Name: _____ Date: _____

Student Exploration: Sine, Cosine, and Tangent Ratios

	Get the Gizmo ready:	
Activity A: **Sine**	• On the **SINE** tab, set *m∠A* to 30°. • Check that **Show side lengths** is turned on. • Drag point C as far as possible to the right.	

1. In Δ*ABC*, $\overline{BC}$ is the *opposite leg* because it is opposite ∠*A*.

    A. What are the lengths of each side?   *AC* = _____   *BC* = _____   *AB* = _____

    B. When *m∠A* = 30°, what is the ratio of *BC* to *AB*? _____

    C. Drag point *C* to the left. Notice that *m∠A* stays the same, so the new triangle is similar to the original. For two different positions of point *C*, record *BC*, *AB*, and $\frac{BC}{AB}$.

    Position 1   **Position 2**

    BC ____ *AB* ____ $\frac{BC}{AB}$ ____   *BC* ____ *AB* ____ $\frac{BC}{AB}$ ____

    What do you notice? _____

2. Drag point *C* all the way to the right so that the length of the hypotenuse $\overline{AB}$ is 14. Turn on **Show sine computation**. The **sine** of angle *A* (or "sin *A*") is the ratio of the opposite leg to the hypotenuse: sin *A* = $\frac{\text{opposite}}{\text{hypotenuse}}$.

    A. What is sin 30°? _____

    B. Turn off **Show sine computation**. Set *m∠A* to 20°. What is sin 20°? _____

    Check your work by turning on **Show sine computation**.

3. With **Show sine computation** turned on, set *m∠A* to 0°.

    A. What is sin 0°? _____

    B. How will the length of $\overline{BC}$ change as *m∠A* increases? _____

    C. Slowly increase *m∠A*. What happens to sin *A*? _____

    D. Set *m∠A* to 90°. What is sin 90°? _____

4. Turn off **Show sine computation**. Set *m∠A* to each of the following angles, and use the side lengths and a calculator to find the sine of each angle. Use the Gizmo to check.

   sin 15° = _____   sin 45° = _____   sin 60° = _____   sin 75° = _____

5. In Δ*DEF*, ∠*F* is a right angle. Suppose *m∠D* = 12° and *EF* = 1.3. Follow the steps below to find the length of the hypotenuse, $\overline{DE}$.

   A. To solve this problem, first draw a sketch of Δ*DEF* in the space to the right.

   B. You know that sin *D* = $\dfrac{\text{OPP}}{\text{HYP}}$. In the space to the right, substitute the known values into this equation. Use *x* for the unknown, *DE*.

   C. Use algebra to solve for *x*. Show your work to the right. Then, use the Gizmo to find the sine value you need. Finally, find *DE* with a calculator.
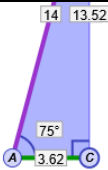
      What is the length of $\overline{DE}$? _____

6. Lars rides a chairlift to the top of a mountain. The chairlift rises at a constant angle of 37°. If the length of the chairlift ride is 1,392 m, what is the elevation gain from the base of the chairlift to the top?

   Draw a right triangle to model this problem and use the Gizmo to find sin 37°. Show your work.

   Elevation gain: _____

Activity B: Cosine	Get the Gizmo ready: • On the **COSINE** tab, set $m\angle A$ to 75°. • Turn on **Show side lengths**. • Drag point C as far as possible to the right.	

1. In $\triangle ABC$, $\overline{AC}$ is the *adjacent leg* because it is next to $\angle A$.

    A. When $m\angle A = 75°$, what is the ratio of *AC* to *AB*? _____

    B. Drag point *C* to the left. For two positions of point *C*, record *AC*, *AB*, and $\dfrac{AC}{AB}$.

    Position 1   **Position 2**

    AC ____   *AB* ____ $\dfrac{AC}{AB}$ ____   *AC* ____   *AB* ____ $\dfrac{AC}{AB}$ ____

    What do you notice? _____

    C. Turn on **Show cosine computation**. The **cosine** of $\angle A$ (or "cos *A*") is the ratio of the

    adjacent leg to the hypotenuse: cos A = $\dfrac{\text{adjacent}}{\text{hypotenuse}}$. What is cos 75°? _____

2. With **Show cosine computation** turned on, set $m\angle A$ to 0°.

    A. What is cos 0°? _____

    B. Slowly increase $m\angle A$. What happens to cos *A*? _____

    C. Set $m\angle A$ to 90°. What is cos 90°? _____

3. Turn off **Show cosine computation**. Set $m\angle A$ to each of the following angles, and use the side lengths and a calculator to find the cosine of each angle. Use the Gizmo to check.

    cos 15° = _____   cos 30° = _____   cos 45° = _____   cos 60° = _____

    Compare cos 35° and sin 55°. _____

4. In Δ*DEF*, ∠*F* is a right angle. Suppose *m*∠*D* = 39° and *DF* = 9.8. Follow the steps below to find the length of the hypotenuse, $\overline{DE}$.

   A. To solve this problem, first draw a sketch of Δ*DEF* in the space to the right.

   B. You know that cos *D* = $\dfrac{ADJ}{HYP}$. In the space to the right, substitute the known values into this equation. Use *x* for the unknown, *DE*.
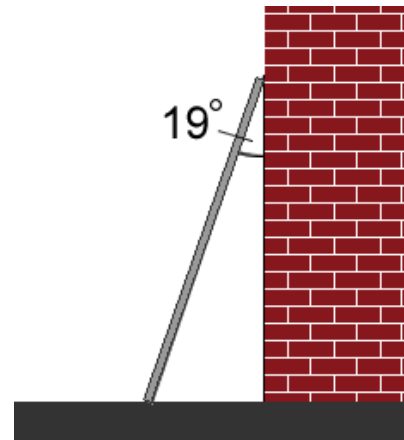
   C. Use algebra to solve for *x*. Show your work to the right. Then, use the Gizmo to find the cosine value you need. Finally, find *DE* with a calculator.

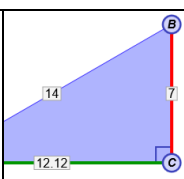   What is the length of $\overline{DE}$? _____

5. A 12-foot ladder leans against a building. The top of the ladder forms an angle of 19° with the top of the building, as shown. How high is the top of the ladder?

   To solve the problem, make a sketch, write an equation involving cosine, find the cosine value you need in the Gizmo, and solve for the unknown height. Show your work below.

   Height of the top of the ladder: _____

   Distance from the bottom of the ladder to the base of

   building: _____

	Get the Gizmo ready:	
Activity C: **Tangent**	• On the **TANGENT** tab, set *m∠A* to 30°. • Turn on **Show side lengths**. • Drag point C as far as possible to the right.	

1. In Δ*ABC*, observe the opposite leg $\overline{BC}$ and the adjacent leg $\overline{AC}$.

    A. When *m∠A* = 30°, what is the ratio of *BC* to *AC*? _____

    B. Drag point *C* to the left. For two positions of point *C*, record *BC*, *AC*, and $\dfrac{BC}{AC}$.

    Position 1   **Position 2**

    BC _____   *AC* _____ $\dfrac{BC}{AC}$ _____   *BC* _____   *AC* _____ $\dfrac{BC}{AC}$ _____

    What do you notice? _____

    C. Turn on **Show tangent computation**. The **tangent** of ∠*A* (or "tan *A*") is the ratio of

    the opposite leg to the adjacent leg: tan *A* = $\dfrac{\text{opposite}}{\text{adjacent}}$. What is tan 30°? _____

2. With **Show tangent computation** turned on, set *m∠A* to 0°.

    A. What is tan 0°? _____

    B. How do you think the tangent will change as *m∠A* increases? _____

    C. Slowly increase *m∠A*. What happens to the tangent? _____

    D. Set *m∠A* to 90°. What is tan 90°? _____

3. Turn off **Show tangent computation**. Set *m∠A* to each of the following angles, and use the side lengths and a calculator to find the tangent of each angle. Use the Gizmo to check.

    tan 15° = _____   tan 45° = _____   tan 60° = _____   tan 75° = _____

4. In ΔDEF, ∠F is a right angle. Suppose
   m∠D = 57° and EF = 8.3. Follow the steps
   below to find the length of the adjacent leg, $\overline{DF}$.

   A. To solve this problem, first draw a
      sketch of ΔDEF in the space to the right.

   B. You know that tan D = $\dfrac{OPP}{ADJ}$. In the
      space to the right, substitute the known
      values into this equation. Use *x* for the
      unknown, *DF*.

   C. Use algebra to solve for *x*. Show your
      work to the right. Then, use the Gizmo
      to find the tangent value you need.
      Finally, find *DF* with a calculator.

      What is the length of $\overline{DF}$? _____

5. Joseph is measuring another tree. He walks
   15.3 m from the base of the tree, lies on his
   stomach, and measures a 25° angle of
   elevation. What is the height of the tree?

   To solve the problem, write an equation using
   tangent, use the Gizmo to find the tangent
   value you need, and solve for the unknown
   height. Show your work below.

   Height of the tree: _____

   25°

   15.3 m
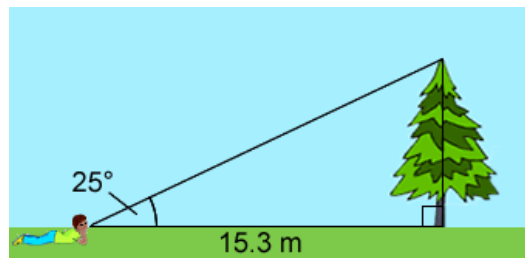
   Distance from Joseph to the top of the tree: _____