

UNIT 04-Bonding

Content Area: **Science**
 Course(s): **IB Chemistry, HL**
 Time Period: **Second Marking period**
 Length: **4 weeks**
 Status: **Published**

Unit Overview

Use theories to explain natural phenomena—molten ionic compounds conduct electricity but solid ionic compounds do not. The solubility and melting points of ionic compounds can be used to explain observations.

STAGE 1- DESIRED RESULTS

2020 New Jersey Student Learning Standards- Science

SCI.9-12.HS-PS1	Matter and Its Interactions
SCI.9-12.HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
SCI.6-8.MS-PS4-1	Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
SCI.6-8.MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Information
- Using Mathematics and Computational Thinking

Cross Cutting Concepts

- Cause and Effect
- Energy and Matter
- Influence of Engineering, Technology, and Science on Society and the Natural World
- Interdependence of Science, Engineering, and Technology
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Functions
- Systems and System Models

Disciplinary Core Ideas

Covalent compounds form by the sharing of electrons.

Lewis (electron dot) structures show the electron domains in the valence shell and are used to predict molecular shape.

The physical properties of molecular substances result from different types of forces between their molecules.

Metallic bonds involve a lattice of cations with delocalized electrons.

Physical Sciences

- PS1A: Structure and Properties of Matter
- PS1B: Chemical Reactions
- PS1C: Nuclear Processes
- PS2A: Forces and Motion
- PS2B: Types of Interaction
- PS3A: Definitions of Energy
- PS3B: Conservation of Energy and Energy Transfer
- PS3C: Relationship Between Energy and Forces
- PS3D: Energy in Chemical Processes and Everyday Life
- PS4A: Wave Properties
- PS4B: Electromagnetic Radiation
- PS4C: Information Technologies and Instrumentation

Engineering. Technology. and Applications of Science

- ETS1A: Defining and Delimiting an Engineering Problem
- ETS1B: Developing Possible Solutions
- ETS1C: Optimizing the Design Solution

Essential Questions

How does the lattice structure in ionic bonds affect their properties?

How do covalent compounds form?

What is the significance and value of Lewis dot structures?

How does intermolecular bonding contribute to the physical properties of substances?

How does the nature of metallic bonding contribute to the properties of metallic elements?

How does hybridization result from the mixing of atomic orbitals to form the same number of new equivalent hybrid orbitals that can have the same mean energy as the contributing atomic orbitals? Explain the theory and give examples.

Enduring Understanding

Covalent compounds form by the sharing of electrons.

Lewis (electron dot) structures show the electron domains in the valence shell and are used to predict molecular shape.

The physical properties of molecular substances result from different types of forces between their molecules.

Metallic bonds involve a lattice of cations with delocalized electrons.

One needs to regard theories as uncertain—hybridization in valence bond theory can help explain molecular geometries, but is limited. Quantum mechanics involves several theories explaining the same phenomena, depending on specific requirements.

Students will know...

Bonding

Ionic Bonding

Covalent Bonding

Polar Covalent

Nonpolar Covalent

Giant Covalent

Metallic Bonding

Intermolecular forces

Molecular Geometry

VSEPR Theory

Solubility

Conductivity

- Positive ions (cations) form by metals losing valence electrons.
- Negative ions (anions) form by non-metals gaining electrons.
- The number of electrons lost or gained is determined by the electron configuration of the atom.
- The ionic bond is due to electrostatic attraction between oppositely charged ions.
- Under normal conditions, ionic compounds are usually solids with lattice structures.
- A covalent bond is formed by the electrostatic attraction between a shared pair of electrons and the positively charged nuclei.
- Single, double and triple covalent bonds involve one, two and three shared pairs of electrons respectively.
- Bond length decreases and bond strength increases as the number of shared electrons increases.
- Bond polarity results from the difference in electronegativities of the bonded atoms.
- Lewis (electron dot) structures show all the valence electrons in a covalently bonded species.
- The “octet rule” refers to the tendency of atoms to gain a valence shell with a total of 8 electrons.
- Some atoms, like Be and B, might form stable compounds with incomplete octets of electrons.
- Resonance structures occur when there is more than one possible position for a double bond in a molecule.
- Shapes of species are determined by the repulsion of electron pairs according to VSEPR theory.
- Carbon and silicon form giant covalent/network covalent structures.
- Intermolecular forces include London (dispersion) forces, dipole-dipole forces and hydrogen bonding.
- The relative strengths of these interactions are London (dispersion) forces < dipole-dipole forces < hydrogen bonds.
- A metallic bond is the electrostatic attraction between a lattice of positive ions and delocalized electrons.
- The strength of a metallic bond depends on the charge of the ions and the radius of the metal ion.
- Alloys usually contain more than one metal and have enhanced properties.
- A hybrid orbital results from the mixing of different types of atomic orbitals on the same atom

Misconceptions:

Students see chemical bonding and forces within chemical structures as totally unrelated.

Students limit their understanding of chemical bonds to those explained in terms of full shell theories.

Students will be able to...

- Deduce the formula and name of an ionic compound from its component ions, including polyatomic ions.
- Explain the physical properties of ionic compounds (volatility, electrical conductivity and solubility) in terms of their structure.
- Deduce the polar nature of a covalent bond from electronegativity values.
- Deduce Lewis (electron dot) structure of molecules and ions showing all valence electrons for up to four electron pairs on each atom.
- Use the VSEPR theory to predict the electron domain geometry and the molecular geometry for species with two, three and four electron domains.
- Predict the bond angles from molecular geometry and presence of non-bonding pairs of electrons.
- Predict the molecular polarity from bond polarity and molecular geometry.
- Deduce the resonance structures, examples include but are not limited to C_6H_6 , CO_3^{2-} and O_3 .
- Explain the properties of giant covalent compounds in terms of their structures.
- Deduce the types of intermolecular force present in substances, based on their structure and chemical formula.
- Explain the physical properties of covalent compounds (volatility, electrical conductivity and solubility) in terms of their structure and intermolecular forces.
- Explain the electrical conductivity and malleability in metals.
- Explain the trends in melting points of metals.
- Explain the properties of alloys in terms of non-directional bonding.
- Predict whether sigma (σ) or pi (π) bonds are formed from the linear combination of atomic orbitals.
- Deduce the Lewis (electron dot) structures of molecules and ions showing all valence electrons for up to six electron pairs on each atom.
- Apply the FC to ascertain which Lewis (electron dot) structure is preferred from different Lewis (electron dot) structures.
- Deduce using VSEPR theory of the electron domain geometry and molecular geometry with five and six electron domains and associated bond angles.
- Explain the wavelength of light required to dissociate oxygen and ozone.
- Describe the mechanism of the catalysis of ozone depletion when catalysed by CFCs and NO_x .
- Explain the formation of sp^3 , sp^2 and sp hybrid orbitals in methane, ethene and ethyne.
- Identify and explain the relationships between Lewis (electron dot) structures, electron domains, molecular geometries and types of hybridization.

STAGE 2- EVIDENCE OF LEARNING

Formative Assessment

- 3- Minute Pause
- A-B-C Summaries
- Analogy Prompt
- Choral Response
- Debriefing
- Exit Card / Ticket
- Hand Signals
- Idea Spinner
- Index Card Summaries
- Inside-Outside Circle Discussion (Fishbowl)
- Journal Entry
- Misconception Check
- Observation
- One Minute Essay
- One Word Summary
- Portfolio Check
- Questions & Answers
- Quiz
- Self-Assessment
- Student Conference
- Think-Pair-Share
- Web or Concept Map

Authentic Assessments

Investigate the various physical properties of substances.

Investigate the molecular geometry of several compounds. (Use molecular models or online 3-d structures.)

Benchmark Assessments

IB unit 4 past exams

STAGE 3- LEARNING PLAN

Instructional Map

- Deduction of the formula and name of an ionic compound from its component ions, including polyatomic ions.
- Explanation of the physical properties of ionic compounds (volatility, electrical conductivity and solubility) in terms of their structure.
- Deduction of the polar nature of a covalent bond from electronegativity values.
- Deduction of Lewis (electron dot) structure of molecules and ions showing all valence electrons for up to four electron pairs on each atom.
- The use of VSEPR theory to predict the electron domain geometry and the molecular geometry for species with two, three and four electron domains.
- Prediction of bond angles from molecular geometry and presence of non-bonding pairs of electrons.
- Prediction of molecular polarity from bond polarity and molecular geometry.
- Deduction of resonance structures, examples include but are not limited to C_6H_6 , CO_3^{2-} and O_3 .
- Explanation of the properties of giant covalent compounds in terms of their structures.
- Deduction of the types of intermolecular force present in substances, based on their structure and chemical formula.
- Explanation of the physical properties of covalent compounds (volatility, electrical conductivity and solubility) in terms of their structure and intermolecular forces.
- Explanation of electrical conductivity and malleability in metals.
- Explanation of trends in melting points of metals.
- Explanation of the properties of alloys in terms of non-directional bonding.
- Deduction of the types of intermolecular force present in substances, based on their structure and chemical formula.
- Explanation of the physical properties of covalent compounds (volatility, electrical conductivity and solubility) in terms of their structure and intermolecular forces.

Modification/Differentiation of Instruction

Differentiation Strategies for Special Education Students

- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate

- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Differentiation Strategies for Gifted and Talented Students

- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Differentiated Strategies for ELL Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required

- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials, including visuals
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Allow students to work at their own pace
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Role play
- Provide graphic organizers, highlighted materials
- Strategy and flexible groups based on formative assessment

Differentiation Strategies for At Risk Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment

504 Plans

Students can qualify for 504 plans if they have physical or mental impairments that affect or limit any of their abilities to:

- walk, breathe, eat, or sleep
- communicate, see, hear, or speak
- read, concentrate, think, or learn
- stand, bend, lift, or work

Examples of accommodations in 504 plans include:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- modified textbooks or audio-video materials
- behavior management support
- adjusted class schedules or grading
- verbal testing
- excused lateness, absence, or missed classwork
- pre-approved nurse's office visits and accompaniment to visits
- occupational or physical therapy

Modification Strategies

- Cooperative Grouping
- Extended Time
- Frequent Breaks
- Highlighted Text
- Interactive Notebook
- Modified Test
- Oral Directions
- Peer Tutoring
- Preferential Seating
- Re-direct

- Repeated Drill and Practice
- Shortened Assignment
- Teacher Notes
- Tutorials
- Use of Additional Reference Materials
- Use of Audio Resources

Differentiation Strategies

High Preparation

- Alternative Assessments
- Choice Boards
- Games and Tournaments
- Group Investigations
- Guided Reading
- Independent Research / Project
- Interest Groups
- Learning Contracts
- Leveled Rubrics
- Literature Circles
- Multiple Intelligence Options
- Multiple Texts
- Personal Agendas
- Project Based Learning (PBL)
- Stations / Centers
- Think-Tac-Toe
- Tiered Activities / Assignments
- Varying Graphic Organizers

Low Preparation

- Choice of Book / Activity
- Cubing Activities
- Exploration by Interest (using interest inventories)
- Flexible Grouping

- Goal Setting With Student
- Homework Options
- Jigsaw
- Mini Workshops to Re-teach or Extend Skills
- Open-ended Activities
- Think-Pair-Share by Readiness, Interest, or Learning Style
- Use of Collaboration
- Use of Reading Buddies
- Varied Journal Prompts
- Varied Product Choice
- Varied Supplemental Materials
- Work Alone / Together

Horizontal Integration

See Appendix

Vertical Integration- Discipline Mapping

Eighth Grade Chemical Interactions

Ninth Grade Chemistry unit in Biology

Tenth Grade CP and Honors Chemistry

Additional Materials

Pearson IB Chemistry, Catrin Brown & Mike Ford

Richard Thornley Video Lessons

WWW.IBChem.com

