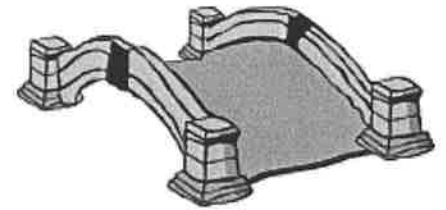


# CIVIL ENGINEER



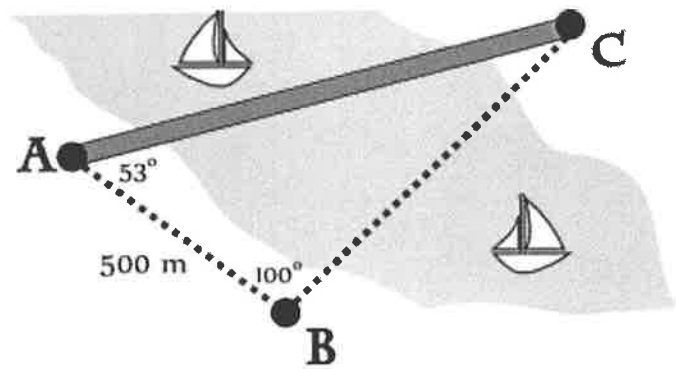
Building bridges and digging tunnels fall under the purview of a civil engineer. A civil engineer specializes in design and construction of things like roads, canals and buildings. Unlike a typical road, if a bridge must be built across a span or if a tunnel must be dug through a hill or a mountain, direct measurements cannot be taken. In these cases, these engineering challenges will require advanced trigonometry and careful analysis.

In these problems, use the illustrations or sketch your own to calculate lengths and make decisions.

## BUILDING BRIDGES

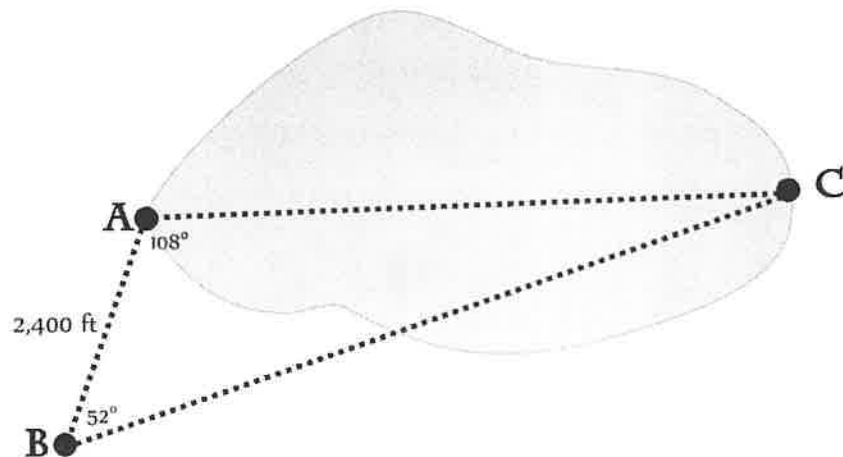
- 1.) A new highway is being built to better connect a growing suburb with downtown. It is required that this bridge crosses a river. To begin preliminary plans, a design firm needs to be able to measure the distance across the river from Point A to Point C. The firm began at Point A, and traveled 500 meters to Point B. The angle formed at angle A was  $53^\circ$  and the angle formed at angle B was  $100^\circ$ . Approximately, what is the distance from Point A to Point C?

The distance would be 1084.6 meters.



- 2.) To estimate the maximum length of an oblong pond from Point A to Point C, a surveyor starts at Point A and walks 2,400 feet southwest to Point B. The angle formed at angle A was  $108^\circ$  degrees and the angle formed at angle B was  $52^\circ$  degrees. Approximate the maximum distance across the pond.

The bridge would be 5529.8 feet.



Name \_\_\_\_\_

Date \_\_\_\_\_

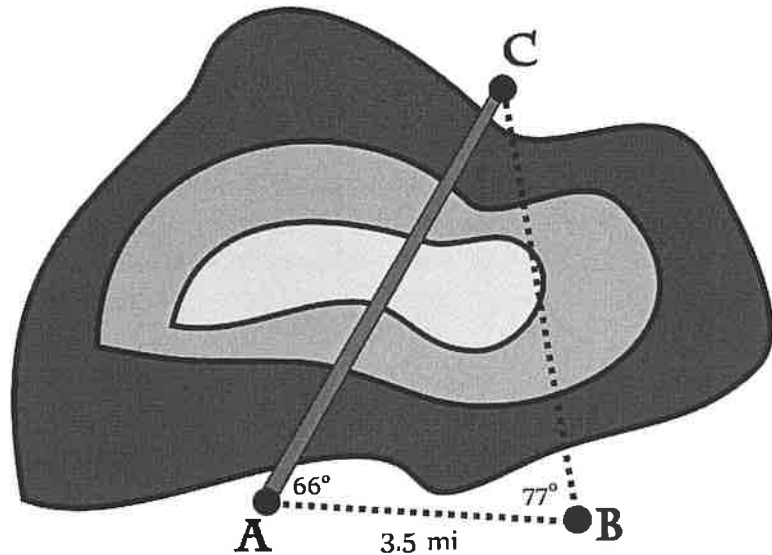
Period \_\_\_\_\_

## DIGGING TUNNELS



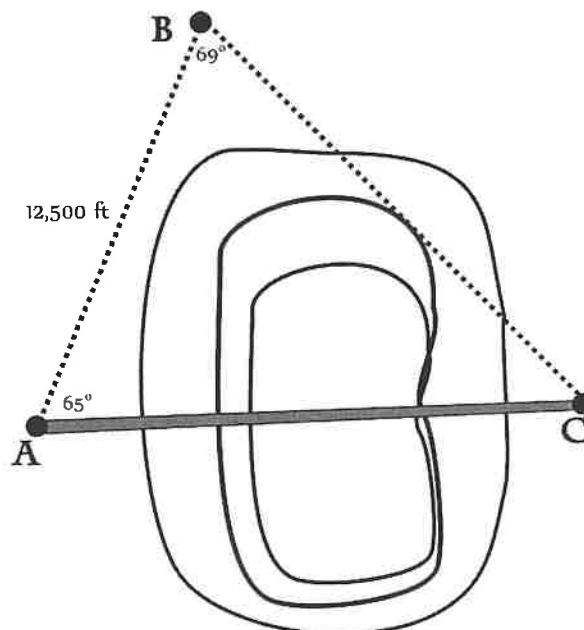
- 3.) In order to alleviate congestion for a highway system, there is a plan to dig a tunnel through a mountain. The city planners need to be able to measure the distance through the mountain from Point A to Point C. The firm began at Point A, and traveled 3.5 miles to Point B. The angle formed at angle A was  $66^\circ$  and the angle formed at angle B was  $77^\circ$ . Approximately, what is the distance from Point A to Point C?

The tunnel would be 5.67 miles.



- 4.) In preparations for an upcoming sewer project that will tunnel through a large elliptical hill, engineers are attempting to measure the shortest length from Point A to Point C. A surveyor starts at Point A and walks 12,500 feet northeast to Point B. The angle formed at angle A was  $65^\circ$ , and the angle formed at angle B was  $69^\circ$ . Approximate the minimum distance through the hill.

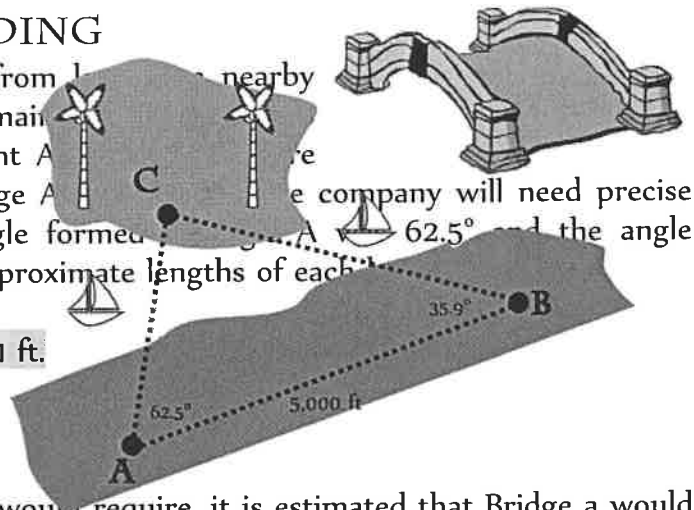
The tunnel would be 16,222.87 feet long.



## ADVANCED BRIDGE BUILDING

- 5.) A tourism company plans to build a bridge from a nearby island to increase potential guests. From the main island, two possible places that the bridge can be started (at Point A and Point C) are 5000 feet apart. To help decide between Bridge A and Bridge B, the company will need precise lengths of the two possible bridges. The angle formed at angle A was  $62.5^\circ$  and the angle formed at angle B was  $35.9^\circ$ . Determine the approximate lengths of each bridge.

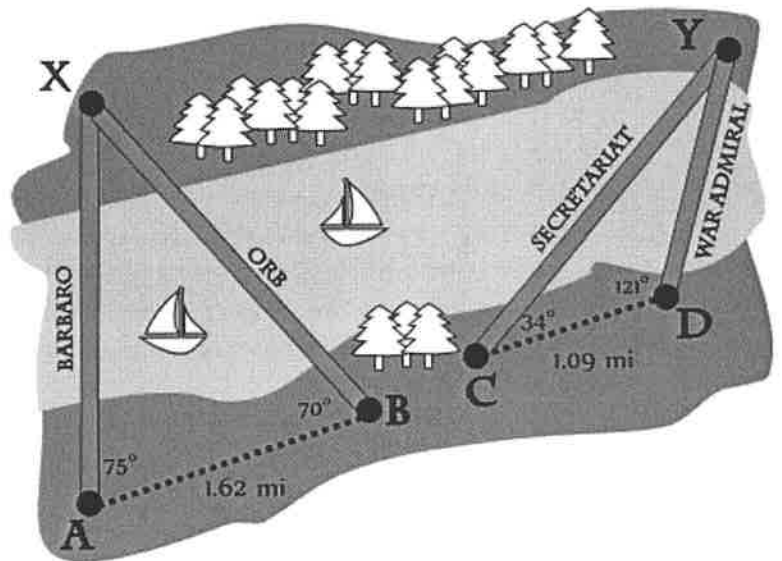
Bridge a would be 2963.6 ft Bridge b would be 4483.1 ft.



- 5a.) Due to specific requirements that each bridge would require, it is estimated that Bridge a would cost \$560 per foot and Bridge b would cost \$490 per foot. How much would it cost to build each bridge? What would be the savings if the less expensive bridge was chosen?

$4483.1 * 490 = 2,196,719$  for Bridge B and  $2963.6 * 560 = 1,659,616$  for Bridge A. Bridge B would cost 537,103 less.

- 6.) A civil engineer has been tasked with putting forward a plan to build a bridge for the Kentucky Lake Bridges Project. The engineer has estimated costs for each project and has performed measurements in an effort to estimate the lengths of each project. Help the engineer finalize her report and make a recommendation.



	BARBARO	ORB	SECRETARIAT	WAR ADMIRAL
LENGTH	2.654 MI	2.728 MI	2.21 MI	1.44 MI
COST / MILE	\$820,780/MI	\$880,321/MI	\$1,150,870/MI	\$1,800,195/MI
TOTAL ESTIMATED COST	\$2,178,350.1	\$2,401,515.7	\$2,543,422.7	2,592,280.8

RECOMMENDATION: BARBARO IS THE MOST COST EFFECTIVE OPTION.

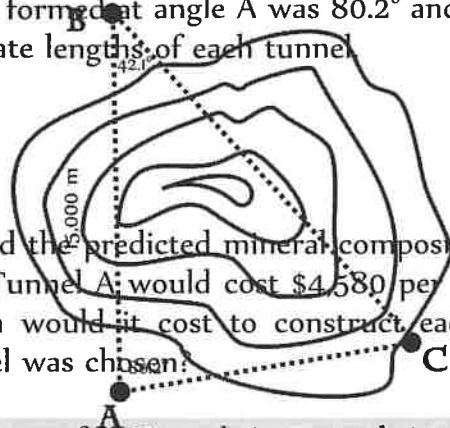
## ADVANCED TUNNEL DIGGING



- 7.) To better connect its citizens, a country has moved forward with plans for a high-speed rail system. In order to complete the project, a tunnel will need to be dug through a mountain. Based on current rail plans, there are two possible places that the tunnel can be started (at Point A and Point B) that are 15,000 meters apart. To help decide between Tunnel a and Tunnel b, the design team will need precise lengths of the two possible tunnels. The angle formed at angle A was  $80.2^\circ$  and the angle formed at angle B was  $40.1^\circ$ . Determine the approximate lengths of each tunnel.

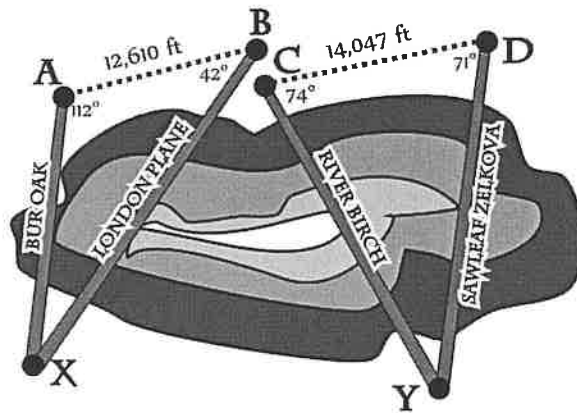
Tunnel a would be 17,119.8 m. Tunnel b is 11,190.5 m

- 7a.) Due to the type of digging that would be required and the predicted mineral composition of the different parts of the mountain, it is estimated that Tunnel A would cost \$4,580 per meter and Tunnel B would cost \$3,875 per meter. How much would it cost to construct each tunnel? What would be the savings if the less expensive tunnel was chosen?



$17,119.8 \times 3875 = \$66,339,225$  for Tunnel B and  $11,190.5 \times 4580 = \$51,252,490$  for Tunnel A. Tunnel A would save \$15,086,735.

- 8.) A civil engineer has been tasked by the city of Sacramento to design a tunnel for the Delta Habitat Conservation Program to ensure reliable water deliveries through the state. The engineer has estimated costs for each project and has performed measurements in an effort to estimate the lengths of each tunnel option. Help the engineer finalize his report and make a recommendation.



	BUR OAK	LONDON PLANE	RIVER BIRCH	SAWLEAF ZELKOVA
LENGTH	19,247.9	26,671.0	23,155.9	23,541.5
COST / FOOT	\$7,982 / FT	\$5,717 / FT	\$6,938 / FT	\$6,439 / FT
TOTAL ESTIMATED COST	\$153,636,737.8	\$152,478,107	\$160,655,634.2	\$151,583,718.5

RECOMMENDATION: SAWLEAF ZELKOVA IS THE LEAST EXPENSIVE OPTION.