Unit 4 Title	**Estimated Time Frame**
Circles and **3-Dimensional Figures**	**40 days or 20 block days**

Big Idea (s)

The properties of polygons, lines, and angles can be used to understand circles; the properties of circles can be used to solve problems involving polygons, lines, and angles.

Essential Question(s)

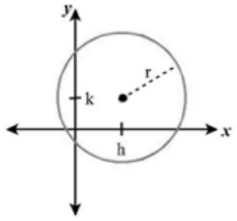
How is the equation of a circle determined in the coordinate plane?
How is a tangent line related to the radius of a circle at the point of tangency?
How are chords related to their central angles and intercepted arcs?
How is the measure of an inscribed angle related to its intercepted arc?
How are the measures of angles, arcs, and segments formed by intersecting secant lines related?

How are three-dimensional figures and polygons related?
How can I use volume to model and solve real-world problems?
How are the prism/cylinder and cone/pyramid formulas alike?
How does the volume of a sphere relate to the volumes of other solids?

Standards for Mathematical Practice (MP.) - The practice standards in bold describe expertise to be intentionally developed in this unit.	**Kentucky Interdisciplinary Literacy Practices (KILP.) -** The practice standards in bold describe expertise to be intentionally developed in Mathematics.
MP.1. Make sense of problems and persevere in solving them. **MP.2. Reason abstractly and quantitatively.** **MP.3. Construct viable arguments and critique the reasoning of others.** **MP.4. Model with mathematics.** **MP.5. Use appropriate tools strategically.** MP.6. Attend to precision. **MP.7. Look for and make use of structure.** **MP.8. Look for and express regularity in repeated reasoning.**	KILP.1 Recognize that text is anything that communicates a message. KLIP.2 Employ, develop, and refine schema to understand and create text. KILP.3 View literacy experiences as transactional, interdisciplinary and transformational. KILP.4 Utilize receptive & expressive language arts to better understand self, others, and the world. KILP.5 Apply strategic practices, with scaffolding & then independently, to approach new literacy tasks. **KILP.6 Collaborate with others to create new meaning.** **KILP.7 Utilize digital resources to learn and share with others.** **KILP.8 Engage in specialized, discipline specific literacy practices.** **KILP.9 Apply high level cognitive processes to think deeply and critically about text.** KILP.10.Develop a literacy identity that promotes lifelong learning.

Common Preconceptions/Misconceptions
Students should have seen the formulas in these standards in the middle grades. What is different for high school students in Advanced Geometry is that these students are asked to justify *with formal and informal proofs.* Students should explore with models. Students should use technology to identify the result of cutting a three-dimensional object and the result of rotating two-dimensional objects. As students analyze two-dimensional and three-dimensional shapes, they gain insights into the structure of specific shapes. For instance, students consider the two-dimensional figures resulting from removing the top of a shoe box or slicing an orange. Students compare and contrast the two-dimensional cross-sections of oranges when sliced at different locations or angles versus slicing. For an extension, students can compare conjectures from circles when slicing a cone at different locations or angles.

KAS Standards	Considerations	Samples of Learning Intentions and Success Criteria
KY.HS.G.16 Identify and describe relationships among angles and segments within the context of circles involving: a. Recognize differences between and properties of inscribed, central, and circumscribed angles. b. Understand relationships between inscribed angles and the diameter of a circle. c. Understand the relationship between the radius of a circle and the line drawn through the point of tangency on that radius. **MP.3, MP.5, and MP.7**	Students recognize and apply relationships, including the relationship between central, inscribed, and circumscribed angles, inscribed angles on a diameter are right angles, and the radius of a circle is perpendicular to the tangent where the radius intersects the circle.	We are learning to identify and describe relationships among inscribed angles, radii, and chords. **(Lesson 10-2, 10-3, 10-4, 10-5a)** ● I can identify inscribed angles, radii, chords, central angles, circumscribed angles, diameter, and tangent. ● I can recognize that inscribed angles on a diameter are right angles. ● I can recognize that the radius of a circle is perpendicular to the radius at the point of tangency. ● I can examine the relationship between central, inscribed, and circumscribed angles by applying theorems about their measures.

KY.HS.G.19 Understand the relationship between the algebraic form and the geometric representation of a circle. a. Write the equation of a circle of a given center and radius using the Pythagorean Theorem. b. **(+)** Derive and write the equation of a circle of a given center and radius using the Pythagorean Theorem. c. **(+)** Complete the square to find the center and radius of a circle given by an equation. **MP.6, MP.8**	 $(x-h)^2+(y-k^2=r^2$	We are learning to derive the equations of a circle given center and radius using the Pythagorean Theorem. **(Lesson 9-3)** ● I can define a circle. ● I can use Pythagorean Theorem to find the radius of a circle. ● I can use the radius and center to find the equation of a circle. ● I can graph a circle and radius or equation.
KY.HS.G.24 Use coordinates within the coordinate plane to calculate measurements of two-dimensional figures. a. Compute the perimeters of various polygons. b. Compute the areas of triangles, rectangles, and other quadrilaterals.★ **MP.2, MP.4**	Students utilize the distance formula to find distances between points in order to find the area and/or perimeter of various geometric figures.	We are learning to connect Algebra and Geometry through coordinates. **(Lesson 9-1)** ● I can use coordinate geometry to calculate perimeter and area of polygons.
KY.HS.G.25 Analyze and determine the validity of arguments for the formulas for the various figures and shapes. a. Finding the circumference and area of a circle. b. Finding the volume of a sphere, prism, cylinder, pyramid, and cone. **MP.3, MP.7**	Students may use dissection arguments, Cavalieri's principle and informal limit arguments in order to find these values for these figures. **Note - No Cavalieri's Principle for General Geometry (right solids only, no oblique).** **Cavalieri's Principle is only in Adv. Geom - see Standard G.26 (+)**	We are learning to model three-dimensional objects and use volume formulas to solve problems. **(Lesson 11-2, 11-3, 11-4)** ● I can use the properties of prisms and cylinders to calculate their volumes. ● I can use the volumes of right pyramids and cones to solve problems. ● I can calculate the volume of a sphere and solve problems involving the volumes of spheres.
KY.HS.G.27 Use volume formulas to solve problems for cylinders, pyramids, cones, spheres, and prisms ★ **MP.4, MP.6**	**General Prism:** V = Bh **Right Circular Cylinder:** V = $\pi r^2 h$ **Pyramid:** V = ⅓ Bh **Right Circular Cone:** V = ⅓ $\pi r^2 h$ **Sphere:** V = 4/3 πr^3	We are learning to use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. **(Lesson 11-2, 11-3, 11-4)** ● I can use the appropriate formula for volume based on the figure. ● I can use volume formulas for cylinders, pyramids, cones, and spheres to solve contextual problems.

KY.HS.G.28 Identify the shapes of two-dimensional cross-sections of three-dimensional objects and identify three-dimensional objects generated by rotations of two-dimensional objects. **MP.5, MP.7**	Students recognize visually the two dimensional shapes created via the cross sections of three dimensional solid figures.	We are learning to describe cross-sections of polyhedrons and rotations of polygons about an axis. **(Lesson 11-1)** ● I can visualize relationships between two-dimensional and three-dimensional objects. ● I can relate the shapes of two-dimensional cross-sections to their three-dimensional objects. ● I can discover three-dimensional objects generated by rotations of two-dimensional objects.
KY.HS.G.29 Use geometric shapes, their measures, and their properties to describe objects in real-world settings. **MP.1, MP.4**		We are learning to describe geometric shapes in real-world settings. **(Lesson 11-2, 11-4)** ● I can solve geometric problems using their measures and properties. ● I can classify a real-world object as a known geometric shape and use this to solve problems in context.

Supporting Standards

KY.HS.G.15 Verify using dilations that all circles are similar. **MP.5, MP.8**

KY.HS.G.17 (+) Apply basic construction procedures within the context of a circle.
a. Construct the inscribed and circumscribed circles of a triangle.
b. Construct a tangent line from a point outside a given circle to the circle.
MP.5, MP.6

KY.HS.G.18 (+) Understand the relationship between an intercepted arc length within a circle and the circle's radius.
a. Derive using similarity, the fact that the length of the arc intercepted by an angle is proportional to the radius. Derive the formula for the area of a sector.
b. Define the radian measure of the angle as the measure of a central angle that intercepts an arc equal in length to the circle's radius. **MP.2, MP.3**

KY.HS.G.26 (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures. **MP.2, MP.5**

KY.HS.G.29 Use geometric shapes, their measures and their properties to describe objects in real world settings. **MP.1, MP.4**

Essential Vocabulary, Theorems, and Postulates

Essential Vocabulary by Topic	Essential Theorems/Postulates by Topic
Circle Vocabulary: central angle, chord, inscribed angle, intercepted arc, major arc, minor arc, semicircle, secant, tangent to a circle; circumscribed figure, inscribed figure, central angle, arc, point of tangency, tangent line, secant line, equation of circle, sector	•Tangent-Radius Theorem (tangent is perpendicular to the radius at the point of contact) •Two-Tangent Theorem (two tangents meeting an external point are congruent) •Congruent chords --> congruent arcs --> congruent central angles •Chords equidistant from the center are congruent •If a diameter is perpendicular to a chord, then it bisects the chord •Inscribed Angles Theorem and corollaries •Angle-arc relationships for all angles with vertices on the center, on the circle, inside the circle but not on the center, and outside the circle •"Power Theorems" (relating segment lengths of chords, secants, and tangent segments of a circle)
3-D Vocabulary: cylinder, prism, pyramid, cone, sphere, hemisphere, area, volume, slant height, edge, vertex, side, altitude, cross-section	•Euler's Formula •Volume of the prism, cylinder, pyramid, cone, and sphere

Common Assessment

Common Assessment Unit 4 Geometry

Anchor Resources

enVision Topic 10 Circles	enVision Topic 11 3-D
MILC - MILC Topic 10 **Circles resources** **FAL** (one per semester): FAL Equations of Circles 1.pdf ** Recommended 2nd-semester Geometry FAL** Desmos to use before starting Topic 10 OR before FAL - **Intro: Equations of Circles • Activity Builder by Desmos**	**MILC - MILC Topic resources for 3-D figures** **3-ACT Math Task** - "Box 'em Up" **Stations Assessment** - •**Topic #11 Performance Task** (use as a mini-test grade) Students can work collaboratively in groups to find the volume of real-life items (coffee can, tissue box, tennis or beach ball, etc)

Flex Day for KSA Testing (**Statistics Review posted on MILC and also highlight Algebra standards in a skills review - include quadratics**)

*Disclaimer: Success Criteria is the evidence students must produce to demonstrate learning. This example is not comprehensive.
** Mathematical Practices (A.MP.1- 8) should be evidenced throughout each unit, depending on the explored tasks. It is important to note that MP. 2 should support learning in every lesson.

******* Modeling Standards: Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★). The star symbol sometimes appears on the heading for a group of standards; in that case, it should be understood to apply to *all* standards in that group.