# Mathematics Curriculum Guide

## *Honors Geometry*

## *2017-18*

# *Topic 11: Circles*

In this unit, students will explore concepts related to circles. Students will begin the unit by acquiring a large collection of terms related to circles. Then they will develop relationships between angles in and around circles by building on exterior angles, using isosceles triangles, and algebraic substitution. They will use inscribed angles to expand their knowledge of angle-arc relationships. Finally, students will develop algebraic equations for circles from the Pythagorean Theorem, and will apply their understanding of radius to vary the problems they can solve.

**Common Misconceptions and/or Errors:**

- **Segments Related to Circles:** Students sometimes get confused identifying segments of a circle. Have students create a Tree Map that includes definitions and diagrams of each type of segment. Discuss the relationship between the segments as well. For example, is a diameter a chord? [Yes, but a chord is not necessarily a diameter.]
- **Angles Formed by Special Segments of Circles:** Students might try to apply the Inscribed Angle Theorem, $m\angle B = \frac{1}{2}m\widehat{AB}$, when the vertex is not on the circle.
- **Equations with Circles:** When asked to give the center of the circle represented by the equation below, students might not take into account the subtraction inside the parentheses. For the equation $(x-3)^2 + (y+7)^2 = 64$, students may write the center as $(-3,7)$. The center is actually $(3,-7)$.

# *Topic 11: Circles*

## Transfer Goals

1) Demonstrate perseverance by making sense of a never-before-seen problem, developing a plan, and evaluating a strategy and solution.
2) Effectively communicate orally, in writing, and using models (e.g., concrete, representational, abstract) for a given purpose and audience.
3) Construct viable arguments and critique the reasoning of others using precise mathematical language.

**Timeframe:** 3 weeks/14 days
**Start Date:** May 10, 2018
**Assessment Dates:** NO TEST

### Standards

**G-CO 1** Know precise definitions of angles, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

**G-C-2** Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

**G-C 3** Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

**G-C 4** Construct a tangent line from a point outside a given circle to a circle.

**G-GPE 1** Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

## Meaning-Making

### Understandings

*Students will understand that…*

- A radius of a circle and the tangent that intersects the endpoint of the radius on the circle have a special relationship.
- A circle has a special relationship to a triangle whose sides are tangent to the circle.
- Information about congruent parts of a circle (or congruent circles) can be used to find information about other parts of the circle (or circles).
- Angles formed by intersecting lines have a special relationship to the arcs the intersecting lines intercept.
- Arcs intercepted by chords that form inscribed angles are related to the inscribed angles.
- Angles formed by intersecting lines have a special relationship to the arcs the intersecting lines intercept.
- Arcs formed by lines intersecting either within a circle or outside a circle are related to the angles formed by the lines.
- There are special relationships between intersecting chords, intersecting chords, intersecting secants, or a secant and tangent that intersect.
- The equation of a circle can be written if its center and radius are known.

### Essential Questions

*Students will keep considering…*

- How can you prove relationships between angles and arcs in a circle?
- When lines intersect a circle, or within a circle, how do you find the measures of resulting angles, arcs, and segments?
- How do you find the equation of a circle in the equation of a circle in the coordinate plane?

## Acquisition

### Knowledge

*Students will know…*

**Vocabulary:** circle, center, diameter, radius, central angle, semicircle, minor arc, major arc, chord, inscribed angle, intercepted arc, locus, point of tangency, secant, standard form of an equation of a circle, tangent to a circle

- **Theorems:** Tangent Lines, Chords and Arcs, Inscribed Angles, Angle Measures, Segment Lengths, Equation of a Circle, Chord-Chord, Secant-Tangent, Tangent-Secant
- **Key Concepts:**
  - Standard Form of an Equation for a Circle: $(x-h)^2+(y-k)^2=r^2$

### Skills

*Students will be skilled at and able to do the following…*

- Use properties of tangent lines to find the lengths of tangent segments and to set up and solve right triangles.
- Use the relationships between central angles, chords and arc length to solve for unknown angles, segments or arcs.
- Given the measure of an inscribed angle, find the measure of its intercepted arc, and vice versa.
- Find the measure of the angle formed by two intersecting chords, secants, or tangents.
- Use the power theorems to find the lengths of segments within or around a circle.
- Find the equation of a circle when given its radius and center
- Find the equation of a circle when given its center and a point on the circle.
- Graph a circle when given its equation.

# *Topic 11: Circles*

Transfer is a student's ability to independently apply understanding in a novel or unfamiliar situation. In mathematics, this requires that students use reasoning and strategy, not merely plug in numbers in a familiar-looking exercise, via a memorized algorithm.

**Transfer goals** highlight the effective uses of understanding, knowledge, and skills we seek in the long run – that is, what we want students to be able to do when they confront new challenges, both in and outside school, beyond the current lessons and unit. These goals were developed so all students can apply their learning to mathematical or real-world problems while simultaneously engaging in the Standards for Mathematical Practices. In the mathematics classroom, assessment opportunities should reflect student progress towards meeting the transfer goals.

With this in mind, the revised **PUSD transfer goals** are:

1) **Demonstrate perseverance by making sense of a never-before-seen problem, developing a plan, and evaluating a strategy and solution.**
2) **Effectively communicate orally, in writing, and by using models (e.g., concrete, representational, abstract) for a given purpose and audience.**
3) **Construct viable arguments and critique the reasoning of others using precise mathematical language.**

**Multiple measures** will be used to evaluate student acquisition, meaning-making and transfer. Formative and summative assessments play an important role in determining the extent to which students achieve the desired results in stage one.

| Formative Assessment | Summative Assessment |
|---|---|
| **Aligning Assessment to Stage One** | |
| • What constitutes evidence of understanding for this lesson?<br>• Through what other evidence during the lesson (e.g. response to questions, observations, journals, etc.) will students demonstrate achievement of the desired results?<br>• How will students reflect upon, self-assess, and set goals for their future learning? | • What evidence must be collected and assessed, given the desired results defined in stage one?<br>• What is evidence of understanding (as opposed to recall)?<br>• Through what task(s) will students demonstrate the desired understandings? |
| **Opportunities** | |
| • Discussions and student presentations<br>• Checking for understanding (using response boards)<br>• Ticket out the door, Cornell note summary, and error analysis<br>• *Performance Tasks* within a Unit<br>• Teacher-created assessments/quizzes | • Unit assessments<br>• Teacher-created quizzes and/or mid-unit assessments<br>• *Illustrative Mathematics* tasks (https://www.illustrativemathematics.org/)<br>• Performance tasks |

# *Topic 11: Circles*

The following pages address how a given skill may be assessed. Assessment guidelines, examples and possible question types have been provided to assist teachers in developing formative and summative assessments that reflect the rigor of the standards. *These exact examples cannot be used for instruction or assessment, but can be modified by teachers.*

| Unit Skills | SBAC Targets (DOK) | Standards | Examples |
|---|---|---|---|
| • Use properties of tangent lines to find the lengths of tangent segments and to set up and solve right triangles.<br>• Use the relationships between central angles, chords and arc length to solve for unknown angles, segments or arcs.<br>• Given the measure of an inscribed angle, find the measure of its intercepted arc, and vice versa.<br>• Find the measure of the angle formed by two intersecting chords, secants, or tangents.<br>• Use the power theorems to find the lengths of segments within or around a circle.<br>• Find the equation of a circle when given its radius and center<br>• Find the equation of a circle when given its center and a point on the circle.<br>• Graph a circle when given its equation. | Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures. (3,4)<br><br>State logical assumptions being used. (2,3)<br><br>Distinguish correct logic or reasoning from that which is flawed and – if there is a flaw in the argument – explain what it is. (2,3,4)<br><br>Base arguments on concrete referents such as objects, drawings, diagrams, and actions. (2,3)<br><br>Determine conditions under which an argument does and does not apply. (3,4) | **G-CO 1** Know precise definitions of angles, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.<br><br>**G-C-2** Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.<br><br>**G-C 3** Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.<br><br>**G-C 4** Construct a tangent line from a point outside a given circle to a circle.<br><br>**G-GPE 1** Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. | **G.C.A.1 Item 1**<br>Prove the circles made by the bike's wheels and the gear are similar by taking measurements, then using transformations and/or algebraically.<br>Possible Solution: One wheel can be translated or reflected onto the other, showing radius and diameter having a 1:1 ratio, or congruence. The gear's and wheel's radii and diameters can be measured as $r$, $R$, d, and D, then the ratios can be found to be the same. Alternatively, the gear's radius and/or diameter can be multiplied by R/r, which will give the radius or diameter of the wheel.<br>  <br>**G.C.A.1 Item 2**<br>James' math class compares the diameters and circumferences of multiple circular objects. They create a table of values and a graphical representation of the data in order to investigate the relationship between the two measurements. What will the class notice about the representations? How does this relate to what you know about circles?<br><br>Possible Solution: James' class will notice that, for every one unit of increase in diameter, there will be an increase in circumference of approximately 3.14 units. They will be able to calculate this rate of change from the table and to see it on the graph. A graph of diameter versus circumference will be a straight line, starting at (0,0) with a slope of approximately 3.14. This relates to what we already know about circumference because the formula for the circumference of a circle is $C = \pi d$ (could be rewritten as approximately $y = 3.14x$, where $x$ represents diameter and $y$ is the circumference). A student may also choose to construct an example of a table of values or graph. |

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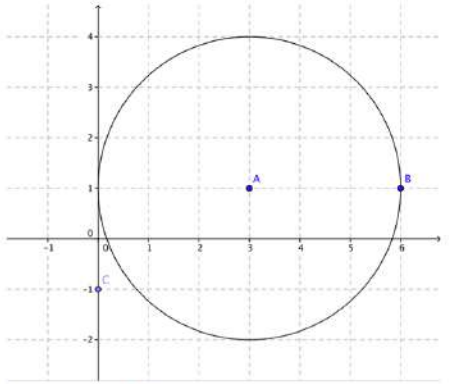
| • Use properties of tangent lines to find the lengths of tangent segments and to set up and solve right triangles.<br>• Use the relationships between central angles, chords and arc length to solve for unknown angles, segments or arcs.<br>• Given the measure of an inscribed angle, find the measure of its intercepted arc, and vice versa.<br>• Find the measure of the angle formed by two intersecting chords, secants, or tangents.<br>• Use the power theorems to find the lengths of segments within or around a circle.<br>• Find the equation of a circle when given its radius and center<br>• Find the equation of a circle when given its center and a point on the circle.<br>• Graph a circle when given its equation. | Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures. (3,4)<br><br>State logical assumptions being used. (2,3)<br><br>Distinguish correct logic or reasoning from that which is flawed and – if there is a flaw in the argument – explain what it is. (2,3,4)<br><br>Base arguments on concrete referents such as objects, drawings, diagrams, and actions. (2,3)<br><br>Determine conditions under which an argument does and does not apply. (3,4) | **G-CO 1** Know precise definitions of angles, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.<br><br>**G-C-2** Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.<br><br>**G-C 3** Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.<br><br>**G-C 4** Construct a tangent line from a point outside a given circle to a circle.<br><br>**G-GPE 1** Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. | **G.C.A.1 Item 3**<br>The medieval labyrinth shown below consists of concentric circles. Justify that any of the circles are similar to each other.<br>  <br>Source: https://www.noetm.org.uk/resources<br><br>Possible Solution: Students can measure the<br>be able to compare radii by using the width<br>should compare multiple circles in order to<br><br>**Item 3:**<br>  <br><br>1. Find the equation of circle $A$.<br>2. Find the points of intersection of the circle and the $x$-axis (round to the nearest hundredth)<br><br>Solution:<br>1. $(x-3)^2+(y-1)^2=9$<br>2. Substitute 0 for $y$: (0.17, 0) or (5.83, 0) |

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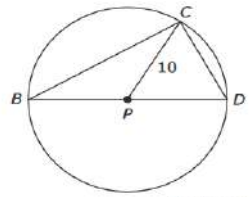
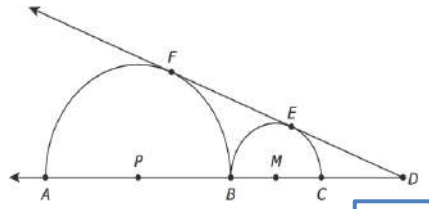
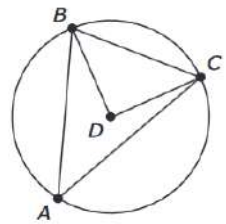
| • Use properties of tangent lines to find the lengths of tangent segments and to set up and solve right triangles.<br>• Use the relationships between central angles, chords and arc length to solve for unknown angles, segments or arcs.<br>• Given the measure of an inscribed angle, find the measure of its intercepted arc, and vice versa.<br>• Find the measure of the angle formed by two intersecting chords, secants, or tangents.<br>• Use the power theorems to find the lengths of segments within or around a circle.<br>• Find the equation of a circle when given its radius and center<br>• Find the equation of a circle when given its center and a point on the circle.<br>• Graph a circle when given its equation. | Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures. (3,4)<br><br>State logical assumptions being used. (2,3)<br><br>Distinguish correct logic or reasoning from that which is flawed and – if there is a flaw in the argument – explain what it is. (2,3,4)<br><br>Base arguments on concrete referents such as objects, drawings, diagrams, and actions. (2,3)<br><br>Determine conditions under which an argument does and does not apply. (3,4) | **G-CO 1** Know precise definitions of angles, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.<br><br>**G-C-2** Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.<br><br>**G-C 3** Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.<br><br>**G-C 4** Construct a tangent line from a point outside a given circle to a circle.<br><br>**G-GPE 1** Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. | Use the information provided to answer Part A and Part B for question 24.<br><br>The figure shows a circle with center $P$, a diameter $\overline{BD}$, and inscribed $\triangle BCD$. The length of $\overline{PC}$ is 10. Let $m\angle CBD = (x)°$ and $m\angle BCD = (x + 54)°$.<br><br>  <br>not to scale<br><br>**24. Part A**<br>What is the value of $x$?<br><br>**Part B**<br>Identify each of the true statements about the figure.<br>Select **all** that apply.<br>Ⓐ The length of $\overline{CD}$ is less than 10.<br>Ⓑ The length of $\overline{CD}$ is equal to 10.<br>Ⓒ The length of $\overline{CD}$ is greater than 10.<br>Ⓓ $\triangle CPD$ is equilateral.<br>Ⓔ The measure of $\angle CPD$ is less than 60°.<br>Ⓕ The measure of $\angle CPD$ is greater than 60°.<br><br>The figure shows two semicircles with centers $P$ and $M$. The semicircles are tangent to each other at point $B$, and $\overline{DE}$ is tangent to both semicircles at $F$ and $E$.<br><br>  <br>If $PB = BC = 6$, what is $ED$?<br>Ⓐ 6<br>Ⓑ $\sqrt{48}$<br>Ⓒ 8<br>Ⓓ $\sqrt{72}$<br><br>**8.** The figure shows $\triangle ABC$ inscribed in circle $D$.<br><br>  <br>If $m\angle CBD = 44°$, find $m\angle BAC$, in degrees. |

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| **Transfer Goals** | | | | | | |
|---|---|---|---|---|---|---|
| 1) Demonstrate perseverance by making sense of a never-before-seen problem, developing a plan, and evaluating a strategy and solution.<br>2) Effectively communicate orally, in writing, and using models (e.g., concrete, representational, abstract) for a given purpose and audience.<br>3) Construct viable arguments and critique the reasoning of others using precise mathematical language. | | | | | | |
| **Essential Questions:**<br>• How can you prove relationships between angles and arcs in a circle?<br>• When lines intersect a circle, or within a circle, how do you find the measures of resulting angles, arcs, and segments?<br>• How do you find the equation of a circle in the equation of a circle in the coordinate plane? | | | | | **Standards:** G-CO 1, G-C 2, G-C 3, G-C 4, G-GPE 1<br><br>**Timeframe:** 3 weeks/14 days<br>**Start Date:** May 10, 2018<br>**Assessment Dates:** NO TEST (content will be included on the final) | |
| **Time** | **Lesson/ Activity** | **Focus Questions for Lessons** | **Understandings** | **Knowledge** | **Skills** | **Resources** |
| 1 day (May 11th) | **Opening Activity:**<br>Determining the Dimensions of a Logo p. 761 | | | | | |
| 2 days (May 12,15) | **Lesson 12-1: Tangent Lines**<br>(pp. 762-769)<br>SMP: 1,3,4<br><br>G-C 2, G-CO 1 | **Focus Question:**<br>• What are the properties of a tangent line to a circle?<br>• How can the properties of tangent lines to a circle help us solve for missing lengths?<br><br>**Inquiry Question:**<br>p. 762 Solve It! | • If a line is tangent to a circle, then it is perpendicular to the radius at the point of tangency.<br>• If two tangent segments have the same external endpoint, then they are congruent. | **Vocab:** tangent to a circle, radius, point of tangency, perpendicular, inscribed, circumscribed<br><br>**Concepts:**<br>• Tangent Lines Theorems<br>• Pythagorean Theorem | • Use properties of tangents to find the lengths of tangent segments.<br>• Use properties of tangents to set up and solve right triangles. | **Common Core Problems:** #4,5, 21, 22, 23, 24, 25, 30<br><br>**STEM:** #9-10, 20<br><br>**Thinking Maps:** Create a Tree Map to represent the Theorems in this lesson. |

Common Core Practices

- ☐ Instruction in the Standards for Mathematical Practices
- ☐ Use of Talk Moves
- ☐ Note-taking
- ☐ Use of Manipulatives
- ☐ Use of Technology
- ☐ Use of Real-world Scenarios
- ☐ Project-based Learning
- ☐ Thinking Maps

| Time | Lesson/ Activity | Focus Questions for Lessons | Understandings | Knowledge | Skills | Additional Resources |
|---|---|---|---|---|---|---|
| 2 Days (May 16-17) | **Lesson 12-2: Chords and Arcs**<br>SMP: 1,3<br>(pp. 771-779)<br><br>**G-C 2, G-CO 1** | **Focus Question:**<br>• What is the relationship between a chord, its intercepted arc and its central angle?<br><br>**Inquiry Question:**<br>p. 771 Solve It! | • Chords equidistant from the center of a circle are congruent.<br>• Central angles that are congruent intercept congruent chords and arcs.<br>• A diameter that is perpendicular to a chord bisects the chord and its arc. | **Vocab:** chord, arc, central angle, intercept, bisect, equidistant, diameter, perpendicular bisector<br><br>**Concepts:**<br>• Theorems regarding congruent central angles, arcs, chords, and centers<br>• Pythagorean Theorem<br>• Triangle Sum Theorem | • Use the relationships between central angles, chords and arc length to solve for unknown angles, segments or arcs. | **Common Core Problems:** #4,5, 18, 19, 20, 21, 22, 29, 33, 34, 35-39<br><br>**Thinking Maps:** Create a Tree Map to represent the Theorems in this lesson. |
| 2 Days (May 18-19) | **Lesson 12-3: Inscribed Angles**<br>SMP: 1,3,4,6<br>(pp. 780-787)<br><br>**G-C 2, G-C 3, G-C 4, G-CO 1** | **Focus Question:**<br>• What is the relationship between an inscribed angle and its intercepted arc?<br>• What is the measure of an angle formed by a chord and a tangent?<br><br>**Inquiry Question:**<br>p. 780 Solve It! | • The measure of an inscribed angle is half the measure of its intercepted arc.<br>• The measure of an angle formed by a tangent and a chord is half the measure of the intercepted arc.<br>• An angle inscribed in a semicircle is a right angle.<br>• The opposite angles of a quadrilateral inscribed in a circle are supplementary. | **Vocab:** inscribed angle, chord, tangent, quadrilateral, diameter, intercepted arc, supplementary<br><br>**Concepts:**<br>• Inscribed Angle Theorem & Corollaries<br>• Pythagorean Theorem<br>• Triangle Sum Theorem<br>• Sum of Interior Angles of a Quadrilateral | • Given the measure of an inscribed angle, find the measure of its intercepted arc, and vice versa. | **Common Core Problems:** #4,5, 19, 22, 26, 27, 28, 29, 31, 32, 33, 34<br><br>**Thinking Maps:** Create a Tree Map to represent the Theorems in this lesson. |
| 1 Day (May 22nd) | **Performance Task:**<br>Revisit "Determining the Dimensions of a Logo"<br>Pages 769 and 787 | | | | | |

| Time | Lesson/ Activity | Focus Questions for Lessons | Understandings | Knowledge | Skills | Additional Resources |
|---|---|---|---|---|---|---|
| 2 Days (May 23-24) | **Lesson 12-4: Angle Measures and Segment Lengths**<br>SMP: 1,3,4<br>(pp. 790-797)<br><br>**G-C 2, G-CO 1** | **Focus Question:**<br>• What are the measures of angles formed by intersecting chords, secants or tangents?<br>• What is the relationship between the segments formed by intersecting tangents, chords, or secants?<br><br>**Inquiry Question:**<br>p. 790 Solve It! | • The measure of an angle formed by two intersecting chords is half the sum of their intercepted arcs.<br>• The measure of an angle formed by two lines that intersect outside a circle is half the difference of their intercepted arcs. | **Vocab:** secant, chord, tangent, intercepted arc<br><br>**Concepts:**<br>• Chord-Chord Power Theorem<br>• Secant-Tangent Power Theorem<br>• Secant-Secant Power Theorem<br>• Triangle Sum Theorem<br>• Pythagorean Theorem | • Find the measure of the angle formed by two intersecting chords, secants, or tangents.<br>• Use the power theorems to find the lengths of segments within or around a circle. | **Common Core Problems:** #5, 7, 14, 29, 31, 35, 36, 37, 40, 41, 42, 43<br><br>**STEM:** #28<br><br>**Thinking Maps:** Create a Tree Map to represent the Theorems in this lesson. |
| 2 Days (May 25-26) | **Lesson 12-5: Circles in the Coordinate Plane**<br>SMP: 1,3,4,7<br>(pp. 798-803)<br><br>**G-GPE 1, G-CO 1** | **Focus Question:**<br>• How do you write the equation of a circle?<br>• Given the equation of a circle, what is the circle's center and radius?<br><br>**Inquiry Question:**<br>p. 798 Solve It! | • The equation of a circle with center *(h, k)* and radius *r* is: $(x-h)^2+(y-k)^2=r^2$<br>• You can write the equation of a circle if you know its center and radius. | **Vocab:** radius, diameter, center, distance, standard form of an equation of a circle<br><br>**Concepts:**<br>• Distance Formula<br>• Pythagorean Theorem<br>• $(x-h)^2+(y-k)^2=r^2$ | • Find the equation of a circle when given its radius and center<br>• Find the equation of a circle when given its center and a point on the circle.<br>• Graph a circle when given its equation. | **Common Core Problems:** #7, 40, 44, 55, 56, 57<br><br>**Thinking Maps:** Create a Circle Map to record ideas in this lesson. |
| 2 Days (May 30-31) | **Review Topic 11 Concepts and Skills**<br>Use Textbook Resources and/or Teacher Created Items for Assessment | | | | | |

Common Core Practices

- ☐ Instruction in the Standards for Mathematical Practices
- ☐ Use of Talk Moves
- ☐ Note-taking
- ☐ Use of Manipulatives
- ☐ Use of Technology
- ☐ Use of Real-world Scenarios
- ☐ Project-based Learning
- ☐ Thinking Maps

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