NM Public Education Department

MATHEMATICS: PRE-CALCULUS

END-OF-COURSE EXAM | GRADE 9–12 | YEAR 17–18

ASSESSMENT BLUEPRINT

Purpose Statement

Pre-Calculus

The Pre-Calculus End-of-Course assessment is designed to measure student proficiency of the Common Core State Standards pertaining to Pre-Calculus. This course-level assessment is provided to all students who have completed Pre-Calculus or related courses.

EOC Assessment Aligns to the Following Course Codes:

- 2053 – Pre-Calculus

Intended as a final exam for the course, this is a summative assessment covering a wide range of content, skills, and applications. Scores are reported at the teacher, school, district, and state levels for the purposes of student grades, curriculum review, and—for optional use—as input into the Educator Effectiveness System.

Resources Required for Testing:

- Graphing calculator allowed for all items with the same restrictions as PARCC
- NMPED Pre-Calculus Reference Sheet

"The EOCs are exams written by New Mexico Teachers for New Mexico Students."
During the 2016-17 school year, teachers were brought together in person and online to revise the blueprints. The NMPED extends our gratitude to those who contributed to this improvement process. Although we were unable to implement *every* suggestion due to conflicting viewpoints at times, this blueprint reflects the best collaborative effort among dedicated peers.

NMPED wants to especially recognize the following person(s) who led the revision for this blueprint:

Ronda Davis, Albuquerque Public Schools, Blueprint Lead
Shafiq Chaudhary, New Mexico Public Education Department

Test Specifications Guide

CCSS Standard Identifier	Content Standard	CCSS Focus Cluster
A.APR.A.1 This coding follows the same identifier in the CCSS	*Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.* CCSS Mathematics Standards are located at: http://www.corestandards.org	*Major* PARCC Claims are identified as Major, Supporting, and Additional
	Item Types: Identifies the format of the response for the item. Response modes on the Algebra I EOC may include: MC Multiple Choice MS Multiple Select EE Equation Editor HS Hot Spot	
	Stimulus: Conveys that a question may include a graph, chart, number line, etc., when measuring the specific standard	
	Assessment Limits & Clarifications: Provides additional supporting information	

Pre-Calculus EoC Test Specifications
Based on Common Core Standards

CCSS STANDARD	CONTENT STANDARD	CCSS FOCUS CLUSTER
A.REI.B.4	Solve quadratic equations in one variable.	Supporting: A2 Major: A1
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
A.REI.D.11	Explain why the x-coordinates of the points where the graph of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e. g., using technology to graph the functions, make table of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.	Major: A2 & A1
	ITEM TYPES: MC	
	STIMULUS: Graph	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
A.APR.D.7+	Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.	Major: A2 & A1

CCSS STANDARD	CONTENT STANDARD	CCSS FOCUS CLUSTER
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks may have a context.	
F.IF.C.7.D+	Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.IF.C.7.E	Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.	Supporting: A2
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks may have a context.	
G.SRT.D.9+	Derive the formula $A = 1/2\ ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks have a context.	
G.SRT.D.10+	Prove the Laws of Sines and Cosines and use them to solve problems.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
G.SRT.D.11+	Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).	Plus

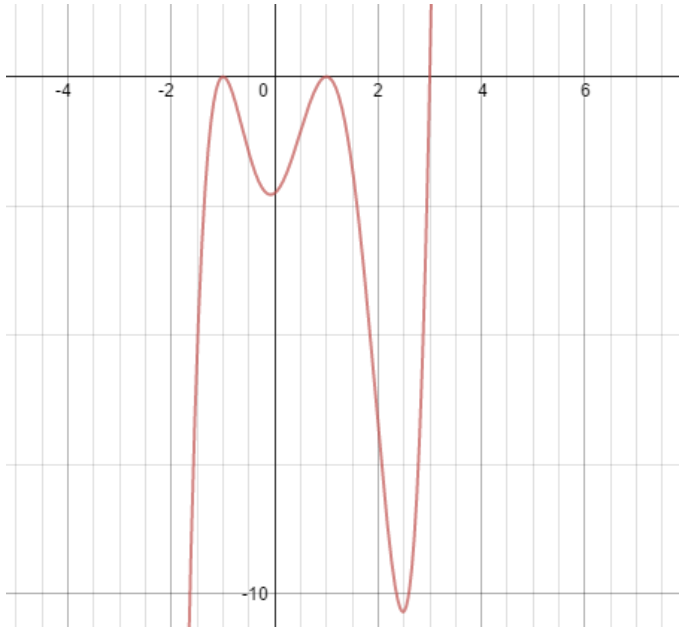
CCSS STANDARD	CONTENT STANDARD	CCSS FOCUS CLUSTER
	ITEM TYPES: MC	
	STIMULUS: Diagram	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.BF.A.1.C+	Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time*.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.BF.B.3	**Build new functions from existing functions.** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.	Additional: A2 & A1
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.BF.B.4	Find inverse functions.	Additional: A2
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a real world context.	
F.TF.A.3+	Use special triangles to determine geometrically the values of sine, cosine, tangent for pi/3, pi/4 and pi/6 and use the unit circle to express the values of sine, cosine, and tangent for pi – x, pi + x, and 2pi – x in terms of their values for x, where x is any real number.	Plus
	ITEM TYPES: MC	

CCSS STANDARD	CONTENT STANDARD	CCSS FOCUS CLUSTER
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: None	
F.TF.A.4+	Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.TF.B.6+	Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks may have a context.	
F.TF.B.7+	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.	Plus
	ITEM TYPES: MC	
	STIMULUS: Diagram	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	
F.TF.C.9+	**Prove and apply trigonometric identities.** Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.	Plus
	ITEM TYPES: MC	
	STIMULUS: None	
	ASSESSMENT LIMITS & CLARIFICATIONS: • Tasks do not have a context.	

Pre - Calculus EoC Reporting Category Alignment Framework						
Reporting Category	**Standard**	**DOK (Item # by DOK)**			**Grand Total**	**CCSS Focus Cluster**
		1	**2**	**3**		
1	A.REI.D.11	1	1		2	Major: A2 & A1
	A.APR.D.7+		2		2	Plus
	A.REI.B.4	1	1		2	Supporting: A2 & Major: A1
2	F.IF.B.4			1	1	Major: A2 & A1
	F.IF.C.7.D+		1		1	Plus
	F.IF.C.7.E	1	1		2	Supporting: A2
3	G.SRT.D.9+	1			1	Plus
	G.SRT.D.10+			1	1	Plus
	G.SRT.D.11+		2	1	3	Plus
4	F.BF.A.1.C+	1	1	1	3	Plus
	F.BF.B.3		1		1	Additional: A2 & A1
	F.BF.B.4	1	1		2	Additional: A2
5	F.TF.A.3+	1	1		2	Plus
	F.TF.A.4+			1	1	Plus
	F.TF.B.6+		1		1	Plus
	F.TF.B.7+		1		1	Plus
	F.TF.C.9+	1		1	2	Plus
	Grand Total	**8**	**14**	**6**	**28**	

Sample Questions

1. Which statement appears to be false about the function graphed below?



A. It has four local extreme values.

B. It is concave up on the approximate interval $(-\frac{1}{2}, \frac{1}{2})$

C. It could be a 3rd degree function.

D. It could be a 5th degree function.

F.IF.C DOK3
Released PED Item

2. Given $f(x) = \log(x)$ and $g(x) = x - 9$. Let $h(x) = f(g(x))$. Which of the following describes the graph of $h(x)$?

A. no x-intercept
no y-intercept
constantly increasing

B. x-intercept is 10
no y-intercept
constantly increasing

C. x-intercept is −8
no y-intercept
constantly increasing

D. x-intercept is 10
no y-intercept
constantly decreasing

F.BF.B DOK 2
Released PED Item

3. Find the equivalent expression of $(\sin\theta + \cos\theta)^2$.

A. $1 + \sin 2\theta$

B. $1 - \sin 2\theta$

C. $1 + \cos 2\theta$

D. $1 - \cos 2\theta$

F.TF.C DOK 3
Released PED Item

4. Given: $\sin\theta = -\frac{15}{17}$ where θ lies in Quadrant IV.

Find: $\cos 2\theta$

A. 1

B. $\frac{23}{17}$

C. $-\frac{7}{17}$

D. $-\frac{161}{289}$

F.TF.C DOK 3
Released PED Item

PARCC

Partnership for Assessment of Readiness for College and Careers

High School Assessment Reference Sheet

1 inch = 2.54 centimeters
1 meter = 39.37 inches
1 mile = 5280 feet
1 mile = 1760 yards
1 mile = 1.609 kilometers

1 kilometer = 0.62 mile
1 pound = 16 ounces
1 pound = 0.454 kilograms
1 kilogram = 2.2 pounds
1 ton = 2000 pounds

1 cup = 8 fluid ounces
1 pint = 2 cups
1 quart = 2 pints
1 gallon = 4 quarts
1 gallon = 3.785 liters
1 liter = 0.264 gallons
1 liter = 1000 cubic centimeters

Triangle	$A = \frac{1}{2}bh$
Parallelogram	$A = bh$
Circle	$A = \pi r^2$
Circle	$C = \pi d$ or $C = 2\pi r$
General Prisms	$V = Bh$
Cylinder	$V = \pi r^2 h$
Sphere	$V = \frac{4}{3}\pi r^3$
Cone	$V = \frac{1}{3}\pi r^2 h$
Pyramid	$V = \frac{1}{3}Bh$

Pythagorean Theorem	$a^2 + b^2 = c^2$
Quadratic Formula	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
Arithmetic Sequence	$a_n = a_1 + (n-1)d$
Geometric Sequence	$a_n = a_1 r^{n-1}$
Geometric Series	$S_n = \frac{a_1 - a_1 r^n}{1 - r}$ where $r \neq 1$
Radians	1 radian $= \frac{180}{\pi}$ degrees
Degrees	1 degree $= \frac{\pi}{180}$ radians
Exponential Growth/Decay	$A = A_0 e^{k(t-t_0)} + B_0$

NMPED PRE-CALCULUS REFERENCE SHEET

Quadratic Formula	Pythagorean Identities
If $a \neq 0$, the solutions of the equation $ax^2 + bx + c = 0$ are given by the formula $$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$	$\sin^2 x + \cos^2 x = 1$ $\tan^2 x + 1 = \sec^2 x$ $1 + \cot^2 x = \csc^2 x$
Half-Angle Identities	**Law of Sines**
$$\sin\frac{u}{2} = \pm\sqrt{\frac{1-\cos u}{2}}$$ $$\cos\frac{u}{2} = \pm\sqrt{\frac{1+\cos u}{2}}$$ $$\tan\frac{u}{2} = \frac{1-\cos u}{\sin u} = \frac{\sin u}{1+\cos u}$$	$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$
Sum and Difference Identities	**Double-Angle Identities**
$\sin(u+v) = \sin u \cos v + \cos u \sin v$ $\sin(u-v) = \sin u \cos v - \cos u \sin v$ $\cos(u+v) = \cos u \cos v - \sin u \sin v$ $\cos(u-v) = \cos u \cos v + \sin u \sin v$ $$\tan(u+v) = \frac{\tan u + \tan v}{1 - \tan u \tan v}$$ $$\tan(u-v) = \frac{\tan u - \tan v}{1 + \tan u \tan v}$$	$\sin 2u = 2\sin u \cos u$ $\cos 2u = \cos^2 u - \sin^2 u$ $$\tan 2u = \frac{2\tan u}{1 - \tan^2 u}$$
Law of Cosines	**Area of a Triangle**
$a^2 = b^2 + c^2 - 2bc\cos A$	Area = $\frac{1}{2}bc\sin A$ Area = $\sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{1}{2}(a+b+c)$