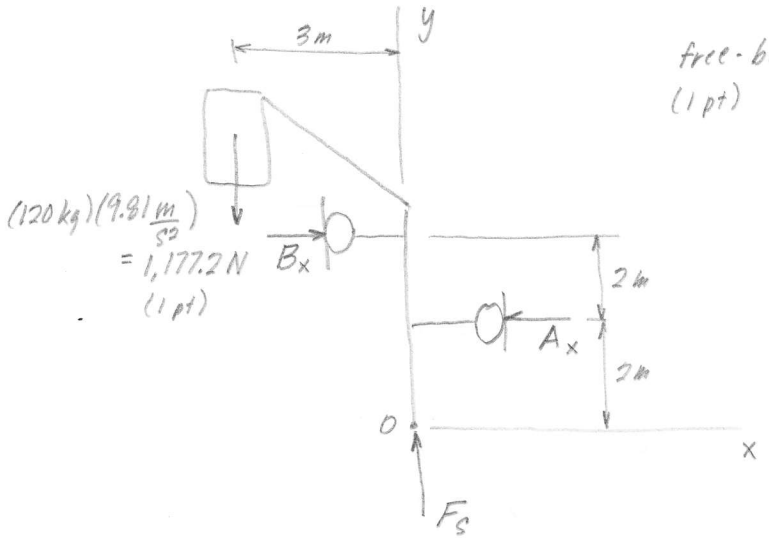
CME 250 – Statics
Exam #5 (10/25/2023)

StarID or TechID (no names) Grading

Show your work (you will not receive any credit if all you have is a final answer, right or wrong).
Do one of the two problems shown below (the second problem is on the back).

1. The 120-kg container has a center of mass at G. The spring when not loaded has a height of 250 mm. The spring stiffness k = 300 kN/m. Determine the height h of the spring when loaded as shown and the reaction at roller A and at roller B.





free-body diagram (1 pt)

$\sum F_x = 0, \quad -A_x + B_x = 0$

$A_x = B_x$ (1 pt)

$\sum F_y = 0, \quad -1,177.2\,N + F_s = 0$

$F_s = 1,177.2\,N$ (1 pt)

$\sum M_o = 0, \quad (1,177.2\,N)(3m) - B_x(4m) + A_x(2m) = 0$ (3 pts)

subst $A_x = B_x$: $(2m)A_x = (1,177.2\,N)(3m)$

$A_x = B_x = 1,765.8\,N$ or **1.77 kN**

$F_s = k(h - h_o)$

spring is in compression, use $F_s = -1,177.2\,N$

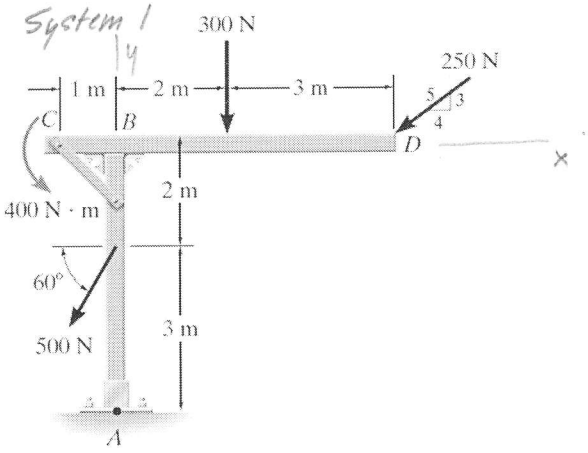
$-1,177.2\,N = 300,000\,\frac{N}{m}(h - 0.250\,m)$

$h - 0.250\,m = -\frac{1,177.2\,N}{300,000\,\frac{N}{m}}$ (3 pts)

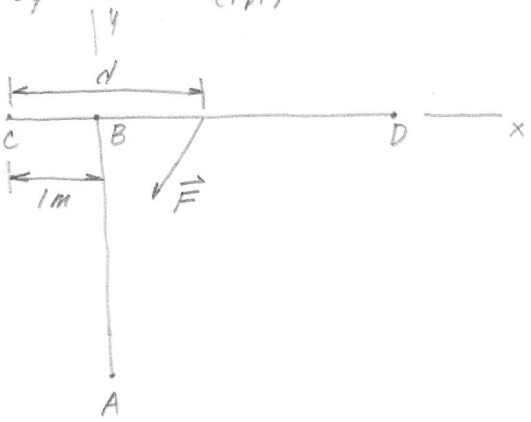
$h = 0.2461\,m$ or **246 mm**

2. Replace the loading on the frame by a single resultant force. Provide the magnitude and the angle of the force measured from the horizontal. Specify where its line of action intersects member CD, measured from end C.

System 1



System 2 (1 pt)



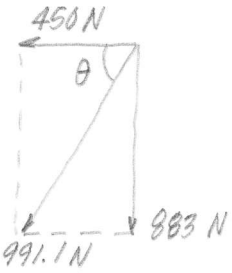
$$(\Sigma \vec{F})_1 = (\Sigma \vec{F})_2$$

$$-500\,N\cos 60°\,i - 500\,N\sin 60°\,j - 300\,N\,j - \frac{4}{5}(250N)\,i - \frac{3}{5}(250N)\,j = \vec{F}$$

$$\vec{F} = -250\,i - 433.0\,j - 300\,j - 200\,i - 150\,j\ (N)$$

$$\vec{F} = -450\,i - 883\,j\ (N) \quad (3\ pts)$$

$$F = \sqrt{(-450N)^2 + (-883N)^2} = 991.1\,N \text{ or } \boxed{991\,N} \quad (1\ pt)$$



$$\tan\theta = \frac{883\,N}{450\,N}$$

$$\boxed{\theta = 63.0°} \quad (1\ pt)$$

$$(\Sigma \vec{M}_B)_1 = (\Sigma \vec{M}_B)_2$$

$$-(500N\cos 60°)(2m) + 400\,N\text{-}m - (300N)(2m) - (\tfrac{3}{5}\,250N)(5m) = -(883N)(d - 1m)$$

$$(-883\,N)\,d = -500 + 400 - 600 - 750 - 883\ (N\text{-}m)$$

$$(-883\,N)\,d = -2{,}333\ (N\text{-}m) \quad (4\ pts)$$

$$d = 2.642\,m \text{ or } \boxed{2.64\,m}$$

or

$$(\Sigma \vec{M}_C)_1 = (\Sigma \vec{M}_C)_2$$

$$-(500N\cos 60°)(2m) - (500N\sin 60°)(1m) + 400\,N\text{-}m - (300N)(3m) - (\tfrac{3}{5}\,250N)(6m) = -(883N)(d)$$

$$d = 2.642\,m \text{ or } \boxed{2.64\,m}$$

(4 pts)

or

$$(\Sigma \vec{M}_A)_1 = (\Sigma \vec{M}_A)_2$$

$$(500N\cos 60°)(3m) + 400\,N\text{-}m - (300N)(2m) + (\tfrac{4}{5}\,250N)(5m) - (\tfrac{3}{5}\,250N)(5m) = -(883N)(d - 1m) + (450N)(5m)$$

$$(-883\,N)\,d = -2{,}333\,N\text{-}m$$

$$d = 2.642\,m \text{ or } \boxed{2.64\,m}$$

(4 pts)