Core Energy Math

Presented by
Illinois Petroleum Resources Board (IPRB)

Original Core Energy Curriculum
Courtesy of Oklahoma Energy Resources Board (OERB)

Aligned to Illinois and Common Core Standards

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What is the IPRB?

The **Illinois Petroleum Resources Board** formed to provide public awareness and education programs and to clean up abandoned well sites throughout the state. Funding for IPRB programs comes from voluntary contributions of oil and natural gas producers and royalty owners in Illinois.

IPRB provides funding and expertise in the reclamation and restoration of abandoned oilfield sites in the State of Illinois. These restoration projects fulfill another goal of IPRB which is to restore abandoned sites previously used for oil and gas production back to commercial or agricultural use for current land owners.

The IPRB Traveling Field Trip Exhibit is FREE to any school or special event in the State. The Exhibit features working models of crude oil and natural gas equipment, and graphical learning stations which students must "explore" to find energy information. Students learn how oil and gas are formed, where and how it is found, and how it is produced and refined. Presentations can be tailored to students of all ages, but our primary concentration is students beginning with the 4th grade through high school.

For more information about the IPRB and free education programs, please visit the IPRB website at iprb.org, contact us at iprb@yahoo.com or call the Illinois Petroleum Resources Board at 618-242-2861.

One of our most important missions is Energy Education! Our program serves two primary goals:

1. To develop and design oil and natural gas education activities for K-12 teachers and students in Illinois.

2. To provide teachers with:
- Workshops statewide that provide free training and resources in energy education
- Educational field trips for students and teachers
- Professional development hours
- Other education resources that help interest students in science and math, energy, and their understanding of how Illinois crude oil and natural gas are an important part of the energy picture and the Illinois economy.

Professional development

The IPRB will provide professional development for use of this curriculum. To receive information on professional development sessions, please contact the IPRB at 618-242-2861 or email office@iprb.org.

Production Profit

The new Illinois Learning Standards incorporating the Common Core Mathematics

Expressions and Equations

CC.8.EE5 Understand the connections between proportional relationships, lines, and linear equations. Graph proportional relationship, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance time equation to determine which of two moving objects has greater speed.

CC.8.EE.7 Analyze and solve linear equations and pairs of simultaneous linear equations. Solve linear equations in one variable.

CC.8EE.8 Analyze and solve linear equations and pairs of simultaneous linear equations. Analyze and solve pairs of simultaneous linear equations.

CC.8EE.8a Understand that solutions to a system of two linear equations in two variables correspond to points of intersections of their graphs, because points of intersection satisfy both equations simultaneously.

CC.8EE.8b Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x+2y=5 and 3x=2y=6 have no solution because 3x+2y cannot simultaneously be 5 and 6.

CC.8EE.8c   Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

CC.8.F.5 Use functions to model relationships between quantities. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Functions

CC.8.F. 1 Define, evaluate, and compare functions. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

CC.8.F.2 Define, evaluate and compare functions. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change

CC.8.F.4 Use functions to model relationships between quantities. Construct a function to model al linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Algebra

CC.9-12A. CED.2 Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

CC.9-12.CED Create equations that describe numbers or relationship. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

CC.9-12A.REI.6 Solve systems of equations. Solve systems of linear equations exactly and approximately (e.g. with graphs), focusing on pairs of linear equations in two variables.

CC.9-12.A.REI.10 Represent and solve equations and inequalities graphically. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

CC.9-12.A.REI.11 Explain why the x-coordinates of the points where the graphs 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 tables 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.

CC.9-12.A.REI.12 Represent and solve equations and inequalities graphically. Graph the solutions to a linear inequality in two variables as a half-plane(excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

CC.9-12.F.IF.1. Build a function that models a relationship between two quantities. Write a function that describes a relationship between two quantities.

CC.9-12.F.IF.4 Interpret functions that arise in applications in terms of the context. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of quantities, and sketch graphs showing the 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.

CC.9-12.F.IF.6 Interpret functions that arise in applications in terms of the context. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

CC.9-12.F.IF.7 Analyze functions using different representations. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Statistics and Probability

CC.9-121.S.ID.6 Summarize, represent, and interpret data on two categorical and quantitative variables. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

CC.9-12.S.ID.7 Interpret linear models. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

CC.9-12.S.IC3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

Quantities

CC.9-12.N.Q.1 Reason quantitatively and use units to solve problems. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Drill in the Right Direction

The new Illinois Learning Standards incorporating the Common Core Mathematics

Expressions and Equations

CC.8EE.8c   Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Functions

CC.8.F. 1 Define, evaluate, and compare functions. Understand that a function is a rule that assigns to each input exactly on output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

CC.8.F.4 Use functions to model relationships between quantities. Construct a function to model al linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Geometry

CC.8.G7 Understand and apply the Pythagorean Theorem. Apply the Pythagorean Theorem to determine unknown sided lengths in right triangles in real-world and mathematical problems in two and three dimensions.

CC.8.G.8 Understand and apply the Pythagorean Theorem. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

CC.8.G.9   Solve real-world and mathematical problems involving volume of cylinders, cones and spheres. Know the formulas for the volume of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Algebra

CC.9-12.A.CED.1 Create equations that describe numbers or relationships. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

CC.9-12A. CED.2 Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Functions

CC.9-12.F.IF.1 Understand the concept of a function and use function notation. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

CC.9-12.F.IF.2 Understand the concept of a function and use function notation. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

CC.9-12.F.IF.6 Interpret functions that arise in applications in terms of the context. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

CC.9-12.F.LE.2 Construct and compare linear, quadratic, and exponential modes and solve problems. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Geometry

CC.9-12.G.SRT.8 Define trigonometric ratios and solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

CC.9-12. G.GPE.5 Use coordinates to prove simple geometric theorems algebraically. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes though a given point).

CC.9-12. GMD.3 Explain volume formulas and use them to solve problems. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

CC.9-12.GMG.1 Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

CC.9-12.G.MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Statistics and Probability

CC.9-12.S.IF.7 Interpret linear models. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Got Oil

The new Illinois Learning Standards incorporating the Common Core Mathematics

Functions

CC.9-12.F.IF.4 Interpret functions that arise in applications in terms of the context.
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.*

CC.9-12.F.IF.6 Interpret functions that arise in applications in terms of the context.
Calculate and interpret the average rate of change of a function presented sym
bolically or as a table) over a specified interval. Estimate the rate of change
from a graph.*

Statistics and Probability

CC.9-12.S.ID.6 Summarize, represent, and interpret data on two categorical and
quantitative variables.
Represent data on two quantitative variables on a scatter plot, and describe how
the variables are related.
a. Fit a function to the data; use functions fitted to data to solve problems in
the context of the data. Use given functions or choose a function suggested by
the context. Emphasize linear, quadratic, and exponential models.
b. Informally assess the fit of a function by plotting and analyzing residuals.
c. Fit a linear function for a scatter plot that suggests a linear association.

Find the Land Man

The new Illinois Learning Standards incorporating the Common Core Mathematics

Geometry

CC.8.G7 Understand and apply the Pythagorean Theorem. Apply the Pythagorean Theorem to determine unknown sided lengths in right triangles in real-world and mathematical problems in two and three dimensions.

Geometry

CC.9-12.G.SRT.8 Define trigonometric ratios and solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
CC.9-12.GMG.1 Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

Statistics and Probability

CC.9-12.S.ID.6 Summarize, represent, and interpret data on two categorical and quantitative variables. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
CC.9-12.S.IF.7 Interpret linear models. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Illinois Petroleum Resource Board
Middle School Math Common Core Standards

4-MD-3
Apply the area and perimeter formulas for rectangles in real world and mathematical problems.

For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.

5-NF-6
Apply and extend previous understanding of multiplication and division to multiply and divide fractions.

Solve real world problems involving multi-application of fractions and mixed numbers. –e.g., by using visual fraction models or equations to represent the problem.

5-NF-7C
Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Solve real-world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions. e.g., by using visual fraction models and equations to represent the problem. For example, how much chocolate will each person get if 3 people share ½ lb of chocolate equally? How many 1/3-cup servings are in 2 cups of raisins?

5-MD-5   **Geometric Measurement: understand concepts of volume and relate volume to multiplication and to addition. Relate volume to the operations of multiplication and addition to solve real world and mathematical problems involving volume.**

5-MD-5b   **Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.**

Apply the formulas V = (l)(w)(h) and V = (b)(h) for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.

5-MD-5c   **Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.**

Recognize volume as additive. Find volumes of solid figures composed of non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.

5-G-1   Graph points on the coordinate plane to solve real-world and mathematical problems. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the

second axis, with the convention that the names of the two axes and the
coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

5-G-2   Graph points on the coordinate plane to solve real-world and mathematical problems.

Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

6-RP-3   **Understand ratio concepts and use ratio reasoning to solve problems.**

Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

6-NS-7c   **Apply and extend previous understandings of numbers to the system of rational numbers.**

Understand ordering and absolute value of rational numbers. Understand the absolute value of a rational number as its distance from 0 on the number line; interpret absolute value as magnitude for a positive or negative quantity in a real-world situation. For example, for an account balance of –30 dollars, write |–30| = 30 to describe the size of the debt in dollars.

6-NS-8   **Apply and extend previous understandings of numbers to the system of rational numbers.**

Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

6-EE-2C   **Apply and extend previous understandings of arithmetic to algebraic expressions.**

Write, read, and evaluate expressions in which letters stand for numbers.

Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of length s = 1/2.

6-EE-6   **Reason about and solve one-variable equations and inequalities.**

Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

6-EE-7   **Reason about and solve one-variable equations and inequalities.**

Solve real-world and mathematical problems by writing and solving equations of the form x + p = q and px = q for cases in which p, q and x are all nonnegative rational numbers.

6-EE-8   **Reason about and solve one-variable equations and inequalities.**

Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams.

6-EE-9   **Represent and analyze quantitative relationships between dependent and independent variables.**

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.*

6-G-1   **Solve real-world and mathematical problems involving area, surface area, and volume.**

Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

6-G-2   **Solve real-world and mathematical problems involving area, surface area, and volume.**

Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and then show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = l\,w\,h$ and $V = b\,h$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

6-G-3   **Solve real-world and mathematical problems involving area, surface area, and volume.**

Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

6-G-4   **Solve real-world and mathematical problems involving area, surface area, and volume.**

Represent three-dimensional figures using nets made up of rectangles and triangles, and then use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

7-RP-1   **Analyze proportional relationships and use them to solve real-world and mathematical problems.**

Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. *For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction 1/2/1/4 miles per hour, equivalently 2 miles per hour.*

7-RP-2   **Analyze proportional relationships and use them to solve real-world and mathematical problems.**

Recognize and represent proportional relationships between quantities.

7-RP-3   **Analyze proportional relationships and use them to solve real-world and mathematical problems.**

Use proportional relationships to solve multistep ratio and percent problems. *Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.*

7-NS-2B   **Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.**

Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.

Understand that integers can be divided, provided that the divison is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then $-(p/q) = (-p)/q = p/(-q)$. Interpret quotients of rational numbers by describing realworld contexts.

7-NS-3   **Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.**

Solve real-world and mathematical problems involving the four operations with rational numbers.

7-EE-3   **Solve real-life and mathematical problems using numerical and algebraic expressions and equations.**

Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *For example: If a*

woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.

7-EE-4   **Solve real-life and mathematical problems using numerical and algebraic expressions and equations.**

Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

7-G-4   **Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.**

Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

7-G-5   **Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.**

Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.

7-G-6   **Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.**

Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

8-EE-8c   **Analyze and solve linear equations and pairs of simultaneous linear equations.**

Analyze and solve pairs of simultaneous linear equations.

Solve real-world and mathematical problems leading to two linear equations in two variables. *For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.*

8-G-9   **Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.**

Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.