Flower Patch Spotted!!

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About Mr. Mitchell

- GK-12 Fellow
- PhD Student- Applied Mathematics
  - More specifically Epidemiology (the study of the spread of diseases)
  - Right now I am taking classes and getting ready for conferences
- I enjoy going to the movies or relaxing at home

Research Background

- Honeybee pollination accounts, annually, for an estimated 14 billion dollars to U.S. agriculture.
- 1/3 of what you eat is typically pollinated by honeybees
- We can use math to study a lot of biological processes, like hive dynamics
- To study these dynamics we must learn as much as possible about the biology of the hive

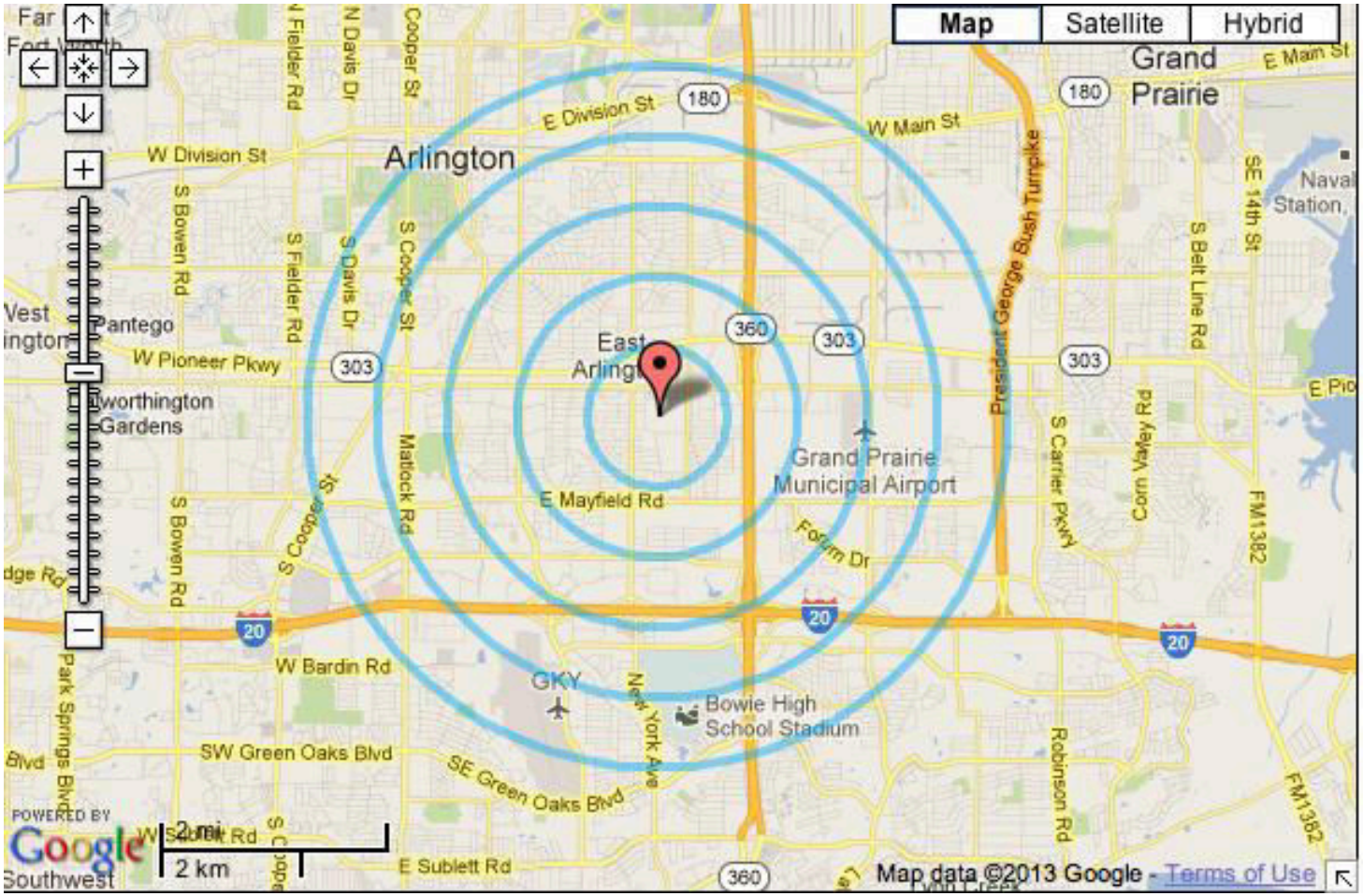
Hive Dynamics and CCD

- How does a hive work?
  - Hive: Young female bees that take care of the brood/queen
  - Foragers: Older female bees that feed the colony by setting out from the hive to collect food
- What is Colony Collapse Disorder?
  - Rapid loss of forager and hive bees, with no dead bodies around the hive, queen is still present
  - Other species of scavengers and foragers avoid a recently collapsed hive for an extended period of time

How do we study diseases?

- Disease spreads are studied through interaction rates
- For humans we have to look at how people interact with other people
- For honeybees we must see how bees interact with other bees, or we can look at how colonies interact
- This would lead us to study foraging region of honeybees

Foraging Regions



How do they navigate?

- To understand this we must know how they see
- Bees see the world much different than us, they can see a much broader spectrum than we can. Here are some examples:

How do they navigate?

- They navigate by the sun
- But how can they do this on a cloudy day?
- Their vision helps them know where the sun is no matter what the conditions
- Do you remember how your mom would say the sun still burns on a cloudy day?

Finding a Flower Patch

- What does a bee do when they find a good flower patch?
  - How do they relate this back to the other bees so they can find the patch?
  - How do we do this?
- Lets play a game.

There is this great place…

- Get in groups of two
- Your job is tell the other person where a place to eat is
- You can only use hand gestures. You may not speak or make noise of any kind.
- The other person can't ask questions and they must draw a map to the place to eat.
- You only get one guess to get it right. (i,e, you only get to draw one map)

There is this great place…

- What was the hardest part about telling the other person where the food was?
- What are some of the most important things to get right when giving directions?
- If you gave your map to someone could they find the place to eat?

The Dance of the Honeybee

- When a honeybee finds a flower patch they come back to the hive and do a dance to show the other bees where it is
- They have to portray two very important things: direction and distance
  - How do you portray these things when giving directions?
  - How did you do it in the game?

The Dance of the Honeybee

- Lets see what the dance looks like:

The Dance of the Honeybee

The Dance of the Honeybee

- There are two parts to the dance:
  - The motion
  - The waggle
- What does each portray?

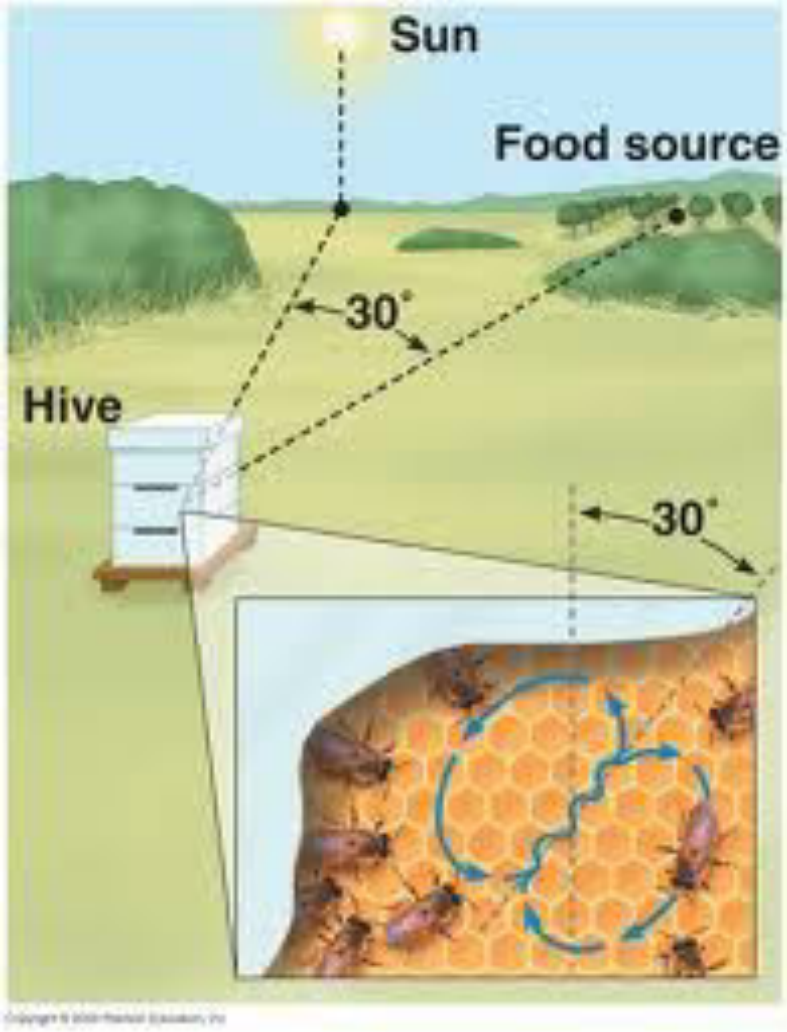
The Motion

- Remember how bees navigate
  - They use the sun
  - So the motion gives the direction the bees need to travel to reach the food.

The Waggle

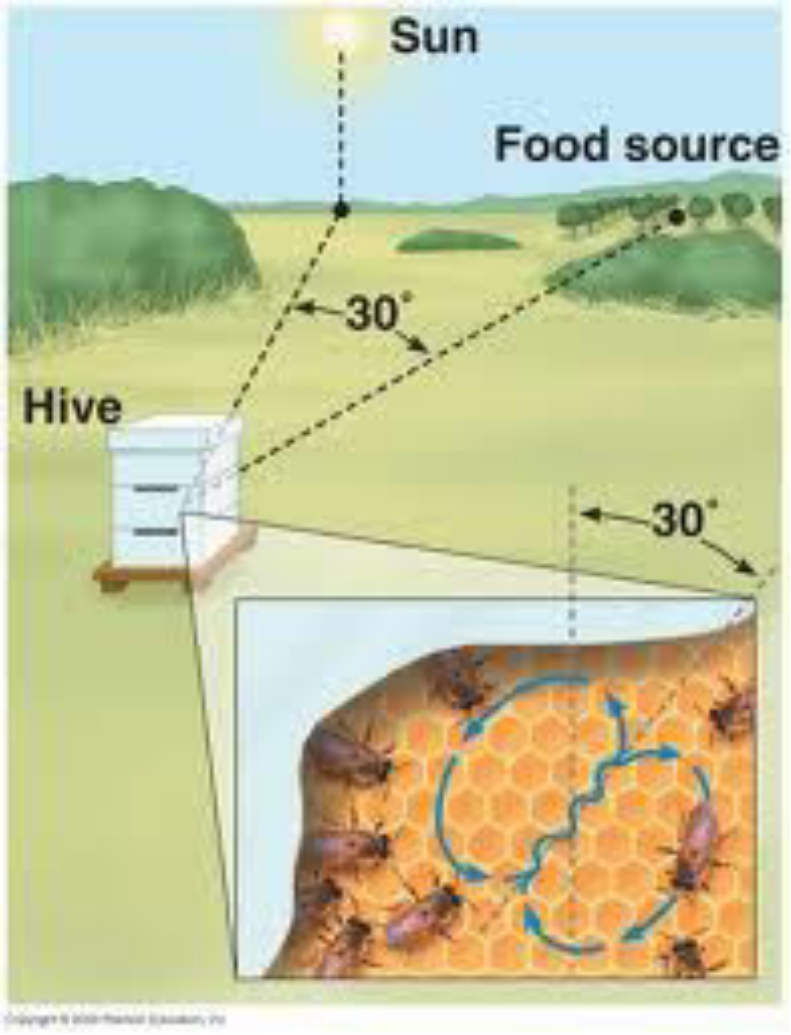
- After they have a direction they need a distance
  - The time it takes to waggle through the center of the dance is the distance (in effort) to the flower patch

The Dance of the Honeybee



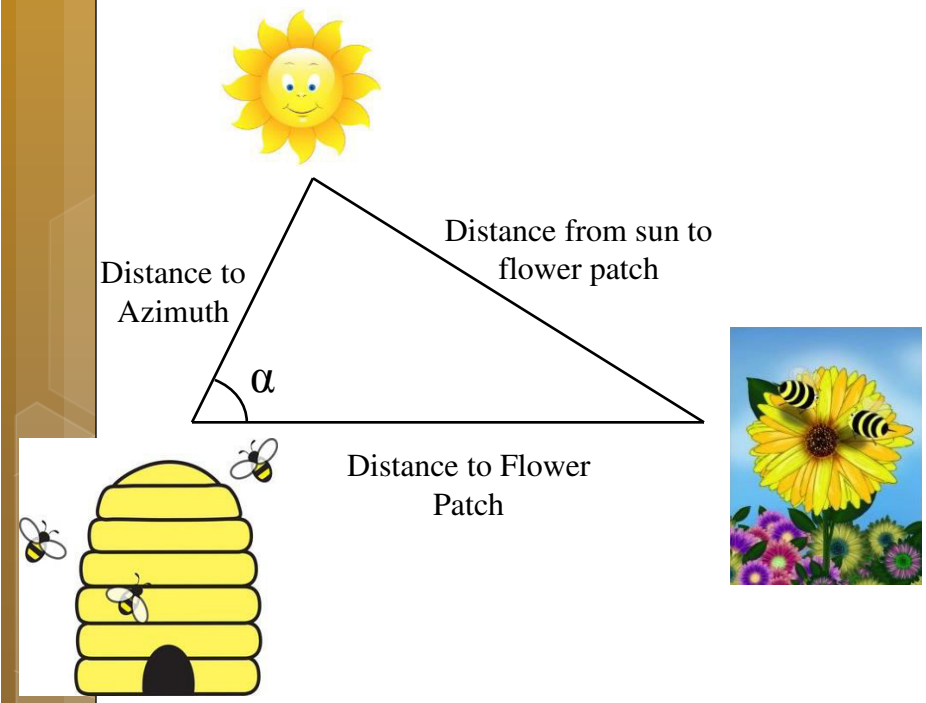
- Look at this example
  - On a horizontal plane the bee could just point to the food
  - Most hives are on a vertical plane
  - They need an orientation and so they must use up as pointing to the sun

The Dance of the Honeybee



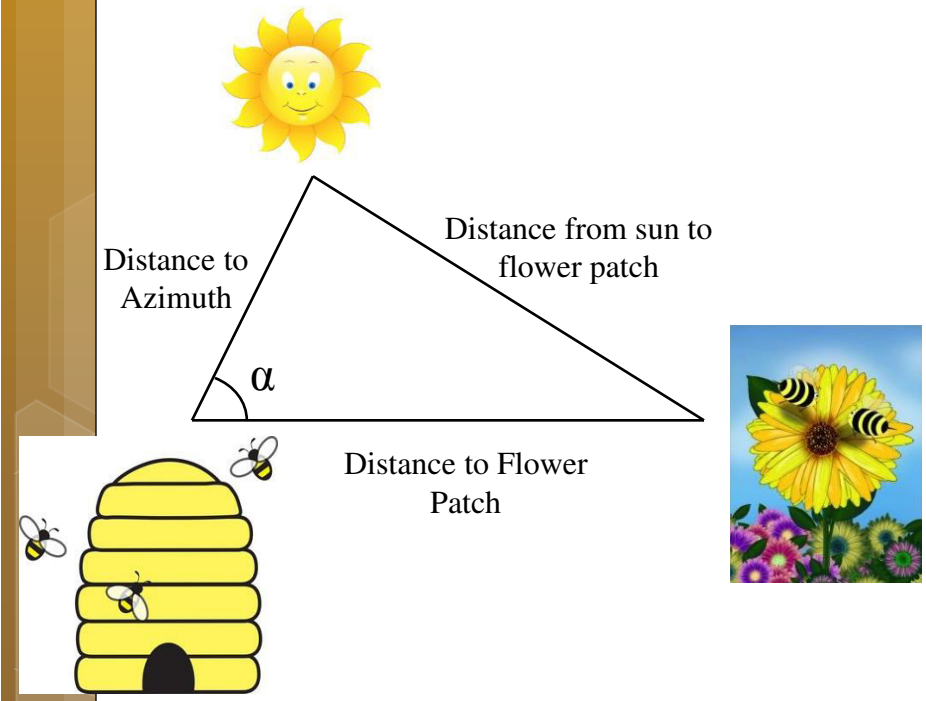
- After a bee sees the dance they now have a direction and a distance to travel
  - They leave the hive and look at the sun and turn the angles degrees that was seen in the dance
  - They then travel the distance and look for the flower patch

The Dance of the Honeybee



- Lets try and look at this mathematically:
- What are they trying to calculate?
- What does it look like when all the sides are connected?
- If we knew some more things could we find some missing pieces?
- Are there any math ideas that can help solve these types of problems?

Flower Patch Spotted!!



- Exercise:
  - A bee has found a flower patch and wants to tell the other bees where it is
  - However her dance doesn't portray all she wants to and some of the information is missing
  - Your job is to use trigonometry to solve the missing parts of the triangle

Flower Patch Spotted!!

Worksheet

NSF GK-12 MAVS Project Lesson Plan Template

Third Six Weeks Trig

GK-12 MAVS Fellow: Chris Mitchell **GK-12 MAVS Mentor Teacher: John Juneau**

Class: IB Math Studies Year Two

Topic: Trigonometric Functions in Biological Situations

Objectives: Students should be able to apply trigonometric formulas to solve for missing information in triangles. This includes right triangle trigonometry and Law of Sine and Law of Cosine. They will do this by seeing the connection of the math to the biology, specifically the foraging regions of honeybees and how they navigate using angles.

Standards: **IB -** 5.3 Right-angled trigonometry

5.4 The sine rule, the cosine rule

TEKS- There are no TEKS for this course.

NCTM- Students should use Cartesian coordinates and other coordinate systems, such as navigational, polar, or spherical systems, to analyze geometric situations. They should draw and construct representations of two- and three-dimensional geometric objects using a variety of tools. Students should be able to Organize and consolidate their mathematical thinking through communication. They should make and investigate mathematical conjectures

Key vocabulary: Law of Cosine, Law of Sine, Trigonometry, Foraging Regions, Honeybees, Radius, Hypotenuse, Right Triangle, Math Modeling

Materials and Resources: Worksheet for foraging regions and trig functions, Calculators, Formula packets

Research Setting/Connection/Motivation: The most important part of mathematical biology is learning to turn the biology into math. In this lesson the students will some biology behind honeybees and their foraging regions. They will learn how trigonometric functions and properties are applicable to biological situations. They will use right triangle trig as well as law of cosine and sine to solve for missing information in a foraging area involving triangles.

Prior knowledge: Students should know basic right triangle trig including formulas for sine, cosine, and tangent. They should know Law of Cosine and Law of Sine. They should be able to recognize when each of these laws is used and what kinds of things they can solve for. They should be able to see and triangle problem and know how to solve for the missing pieces.

Lesson Presentation: Students will see how real world trigonometry is used in nature.

Engagement Students will get into pairs and play a game. The point is to get the to tell the other student where a place to eat is. Students will not talk at all, so no questions, and they will use hand gestures to tell the other student where the place is. The student will draw a map to the place and they will have only one attempt to draw the map.
Exploration Students will explore topics by answering questions about the topics discussed. They will try to give explanations themselves rather than the teacher giving them the answer.
Explanation Students will use the information given to come up with concepts that relate to math. They will explain the details of the engagement activity to see what the problems were with the type of communication used.

Elaboration
Students will see how the biology relates to math, i.e. where the trig comes in. They will do a worksheet that helps them connect the concepts learned and discussed.
Evaluation
Students will be graded on the worksheet completion.

Vertical Strands:

M.1B use multiple approaches (algebraic, graphical, and geometric methods) to solve problems from a variety of disciplines;

G.8F use conversions between measurement systems to solve problems in real world situations

P.3E solve problems from physical situations using trigonometry, including the use of Law of Sines, Law of Cosines, and area formulas and incorporate radian measure where needed;

G.8C derive, extend, and use the Pythagorean Theorem;

G.11C develop, apply, and justify triangle similarity relationships, such as right triangle ratios, trigonometric ratios, and Pythagorean triples using a variety of methods

Teacher Notes:

Presentation

- Introduction to fellow
- Research Background
- How to study diseases (foraging regions)
- Navigation biology
- Directions game
- The dance of the honeybee

Procedure

- Students will engage in questions during the PowerPoint
- They will play a game
- Then they will do a worksheet

This lesson went very well. The students really seemed to be very interested in the topics discussed. They were very engaged and loved the game. They saw the point of the game was to be challenging. Though if they knew the other person in their pair well it made the game easier, so it might be good to pair them up with people they don't know. The worksheet can be designed to handle any type of trig, even thought I used law of cosine and law of sine. More explanation on the worksheet will help too. We had to put the formulas on the board even though they knew them and had them in their formula packets.

Student Worksheets/Handouts/PowerPoint

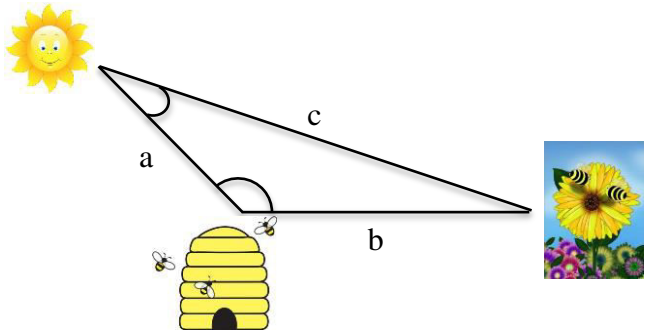
6.28.12

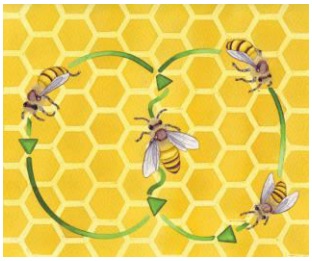
IB Math Studies Name:_____

Flower Patch Spotted

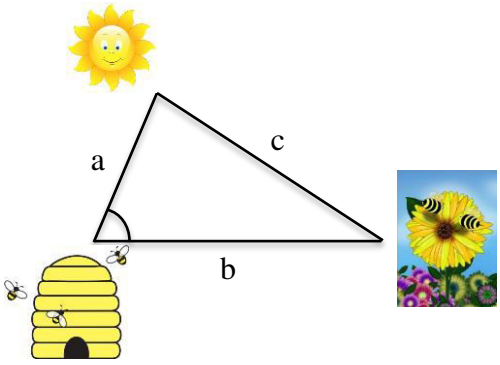
A honeybee has just spotted a great flower patch. She returns to the hive to show the other bees where it is but some of the information gets lost during the dance. Your job is to help the bees find the flower patch so the hive can survive. Use the information given to find the missing pieces of the triangle. You will use either Sine rule or Cosine rule. (Hint: The formulas are in your packet)
Remember that 1 sec = 1000 meters during the waggle dance.
The triangle will be called SHF (S-Sun, H-Hive, F-Flower Patch)

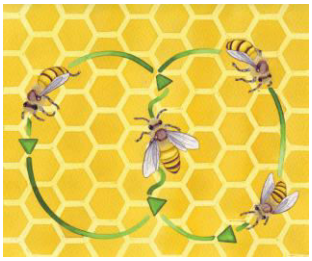
1. In triangle SHF, the worker bees can't figure out how far to go once they leave the hive. The angle to turn away from the sun when they leave the hive is 135°. Also the distance from S to F is 1600 meters and the angle S is 26.2°. Find the distance from H to F (find b).



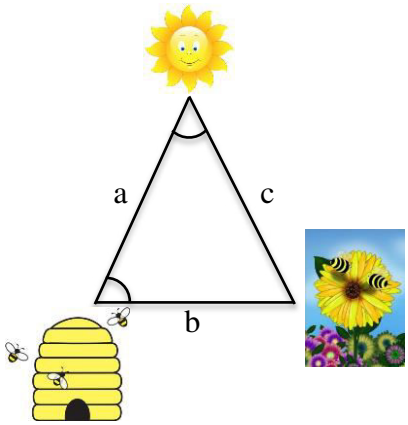


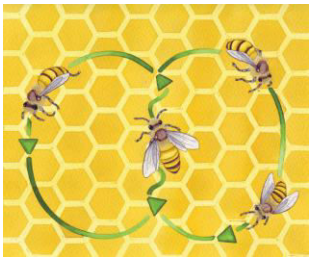
2. In triangle SHF, the worker bees can't seem to get the direction down. From the bee dance the bee has waggled for 1 second through the middle. Also angle S is 37.9° and the distance from the sun to the flower patch is 1500 meters. Find angle H.



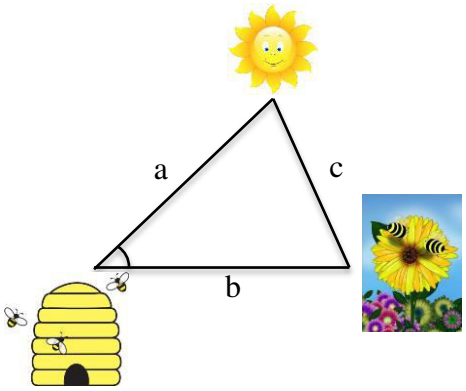


3. In triangle SHF, the bees need to find the distance to the flower patch. Angle H is 80° and angle S is 20°. Also know the distance from the H to S is 1000 meters. Find side b.

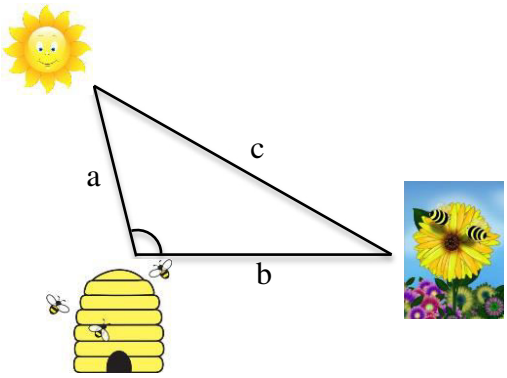




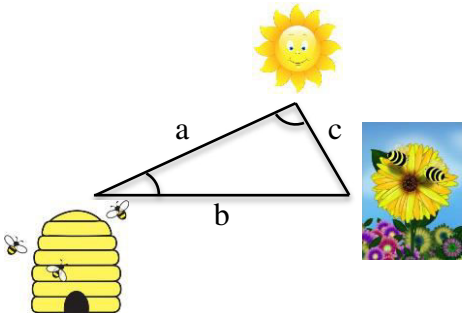
4. In triangle SHF, the bees don't know the angle to turn once they leave the hive. The waggle from the dance was 1.12 seconds and that the distance from H to S is 1230 meters and the distance from S to F is 1000 meters. Find angle H.



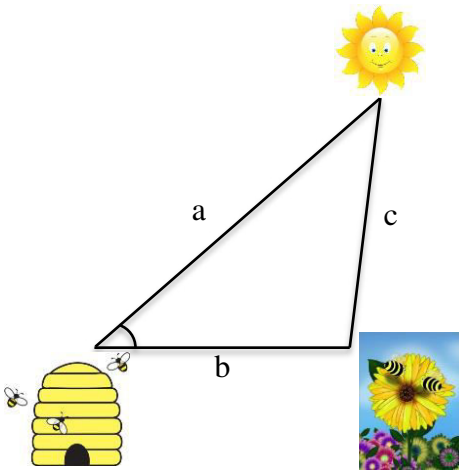
5. In triangle SHF, the angle the bees need to know how far to travel. Angle S is 38° and the distance from H to S is 800 meters. Also the distance from S to F is 1500 meters. Find side b.



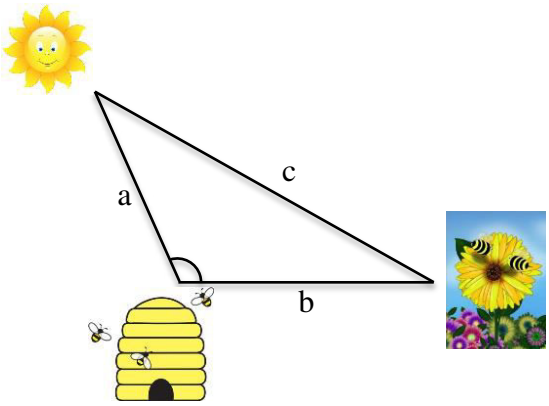
6. In triangle SHF, the bees need to know what direction to turn when they leave the hive. Angle S is 67°. The distance from S to F is 700 meters. Also the bee has waggled in the dance for 1.3 seconds. Find angle H.

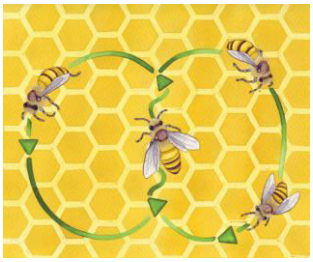


7. In triangle SHF, the angle H is lost again. The distance from H to S is 2000 meters. The distance from S to F is 1600 meters. Also the bee waggled for 0.8 seconds in the dance. Find angle H.

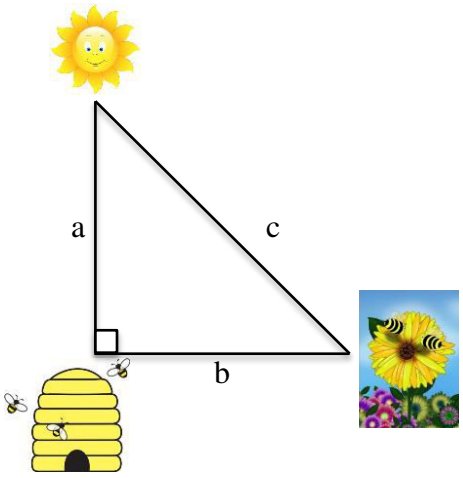


8. In triangle SHF, the distance was lost in the dance. The distance from H to S is 750 meters. Angle H is 97° and angle S is 51°. Find side b.





1. In triangle SHF, the direction to turn is directly east of the hive but they don't know how far to travel. The distance from S to F is 4000 meters and angle F is 30°. Find side b.



1. In triangle SHF, the distance to travel has been lost again. The distance from H to S is 5000 meters and angle S is 26°. Find side b.