

Dilution of household bleach: Applying ratios and proportions to solve real-life problems

Key Stage: 3

Strand: Number and Algebra Strand

Learning Unit: Rates, ratios and proportions

Objective:

- (i) Connect STEM education and real life
- (ii) Solve real-life problems by applying percentages, ratios and proportions
- (iii) Raise awareness of preventing infectious diseases

Relationship with other KLA(s) in STEM Education:

The Unit 12 “A Healthy Body” of Science at junior secondary

Resources Required :

1. Spreadsheet software
2. Online resources on household bleach (see note for teachers on the following page), and pictures of bleach ingredient labels

Background:

Infectious diseases caused by viruses, such as influenza, avian influenza, SARS, and the recent Coronavirus Diseases 2019 (COVID-19) , not only endanger personal health, but also pose a great threat to public health. To prevent infectious diseases and fight against the epidemic, it is important for citizens to work together to maintain household and personal hygiene. In doing so, the use of diluted bleach for household cleaning and disinfection is one of the common measures.

Description of the Activity:

1. The teacher briefs students that many citizens may use diluted household bleach to disinfect their homes. Bleach is a strong and effective household disinfectant. Its main ingredient (i.e., the active ingredient) is sodium hypochlorite which can deteriorate the protein of microorganisms, and effectively kill bacteria, fungi and viruses.
2. The teacher distributes the worksheet to students, asks students about the meaning of the dilution ratio of household bleach (such as “1:99” or “1:49”), and reviews the concept of ratio and proportion with students.
3. The students are divided into small groups to discuss the related problems on the worksheet:
 - Using the knowledge of ratio and proportion, calculate the portion of bleach from given volumes of “1:99” and “1:4” diluted bleach respectively, to explore how to dilute “1:4” diluted bleach to “1:99” diluted bleach.
 - The teacher further explains that the dilution ratio of bleach is actually calculated based on the bleach with concentration of sodium hypochlorite being 5.25%. Therefore, when the concentration of sodium hypochlorite in bleach is not 5.25%, the dilution ratio must be adjusted.

- The teacher may point out that when the bleach is diluted, the active ingredient in the bleach (i.e., the amount of sodium hypochlorite) will not increase or decrease, but appropriate concentrations can be used for different related purposes.
 - Students use the knowledge of percentage, ratio and proportion to calculate the concentration of sodium hypochlorite in “1:99” diluted bleach.
 - Students collect the ingredient labels of different brands of bleach on the Internet or in market to find out the respective concentrations of sodium hypochlorite. By considering the concentration of sodium hypochlorite, students discuss how to calculate the amount of bleach if a given volume of “1:99” and “1:49” diluted bleach is to be prepared.
4. Students complete the worksheet and report the discussion results.
 5. The teacher may consider collaborating with computer teachers to guide students to use spreadsheets or other software packages (such as mobile phone application software) to design tools which can quickly calculate the dilution ratio.

Notes for teachers

1. The use of diluted bleach prepared with household bleach containing 5.25% sodium hypochlorite is as follows:
 - (i) 1:99 diluted household bleach (mixing 1 part of 5.25% bleach with 99 parts of water) is used for general household cleaning and disinfection.
 - (ii) 1:49 diluted household bleach (mixing 1 part of 5.25% bleach with 49 parts of water) is used for surfaces or articles contaminated with vomitus, excreta and secretions.
 - (iii) 1:4 diluted household bleach (mixing 1 part of 5.25% bleach with 4 parts of water) is used for surfaces or articles contaminated with blood spillage.
2. The teacher may consider the following method to calculate the effective dose:

The *multiplier* (M) of the amount of a certain kind of bleach = $5.25\% \div$ (Sodium hypochlorite concentration of the bleach); and then the amount of the bleach required = VM mL, where V mL is the amount of bleach with sodium hypochlorite concentration of 5.25% used for the dilution. That is,

 - When using bleach with sodium hypochlorite concentration of 5.25% to make 1 liter of “1:99” diluted bleach, the amount of bleach required = $(1000 \times \frac{1}{1+99})$ mL = 10 mL.
 - Hence, when using bleach with sodium hypochlorite concentration of 2%, the multiplier of the amount of the bleach is $5.25\% \div 2\% = 2.625$, and the amount of bleach required = (10×2.625) mL = 26.25 mL.
3. The teacher should emphasise to students the guidelines for the safe use of bleach which can be found in the websites of the Consumer Council and the Centre for Health Protection as reference:

Consumer Council “10 Must-read Tips for Using Bleach”:

https://www.consumer.org.hk/ws_en/news/specials/2020/bleach-usage.html

Centre for Health Protection “The Use of Bleach”:
https://www.chp.gov.hk/files/pdf/the_use_of_bleach.pdf

**Dilution of household bleach:
Applying ratios and proportions to solve real-life problems
Worksheet**

1. We often hear “1:99 bleach” , “1:49 bleach” and so on. Make use of your knowledge in ratio to explain the meaning of these terms.

2. Refer to the online resources of the Centre for Health Protection on the use of bleach (https://www.chp.gov.hk/files/pdf/the_use_of_bleach.pdf), learn more about the main ingredient (active ingredient) of bleach and the mathematical topics related to diluted bleach.

3. Calculate the amount of bleach and water (in mL) respectively in 500 mL of “1:99” diluted bleach and 500 mL of “1:4” diluted bleach.

4. Using the knowledge in ratio and proportion, explore the method of producing 1 L of “1:99” diluted bleach with water and 200 mL of “1: 4” diluted bleach.

5. It is known that “1:99” diluted bleach is produced by adding 99 parts of water to 1 part of bleach with sodium hypochlorite concentration of 5.25%. From this, calculate the concentration (in %) of sodium hypochlorite in the “1:99” diluted bleach.

6. The production of diluted bleach of “1:99”, “1:49”, etc. bases on the assumption that the sodium hypochlorite concentration of the bleach is 5.25%. However, sodium hypochlorite concentration of bleach sold in the market is often not 5.25%. Therefore, the portion of bleach must be increased or decreased, and the portion of water must also be adjusted accordingly so as to produce the same diluted bleach (As shown in Example 1 and Example 2 in the table below). You may also refer to the calculation method in the online resource of the Centre for Health Protection on the use of bleach
(https://www.chp.gov.hk/files/pdf/the_use_of_bleach.pdf) .

- (a) Try to collect the ingredient labels of different brands of bleach, find out their sodium hypochlorite concentration, and calculate the amount of bleach and water required to produce the diluted bleach as required. (Give the answers correct to the nearest mL if necessary.)

Produce 1 L of “1:99” diluted bleach:

Bleach brand	Example 1 Standard	Example 2	B	C	D
Sodium hypochlorite concentration (%)	5.25	2.5	8.5		
Bleach required (mL)	10	21			
Water required (mL)	990	979			

Produce 600 m L of “1:49” diluted bleach:

Bleach brand	Standard	A	B	C	D
Sodium hypochlorite concentration (%)	5.25	2.5	8.5		
Bleach required (mL)	12				
Water required (mL)	588				

- (b) Try to use a spreadsheet or other software packages to design a tool to help calculate the amount of bleach and water required to produce specific amount of diluted bleach of specific concentration when using bleach of different concentrations of sodium hypochlorite.

Input variable: sodium hypochlorite concentration of bleach (%)、dilution ratio (1:n)、the amount of diluted bleach needed (L)

Output variable: The amount of bleach (mL)、the amount of water (mL or L)

You can use appropriate algebraic language to write a suitable formula to help you design the tool.

**Dilution of household bleach:
Applying ratios and proportions to solve real-life problems
Worksheet**

1. We often hear “1:99 bleach” , “1:49 bleach” and so on. Make use of your knowledge in ratio to explain the meaning of these terms.

“1:99” : mixing 1 part of bleach with 99 parts of water

“1:49” : mixing 1 part of bleach with 49 parts of water

2. Refer to the online resources of the Centre for Health Protection on the use of bleach (https://www.chp.gov.hk/files/pdf/the_use_of_bleach.pdf), learn more about the main ingredient (active ingredient) of bleach and the mathematical topics related to diluted bleach.

3. Calculate the amount of bleach and water (in mL) respectively in 500 mL of “1:99” diluted bleach and 500 mL of “1:4” diluted bleach.

“1:99”

$$\text{Amount of bleach} = \left(500 \times \frac{1}{1+99}\right) \text{ mL} = 5 \text{ mL}$$

$$\text{Amount of water} = \left(500 \times \frac{99}{1+99}\right) \text{ mL} = 495 \text{ mL}$$

“1:4”

$$\text{Amount of bleach} = \left(500 \times \frac{1}{1+4}\right) \text{ mL} = 100 \text{ mL}$$

$$\text{Amount of water} = \left(500 \times \frac{4}{1+4}\right) \text{ mL} = 400 \text{ mL}$$

4. Using your knowledge in ratio and proportion, explore the method of producing 1 L of “1:99” diluted bleach with water and 200 mL of “1:4” diluted bleach.

To produce 1 L of “1:99” diluted bleach, contains 10 mL of bleach and 990 mL of water are needed; whilst in 200 mL of “1:4” diluted bleach, amount of bleach = $\left(200 \times \frac{1}{1+4}\right)$ mL = 40 mL, which is 4 times the amount needed for 1 L of “1:99” diluted bleach. Therefore, in $\frac{200}{4}$ mL = 50 mL of “1:4” diluted bleach, there is 10 mL of bleach. Hence, adding 950 mL of water will get 1 L of “1:99” diluted bleach. (Other methods can also be used)

5. It is known that “1:99” diluted bleach is produced by adding 99 parts of water to 1 part of bleach with sodium hypochlorite concentration of 5.25%. From this, calculate the concentration (in %) of sodium hypochlorite in the “1:99” diluted bleach.

Let the concentration of sodium hypochlorite in the “1:99” diluted bleach water be x %,

Since the addition of water does not change the amount of sodium hypochlorite in the diluted bleach, the concentration of sodium hypochlorite is inversely proportional to the total volume of the diluted bleach.

$$\therefore \frac{5.25}{x} = \frac{1+99}{1}$$

$$100x = 5.25$$

$$x = 0.0525$$

The concentration of sodium hypochlorite in “1:99” diluted bleach is 0.0525%.

6. The production of diluted bleach of “1:99”, “1:49”, etc. based on the assumption that the sodium hypochlorite concentration of the bleach is 5.25%. However, sodium hypochlorite concentration of bleach sold in the market is often not 5.25%. Therefore, the portion of bleach must be increased or decreased, and the portion of water must also be adjusted accordingly so as to produce the same diluted bleach (As shown in Example 1 and Example 2 in the table below). You may also refer to the calculation method in the online resource of the Centre for Health Protection on the use of bleach
(https://www.chp.gov.hk/files/pdf/the_use_of_bleach.pdf) .
- (a) Try to collect the ingredient labels of different brands of bleach, find out their sodium hypochlorite concentration, and calculate the amount of bleach and water required to produce the diluted bleach as required. (Give the answers correct to the nearest mL if necessary.)

Produce 1 L of “1:99” diluted bleach:

Bleach brand	Example 1 Standard	Example 2	B	C	D
Sodium hypochlorite concentration (%)	5.25	2.5	8.5	1	6.4
Bleach required (mL)	10	21	6	53	8
Water required (mL)	990	979	994	947	992

Produce 600 m L of “1:49” diluted bleach:

Bleach brand	Standard	A	B	C	D
Sodium hypochlorite concentration (%)	5.25	2.5	8.5	1	6.4
Bleach required (mL)	12	25	7	63	10

Water required (mL)	588	575	593	537	590
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- (b) Try to use a spreadsheet or other software packages to design a tool to help calculate the amount of bleach and water required to produce specific amount of diluted bleach of specific concentration when using bleach of different concentrations of sodium hypochlorite.

Input variable: sodium hypochlorite concentration of bleach (%) 、 dilution ratio (1:n) 、 the amount of diluted bleach needed (L)

Output variable: The amount of bleach (mL) 、 the amount of water (mL or L)

You can use appropriate algebraic language to write a suitable formula to help you design the tool.