Concentrations (At Home)

Middle School / High School

Introduction

One of the biggest issues facing producers today are the misconceptions surrounding some of the most fundamental practices of production, the use of sprayed pesticides, herbicides and fertilizers. Through the ubiquitous availability of news platforms, either through social media or through traditional internet sites, the average individual is being bombarded with information that comes from a flawed understanding of the basic principles of concentrations and appropriate application. Herbicides, such as glyphosate, are readily available for purchase in formulations for home use as well as commercial agricultural formulations. This lab will investigate the non-standardized formulations of at-home glyphosate products and application suggestions as opposed to the commercial agricultural products and practices. Special attention will be paid to the ideas of concentrations, dilutions, and application surface area for both types of application situations. Is the commercial consumer really using more than the at-home consumer when we do the math? We will also consider the question: what constitutes too much application?

Materials

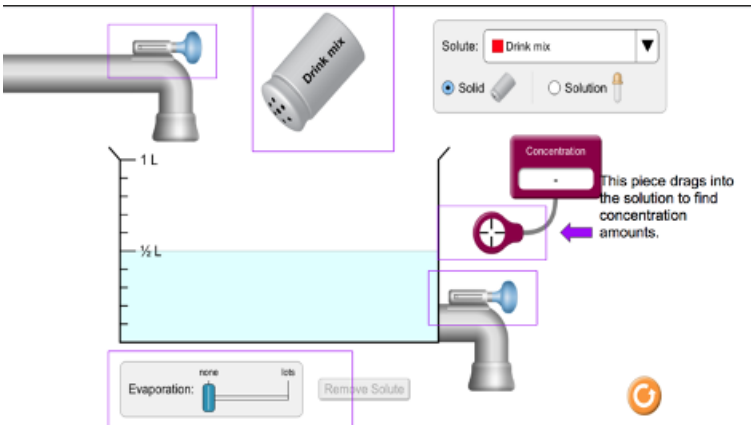
- An html5 compatible device: iPad or computer
- Pencil
- Printed worksheets or scrap notebook paper for writing
- Scenario Cards Worksheet
- Concentrating on Concentration Worksheet

Directions

On your laptop or computer go to Phet: Concentrations ©

https://phet.colorado.edu/sims/html/concentration/latest/concentration_en.html

1. The pieces in the photo that are boxed in purple are movable and will alter your amount of concentration or solution.



2. Move the concentration sensor into your solution before beginning. In the image it is the piece with text beside it saying that it moves.
3. Add a couple shakes of "drink mix" to the water then take a couple minutes to see how the moving parts work and affect the concentration of the solution.
4. Hit the restart arrow when you are done experimenting.
   a. Don't forget to add your concentration sensor.
5. Once again, add a couple shakes of drink mix to the water and fill in the remaining boxes of the table:

Action	Drink Mix Added	Water is Added	Evaporation Occurs	Solution is drained	Solute is Removed
What happens to concentration?					

6. Hit the restart arrow when you are done completing the chart.
7. Change the "drink mix" to one of your other solute options. Remain on the solid setting and add as much as you can. Answer the questions below:
   a. How do you know when a solution is saturated?
   b. When a solution is saturated, and additional solid solute is added, what happens?
   c. How does adding this additional solute change the concentration of the saturated solution?
   d. How does evaporation change the concentration of a saturated solution?
8. Hit the restart arrow and add your concentration sensor.
9. Choose a new solute and move from a solid to a solution.
   a. How can you measure the concentration of the solution inside the dropper?
   b. How might you get that concentrated solution to become saturated?
   c. Does it work?
   d. Do you think it would work for other solutions? Yes or No Why or why not?
   e. Are the concentrations of all of the solutions the same?

Brainstorming

- Create a list of where we would see solutions being prepared or used in the agricultural world. Challenge yourself to come up with at least 10 different applications of solutions in agriculture.
- Next watch how solutions are used as chemical sprays for herbicides in Peterson Farm Brothers © video on Chemical Application: https://youtu.be/AAXcFeRRZDk
  - As you watch, focus on how the solutions are mixed in the spraying tank but also on how the applicator is precisely applying the spray so that there is a control on how much spray is being used in one area.

Compare and Contrast Home Use vs. Commercial Use

Using the scenario cards provided, work through exactly how much of the active ingredient (solute), in this case glyphosate, is being sprayed per square foot of land for each scenario.

Scenario Cards

EPA Regulations: % Active Ingredient = 41% 8 qts. of product 44 gal. of water Area Covered: 1 acre	Home: Premixed % Active Ingredient = 2.0% 1 gal. of product 1 gal. of water Area Covered: 300 sq-ft.
Farm 1: % Active Ingredient = 41% Tank size: 1,000 gals. Area Covered: 70 Acres 32 oz. product/acre	Home: Concentrated % Active Ingredient = 5.030% 32 oz. of product 1 gal. of water Area covered: 75 sq-ft.
Farm 2: % Active Ingredient = 41% Area Covered: 1 acre 25.6 oz. of product 20 gal. of water	Home: Super Concentrated % Active Ingredient = 50.2% 2.5 oz. of product 1 gal. of water Area Covered: 300 sq-ft.
Farm 3: % Active ingredient = 41% Area Covered: 43 acres 15 gal. of product 630 gal. of water	Home: Dry Mix % Active Ingredient = 73.3% 1 gal. of product 1 gal. of water Area Covered: 300 sq-ft.

Questions

Based on the data collected and analyzed above, answer the following questions.

1. List at least two ways the home use and the farm use products are different.

2. Why did all of the units need to be the same on our calculations?

3. How are home application and farm application likely to be different? (Hint: Think back to the video, what tech do farmers have?)

4. Based on the evidence seen above, are you surprised by any of the numbers you calculated? Did it seem more or less than you anticipated?

5. Based on this particular set of data, how do farmers and homeowners compare in their use of the chemical glyphosate. (Include the terms, area, active ingredient, and concentration in your answer.)

Concentrating on Concentrations

What you need to know!

% Glyphosate: ??
(v/v) Amount of Product: ??
Amount of Water: ??
Area Covered: ??

Helpful Conversions!

32 oz. = 1 qt.
128 oz. = 1 gal.
43,560 sq-ft. = 1 Acre

How to Calculate Concentration of Glyphosate:

$$\frac{\text{(Amount of Product in oz.)(\% Glyphosate in Product)}}{\text{(Amount of Water in oz.)}} = \text{\% Glyphosate/Water}$$

How to Calculate Glyphosate / Sq ft:

$$\frac{\text{(oz. of glyphosate)}}{\text{(Area Covered in Sq-ft.)}}$$

Scenario	% Glyphosate	Amount Product	Amount Water	Area Covered	% v/v Glyphosate/Water	Glyphosate/ Sq-ft.
EPA Regulations						
Farm 1						
Farm 2						
Farm 3						
Home, Premixed						
Home, Concentrate						
Home, Super Concentrate						
Home, Dry Mix						

Answer Key

Answers to questions under bullet #7:

a. How do you know when a solution is saturated?
   If more solute is added and it does not dissolve, then the original solution was saturated. You will notice in the simulation, if you continue to add solute after saturation, it collects on the bottom of the container.

b. When a solution is saturated, and additional solid solute is added, what happens?
   You will notice in the simulation, if you continue to add solute after saturation, it collects on the bottom of the container.

c. How does adding this additional solute change the concentration of the saturated solution?
   It does not change the concentration of the saturated solution.

d. How does evaporation change the concentration of a saturated solution?
   Evaporation does not change the concentration of a saturated solution.

Answers to questions under bullet #9:

a. How can you measure the concentration of the solution inside the dropper?
   Possible Answer: You can drain the water from the tank, add only solution into the tank, and place the concentration sensor into the solution.

b. How might you get that concentrated solution to become saturated?
   Possible Answer: You can evaporate the solution until there is solute at the bottom of the tank. Then add enough additional solution for it to become saturated.

c. Does it work?
   Answers will vary

d. Do you think it would work for other solutions? Yes or No Why or why not?
   Answers Will Vary

e. Are the concentrations of all of the solutions the same?
   No

Answers to questions under questions sheet:

1. List at least two ways the home use and the farm use products are different.
   Answers here can vary. Some main ideas to look for are: Glyphosate is regulated in commercial usages; it is not regulated at home. Commercial applicators are required to be trained to use products while home applicators are not.

2. Why did all of the units need to be the same on our calculations?
   To make sure that we are comparing the same amounts of the same substance. If we used different units, it would paint an incorrect picture with our data.

3. How are home application and farm application likely to be different? (Hint: Think back to the video. What tech do farmers have?)
   Answers here may vary.

4. Based on the evidence seen above, are you surprised by any of the numbers you calculated? Did it seem more or less than you anticipated?
   Answers will vary.

5. Based on this particular set of data, how do farmers and homeowners compare in their use of the chemical glyphosate. (Include the terms, area, active ingredient, and concentration in your answer.)
   Student responses will vary. Ultimately, they should understand that commercial applications use less Glyphosate per sq ft than home applications.

Concentrating on Concentrations - ANSWER KEY

What you need to know!

% Glyphosate: ??
(v/v) Amount of Product: ??
Amount of Water: ??
Area Covered: ??

Helpful Conversions!

32 oz. = 1 qt.
128 oz. = 1 gal.
43,560 sq-ft. = 1 Acre

How to Calculate Concentration of Glyphosate:

$$\frac{(\text{Amount of Product in oz.})(\%\ \text{Glyphosate in Product})}{(\text{Amount of Water in oz.})} = \%\ \text{Glyphosate/Water}$$

How to Calculate Glyphosate / Sq ft:

$$\frac{(\text{oz. of glyphosate})}{(\text{Area Covered in Sq-ft.})}$$

Scenario	% Glyphosate	Amount Product	Amount Water	Area Covered	% v/v Glyphosate/Water	Glyphosate/ Sq-ft.
EPA Regulations	41%	256 oz	5,632 oz	43,560 sq-ft	1.86	.0059
Farm 1	41%	2,240 oz	128,000 oz	3,049,200 sq-ft	.7175	.0007
Farm 2	41%	25.6 oz	2,560 oz	43,560 sq-ft	.41	.0006
Farm 3	41%	1920 oz	80640 oz	1,873,080 sq-ft	.976	.0010
Home, Premixed	2%	128 oz	128 oz	300 sq-ft	2	.4267
Home, Concentrate	5.030%	32 oz	128 oz	75 sq-ft	1.2575	.4267
Home, Super Concentrate	50.2%	2.5 oz	128 oz	300 sq-ft	.980	.0083
Home, Dry Mix	73.3%	128 oz	128 oz	300 sq-ft	73.3%	.4267