

1 Basic Concepts

1. (a) $17.9 \text{ in.} (25.40 \text{ mm})/1 \text{ in.} = 455 \text{ mm} = 0.455 \text{ m}$ <
 (b) $6.4 \text{ ft} (304.8 \text{ mm})/1 \text{ ft} = 1951 \text{ mm} = 1.951 \text{ m}$ <
 (c) $13.8 \text{ in.} (25.40 \text{ mm})/1 \text{ in.} = 351 \text{ mm} = 0.351 \text{ m}$ <
 (d) $95.2 \text{ ft} (304.8 \text{ mm})/1 \text{ ft} = 29.0 \times 10^3 \text{ mm} = 29.0 \text{ m}$ <
2. (a) $10.2 \text{ m} (39.37 \text{ in.})/1 \text{ m} = 402 \text{ in.} = 33.5 \text{ ft}$ <
 (b) $45.0 \text{ m} (39.37 \text{ in.})/1 \text{ m} = 1772 \text{ in.} = 147.6 \text{ ft}$ <
 (c) $204 \text{ mm} (39.37 \text{ in.})/1000 \text{ mm} = 8.03 \text{ in.} = 0.669 \text{ ft}$ <
 (d) $4600 \text{ mm} (39.37 \text{ in.})/1000 \text{ mm} = 181.1 \text{ in.} = 15.09 \text{ ft}$ <
3. $1 \text{ hr} = 3600 \text{ s}$
 $1 \text{ mi} = 5280 \text{ ft}$
 $\frac{60 \text{ mi}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} = 88.0 \frac{\text{ft}}{\text{s}}$ <
4. (a) $60 \text{ W} \times \frac{1 \text{ hp}}{745.7 \text{ W}} = 0.0805 \text{ hp}$ <
 (b) $210 \text{ hp} \times \frac{745.7 \text{ W}}{1 \text{ hp}} = 156\,597 \text{ W}$ <
5. (a) $23.5 \text{ lb} (4.448 \text{ N})/1 \text{ lb} = 104.5 \text{ N} = 0.1405 \text{ kN}$ <
 (b) $5.8 \text{ kips} (4448 \text{ N})/1 \text{ kip} = 25.8 \times 10^3 \text{ N} = 25.8 \text{ kN}$ <
 (c) $250 \text{ lb} (4.448 \text{ N})/1 \text{ lb} = 1112 \text{ N} = 1.112 \text{ kN}$ <
 (d) $15.9 \text{ kips} (4448 \text{ N})/1 \text{ kip} = 70.7 \times 10^3 \text{ N} = 70.7 \text{ kN}$ <
6. (a) $52.9 \text{ N} (0.2248 \text{ lb})/1 \text{ N} = 11.89 \text{ lb} = 0.01189 \text{ kip}$ <
 (b) $6.85 \text{ kN} (224.8 \text{ lb})/1 \text{ kN} = 1540 \text{ lb} = 1.540 \text{ kips}$ <
7. (a) $250 \text{ kg} \times 9.81 \text{ m/s}^2 = 2450 \text{ N} = 2.45 \text{ kN}$ <
 (b) $4.5 \text{ Mg}: 4.5 \times 10^3 \text{ kg} \times 9.81 \text{ m/s}^2 = 44.1 \times 10^3 \text{ N} = 44.1 \text{ kN}$ <
 (c) $375 \times 9.81 \text{ m/s}^2 = 3680 \text{ N} = 3.68 \text{ kN}$ <
 (d) $25.0 \text{ Mg}: 25 \times 10^3 \text{ kg} \times 9.81 \text{ m/s}^2 = 245 \times 10^3 \text{ N} = 245 \text{ kN}$ <
 (e) $140.0 \text{ kg}: 140 \text{ kg} \times 9.81 \text{ m/s}^2 = 1373 \text{ N} = 1.373 \text{ kN}$ <
8. (a) $2000 \text{ N}/9.81 \text{ m/s}^2 = 204 \text{ kg}$ <
 (b) $3.50 \text{ kN}: 3500 \text{ N}/9.81 \text{ m/s}^2 = 357 \text{ kg}$ <
 (c) $1200 \text{ N}/9.81 \text{ m/s}^2 = 122.3 \text{ kg}$ <
 (d) $4.40 \text{ kN}: 4400 \text{ N}/9.81 \text{ m/s}^2 = 449 \text{ kg}$ <
9. (a) $62.428 \text{ lb/ft}^3 (1 \text{ ft}/0.3048)^3 \times (4.448 \text{ N/lb}) = 9810 \text{ N/m}^3 = 9.81 \text{ kN/m}^3$ <
 (b) $62.428 \frac{\text{lb}}{\text{ft}^3} \times \frac{1 \text{ ft}^3}{1728 \text{ in}^3} \times \frac{231 \text{ in}^3}{\text{gal}} \times 55 \text{ gal} = 459 \text{ lb}$ <
10. $150(10 \text{ in.} \times 22 \text{ in.}) \times (1 \text{ ft}^2/144 \text{ in.}^2) = 229 \text{ lb/ft}$ <
 $(229 \text{ lb/ft})(1 \text{ ft}/0.3048 \text{ m})(4.448 \text{ N/lb}) = 3344 \text{ N/m} = 3.34 \text{ kN/m}$ <
 $(3344 \text{ N/m})(1 \text{ kg}/9.81 \text{ N}) = 341 \text{ kg/m}$ <
11. $(1 \text{ lb/in.}^2)(4.448 \text{ N/lb}) \times (1 \text{ in.}/0.02540 \text{ m})^2 = 6894 \text{ N/m}^2 = 6.89 \text{ kPa}(\text{kN/m}^2)$ <
 $[(6894 \text{ N/m}^2)/(1 \text{ lb/in.}^2)] \times (14.7 \text{ lb/in.}^2) = 101\,340 \text{ Pa} = 101.3 \text{ kPa}(\text{kN/m}^2)$ <

$$\begin{aligned}
 12. \quad & 250 \text{ MN/m}^2 = 250 \times 10^6 \text{ N/m}^2 \\
 & (250 \times 10^6 \text{ N/m}^2)(1 \text{ lb}/4.448 \text{ N}) \times (1 \text{ m}/39.37 \text{ in.})^2 = 36.3 \times 10^3 \text{ lb/in.}^2 \text{ (psi)} < \\
 & = 36.3 \text{ kips/in.}^2 \text{ (ksi)} < \\
 & 55 \text{ MN/m}^2 = 55 \times 10^6 \text{ N/m}^2 \\
 & (55 \times 10^6 \text{ N/m}^2)(1 \text{ lb}/4.448 \text{ N}) \times (1 \text{ m}/39.37 \text{ in.})^2 < \\
 & = 7.98 \times 10^3 \text{ lb/in.}^2 \text{ (psi)} = 7.98 \text{ kips/in.}^2 \text{ (ksi)} <
 \end{aligned}$$

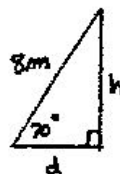
$$13. \quad 43,560 \text{ ft}^2(0.3048 \text{ m/ft})^2 = 4050 \text{ m}^2 <$$

$$\begin{aligned}
 14. \quad & 400 \text{ MN/m}^2 = 400 \times 10^6 \text{ N/m}^2 \\
 & 400 \times 10^6 \text{ N/m}^2(1 \text{ lb}/4.448 \text{ N}) \times (1 \text{ m}/39.37 \text{ in.})^2 = 58.0 \times 10^3 \text{ lb/in.}^2 \text{ (psi)} < \\
 & = 58.0 \text{ kips/in.}^2 \text{ (ksi)} < \\
 & 70 \times 10^6 \text{ N/m}^2(1 \text{ lb}/4.448 \text{ N}) \times (1 \text{ m}/39.37 \text{ in.})^2 = \\
 & 10.15 \times 10^3 \text{ lb/in.}^2 \text{ (psi)} < \\
 & = 10.15 \text{ kips/in.}^2 \text{ (ksi)} <
 \end{aligned}$$

$$\begin{aligned}
 15. \quad & (a) \quad c^2 = (475)^2 + (950)^2 \\
 & \quad c = 1062 \text{ mm} < \\
 & \quad \theta = \arctan(475/950) = 26.6^\circ \\
 & \quad \sin 26.6^\circ = 0.447 < \\
 & \quad \cos 26.6^\circ = 0.894 <
 \end{aligned}$$

$$\begin{aligned}
 & (b) \quad c^2 = 8^2 + 6^2, c = 10 \text{ ft} \\
 & \quad \sin \theta = (6/10) = 0.6 < \\
 & \quad \cos \theta = (8/10) = 0.8 <
 \end{aligned}$$

$$\begin{aligned}
 16. \quad & (a) \quad \frac{d}{8 \text{ m}} = \cos 70^\circ = 0.3420 \\
 & \quad d = 8 \text{ m} \times 0.3420 = 2.74 \text{ m} < \\
 & (b) \quad \frac{h}{8 \text{ m}} = \sin 70^\circ = 0.9397 \\
 & \quad h = 8 \text{ m} \times 0.9397 = 7.52 \text{ m} <
 \end{aligned}$$



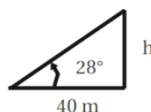
$$\text{CHECK: } d^2 + h^2 = (8 \text{ m})^2?$$

$$\begin{aligned}
 17. \quad & \theta_1 = 45^\circ, \theta_2 = 35^\circ, d = 300 \text{ mm} \\
 & \text{Eliminating } b \text{ from the two Eq. (a) of Prob. 1.16, we have} \\
 & (c + d)/\tan \theta_1 = d/\tan \theta_2 \\
 & c = d(\tan \theta_1 - \tan \theta_2)/\tan \theta_2 = 300(\tan 45^\circ - \tan 35^\circ)/\tan 35^\circ \\
 & c = 128.4 \text{ m} <
 \end{aligned}$$

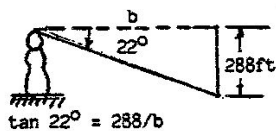
$$\begin{aligned}
 & \text{From Eq. (a), we have} \\
 & b = (c + d)/\tan \theta_1 \\
 & = (128.4 + 300)/\tan 45^\circ = 428 \text{ m} <
 \end{aligned}$$

$$\begin{aligned}
 18. \quad & b = 10 \text{ ft} = 120 \text{ in.} \\
 & h = 5 \text{ ft } 8 \text{ in.} = 68 \text{ in.} \\
 & \tan \theta = h/b = 68/120; \theta = 29.5^\circ <
 \end{aligned}$$

$$\begin{aligned}
 19. \quad & \tan 28^\circ = h/40 \\
 & h = 40 \tan 28^\circ \\
 & h = 21.3 \text{ m} <
 \end{aligned}$$



20.

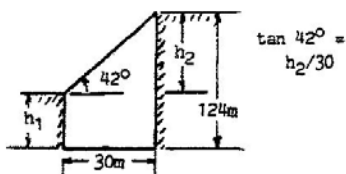


$$\tan 22^\circ = 288/b$$

$$b = 288/\tan 22^\circ = 712.8 = 713 \text{ ft}$$

<

21.



$$h_2 = 30 \tan 42^\circ = 27.0 \text{ m}$$

<

$$h_1 = 124 - h_2 = 124 - 27.0 = 97.0 \text{ m}$$

<

22.

Distance $AE = BC = 200 \text{ ft}$

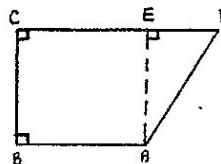
Distance $ED = 340 \text{ ft} - 225 \text{ ft} = 115 \text{ ft}$

Then for triangle AED :

$$(AD)^2 = (200 \text{ ft})^2 + (115 \text{ ft})^2$$

$AD = \text{Road frontage} = 230.7 \text{ ft}$

<



23.

In triangle ABD :

$$\frac{AD}{6.0 \text{ m}} = \sin 54^\circ \text{ or } AD = 4.854 \text{ m}$$

$$\frac{BD}{6.0 \text{ m}} = \cos 54^\circ \text{ or } BD = 3.527 \text{ m}$$

In triangle ACD :

$$(CD)^2 + (4.854 \text{ m})^2 = (8.0 \text{ m})^2$$

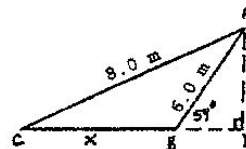
$$CD = 6.359 \text{ m}$$

Then: $x = BC = CD - BD$

$$x = 6.359 \text{ m} - 3.527 \text{ m}$$

$$x = 2.832 \text{ m}$$

<



24.

$$(AC)^2 = (14 \text{ in.})^2 + (14 \text{ in.})^2$$

$$AC = 19.8 \text{ in.}$$

$$AB = BC = \frac{1}{2}(80 \text{ in.} - 2 \times 14 \text{ in.})$$

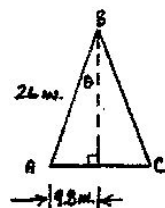
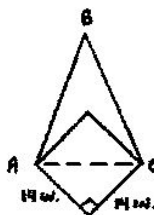
$$AB = BC = 26 \text{ in.}$$

$$\sin \theta = \frac{9.8 \text{ in.}}{26 \text{ in.}} = 0.3769$$

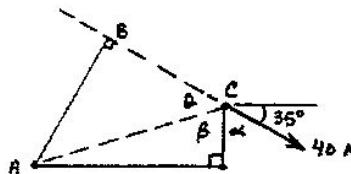
$$\theta = 22.14^\circ$$

$$\text{Angle } ABC = 2\theta = 44.3^\circ$$

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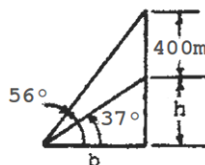
25. Using bracket dimensions:
 $(AC)^2 = (2.5 \text{ m})^2 + (0.6 \text{ m})^2$
 $AC = 2.57 \text{ m}$
 $\tan \beta = \frac{2.5 \text{ m}}{0.6 \text{ m}} = 4.1667 \Rightarrow \beta = 76.5^\circ$
 $\alpha = 90^\circ - 35^\circ = 55^\circ$
 $\theta = 180^\circ - \alpha - \beta = 48.5^\circ$
 In triangle ABC:
 $\frac{AB}{AC} = \sin \theta$
 $AB = 1.93 \text{ m}$



26. (a) In triangle ECG, let angle $CEG = \theta$. Then:
 $\frac{CG}{EG} = \tan \theta = \frac{16 \text{ ft}}{(8 \text{ ft} + 8 \text{ ft})} = 1.0000$
 So: $\theta = 45^\circ$
 Similarly, the following angles are equal to θ :
 $BAH, BGH, DGF, ABH, GBH, BCG, FDG, EDF$, and DCG .

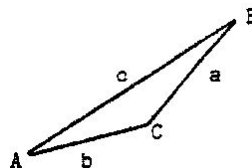
- (b) In triangle DEF, $\frac{DF}{EF} = \tan 95^\circ = 1.0000$
 so $DF = BH = 8 \text{ ft}$
 and $(DE)^2 = (8 \text{ ft})^2 + (8 \text{ ft})^2$
 or $DE = 11.31 \text{ ft} = DG = BG = AB$
 Since angle $CDG = 90^\circ$,
 then $CD = DG = CB = BG = 11.31 \text{ ft}$
 Total lineal feet:
 $(6 @ 8 \text{ ft}) + (6 @ 11.31 \text{ ft}) + (1 @ 16 \text{ ft}) = 132 \text{ ft}$

27. From the Fig.
 $\tan 37^\circ = h/b$ (a)
 $\tan 56^\circ = (400 + h)/b$ (b)



Eliminating b between
 Eqs. (a) and (b), we have
 $h/\tan 37^\circ = (400 + h)/\tan 56^\circ$
 or $h(\tan 56^\circ - \tan 37^\circ) = 400 \tan 37^\circ$
 $h = 400 \tan 37^\circ / (\tan 56^\circ - \tan 37^\circ)$
 $h = 413.5 = 414 \text{ m}$

28. (a) For Fig.
 $a = 7 \text{ in.}, B = 40^\circ, C = 30^\circ$
 $A = 180^\circ - B - C = 110^\circ$
 From Fig. and law of sines
 $b/\sin 40^\circ = c/\sin 30^\circ = 7/\sin 110^\circ$
 $b = 7 \sin 40^\circ / \sin 110^\circ = 4.79 \text{ in.}$ <
 $c = 7 \sin 30^\circ / \sin 110^\circ = 3.72 \text{ in.}$ <



- (b) $a = 3 \text{ m}, b = 6 \text{ m}, C = 48^\circ$
 From Fig. and law of cosines
 $c^2 = (6)^2 + (3)^2 - 2(6)(3) \cos 48^\circ$
 $c = 4.57 \text{ m}$ <
 From Fig. and law of sines
 $\sin A/3 = \sin 48^\circ/4.57$
 $\sin A = 0.4878; A = 29.2^\circ$ <
 $B = 180^\circ - A - C; B = 102.8^\circ$ <

(c) $a = 8 \text{ ft}$, $b = 7 \text{ ft}$, $A = 60^\circ$

From Fig. and law of sines

$$\sin B/7 = \sin 60^\circ/8$$

$$\sin B = 0.7578; B = 49.3^\circ <$$

$$C = 180^\circ - A - B; C = 70.7^\circ <$$

From Fig. and law of cosines

$$c^2 = (7)^2 + (8)^2 - 2(7)(8) \cos 70.7^\circ$$

$$c = 8.72 \text{ ft} <$$

(d) $a = 4 \text{ m}$, $b = 7 \text{ m}$, $c = 9 \text{ m}$

From Fig. and law of cosines

$$(9)^2 = (7)^2 + (4)^2 - 2(7)(4) \cos C$$

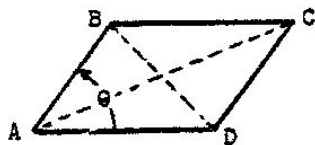
$$\cos C = -0.2857; C = 106.6^\circ <$$

$$\& (4)^2 = (7)^2 + (9)^2 - 2(7)(9) \cos A$$

$$\cos A = 0.9048; A = 25.2^\circ <$$

$$B = 180^\circ - A - C; B = 48.2^\circ <$$

29.



(a) 8 in., 12.5 in., 65°

From Fig. and law of cosines

$$(AC)^2 = (8)^2 + (12.5)^2 - 2(8)(12.5) \times \cos(180^\circ - 65^\circ); AC = 17.46 \text{ in.} <$$

$$(BD)^2 = (8)^2 + (12.5)^2 - 2(8)(12.5) \times \cos 65^\circ; BD = 11.65 \text{ in.} <$$

(b) 550 mm, 320 mm, 55°

From Fig. and law of cosines

$$(AC)^2 = (550)^2 + (320)^2 - 2(550)(320) \times \cos(180^\circ - 55^\circ); AC = 779 \text{ mm} <$$

$$(BD)^2 = (550)^2 + (320)^2 - 2(550)(320) \times \cos 55^\circ; BD = 451 \text{ mm} <$$

(c) 10.3 ft, 12.5 ft, 45°

From Fig. and law of cosines

$$(AC)^2 = (10.3)^2 + (12.5)^2 - 2(10.3)(12.5) \cos(180^\circ - 45^\circ) AC = 21.1 \text{ ft} <$$

$$(BD)^2 = (10.3)^2 + (12.5)^2 - 2(10.3)(12.5) \cos 45^\circ BD = 8.96 \text{ ft} <$$

(d) 5 m, 12 m, 125°

From Fig. and law of cosines

$$(AC)^2 = (5)^2 + (12)^2 - 2(5)(12) \times \cos(180^\circ - 125^\circ); AC = 10.01 \text{ m} <$$

$$(BD)^2 = (5)^2 + (12)^2 - 2(5)(12) \times \cos 125^\circ; BD = 15.42 \text{ m} <$$

30.

From Fig. and the law of cosines

$$(AB)^2 = (5)^2 + (8)^2 - 2(5)(8) \cos 40^\circ$$

$$AB = 5.26 \text{ ft} <$$

From Fig. and law of sines

$$\sin A/8 = \sin 40^\circ/5.26$$

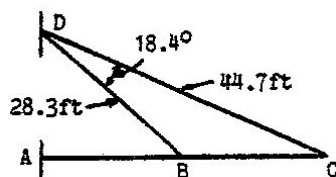
$$\sin A = 0.9768$$

$$A = 180^\circ - 77.6^\circ = 102.4^\circ$$

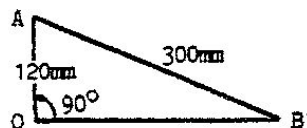
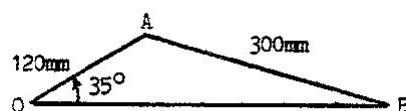
$$\theta = A - 90^\circ = 102.4^\circ - 90^\circ = +12.4^\circ <$$

31. From Fig. and law of cosines
 $(BC)^2 = (28.3)^2 + (44.7)^2 - 2(28.3)(44.7) \cos 18.4^\circ$
 $BC = 19.96 \text{ ft} \quad <$

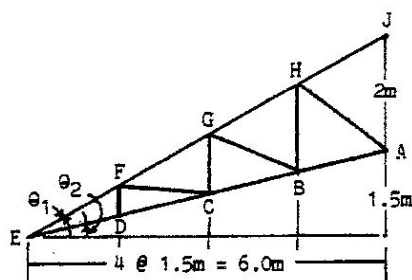
From Fig. and law of sines
 $\sin \angle BCD / 28.3 = \sin \angle DBC / 44.7 = \sin 18.4^\circ / 19.96$
 $\sin \angle BCD = 0.4475; \angle BCD = 26.6^\circ \quad <$
 $\sin \angle DBC = 0.7068$
 $\angle DBC = 180^\circ - 44.98^\circ = 135.0^\circ \quad <$
 $\angle DBA = 180^\circ - 135.0^\circ = 45^\circ \quad <$
 $AD = AB \tan \angle ABD = AC \tan \angle BCD$
 $AB \tan 45^\circ = (AB + 19.96) \tan 26.6^\circ$
 $AB = 20.02 \text{ ft}$
 $AC = 19.96 + 20.02 = 40.0 \text{ ft} \quad <$



32. $OA = 120 \text{ mm}, AB = 300 \text{ mm}$
 From the law of sines
 $\sin 35^\circ / 300 = \sin A / OB = \sin B / 120$
 $\sin B = (120/300) \sin 35^\circ$
 $\text{Angle } B = 13.26^\circ$
 $\text{Angle } A = 180^\circ - 13.26^\circ - 35^\circ$
 $= 131.7^\circ$
 $OB = 300 \sin A / \sin 35^\circ$
 $= 300 \sin 131.7^\circ / \sin 35^\circ$
 $OB = 390 \text{ mm} \quad <$
 $(120)^2 + (OB')^2 = (300)^2$
 $OB' = 275 \text{ mm} \quad <$
 Distance moved = $OB - OB' = 390 - 275 = 115.0 \text{ mm} \quad <$

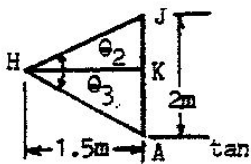


33. Fig. (1)



- (a) From Fig. (1)
 $\tan \theta_1 = 1.5/6; \quad \theta_1 = 14.04^\circ$
 $\tan \theta_2 = (2 + 1.5)/6; \quad \theta_2 = 30.26^\circ$
 and $\angle GCB = 90^\circ - \theta_2 = 75.96^\circ$
 $= 76.0^\circ \quad <$

(b) From Fig. (2)



$$\begin{aligned} JK &= 1.5 \tan \theta_2 = 0.875 \text{ m} \\ KA &= 2 - JK = 1.125 \text{ m} \\ \tan \theta_3 &= 1.125/1.5 \\ \theta_3 &= 36.87^\circ \\ \angle AHJ &= \theta_1 + \theta_2 = 67.1^\circ < \end{aligned}$$

Fig. (2)

34.

From the Fig.

$$\tan \theta_1 = 3/36$$

$$\theta_1 = 4.76^\circ$$

$$\angle BAH = 90^\circ - \theta_1 = 85.2^\circ <$$

$$(AD)^2 = (3)^2 + (36)^2$$

$$AD = 36.12$$

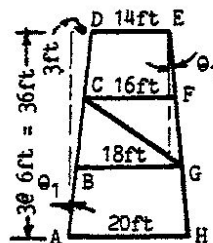
$$BC = AD/3 = 12.04 \text{ ft}$$

$$\angle BAH = \angle CBG$$

From Fig. and law of cosines

$$(CG)^2 = (18)^2 + (12.04)^2 - 2(18)(12.04) \cos 85.2^\circ$$

$$CG = 20.81 \text{ ft}$$



From the figure of the tower and the law of sines

$$\frac{\sin \angle BCG}{18} = \frac{\sin 85.2^\circ}{20.81}$$

$$\sin \angle BCG = 0.8615$$

$$\angle BCG = 59.5^\circ <$$

$$\angle DEF = 90 + \theta_1 = 94.8^\circ <$$

35.

(a) Law of sines:

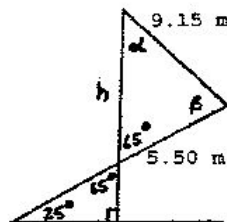
$$\frac{9.15 \text{ m}}{\sin 65^\circ} = \frac{5.50 \text{ m}}{\sin \alpha}$$

$$\alpha = 33.0^\circ$$

$$\beta = 180^\circ - 65^\circ - \alpha = 82.0^\circ$$

$$\text{So } \frac{9.15 \text{ m}}{\sin 65^\circ} = \frac{h}{\sin 82.0^\circ}$$

$$h = 10.0 \text{ m} <$$



(b) Law of sines:

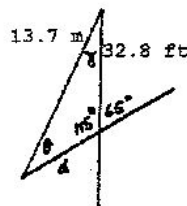
$$\frac{13.7 \text{ m}}{\sin 115^\circ} = \frac{10.0 \text{ m}}{\sin \theta}$$

$$\theta = 41.4^\circ$$

$$\gamma = 180^\circ - 115^\circ - \theta = 23.6^\circ$$

$$\frac{13.7 \text{ m}}{\sin 115^\circ} = \frac{d}{\sin 23.6^\circ}$$

$$d = 6.05 \text{ m} <$$



36.

In triangle ABD, law of sines yields:

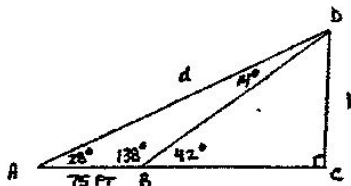
$$\frac{d}{\sin 138^\circ} = \frac{75 \text{ ft}}{\sin 14^\circ}$$

$$d = 207.4 \text{ ft}$$

In right triangle ACD:

$$\frac{h}{207.4 \text{ ft}} = \sin 28^\circ = 0.4695$$

$$h = 97.4 \text{ ft, tree will hit house} <$$

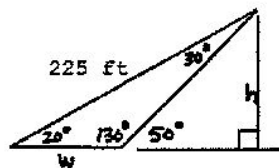


37. (a) Law of sines:

$$\frac{225 \text{ ft}}{\sin 130^\circ} = \frac{W}{\sin 30^\circ}$$

$$W = 146.9 \text{ ft}$$

<



- (b) $h = (225 \text{ ft})\sin 20^\circ = 77.0 \text{ ft}$

$$V = \frac{1}{2}(146.9 \text{ ft})(77.0 \text{ ft})\left(\frac{5280 \text{ ft}}{8}\right)$$

$$= 3,732,729 \text{ ft}^3$$

$$V = \frac{1 \text{ cu. yd.}}{27 \text{ ft}^3} \times 3,732,729 \text{ ft}^3$$

$$V = 138,249 \text{ cu. yds.}$$

<

- (c) No. of truckloads = $\frac{138,249 \text{ cu. yds.}}{20 \text{ cu. yds./truck}}$
 $= 6,912 \text{ truckloads}$

<

38. From law of cosines:

$$R^2 = (18)^2 + (32)^2 - 2(18)(32) \cos 41.5^\circ$$

$$R = 22.0 \text{ ft}$$

<

From law of sines:

$$\frac{18 \text{ ft}}{\sin B} = \frac{22.0 \text{ ft}}{\sin 41.5^\circ}$$

$$\sin B = 0.5421$$

$$B = 32.8^\circ$$

<

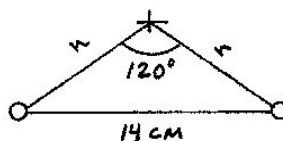
39. From law of cosines:

$$(14)^2 = r^2 + r^2 - 2(r)(r) \cos 120^\circ$$

$$r = 8.08 \text{ cm}$$

$$d = 2r = 16.2 \text{ cm}$$

<



40. $D = \begin{vmatrix} -15 & 21 \\ -2 & 3 \end{vmatrix} = -15(3) - 21(-2)$
 $= -3$

$$Dx = \begin{vmatrix} 12 & 21 \\ 17 & 3 \end{vmatrix} = 12(3) - (21)(17)$$

$$= -321$$

$$Dy = \begin{vmatrix} -15 & 12 \\ -2 & 17 \end{vmatrix} = -15(17) - (12)(-2)$$

$$= -231$$

Dividing Dx and Dy by D , we have

$$x = \frac{-321}{-3} = 107, \quad y = \frac{-231}{-3} = 77$$

<

41. $D = \begin{vmatrix} 19 & -20 \\ 20 & -21 \end{vmatrix} = 19(-21) - (-20)(20) = 1$

$$Du = \begin{vmatrix} -22 & -20 \\ -23 & -21 \end{vmatrix} = (-22)(-21) - (-20)(-23) = 2$$

$$Dv = \begin{vmatrix} 19 & -22 \\ 20 & -23 \end{vmatrix} = 19(-23) - (-22)(20) = 3$$

Dividing Du and Dv by D , we have

$$u = \frac{2}{1} = 2, \quad v = \frac{3}{1} = 3 <$$

$$42. \quad D = \begin{vmatrix} 5 & -3 \\ 3 & -5 \end{vmatrix} = 5(-5) - (-3)(3) = -16$$

$$Dm = \begin{vmatrix} 9 & -3 \\ -9 & -5 \end{vmatrix} = 9(-5) - (-3)(-9) = -72$$

$$Dn = \begin{vmatrix} 5 & 9 \\ 3 & -9 \end{vmatrix} = 5(-9) - 9(3) = -72$$

Dividing Dm and Dn by D , we have

$$m = \frac{-72}{-16} = 4.5, \quad n = \frac{-72}{-16} = 4.5 <$$

$$43. \quad D = \begin{vmatrix} 2 & 2 \\ 1 & -1 \end{vmatrix} = (2)(-1) - (1)(2) = -4$$

$$DA = \begin{vmatrix} 3 & 2 \\ -0.9 & -1 \end{vmatrix} = (3)(-1) - (-0.9)(2) = -1.2$$

$$DB = \begin{vmatrix} 2 & 3 \\ 1 & -0.9 \end{vmatrix} = (2)(-0.9) - (1)(3) = -4.8$$

Then:

$$A = \frac{DA}{D} = \frac{-1.2}{-4} = 0.3 <$$

$$B = \frac{DB}{D} = \frac{-4.8}{-4} = 1.2 <$$

44.

$$x = \begin{vmatrix} 0 & -5 \\ -4 & 1 \\ 3 & -5 \\ 6 & 1 \end{vmatrix}$$

$$\begin{array}{rcl} \downarrow & \downarrow & \downarrow \\ 3x - 5y = 0 & < \\ 6x + 1y = -4 & < \end{array}$$

$$45. \quad -7x + 10y = 10 <$$

$$9x - 5y = -5 <$$

$$x = \frac{\begin{vmatrix} 10 & 10 \\ -5 & -5 \end{vmatrix}}{\begin{vmatrix} -7 & 10 \\ 9 & -5 \end{vmatrix}} = \frac{(-50) - (-50)}{(35) - (90)} = \frac{0}{-55} = 0 <$$

$$y = \frac{\begin{vmatrix} -7 & 10 \\ 9 & -5 \end{vmatrix}}{\begin{vmatrix} -7 & 10 \\ 9 & -5 \end{vmatrix}} = \frac{(35) - (90)}{(35) - (90)} = \frac{-55}{-55} = +1 <$$

Equation set is valid.

$$\begin{aligned} 46. \quad \$10.10 &= F + 12r &< \\ \$13.95 &= F + 19r &< \end{aligned}$$

$$F = \frac{\begin{vmatrix} 10.10 & 12 \\ 13.95 & 19 \end{vmatrix}}{\begin{vmatrix} 1 & 12 \\ 1 & 19 \end{vmatrix}} = \frac{(191.90) - (167.40)}{(19) - (12)}$$

$$F = \$3.50 \quad <$$

$$r = \frac{\begin{vmatrix} 1 & 10.10 \\ 1 & 13.95 \end{vmatrix}}{\begin{vmatrix} 1 & 12 \\ 1 & 19 \end{vmatrix}} = \frac{(13.95) - (10.10)}{(19) - (12)}$$

$$r = \$0.55/\text{lb} \quad <$$

$$\begin{aligned} 47. \quad C &= \text{Cost of one } 2 \times 4 \\ P &= \text{Cost of one } 2 \times 6 \end{aligned}$$

$$350C + 200P = \$1077.50 \quad <$$

$$140C + 125P = \$527.75 \quad <$$

$$C = \frac{\begin{vmatrix} 1077.50 & 200 \\ 527.75 & 125 \end{vmatrix}}{\begin{vmatrix} 350 & 200 \\ 140 & 125 \end{vmatrix}} = \frac{29,137.50}{15,750}$$

$$C = \$1.85 \quad <$$

$$P = \frac{\begin{vmatrix} 350 & 1077.50 \\ 140 & 527.75 \end{vmatrix}}{15,750} = \frac{33,862.50}{15,750}$$

$$P = \$2.15 \quad <$$

$$48. \quad (1^{\text{st}} \text{ column})$$

$$D = \begin{vmatrix} 2 & 3 & -2 \\ 1 & 1 & 1 \\ -1 & -3 & 2 \end{vmatrix} = 2[1(2) - 1(-3)] - 1[3(2) - (-2)(-3)] + (-1)[3(1) - (-2)(1)] = 5$$

$$(2^{\text{nd}} \text{ row})$$

$$\begin{aligned} Dx &= \begin{vmatrix} -7 & 3 & -2 \\ 2 & 1 & 1 \\ 5 & -3 & 2 \end{vmatrix} = -2[3(2) - (-2)(-3)] + 1[(-7)(2) - (-2)(5)] - 1[(-7)(-3) - (3)(5)] \\ &= -10 \end{aligned}$$

$$(1^{\text{st}} \text{ column})$$

$$Dy = \begin{vmatrix} 2 & -7 & -2 \\ 1 & 2 & 1 \\ -1 & 5 & 2 \end{vmatrix} = 2[2(2) - 1(5)] - 1[(-7)(2) - (-2)(5)] + (-1)[(-7)(1) - (-2)(2)] = 5$$

$$(1^{\text{st}} \text{ column})$$

$$Dz = \begin{vmatrix} 2 & 3 & -7 \\ 1 & 1 & 2 \\ -1 & -3 & 5 \end{vmatrix} = 2[1(5) - 2(-3)] - 1[3(5) - (-7)(-3)] + (-1)[3(2) - (-7)(1)] = 15$$

Dividing Dx , Dy , & Dz by D , we have

$$x = \frac{-10}{5} = -2, y = \frac{5}{5} = 1, z = \frac{15}{5} = 3 \quad <$$

$$49. \quad D = \begin{vmatrix} 1 & 3 & 2 \\ -2 & -2 & 3 \\ -1 & 1 & 1 \end{vmatrix} \begin{vmatrix} 1 & 3 \\ -2 & -3 \\ -1 & 1 \end{vmatrix} = +1(-2)(1) + (3)(3)(-1) + (2)(-2)(1) - (2)(-2)(-1)$$

$$-(1)(3)(1) - (3)(-2)(1) = -16$$

$$DP = \begin{vmatrix} 2 & 3 & 2 \\ 1 & -2 & 3 \\ -1 & 1 & 1 \end{vmatrix} \begin{vmatrix} 2 & 3 \\ 1 & -2 \\ -1 & 1 \end{vmatrix} = + (2)(-2)(1) + (3)(3)(-1) + (2)(1)(1) - (2)(-2)(-1)$$

$$- (2)(3)(1) - (3)(1)(1) = -24$$

$$DQ = \begin{vmatrix} 1 & 2 & 2 \\ -2 & 1 & 3 \\ -1 & -1 & 1 \end{vmatrix} \begin{vmatrix} 1 & 2 \\ -2 & 1 \\ -1 & -1 \end{vmatrix} = + (1)(1)(1) + (2)(3)(-1) + (2)(-2)(-1) - (2)(1)(-1)$$

$$- (1)(3)(-1) - (2)(-2)(1) = 8$$

$$DR = \begin{vmatrix} 1 & 3 & 2 \\ -2 & -2 & 1 \\ -1 & 1 & -1 \end{vmatrix} \begin{vmatrix} 1 & 3 \\ -2 & -2 \\ -1 & 1 \end{vmatrix} = + (1)(-2)(-1) + (3)(1)(-1) + (2)(-2)(1) - (2)(-2)(-1)$$

$$- (1)(1)(1) - (3)(-2)(-1) = -16$$

Dividing DP , DQ , & DR by D , we have $P = \frac{-24}{-16} = 1.5$,

$$Q = \frac{8}{-16} = -0.5, R = \frac{-16}{-16} = 1 <$$

$$50. \quad D = \begin{vmatrix} 0 & 1 & 2 \\ -2 & 2 & -1 \\ 3 & -1 & 1 \end{vmatrix} \begin{vmatrix} 0 & 1 \\ -2 & 2 \\ 3 & -1 \end{vmatrix} = + (0)(2)(1) + (1)(-1)(3) + (2)(-2)(-1) - (2)(2)(3)$$

$$- (0)(-1)(-1) - (1)(-2)(1) = -9$$

$$Dx = \begin{vmatrix} 1 & 1 & 2 \\ 3 & 2 & -1 \\ 2 & -1 & 1 \end{vmatrix} \begin{vmatrix} 1 & 1 \\ 3 & 2 \\ 2 & -1 \end{vmatrix} = + (1)(2)(1) + (1)(-1)(2) + (2)(3)(-1) - (2)(2)(2)$$

$$- (1)(-1)(-1) - (1)(3)(1) = -18$$

$$Dy = \begin{vmatrix} 0 & 1 & 2 \\ -2 & 3 & -1 \\ 3 & 2 & 1 \end{vmatrix} \begin{vmatrix} 0 & 1 \\ -2 & 3 \\ 3 & 2 \end{vmatrix} = + (0)(3)(1) + (1)(-1)(3) + (2)(-2)(2) - (2)(3)(3)$$

$$- (0)(-1)(2) - (1)(-2)(1) = -27$$

$$Dz = \begin{vmatrix} 0 & 1 & 1 \\ -2 & 2 & 3 \\ 3 & -1 & 2 \end{vmatrix} \begin{vmatrix} 0 & 1 \\ -2 & 2 \\ 3 & -1 \end{vmatrix} = + (0)(2)(2) + (1)(3)(3) + (1)(-2)(-1) - (1)(2)(3)$$

$$- (0)(3)(-1) - (1)(-2)(2) = 9$$

Dividing Dx , Dy , & Dz by D , we have

$$x = \frac{-18}{-9} = 2, y = \frac{-27}{-9} = 3, z = \frac{9}{-9} = -1 <$$

$$51. \quad D = \begin{vmatrix} 2 & 3 & 2 \\ 2 & 1 & -4 \\ 1 & 2 & 1 \end{vmatrix} \begin{vmatrix} 2 & 3 \\ 2 & 1 \\ 1 & 2 \end{vmatrix} = + (2)(1)(1) + (3)(-4)(1) + (2)(2)(2) - (2)(1)(1)$$

$$- (2)(-4)(2) - (3)(2)(1) = 6$$

$$DA = \begin{vmatrix} 3 & 3 & 2 \\ 4 & 1 & -4 \\ 2 & 2 & 1 \end{vmatrix} \begin{vmatrix} 3 & 3 \\ 4 & 1 \\ 2 & 2 \end{vmatrix} = + (3)(1)(1) + (3)(-4)(2) + (2)(4)(2) - (2)(1)(2)$$

$$- (3)(-4)(2) - (3)(4)(1) = 3$$

$$DB = \begin{vmatrix} 2 & 3 & 2 \\ 2 & 4 & -4 \\ 1 & 2 & 1 \end{vmatrix} \begin{vmatrix} 2 & 3 \\ 2 & 4 \\ 1 & 2 \end{vmatrix} = + (2)(4)(1) + (3)(-4)(1) + (2)(2)(2) - (2)(4)(1)$$

$$- (2)(-4)(2) - (3)(2)(1) = 6$$

$$DC = \begin{vmatrix} 2 & 3 & 3 \\ 2 & 1 & 4 \\ 1 & 2 & 2 \end{vmatrix} \begin{vmatrix} 2 & 3 \\ 2 & 1 \\ 1 & 2 \end{vmatrix} = + (2)(1)(2) + (3)(4)(1) + (3)(2)(2) - (3)(1)(1)$$

$$- (2)(4)(2) - (3)(2)(2) = -3$$

Dividing DA , DB , & DC by D , we have

$$A = \frac{3}{6} = 0.5, B = \frac{6}{6} = 1, C = \frac{-3}{6} = -0.5 \quad <$$

52. L = Lightest casting weight
 M = Middle casting weight
 H = Heaviest casting weight

$$L + M + H = 1867 \quad <$$

$$H - L = 395 \quad <$$

$$2L = M + H - 427 \quad <$$

Aligning equations:

$$L + M + H = 1867 \quad <$$

$$-L \quad + H = 395 \quad <$$

$$2L - M - H = -427 \quad <$$

$$L = \frac{\begin{vmatrix} 1867 & 1 & 1 \\ 395 & 0 & 1 \\ -427 & -1 & -1 \end{vmatrix}}{\begin{vmatrix} 1 & 1 & 1 \\ -1 & 0 & 1 \\ 2 & -1 & -1 \end{vmatrix}} = \frac{1440}{3} = 480 \text{ lb} \quad <$$

$$M = \frac{\begin{vmatrix} 1 & 1867 & 1 \\ -1 & 395 & 1 \\ 2 & -427 & -1 \end{vmatrix}}{\begin{vmatrix} 1 & 1 & 1 \\ -1 & 0 & 1 \\ 2 & -1 & -1 \end{vmatrix}} = \frac{1536}{3} = 512 \text{ lb} \quad <$$

$$H = \frac{\begin{vmatrix} 1 & 1 & 1867 \\ -1 & 0 & 395 \\ 2 & -1 & -427 \end{vmatrix}}{\begin{vmatrix} 1 & 1 & 1 \\ -1 & 0 & 1 \\ 2 & -1 & -1 \end{vmatrix}} = \frac{2625}{3} = 875 \text{ lb} \quad <$$