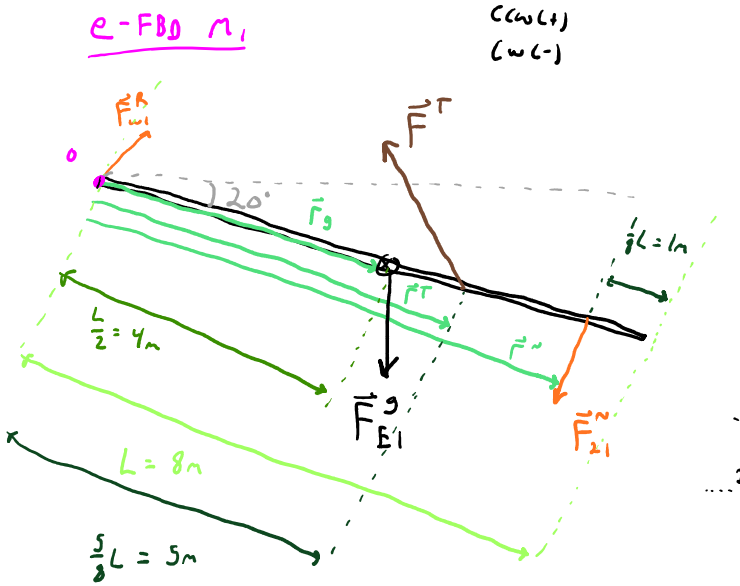
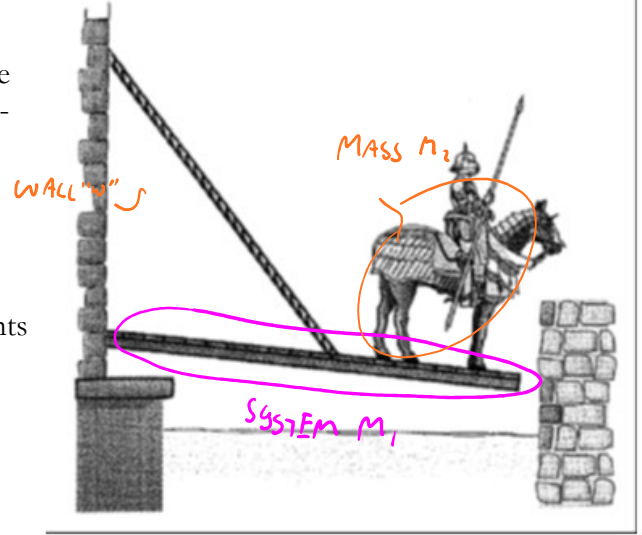
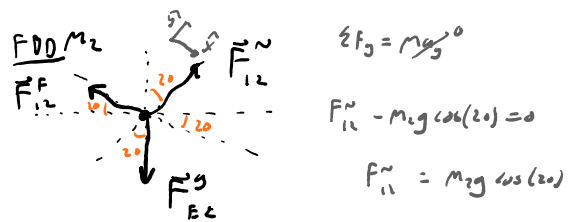


**Week 2 CHW Solutions**  
**Question 1:**

Sir Lance a Lost's new draw bridge was designed poorly and stops at an angle of  $20^\circ$  below the horizontal. Sir Lost and his steed stop when their combined center of mass is 1.0 m from the end of the bridge. The bridge is 8.0 m long and has a mass of 2000 kg; the lift cable is attached to the bridge 5.0 m from the castle end and to a point 12 m above the bridge. Sir Lost's mass combined with his armor and steed is 1000 kg.

- Use the related quantities sensemaking technique to compare the combined gravitational force acting on Sir Lance a Lost, his armor, and his steed (treat these as one object) with the normal and frictional forces from the bridge acting on his steed.
- Determine the tension in the cable.
- Find the horizontal and vertical force components acting on the bridge at the castle end.



$$\sum \tau_o = I_o \alpha$$

$$\tau_{wall}^N + \tau_{E1}^G + \tau^T + \tau_{E1}^F = 0$$

$\theta/2 \approx 0$

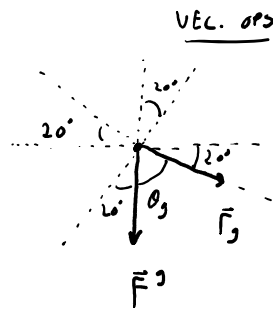
$$-r_g F_{E1}^G \sin \theta_g + r_T F^T \sin \theta_T - r_{E1} F_{E1}^N \sin \theta_{E1} = 0$$

$$-\frac{1}{2} L m_1 g \sin(70) + \frac{5}{8} L F^T \sin(128.9) - \frac{7}{8} L F_{E1}^N = 0$$

$$-\frac{1}{2} m_1 g \sin(70) + \frac{5}{8} F^T \sin(128.9) - \frac{7}{8} m_2 g \cos(20) = 0$$

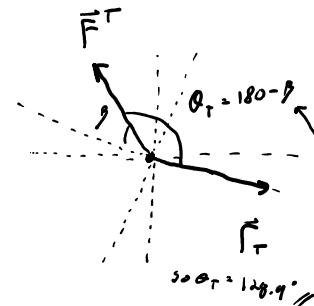
$$- 9208.99 \text{ N} + 0.4864 F^T - 9057.86 \text{ N} = 0$$

$$\text{a) } \boxed{F^T = 35500 \text{ N}}$$

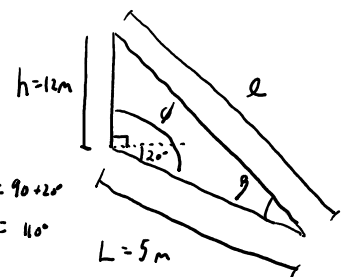


So,  $\theta_g = 90 - 20^\circ$

$\theta_g = 70^\circ$



GEOMETRY



Law of Cosines

$$l = \sqrt{h^2 + L^2 - 2hL \cos(\phi)}$$

$$l = \sqrt{12^2 + 5^2 - 2(12)(5) \cos(110)}$$

$$l = 14.49 \text{ m}$$

Law of Sines

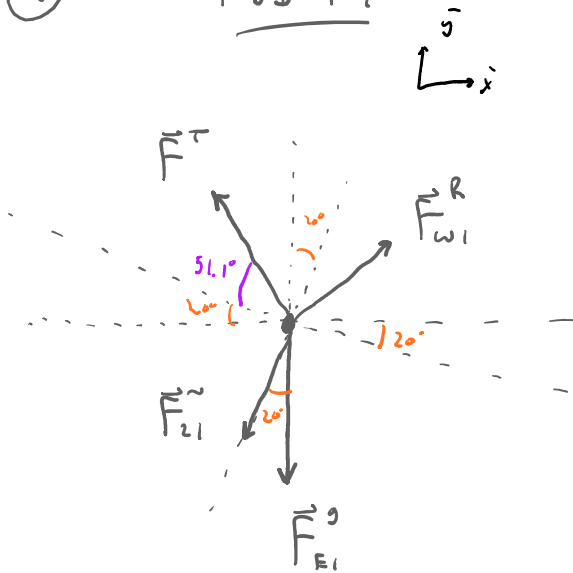
$$\frac{l}{\sin \phi} = \frac{h}{\sin \theta}$$

$$\frac{14.49}{\sin(110)} = \frac{12}{\sin \theta}$$

$$\theta = 51.10^\circ$$

(b)

FBD  $m_1$



$$\sum F_y = m_1 a_y = 0$$

$$F_{w1}^R + F^T \sin(51.1) - F_{z1}^R \cos(20) - m_1 g = 0$$

$$F_{w1}^R + F^T \sin(71.1) - m_2 g \cos^2(20) - m_1 g = 0$$

$$F_{w1}^R + 33596 \text{ N} - 9653.6 \text{ N} - 14600 \text{ N} = 0$$

$$F_{w1}^R \approx -5330 \text{ N}$$

$$\sum F_x = m_1 a_x = 0$$

$$F_{w1}^R - F^T \cos(51.1 + 20) - F_{z1}^R \sin(20) = 0$$

$$F_{w1}^R - F^T \cos(71.1) - m_2 g \cos(20) \sin(20) = 0$$

$$F_{w1}^R - 11499 \text{ N} - 3149.7 = 0$$

$$F_{w1}^R \approx 14600 \text{ N}$$