



Quantum Tutors Content Index

Please use this document as a teaching/learning reference guide to ensure that you get the most benefit from the Quantum Tutors. If you have any questions or need assistance, please contact:

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Quantum Tutors: Chemistry

MEASUREMENT TUTOR

Primary Learning Objectives

- Estimating using metric units
- Developing familiarity with common metric units
- Common metric units of length, volume and mass
- Name, symbol and size of most metric units
- Metric measuring devices appropriate for middle and high school
- Precision of common metric measuring devices
- Significant figures associated with common metric measuring devices
- Proper form for measurements taken with common metric measuring devices
- Range of common metric measuring devices
- Dimensions associated with common metric measuring devices
- Limitations of common metric measuring devices

Secondary Learning Objectives

- Working definitions of all necessary scientific terms
- Modeling of organized problem-solving techniques
- Selection of appropriate metric units
- Conversion between some common metric units
- Relationship between some common metric and English units
- Dealing with significant figures in metric conversion
- Definition of most common metric units
- Relationship between significant figures and metric conversion
- Relationship between units and dimensions
- Identifying common errors in recording measurements

ELEMENTS TUTOR

Primary Learning Objectives

- Recognition of common elements
- Correct form for a chemical symbol
- Symbols for the common elements
- Properties of the common elements
- Uses of the common elements
- Where to find common elements in your community

Secondary Learning Objectives

- How to find an element on the periodic table
- Names of the families of elements
- Location of the families of elements on the periodic table
- Relationship between an element's activity and its location on the periodic table
- Elements that have special characteristics
- Elements that are necessary in the human diet
- How chemical symbols are used to write chemical formulas
- Encouraging safety in handling chemicals
- Identifying common errors in writing chemical symbols

IONIC COMPOUND FORMULAS TUTOR

Primary Learning Objectives

- Common cations
- Common anions
- Combining ions to form chemical formulas
- Nomenclature of ionic compounds
- Correct form for an ionic compound formula
- Meaning of a subscript
- Proper use of subscripts
- Charges of the common ions
- Charge conservation in writing an ionic compound formula
- How to determine whether subscripts are necessary
- Interpretation of a chemical formula
- Proper use of parentheses in a chemical formula

Secondary Learning Objectives

- Working definitions of all necessary scientific terms
- Modeling of organized problem-solving techniques
- Symbols for the common elements
- Elements with multiple oxidation numbers
- Polyatomic ions
- Identifying common errors in writing ionic formulas

MATHEMATICS OF CHEMICAL FORMULAS TUTOR

Primary Learning Objectives

- Interpretation of chemical formulas
- Interpretation of subscripts in terms of number of atoms
- Atomic mass and the atomic mass unit
- The concept of formula mass
- Calculating formula mass
- The concept of gram formula mass
- Conversion from formula mass to gram formula mass
- Using gram formula mass to compare the number of formula units of different substances
- The mole and the number of formula units
- Mass and the number of formula units
- Mass of the same number of different formula units
- Percent composition of a compound
- Application of percent composition
- Discussion of the mole concept
- Mass of one mole of any element
- Mass of one mole on any compound
- Conversion from mass to moles
- Conversion from moles to mass
- Determination of empirical formula from percent composition

Secondary Learning Objectives

- Working definitions of all necessary chemical terms
- Modeling of organized problem-solving techniques
- Carbon-12 as the basis for assigning atomic mass
- The value of one atomic mass unit in grams
- Symbol for atomic mass unit
- Relationship between the terms atomic mass and atomic weight
- Reference to the Law of Definite Composition
- Representing a percent as a decimal
- Avogadro's number

EQUATION BALANCING TUTOR

Primary Learning Objectives

- Balancing chemical equations
- The role of coefficients in balancing a chemical equation
- How to determine if an element in an equation is balanced
- How to recognize when a chemical equation is balanced
- A procedure for successfully balancing chemical equations
- How to determine the order to balance elements in a chemical equation
- Handling of free elements in balancing a chemical equation
- Interpretation of a balanced chemical equation in terms of formula units
- Interpretation of a balanced equation in terms of mass

Secondary Learning Objectives

- The role of fractional coefficients in balancing a chemical equation
- Standard form for a balanced equation
- Dealing with polyatomic ions while balancing a chemical equation
- Working definitions of scientific terms
- Identifying common errors in balancing chemical equations
- Application of a balanced chemical equation
- Modeling of successful techniques for balancing chemical equations

OXIDATION NUMBERS TUTOR

Primary Learning Objectives

- Rules for assigning oxidation numbers in compounds
- Rules for assigning oxidation number in polyatomic ions
- Rationale underlying the rules for assigning oxidation numbers
- Order of application of rules for assigning oxidation numbers
- Modeling successful approaches to assigning oxidation numbers
- Charges of the common ions

Secondary Learning Objectives

- Polyatomic ions
- Electronegativity
- Techniques for avoiding common errors in assigning oxidation numbers
- Elements that exhibit multiple oxidation numbers
- Relationship between an element's oxidation number and its location on the periodic table
- Names of the families of elements
- Location of the families of elements on the periodic table
- Similarities among the transition metals
- Distinguishing between charge and oxidation number

STOICHIOMETRY TUTOR

Primary Learning Objectives

- Necessity of a balanced chemical equation
- Application of a balanced chemical equation
- Converting chemical names to chemical formulas
- Application of the mole concept
- The need for the molar unit
- Conversion of grams to moles
- Conversion of moles to grams
- Relationship between coefficients in a balanced chemical equation and molar quantities
- Making stoichiometry calculations
- Mathematics of stoichiometry
- Role of proportional thinking in stoichiometry
- Recognizing a limiting reactant problem
- Identifying the limiting reactant
- How to solve a limiting reactant problem

Secondary Learning Objectives

- Proper representation of metric quantities
- Working definitions of scientific terms
- Application of gram formula mass
- Modeling successful techniques for solving stoichiometry problems
- Encouraging understanding above rote procedure
- Developing ability to predict future steps in the problem solution
- Application of significant figures and rounding

CHEMICAL REACTIONS TUTOR

Primary Learning Objectives

- How to recognize a synthesis (or combination) reaction
- Conditions necessary for a synthesis reaction to occur
- Three common types of synthesis reactions
- How to recognize a decomposition reaction
- Conditions necessary for a decomposition reaction to occur
- Six common types of decomposition reactions
- How to recognize a single replacement reaction
- Conditions necessary for a single replacement reaction to occur
- Four common types of single replacement reactions
- How to recognize a double replacement reaction
- Conditions necessary for a double replacement reaction to occur
- Three common types of double replacement reactions
- How to determine the products in a chemical equation by studying reaction types
- The activity series and how to apply it to chemical reactions
- Solubility and how it relates to chemical reactions

Secondary Learning Objectives

- Chemical nomenclature
- Working definitions of scientific terms
- Acid and acid anhydride
- Base and basic anhydride
- Implications of a free element in an equation

CHEMICAL BONDING TUTOR

Primary Learning Objectives

- What is a chemical bond
- Role of electrons in bond formation
- Ionic bonding
- Characteristics of ionic bonds
- Covalent bonding
- Characteristics of covalent bonds
- Physical properties of ionic compounds
- Physical properties of covalent compounds
- How to predict physical properties like solubility, hardness, physical state, and melting point from bond characteristics
- Electronegativity
- Implications of electronegativity difference
- Ways to predict electronegativity difference from the periodic table
- Role of electronegativity in determining bonding type
- Conditions necessary for a polar bond
- Conditions necessary for a polar molecule
- How to predict bond polarity
- How to predict molecular polarity
- How a polar molecule differs from a nonpolar molecule
- How to observe (or predict) trends on the periodic table
- How to predict an element's characteristics from its location on the periodic table
- Properties of metals
- Properties of nonmetals
- How to predict chemical activity by an element's location on the periodic table
- How to predict whether an element will form a positive or negative ion

Secondary Learning Objectives

- Working definitions of all necessary scientific terms
- Modeling of organized problem-solving techniques
- Diatomic molecules
- Binary compounds
- Why noble gases don't normally form bonds
- Stable octet of electrons
- Valence shell
- Double and triple bonds
- Ionization energy and its implications
- Names of the families of elements
- Location of the families of elements on the periodic table
- Energy associated with bond formation
- Chemical properties of metals and nonmetals
- Molecular geometry

Quantum Tutors: Applied Mathematics for Science

MEASUREMENT TUTOR

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RATIO AND PROPORTION TUTOR

Primary Learning Objectives

- Recognizing characteristics of a ratio and proportion problem
- Understanding the rationale for using ratio and proportion to solve problems
- Using logic to solve ratio and proportion problems
- Identifying when to use ratio and proportion
- Using proper notation
- Understanding the role of units
- Finding helpful clues in ratio and proportion problems
- Estimating an answer
- Modeling successful approaches for solving ratio and proportion problems
- Developing understanding of proportional reasoning
- Alternate forms for the same ratio and proportion problem

Secondary Learning Objectives

- Identifying the known and unknown ratio
- Conversion of common fractions to decimals
- Alternate approaches for solving ratio and proportion problems
- Handling positive and negative signs
- Examples illustrating ratio and proportion from everyday life
- Working definitions of necessary mathematical terms
- Learning how to convert a word problem into mathematical notation

PERCENTAGES TUTOR

Primary Learning Objectives

- Finding a percentage of a number
- Finding the percentage one number is of another
- Finding the number that another number is a percentage of
- Determining the possible limits of an answer
- Interpreting a percentage problem in terms of everyday life
- Developing a mental concept of values expressed in percent
- Identifying important clues in percentage problems
- Modeling successful approaches for solving percentage problems
- Understanding the application and importance of percent concepts
- Using landmark percentages, such as 10% or 50%, for estimating the answer to a percentage problem
- Calculating the exact answer to a percentage problem
- Correctly using the percent sign
- Converting a percent to a fraction

Secondary Learning Objectives

- Working definitions of necessary mathematical terms
- Expressing a percent as a decimal
- Alternate ways to state the same percentage problem
- Using logic in solving percentage problems
- Determining if an estimate is reasonable
- Thinking about percentages greater than 100%
- The value of recognizing 50% of a number
- The role of calculators in learning the concept of percent

SCIENTIFIC NOTATION TUTOR

Primary Learning Objectives

- Determining when to use scientific notation
- Entering an exponent into the Tutor
- Entering a value in scientific notation into the Tutor
- Interpreting an exponent
- Applying powers of ten
- Determining the exponent in scientific notation
- Determining the mantissa in scientific notation
- Determining whether the exponent is positive or negative
- Meaning of positive and negative exponents
- Converting a regular number to scientific notation
- Converting scientific notation to a regular number
- Representing significant figures in scientific notation
- Comparing regular numbers and numbers written in scientific notation
- Identifying equivalent forms of the same number

Secondary Learning Objectives

- Understanding the role of units
- Normalizing a number
- Distinguishing between exponential notation and scientific notation
- Applying scientific notation
- Multiplication, division, addition and subtraction involving numbers written in scientific notation
- Working definitions of necessary mathematical terms

METRIC UNITS TUTOR

Primary Learning Objectives

- Recognizing common metric units of length, mass and volume
- Learning the symbols for common metric units
- Understanding the size of commonly used metric units
- Using the prefixes for common metric units
- Using the proper form for recording metric values
- Understanding the relationship between units and dimensions
- Understanding the nature of significant figures
- Using significant figures in metric measurement and conversion
- Determining the number of significant figures
- Relating metric measurements to the real world
- Converting from one metric unit to another
- Understanding the decimal nature of the metric system
- Predicting the answer in metric conversion
- Understanding the relationship between different metric units
- Comparing the size of two metric units
- Predicting whether the numerical value will increase or decrease during conversion

Secondary Learning Objectives

- Recognizing temperature and time as additional dimensions
- Understanding the logic of metric conversions
- Real world examples to enhance understanding of metric conversion
- Estimating metric measurements
- Working definitions of necessary mathematical terms