Homework Set #1

1–7. A rocket has a mass of $250(10^3)$ slugs on earth. Specify (a) its mass in SI units and (b) its weight in SI units. If the rocket is on the moon, where the acceleration due to gravity is $g_m = 5.30 \text{ ft/s}^2$, determine to three significant figures (c) its weight in SI units and (d) its mass in SI units.

Using Table 1-2 and applying Eq. 1-3, we have

a) $$250(10^3)\text{ slugs} = \left[250(10^3)\text{ slugs}\right]\left(\frac{14.5938\text{ kg}}{1\text{ slugs}}\right)$$
$$= 3.64845(10^6)\text{ kg}$$
$$= 3.65\text{ Gg} \qquad \textbf{Ans}$$

b) $$W_e = mg = \left[3.64845(10^6)\text{ kg}\right](9.81\text{ m/s}^2)$$
$$= 35.791(10^6)\text{ kg}\cdot\text{m/s}^2$$
$$= 35.8\text{ MN} \qquad \textbf{Ans}$$

c) $$W_m = mg_m = \left[250(10^3)\text{ slugs}\right](5.30\text{ ft/s}^2)$$
$$= \left[1.325(10^6)\text{ lb}\right]\left(\frac{4.4482\text{ N}}{1\text{ lb}}\right)$$
$$= 5.894(10^6)\text{ N} = 5.89\text{ MN} \qquad \textbf{Ans}$$

Or

$$W_m = W_e\left(\frac{g_m}{g}\right) = (35.791\text{ MN})\left(\frac{5.30\text{ ft/s}^2}{32.2\text{ ft/s}^2}\right) = 5.89\text{ MN}$$

d) Since the mass is independent of its location, then

$$m_m = m_e = 3.65(10^6)\text{ kg} = 3.65\text{ Gg} \qquad \textbf{Ans}$$

***1–8.** If a car is traveling at 55 mi/h, determine its speed in kilometers per hour and meters per second.

$$55\text{ mi/h} = \left(\frac{55\text{ mi}}{1\text{ h}}\right)\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{0.3048\text{ m}}{1\text{ ft}}\right)\left(\frac{1\text{ km}}{1000\text{ m}}\right)$$
$$= 88.5\text{ km/h} \qquad \textbf{Ans}$$

$$88.5\text{ km/h} = \left(\frac{88.5\text{ km}}{1\text{ h}}\right)\left(\frac{1000\text{ m}}{1\text{ km}}\right)\left(\frac{1\text{ h}}{3600\text{ s}}\right) = 24.6\text{ m/s} \qquad \textbf{Ans}$$

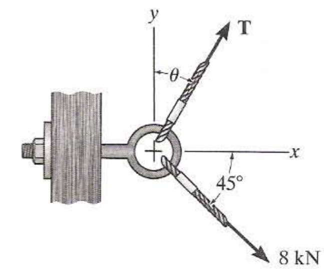
1–9. The *pascal* (Pa) is actually a very small unit of pressure. To show this, convert $1\text{ Pa} = 1\text{ N/m}^2$ to lb/ft^2. Atmospheric pressure at sea level is 14.7 lb/in^2. How many pascals is this?

Using Table 1-2, we have

$$1\text{ Pa} = \frac{1\text{ N}}{\text{m}^2}\left(\frac{1\text{ lb}}{4.4482\text{ N}}\right)\left(\frac{0.3048^2\text{ m}^2}{1\text{ ft}^2}\right) = 20.9(10^{-3})\text{ lb/ft}^2 \qquad \textbf{Ans}$$

$$1\text{ ATM} = \frac{14.7\text{ lb}}{\text{in}^2}\left(\frac{4.4482\text{ N}}{1\text{ lb}}\right)\left(\frac{144\text{ in}^2}{1\text{ ft}^2}\right)\left(\frac{1\text{ ft}^2}{0.3048^2\text{ m}^2}\right)$$
$$= 101.3(10^3)\text{ N/m}^2$$
$$= 101\text{ kPa} \qquad \textbf{Ans}$$

2–3. If the magnitude of the resultant force is to be 9 kN directed along the positive x axis, determine the magnitude of force **T** acting on the eyebolt and its angle θ.



The parallelogram law of addition and the triangular rule are shown in Figs. a and b, respectively.

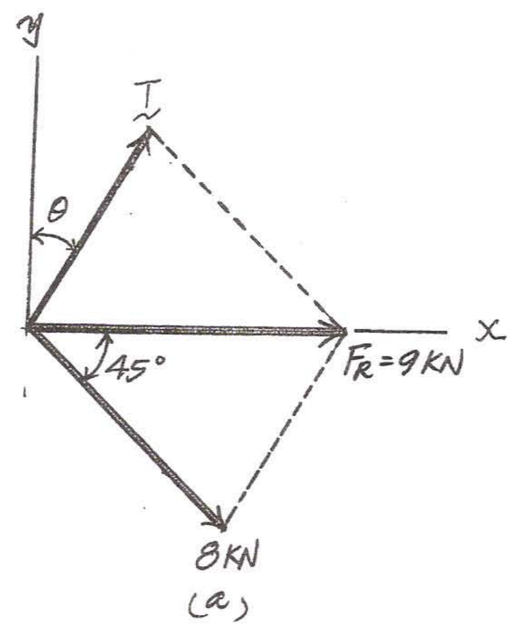
Applying the law of cosines to Fig. b,

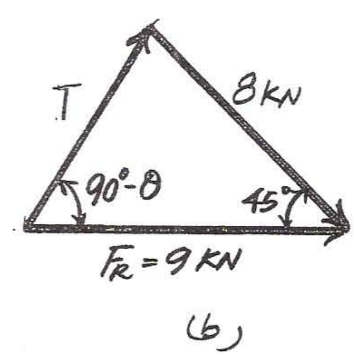
$$T = \sqrt{8^2 + 9^2 - 2(8)(9)\cos 45^\circ}$$
$$= 6.571 \text{ kN} = 6.57 \text{ kN}$$ **Ans.**

Applying the law of sines to Fig. b and using this result, yields

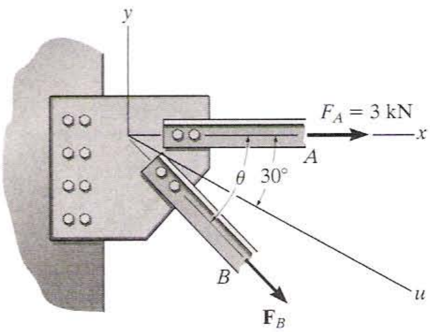
$$\frac{\sin(90^\circ - \theta)}{8} = \frac{\sin 45^\circ}{6.571}$$

$$\theta = 30.6^\circ$$ **Ans.**





*2–8. If the resultant force is required to act along the positive u axis and have a magnitude of 5 kN, determine the required magnitude of $\mathbf{F}_B$ and its direction θ.



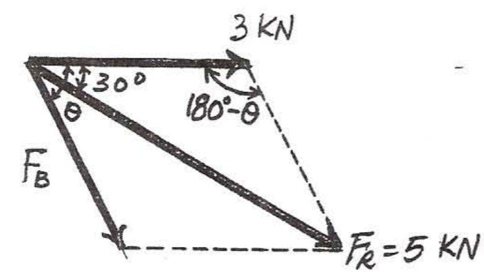
The parallelogram law of addition and the triangular rule are shown in Figs. *a* and *b*, respectively.

Applying the law of cosines to Fig. *b*,

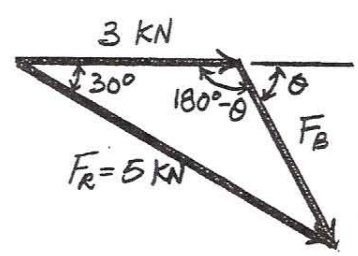
$$F_B = \sqrt{3^2 + 5^2 - 2(3)(5)\cos 30°}$$
$$= 2.832 \text{ kN} = 2.83 \text{ kN}$$ **Ans.**

Using this result and realizing that $\sin(180° - \theta) = \sin\theta$, the application of the sine law to Fig. *b*, yields

$$\frac{\sin\theta}{5} = \frac{\sin 30°}{2.832} \qquad \theta = 62.0°$$ **Ans.**

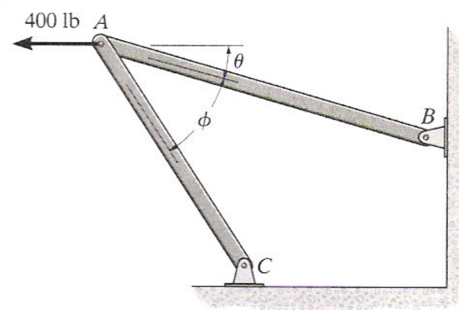


(a)



(b)

2–14. Determine the design angle θ ($0° \leq \theta \leq 90°$) for strut AB so that the 400-lb horizontal force has a component of 500 lb directed from A towards C. What is the component of force acting along member AB? Take $\phi = 40°$.



Parallelogram Law : The parallelogram law of addition is shown in Fig. (a).

Trigonometry : Using law of sines [Fig. (b)], we have

$$\frac{\sin\theta}{500} = \frac{\sin 40°}{400}$$

$$\sin\theta = 0.8035$$

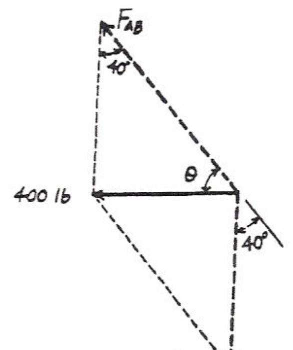
$$\theta = 53.46° = 53.5° \qquad \textbf{Ans}$$

Thus, $\quad \psi = 180° - 40° - 53.46° = 86.54°$

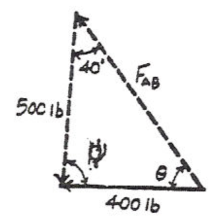
Using law of sines [Fig. (b)]

$$\frac{F_{AB}}{\sin 86.54°} = \frac{400}{\sin 40°}$$

$$F_{AB} = 621 \text{ lb} \qquad \textbf{Ans}$$

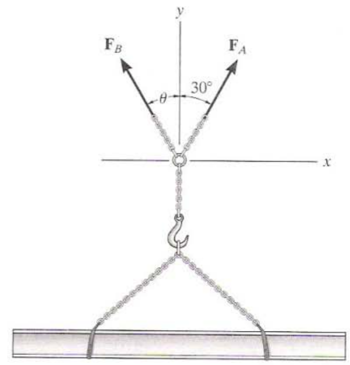


(a)



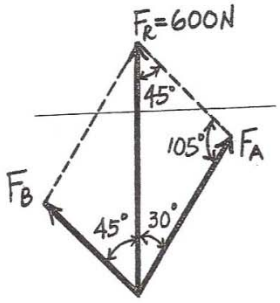
(b)

*2–28. The beam is to be hoisted using two chains. Determine the magnitudes of forces $\mathbf{F}_A$ and $\mathbf{F}_B$ acting on each chain in order to develop a resultant force of 600 N directed along the positive y axis. Set $\theta = 45°$.

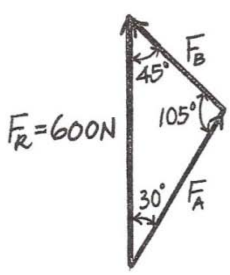


$$\frac{F_A}{\sin 45°} = \frac{600}{\sin 105°}; \qquad F_A = 439 \text{ N} \qquad \text{Ans}$$

$$\frac{F_B}{\sin 30°} = \frac{600}{\sin 105°}; \qquad F_B = 311 \text{ N} \qquad \text{Ans}$$



(a)



(b)