

Chemistry Virtual Labs

Below is a vetted set of browser-compatible virtual lab experiences that can be used for students enrolled in Regents Chemistry in the 2020-21 school year.

- Lab activities are arranged by the ten units that comprise the Chemistry section of the [NYC Department of Education 9-12 Science Scope and Sequence](#).
- Each lab activity includes **links** to
 - o the lab activity or simulation
 - o a student-facing worksheet or resource
 - o in some cases, teacher-facing resources; e.g. implementation info, lesson plans.
- A **brief description** of the lab activity is provided, as is the anticipated **duration of the lab** activity, so that you can calculate the total amount of virtual lab activities that you are assigning to ensure that your students meet the 1200-minute laboratory requirement for NYSED Regents courses.
- **Translation information** for teachers working with multilingual learners is included, as are relevant **science standards**, including
 - o 1996 MST standards (on which the current Regents are based)
 - o Science and engineering practices (SEPs)
 - o Cross-cutting concepts (CCCs).
- Some labs also include **notes** that provide additional guidance around implementation.

This Chemistry Virtual Labs Guide also contains guidance from New York State around [NYSED 2020-21 Science Laboratory Requirements](#) at the end of the document.

Note to Teacher: To make a copy of this document that you can modify, go to the "File" menu and click "Make a Copy"

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NYSED 2020-21 Science Laboratory Requirements		

Unit Name and Number: The Physical Nature of Matter

PhET simulation: States of Matter

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html

Description: This simulation enables students to observe different states of matter, phase changes, and intermolecular interactions in a variety of elements and molecules.

Duration (minutes): 30

Teacher-Facing Resources: <https://phet.colorado.edu/en/simulation/states-of-matter>

Student-Facing Resources:

<https://docs.google.com/document/d/1QSocpRFiVkvvQSk1aqE32eBODK-9x-SW/edit?usp=sharing&oid=118373835077627570043&rtpof=true&sd=true>

Translation Information:

- For page translation, click on "Choose language" found at the bottom of the site and choose preferred language. Additionally, more languages can be found by using the Google Translate extension.
- Open "Translation" tab (below SIM): Simulation available in many languages.
- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- Matter is classified as a pure substance or as a mixture of substances. (3.1q)
- Compounds can be differentiated by their chemical and physical properties. (3.1dd)
- The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure. (3.1jj)
- The three phases of matter (solids, liquids, gases) have different properties. (3.1kk)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Phase Changes

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/phases-of-matter/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore how heat and energy related to phase change.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1CNBAHm7CKEE8XwGORzGfsHI2q1WxczfC/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: see teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards: The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure. (3.1jj)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
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Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Air Matter (Mixtures)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/what-is-air/app/index.html?lang=en&referrer=ck12 Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore the composition of air and learn about the different atoms and molecules that we breathe every day.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1lfvsH6Zb00RrAHcjJYfTz_Ccm-Wfry0v/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: (see Lesson Plan Hyperlink column)

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MST Science Standards:

- Matter is classified as a pure substance or as a mixture of substances. (3.1q)
- Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed. (3.1s)
- The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties. (3.1t)

Science and Engineering Practices: Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Rock Candy (Solubility)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/solubility/app/index.html?lang=en&referrer=ck12Lancher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students learn to make rock candy by exploring the effect of temperature on the solubility of sugar in water.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1vzvq9MglYhyribFLS3EdT5GATNXkESEF/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: (see Lesson Plan Hyperlink column)

Translation Information: Google Translate extension will translate page

MST Science Standards:

- Differences in properties such as density, particle size, molecular polarity, boiling and freezing points, and solubility permit physical separation of the components of the mixture. (3.1nn)
- A solution is a homogeneous mixture of solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent. (3.1oo)
- The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm). (3.1pp)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
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Notes:

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- Shared via Google Classroom and email

Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Salty Roads (Properties of Solutions)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/freezing-point/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore how salts can keep roads clear of ice in the winter by learning how the role of electrolytes in depressing the freezing point of water, using the example of salting roads in winter weather.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1M_otBb1r--CluB1DH1-ZqJokkd-VB2R/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: See teacher-facing resources

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MST Science Standards:

- A solution is a homogeneous mixture of solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent. (3.1oo)
- The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm). (3.1pp)
- The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of the solute particles, the greater the effect. (3.1qq)

Science and Engineering Practices:

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Notes:

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- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Hot Pack/Cold Pack (Conservation of Energy)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/exothermic-and-endothermic/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore endothermic and exothermic process by making a cold pack or hot pack.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1ieBWSyP3vUpNrKzInrgUHRBwAKccZ2ds/edit?usp=drive_link&ouid=118373835077627570043&rtmpof=true&sd=true

Student-Facing Resources: see Teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- Chemical and physical changes can be exothermic or endothermic. (4.1b)
- Heat is a transfer of energy (usually thermal energy) from a body of higher temperature to a body of lower temperature. Thermal energy is the energy associated with the random motion of atoms and molecules. (4.2a)
- Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is not a form of energy. (4.2b)
- The concepts of kinetic and potential energy can be used to explain physical processes that include: fusion (melting), solidification (freezing), vaporization (boiling, evaporation), condensation, sublimation, and deposition. (4.2c)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Going Fishing (Density)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/density/app/index.html?lang=en&referrer=ck12Lau ncher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students learn how the density of a material determines if it floats or sinks in water. Additionally, students can create their own materials to explore density.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1luMKSy5dJOEOoBPo6vzpOCJVaNsIUZ-8/edit?usp=drive_link&ouid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: (see Lesson Plan Hyperlink column)

Translation Information: Google Translate extension will translate page

MST Science Standards: Differences in properties such as density, particle size, molecular polarity, boiling and freezing points, and solubility permit physical separation of the components of the mixture. (3.1nn)

Science and Engineering Practices:

- **Developing and Using Models:** Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- **Planning and Carrying Out Investigations:** Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.
- **Analyzing and Interpreting Data:** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution; Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
- **Constructing Explanations and Designing Solutions:** Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

- **Notes:**
- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: The Physical Nature of Matter

CK-12 Simulation: States of Matter

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/states-of-matter/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students compare three states of matter: solid, liquid, and gas.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1QSocpRFiVkvvQSk1aqE32eBODK-9x-SW/edit?usp=drive_link&ouid=118373835077627570043&rtmpof=true&sd=true

Student-Facing Resources: (see Lesson Plan Hyperlink column)

Translation Information: Google Translate extension will translate page

MST Science Standards: The three phases of matter (solids, liquids, gases) have different properties. (3.1kk)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
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- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 1. The Physical Nature of Matter

CK-12 Simulation: Camping (Chemical and Physical Changes)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/campout/app/index.html?lang=en&referrer=ck12Lancher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore a campsite to observe different chemical changes and physical changes.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/16AfSuU_Cr8TsrvZPC0K2-xWE0uYCl3uQ/edit?usp=sharing&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: (see Lesson Plan Hyperlink column)

Translation Information: Google Translate extension will translate page

- **MST Science Standards:**
- A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties. (3.2a)
- Chemical and physical changes can be exothermic or endothermic. (4.1b)

Science and Engineering Practices:

- **Developing and Using Models:** Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- **Constructing Explanations and Designing Solutions:** Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- **Patterns:** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- **Scale, Proportion, and Quantity:** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 1: The Physical Nature of Matter

CK-12 Simulation: Around the World (Boiling and Vapor Pressure)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/boiling-point/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students travel around the world to different locations and explore the relationship between altitude, vapor pressure, and boiling point.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/18-vhMQOs5_ncrbwwRpyk7GF9EAa2XZPT/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: See teacher-facing resources

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MST Science Standards: The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure. (3.1jj)

Science and Engineering Practices:

- **Developing and Using Models:** Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
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Notes:

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Unit Name and Number: 2: Atomic Concepts

PhET Simulation: Build an Atom

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

Description: In this simulation, students explore building an atom out of protons, neutrons, and electrons, and see how the element, charge, and mass change. Then play a game to test your ideas!

Duration (minutes): 60

Teacher-Facing Resources: <https://phet.colorado.edu/en/simulation/build-an-atom>

Student-Facing Resources:

https://docs.google.com/document/d/1Q3z0d7hCnwfsC09Oz8gxVIbr0BQNK74b/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Translation Information:

- For page translation, click on "Choose language" found at the bottom of the site and choose preferred language. Additionally, more languages can be found by using the Google Translate extension.
- Open "Translation" tab (below SIM): Simulation available in many languages.
- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- The modern model of the atom has evolved over a long period of time through the work of many scientists. (3.1a)
- Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons. (3.1b)
- Subatomic particles contained in the nucleus include protons and neutrons. (3.1c)
- The proton is positively charged, and the neutron has no charge. The electron is negatively charged. (3.1d)
- Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom. (3.1e) Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element. (3.1m)
- The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes. (3.1n)
- When an atom gains one or more electrons, it becomes a negative ion and its radius increases. When an atom loses one or more electrons, it becomes a positive ion and its radius decreases. (5.2c)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
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Unit Name and Number: 2: Atomic Concepts

CK-12 Simulation: Average Atomic Mass

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/average-atomic-mass/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore how percentage abundances of different isotopes affect the average atomic mass for that given element. Students form connections between the average atomic mass and a person's body mass. (Assuming that the person's has

Duration (minutes): 45

Teacher-Facing Resources: N/A

Student-Facing Resources:

https://docs.google.com/document/d/1gAr9_5rjn3P_LbYRDg53FJCWIYxY-edc/edit?usp=drive_link&ouid=118373835077627570043&rtpof=true&sd=true

Translation Information: Google Translate extension will translate page

MST Science Standards:

- Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element. (3.1m)
- The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes. (3.1n)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems; Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Teacher is required to log-in to CK-12; Students do not need to log-in; Shared via Google Classroom and email

Unit Name and Number: 2: Atomic Concepts

CK-12 Simulation: Rutherford's Gold Foil Experiment

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/gold-foil/app/index.html?lang=en&referrer=ck12Lau ncher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students design hypothetical models of an atom and test them using Ernest Rutherford's Gold Foil experimental design. Students use the evidence from Rutherford's experiment and what they know about how objects travel through empty space

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1j22T-VniSO_SINeuBy5SIzqcB-bK4FC/edit?usp=drive_link&oid=118373835077627570043&rtpof=true&sd=true

Student-Facing Resources: See teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- The modern model of the atom has evolved over a long period of time through the work of many scientists. (3.1a)
- Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons. (3.1b)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 3: Nuclear Chemistry

PhET Simulation: Isotopes and Atomic Mass

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/isotopes-and-atomic-mass/latest/isotopes-and-atomic-mass_en.html

Description: Use the simulation to explore isotope stability and determine radioisotopes.

Duration (minutes): 60

Teacher-Facing Resources: <https://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass>

Student-Facing Resources:

Google Doc Option 1:

<https://docs.google.com/document/d/1JQI9t4AGa90AGdHuLpOeSu5AK1Gm0PWm>

Google Doc Option 2: <https://docs.google.com/document/d/1hEfqj-cF1GOs5AfgPFVAwelaPs7eGOs>

Translation Information:

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- Open "Translation" tab (below SIM): Simulation available in many languages.
- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element. (3.1m)
- The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes. (3.1n)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Using Mathematics and Computational Thinking: Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 4: Chemical Bonding

CK-12 Simulation: Soap (molecular polarity)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/soap/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students learn the chemistry behind the ability of soap molecules to remove stains from clothing. The amphipathic nature of soap molecules is highlighted.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1MgtuVzFHcNTTyVyeC_hn9Pg8sdq-INr4

Student-Facing Resources: (see Lesson Plan Hyperlink column)

Translation Information: Google Translate extension will translate page

MST Science Standards:

- The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond. (5.2k)
- Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO₂, CH₄, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH₃, and H₂O. (5.2l)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 4: Chemical Bonding

CK-12 Simulation: Dripping Droplets (intermolecular forces)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/intermolecular-forces/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore intermolecular forces by seeing how many drops of a liquid a penny can hold.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1Ok_rr44zf2Ri8Cr1iPXW2f5qX_FwGFHg

Student-Facing Resources: (see Lesson Plan Hyperlink column)

Translation Information: Google Translate extension will translate page

MST Science Standards: Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force. (5.2m)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 4: Chemical Bonding

PhET Simulation: Molecule Polarity

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/molecule-polarity/latest/molecule-polarity_en.html

Description: Students explore the relationship between electronegativity and polarity in molecules.

Duration (minutes): 45

Teacher-Facing Resources: <https://phet.colorado.edu/en/simulation/molecule-polarity>

Student-Facing Resources:

<https://docs.google.com/document/d/1lLauhZYkcc27xaPXtuDjeA5MZm3VvEU>

Translation Information:

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- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- Electronegativity indicates how strongly an atom of an element attracts electrons in chemical bonds. Electronegativity values are assigned according to arbitrary scales. (5.2j)
- The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond. (5.2k)
- Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO₂, CH₄, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH₃, and H₂O. (5.2l)
- Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force. (5.2m)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 4: Chemical Bonding

CK-12 Simulation: Balancing Chemical Equations

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/balancing-chemical-equations/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students learn the basics of chemical equations by watching methane bubbles light on fire. In addition, students have an opportunity to practice balancing chemical equations.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

<https://docs.google.com/document/d/115EHKKzHIm0Dg3GWyOH3Zsfk7A5Gp1Fg>

Student-Facing Resources: See teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- When a bond is broken, energy is absorbed. When a bond is formed, energy is released. (5.2i)
- A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction. (3.3c)
- The formula mass of a substance is a sum of the atomic masses. The molar mass (gram-formula mass) of a substance equals one mole of that substance. (3.3e)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in

- Shared via Google Classroom and email

Unit Name and Number: 4: Chemical Bonding

PhET Simulation: Balancing Chemical Equations

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_en.html

Description: In this simulation, students explore and balance a variety of chemical equations, and explore the concept of conservation of mass.

Duration (minutes): 60

Teacher-Facing Resources:

https://docs.google.com/document/d/10iBxgTBY_f4h_h1Znv9aVwfKrCJ4b--Z

Student-Facing Resources:

https://docs.google.com/document/d/1VEwZuCPeCXwu6Oa2LvWmY9eldmEXtU_L

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MST Science Standards:

- When a bond is broken, energy is absorbed. When a bond is formed, energy is released. (5.2i)
- A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction. (3.3c)
- The formula mass of a substance is a sum of the atomic masses. The molar mass (gram-formula mass) of a substance equals one mole of that substance. (3.3e)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 5: Periodicity

AACT Simulation: Periodic Trends - Ionization Energy, Atomic Radius and Ionic Radius

Virtual Lab Hyperlink: <https://teachchemistry.org/classroom-resources/periodic-trends-simulation>

Description: In this activity, students examine an interactive periodic table of elements to identify distinguishing features of elements in an interactive periodic table, and to then use these features to extrapolate periodic trends.

Duration (minutes): 45

Teacher-Facing Resources: N/A

Student-Facing Resources:

https://docs.google.com/document/d/1j2e34DlMcht4c4pVgosEUkv2DwApK_RY

Translation Information: Google Translate extension will translate this page

MST Science Standards:

- The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of the element. The elements on the Periodic Table are arranged in order of increasing atomic number. (3.1y)
- The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/non-metallic properties. (3.1aa)
- The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties. (3.1bb)
- The number of protons in an atom (atomic number) identifies the element. The sum of the protons and neutrons in an atom (mass number) identifies the isotope. Common notations that represent isotopes include: ^{14}C , $^{14}_6\text{C}$, carbon-14, C-14. (3.1g)
- The outermost electrons in an atom are called the valence electrons. In general, the number of valence electrons affects the chemical properties of an element. (3.1l)
- Elements can be classified by their properties and are located on the Periodic Table as metals, non-metals, metalloids (B, Si, Ge, As, Sb, Te) and noble gases. (3.1v)

Science and Engineering Practices:

- **Developing and Using Models:** Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- **Constructing Explanations and Designing Solutions:** Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Here is the other website required for this virtual lab: <http://www.thecatalyst.org/electabl.html>

Unit Name and Number: 6: Moles/Stoichiometry

PhET Simulation: Reactants, Products, and Leftovers (Chemical Reactions, Limiting Reactants)

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/reactants-products-and-leftovers/latest/reactants-products-and-leftovers_en.html

Description: In this activity, students explore the concepts of reactants, products, and limiting factors in chemical reactions. They initially explore this through a simulation with sandwich materials, and then transition to molecules.

Duration (minutes): 45

Teacher-Facing Resources: <https://phet.colorado.edu/en/simulation/reactants-products-and-leftovers>

Student-Facing Resources:

<https://docs.google.com/document/d/1tLDy182pFVwQlgB5wnAlPwbbfnnS7m6v>

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- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction. (3.3c)
- In all chemical reactions, there is a conservation of mass, energy and charge. (3.3a)

Science and Engineering Practices: Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Cross-Cutting Concepts: Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 6: Moles/Stoichiometry

CK-12 Simulation: Airbag (gas stoichiometry, decomposition reaction)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/decomposition-reaction/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore how decomposition reactions are used to inflate an airbag in a car crash.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

<https://docs.google.com/document/d/1lqZP6LGVtj8hXTSSKBCC2Tp9efG6AJET>

Student-Facing Resources: See teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- A compound is a substance composed of two or more different elements that are chemically combined in fixed proportions. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC (International Union of Pure and Applied Chemistry — <http://www.iupac.org/>) System (3.1cc)
- The formula mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram formula mass) of a substance equals one mole of that substance. (3.3e)
- Equal volumes of gases at the same temperature and pressure contain an equal number of particles. (3.4e)
- The empirical formula of a compound is the simplest whole-number ratio of the atoms of elements in the compound. It may be different from the molecular formula, which is the actual ratio of atoms in a molecule of that compound. (3.3d)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data

support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 6: Moles/Stoichiometry

CK-12 Simulation: Mole Carnival (molar mass)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/mole-carnival/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students use dimensional analysis to practice converting between mass, volume, moles and number of particles of different objects found at a carnival.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1Nr0MBpp63Uknx3E65Aulkn_o1UjjFkZu

Student-Facing Resources: See teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- The concentration of the solution may be expressed in molarity (M), percent by volume, percent by mass or parts per million (ppm). (3.1pp)
- The formula mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram formula mass) of a substance equals one mole of that substance. (3.3e)
- The empirical formula of a compound is the simplest whole-number ratio of the atoms of elements in the compound. It may be different from the molecular formula, which is the actual ratio of atoms in a molecule of that compound. (3.3d)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Using Mathematics and Computational Thinking: Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m³, acre-feet, etc.).

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12; Students do not need to log-in; Shared via Google Classroom and email

Unit Name and Number: 6: Moles/Stoichiometry

PhET Simulation: Molarity

Virtual Lab Hyperlink: https://phet.colorado.edu/sims/html/molarity/latest/molarity_en.html

Description: Students explore the relationship between solution concentration and molarity.

Duration (minutes): 80

Teacher-Facing Resources: Link to teacher resources: <https://phet.colorado.edu/en/simulation/molarity>

Student-Facing Resources:

https://docs.google.com/document/d/1k1ujkPKTM_iqinfE39sevh4qa-cm8zEo

Translation Information:

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- Open "Translation" tab (below SIM): Simulation available in many languages.
- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- A solution is a homogeneous mixture of solute dissolved in solvent. The solubility of the solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and the solvent. (3.100)
- The concentration of the solution may be expressed in molarity (M), percent by volume, percent by mass or parts per million (ppm). (3.1pp)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 6: Moles/Stoichiometry

Concord Consortium: Chemical Reactions and Stoichiometry

Virtual Lab Hyperlink:

https://authoring.concord.org/activities/10033/4407e76d-0609-440e-bf9a-55eb93542512?show_index=true

Description: This interactive activity allows students to explore how concentration and temperature affect reaction rates, and the impact of limiting factors on reactions.

Duration (minutes): 45

Teacher-Facing Resources: N/A

Student-Facing Resources:

<https://docs.google.com/document/d/1i5d6sOfiyJRkhHT9Nf1onO3UL4YCISAt>

Translation Information: Google Translate extension will translate page

MST Science Standards:

- A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction. (3.3c)
- In all chemical reactions, there is a conservation of mass, energy and charge. (3.3a)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Unit Name and Number: 6: Moles/Stoichiometry

CK-12 Simulation: Salty Roads (Properties of Solutions)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/freezing-point/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore how salts can keep roads clear of ice in the winter by learning how different types and concentrations of salts affect the freezing point of a solution.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1M_otBb1r--CluB1DH1-_ZqJokkd-VB2R

Student-Facing Resources: see teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- A solution is a homogeneous mixture of solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent. (3.1oo)
- The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm). (3.1pp)
- The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of the solute particles, the greater the effect. (3.1qq)

Science and Engineering Practices:

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- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

- Teacher is required to log-in to CK-12
- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 7: Kinetics & Equilibrium

CK-12 Simulation: Flat vs. Fizzy Soda (Le Châtelier's Principle)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/le-chateliers-principle/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore Le Châtelier's Principle by changing the volume, pressure, and temperature of a soda bottle. They can also try carbonating the soda to see how adding a reactant affects the equilibrium.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

https://docs.google.com/document/d/1ccX6Ri0c3dxbMfWGUA_k_zStayTaQ2y

Student-Facing Resources: see teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards: Le Chatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium. (3.4j)

Science and Engineering Practices:

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- Students do not need to log-in

- Shared via Google Classroom and email

Unit Name and Number: 7: Kinetics & Equilibrium

PhET Simulation: Gas Properties

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_en.html

Description: Students explore properties of an ideal gas, and as a result, observe kinetic-molecular theory and the effect of temperature and pressure on the behavior of gas particles.

Duration (minutes): 60

Teacher-Facing Resources: Link for teacher resources:

<https://phet.colorado.edu/en/simulation/gas-properties>

Student-Facing Resources:

<https://docs.google.com/document/d/1elfgpQCfc5H1kO13sabSOtTa3fki4QzI>

Translation Information:

- For page translation, click on "Choose language" found at the bottom of the site and choose preferred language. Additionally, more languages can be found by using the Google Translate extension.
- Open "Translation" tab (below SIM): Simulation available in many languages.
- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- Collision theory states that a reaction is most likely to occur if reactant particles collide with proper energy and orientation. (3.4d)
- The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst. (3.4f)
- The concept of an ideal gas is a model to explain the behavior of gases. A real gas is most like an ideal gas when the gas is at low pressure and high temperature. (3.4a)
 - Kinetic molecular theory (KMT) for an ideal gas states that all gas particles:
 - are in random, constant straight-line motion.
 - are separated by great distances relative to their size; the volume of the gas particles is considered negligible.
 - have no attractive forces between them.
 - have collisions that may result in a transfer of energy between gas particles, but the total energy of the system remains constant. (3.4b)
- Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collision among gas particles. (3.4c)

Science and Engineering Practices:

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- Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
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- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 8: Acids & Bases

PhET Simulation: pH Scale

Virtual Lab Hyperlink: https://phet.colorado.edu/sims/html/ph-scale/latest/ph-scale_en.html

Description: Test the pH of things like coffee, spit, and soap to determine whether each is acidic, basic, or neutral. Visualize the relative number of hydroxide ions and hydronium ions in solution. Switch between logarithmic and linear scales. Investigate whether cha

Duration (minutes): 60

Teacher-Facing Resources: <https://phet.colorado.edu/en/simulation/ph-scale>

Student-Facing Resources:

<https://docs.google.com/document/d/1P6bn8a3P84KheafBViE51ZUSOn7I6zf7>

Translation Information:

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- Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- The acidity or alkalinity of an aqueous solution can be measured by its pH value. The relative level of acidity or alkalinity of these solutions can be shown by using indicators. (3.1ss)
- On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration. (3.1tt)

Science and Engineering Practices:

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- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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Unit Name and Number: 8: Acids & Bases

PhET Simulation: Acids and Bases

Virtual Lab Hyperlink:

https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html

Description: How do strong and weak acids differ? Use lab tools on your computer to find out! Dip the paper or the probe into a solution to measure the pH, or put in the electrodes to measure the conductivity. Then see how concentration and strength affect pH. Can a weak

Duration (minutes): 60

Teacher-Facing Resources: Link for teacher resources:

<https://phet.colorado.edu/en/simulation/acid-base-solutions>

Student-Facing Resources:

https://docs.google.com/document/d/1yJMWJ9SGg20UGJjrDqUn8bztn6_4Y9Rs

Translation Information: For page translation, click on "Choose language" found at the bottom of the site and choose preferred language. Additionally, more languages can be found by using the Google Translate extension.

Open "Translation" tab (below SIM): Simulation available in many languages.

Tips for Teachers PDF available in English and Spanish

MST Science Standards:

- Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes. (3.1uu)
- Arrhenius acids yield $H^+(aq)$, hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as $H_3O^+(aq)$, hydronium ion. (3.1vv)
- Arrhenius bases yield $OH^-(aq)$, hydroxide ion as the only negative ion in an aqueous solution. (3.1ww)
- In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water. (3.1xx)

Science and Engineering Practices:

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- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion; Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Notes: Open "For Teachers" tab (below SIM): Tips for Teachers PDF provides an overview of the sim controls, model simplifications, and insights into student thinking. Teachers may select one of the teacher-developed activities that accompanies this sim or can develop their own activity to accompany the SIM.

Unit Name and Number: 8: Acids & Bases

Royal Society of Chemistry: Titration Screen Experiment

Virtual Lab Hyperlink:

<http://www.rsc.org/learn-chemistry/resource/res00002077/titration-screen-experiment?cmpid=CMPO007002>

Description: Students virtually carry out all steps of an acid-base titration to address a fictional acid spill. Students complete a virtual lab book and earn points as they proceed successfully through each stage of the process. There are four increasingly complex levels of titration that teachers have the option of using as extensions or challenges.

Duration (minutes): 30

Teacher-Facing Resources:

https://drive.google.com/file/d/13HyXNOIGmer65aFpMSUftFClySUWy2uq/view?usp=drive_link

Student-Facing Resources: Students will be able to save their completed work in a student notebook.

<https://docs.google.com/document/d/1fJ1Z5t4cTTqKpiys6a6c7iex1nfp3FzN>

Translation Information: Google Translate extension will translate page

MST Science Standards:

- In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water. (3.1xx)
- Titration is a laboratory process in which a volume of a solution of known concentration is used to determine the concentration of another solution. (3.1zz)

Science and Engineering Practices:

- Developing and Using Models: Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
- Using Mathematics and Computational Thinking: Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
- Constructing Explanations and Designing Solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Unit Name and Number: 9: Oxidation & Reduction

CK-12 Simulation: Battery (electrochemical reaction)

Virtual Lab Hyperlink:

<https://interactives.ck12.org/simulations/chemistry/redox-reaction/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html>

Description: In this simulation, students explore how batteries use redox reactions to create electrical energy to power a flashlight.

Duration (minutes): 45

Teacher-Facing Resources: CK-12 Resources are designed to be distributed to students, but include an answer key for teachers. Teachers should remove this answer key before sharing this resource with students.

<https://docs.google.com/document/d/1L31le6peroNTzkQbLsIF-Ra2AdK0YNry>

Student-Facing Resources: See teacher-facing resources

Translation Information: Google Translate extension will translate page

MST Science Standards:

- An oxidation-reduction (redox) reaction involves the transfer of electrons (e⁻). (3.2d)
- Reduction is the gain of electrons. (3.2e)
- A half-reaction can be written to represent reduction. (3.2f)
- Oxidation is the loss of electrons. (3.2g)
- A half-reaction can be written to represent oxidation. (3.2h)
- In a redox reaction the number of electrons lost is equal to the number of electrons gained. (3.3b)

Science and Engineering Practices:

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Cross-Cutting Concepts:

- Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Notes:

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- Students do not need to log-in
- Shared via Google Classroom and email

Unit Name and Number: 10: Carbon and Organic Chemistry

Royal Society of Chemistry: Aspirin Screen Experiment

Virtual Lab Hyperlink: <https://edu.rsc.org/resources/aspirin-screen-experiment/1644.article>

Description: In this activity, students will learn how to synthesize aspirin, set up and run a simulated experiment, and determine how much aspirin is produced.

Duration (minutes): 30

Teacher-Facing Resources:

https://drive.google.com/file/d/11FGpGvpFOuAJYK2On2V9MCsmMTvSbdd/view?usp=drive_link

Student-Facing Resources: Students will be able to save their completed work in a student lab notebook.

<https://docs.google.com/document/d/1SO81fQ-4qQTERPdHTHQfOejZPLdpFpw>

Translation Information: Google Translate extension will translate page

MST Science Standards:

- Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC (International Union of Pure and Applied Chemistry – <http://www.iupac.org>) System. (3.1ff)
- Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond. (3.1gg)
- Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds. (3.1hh)

Science and Engineering Practices:

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Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NYSED 2020-21 Science Laboratory Requirements

(From [Recovering, Rebuilding, and Renewing: The Spirit of New York's Schools](#))

Per Commissioner's Regulations, courses that culminate in a Regents examination in science must include 1200 minutes of laboratory experiences. Due to the possibility of a hybrid or fully remote model of instruction as a result of COVID-19, the 1200-minute lab requirement can be met through hands-on laboratory experiences, virtual laboratory experiences, or a combination of virtual and hands-on laboratory experiences coupled with satisfactory lab reports for the 2020-21 school year. This laboratory requirement is in addition to the course requirement and entitles a student to admission to a culminating Regents Exam. The school district is responsible for aligning laboratory experiences specific to each science course; determining the mode or modes of instruction; and identifying a viable vetted list of acceptable virtual labs or a combination of virtual and hands-on labs that a student would need to complete for each science course that culminates in a Regents examination. Schools must determine a method for students to record laboratory experiences and satisfactory lab reports. In a virtual environment, emphasis should be placed on the quality of the experience and the satisfactory completion of each laboratory experience rather than the time spent in completing such laboratory experience. Any student who has completed all laboratory experiences in accordance with teacher expectations shall be deemed to have met the 1200-minute requirement.