

# Higher Math

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# NTHS Curriculum Syllabus

All listed concepts are from the 4-Level track.

## Algebra II

### Unit 1

Chapter Numbers: 1.1, 2.4, 1.2, 1.3

- Absolute Value Inequalities
- Radicals
- Complex Numbers
- Simplifying Rational Expressions

### Unit 2

Chapter Numbers: 3.1, 3.2, 3.3, 3.4, 2.7, 3.5, 3.7

- Odd/Even Functions
- Composite Functions
- Circles (equation)

### Unit 3

- Solving high degree polynomial equations
- Solving exponential and radical equations
- Graphing exponential and radical functions
- Solving equations with two absolute values
- Domain, Range, Increasing/Decreasing, zeros

### Unit 4

Chapter Numbers: 4.1, 4.2, 4.3

- End behavior (w/o limit notation)
- Descartes' Rule of Signs
- Rational Root Theorem
- Synthetic Division (optional)
- Multiplicity

## Unit 5

### Chapter Numbers: 4.5

- Graphing rational functions
- Oblique asymptotes
- Removable discontinuities
- Simplifying rational expressions

## Trigonometry

## Unit 6

### Chapter Numbers: 5.1, 5.2, 5.3, 5.4, 5.5

- Domain/Range of Inverse Functions
- Logarithms
- Graphing logarithmic functions
- Simplifying logarithmic expressions
- Change of Base Formula
- Exponential growth/decay
- Half-life

## Unit 7

### Chapter Numbers: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6,

- Basic trigonometry functions: sin, cos, tan
- Unit Circle
- Basic trigonometry identities
- Graphing trigonometric functions
  - Period, Amplitude, phase-shift

## Unit 8

### Chapter Numbers: 7.1, 7.2, 7.3, 7.4, 7.6

- Pythagorean Trigonometric Identities
- Cofunction Identities
- Even/Odd Identities
- Sum and Difference Formulae (Trig funcs)
- Double Angle Identities
- Proving Identities
- Solving trigonometric equations
- Inverse trigonometric functions

# Analytic Geometry

## Unit 1: Conics

- Circles
- Parabolas
  - Foci, Directrix, Latus recta
- Ellipses
  - Foci, vertices, covertices, major axis, minor axis, latus recta
  - Eccentricity
- Hyperbolas
  - Vertices, foci, asymptotes, eccentricity, latus recta
  - Directrix

## Unit 2: Transformations

- Terminology
  - Image, pre-image, translated, dilation, invariant, rotation.
- Rotation matrix
- Reflection matrix
- Inverse dilation, inverse rotation, inverse reflection
- Combining transformation matrices.
- Translating axes

## Unit 3: Conic Transformations

- Rotating axes
- "Eliminating the  $xy$  term"

## Unit 4: Polar

- Graphing
- Conversions to Rectangular
- Auxiliary Graphs
- Circles, Parabolas, Ellipses, Hyperbolas in Polar

## Unit 5: Vectors

- Head, tail, magnitude
- Dot product

- Cosine dot product theorem
- Cross product
  - Sine cross product theorem
- 3D Vectors, 3D lines
- Projections
- 3D planes
  - Normal vector
- Distance between points, planes, and lines.

## Unit 6: Cycloids

- Parametric equations
- Graphing cycloids
  - Epicycloid, hypocycloid

## Pre-Calc and Discrete Math

### Unit 1: Counting

- Permutations and Combinations
- Nested sums
- Ball and Urn

### Unit 2: Probability

- Basic and Conditional Probability
  - Probability trees
- Binomial Probability
- Poisson Probability
- Recursive Probability

### Unit 3: Induction

- Proof by Induction
  - Basis step, inductive step
- Divisibility induction
  - Mod function
- Sequences

- Explicit formula, recursive formula

#### Unit 4: Limits

- Notation
- Removable discontinuities with limits
  
- End behavior

#### Unit 5: Graph Theory

- Traveling Salesperson
  - Cycles, total routes, unique routes, vertex, edge, optimal solution
  - Nearest neighbor method
  - Sorted edges method
  - Spanning trees
    - Prim's Algorithm
  
  - Christofides Algorithm
    - Eulerization

#### Unit 6: More Limits

- Secants and Tangents
- Instantaneous rate of change
- Difference quotient

#### AP Calculus BC

##### Unit 1:

- Limit Definition of a Derivative
- Power Rule
- Product Rule
- Quotient Rule
- Trig Derivatives
- Chain Rule
- Implicit Differentiation
- Linearization

##### Unit 2:

- Extreme Value Theorem
- Intermediate Value Theorem

- Mean Value Theorem
- End behavior
- Optimization
- Related Rates

Unit 3:

- Derivatives of inverses
- Derivatives of exponential functions
- Derivatives of logarithmic functions
- Derivatives of inverse trigonometry functions

Unit 4:

- Riemann Sums
- Definite Integrals, Indefinite Integrals
- Fundamental Theorem of Calculus
- U-substitution

Unit 5:

- L' Hospital's Rule
- Area between curves
- Volume of 3D solids
  - Disks, washers
  - Shells
- Integral applications

Unit 6:

- Integration by Parts
- Partial Fractions
- Improper Integrals
- Arc Length
- Trig Substitution

Unit 7:

- Slope Fields
- Euler's Method
- Separation of Variables
- Population Growth
  - Logistic Growth, carrying capacity

Unit 8:

- Derivatives of parametric equations
- Vector calculus
  - Velocity, acceleration vectors, speed
- Polar Arc Length

#### Unit 9:

- N-th term test
- Comparison Test
- Integral Test
- Limit Comparison Test
- Alternating Series
  - Absolute Convergence
- Ratio Test

#### Unit 10:

- Power Series
  - Interval of convergence, radius of convergence, center
- Taylor and Maclaurin Series
- LaGrange Error Estimation

#### AP Computer Science

Textbook: Java Concepts Early Objects, Enhanced e-book, 9th edition

#### Chapters 1, 2, 3

- Constructors
  - Default constructor, parameterized constructors
- Methods
  - Notation, parameters, arguments, return values
- Overloading methods and constructors
- Implicit this
- Object references, instances
- Getter and setter methods

#### Chapter 4

- Primitives, classes
- Integer division, modulus, casting doubles to ints, powers
- Edge cases
- Usage of Epsilon when comparing doubles for equality

## Chapter 5

- Operators
- Comparing floats
- Comparing strings
- DeMorgan's Law
- Short-Circuiting

## Chapter 6

- For loops
- While loops
- Sentinel values
- Tracing

## Chapter 7

- Nested loops
- Enhanced For loops
- Side Effects

## Chapter 8,9

- Object oriented programming
- Polymorphism
- Abstraction
- Encapsulation
- Superclass
- Subclass
- Inheritance

## Chapter 13

- Recursion
- Trace and write recursive methods
- Binary and Hexadecimal
- Tail recursion
- Helper methods

## Chapter 14

- Selection Sort
- Bubble Sort
- Insertion Sort
- Merge Sort

## Multivariable Calculus and Linear Algebra

### Unit 1: Review

- Parametric Equations
- Calculus with Parametric Equations
- Polar
- Areas and Lengths in Polar
- Coordinates in 3D/Vectors
- Dot Product
- Cross Product
- Lines and Planes
- Cylinders and Quadric Surfaces

### Unit 2: Partial Derivatives

- Functions of Several Variables
- Limits and Continuity
- Partial Derivatives
- Tangent Planes and Linear Approximations
- Chain Rule
- Directional Derivatives, Gradient Vectors
- Extrema
- LaGrange Multipliers

### Unit 3:

- Double Integrals over Rectangles
- Double Integrals over General Regions
- Double Integrals in Polar
- Applications
- Surface Area
- Triple Integrals
  - Cartesian, Cylindrical, Spherical
- Change of Variables
- Center of Mass

### Unit 4:

- Vector Functions and Space Curves
- Vector Fields

- Line Integrals
- Fundamental Theorem for Line Integrals
- Green's Theorem
- Curl and Divergence
- Parametric Surfaces and their Areas
- Surface Integrals
- Stokes' Theorem
- Divergence Theorem

#### Unit 5:

- Differential Equations
  - Second-order linear equations
  - Nonhomogeneous Linear Equations
  - Applications

End of MV, start of LA

#### Unit 1:

- Systems of Linear Equations
- Gaussian Elimination
- Matrix Operations
- Inverse and Properties of Matrices
- Elementary Matrices
- Linear Systems and Invertible Matrices
- Diagonal, Triangular, and Symmetric Matrices
- Formal Definition of Functions, Matrix Transformations
- Applications of Linear Systems

#### Unit 2

- Cofactor Expansion
- Row Reduction
- Determinant Properties and Cramer's Rule
- Vectors in  $n$ -space
- Norm, Dot Product, Distance in  $\mathbb{R}^n$
- Orthogonality
- Geometry of Linear Systems
- Cross Product

#### Unit 3:

- Real Vector Spaces
- Subspaces
- Linear Independence

- Coordinates and Basis
- Change of Basis
- Row, Column, and Null Space
- Rank, Nullity

# Geometry

# Geometry PK Correlation

Geometry Mathnasium Material NT Correlation

Unit 1:

## Section 1.1 Symmetry

- Line Symmetry - PK3514
- Point Symmetry -
- Rotational Symmetry - PK3104
- Translational Symmetry - PK3104

## Section 1.2 So, What's the Point

- Definition of a point - PK824
- Definition of a plane - PK824
- Definition of a line - PK824
- Definition of a segment - PK824
- Definition of a ray - PK824
- Union/Intersection - PK824
- Locus of Points/Endpoints - FO2160

## Section 1.3 Nspire Intro

## Section 1.4 Transformations

- Isometries {Translation PK3509, Rotation PK3510, Reflection PK3511, Dilation PK3512}
- Dilations
- Pre-image/image (Steps to transformation) - PK3581

## Section 1.5 Transformations by Hand

- Translating by vectors
- Reflecting across lines - PK3584
- Rotating around a central point

- Dilating from point - PK3583

## Unit 2: Transformations with Coordinates

### Section 2.1 Transformations

- Graphing points/ translating points - PK3509
- Reflecting, rotating, dilating on the graph - PK3511, PK3512

### Section 2.2 Things I Learned in Algebra

- Midpoints - PK3434
- Length of segments - PK3435
- Slopes of lines - PK3408

### Section 2.3 More Geometry and Algebra!

- Altitudes - PK3552
- Perpendicular Bisectors - PK3552
- Medians - PK3552

### Section 2.4 One Magic Moment, One Magical Point

- Solving systems of linear equations/finding the intersection of lines - {Substitution PK3417, Elimination PK3418, Graphing PK3416, Problem-Solving PK3452}
- Reflecting points over oblique lines - PK3584
- Determining medians/perpendicular bisectors on shapes graphically
- Distance between two lines -

## Unit 3: Congruent Triangles

### Section 3.1 It's Only Logical

- Conditional Statements - PK3530

### Section 3.2 Three is a Magic Number

- AAS, SAS, SSS, ASA - PK4571, PK4570
- Describing transformations

### Section 3.3 Congruent Triangles

- Vertical Angles - PK3580, PK3572, PK3573
- Reflexive Property - PK3533
- Transitive Property - PK3533
- Two-column proofs - PK3533

#### Section 3.4 Supps and Comps

- Complementary angles - PK3507
- Supplementary angles - PK3507
- Corresponding supp/comp proof reasons

#### Section 3.5 Addition and Subtraction

- Addition theorem - PK3566
- Subtraction theorem

#### Section 3.6 Multiplication and Division

- Multiplication theorem
- Division theorem

### Unit 4: Constructions

#### Section 4.1: The Basics

- Copying a segment - FO0023
- Adding segments - FO0023
- Copying an angle - FO0023
- Bisecting an angle - FO0023
- Constructing SSS triangle
- Triangle Inequality Theorem

#### Section 4.2: Constructing Perpendiculars

- Constructing a perpendicular bisector - FO0023
- Construct a perpendicular to a segment - FO0023
- Construct a perpendicular to a line through a point not on the line

#### Section 4.3 Points of Concurrency

- Point of concurrency - PK3559
- Incenter - PK3559
- Circumcenter - PK3559

- Centroid - PK3559
- Orthocenter - PK3559

## Unit 5: Proving Triangles Congruent is Not the Goal, It's the Process

### Section 5.1: The End of CPCTC

- "CPCTC" - PK3573 (page 6)
- Circles - Congruent Radii

### Section 5.2: Turn It Up To 11: Draw a line & overlapping triangles

### Section 5.3: Classify Triangles

- The sum of triangle angles equals 180
- Equilateral, Isosceles, Scalene - PK3099
- Acute, Right, Obtuse Triangles - FO111
- The longest side is opposite the largest angle

### Section 5.4: My Favorite Theorems

- Isosceles - base angle/base sides
- Isosceles - angle bisector = median = altitude

### Section 5.5: RHL

- RHL Proof

## Unit 6: The Next Chapter

### Section 6.1: The Questions of Mathematics

- If two angles supp and comp  $\rightarrow$  rt angles

### Section 6.2: No Picture? Then Make a Picture

- Draw it out

### Section 6.3: Perpendicular Bisector and Equidistance

- If a pt is on the perp bisector, it is central to the endpoints
- If two points are equidistant to the endpoints of a seg -> they form the perp bisector

#### Section 6.4: If It's Not This, Then It's Got To Be This 404

- Proof by Contradiction

### Unit 7: Lines, Angles, Quads

#### Section 7.1: Parallel Lines

- Transversal
- Alternate Interior Angles, Alternate Exterior Angles, Corresponding Angles, Same Same Interior Angles - FO272

#### Section 7.2: Parallel Lines Keep Going

- Constructing parallel lines

#### Section 7.3: Quadrilaterals

- Definition of a quadrilateral
- Properties of a parallelogram
- Properties of a kite
- Properties of a rectangle
- Properties of a rhombus
- Properties of a square
- properties of a trapezoid
- Properties of a isosceles trapezoid - PK3099

#### Section 7.4: More Quadrilaterals

- Solving problems involving properties of quads

#### Section 7.5: It looks like a parallelogram

- Properties of a parallelogram
  - Both pairs of opposite sides are parallel
  - Both pairs of opposite sides are congruent
  - Both diagonals bisected
  - Same pair of opposite sides and congruent = parallelogram
  - The sum of angles in quadrilaterals is 360.

## Section 7.6: Special Quads

- Solving problems using obscure properties of quads.

## Unit 8: Similarity

### Section 8.1: Dilations

### Section 8.2: Dilations pt. Deux

### Section 8.3: Similarity

### Section 8.4: Proving Similar Triangles

### Section 8.5: Proportions Without Similar Triangles

## Unit 9: Right Triangles

### Section 9.1: Rt Triangle inside a Rt Triangle

### Section 9.2: Pythagorean Theorem - PK3363

### Section 9.3: Right Triangle Families - PK3363

### Section 9.4: Rt Triangles in 3D Figures -

### Section 9.5: Special Right Triangles - PK3561

### Section 9.6: Right Triangle Trigonometry - PK3916

### Law of Cosines - PK3914, PK3915

### Law of Sines - PK3913, PK3915

## Unit 10: Polygons

Section 10.1: Polygon Formulas - PK3501, PK3550, PK3551

Section 10.2: What is Regular? - PK3501

Section 10.3: Constructing of Regular Polygons - FO 023 (page 29)

Section 10.4: Tessellations - FO 194

Unit 11: Circles

Section 11.1: Chords of Circles - PK3562

Section 11.2: From the Center to the Arc

Section 11.3: Tangents - PK3569

Section 11.4: Angle-Arc Relationships - PK3568

Section 11.5: Arcs have Length and Measure - PK3588

Section 11.6: Power of the Poin

Unit 12: Area

Section 12.1: Area Basics - PK3089

Section 12.2: More Area Formulas - PK3362(Rectangles), PK3364(Triangles), PK3365(Circles), PK3523(Parallelograms), PK3524(Trapezoids)

Section 12.3: Regular Polygons - PK3590

Section 12.4: Sectors of Circles - PK3588

Section 12.5: Ratios of Areas - PK3582

Unit 13: 3D

Section 13.1: Lines and Planes in Space - PK0804 (skew lines)

Section 13.2: If You Look At It That Way - ???

Section 13.3: Cross-Sections of 3D Objects - FO 242, FO 188

Unit 14: Surface Area and Volume

Section 14.1: Surface Area - PK3527, PK3595

Section 14.2: SA of Cylinders and Cones - PK3527, PK3595

Section 14.3: Volume Basics - PK3528, PK3596

Section 14.4: Volumes with an Apex - PK3528, PK3596

Section 14.5: Spheres - PK3555

Unit 15: Modeling - Difficult to find any Mathnasium material with geometric modeling. PK3534 and PK3535 have some geometric problem-solving

Section 15.1: Intro to Modeling

Section 15.2: Art Gallery Watchmen

Section 15.3: Packaging and Packing

Section 15.4: Airports

Geometry

# New Trier Geometry Textbook Reviews + Answer Keys

[link](#)

# Algebra 2

Algebra 2

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# Calculus

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