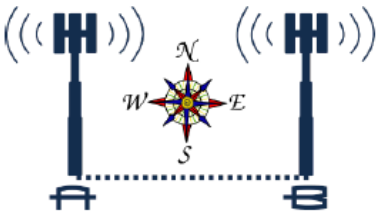
TRIANGULATION

Name _____ Date _____

As the world becomes increasingly reliant on mobile technology, we have never been more connected. As a cell phone searches for a signal, its location is pinpointed and coordinated across a number of applications. Your precise location is used on a Google Map or even Facebook. Cell towers can determine how strong a signal is to a specific phone (i.e. how far away the phone is from the tower) and the general direction the phone is from the tower. The Law of Sines and the Law of Cosines can be used in these cases to get a better sense of where an individual phone may be located.

In each of these problems, information is relayed from two cell towers (the western and the eastern), but there is missing information that is needed. These towers are along the same theoretical horizontal line as seen on the right. (CAUTION: Be careful when reading the angles. If a direction is given like 5° east of north, then that would mean 85° on the traditional protractor with a theoretical horizontal)



1. **Two Directions.** The western and eastern cell towers are 10 miles apart. From the western cell tower, a phone signal is 10° *north of east*. From the eastern cell tower, the signal is 20° *west of north*. How far away is the cell phone from each of the towers? *Sketch a diagram.*

2. **One Direction, One Distance.** The distance between two cell towers is 42 miles. From the western cell tower, a phone signal is 20° *north of east* and is 48 miles away. How far is this cell phone from the eastern cell tower? *Sketch a diagram.*

3. **Two Distances.** The distance between the two towers is 38 miles. From the western cell tower a phone is 21 miles away, and from the eastern cell tower the same phone is 52 miles away. Determine the angles and the directions from each of the cell towers. *Sketch a diagram.*

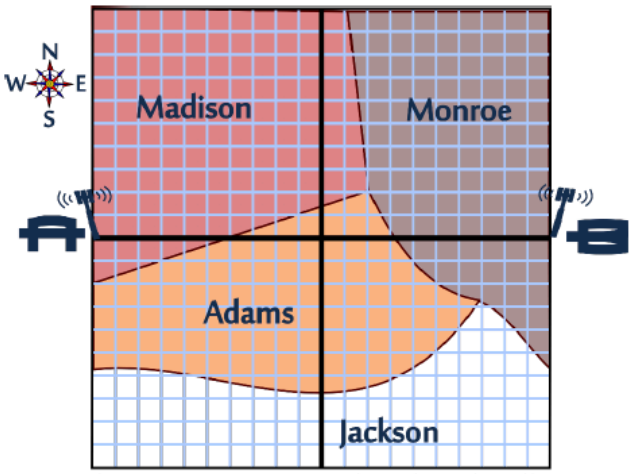
FORENSICS

Name _____ Date _____

In the present, important ethical questions about surveillance are being asked. The idea that people can be watched at any time is highly controversial. However, some agree that there are some avenues where this could be a good thing.

The world of forensics is glamorized on TV shows like *CSI* and often is associated with dissecting a crime scene, combing for hair samples and swabbing for a trace of DNA. In the tech era, mobile devices are used as forensics evidence in court. Since mobile phones can be tracked at all times, proving that a suspect was at a certain location at a certain time has become more scientific. To date, thousands of criminal cases have been proven with forensic cell phone evidence. Some in law enforcement are optimistic that advances in technology may mean that at some point there could be a foolproof system where a criminal cannot get away with a crime.

In this assignment you must use the Law of Sines and the Law of Cosines to determine where a cell phone travels based on its records. **(Please Note: since the world is a sphere and not a plane, this activity is only a simulation and a more simplified version of what professionals actually do.)**



(Cell Towers are located at (-10, 0) and (10, 0))
all units are in miles

ACROSS THE COUNTY

The map on the left is a 400 mi² snapshot of a state where four counties converge. Cell Phone Towers A and B are 20 miles apart.

Records for Cell Phone 555-2640		
	Tower A	Tower B
9:12	Unknown	7.68 miles away 23° North of West
10:36	7.28 miles away (toward the south)	19.28 miles away

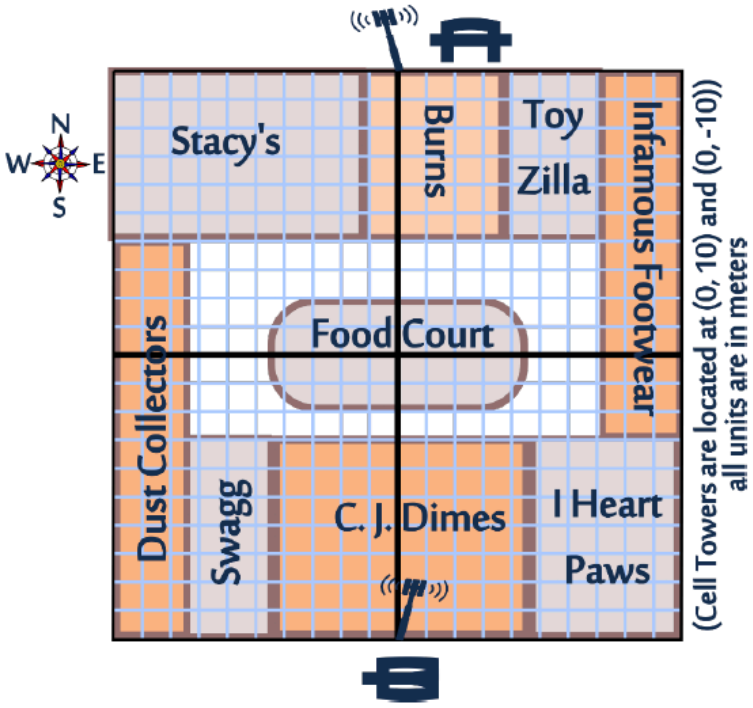
Solve for the missing sides and angles and use a protractor to sketch the triangle.

9:12	**10:36**
1a) How far away was the phone from Tower A?	1b) Describe the location of the phone from Tower B in terms of its angle.
2a) What county was the phone in at 9:12?	2b) What county was the phone in at 10:36?

AT THE MALL

The map on the right is a 400 m² look at the local mall. Cell Phone Towers A and B are 20 meters apart.

Records for Cell Phone 555-0518		
	Tower A	Tower B
2:58	12 meters away 48.6° West of South	Unknown
3:12	19.2° West of South	19.5° North of West
3:55	10 meters away	29.7° East of North



Solve for the missing sides and angles and use a protractor to sketch the triangle.

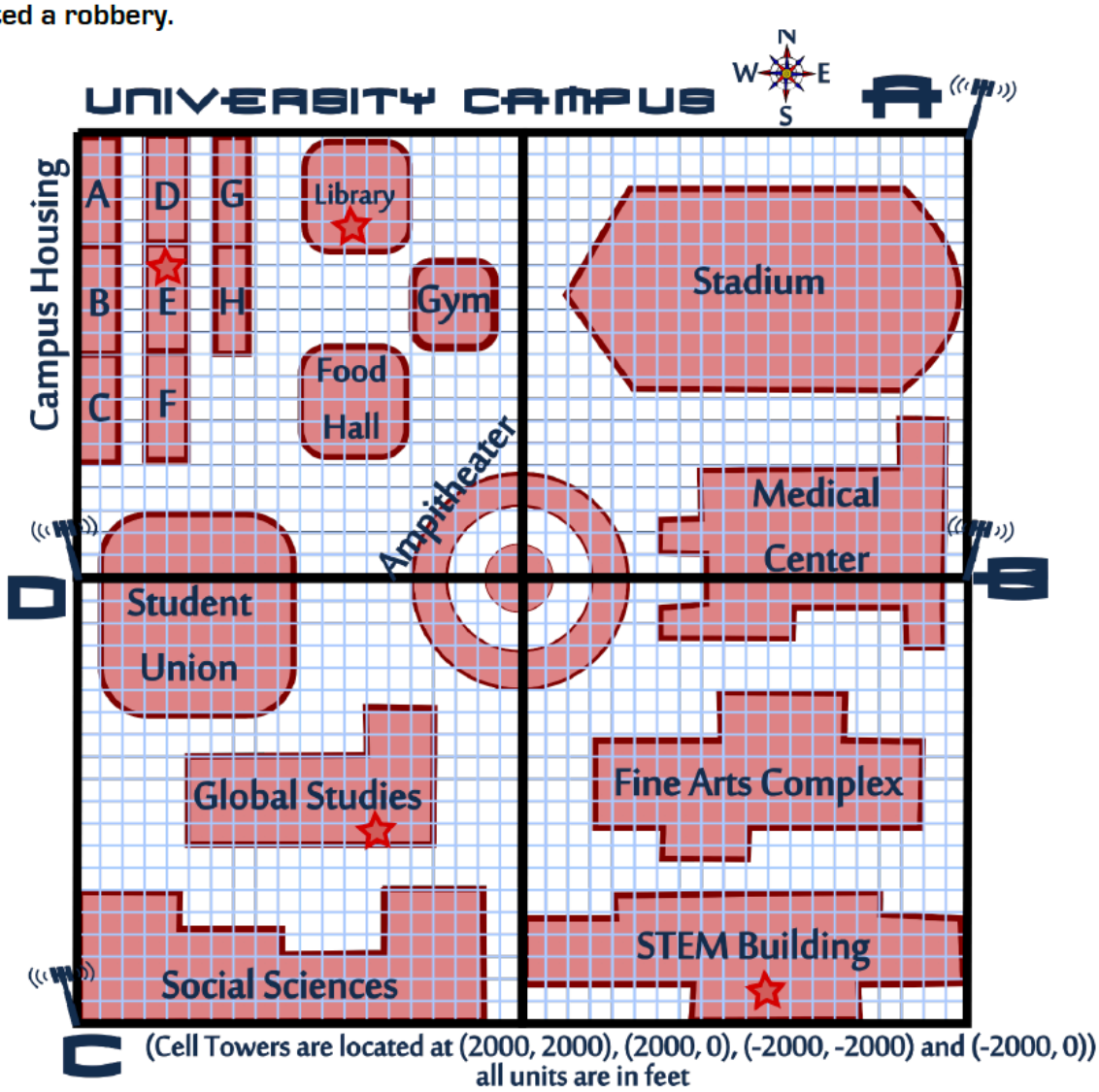
2.58	**3.12**	**3.55**
1a) How far away was the phone from Tower B?	1b) How far away was the phone from Tower A?	1c) Describe the location of the phone from Tower A in terms of its angle.
2a) What store was this phone in at 2:58?	2b) What store was this phone in at 3:12?	2c) What store was this phone in at 3:55?
3. Describe a possible route of this shopper during this time at the mall.		

CATCH THE SUSPECT

Name _____ Date _____

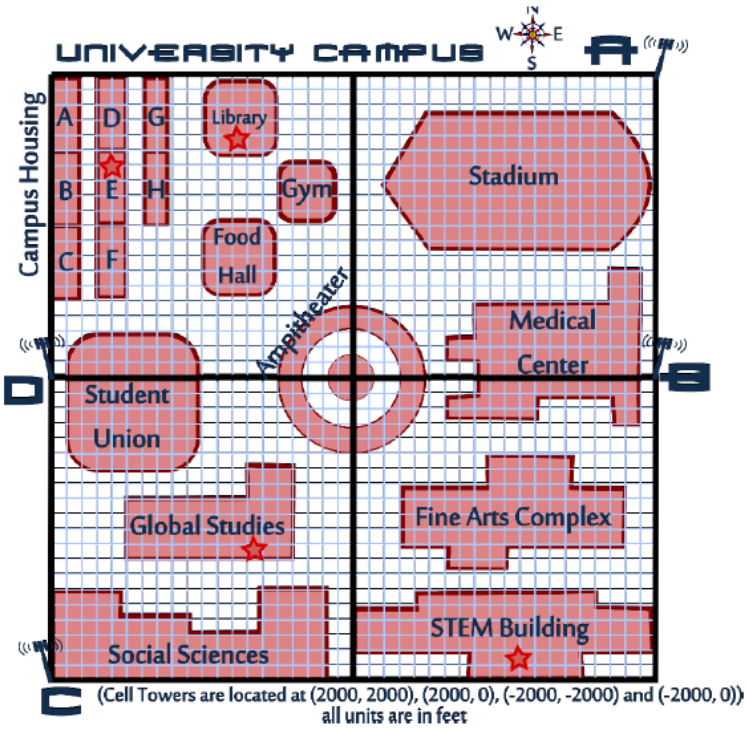
A serial crime spree has rocked a university campus. Robberies occurred at a number of places from 1:00AM to 1:40AM. Based on a preliminary investigation, police know that it was just one person who committed all the crimes. They have compiled a list of four suspects and have secured search warrants to seize their cell phone records. They hope that these records will determine the identity of the guilty party.

Please note that since the world is a sphere and not a plane, this activity is only a simulation and a more simplified version of what professionals actually use. **In this assignment you must use the Law of Sines and Law of Cosines to determine where a cell phone was located based on its records. Below is a map of 16,000,000 ft² of campus. Stars denote the four locations that reported a robbery.**



SUSPECT ALPHA

	Tower A	Tower B	Tower C	Tower D
1:00	—	—	50.71° East of North	1590.56 feet away
1:10	—	41.2° West of South	—	3623.57 feet away
1:20	—	1450 feet away	—	5.2° South of East
1:30	6.58° South of West	34.44° North of West	—	—
1:40	—	3669.8 feet away	—	62.9° North of East

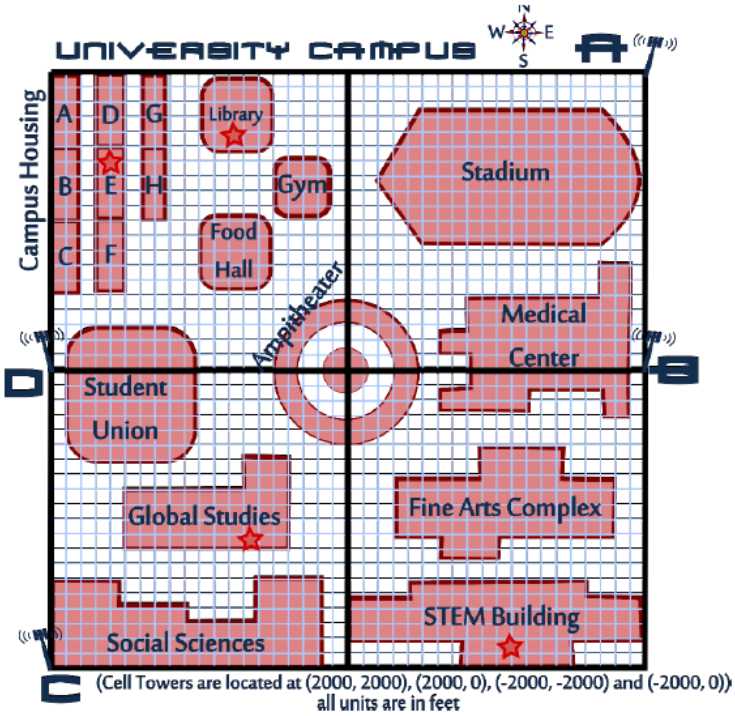


WORK SPACE

	Location of Cell Phone
1:00	
1:10	
1:20	
1:30	
1:40	

SUSPECT BETA

	Tower A	Tower B	Tower C	Tower D
1:00	—	28.3° North of West	—	1935.5 feet away
1:10	1321.3 feet away	1667.4 feet away	—	—
1:20	—	—	1473.1 feet away	1559.12 feet away
1:30	—	2103.1 feet away	—	4° North of East
1:40	—	17.9° North of West	—	41.1° North of East

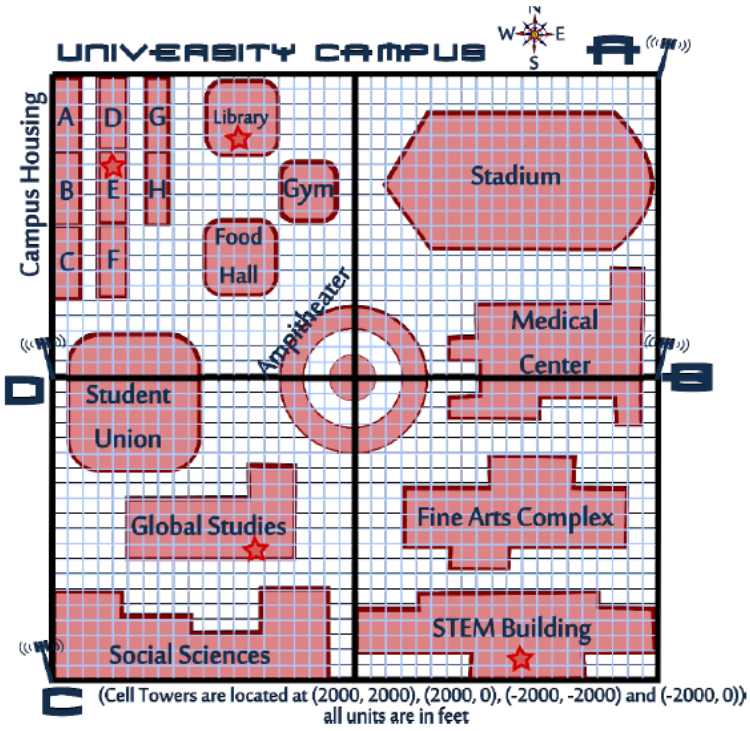


WORK SPACE

	Location of Cell Phone
1:00	
1:10	
1:20	
1:30	
1:40	

SUSPECT GAMMA

	Tower A	Tower B	Tower C	Tower D
1:00	—	—	6.3° East of North	365 feet away
1:10	—	66.2° South of West	—	32° South of East
1:20	—	984.2 feet away	—	10° South of East
1:30	—	—	1423.9 feet away	1561.1 feet away
1:40	6.58° South of West	57.92° West of North	—	—

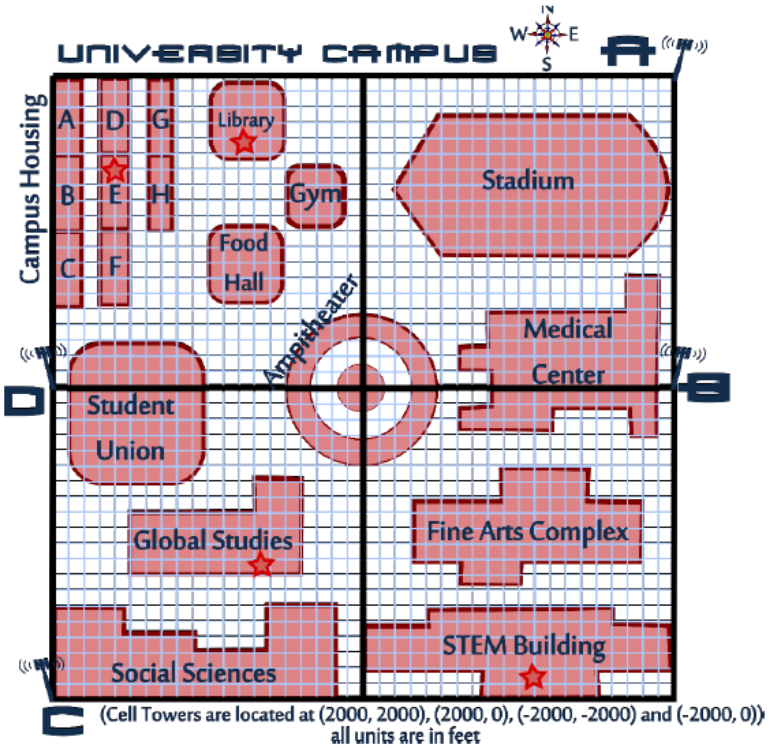


WORK SPACE

	Location of Cell Phone
1:00	
1:10	
1:20	
1:30	
1:40	

SUSPECT DELTA

	Tower A	Tower B	Tower C	Tower D
1:00	3133.69 feet away	3571.06 feet away	—	—
1:10	—	19.85° North of West	—	17.1° East of North
1:20	—	—	45° North of East	1421.27 feet away
1:30	—	1882.47 feet away	—	28° South of East
1:40	10° West of South	353 feet away	—	—



WORK SPACE

	Location of Cell Phone
1:00	
1:10	
1:20	
1:30	
1:40	

ANALYSIS OF INVESTIGATION

Name _____ Date _____

Use the results of your cell phone forensics investigation to answer the following questions.

1. Based on your analysis of the cell phone data, are there any suspects that can be ruled out? Why or why not?

2. After careful analysis of surveillance footage, it has been determined that the robbery at the Global Studies Center occurred at 1:25. Does that affect the results of your investigation?

3. In a paragraph, use your research to determine which suspect is most likely to have committed the crimes. Provide a detailed analysis in regards to why you believe one suspect is more likely than another. You can provide an explanation why certain suspects may be ruled out.