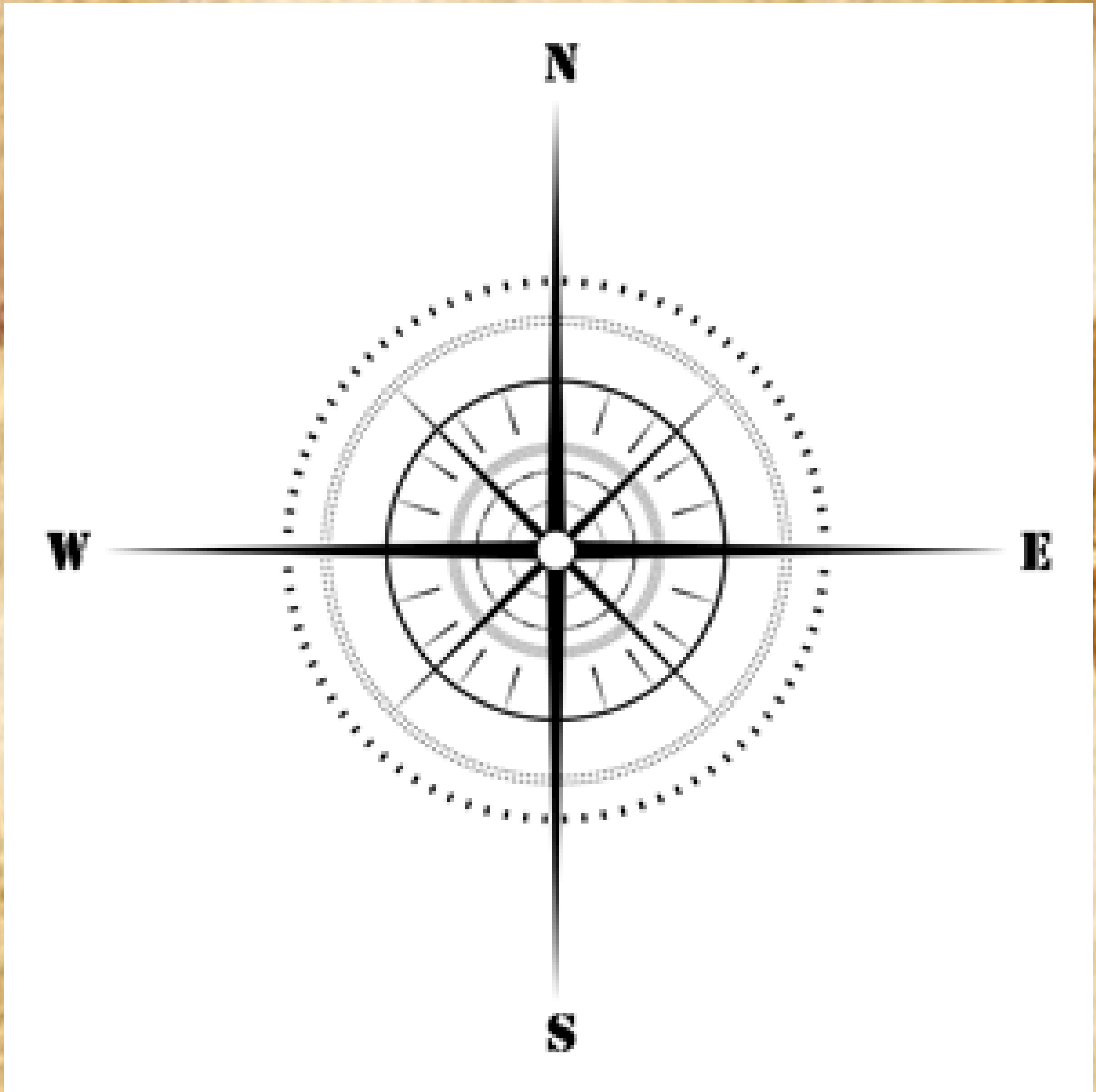
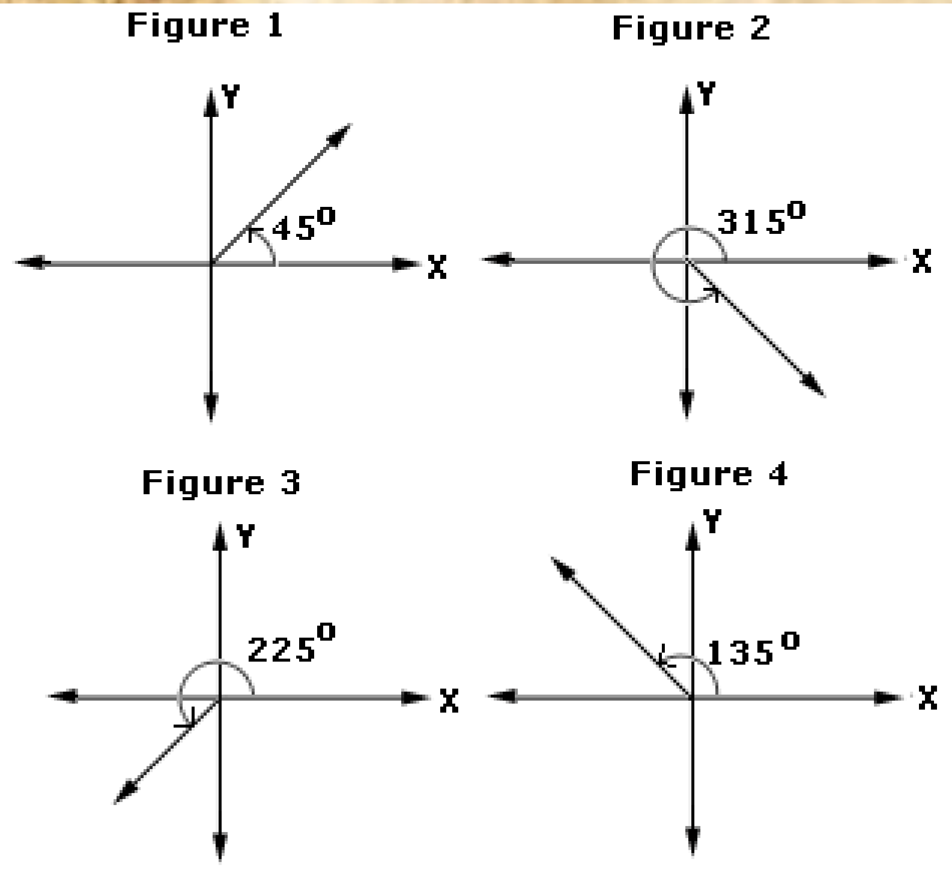
Sec 9.5

Applications of Trigonometry to Navigation and Surveying


N
W
E
S

Which direction?

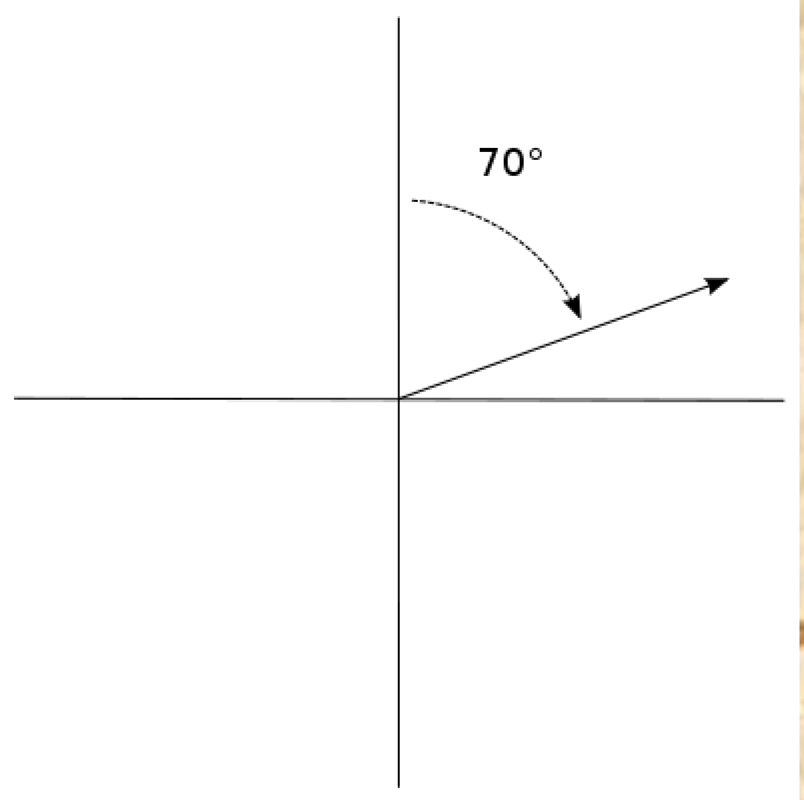
- In basic Trig… standard position:



Start on the x-axis.
Counter clockwise

Which direction?

- Navigation… used by ships, planes etc.

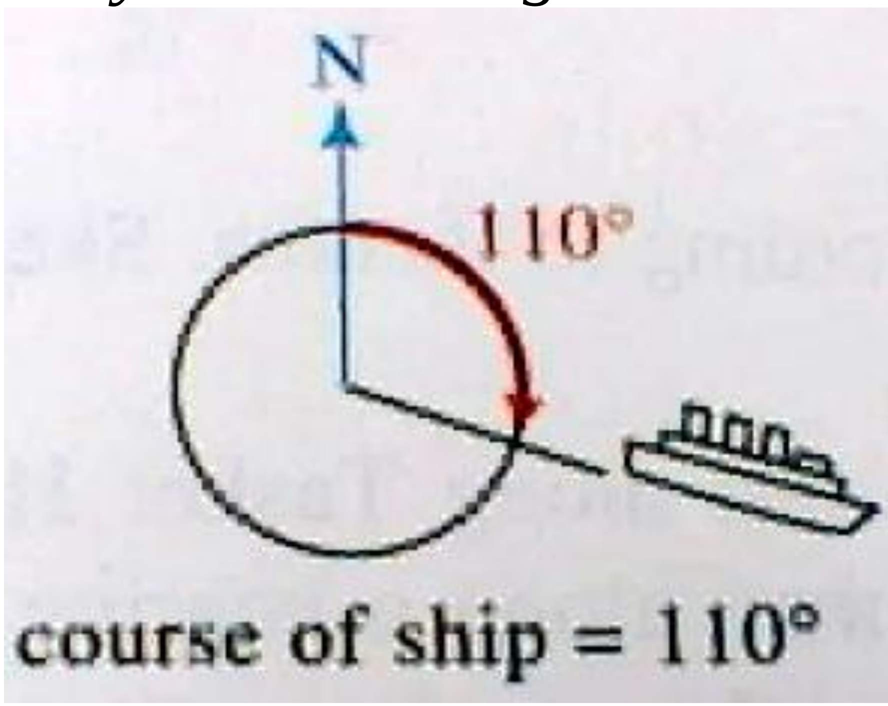


Start on the y-axis.
Clockwise
Given using 3 digits

9.5 Applications of Trigonometry to Navigation and Surveying

Objective

To use trigonometry to solve navigation and surveying problems.



The course of a ship or plane is the ∠, measured clockwise, from the north direction to the direction of the ship or plane.

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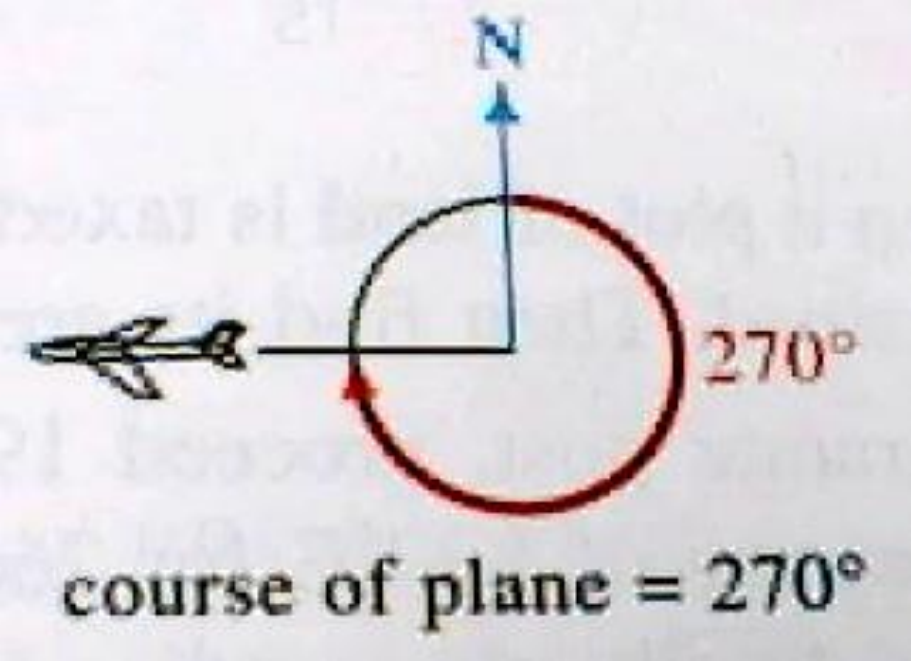

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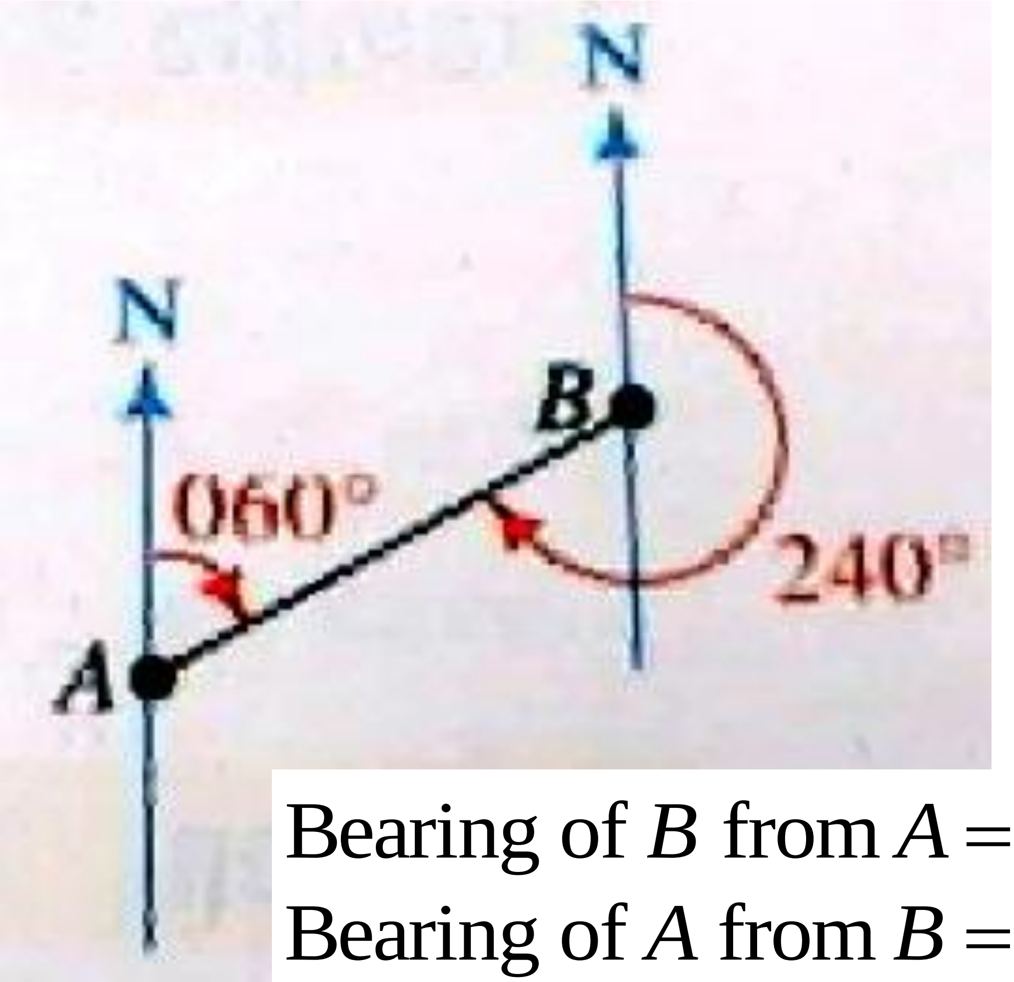

Bearing of B from A =

Bearing of A from B =

The course of a ship or plane is the ∠, measured clockwise, from the north direction to the direction of the ship or plane.

Example 1. A ship proceeds on a course of 300° for 2 hours at a speed of 15 knots (1 knot = 1 nautical mile per hour). Then it changes course to 230°, continuing at 15 knots for 3 more hours. At that time, how far is the ship from its starting point?

Make a diagram

Always measure clockwise

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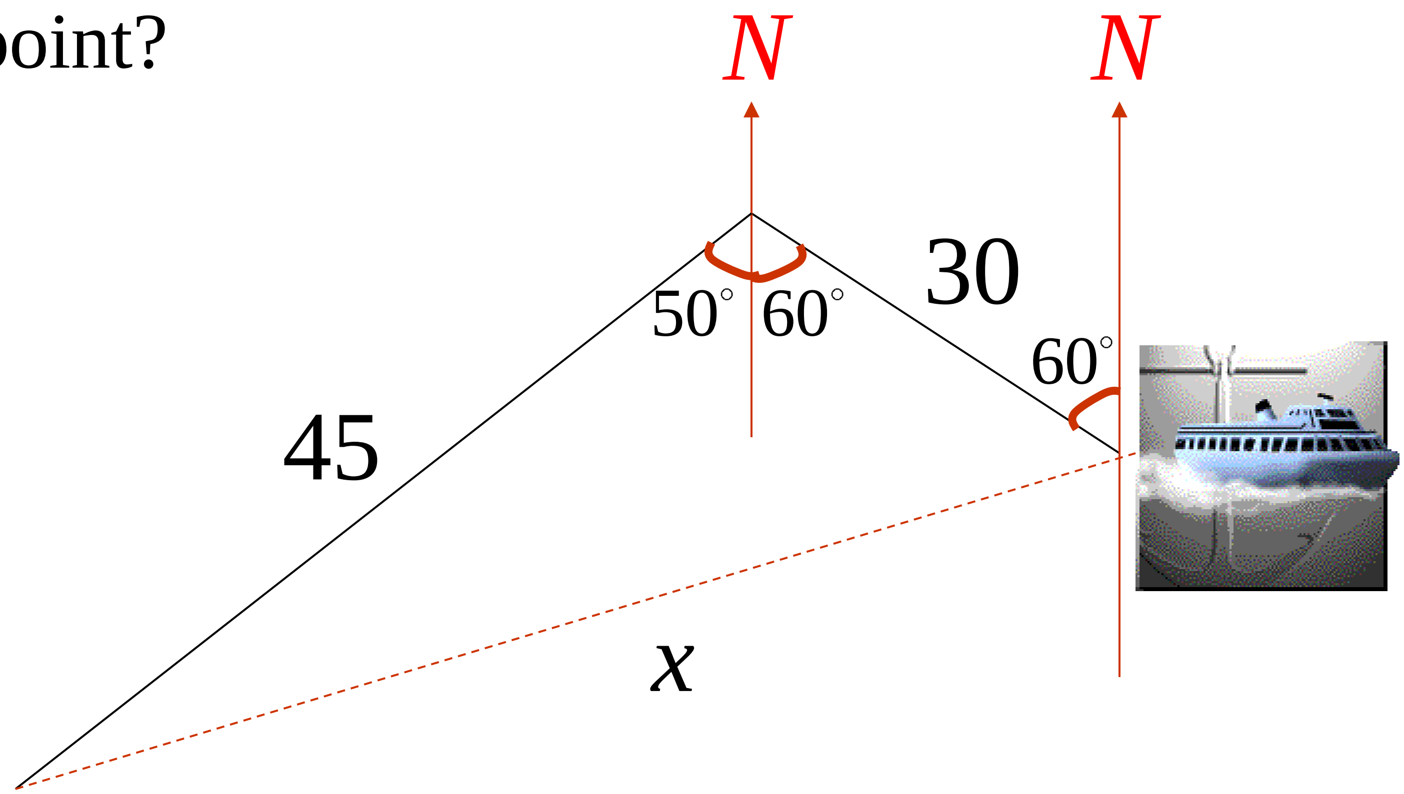
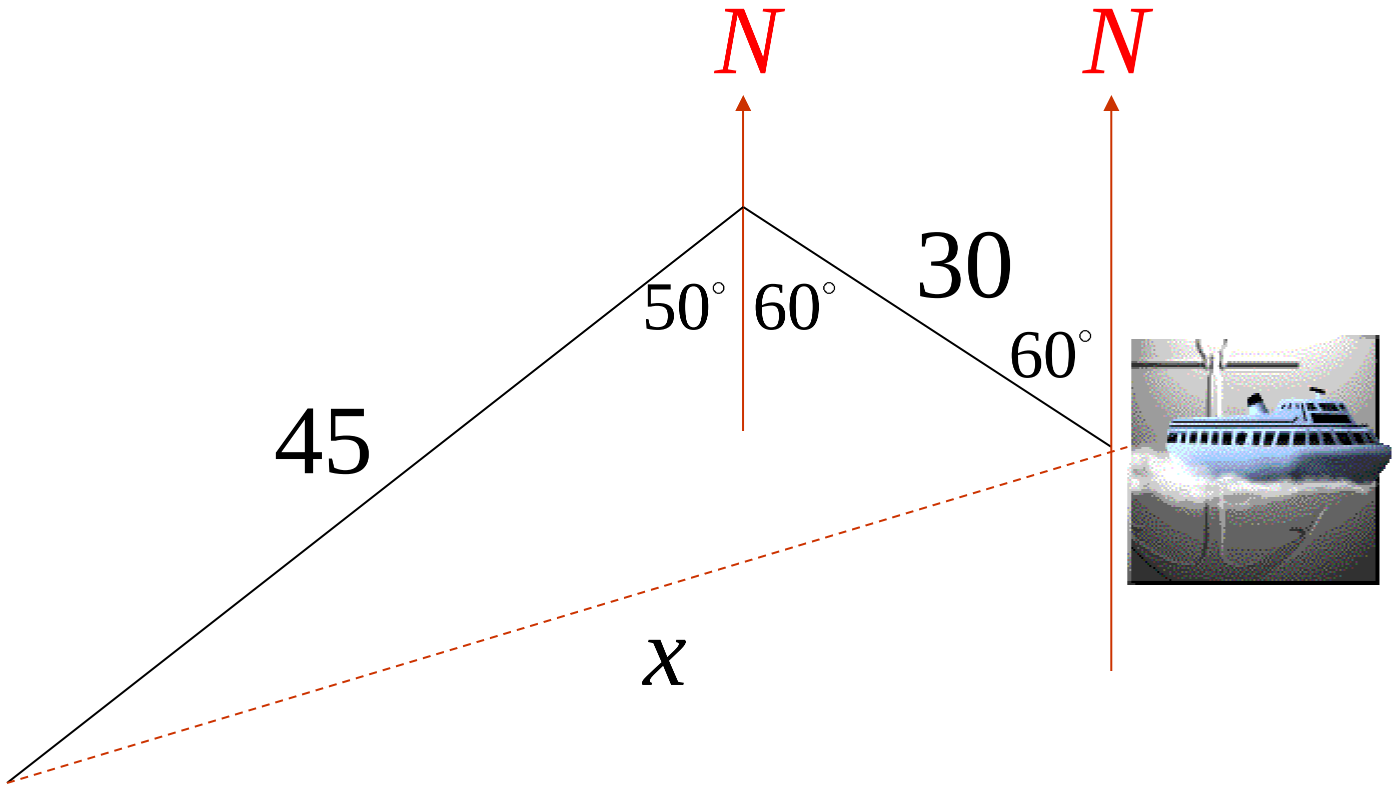
Law of Cosines



$$(OPP)^2 = (ADJ_1)^2 + (ADJ_2)^2 - 2(ADJ_1)(ADJ_2)\cos(\angle)$$

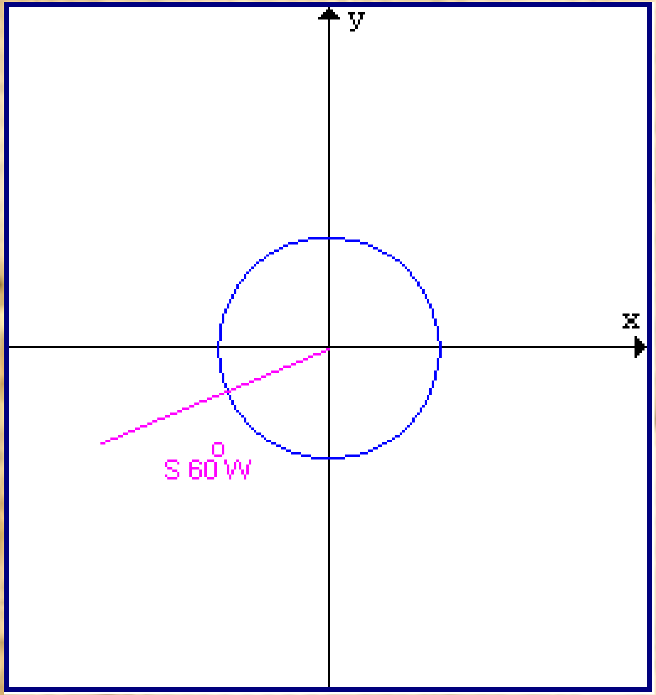
Law of Cosines



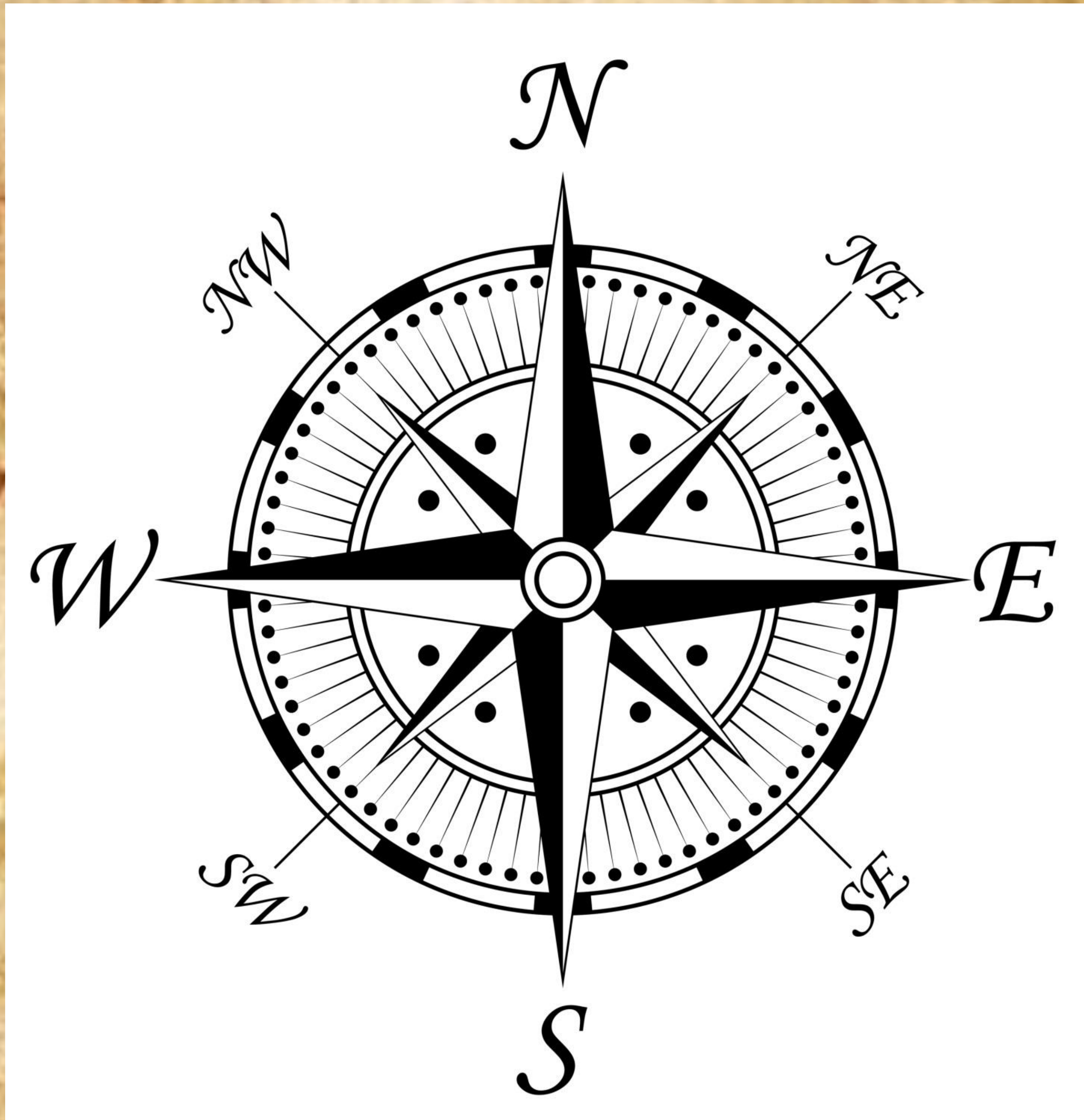
$$(OPP)^2 = (ADJ_1)^2 + (ADJ_2)^2 - 2(ADJ_1)(ADJ_2)\cos(\angle)$$

Which direction?

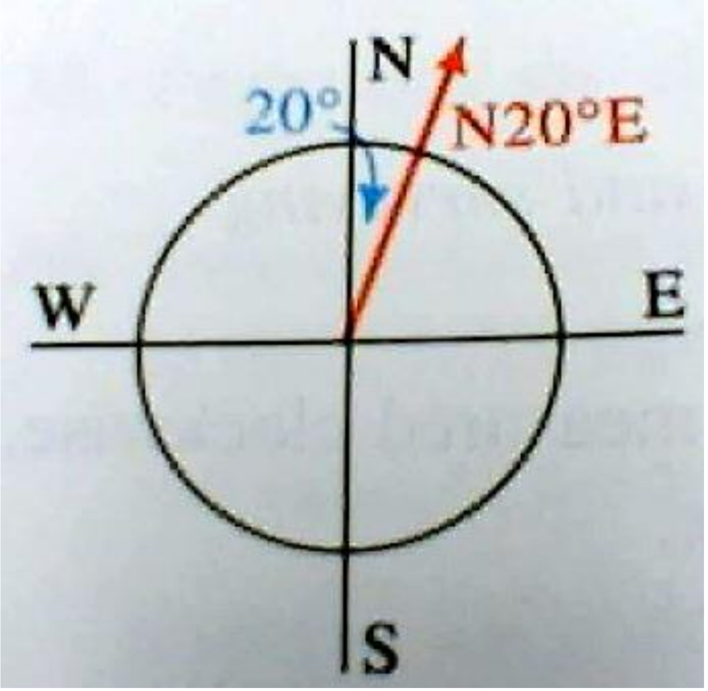
- In surveying, a compass reading is usually given as an acute angle from the north-south line toward the east or west line.

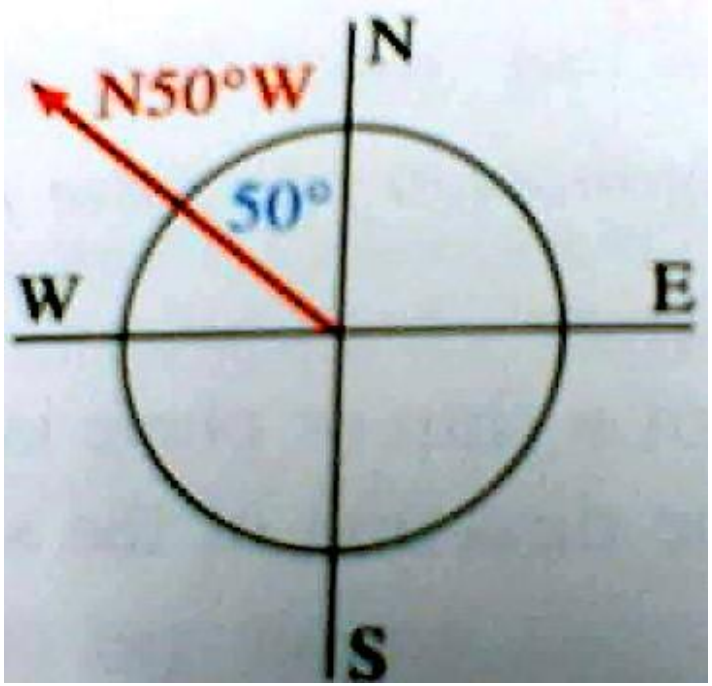


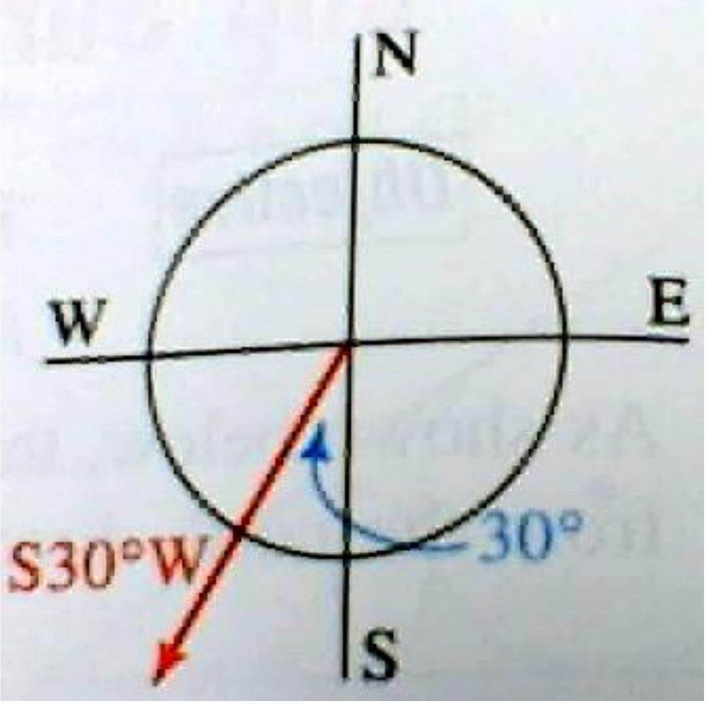
a) Start on the y-axis.
b) Clockwise
c) The angle is always acute.


N
NW
NE
W
E
SW
SE
S


N
S







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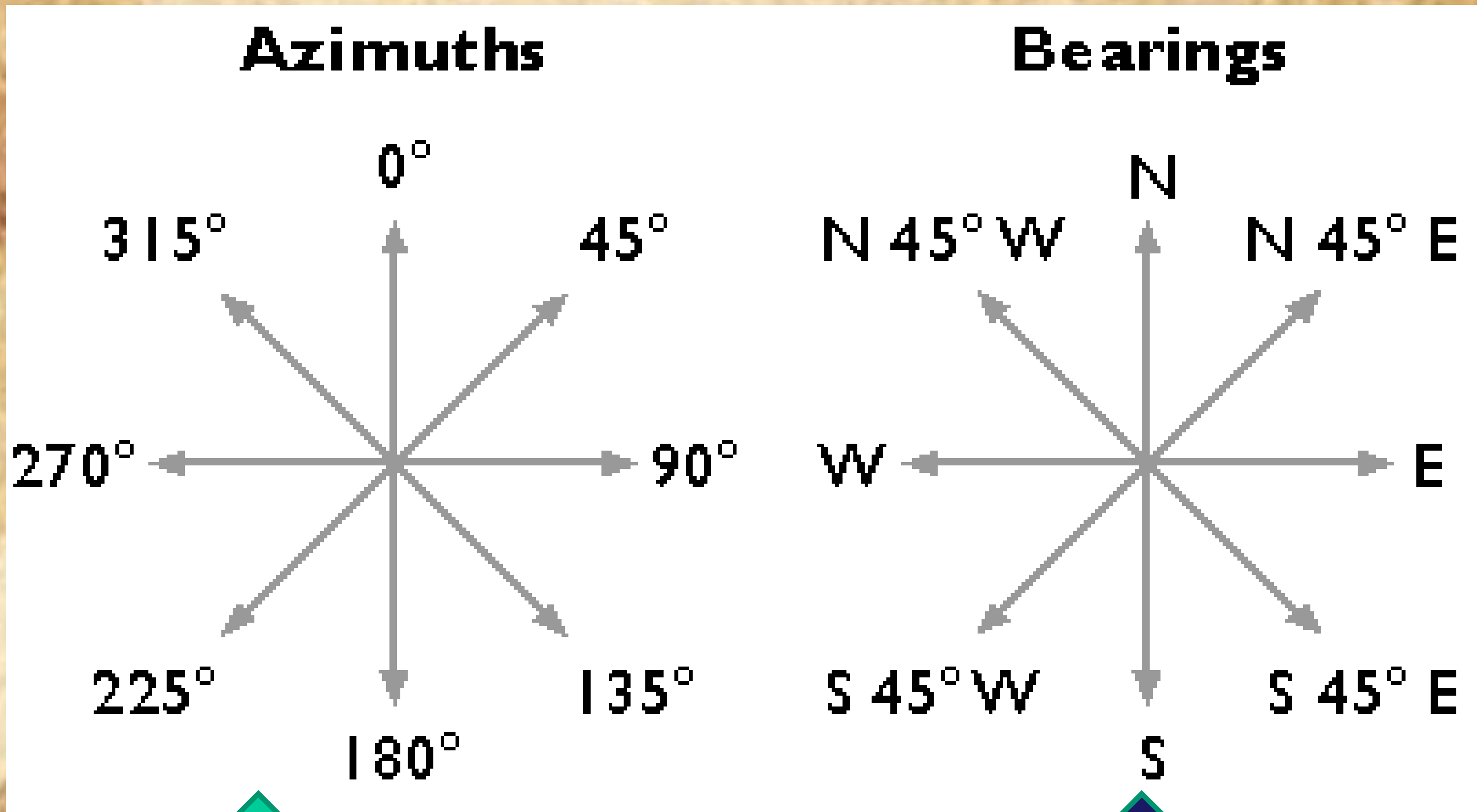


Navigation

Surveying

NE Sandy and NE 40th meet at approx 58 degree angle.

Give directions from the Formation Area to the disband Area.

a) Using navigation system.
b) Using the survey method.

Basic Hints and rules

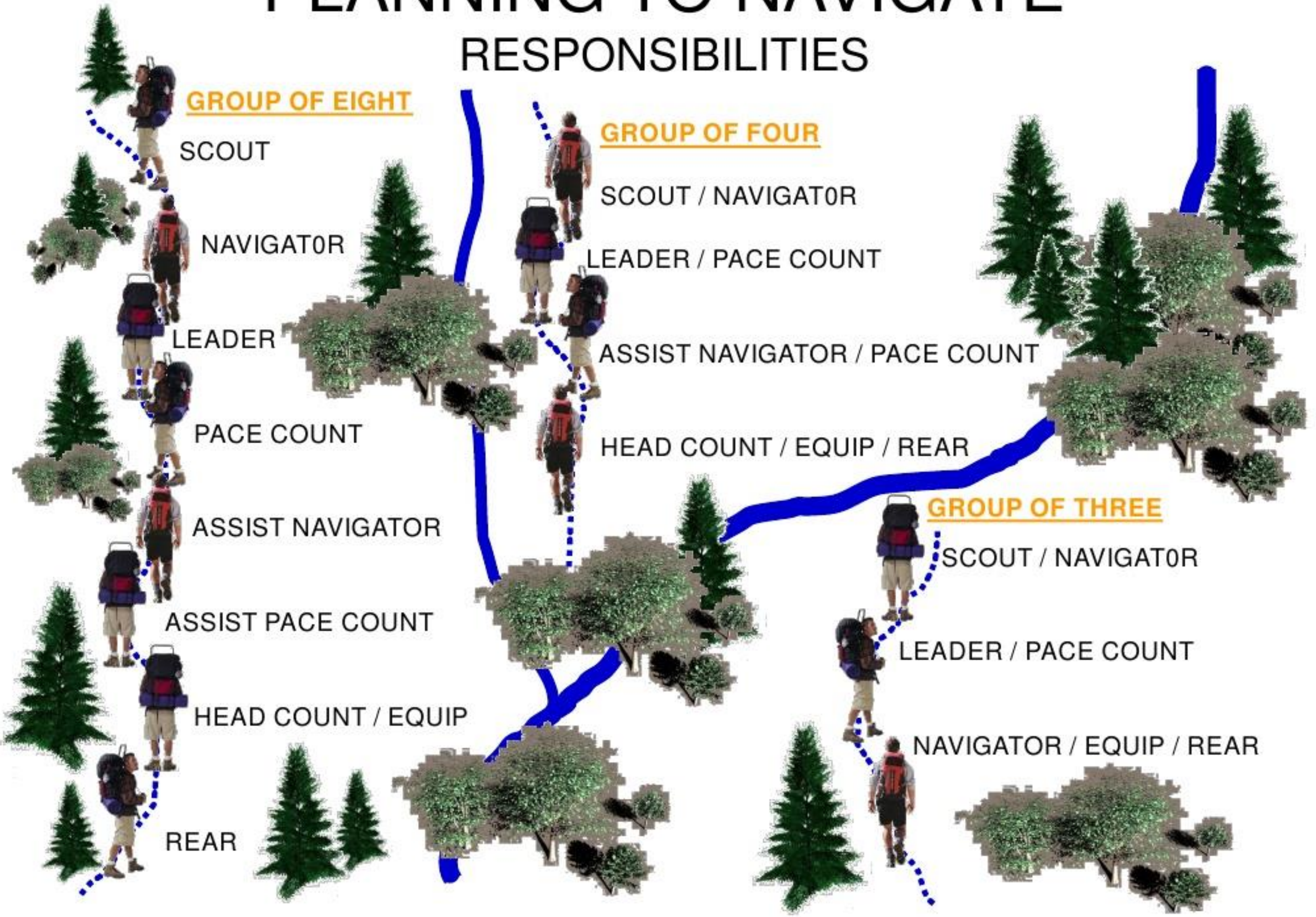
- Make a diagram… give yourself drawing space *all* around the diagram.
- Although drawing to scale might be hard, come as close to a scale as possible.
- Write all the given information on your diagram.

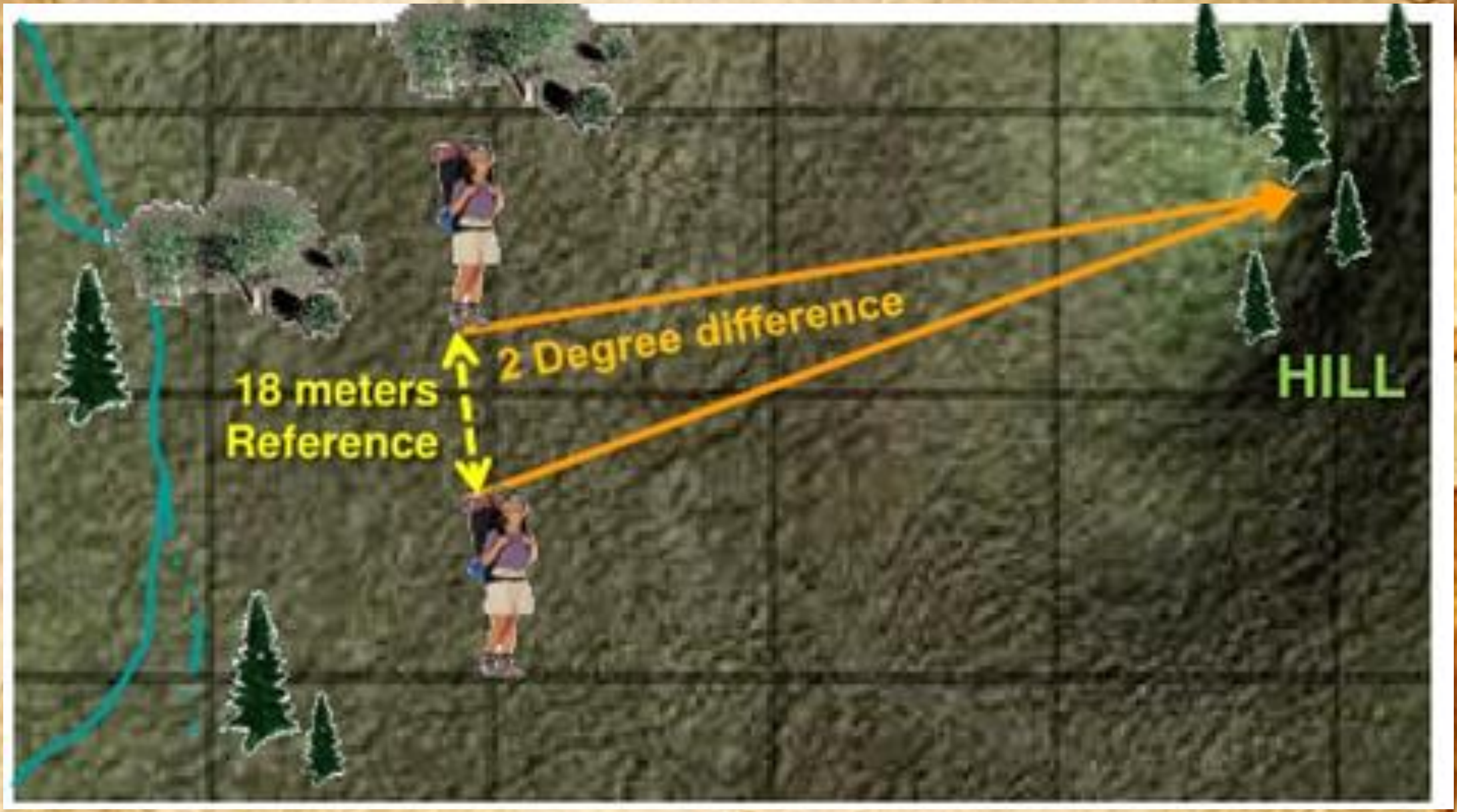
Basic Hints and rules

- Include a lightly drawn x and y axes at each point.
- Find as many angles and sides as you can.
- Apply as many geometry rules as you can.

PLANNING TO NAVIGATE

RESPONSIBILITIES





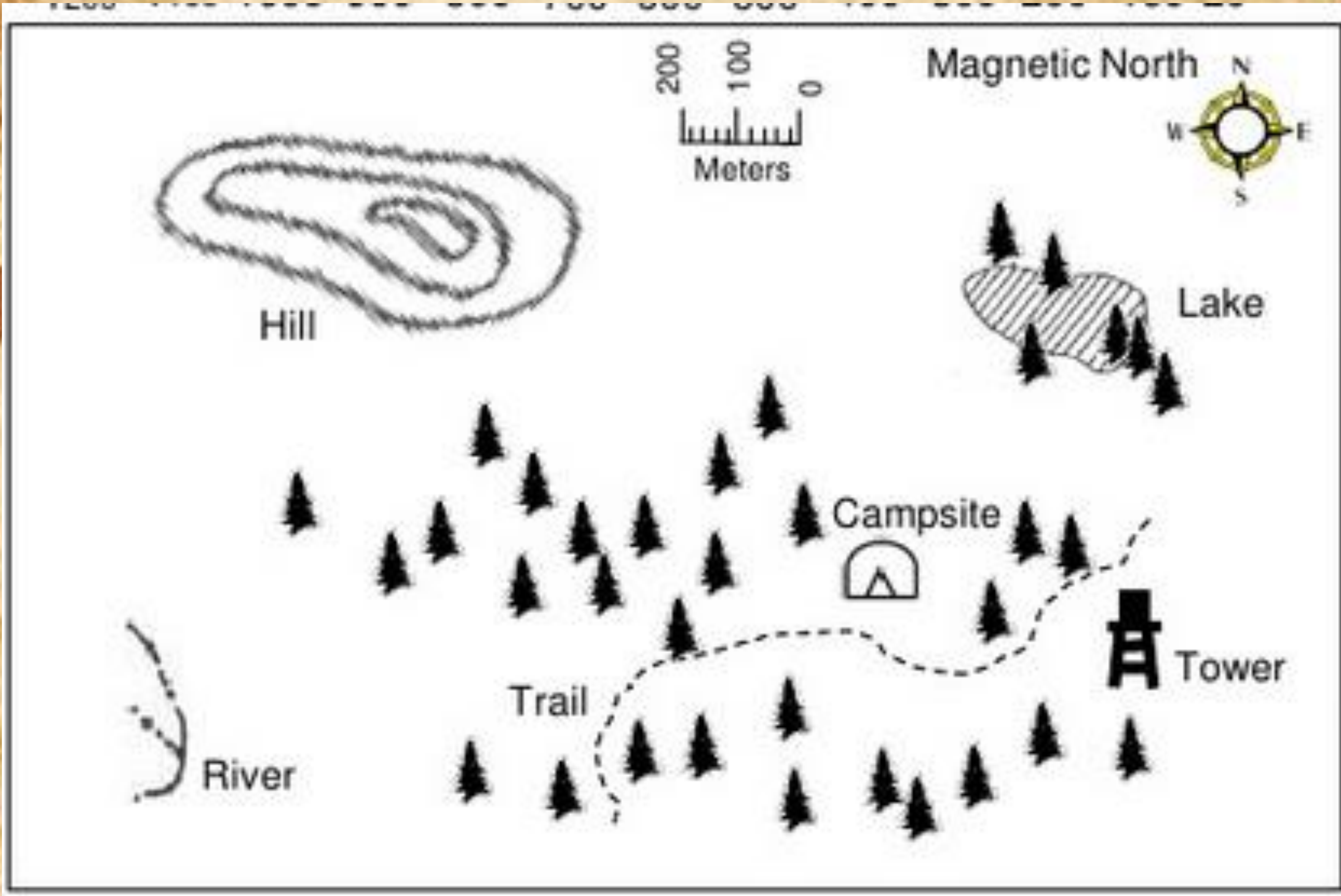
2 Degree difference
18 meters
Reference
HILL

Camping:

Give direction from the camp site to each of 4 points of interest:

a) The river
b) The lake
c) To the tower
d) The hill

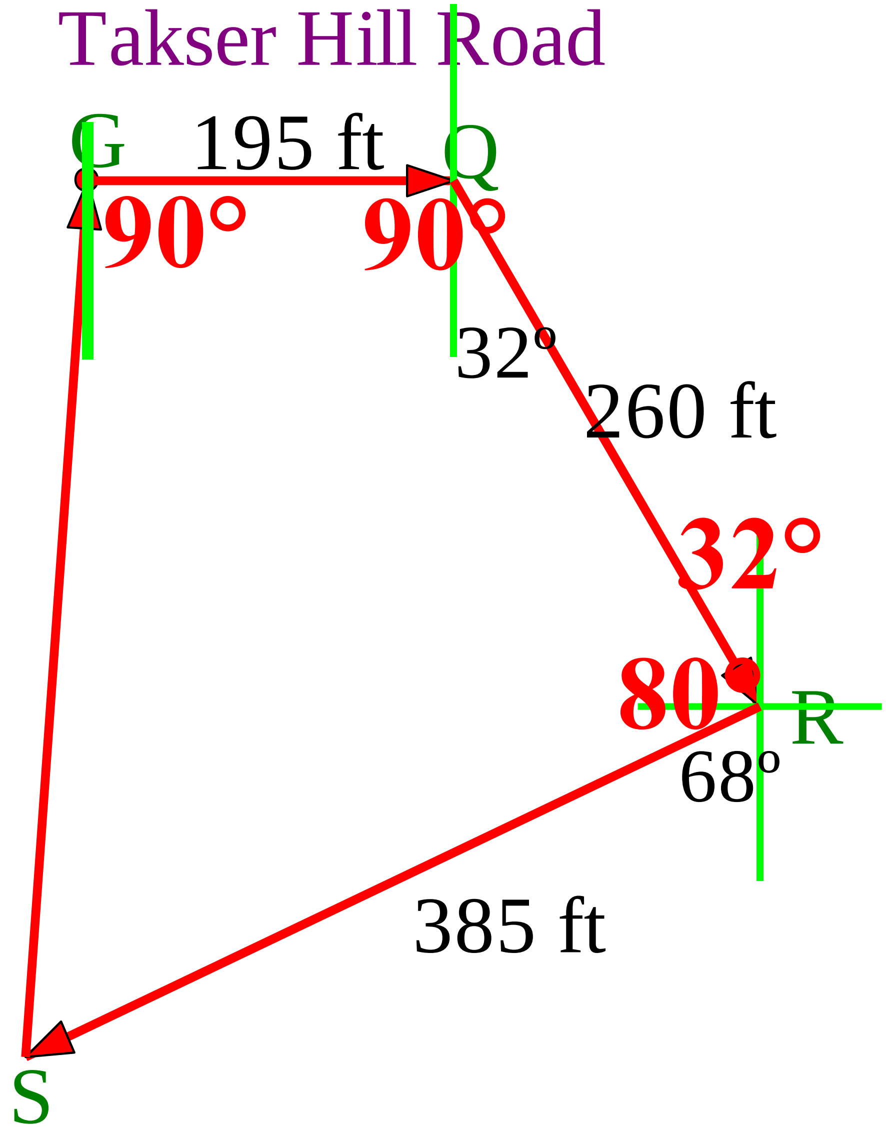
Generate clarifying questions!

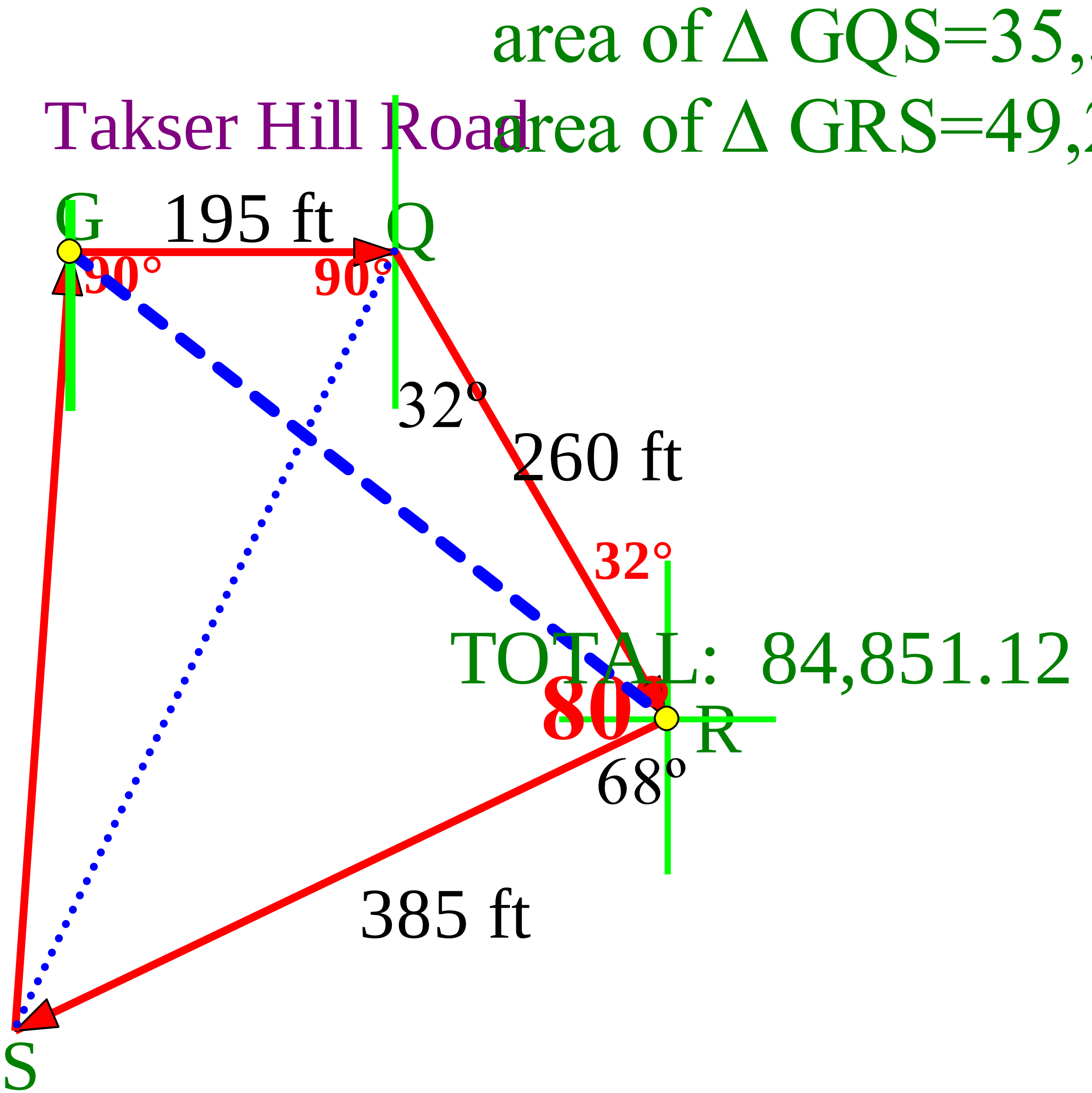

Magnetic North
N
W
E
S
200
100
0
Meters
Hill
Lake
Campsite
Tower
Trail
River

Example 2. Very often a plot of land is taxed according to its area. Sketch the plot of land described. Then find its area.

From a granite post, proceed 195 ft east along Tasker Hill Road, then along a bearing of S32°E for 260 ft, then along a bearing of S68°W for 385 ft, and finally along a line back to the granite post.

With these types of problems, a careful diagram is essential.
Next slide will demonstrate all the steps.
Make sure to have your geometric tools and math wits about you!


Takser Hill Road
G
195 ft
Q
90°
90°
32°
260 ft
32°
80°
R
68°
385 ft
S


area of Δ GQS=35,5
area of Δ GRS=49,2
Takser Hill Road
G
195 ft
Q
90°
90°
32°
260 ft
32°
TOTAL: 84,851.12
80°
R
68°
385 ft
S

A plot of land is taxed according to its area. Sketch the plot of land described, then find its area.

$$k = \frac{1}{2}ab\sin C$$

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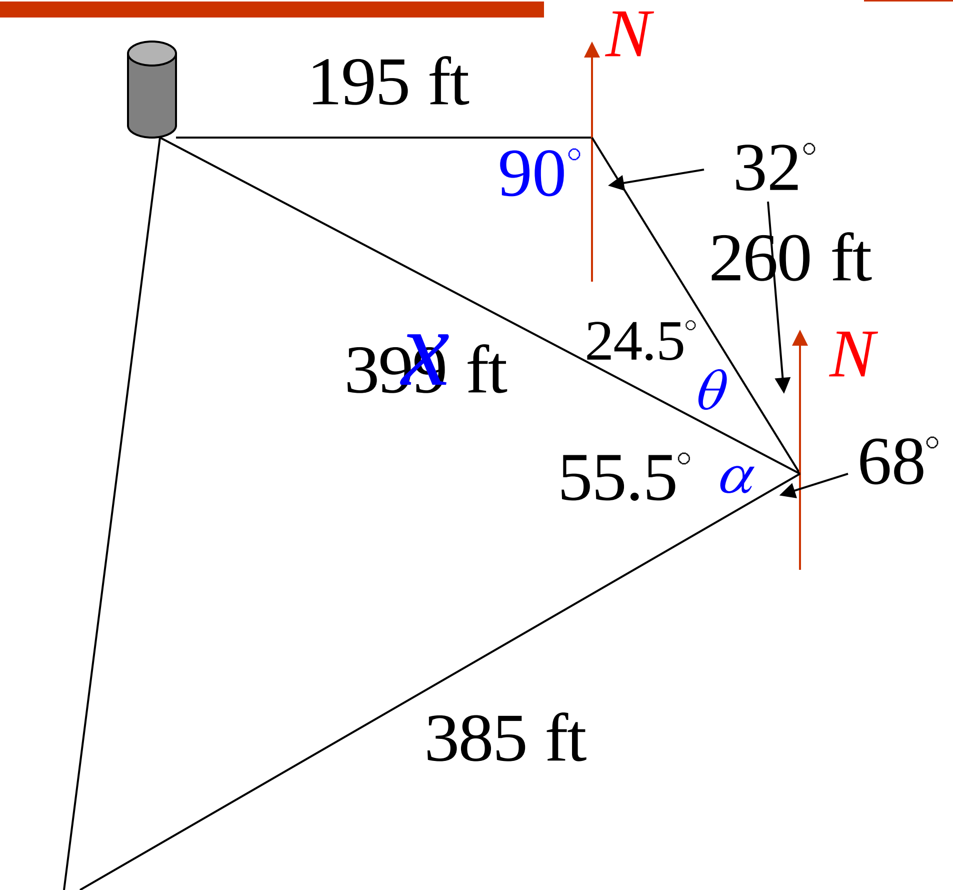


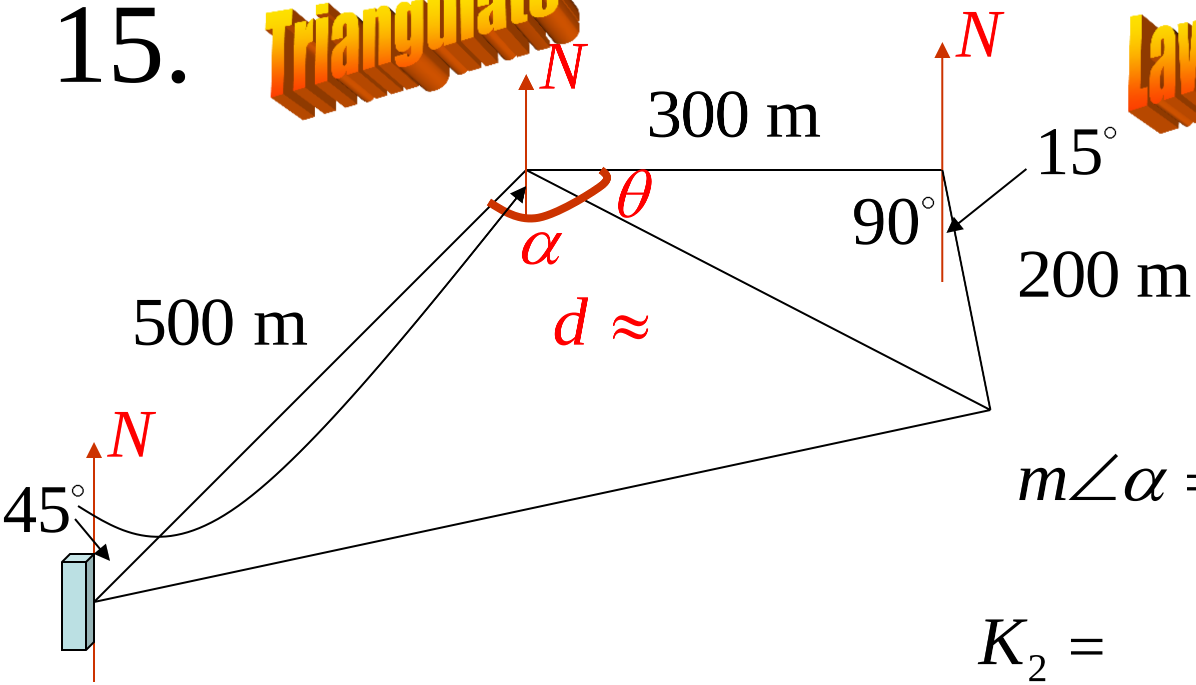
500 m NE;

Presentation

15. Triangulate

Law of Sines

$$\frac{\sin\theta}{200} = \underline{\qquad\qquad}$$



$m\angle\alpha =$

$K_2 =$

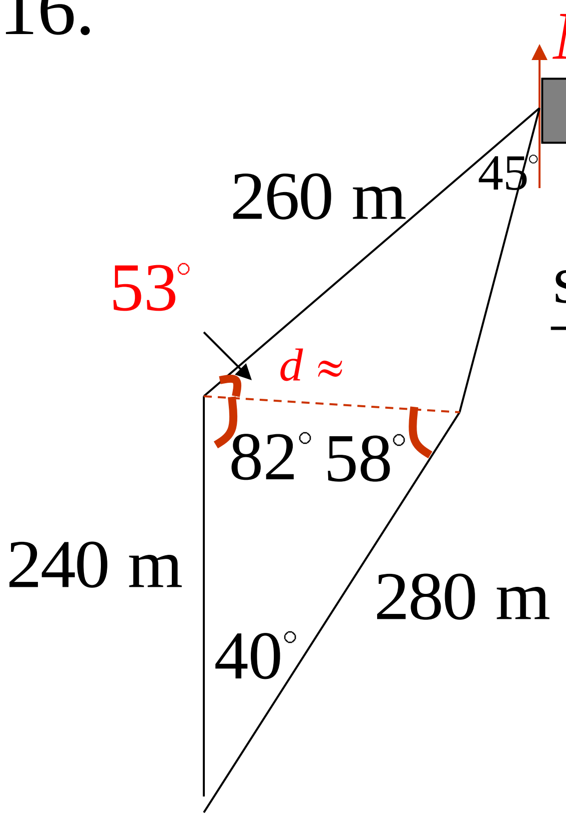
$K_1 =$

$d^2 =$

$Area \approx$

260 m SW;

16.



$$\frac{\sin\theta}{240} = \underline{\qquad}$$

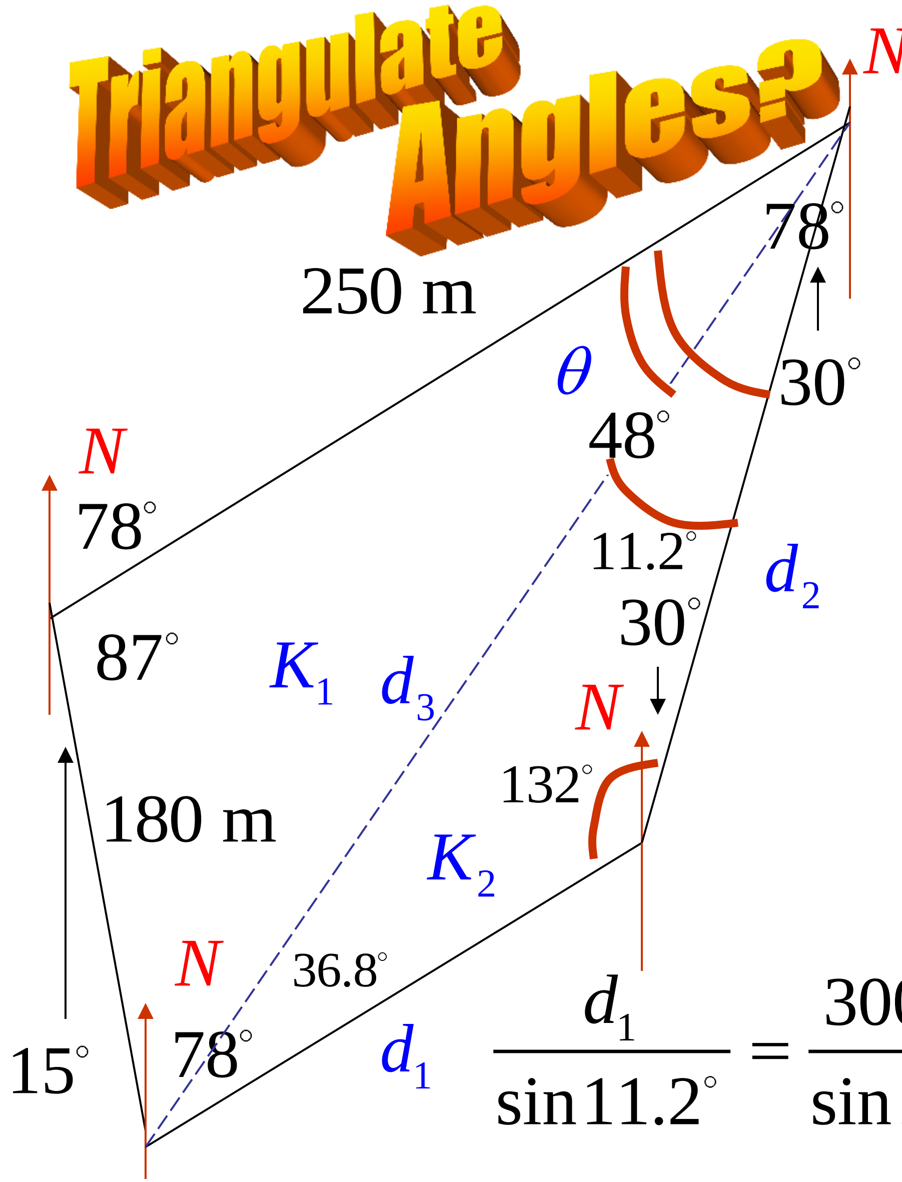
$K =$

$d^2 =$

$K =$

Area ≈

Presentation



Law of Sines

$$\frac{\sin\theta}{180} = \frac{\sin 87^\circ}{300.32}$$

$$\frac{d_1}{\sin 11.2^\circ} = \frac{300.32}{\sin 132^\circ}$$

$$(d_3)^2 =$$

$$K_1 + K_2 \approx$$

- click here for a sample test

Homework:

- **Sec 9.5 written exercises**
- **7-13 odds; 15, 16, 17**

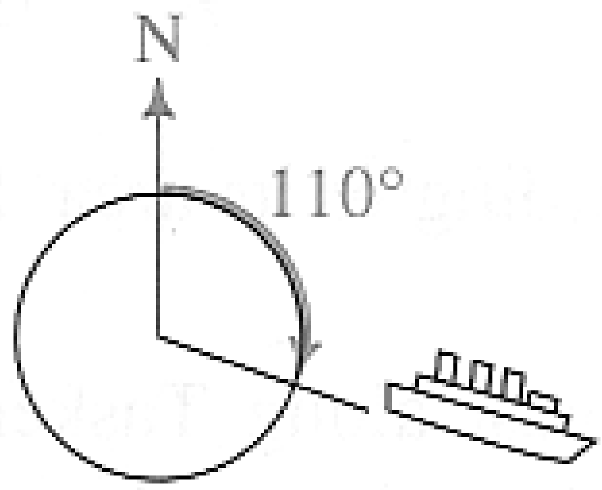
In class Exit Slip:

- **Page 353 Problem #17.**
- **Only full solutions will be considered.**

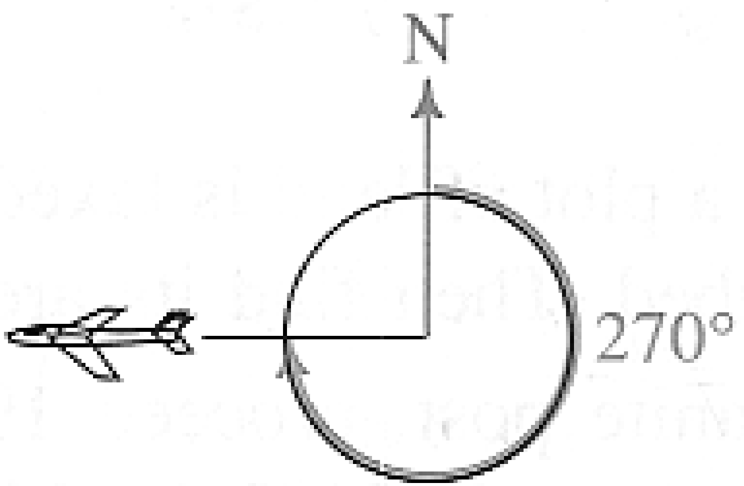
If you were absent, see Navi for make up Exit Slip.

Applications of Trig to Navigation and Surveying

The course of a ship or plane is the angle, measured clockwise, from the north direction to the direction of the ship or plane.

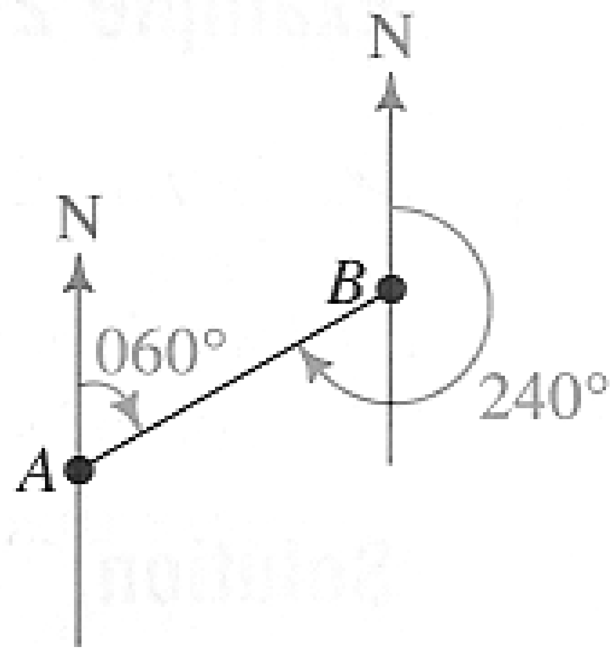


course of ship = 110°



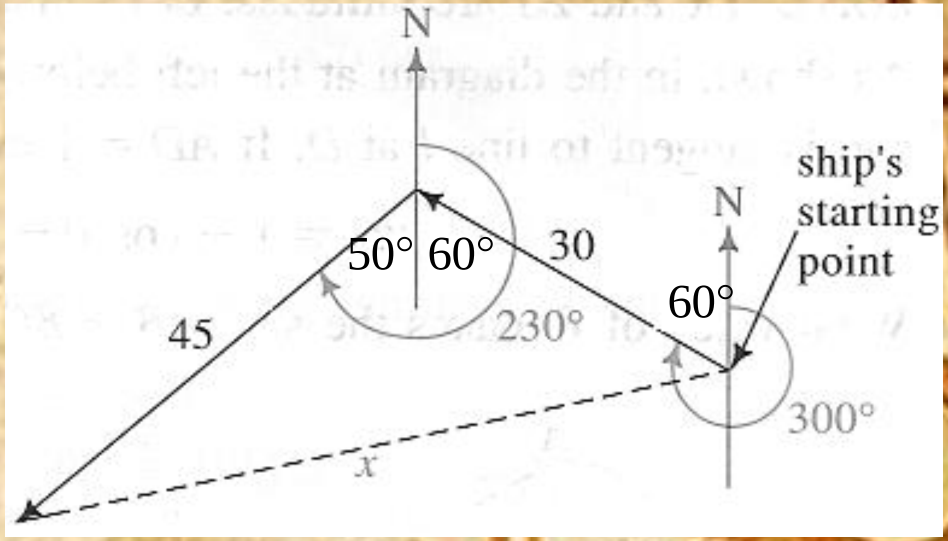
course of plane = 270°

As shown, the compass bearing of one location from another is measured in the same way. Note that compass bearings and courses are given with three digits, such as 060º rather than 60º



bearing of B from $A = 060°$
bearing of A from $B = 240°$

G



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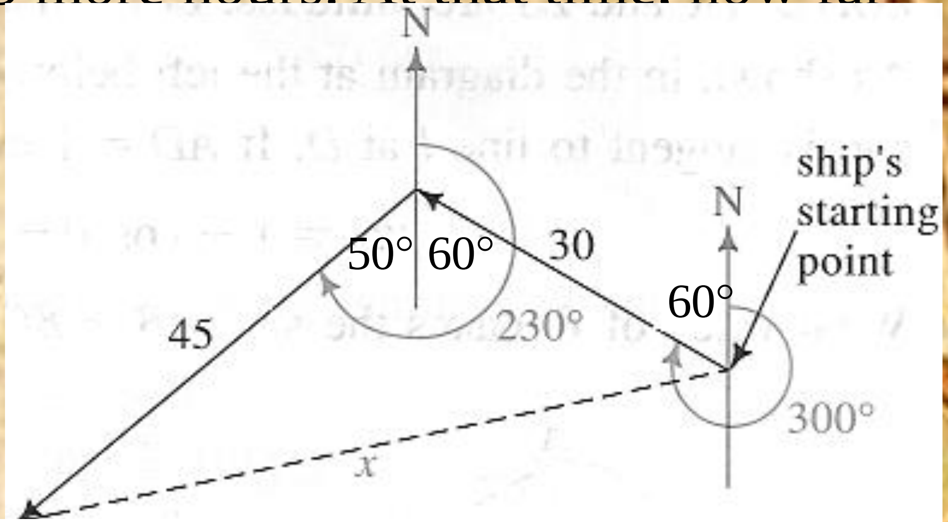
Make a diagram



The ship travels first along a path of length $2 \cdot 15 = 30$ nautical miles and then along a path of length $3 \cdot 15 = 45$ nautical miles. The angle between the two paths is 110°. (You can find this angle by drawing north-south lines and using geometry.) To find x, the distance of the ship from its starting point, use the law of cosines:

$$x^2 = 30^2 + 45^2 - 2 \cdot 30 \cdot 45 \cdot \cos 110^\circ \approx 3848$$

Thus, $x \approx \sqrt{3848} \approx 62.0$ nautical miles.

Example 2. Very often a plot of land is taxed according to its area. Sketch the plot of land described. Then find its area.

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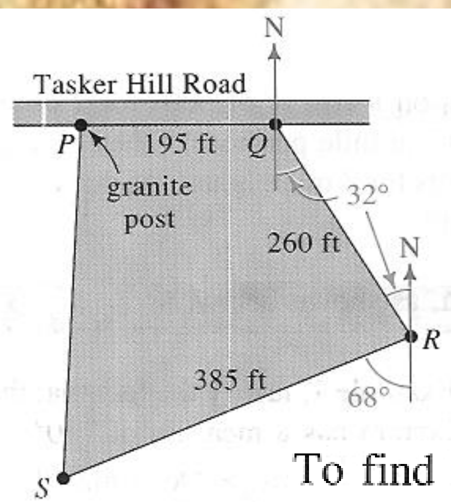


From the bearings given, we deduce that:

$$\angle PQR = 90° + 32° = 122°$$

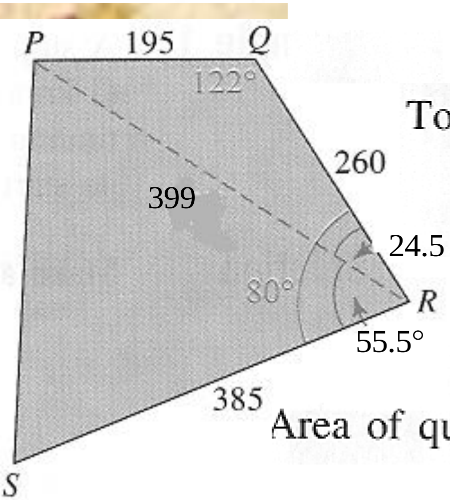
$$\angle QRS = 180° - (32° + 68°) = 80°$$

To find the area of $PQRS$, we divide the quadrilateral into two triangles by introducing $\overline{PR}$. Area of $\triangle PQR = \frac{1}{2} \cdot PQ \cdot QR \cdot \sin Q$

$$= \frac{1}{2} \cdot 195 \cdot 260 \cdot \sin 122° \approx 21{,}500 \text{ ft}^2$$

To find PR, we use the law of cosines:

$$PR^2 = 195^2 + 260^2 - 2 \cdot 195 \cdot 260 \cdot \cos 122° \approx 159{,}000 \quad PR \approx 399 \text{ ft.}$$



To find $\angle PRS$, we find $\angle PRQ$ by the law of sines:

$$\frac{\sin PRQ}{195} = \frac{\sin 122°}{399} \quad \sin PRQ = \frac{195 \sin 122°}{399} \quad \angle PRQ \approx 24.5°$$

Therefore, $\angle PRS = \angle QRS - \angle PRQ \approx 80° - 24.5° = 55.5°$.

Area of $\triangle PRS = \frac{1}{2} \cdot PR \cdot RS \cdot \sin PRS \approx \frac{1}{2} \cdot 399 \cdot 385 \cdot \sin 55.5° \approx 63{,}300 \text{ ft}^2$

Area of quadrilateral $PQRS$ = area of $\triangle PQR$ + area of $\triangle PRS \approx 21{,}500 + 63{,}300$

$$= 84{,}800 \text{ ft}^2$$

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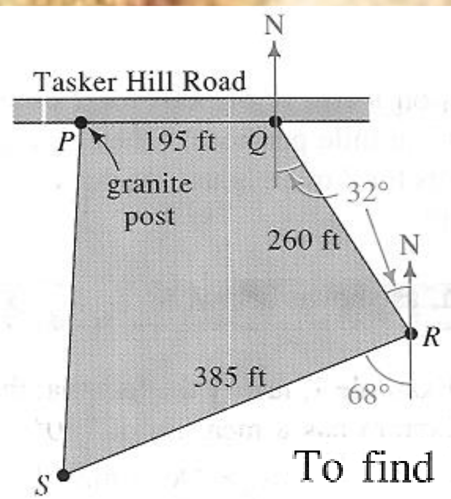

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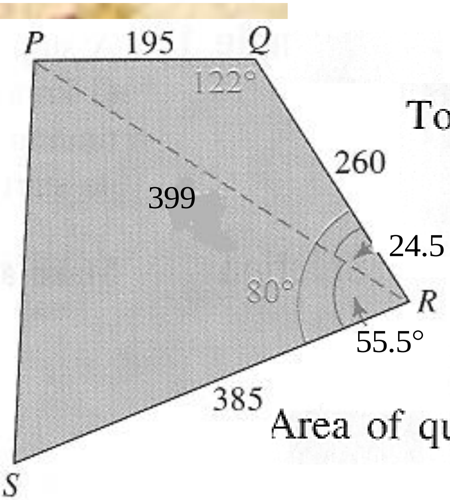

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