

# Instructional Framework for Computational Science

## Chemistry I and Chemistry I Honors

Day	Student Skills	Instructional Strategies	Probing Questions	Assessment Process	
				Student Product/Behavior	Feedback
1	1. <b>Identify</b> real-world problem associated with standards-based concept(s).	Teacher poses introductory questions to entire class with feedback to determine students' prior knowledge of gases. (Ex. What properties of gases can be measured?)  Teacher poses probing questions to students to peak their interest in the unit.	<ul style="list-style-type: none"> <li>How does a hot air balloon work?</li> <li>Why don't NASCAR teams fully inflate the tires at the beginning of a run?</li> <li>What is the coldest temperature?</li> <li>What do you think would happen if we reach the coldest temperature possible?</li> <li>Why do scuba divers suffer from the bends if they ascend incorrectly?</li> <li>What causes altitude sickness?</li> </ul>	Students will provide answers introductory questions about properties of gases.  Students will brainstorm possible answers to probing questions which will be explored the next couple of days in the labs and through the models.	Teacher provides additional introductory information about gases needed for this module.  There will probably be misconceptions with how a hot air balloon works. The class will collectively work until they reach the correct answer. Students should realize that if the air expands in a hot air balloon, that it would also expand in a tire when heated.
5	2. <b>Develop</b> background skills and knowledge. <ul style="list-style-type: none"> <li>Perform background research.</li> <li>Develop content understanding of key variables.</li> <li>Conduct investigations (labs) to gather data.</li> <li>Learn to use a modeling tool (e.g., STELLA).</li> </ul>	<ol style="list-style-type: none"> <li>Students complete anticipatory guide and read text/articles on websites. Develop Kinetic Molecular Theory.</li> <li>Carry out Boyle's Law Lab.</li> <li>Excel – teach graphing and regression.</li> <li>Limited direct instruction on Boyle's Law.</li> <li>Repeat steps 2-4 for Charles' Law.</li> <li>Develop Combined Gas Law.</li> <li>Conduct class discussion of results and problems.</li> </ol>	<ul style="list-style-type: none"> <li>What is the relationship between pressure and volume?</li> <li>How do you know?</li> <li>What is the relationship between temperature and volume?</li> <li>How do you know?</li> <li>What are the different factors that affect volume of gases?</li> <li>Why use Excel as a model?</li> <li>How do you enter a formula in Excel?</li> </ul>	<ol style="list-style-type: none"> <li>Students review their answers to the anticipatory guide and correct.</li> <li>Collect Data</li> <li>Analyze Data. Produce correctly formatted graphs with regression line.</li> <li>Take notes/ solve problems from text/other sources.</li> <li>Same as above.</li> <li>Take notes/ solve problems.</li> <li>Class discussion of labs and problems.</li> </ol>	<ol style="list-style-type: none"> <li>Students will use an "Anticipation/Prediction Guide" in reading the assigned article(s); they will correct their responses.</li> <li>&amp; 3. Student will receive a 20-point lab grade based upon rubric.</li> <li>Students will have the opportunity to check their answers and determine if they are solving problems correctly.</li> <li>Same as above.</li> <li>Same as #4.</li> <li>Teacher provides feedback to students as they discuss in class.</li> </ol>
2	3. <b>Simplify</b> real-world problem. <ul style="list-style-type: none"> <li>Determine applicable principles/laws/procedures.</li> <li>Explain assumptions.</li> </ul>	From lab results, student groups determine the relationships of volume, pressure, and temperature in gases.  Teacher demonstrates limitations of modeling and students determine the assumptions of the Gas Laws.	<ul style="list-style-type: none"> <li>What happens to the gas molecules at low temperature?</li> <li>Do you expect a gas to behave differently under these conditions?</li> <li>With Charles' Law lab: Why did you measure length not volume?</li> <li>What assumptions do you have to make? (i.e. What do you have to leave out?)</li> <li>Do you think all gases always behave as they did in the lab? Why or why not?</li> <li>Do you think all gases behave the same as they did in the lab at extreme temperatures and pressures?</li> </ul>	Answer questions in writing (lab reports) and orally (class discussions).  Lab groups list limitations/assumptions.	Lab reports will be graded. Oral questions will be pursued until a workable answer is reached.  Teacher guidance as circulating to lab groups on limitations and assumptions.
	4. <b>Identify</b> variables and interrelationships. <ul style="list-style-type: none"> <li>Make a diagram or flowchart connecting ideas from research.</li> </ul>	Student lab groups create flow charts showing the relationships of these variables on gases: <ul style="list-style-type: none"> <li>P= pressure</li> <li>V = volume</li> <li>T = temperature (K)</li> <li>PV = k</li> <li>V/T = k</li> </ul>	<ul style="list-style-type: none"> <li>What is the relationship between: <ul style="list-style-type: none"> <li>Pressure and volume?</li> <li>Volume and temperature?</li> <li>Pressure and temperature?</li> </ul> </li> <li>Are units important? Why/why not?</li> <li>What variables will you use? Why did you choose them?</li> <li>How can you graphically display the relationship between these variables?</li> <li>Have you thought about the x and y axis? What data will you display on them?</li> </ul>	Flow charts with narrative explaining the identified relationships.  Answer questions.  Take notes.	Student lab groups pair and explain their flow charts with teacher circulating to be sure students have correct relationships.  All issues will be discussed and addressed in laboratory groups and in class with feedback as needed.
2	5. <b>Defend</b> the identified relationships and assumptions. <ul style="list-style-type: none"> <li>Present and defend in groups.</li> </ul>	Each lab group completes a "Thinking Cube" from their lab observations.	<ul style="list-style-type: none"> <li>What relationships did you find in the Boyle's and Charles' Gas Law labs?</li> <li>How did you derive these relationships from your research?</li> </ul>	Work together collaboratively in order to develop Boyle's Law, determine absolute zero, and develop Charles' Law. Demonstrate knowledge learned by completing the "Thinking Cube."	They will get immediate feedback when they see if (1) their data is linear and (2) they achieve -273°C for absolute zero.  Teacher assessment of "Thinking Cube."
	6. <b>Represent</b> relationships in terms of mathematical equations. <ul style="list-style-type: none"> <li>Use diagrams and relationships to derive mathematical equations</li> <li>Determine theoretical numbers in absence of real figures.</li> </ul>	Teacher uses student results from gas labs to develop the formulas below: <ul style="list-style-type: none"> <li><math>P_1V_1=P_2V_2</math></li> <li><math>V_1/T_1=V_2/T_2</math></li> </ul>	<ul style="list-style-type: none"> <li>What is the math that underlies your graphical representation?</li> <li>What does the math mean and how can it be used to explain the situations below?</li> <li>Using either diagrams or mathematical equations, explain the answer to the following question assigned to your group: <ol style="list-style-type: none"> <li>How does a hot air balloon work?</li> <li>Why don't NASCAR teams fully inflate the tires at the beginning of a run?</li> <li>What is the coldest temperature?</li> <li>What do you think would happen if we reach the coldest temperature possible?</li> <li>Why do scuba divers suffer from the bends if they ascend correctly?</li> <li>What causes altitude sickness?</li> </ol> </li> </ul>	Draw diagrams explaining Boyle's and Charles' Gas Laws.  Group presentation of answers to probing question.	Grading of presentation according to specified rubric.
2	7. <b>Translate</b> variables and relationships into computational model. <ul style="list-style-type: none"> <li>Translate model into computational process.</li> <li>Review math equations.</li> <li>Run the model.</li> <li>Get results.</li> <li>Explore range of validity.</li> <li>Run check cases.</li> </ul>	Students will work in groups of 2-4 depending upon class size and availability of CBL units and computer stations.  Students use Excel and create models of their data. They also use Excel to predict and then compare to the formulas.	<ul style="list-style-type: none"> <li>What is the equation for the relationship between pressure and volume as demonstrated in the lab/model?</li> <li>What is the equation for the relationship between temperature and volume as demonstrated in the lab/model?</li> <li>Compare your results with 4 other teams. What did you learn?</li> <li>What do the results look like? Is that what you expected? Why or why not?</li> </ul>	Ability to work other gas law problems related to pressure, temperature, and volume.	Comparison of student results with other students.  Ability to solve and model other gas law problems independently.
1	8. <b>Interpret</b> findings. <ul style="list-style-type: none"> <li>Evaluate results.</li> <li>Draw conclusions.</li> <li>Make recommendations.</li> </ul>	Student groups will need to reach consensus on the relationships of volume, temperature, and pressure for gases based on their lab observations and models created in Excel.	<ul style="list-style-type: none"> <li>How confident do you feel about the accuracy of your results?</li> <li>Do we need more data?</li> <li>If pressure is doubled, what happens to volume?</li> <li>What relationships between pressure and volume are shown on the graphs?</li> <li>Did your data accurately predict absolute zero? If not, why?</li> </ul>	Lab groups' answers to probing questions.	Teacher will review answers.  Students will examine new data and determine which is correct/incorrect models of the Gas Laws.
2	9. <b>Communicate</b> findings Presentation, letter, essay, etc.	Write conclusion of their findings as a group paper using a RAFT. R = role A = audience F = format T = topic  As a gas molecule, write a letter of complaint to the NASCAR team, the balloonist, or the scuba diver about the problem(s) that pressure, temperature, and/or volume are creating in your "life."	<ul style="list-style-type: none"> <li>In your RAFT situation, consider the following: <ul style="list-style-type: none"> <li>To whom will you write and what complaint will you choose?</li> <li>What data do you have to support your complaint?</li> <li>What problems are being created in your "life as a gas" by the variables that have been explored?</li> </ul> </li> </ul>	Group letter of complain.	Groups will trade letters and score according to specified rubric.  Teacher will also assess and provide feedback.