



Connected Chemistry

Solutions Unit

Lesson 5: Factors Affecting Solubility



Student's Lesson at a Glance

Lesson Summary

Students explore demonstrations and simulations on the factors that affect solubility, including agitation, amount of solute added, temperature and pressure. Students develop the ability to explain the relationships that exist between these variables on both the macroscopic and submicroscopic level.

SWBAT (Students Will Be Able To)

- Determine what factors do and do not affect the solubility of a substance (e.g., polarity, size of molecules, temperature, agitation, pressure, composition, and amount of substance already dissolved in solution)

Essential Vocabulary

Keep a list of all important words from this lesson. This list, in addition to the lists from other lessons, will make studying easier and improve scientific communication skills. The essential vocabulary from the unit is in bold. Additional words that will expand your scientific vocabulary are in italics.



Connected Chemistry Reminder

- Many questions will ask you “what you think” or “to make predictions.” The only answer that is wrong is the answer that is left blank.
- The terms solute and solvent can be easily confused. The solute is the substance that is being dissolved. The solvent is the substance that dissolves the solute at a specific temperature.
- Use the vocabulary and note section to take organized notes so that studying for tests and quizzes will be easier.
- Supporting claims with evidence is not only a skill that scientists use, but a skill that will help you in other classes and everyday life.
- Draw a key when you are sketching. Symbolic keys can help you and others decode your sketches at a later time.
- Ions will be seen in the simulation. Make sure they are included in the key in addition to regular atoms of the substance.
- Make sure you understand the difference between the independent and dependent variable in an experiment.

Notes

Homework

Upcoming Quizzes/ Tests



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Activity 1: Connecting

1. Define "agitation" of a mixture in your own words.

2. What do you think is the purpose of agitating a solution?

Your teacher will make a table salt and water solution. The solution needs to be very concentrated. While stirring quickly, your teacher will add table salt into the room temperature water. Stirring is one way to *agitate* a solution. Carefully observe what happens to the mixture during stirring and after stirring ends.



3. Other than adding more water into the solution, how could your teacher dissolve table salt faster?



Activity 2: Demonstration of Solubility Changes

Part 1: Use Simulation 3, Set 1

In these simulations pressure, temperature, solute and solvent amounts may be adjusted. Using the CCC simulation, your teacher will show you the interaction between table salt and room temperature water at the submicroscopic level. Your teacher will add add solute and then the solvent according to class feedback. Temperature and pressure will not be adjusted for the demonstration. Use concentration tab to determine solution volume and amount of solute dissolved.

- *Create a submicroscopic sketch, record the temperature of the simulation and record observations.*



Solution of sodium chloride and water	Submicroscopic Sketch	Record Data from Monitors			
		Temperature		Pressure	
		Amount of Solvent		Amount of Solute Added	
		Amount of Solute Dissolved			
		Record your Observations			
Key					

4. If you adjust more than one variable at a time, will you be able to determine relationships between individual variables? *Explain*

5. What are the possible relationships that can exist between an independent and dependent variable? *Explain your example.*

**Part 2**

The simulations calculate solution volume *additively*. This means that the solution volume in the simulation is equal to the volume of solute added to the volume of solvent. Examine the table below that was taken from actual experimental data and graph the data. *Be sure to label the axes.*

Graph paper can be found on pages 80-81.

Amount of sodium chloride (mL) Added to 100 mL of water	Change in volume of solution (mL)
1.00	0.38
2.02	0.57
3.02	0.87
4.02	1.28
5.03	1.52
6.00	1.90
6.99	2.35
7.97	2.60
8.99	3.00
10.07	3.60

6. What relationship, if any, exists between the amount of solute added and the total volume of the solution?

7. How does this real-life data vary from the virtual data that was collected in the simulations?

8. Explain from the submicroscopic level why the amount of solute added changes the volume of the solution.



Activity 3: Simulation of Changes

Part 1: Varying Temperature: Use Simulation 3, Sets 1, 3, and 6

In this activity, you will manipulate one variable while keeping the other variables constant. The variable that you manipulate is called the independent variable. In the table below, the independent variable column has a bold border. You will manipulate the temperature of the system by changing the amount of heat added. The other variables are to be the same for each trial. Add solute before adding solvent. The variable that is changing as a result of the manipulation of the independent variable is called the dependent variable. The dependent variable (marked with an asterisk) is the amount of dissolved solute. Complete three different trials of one mixture. Pause each trial at 30 seconds and sketch as directed below for trials 1, 2, and 3. Make sure to include labels for all measurements.

Mixture	Trial	Temp (°C)	Pressure (atm)	Amount of solute added (g)	Volume of solvent (mL)	Volume of solution (mL)	* Amount of dissolved solute (g)
	1						
	2						
	3						

Sketch submicroscopic picture of trial 1 after 30 seconds	Sketch submicroscopic picture of trial 2 after 30 seconds	Sketch submicroscopic picture of trial 3 after 30 seconds
Observations	Observations	Observations
Key		



9. What kind of relationship exists between the amount of solute that dissolves and temperature? Is relationship direct or indirect?

10. Some people like to brew sweet ice tea at very cold temperatures. Based on your observations, will tea brew faster or slower at cold temperatures? *Explain your answer at the submicroscopic level.*

11. Using your submicroscopic sketches, explain how increasing the temperature affects the ability of a solute to dissolve.

Part 2: Varying Pressure

Complete three different pressure trials for one mixture while keeping all other variables constant. Using the counters on the simulation, record the amount of solute dissolved in the column with an asterisk at each pressure that you select.

Pause at 30 seconds and sketch as directed below for trials 1, 2 and 3. Make sure to include labels for all measurements.

Mixture	Trial	Temp (°C)	Pressure (atm)	Amount of solute added (g)	Volume of solvent (mL)	* Amount of dissolved solute (g)
	1					
	2					
	3					

Sketch submicroscopic picture of trial 1 after 30 seconds	Sketch submicroscopic picture of trial 2 after 30 seconds	Sketch submicroscopic picture of trial 3 after 30 seconds
Observations	Observations	Observations
Key		



13. Is there a relationship between the amount of solid solute dissolved in liquid solvent and pressure? If so, what is the relationship?

14. Using your submicroscopic sketches, explain how increasing the pressure affects the ability of a solid solute to dissolve in a liquid solvent.

15. Make a graph of the amount of solid solute dissolved in liquid solvent versus pressure. *Be sure to label the axes. Graph paper can be found on pages 80-81 if needed.*



Part 3: Varying the Amount of Solute

Complete three different trials of one mixture by adding different amounts of solute while keeping the other variables constant. You should include a wide range of amounts. Using the counters on the simulation, record the amount of solute dissolved for each different amount of solute that you added in the column with an asterisk. Pause at 30 seconds and sketch as directed below for trials 1, 2 and 3. Make sure to include labels for all measurements.

Mixture	Trial	Temp (°C)	Pressure (atm)	Amount of solute added (g)	Volume of solvent (mL)	* Amount of dissolved solute (g)
	1					
	2					
	3					

Sketch submicroscopic picture of trial 1 after 30 seconds	Sketch submicroscopic picture of trial 2 after 30 seconds	Sketch submicroscopic picture of trial 3 after 30 seconds
Observations	Observations	Observations
Key		



16. Is there a relationship between the amount of solid solute added and the amount of solute that dissolves? If so what is the relationship?

17. Is the relationship between amount solute added and the amount of solute dissolved a direct or inverse relationship?

18. Assuming that the water temperature and the amount of sugar used are kept constant, why would sugar dissolve more easily into bottled water than into tap water?

19. Using your submicroscopic sketches, explain how increasing the amount of solute affects the ability of a solute to dissolve.

20. Make a graph of the amount of solid solute added and the amount of solute that dissolves. *Be sure to label the axes. Graph paper can be found on pages 80-81 if needed.*



Activity 4: Teacher Facilitated Discussion

As a class, use the data from the small groups to complete the table below. Use only the substances that were soluble in water. Use the class data to complete the analysis questions.

Group	Mixture	Trial	Part 1		Part 2		Part 3	
			Temp (°C)	Solute Dissolved (g)	Pressure (atm)	Solute Dissolved (g)	Solute Added (g)	Solute Dissolved (g)
A	Sodium chloride + Water	1						
		2						
		3						
B	Calcium chloride + Water	1						
		2						
		3						
C	Sodium bicarbonate + Water	1						
		2						
		3						



21. How does the solubility of calcium chloride differ from the solubility of sodium chloride?

22. Based on the data collected, what solid substance is the most soluble in 100 grams of water at approximately 60 °C? *Support your claim with evidence.*

23. Based on the data collected, what solid substance was the least soluble in 100 grams of water at approximately 60 °C? *Support your claim with evidence.*

24. What independent variable has no relationship to the dependent variable of solubility for the three solutions that contain a solid solute and liquid solvent? Explain why this variable has no relationship to solubility.

25. Explain how each variable has an effect or does not have an effect on the solubility of a substance at the submicroscopic level.
