Indiana Academic Standards for Mathematics – Trigonometry
Adopted April 2014 – Standards Resource Guide Document

This Teacher Resource Guide has been developed to provide supporting materials to help educators successfully implement the Indiana Academic Standards for Trigonometry Mathematics – Adopted April 2014. These resources are provided to help you in your work to ensure all students meet the rigorous learning expectations set by the Academic Standards. Use of these resources is optional – teachers should decide which resource will work best in their

This resource document is a living document and will be frequently updated.
Please send any suggested links and report broken links to:
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The Indiana Department of Education would like to thank Jan McNulty for her contributions to this document.

The examples in this document are for illustrative purposes only, to promote a base of clarity and common understanding. Each example illustrates a standard but please note that examples are not intended to limit interpretation or classroom applications of the standards.

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GOOD WEBSITES FOR MATHEMATICS:
http://nlvm.usu.edu/en/nav/vlibrary.html
http://www.math.hope.edu/swanson/methods/applets.html
http://learnzillion.com
http://illuminations.nctm.org
https://teacher.desmos.com
http://illustrativemathematics.org
http://www.insidemathematics.org
https://www.khanacademy.org/
https://www.teachingchannel.org/
http://map.mathshell.org/materials/index.php
https://www.istemnetwork.org/index.cfm
http://www.azed.gov/azccrs/mathstandards/

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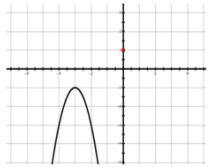
	Indiana Academic Standard for Mathematics Trigonometry – Adopted April 2014	Highlighted Vocabulary Words from the Standard Defined	Specific Trigonometry Example for the Standard	Specific Trigonometry Electronic Resource for the Standard
		Conics		
MA.TR.CO.1:	TR.CO.1: Determine how the graph of a parabola changes if a, b and c changes in the equation y = a(x – b)^2 + c. Find an equation for a parabola when given sufficient information.		Wrrite the equation for the given parabola. 	http://www.ghc.edu/lc/Handouts/Math/parabolic%20graph.pdf
MA.TR.CO.2:	TR.CO.2: Derive the equation of a parabola given a focus and directrix.	Define parabola as the set of all points that are the same distance from a fixed point (focus) as they are from a fixed line (directrix).	Write the equation of a parabola whose focus is at (3, -2) and whose directrix is the equation x = - 1	http://hotmath.com/hotmath_help/topics/finding-the-equation-of-a-parabola-given-focus-and-directrix.html https://www.khanacademy.org/math/algebra2/conics_precalc/parabolas_precalc/v/using-the-focus-and-directrix-to-find-the-equation-of-a-parabola
MA.TR.CO.3:	TR.CO.3: 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.	Define a circle as the set of all points (x, y) that are the same distance from a fixed point (center, (h, k))	Write the equation of a circle whose center is at (2, 4)With a radius of 3.	http://www.regentsprep.org/Regents/math/algtrig/ATC1/circlelesson.htm https://www.khanacademy.org/math/algebra2/conics_precalc/circles-tutorial-precalc/v/radius-and-center-for-a-circle-equation-in-standard-form
MA.TR.CO.4:	TR.CO.4: Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.		Write the equation of an ellipse given the foci coordinates are (1,5) and (1, -1) and the length of the major axis is 20	http://www.youtube.com/watch?v=V5dBFw0Y0pE http://www.vitutor.com/geometry/conics/ellipse_equation.html
MA.TR.CO.5:	TR.CO.5: Graph conic sections. Identify and describe features like center, vertex or vertices, focus or foci, directrix, axis of symmetry, major axis, minor axis, and eccentricity.		Graph the hyperbola, identify the vertices, foci, Asymptotes and eccentricity. $\frac{(y+1)^2}{16} - \frac{(x+5)^2}{9} = 1$	http://www.math.tamu.edu/~baurispa/math150/150ch10_1-3.pdf http://www.algebra.com/algebra/homework/Quadratic-relations-and-conic-sections.faq?hide_answers=1&beginning=4500
MA.TR.CO.6:	TR.CO.6: Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.			https://learnzillion.com/lessonsets/465-give-arguments-for-formulas-of-circumference-and-area-of-a-circle-and-the-volume-of-a-cylinder-pyramid-and-cone http://www.schools.utah.gov/CURR/mathsec/Core/Secondary-II/II-6-G-GMD-1.aspx

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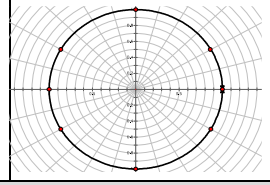
Unit Circle				
MA.TR.UC.1:	TR.UC.1: Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.		Use a paper plate as a model of the unit circle, locate the origin(center) and draw x and y axis through the center. Label the points (1, 0) (0,1) (-1, 0) and (0,-1) and corresponding degree measures of 0, 90, 180, 360. Then have students label the corresponding measures of the arc lengths associated with each angle. Discuss the benefits of having an angle defined as a measure of length. Find the radian measure of the angle 210 degrees.	http://www.regentsprep.org/Regents/math/algtrig/ATM1/arclengthlesson.htm http://math.ucsd.edu/~wgarner/math4c/textbook/chapter5/angles_radians.htm
MA.TR.UC.2:	TR.UC.2: Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.		Add more details to the paper plate such as coordinates of each of the 30's, 45's and 60's families noting how the signs change as you move into other quadrants. Also note the relationship of cos, sin to x and y Find the cos $(4\pi/3)$	https://learnzillion.com/lessonsets/573-explain-how-the-unit-circle-in-the-coordinate-plane-enables-the-extension-of-trigonometric-functions-to-all-real-numbers
MA.TR.UC.3:	TR.UC.3: Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.	even: for every (x, y) there exists (-x, y) odd: for every (x, y) there exists (-x, -y) periodicity: the cycle repeats itself with each rotation around the circle.	Sin (20) = a, find sin (-20) , sin 380 	http://hotmath.com/help/gt/genericalg2/section_11_2.html http://www.shmoop.com/common-core-standards/ccss-hs-f-tf-4.html
Geometry				
MA.TR.G.1:	TR.G.1: Solve real-world problems with and without technology that can be modeled using right triangles, including problems that can be modeled using trigonometric ratios. Interpret the solutions and determine whether the solutions are reasonable.		Textbooks should be rich with problems involving Right triangle trig. Angles of elevation, angles of Depression, surveying problems, line of sight. The angle of elevation to the top of a building is 35 degrees from a distance of 200 ft. Find the height of the building.	https://learnzillion.com/lessonsets/769-solve-problems-using-trigonometric-ratios-and-the-pythagorean-theorem
MA.TR.G.2:	TR.G.2: Explain and use the relationship between the sine and cosine of complementary angles.		Given the sin 23=0.3907. Find cos 67 Given: cos x = 4/5 , find sin $(\pi/2 - x)$ Compare the graphs of y=sinx to y= cos$(\pi/2 - x)$	https://www.illustrativemathematics.org/illustrations/1443 https://learni.st/users/60/boards/3370-sine-and-cosine-of-complementary-angles-common-core-standard-9-12-g-srt-7

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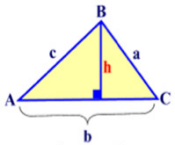
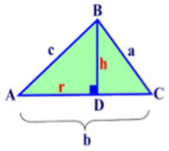
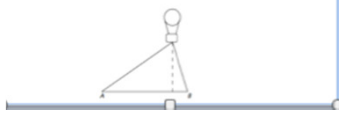
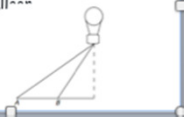
MA.TR.G.3:	TR.G.3: Use special triangles to determine the values of sine, cosine, and tangent for π/3, π/4, and π/6. Apply special right triangles to the unit circle and use them to express the values of sine, cosine, and tangent for x, π + x, and 2π – x in terms of their values for x, where x is any real number.		See discussion on the paper plate in standard TR.UC.2 Have students create a chart with all of the special angles and all of the trig ratios. After filling in first quadrant angles, have students Use information from paper plates to Fill in the rest of the chart. Find the tan(11π/6)	http://www.youtube.com/playlist?list=PL32D15524DE70A7F1 http://www.cpalms.org/Public/PreviewResource/Preview/48711
MA.TR.G.4:	TR.G.4: Prove the Laws of Sines and Cosines and use them to solve problems.	 $\sin A = \frac{h}{c} \quad \sin C = \frac{h}{a}$ $h = c\sin A \quad h = a\sin C$ $c\sin A = a\sin C$ $\frac{c\sin A}{ac} = \frac{a\sin C}{ac}$ $\frac{\sin A}{a} = \frac{\sin C}{c}$ With a different orientation of the triangle, one could also tie in $\frac{\sin B}{b}$ **So the Law of Sines is:** $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$	LAW OF COSINES Triangle *ABC* at the right does not contain a right angle. A perpendicular is dropped from vertex *B*. It can now be observed that:  $\sin \measuredangle A = \frac{h}{c} \Rightarrow h = c\sin \measuredangle A$ $\cos \measuredangle A = \frac{r}{c} \Rightarrow r = c\cos \measuredangle A$	http://www.clarku.edu/~djoyce/trig/laws.html http://www.utdallas.edu/dept/abp/PDF_Files/Precalculus_Folder/LawofSinesandCosines.pdf
MA.TR.G.5:	TR.G.5: Understand and apply the Laws of Sines and Cosines to solve real-world and other mathematical problems involving right and non-right triangles.	Using the Pythagorean Theorem in triangle *CBD*, we have; Substituting for *h* and *r* we have: $a^2 = (c\sin A)^2 + (b - c\cos A)^2$ $a^2 = c^2\sin^2 A + b^2 - 2bc\cos A + c^2\cos^2 A$ $a^2 = c^2(\sin^2 A + \cos^2 A) + b^2 - 2bc\cos A$ $a^2 = c^2(1) + b^2 - 2bc\cos A$ $a^2 = c^2 + b^2 - 2bc\cos A$	A hot air balloon is hovering over Conner Prairie. Person A views the balloon at an angle of elevation of 25° while person B views the balloon at an angle of elevation of 40°. If A and B are 4000 feet apart, find the height of the balloon.  A hot air balloon is hovering over Conner Prairie. Person A views the balloon at an angle of elevation of 25° while person B views the balloon at an angle of elevation of 40°. If A and B are 4000 feet apart, find the height of the ball... 	http://www.muhsd.k12.ca.us/cms/lib5/CA01001051/Centricity/Domain/547/Trig/13-6%20Law%20of%20Cosines.pdf http://facstaff.gpc.edu/~ahendric/Math1113/sec6_1notes/sec6_1lawofsines_07.htm

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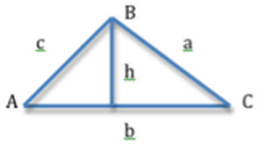
MA.TR.G.6:	TR.G.6: Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line. Use the formula to find areas of triangles.		A=42 degrees, b = 20 and c = 14. Find area.  Area = $\frac{1}{2}bh$ Sin C = $\frac{h}{a}$ so h = aSinC make the substitution for h Area = $\frac{1}{2}abSinC$	http://www.virtualnerd.com/common-core/hsf-geometry/HSG-SRT-right-triangle-similarity-trigonometry/D/9 http://www.mathsisfun.com/algebra/trig-area-triangle-without-right-angle.html
		Periodic Functions		
MA.TR.PF.1:	TR.PF.1: Find a sinusoidal function to model a data set and explain the parameters of the model.	Create a scatter plot of the following data using the day of the year as the independent variable and the amount of daylight as the dependent variable.	Regressions Based on the shape of the graph, what type of regression will be appropriate? (Hint: You might want to anticipate what the data might look like for the next year or two.) Explain your decision by providing two aspects of the graph that are unique to this type of equation. Write your regression equation. How well does it fit the data? Explain. Find the Domain and Range of the regression curve.	http://www.mathdemos.org/mathdemos/sinusoidapp/sinusoidapp.html http://www.analyzemath.com/trigonometry/model_sine.html
MA.TR.PF.2:	TR.PF.2: Graph trigonometric functions with and without technology. Use the graphs to model and analyze periodic phenomena, stating amplitude, period, frequency, phase shift, and midline (vertical shift).		The number of hours of sunlight in Indianapolis can be modeled by a sinusoidal function. On June 24th (day 175), the longest day of the year, there will be 15 hours on sunlight. On December 21st (day 355), the shortest day of the year there will be 9.5 hours of sunlight. Write an equation that could be used to predict the hours of daylight on any day of the year.	https://www.khanacademy.org/math/trigonometry/trig-function-graphs/trig_graphs_tutorial/v/we-graph--domain--and-range-of-sine-function http://www.themathpage.com/atrig/graphs-trig.htm
MA.TR.PF.3:	TR.PF.3: Construct the inverse trigonometric functions of sine, cosine, and tangent by restricting the domain.		Have students graph the original trig functions, then sketch their inverses by exchanging the x and y values. Have students highlight the section of the new graph that passes a vertical line test. Identify the resulting domain and range.	http://www.regentsprep.org/Regents/math/algtrig/ATT8/inversetrig.htm http://www.calculatorsoup.com/calculators/trigonometry/graphs-inversefunctions.php

Day of Month – 2008	Day of Year	Amount of Daylight (min)
January 6th	6	553
January 20th	20	574
February 3rd	34	604
February 17th	48	640
March 2nd	62	678
March 16th	76	719
March 30th	90	759
April13th	104	798
April 27th	118	835
May 11th	132	869
May 25th	146	895
June 8th	160	912
June 22nd	174	917
July 6th	188	909
July 20th	202	890
August 3rd	216	861
August 17th	230	828
August 31st	244	790
September 14th	258	751
September 28th	272	711
October 12th	286	673
October 26th	300	634
November 9th	314	600
November 23rd	328	570
December 7th	342	551
December 21st	356	544

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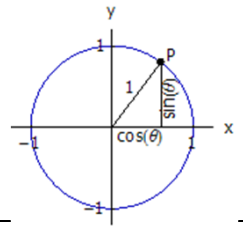
MA.TR.PF.4:	TR.PF.4: Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.			http://www.themathpage.com/atrig/inverseTrig.htm http://www.regentsprep.org/Regents/math/algtrig/ATT8/inversetrig2.htm
MA.TR.PF.5:	TR.PF.5: Prove the addition and subtraction formulas for sine, cosine, and tangent. Use the formulas to solve problems.		http://www.youtube.com/watch?v=ObaA-rYHO9o Naturalists find that the populations of some animals varies periodically with time. The deer population in the Hoosier National forest varies according to the model, $D = 2000 \sin(\pi/6(m - 1)) + 14000$. Determine the months, m, in which the deer population is 12,500.	http://mathworld.wolfram.com/TrigonometricAdditionFormulas.html http://www.cut-the-knot.org/triangle/SinCosFormula.shtml
MA.TR.PF.6:	TR.PF.6: Prove the double- and half-angle formulas for sine, cosine, and tangent. Use the formulas to solve problems.		http://www.youtube.com/watch?v=S9XkwZ4n3b4	http://home.windstream.net/okrebs/page103.html http://www.intmath.com/analytic-trigonometry/4-half-angle-formulas.php
MA.TR.PF.7:	TR.PF.7: Define and use the trigonometric ratios (sine, cosine, tangent, cotangent, secant, cosecant) in terms of angles of right triangles and the coordinates on the unit circle.		The coordinates of a point on the terminal side of an angle, theta are $\left(-\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$, find the 6 trig ratios for angle theta.	http://www.snow.edu/jonathanb/Courses/Math1060/unit_circ_trig.html https://www.khanacademy.org/math/trigonometry/unit-circle-trig-func/Trig-unit-circle/v/unit-circle-definition-of-trig-functions-1
Identities				
MA.TR.ID.1:	TR.ID.1: Prove the Pythagorean identity sin^2(x) + cos^2(x) = 1 and use it to find trigonometric ratios, given sin(x), cos(x), or tan(x), and the quadrant of the angle.			http://www.themathpage.com/atrig/proof.htm http://www.regentsprep.org/Regents/math/algtrig/ATT9/pythagoreanid.htm
MA.TR.ID.2:	TR.ID.2: Verify basic trigonometric identities and simplify expressions using these and other trigonometric identities.		Prove: tan x + cot x = sec x csc x	http://symbolab.com/solver/trigonometric-identity-calculator

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Polar Coordinates				
MA.TR.PC.1:	TR.PC.1: Define polar coordinates and relate polar coordinates to Cartesian coordinates.		Convert polar coordinates : [3, 2π/3] to rectangular . Convert rectangular coordinates (4, -4) to polar.	http://www.mathsisfun.com/polar-cartesian-coordinates.html http://mathinsight.org/polar_coordinates
MA.TR.PC.2:	TR.PC.2: Translate equations from rectangular coordinates to polar coordinates and from polar coordinates to rectangular coordinates. Graph equations in the polar coordinate plane.		Convert the polar equation to rectangular form: $r = 2 \sin \vartheta + 3 \cos \vartheta$ Graph the polar equation: $r = 2 \cos 3\vartheta$ Identify it by name.	http://tutorial.math.lamar.edu/Classes/CalcII/PolarCoordinates.aspx http://www.mathhands.com/104/hw/104c06s03ns.pdf
Vectors				
MA.TR.V.1:	TR.V.1: Solve problems involving velocity and other quantities that can be represented by vectors.		A baseball heading on a bearing of 140 at 150mph is facing a wind speed of 15 mph on a bearing of 250 . What is the new speed and direction of the baseball?	http://patrickjmt.com/word-problems-involving-velocity-or-other-forces-vectors-ex-1/ http://www.youtube.com/watch?v=MINlnq4YvEY
MA.TR.V.2:	TR.V.2: Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).		Draw vector v= < -3 , 4 > Draw 2 v Draw - v	http://www.cpalms.org/Public/PreviewStandard/Preview/5535?ShowRelatedResources=true#
MA.TR.V.3:	TR.V.3: Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).		Let v = < 2, 1 > Find the magnitude, || v || Find || 2v || Find 2|| v ||	http://www.shmoop.com/common-core-standards/ccss-hs-n-vm-5b.html