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## About the Charles A. Dana Center at The University of Texas at Austin

The Dana Center develops and scales math and science education innovations to support educators, administrators, and policy makers in creating seamless transitions throughout the K–14 system for all students, especially those who have historically been underserved.

We work with our nation’s education systems to ensure that every student leaves school prepared for success in postsecondary education and the contemporary workplace—and for active participation in our modern democracy. We are committed to ensuring that the accident of where a student attends school does not limit the academic opportunities he or she can pursue. Thus, we advocate for high academic standards, and we collaborate with local partners to build the capacity of education systems to ensure that all students can master the content described in these standards.

Our portfolio of initiatives, grounded in research and two decades of experience, centers on mathematics and science education from prekindergarten through the early years of college. We focus in particular on strategies for improving student engagement, motivation, persistence, and achievement.

We help educators and education organizations adapt promising research to meet their local needs and develop innovative resources and systems that we implement through multiple channels, from the highly local and personal to the regional and national. We provide long-term technical assistance, collaborate with partners at all levels of the education system, and advise community colleges and states.

We have significant experience and expertise in the following:

- Developing and implementing standards and building the capacity of schools, districts, and systems
- Supporting education leadership, instructional coaching, and teaching
- Designing and developing instructional materials, assessments, curricula, and programs for bridging critical transitions
- Convening networks focused on policy, research, and practice

The Center was founded in 1991 at The University of Texas at Austin. Our staff members have expertise in leadership, literacy, research, program evaluation, mathematics and science education, policy and systemic reform, and services to high-need populations. We have worked with states and education systems throughout Texas and across the country. For more information about our programs and resources, see our homepage at [www.utdanacenter.org](http://www.utdanacenter.org).

## About the Dana Center Mathematics Pathways

The Dana Center Mathematics Pathways (DCMP) is a systemic approach to improving student success and completion through implementation of processes, strategies, and structures based on four fundamental principles:

1. Multiple pathways with relevant and challenging mathematics content aligned to specific fields of study
2. Acceleration that allows students to complete a college-level math course more quickly than in the traditional developmental math sequence
3. Intentional use of strategies to help students develop skills as learners
4. Curriculum design and pedagogy based on proven practice

The Dana Center has developed curricular materials for three accelerated pathways—*Statistical Reasoning*, *Quantitative Reasoning*, and *Reasoning with Functions I* and *Reasoning with Functions II* (a two-course preparation for Calculus). The pathways are designed for students who have completed arithmetic or who are placed at a beginning algebra level. All three pathways have a common starting point—a developmental math course that helps students develop foundational skills and conceptual understanding in the context of college-level course material.

In the first term, we recommend that students also enroll in a learning frameworks course to help them acquire the strategies—and tenacity—necessary to succeed in college. These strategies include setting academic and career goals that will help them select the appropriate mathematics pathway.

In addition to the curricular materials, the Dana Center has developed tools and services to support project implementation. These tools and services include an implementation guide, data templates and planning tools for colleges, and training materials for faculty and staff.

## Acknowledgments

The development of the Dana Center Mathematics Pathways curricular materials began with the formation of the **DCMP Curricular Design Team**, who set the design standards for how the curricular materials for individual DCMP courses would be designed. The team members are:

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The Dana Center then convened faculty from each of the DCMP codevelopment partner institutions to provide input on key usability features of the instructor supports in curricular materials and pertinent professional development needs. Special emphasis was placed on faculty who need the most support, such as new faculty and adjunct faculty. The **Usability Advisory Group** members are:

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2.B	2.B	Right Triangles and Rates <i>Determine the distance between two points in a plane using the Pythagorean theorem</i> <i>Determine the relationships between the rates of change among the sides of a dynamically changing right triangle</i>	15	13	23	2.B
2.C	2.C	Distance and Arc Length <i>Use the Pythagorean theorem to evaluate the distance between two points</i> <i>Use the Pythagorean theorem to estimate the length of a curve</i> <i>Use distances measured to determine average velocities</i>	18	15	27	2.C

Lesson	Preview Assignment	Lesson Title and Description	In-Class Activities with Answers	In-Class Activities (Student)	Lesson Planning Suggestions	Practice Assignment
<b>Lesson 3: Rates of Change: Expanding Circles and Spheres</b>						
		Circles and Rates of Change <i>Determine the average rate of change of the circumference of a circle as a function of the average rate of change of the radius</i>				
3.A	3.A	<i>Determine the average rate of change of the area of a circle as a function of the average rate of change of the radius</i> <i>Determine the average rate of change of the volume of a disk as a function of the average rate of change of the radius</i>	22	19	31	3.A
		Spheres and Rates of Change <i>Use the relationship between volume and radius of a sphere to determine the relationship between their rates of change</i> <i>Compute rates of change</i>				
3.B	3.B		25	21	36	3.B
		Forming Effective Study Groups <i>Describe how to form and conduct an effective study group</i> <i>Identify key characteristics of effective study groups</i>				
3.C	-		29	23	41	-
<b>Lesson 4: Equations of Circles</b>						
		Distance on the Line <i>Compute the distance between two numbers on the number line as represented by an absolute value</i>				
4.A	4.A	<i>Solve equations and inequalities involving absolute values</i> <i>Interpret intervals using absolute value notation</i>	31	25	45	4.A

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4.B	4.B	<p>Circles</p> <p><i>Given a point, P and a positive distance, r, determine an equation whose graph is a circle centered at P and with radius r</i></p> <p><i>Given two points in the plane, determine the equation of the smallest circle containing both points</i></p> <p><i>Given two points in the plane, determine the center and radius of the smallest circle containing both points</i></p>	36	29	50	4.B
4.C	4.C	<p>Equations of Circles</p> <p><i>Determine the center and radius of the graph of a quadratic equation when the graph is a circle</i></p> <p><i>Sketch the graph of a quadratic equation</i></p>	39	31	54	4.C
<b>Lesson 5: Similar Triangles, Circular Motion, and Measuring Angles</b>						
5.A	5.A	<p>Moving Shadows</p> <p><i>Use similar triangles to model static relationships between quantities</i></p> <p><i>Use similar triangles to model dynamic relationships between quantities</i></p>	43	33	60	5.A
5.B	5.B	<p>Home Improvement</p> <p><i>Set up and solve geometric optimization problems</i></p> <p><i>Maximize the area of a rectangle inscribed inside an equilateral triangle</i></p>	47	37	65	5.B
5.C	5.C	<p>You Spin Me Round</p> <p><i>Calculate the speed of an object in uniform circular motion</i></p> <p><i>Use proportional reasoning to find arc lengths and areas of circular sectors</i></p> <p><i>Determine the radian measure of the central angle of a given circular sector</i></p>	52	39	71	5.C



Lesson	Preview Assignment	Lesson Title and Description	In-Class Activities with Answers	In-Class Activities (Student)	Lesson Planning Suggestions	Practice Assignment
<b>Lesson 6: Related Rates and Optimization: Cones and Cylinders</b>						
6.A	6.A	Red Plastic Cup <i>Calculate the surface area and volume of a cylinder</i> <i>Calculate surface areas and volumes of cones and frustrums</i>	56	43	77	6.A
6.B	6.B	Can It! <i>Determine the dimensions of a cylinder of given volume with minimum surface area</i>	60	47	82	6.B
6.C	6.C	Off to a Rocky Start <i>Model the changing dimensions in a cone</i> <i>Compute the average rates of change of dimensions in a cone</i> <i>Estimate instantaneous rates of change of dimensions in a cone</i>	64	51	87	6.C
6.D	6.D	A Geometric Problem <i>Determine the dimensions of a cylinder inscribed in a cone which produces the greatest volume</i>	69	55	92	6.D
<b>Lesson 7: Sinusoidal Models</b>						
7.A	7.A	Modeling Tides <i>Sketch a graph of a function based on data to model a physical situation</i> <i>Interpret a mathematical model of a physical situation and use the model to make decisions</i>	72	57	96	7.A
7.B	7.B	Pendulum Motion <i>Identify the period of a sinusoidal function from its graph</i> <i>Given the graph of a sinusoidal position function, sketch the graph of the corresponding velocity function</i>	77	61	101	7.B

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7.C	7.C	<p>Modeling Temperature Change</p> <p><i>Identify the period, amplitude, and midline of a sinusoidal function given its graph</i></p> <p><i>Interpret the meanings of period, amplitude, and midline in the context of a model</i></p> <p><i>Create a graphical approximation of a sinusoidal function which models given data</i></p>	82	65	105	7.C
<b>Lesson 8: The Unit Circle</b>						
8.A	8.A	<p>Constructing Sinusoidals From Circles</p> <p><i>Graph the horizontal and vertical coordinates of a point as it moves around a circle</i></p> <p><i>Interpret circle diagrams in the context of a model</i></p>	87	69	109	8.A
8.B	8.B	<p>The Sine and Cosine Functions</p> <p><i>Compute some important values of the sine and cosine functions using the unit circle</i></p> <p><i>Evaluate and graph the sine and cosine functions using a graphing calculator or app, using radians appropriately</i></p> <p><i>Interpret formulas for sinusoidal functions in the context of a model</i></p>	91	73	112	8.B
8.C	8.C	<p>Special Angles</p> <p><i>Locate special angles on the unit circle</i></p> <p><i>Give measures of special angles on the unit circle, both in degrees and in radians</i></p> <p><i>Compute exact values for the sine and cosine of these special angles</i></p>	95	77	116	8.C
8.D	8.D	<p>Special Values of Sinusoidal Functions</p> <p><i>Locate the special points on the graphs of sinusoidal functions</i></p> <p><i>Interpret the special points of a sinusoidal function in the context of a model</i></p>	101	81	120	8.D

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<b>Lesson 9: Circles and Sinusoidal Models</b>						
		Non-Unit Circles <i>Model a physical situation using a non-unit circle</i>				
9.A	9.A	<i>Sketch the graph of a sine or cosine function represented by a non-unit circle</i> <i>Find a formula for a sine or cosine function represented by a non unit circle</i>	105	85	124	9.A
		Changes in Angle and Radius <i>Find the (x,y) coordinates of points on a nonunit circle</i>				
9.B	9.B	<i>Find the radius of a non-unit circle and an angle to correspond to a point (x,y)</i> <i>Describe how changes in angle and radius affect the location of points</i>	110	89	130	9.B
		Damped Harmonic Motion				
9.C	9.C	<i>Model damped harmonic motion with a function using formulas and graphs</i>	114	93	135	9.C
<b>Lesson 10: Analyzing Sinusoidal Functions</b>						
		Modeling the Motion of a Pendulum <i>Write and graph equations that model the oscillations of a pendulum</i> <i>Identify those parameters that affect the amplitude of a pendulum's motion</i>				
10.A	10.A		118	97	139	10.A
		Modeling Cell Phone Signals <i>Write equations that model the oscillations of a pendulum</i> <i>Identify those parameters that affect the amplitude of a pendulum's motion</i>				
10.B	10.B		123	101	143	10.B
		Modeling the Vibration of a Cell Phone <i>Determine the amount of horizontal shift present in a sine function</i>				
10.C	10.C		129	105	148	10.C

Lesson	Preview Assignment	Lesson Title and Description	In-Class Activities with Answers	In-Class Activities (Student)	Lesson Planning Suggestions	Practice Assignment
<b>Lesson 11: Transformations of Sinusoidal Functions</b>						
11.A	11.A	Staying Current Around the World <i>Starting with a formula, calculate the period and amplitude of a sine function and use this information to produce a graph of the function</i> <i>Estimate the period and amplitude of a sine function from its graph</i>	135	109	153	11.A
11.B	11.B	Periodic Models with Vertical Shifts <i>Determine maximum and minimum values (and when they occur) of a sinusoidal model</i> <i>Determine the period of a sinusoidal model</i> <i>Explain the similarities and differences after a function has undergone a vertical shift</i>	141	113	158	11.B
11.C	11.C	Periodic Models with Horizontal Shifts <i>Make appropriate changes to an algebraic model to result in the necessary horizontal shift</i> <i>Discuss how different parameters will affect the amplitude, period, vertical shift, and horizontal shifts of sine functions</i>	144	115	162	11.C
<b>Lesson 12: Describing Change in Sinusoidal Functions</b>						
12.A	12.A	Rate of Change of Sine <i>Compute the average rate of change of <math>\sin x</math></i> <i>Determine a formula for the average rate of change of <math>\sin x</math></i> <i>Use technology to graph the average rate of change of <math>\sin x</math></i>	148	119	166	12.A
12.B	12.B	A Closer Look at Rate of Change of Sine <i>Examine, compute, and compare the maximum average rate of change for a variety of sine functions</i>	151	121	170	12.B

Lesson	Preview Assignment	Lesson Title and Description	In-Class Activities with Answers	In-Class Activities (Student)	Lesson Planning Suggestions	Practice Assignment
12.C	12.C	<p>Applications of Rate of Change of Sine</p> <p><i>Use a graph to estimate where the greatest average rate of change may occur</i></p> <p><i>Calculate the average rate of change of a complex function</i></p> <p><i>Determine when oscillations have decreased below a given criterion</i></p>	162	125	175	12.C
12.D	12.D	<p>Amplitude Decay of Sine Functions</p> <p><i>Determine the formula for a function given its graph</i></p> <p><i>Identify how the amplitude of a given function decays</i></p>	169	129	179	12.D
<b>Lesson 13: Right Triangle Trigonometry</b>						
13.A	13.A	<p>From Circles to Triangles</p> <p><i>Use sine and cosine to determine side lengths of a right triangle</i></p>	172	131	183	13.A
13.B	13.B	<p>From Circles to Triangles (Continued)</p> <p><i>Use sine and cosine to determine side lengths of a right triangle</i></p>	177	135	187	13.B
13.C	13.C	<p>Hypotenuse Trouble</p> <p><i>Use the right triangle definitions of sine and cosine to find the hypotenuse of a right triangle when given a leg and an acute angle</i></p> <p><i>Find a second leg using the Pythagorean theorem once the hypotenuse and the first leg are known</i></p>	180	137	192	13.C
13.D	13.D	<p>A Sine of Things to Come</p> <p><i>Solve for a missing leg of a right triangle when given one leg and an acute angle without solving for the hypotenuse first</i></p>	182	139	196	13.D

Lesson	Preview Assignment	Lesson Title and Description	In-Class Activities with Answers	In-Class Activities (Student)	Lesson Planning Suggestions	Practice Assignment
<b>Lesson 14: Inverse Trigonometric Functions</b>						
		Does Inverse Cosine Exist? <i>Identify a reasonable restricted domain for the cosine function</i>				
14.A	14.A	Determine the domain and range of the inverse cosine function <i>Evaluate inverse cosine at several special values</i>	185	143	200	14.A
		Understanding the Inverse Cosine Functions <i>Plot points on the graph of an inverse function given points on the graph of the function</i>				
14.B	14.B	Use the graph of a function to help determine the steepness of the graph of the inverse function <i>Sketch a graph of the inverse cosine function</i>	189	147	204	14.B
		Is This Ladder Safe? <i>Use inverse sine and cosine to determine when a ladder is being used safely</i>				
14.C	14.C	Solve simple expressions using inverse sine and cosine	193	151	208	14.C
<b>Lesson 15: Solving Trigonometric Equations</b>						
		Equations Involving Sine and Cosine <i>Solve for an unknown angle in an equation involving sine or cosine</i>				
15.A	15.A	Use a calculator or app to evaluate inverse sine and inverse cosine <i>Use a model involving inverse trigonometric functions to make decisions about a physical situation</i>	196	153	212	15.A
		Solving for Obtuse Angles <i>Find angle measures in the first and second quadrants corresponding to values of sine and cosine</i>				
15.B	15.B	Determine the correct angle corresponding to a given value of sine or cosine, in the context of a problem	200	157	217	15.B

<b>Lesson</b>	<b>Preview Assignment</b>	<b>Lesson Title and Description</b>	<b>In-Class Activities with Answers</b>	<b>In-Class Activities (Student)</b>	<b>Lesson Planning Suggestions</b>	<b>Practice Assignment</b>
15.C	15.C	Choosing the Quadrant <i>Solve and Equation involving sine or cosine for an unknown angle in a specified quadrant or interval</i> <i>Find multiple solutions for a trigonometric equation</i>	204	161	222	15.C
15.D	15.D	Solving Trigonometric Equations <i>Find all of the solutions to an equation involving sine or cosine within a specified interval</i>	209	165	226	15.D
<b>Lesson 16: The Pythagorean Identity and Polar Curves</b>						
16.A	16.A	The Pythagorean Identity <i>Prove identities using the Pythagorean identity</i> <i>Use the Pythagorean identity to find values of sine and cosine</i>	213	169	231	16.A
16.B	16.B	Is My Answer Right? <i>Use the Pythagorean identity to rewrite trigonometric expressions in equivalent forms</i>	216	171	236	16.B
16.C	16.C	Polar Graphs <i>Plot Points in Polar Coordinates</i> <i>Use Technology to produce graphs of polar curves</i>	220	173	241	16.C
16.D	16.D	A Gallery of Polar Curves <i>Convert a Cartesian equation to polar form</i> <i>Graph polar curves using technology</i>	225	117	247	16.D

Lesson	Preview Assignment	Lesson Title and Description	In-Class Activities with Answers	In-Class Activities (Student)	Lesson Planning Suggestions	Practice Assignment
<b>Lesson 17: Sum and Difference Identities</b>						
		Angle and Sum Identities				
17.A	17.A	<i>Apply the angle sum identities for sine and cosine</i>	232	181	252	17.A
		What's the Difference				
17.B	17.B	<i>Manipulate trigonometric expressions using the angle sum and difference identities for sine and cosine</i>	236	183	256	17.B
		Guitar Harmonics				
17.C	17.C	<i>Manipulate trigonometric expressions using the angle sum and difference formulas for sine and cosine</i> <i>Determine the locations of the nodes of a standing wave</i>	241	185	260	17.C
		In Tune				
17.D	17.D	<i>Use a sum-to-product identity to rewrite and analyze the sum of two sine functions</i>	246	189	266	17.D
<b>Lesson 18: Double and Half-Angle Formulas</b>						
		Projectile Motion				
18.A	18.A	<i>Use the double-angle formula for sine to maximize certain trigonometric expressions</i> <i>Use the double-angle formula to determine the sine of twice an angle based on the sine and cosine of the original angle</i>	250	191	272	18.A
		Malus' Law				
18.B	18.B	<i>Use the double angle formula for cosine to solve equations involving a <math>\cos^2(x)</math></i> <i>Use the double angle formula to determine the cosine of twice an angle based on the sine and cosine of the original angle</i>	255	195	277	18.B



<b>Lesson</b>	<b>Preview Assignment</b>	<b>Lesson Title and Description</b>	<b>In-Class Activities with Answers</b>	<b>In-Class Activities (Student)</b>	<b>Lesson Planning Suggestions</b>	<b>Practice Assignment</b>
18.C	18.C	Planetary Motion <i>Use the half angle formulas to compute the sine and cosine values of a half angle based on the sine and cosine values of the original angle</i>	259	199	281	18.C
18.D	18.D	Circular Motion <i>Solve a trigonometric equation by obtaining common arguments for all trigonometric functions</i>	264	203	286	18.D
<b>Lesson 19: Law of Sines and Law of Cosines</b>						
19.A	19.A	The Montreal Tower <i>Solve oblique triangles in which two angles and one side are known</i>	268	205	290	19.A
19.B	19.B	Can You Hear Me Now? <i>Use the Law of Sines to determine missing angles in triangles</i>	272	209	295	19.B
19.C	19.C	Play Ball! <i>Use the Law of Cosines to find the missing side of a triangle when two sides and the angle between them are given</i>	277	213	300	19.C
19.D	19.D	Here Comes the Sun <i>Find the missing angles in a triangle when all three sides are known</i>	282	217	304	19.D
19.E	19.E	Sines or Cosines? <i>Develop a strategy for solving a given oblique triangle</i>	286	219	309	19.E
<b>Lesson 20: Secant and Tangent Functions</b>						
20.A	20.A	The Tangent Function <i>Use the tangent function to determine unknown lengths in a right triangle</i>	290	221	315	20.A
20.B	20.B	Graphing the Tangent Function <i>Sketch the graph of the tangent function Interpret the graph of the tangent function in the context of a model</i>	295	225	319	20.B

<b>Lesson</b>	<b>Preview Assignment</b>	<b>Lesson Title and Description</b>	<b>In-Class Activities with Answers</b>	<b>In-Class Activities (Student)</b>	<b>Lesson Planning Suggestions</b>	<b>Practice Assignment</b>
20.C	20.C	<p>The Inverse Tangent Function</p> <p><i>Use the inverse tangent function to model a physical situation</i></p> <p><i>Use the inverse tangent function to find an unknown angle in a right triangle</i></p>	300	229	323	20.C
20.D	20.D	<p>The Secant Function</p> <p><i>Use the decant function to compute missing lengths of a right triangle</i></p>	304	231	327	20.D
20.E	20.E	<p>Identities Involving Secant and Tangent</p> <p><i>Derive identities for tangent and secant using the identities for sine and cosine</i></p> <p><i>Interpret the identities for tangent and secant in the context of a physical problem</i></p>	308	235	331	20.E
<b>Lesson 21: Cosecant and Cotangent Functions</b>						
21.A	21.A	<p>The Cotangent Function</p> <p><i>Use the cotangent function to solve problems involving right triangles</i></p> <p><i>Interpret the graph of the cotangent function in the context of a model</i></p>	312	239	335	21.A
21.B	21.B	<p>Inverting the Cotangent Function</p> <p><i>Solve an equation involving the cotangent function for an unknown angle</i></p> <p><i>Graph the inverse cotangent function using a calculator or app and interpret the graph in the context of a model</i></p>	317	243	339	21.B
21.C	21.C	<p>The Cosecant Function</p> <p><i>Model relationships between quantities using the cosecant function</i></p> <p><i>Interpret the graph of the cosecant function in the context of a model</i></p> <p><i>Derive some identities involving the cosecant funtion</i></p>	321	245	345	21.C

<b>Lesson</b>	<b>Preview Assignment</b>	<b>Lesson Title and Description</b>	<b>In-Class Activities with Answers</b>	<b>In-Class Activities (Student)</b>	<b>Lesson Planning Suggestions</b>	<b>Practice Assignment</b>
		Inverses of Secant and Cosecant <i>Write the inverse secant and the inverse cosecant in terms of the inverse sine and the inverse cosine</i>				
21.D	21.D	<i>Find the inverses of functions involving secant and cosecant</i>  <i>Interpret inverse function involving secant and cosecant in the context of a model</i>	325	249	350	21.D
<b>Lesson 22: Applications of Periodic Functions</b>						
		Rising Carbon Dioxide <i>Develop a model that incorporates both a large-scale trend along with a smaller scale cyclic behavior</i>				
22.A	22.A		329	253	354	22.A
		Car Wheels <i>Develop a model that incorporates both linear and cyclic behavior</i>				
22.B	22.B		332	255	358	22.B
		Train Wheels <i>Develop a model that incorporated both linear and cyclic behavior</i>				
22.C	22.C		336	257	363	22.C
		Amplitude Modulation <i>Explain how AM radio signals encode information</i> <i>Extract the message and carrier signals from the graph of an AM radio signal</i>				
22.D	22.D		339	259	368	22.D

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