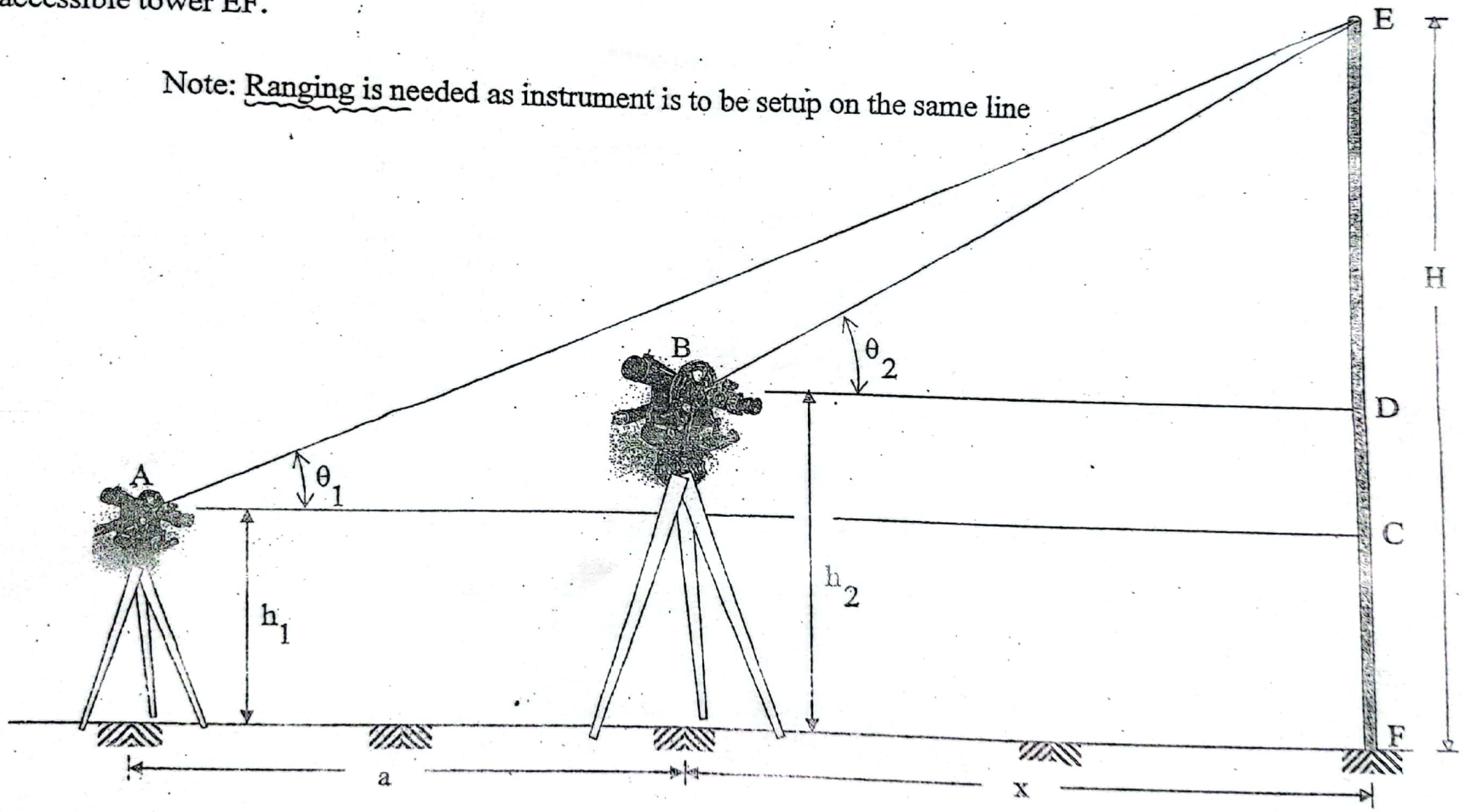
# Height & Distance Problem

## Determination of Height of an Inaccessible Tower

Calculate height 'H" of an inaccessible tower EF.

Note: Ranging is needed as instrument is to be setup on the same line




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# Determination of Height of an Inaccessible Tower

H = height of the tower
$h_1$ and $h_2$ = height of the instruments
a = known distance.

Triangle ΔACE

$$\Rightarrow \frac{(H-h_1)}{(a+x)} = \tan\theta_1$$

$$\Rightarrow (H-h_1) = (a+x)\tan\theta_1$$

$$\Rightarrow H = h_1 + a\tan\theta_1 + x\tan\theta_1 \quad \ldots\ldots (1)$$

Triangle ΔABDE

$$\Rightarrow \frac{(H-h2)}{x} = \tan\theta_2$$

$$\Rightarrow H - h_2 = x\tan\theta_2$$

$$\Rightarrow H = h_2 + x\tan\theta_2 \quad \ldots\ldots (2)$$

Equating (1) and (2)

$$\Rightarrow H = h_1 + a\tan\theta_1 + x\tan\theta_1 = h_2 + x\tan\theta_2$$

$$\Rightarrow x(\tan\theta_1 - \tan\theta_2) = h_2 - h_1 - a\tan\theta_1$$

$$\Rightarrow x = \frac{(h_2 - h_1 - a\tan\theta_1)}{(\tan\theta_1 - \tan\theta_2)}$$

Now height of the tower can be determined by using equation (1) or (2).

$$\Rightarrow H = h_1 + a\tan\theta_1 + x\tan\theta_1$$

$$\Rightarrow H = h_1 + a\tan\theta_1 + \frac{(h_2 - h_1 - a\tan\theta_1)}{(\tan\theta_1 - \tan\theta_2)} \times \tan\theta_1$$

or $\Rightarrow H = h_2 + x\tan\theta_2$

or $\Rightarrow H = h_2 + \frac{(h_2 - h_1 - a\tan\theta_1)}{(\tan\theta_1 - \tan\theta_2)} \times \tan\theta_2$



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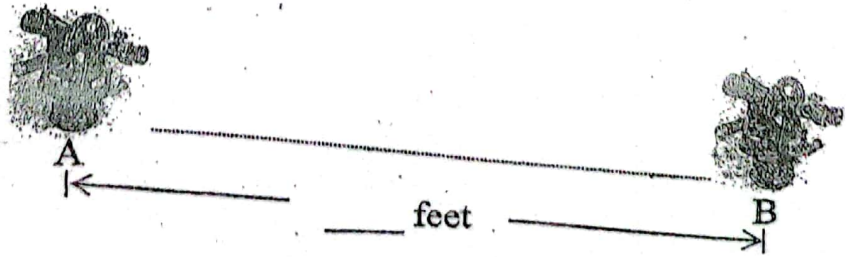
## Determination of Aerial Distance



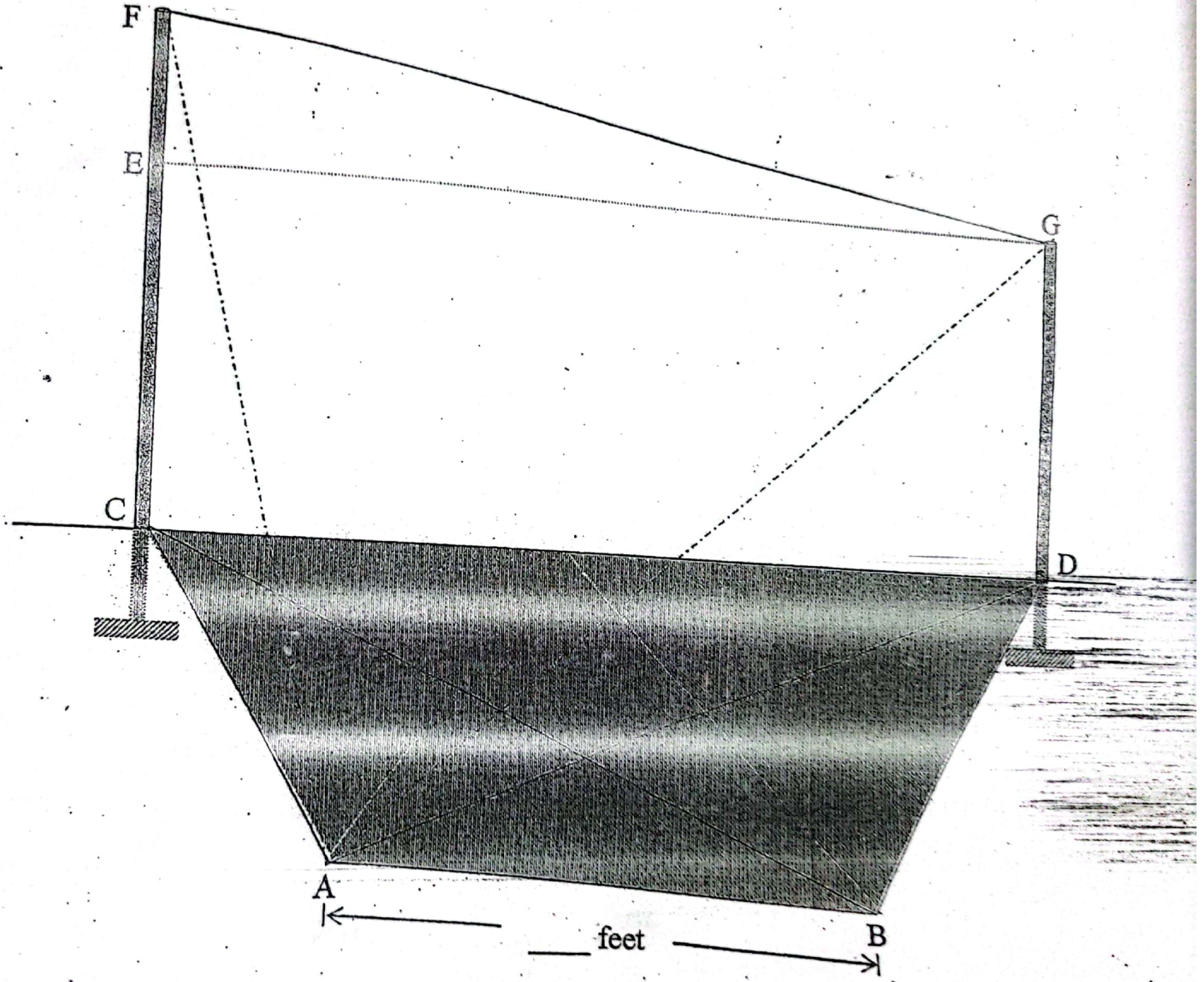




Calculate aerial distance between point F & G




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# Determination of Aerial Distance

The following angles are measured using transit theodolite.

| Theodolite station | Angle measured |
|---|---|
| A | $\angle CAD =$ _____ (horizontal angle) |
| | $\angle BAD =$ _____ (horizontal angle) |
| | $\angle CAF =$ _____ (vertical angle) |
| | $\angle DAG =$ _____ (vertical angle) |
| B | $\angle ABC =$ _____ (horizontal angle) |
| | $\angle CBD =$ _____ (horizontal angle) |

Distance between two theodolite stations (A & B) is _____ feet. Calculate the aerial distance between two points EG.

$\Delta ABC$ horizontal triangle

$\angle BAC = \angle BAD + \angle CAD =$ _____

$\Rightarrow \angle ABC + \angle ACB + \angle BAC = 180^0$

$\Rightarrow$ _____ $+ \angle ACB +$ _____ $= 180^0$

$\Rightarrow \angle ACB =$ _____

$$\frac{AB}{\sin\angle ACB} = \frac{BC}{\sin\angle BAC} = \frac{AC}{\sin\angle ABC}$$

$$\Rightarrow AC = \frac{AB}{\sin\angle ACB} \times \sin\angle ABC =$$ _____ feet

$$\& \Rightarrow BC = \frac{AB}{\sin\angle ACB} \times \sin\angle BAC =$$ _____ feet

$\Delta ACF$ vertical triangle

$$\frac{CF}{AC} = \tan\angle CAF$$

$\Rightarrow CF = AC \tan\angle CAF =$ _____ feet

---

$\Delta ABD$ horizontal triangle

$\angle ABD = (\angle ABC + \angle CBD) =$ _____

$\Rightarrow \angle ABD + \angle ADB + \angle BAD = 180^0$

$\Rightarrow$ _____ $+ \angle ADB +$ _____ $= 180^0$

$\Rightarrow \angle ADB =$ _____



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$$\frac{AB}{\sin\angle ADB} = \frac{BD}{\sin\angle BAD} = \frac{AD}{\sin\angle ABD}$$

$$\Rightarrow AD = \frac{AB}{\sin\angle ADB} \times \sin\angle ABD = _____ \text{ feet}$$

$$\& \Rightarrow BD = \frac{AB}{\sin\angle ADB} \times \sin\angle BAD = _____ \text{ feet}$$

$\Delta ADG$ vertical triangle

$$\frac{DG}{AD} = \tan\angle DAG$$

$$\Rightarrow DG = AD \tan\angle DAG = _____ \text{ feet}$$

---

$\Delta ACD$ horizontal triangle

$$\cos\angle CAD = \frac{AC^2 + AD^2 - CD^2}{2.AC.AD}$$

$$\Rightarrow CD = \sqrt{AC^2 + AD^2 - 2.AC.AD.\cos\angle CAD}$$

$$\Rightarrow CD = _____ \text{ feet}$$

or $\Delta BCD$ horizontal triangle

$$\cos\angle CBD = \frac{BC^2 + BD^2 - CD^2}{2.BC.BD}$$

$$\Rightarrow CD = \sqrt{BC^2 + BD^2 - 2.BC.BD.\cos\angle CBD}$$

$$\Rightarrow CD = _____ \text{ feet}$$

---

$$FG = \sqrt{EG^2 + EF^2}$$

$$\Rightarrow FG = \sqrt{CD^2 + (CF - CE)^2}$$

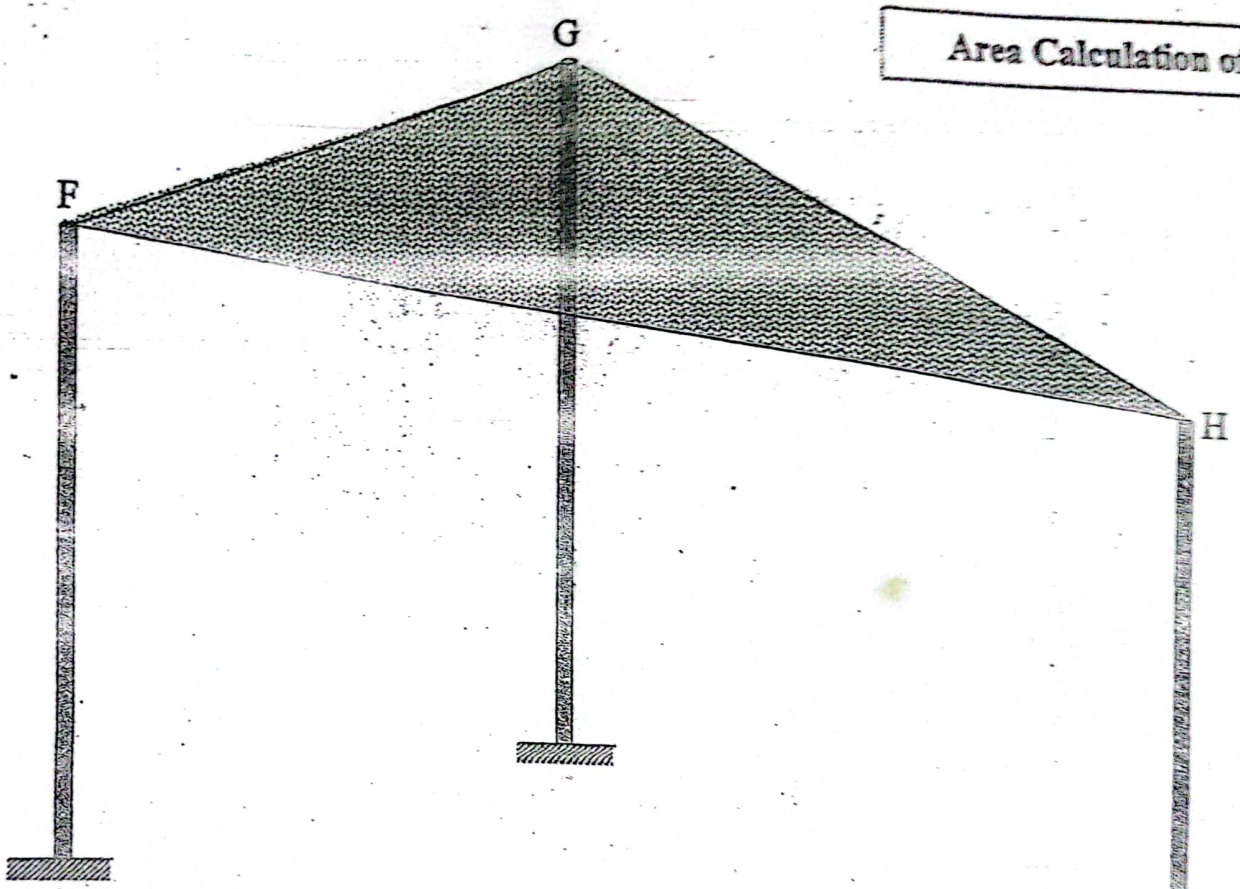
$$\Rightarrow FG = \sqrt{CD^2 + (CF - DG)^2}$$

$$\Rightarrow FG = _____ \text{ feet}$$

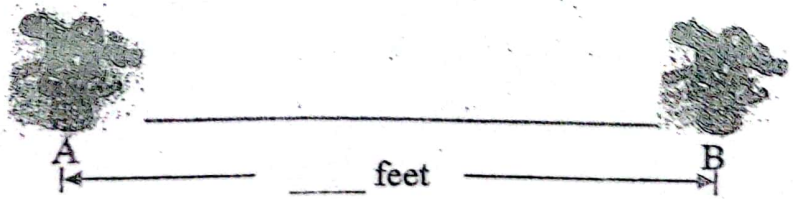


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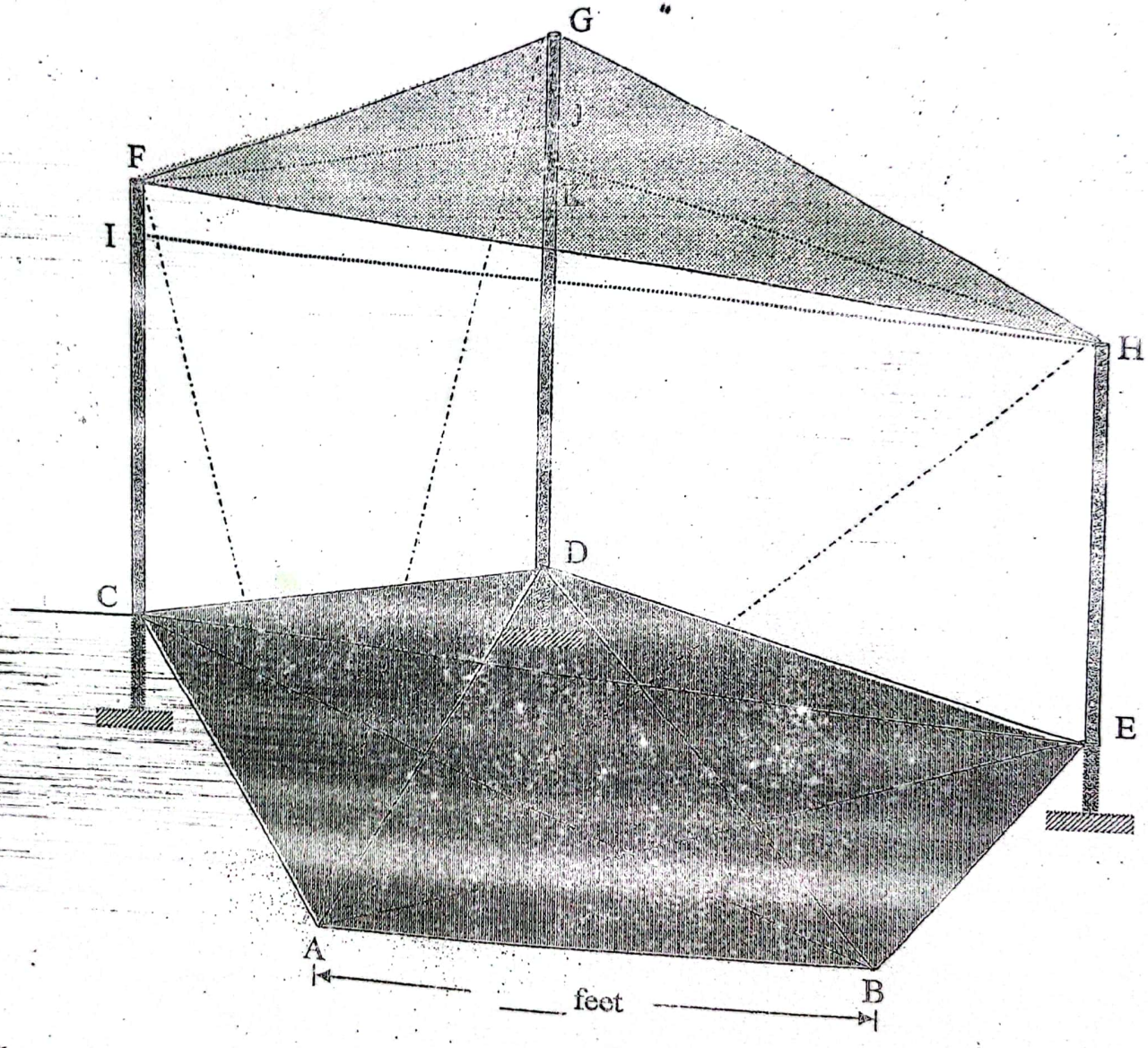
## Area Calculation of Space Triangle




Calculate area of space triangle FGH.




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