**Honors Chemistry II Unit 4 Tentative Agenda** Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Bonding & Intermolecular Forces

| **Date** | **Agenda** |
| --- | --- |
| Wednesday 10/16 | * Go over Unit 3 Test
* Chapter 8 Notes
* HW:
	+ Read the standards you will be addressing in this unit (they are attached to this document)
	+ Read Chapter 8
 |
| Thursday 10/17 | * Finish Chapter 8 Notes
* Start Chapter 9 Notes
* HW:
	+ Mastering Chemistry 1-29
	+ Read Chapter 9
 |
| Friday 10/18 | * Chapter 8 Quiz
* Finish Chapter 9 Notes
* HW:
	+ Mastering Chemistry 30-45
 |
| Monday 10/21 | * Mastering in Class (many out on field trip)
* HW:
	+ Mastering Chemistry 46-62
 |
| Tuesday 10/22 | * Lewis Structures Practice
* Read Chapter 11 (finish for homework)
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| Wednesday 10/23 | * Go Over Lewis Structures Practice
* Finish Chapter 9 and/or start Chapter 11 notes
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| Thursday 10/24 | * Chapter 9 Quiz
* Chapter 11 Notes
* Hint of the day: Review Catalysts
* HW: Mastering Chemistry 63-92
 |
| Friday 10/25 | * Finish Chapter 11 Notes.
* Mastering Chemistry: Work on in class.
* Hint of the day: Review reaction-energy diagrams.
* HW: Prelab
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| Monday 10/28 | * Chapter 11 Quiz
* Begin Lab (Qualitative Analysis of Chemical Bonding: Inquiry Lab #6)
* Hint of the day: Review naming ionic and covalent compounds from honors chemistry.
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| Tuesday 10/29 | * Mole Day!!!
* Finish Lab
* Hint of the day: Review entropy.
* HW: Begin Review
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| Wednesday 10/30 | * Review
* Hint of the day: How does the polarity of a gas relate to the ability of that gas to dissolve in water?
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| Thursday 10/31 | * Unit 4 Test
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| Monday 11/4 | * Go over Unit 4 Test
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**INTERMOLECULAR FORCES**

**LO 2.11 The student is able to explain the trends in properties and/or predict properties of samples consisting of particles with no permanent dipole on the basis of London dispersion forces. [See SP 6.2, 6.4]**

Essential knowledge 2.B.1: London dispersion forces are attractive forces present between all atoms and molecules. London dispersion forces are often the strongest net intermolecular force between large molecules.

a. A temporary, instantaneous dipole may be created by an uneven distribution of electrons around the nucleus (nuclei) of an atom (molecule).

b. London dispersion forces arise due to the Coulombic interaction of the temporary dipole with the electron distribution in neighboring atoms and molecules.

c. Dispersion forces increase with contact area between molecules and with increasing polarizability of the molecules. The polarizability of a molecule increases with the number of electrons in the molecule, and is enhanced by the presence of pi bonding.

**LO 2.13 The student is able to describe the relationships between the structural features of polar molecules and the forces of attraction between the particles. [See SP 1.4, 6.4]**

Essential knowledge 2.B.2: Dipole forces result from the attraction among the positive ends and negative ends of polar molecules. Hydrogen bonding is a strong type of dipole-dipole force that exists when very electronegative atoms (N, O, and F) are involved.

a. Molecules with dipole moments experience Coulombic interactions that result in a net attractive interaction when they are near each other.

1. Intermolecular dipole-dipole forces are weaker than ionic forces or covalent bonds.

2. Interactions between polar molecules are typically greater than between nonpolar molecules of comparable size because these interactions act in addition to London dispersion forces.

3. Dipole-dipole attractions can be represented by diagrams of attraction between the positive and negative ends of polar molecules trying to maximize attractions and minimize repulsions in the liquid or solid state.

4. Dipole-induced dipole interactions are present between a polar and nonpolar molecule. The strength of these forces increases with the magnitude of the dipole of the polar molecule and with the polarizability of the nonpolar molecule.

b. Hydrogen bonding is a relatively strong type of intermolecular interaction that exists when hydrogen atoms that are covalently bonded to the highly electronegative atoms (N, O, and F) are also attracted to the negative end of a dipole formed by the electronegative atom (N, O, and F) in a different molecule, or a different part of the same molecule. When hydrogen bonding is present, even small molecules may have strong intermolecular attractions.

✘✘ Other cases of much weaker hydrogen bonding are beyond the scope of the AP Chemistry course and exam.

Rationale: The hydrogen bonding that occurs when hydrogen is bonded to highly electronegative atoms (N, O, and F) will be emphasized as will the electrostatic versus covalent nature of the bond. We will not include other cases of much weaker hydrogen bonding in the AP Chemistry course.

c. Hydrogen bonding between molecules, or between different parts of a single molecule, may be represented by diagrams of molecules with hydrogen bonding and indications of location of hydrogen bonding.

d. Ionic interactions with dipoles are important in the solubility of ionic compounds in polar solvents.

**LO 2.16 The student is able to explain the properties (phase, vapor pressure, viscosity, etc.) of small and large molecular compounds in terms of the strengths and types of intermolecular forces. [See SP 6.2]**

Essential knowledge 2.B.3: Intermolecular forces play a key role in determining the properties of substances, including biological structures and interactions.

a. Many properties of liquids and solids are determined by the strengths and types of intermolecular forces present.

1. Boiling point

2. Surface tension

3. Capillary action

4. Vapor pressure

b. Substances with similar intermolecular interactions tend to be miscible or soluble in one another.

**LO 2.18 The student is able to rank and justify the ranking of bond polarity on the basis of the locations of the bonded atoms in the periodic table. [See SP 6.1]**

Essential knowledge 2.C.1: In covalent bonding, electrons are shared between the nuclei of two atoms to form a molecule or polyatomic ion. Electronegativity differences between the two atoms account for the distribution of the shared electrons and the polarity of the bond.

a. Electronegativity is the ability of an atom in a molecule to attract shared electrons to it.

b. Electronegativity values for the representative elements increase going from left to right across a period and decrease going down a group. These trends can be understood qualitatively through the electronic structure of the atoms, the shell model, and Coulomb’s law.

c. Two or more valence electrons shared between atoms of identical electronegativity constitute a nonpolar covalent bond.

d. However, bonds between carbon and hydrogen are often considered to be nonpolar even though carbon is slightly more electronegative than hydrogen. The formation of a nonpolar covalent bond can be represented graphically as a plot of potential energy vs. distance for the interaction of two identical atoms. Hydrogen atoms are often used as an example.

1. The relative strengths of attractive and repulsive forces as a function of distance determine the shape of the graph.

2. The bond length is the distance between the bonded atoms’ nuclei, and is the distance of minimum potential energy where the attractive and repulsive forces are balanced.

3. The bond energy is the energy required for the dissociation of the bond. This is the net energy of stabilization of the bond compared to the two separated atoms. Typically, bond energy is given on a per mole basis.

e. Two or more valence electrons shared between atoms of unequal electronegativity constitute a polar covalent bond.

1. The difference in electronegativity for the two atoms involved in a polar covalent bond is not equal to zero.

2. The atom with a higher electronegativity will develop a partial negative charge relative to the other atom in the bond. For diatomic molecules, the partial negative charge on the more electronegative atom is equal in magnitude to the partial positive charge on the less electronegative atom.

3. Greater differences in electronegativity lead to greater partial charges, and consequently greater bond dipoles.

4. The sum of partial charges in any molecule or ion must be equal to the overall charge on the species.

f. All bonds have some ionic character, and the difference between ionic and covalent bonding is not distinct but rather a continuum. The difference in electronegativity is not the only factor in determining if a bond is designated ionic or covalent. Generally, bonds between a metal and nonmetal are ionic, and between two nonmetals the bonds are covalent. Examination of the properties of a compound is the best way to determine the type of bonding.

**LO 5.9 The student is able to make claims and/or predictions regarding relative magnitudes of the forces acting within collections of interacting molecules based on the distribution of electrons within the molecules and the types of intermolecular forces through which the molecules interact. [See SP 6.4]**

Essential knowledge 5.D.1: Potential energy is associated with the interaction of molecules; as molecules draw near each other, they experience an attractive force.

a. Chemists categorize intermolecular forces in terms of the nature of the charge distributions in the molecules involved. Thus, dipole-dipole, dipole-induced dipole, and induced dipole-induced dipole (dispersion) can be defined.

b. All substances will manifest dispersion forces, and these forces tend to be larger when the molecules involved have more electrons or have a larger surface area.

c. Hydrogen bonding is a relatively strong type of intermolecular interaction that occurs when hydrogen atoms that are covalently bonded to the highly electronegative atoms (N, O, and F) are also attracted to the negative end of a dipole formed by the electronegative atom (N, O, and F) in a different molecule, or a different part of the same molecule. When hydrogen bonding is present, even small molecules may have strong intermolecular attractions.

**BONDING**

**LO 2.20 The student is able to explain how a bonding model involving delocalized electrons is consistent with macroscopic properties of metals (e.g., conductivity, malleability, ductility, and low volatility) and the shell model of the atom. [See SP 6.2, 7.1, connects to 2.D.2]**

Essential knowledge 2.C.3: Metallic bonding describes an array of positively charged metal cores surrounded by a sea of mobile valence electrons.

a. The valence electrons from the metal atoms are considered to be delocalized and not associated with any individual atom.

b. Metallic bonding can be represented as an array of positive metal ions with valence electrons drawn among them, as if the electrons were moving (i.e., a sea of electrons).

c. The electron sea model can be used to explain several properties of metals, including electrical conductivity, malleability, ductility, and low volatility.

d. The number of valence electrons involved in metallic bonding, via the shell model, can be used to understand patterns in these properties, and can be related to the shell model to reinforce the connections between metallic bonding and other forms of bonding

**LO 2.21 The student is able to use Lewis diagrams and VSEPR to predict the geometry of molecules, identify hybridization, and make predictions about polarity. [See SP 1.4]**

Essential knowledge 2.C.4: The localized electron bonding model describes and predicts molecular geometry using Lewis diagrams and the VSEPR model.

a. Lewis diagrams can be constructed according to a well-established set of principles.

b. The VSEPR model uses the Coulombic repulsion between electrons as a basis for predicting the arrangement of electron pairs around a central atom.

c. In cases where more than one equivalent Lewis structure can be constructed, resonance must be included as a refinement to the Lewis structure approach in order to provide qualitatively accurate predictions of molecular structure and properties (in some cases).

d. Formal charge can be used as a criterion for determining which of several possible valid Lewis diagrams provides the best model for predicting molecular structure and properties.

✘✘The use of formal charge to explain why certain molecules do not obey the octet rule is beyond the scope of this course and the AP Exam. Rationale: Explaining why certain molecules do NOT obey the octet rule is beyond the scope of the course. The scope of the course DOES include the use of formal charge to evaluate different structures that follow the octet rule and the limitations of using Lewis structures for molecules with odd numbers of electrons or expanded octets.

e. The combination of Lewis diagrams with the VSEPR model provides a powerful model for predicting structural properties of many covalently bonded molecules and polyatomic ions, including the following:

1. Molecular geometry

2. Bond angles

3. Relative bond energies based on bond order

4. Relative bond lengths (multiple bonds, effects of atomic radius)

5. Presence of a dipole moment

f. As with any model, there are limitations to the use of the Lewis structure model, particularly in cases with an odd number of valence electrons. Recognizing that Lewis diagrams have limitations is of significance.

✘✘ Learning how to defend Lewis models based on assumptions about the limitations of the models is beyond the scope of this course and the AP Exam.

Rationale: Learning how to defend Lewis models does not strengthen understanding of the big ideas.

g. Organic chemists commonly use the terms “hybridization” and “hybrid orbital” to describe the arrangement of electrons around a central atom. When there is a bond angle of 180°, the central atom is said to be sp hybridized; for 120°, the central atom is sp2 hybridized; and for 109°, the central atom is sp3 hybridized.

Students should be aware of this terminology, and be able to use it. When an atom has more than four pairs of electrons surrounding the central atom, students are only responsible for the shape of the resulting molecule.

✘✘An understanding of the derivation and depiction of these orbitals is beyond the scope of this course and the AP Exam. Current evidence suggests that hybridization involving d orbitals does not exist, and there is controversy about the need to teach any hybridization. Until there is agreement in the chemistry community, we will continue to include sp, sp2, and sp3 hybridization in the current course.

Rationale: The course includes the distinction between sigma and pi bonding, the use of VSEPR to explain the shapes of molecules, and the sp, sp2, and sp3 nomenclature. Additional aspects related to hybridization are both controversial and do not substantially enhance understanding of molecular structure.

h. Bond formation is associated with overlap between atomic orbitals. In multiple bonds, such overlap leads to the formation of both sigma and pi bonds. The overlap is stronger in sigma than pi bonds, which is reflected in sigma bonds having larger bond energy than pi bonds. The presence of a pi bond also prevents the rotation of the bond, and leads to structural isomers. In systems, such as benzene, where atomic p-orbitals overlap strongly with more than one other p-orbital, extended pi bonding exists, which is delocalized across more than two nuclei. Such descriptions provide an alternative description to resonance in Lewis structures. A useful example of delocalized pi bonding is molecular solids that conduct electricity. The discovery of such materials at the end of the 1970s overturned a long-standing assumption in chemistry that molecular solids will always be insulators.

i. Molecular orbital theory describes covalent bonding in a manner that can capture a wider array of systems and phenomena than the Lewis or VSEPR models. Molecular orbital diagrams, showing the correlation between atomic and molecular orbitals, are a useful qualitative tool related to molecular orbital theory.

✘✘ Other aspects of molecular orbital theory, such as recall or filling of molecular orbital diagrams, are beyond the scope of this course and the AP Exam.

Rationale: As currently covered in freshman college chemistry textbooks, molecular orbital theory is superficially taught and limited to homonuclear molecules in the second period. Algorithmic filling of such MO diagrams does not lead to a deeper conceptual understanding of bonding. The course does include the important distinction between sigma and pi bonding

**LO 2.22 The student is able to design or evaluate a plan to collect and/or interpret data needed to deduce the type of bonding in a sample of a solid. [See SP 4.2, 6.4]**

In solids, the properties of the material reflect the nature and strength of the interactions between the constituent particles. For this reason, the type of bonding that predominates in a solid material, and the nature of the interactions between the particles comprising the solid, can generally be inferred from the observed macroscopic properties of the material.

Properties such as vapor pressure, conductivity as a solid and in aqueous solution, and relative brittleness or hardness can generally be explained in this way. Although recognizing the properties that can be associated with a particular type of bonding is valuable in categorizing materials, relating those properties to the structure of the materials on the molecular scale, and being able to make reasoned predictions of the properties of a solid based on its constituent particles, provides evidence of deeper conceptual understanding.

**LO 2.29 The student can create a representation of a covalent solid that shows essential characteristics of the structure and interactions present in the substance. [See SP 1.1]**

**LO 2.30 The student is able to explain a representation that connects properties of a covalent solid to its structural attributes and to the interactions present at the atomic level. [See SP 1.1, 6.2, 7.1]**

Essential knowledge 2.D.3: Covalent network solids generally have extremely high melting points, are hard, and are thermal insulators. Some conduct electricity.

a. Covalent network solids consist of atoms that are covalently bonded together into a two-dimensional or three-dimensional network.

1. Covalent network solids are only formed from nonmetals: elemental (diamond, graphite) or two nonmetals (silicon dioxide and silicon carbide).

2. The properties of covalent network solids are a reflection of their structure.

3. Covalent network solids have high melting points because all of the atoms are covalently bonded.

4. Three-dimensional covalent networks tend to be rigid and hard because the covalent bond angles are fixed.

5. Generally, covalent network solids form in the carbon group because of their ability to form four covalent bonds.

b. Graphite is an allotrope of carbon that forms sheets of two-dimensional networks.

1. Graphite has a high melting point because the covalent bonds between the carbon atoms making up each layer are relatively strong.

2. Graphite is soft because adjacent layers can slide past each other relatively easily; the major forces of attraction between the layers are London dispersion forces.

c. Silicon is a covalent network solid and a semiconductor.

1. Silicon forms a three-dimensional network similar in geometry to a diamond.

2. Silicon’s conductivity increases as temperature increases.

3. Periodicity can be used to understand why doping with an element with one extra valence electron converts silicon into an n-type semiconducting (negative charge carrying) material, while doping with an element with one less valence electron converts silicon into a p-type semiconducting (positive charge carrying) material. Junctions between n-doped and p-doped materials can be used to control electron flow, and thereby are the basis of modern electronics.

**LO 2.31 The student can create a representation of a molecular solid that shows essential characteristics of the structure and interactions present in the substance. [See SP 1.1]**

**LO 2.32 The student is able to explain a representation that connects properties of a molecular solid to its structural attributes and to the interactions present at the atomic level. [See SP 1.1, 6.2, 7.1]** Essential knowledge 2.D.4: Molecular solids with low molecular weight usually have low melting points and are not expected to conduct electricity as solids, in solution, or when molten.

a. Molecular solids consist of nonmetals, diatomic elements, or compounds formed from two or more nonmetals.

b. Molecular solids are composed of distinct, individual units of covalently bonded molecules attracted to each other through relatively weak intermolecular forces.

1. Molecular solids are not expected to conduct electricity because their electrons are tightly held within the covalent bonds of each constituent molecule.

2. Molecular solids generally have a low melting point because of the relatively weak intermolecular forces present between the molecules.

3. Molecular solids are sometimes composed of very large molecules, or polymers, with important commercial and biological applications.

| [**#**](http://session.masteringchemistry.com/myct/yui-dt0-href-ordinal) | [**ITEM TYPE**](http://session.masteringchemistry.com/myct/yui-dt0-href-itemType) | [**TITLEShow Descriptions**](http://session.masteringchemistry.com/myct/yui-dt0-href-title) | **DIFFICULTY** | **MEDIAN TIME** |
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| [**This Course**](http://session.masteringchemistry.com/myct/yui-dt0-href-courseDifficulty) | [**System**](http://session.masteringchemistry.com/myct/yui-dt0-href-systemDifficulty) | [**This Course**](http://session.masteringchemistry.com/myct/yui-dt0-href-formattedCourseTime) | [**System**](http://session.masteringchemistry.com/myct/yui-dt0-href-formattedSystemTime) |
| 1 | Tutorial | [Chemical Bonding](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795974) | -- | 1 | -- | 1m |
| 2 | Tutorial | [Introduction to Lewis Structures](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795841) | -- | 1 | -- | 3m |
| 3 | Tutorial | [Lewis Structures for Covalent Compounds](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795988) | -- | 3 | -- | 12m |
| 4 | End-of-Chapter | [Give It Some Thought: 8.5](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795980) | -- | 1 | -- | 1m |
| 5 | End-of-Chapter | [Give It Some Thought: 8.6](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796024) | -- | 1 | -- | 1m |
| 6 | End-of-Chapter | [Problem 8.5](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795990) | -- | 3 | -- | 4m |
| 7 | Tutorial | [Periodic Trends in Electronegativity](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795995) | -- | 2 | -- | 7m |
| 8 | Tutorial | [Covalent, Polar Covalent, and Ionic Bonds](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29795999) | -- | 2 | -- | 9m |
| 9 | Tutorial | [Bond Polarity](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796001) | -- | 1 | -- | 2m |
| 10 | End-of-Chapter | [Give It Some Thought: 8.11](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796012) | -- | 1 | -- | 1m |
| 11 | End-of-Chapter | [Give It Some Thought: 8.10](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796034) | -- | 1 | -- | 1m |
| 12 | End-of-Chapter | [Give It Some Thought: 8.9](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796013) | -- | 1 | -- | 1m |
| 13 | End-of-Chapter | [Problem 8.36](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796072) | -- | 1 | -- | 4m |
| 14 | Tutorial | [Formal Charges and Resonance](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796088) | -- | 3 | -- | 8m |
| 15 | Tutorial | [Formal Charge of a Diatomic Molecule](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796061) | -- | 2 | -- | 3m |
| 16 | End-of-Chapter | [Problem 8.7](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796093) | -- | 2 | -- | 5m |
| 17 | Tutorial | [Introduction to Resonance](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796128) | -- | 1 | -- | 3m |
| 18 | Tutorial | [Structures of Oxoanions](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796144) | -- | 2 | -- | 7m |
| 19 | End-of-Chapter | [Give It Some Thought: 8.14](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796113) | -- | 1 | -- | 1m |
| 20 | End-of-Chapter | [Problem 8.6](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796117) | -- | 1 | -- | 6m |
| 21 | End-of-Chapter | [Problem 8.48](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796955) | -- | 2 | -- | 19m |
| 22 | Tutorial | [The Octet Rule](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796970) | -- | 2 | -- | 4m |
| 23 | End-of-Chapter | [Give It Some Thought: 8.16](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796973) | -- | 1 | -- | 1m |
| 24 | End-of-Chapter | [Problem 8.60](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29797024) | -- | 1 | -- | 1m |
| 25 | Tutorial | [Bond Dissociation Energies](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796998) | -- | 2 | -- | 10m |
| 26 | Tutorial | [Bond Order, Bond Energy, and Bond Length](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796977) | -- | 1 | -- | 3m |
| 27 | End-of-Chapter | [Give It Some Thought: 8.18](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29796979) | -- | 1 | -- | 1m |
| 28 | End-of-Chapter | [Problem 8.71](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29797013) | -- | 3 | -- | 9m |
| 29 | End-of-Chapter | [Give It Some Thought: 9.1](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798827) | -- | 1 | -- | 1m |
| 30 | Tutorial | [Molecular Geometry](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798849) | -- | 1 | -- | 4m |
| 31 | Tutorial | [Bond Angles](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798830) | -- | 1 | -- | 5m |
| 32 | Tutorial | [VSEPR](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798888) | -- | 2 | -- | 2m |
| 33 | Tutorial | [Molecular Shapes and Bond Angles](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798870) | -- | 3 | -- | 4m |
| 34 | Tutorial | [Electronic Geometry](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798850) | -- | 1 | -- | 5m |
| 35 | Tutorial | [Molecular Geometry II](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798892) | -- | 2 | -- | 3m |
| 36 | End-of-Chapter | [Give It Some Thought: 9.2](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798894) | -- | 2 | -- | 1m |
| 37 | End-of-Chapter | [Give It Some Thought: 9.4](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798873) | -- | 1 | -- | <1m |
| 38 | End-of-Chapter | [Problem 9.3](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798874) | -- | 2 | -- | 4m |
| 39 | End-of-Chapter | [Problem 9.18](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798840) | -- | 1 | -- | 1m |
| 40 | End-of-Chapter | [Problem 9.27](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798858) | -- | 1 | -- | 10m |
| 41 | End-of-Chapter | [Go Figure 9.8](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798861) | -- | 1 | -- | 1m |
| 42 | Test Bank | [Chapter 9 Question 9 - Algorithmic](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798900) | -- | 1 | -- | 1m |
| 43 | Test Bank | [Chapter 9 Question 10 - Algorithmic](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798907) | -- | 1 | -- | 1m |
| 44 | Tutorial | [Molecule Polarity](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798901) | -- | 2 | -- | 7m |
| 45 | End-of-Chapter | [Problem 9.43](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798943) | -- | 3 | -- | 3m |
| 46 | End-of-Chapter | [Problem 9.45](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798923) | -- | 2 | -- | 8m |
| 47 | Tutorial | [Formation of a Chemical Bond](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798971) | -- | 4 | -- | 11m |
| 48 | Tutorial | [Animation—Hydrogen Molecule Bond Formation](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29798953) | -- | 4 | -- | 8m |
| 49 | Tutorial | [Geometry and Bond Angles in Covalent Molecules](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799011) | -- | 1 | -- | 6m |
| 50 | Tutorial | [Enthalpy of Sigma and Pi Bonds](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799014) | -- | 2 | -- | 12m |
| 51 | Tutorial | [± Isomerization of a Double Bond](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799016) | -- | 3 | -- | 10m |
| 52 | Tutorial | [Geometry, Bond Angles, Hybridization, and Polarity](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799047) | -- | 1 | -- | 5m |
| 53 | End-of-Chapter | [Problem 9.48](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799050) | -- | 1 | -- | 1m |
| 54 | Tutorial | [Orbital Overlap: Sigma and Pi Bonding](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799293) | -- | 3 | -- | 7m |
| 55 | End-of-Chapter | [Problem 9.8](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799326) | -- | 2 | -- | 6m |
| 56 | End-of-Chapter | [Give It Some Thought: 9.11](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799253) | -- | 1 | -- | <1m |
| 57 | End-of-Chapter | [Go Figure 9.34](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799334) | -- | 2 | -- | 1m |
| 58 | End-of-Chapter | [Go Figure 9.33](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799314) | -- | 1 | -- | <1m |
| 59 | End-of-Chapter | [Problem 9.9](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799338) | -- | 1 | -- | 3m |
| 60 | Tutorial | [Molecular Orbital Diagrams and Bond Order](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799350) | -- | 2 | -- | 4m |
| 61 | Tutorial | [Analysis of Sulfur Tetrafluoride Monoxide](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799422) | -- | 2 | -- | 17m |
| 62 | Tutorial | [Lewis Structures Theory](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799423) | -- | 3 | -- | 11m |
| 63 | End-of-Chapter | [Problem 11.11](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799569) | -- | 3 | -- | 4m |
| 64 | End-of-Chapter | [Problem 11.12](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799524) | -- | 2 | -- | 3m |
| 65 | Tutorial | [Intermolecular Forces](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799476) | -- | 3 | -- | 11m |
| 66 | Tutorial | [Intermolecular Forces in Liquids](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799507) | -- | 1 | -- | 1m |
| 67 | Tutorial | [Homologous Series: Relating Intermolecular Forces, Boiling Points, and Molecular Formula](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799582) | -- | 3 | -- | 6m |
| 68 | Tutorial | [Animation—Hydrogen Bonding](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799532) | -- | 2 | -- | 7m |
| 69 | End-of-Chapter | [Give It Some Thought: 11.1](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799514) | -- | 2 | -- | 1m |
| 70 | End-of-Chapter | [Give It Some Thought: 11.2](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799583) | -- | 1 | -- | <1m |
| 71 | End-of-Chapter | [Problem 11.17](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799516) | -- | 2 | -- | 3m |
| 72 | End-of-Chapter | [Problem 11.18](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799588) | -- | 1 | -- | 3m |
| 73 | End-of-Chapter | [Problem 11.21](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799605) | -- | 1 | -- | 1m |
| 74 | End-of-Chapter | [Problem 11.22](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799606) | -- | 1 | -- | 1m |
| 75 | Tutorial | [Capillary Action](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799589) | -- | 2 | -- | 4m |
| 76 | Tutorial | [Viscosity, Surface Tension, and Intermolecular Forces](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799591) | -- | 1 | -- | 3m |
| 77 | End-of-Chapter | [Give It Some Thought: 11.3](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799645) | -- | 1 | -- | 1m |
| 78 | Tutorial | [± Heating and Cooling Curves](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799599) | -- | 3 | -- | 14m |
| 79 | Tutorial | [Animation—Changes of State](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799635) | -- | 2 | -- | 8m |
| 80 | End-of-Chapter | [Problem 11.44](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799702) | -- | 2 | -- | 6m |
| 81 | End-of-Chapter | [Problem 11.43](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799652) | -- | 4 | -- | 6m |
| 82 | Tutorial | [Properties of Liquids](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799668) | -- | 2 | -- | 4m |
| 83 | End-of-Chapter | [Problem 11.49](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799676) | -- | 1 | -- | 2m |
| 84 | End-of-Chapter | [Problem 11.53](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799731) | -- | 1 | -- | 1m |
| 85 | Tutorial | [Phase Diagrams and Phase Changes](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799721) | -- | 2 | -- | 6m |
| 86 | Tutorial | [Regions in a Phase Diagram](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799745) | -- | 1 | -- | 3m |
| 87 | Tutorial | [Animation—The Phase Diagram of Water](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799782) | -- | 2 | -- | 9m |
| 88 | Tutorial | [Interactive Activity—Phase Diagrams for Carbon Dioxide](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799772) | -- | 1 | -- | 7m |
| 89 | End-of-Chapter | [Problem 11.61](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799784) | -- | 2 | -- | 5m |
| 90 | End-of-Chapter | [Problem 11.7](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799750) | -- | 1 | -- | 4m |
| 91 | Tutorial | [± Characteristics of Liquefied Gases](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799795) | -- | 3 | -- | 12m |
| 92 | Tutorial | [Drawing and Predicting Lewis Structures](http://session.masteringchemistry.com/myct/itemView?showStatsForCourse=1110976&view=solution&showStats=1&assignmentProblemID=29799876) | -- | 4 | -- | 25m |
| **Average:** |  | **Total:** |  |
| **--** | **1.8** | **--** | **452m** |