Enhancing Learning through Practical Tasks

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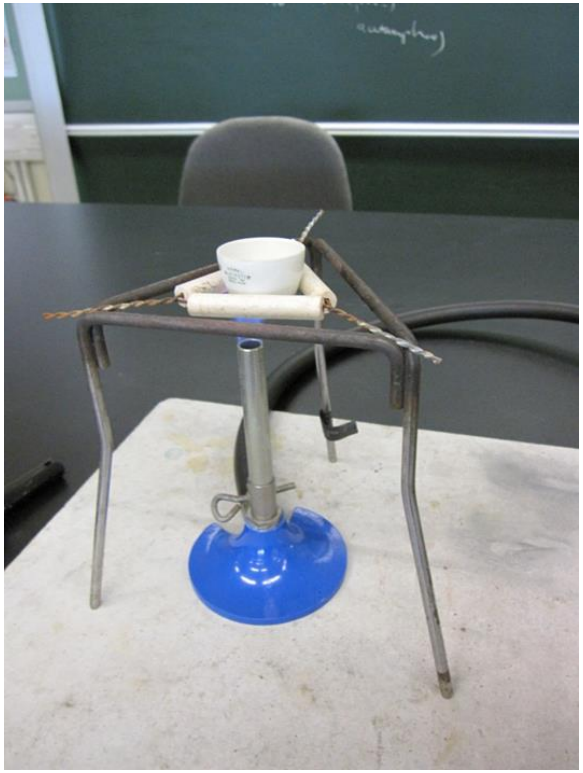
Science Education Section, EDB

- Mole concept and stoichiometry
  - Decomposition of Baking Soda
  - Determining the stoichiometry of reaction between ClO^- and $S_2O_3^{2-}$ / OH^-
- Microscopic World II
  - Evaporation and Intermolecular Attractions
  - Preparation of “Slime”

Decomposition of Baking Soda – Mole Relationships and the Balanced Equation

Possible Decomposition Reactions

- sodium hydrogencarbonate (s) → sodium hydroxide (s) + carbon dioxide (g)
- sodium hydrogencarbonate (s) → sodium oxide (s) + carbon dioxide (g) + water (g)
- sodium hydrogencarbonate (s) → sodium carbonate (s) + carbon dioxide (g) + water (g)



https://www.flinnsci.com/media/620792/91323.pdf

$NaHCO_3(s) \rightarrow NaOH(s) + CO_2(g)$

2.00 g 0.952 g

$2NaHCO_3(s) \rightarrow Na_2O(s) + 2CO_2(g) + H_2O(g)$

2.00 g 0.738 g

$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$

2.00 g 1.26 g

Further discussion:

Sodium hydrogencarbonate is used as baking powder for making cake. Based on this information and the products of the suggested equations, which reaction(s) is/are not possible? Explain your answer.

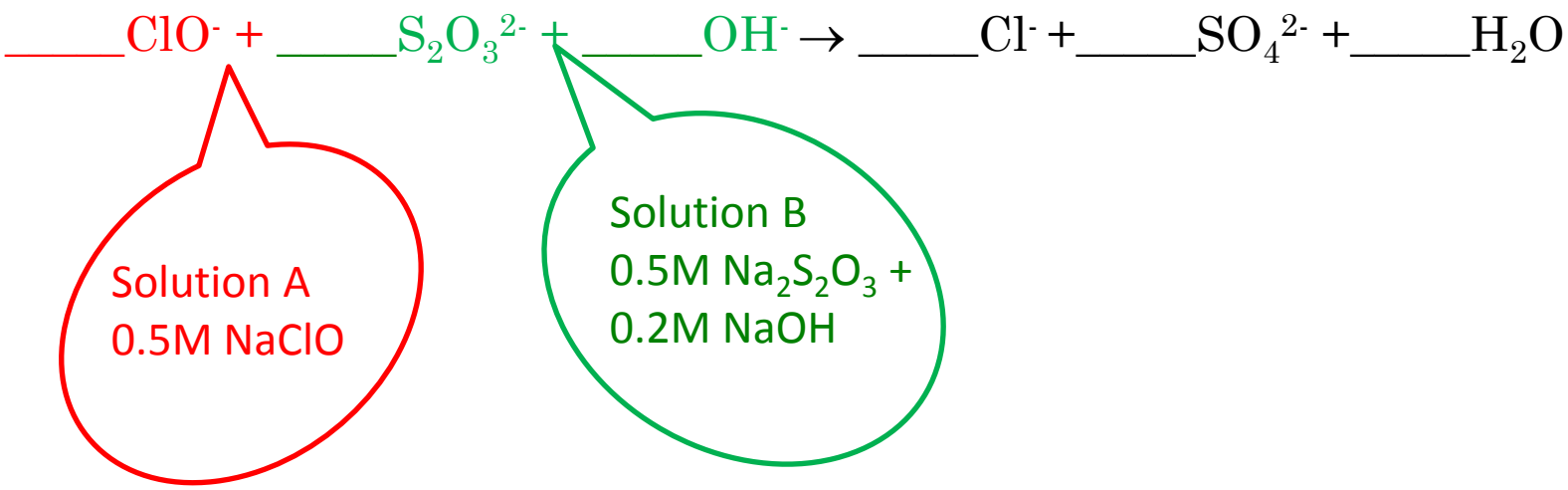
Follow-up Activity

- To determine the amount of baking soda needed to produce the assigned mass of sodium carbonate without any excess

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$
$$\text{? g} \qquad\qquad 1.26\ \text{g}$$

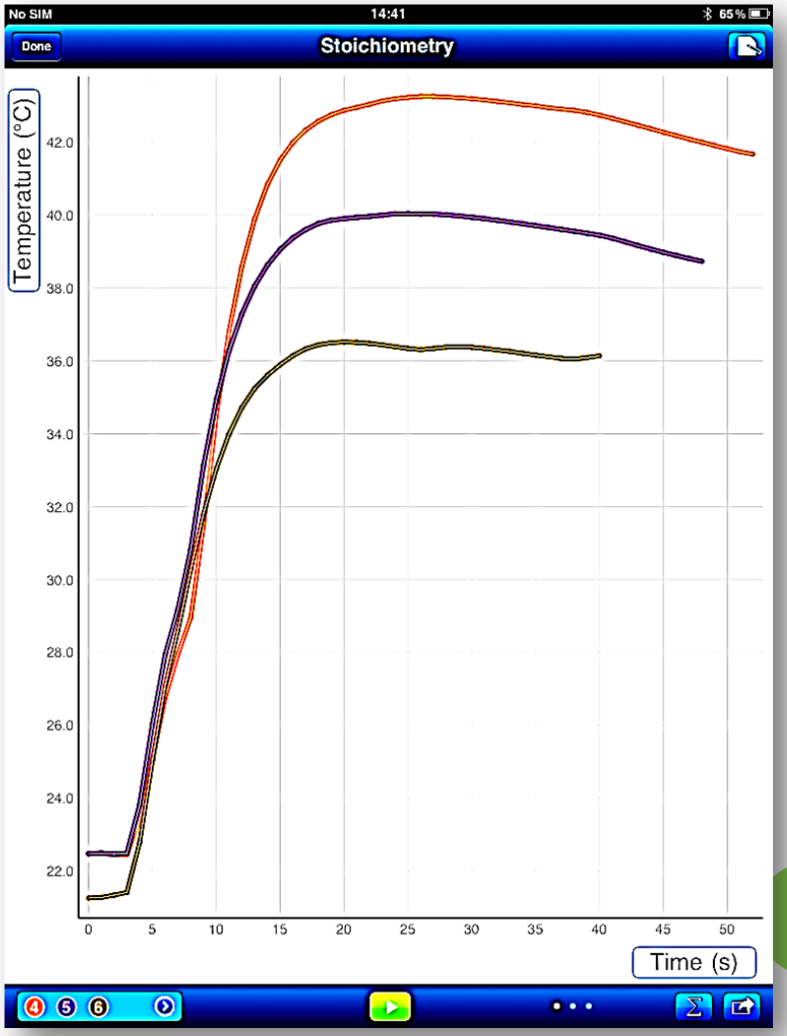
Determining the stoichiometry of a reaction

To determine the stoichiometry of a chemical reaction:



Volume of solution A (mL)	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Volume of solution B (mL)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

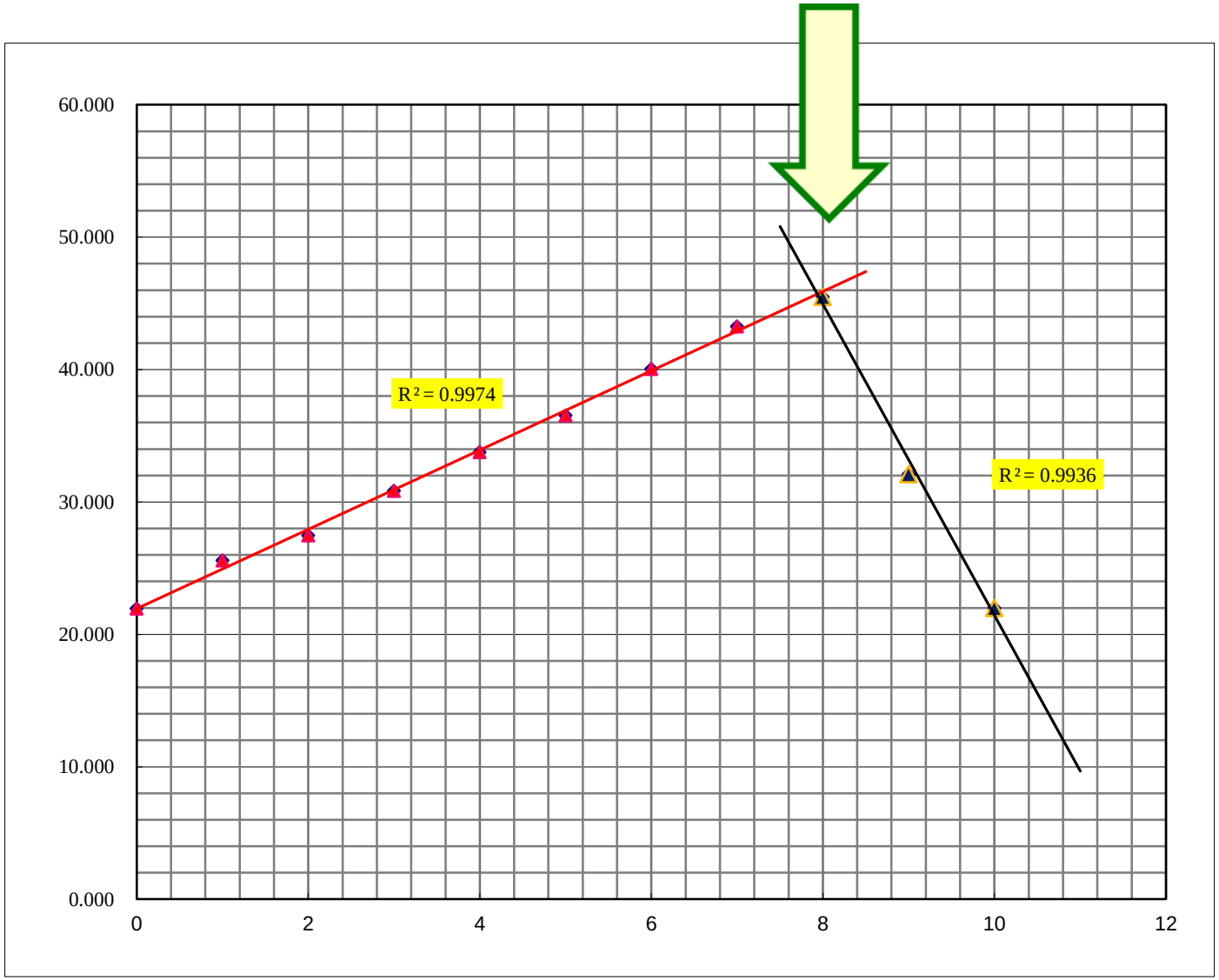

B
A


No SIM
14:41
65%
Done
Stoichiometry
Temperature (°C)
42.0
40.0
38.0
36.0
34.0
32.0
30.0
28.0
26.0
24.0
22.0
0
5
10
15
20
25
30
35
40
45
50
Time (s)

Sample Result

Volume of Solution A (ClO^-, cm^3)	Max Temp (degree C)
10	21.977
9	32.091
8	45.478
7	43.259
6	40.040
5	36.517
4	33.743
3	30.819
2	27.465
1	25.583
0	21.948

Sample Result



Data analysis

Based on the volume of reactants needed for the largest temperature change, determine the correct stoichiometry for the reaction.

Reactant	Volume of each reactant (mL)	Calculations	Moles of each reactant (mol)
Solution A: 0.5M sodium hypochlorite (NaClO)			
Solution B: 0.5 M sodium thiosulphate ($Na_2S_2O_3$)			

For every 1 mole of $Na_2S_2O_3$ that reacts, ____ moles of NaClO are needed.

Discussion

$$4\ ClO^- + S_2O_3^{2-} + 2\ OH^- \rightarrow 4\ Cl^- + 2\ SO_4^{2-} + H_2O$$

Volume of solution A (mL)	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Volume of solution B (mL)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Which is limiting reactant?

Prepare 1000 mL of 0.5 M sodium hypochlorite (NaClO) solution by following the steps below: Determine the volume of bleach required using the table below. The percent of sodium hypochlorite may be found written on the product label.

Amount of bleach required to make the sodium hypochlorite solution

Percent Sodium Hypochlorite Your Bleach Contains (% by volume)	Amount of Bleach to Use (mL)
4%	846
5%	677
5.25%	645
6%	564
Other %	See calculation below

Determining the volume of bleach required to make a 0.5 M hypochlorite solution by using the following steps:

i. The volume of bleach required is determined by converting the percent sodium hypochlorite into molarity using the density of bleach (1.10g / mL) and the molar mass of sodium hypochlorite (74.44 g / mol).

Molarity (mol / L) = (% NaClO) x 1.10 / 74.44 x 1000

ii. The formula $M_1V_1 = M_2V_2$ is then used to calculate the volume needed. To determine the volume of bleach to be diluted for 1.0 L of a 0.5 M solution, substitute the molarity calculated above into the following equation:

Volume (mL) of bleach = 1000 x 0.5 / molarity of NaClO

Determining concentration of sodium hypochlorite

- $OCl^- + 2I^- + 2H^+ \rightarrow Cl^- + I_2 + H_2O$

  excess

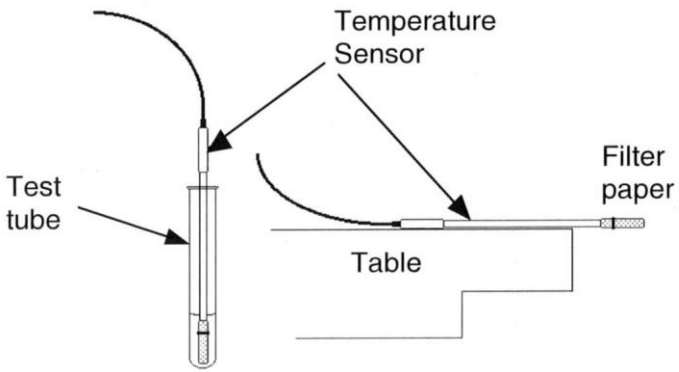
- $2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$

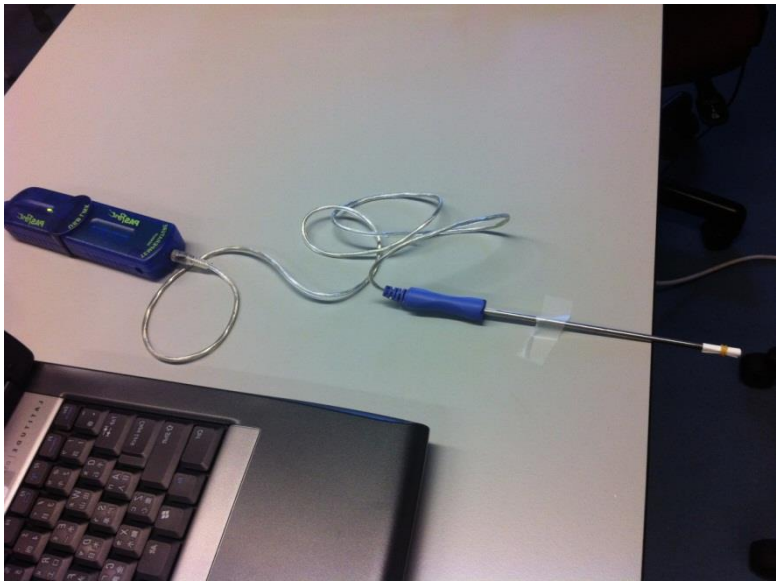
(titration using starch as indicator)

Evaporation and Intermolecular Attractions

- To study temperature changes caused by evaporation of the following liquids:

  ethanol, propan-1-ol, butan-1-ol, pentane, hexane
- To relate temperature changes to the strength of the intermolecular forces of the liquid





Pre-laboratory exercise

1. Complete the following table.

Substance	**Formula**	**Structural Formulae**	**Molecular Mass**	**Existence of Hydrogen Bond (Yes or No)**
Ethanol	C_2H_5OH			
Propan-1-ol	C_3H_7OH			
Butan-1-ol	C_4H_9OH			
Pentane	C_5H_{12}			
Hexane	C_6H_{14}			

2. (a) Predict which of the alcohols above will give the greatest temperature change in evaporation.

   (b) Predict which of the alkanes above will give the greatest temperature change in evaporation.

Sample Result

Substance	Temperature decrease (°C)
Ethanol	9.1
Propan-1-ol	6.4
Butan-1-ol	3.3
Pentane	16.2
Hexane	13.9

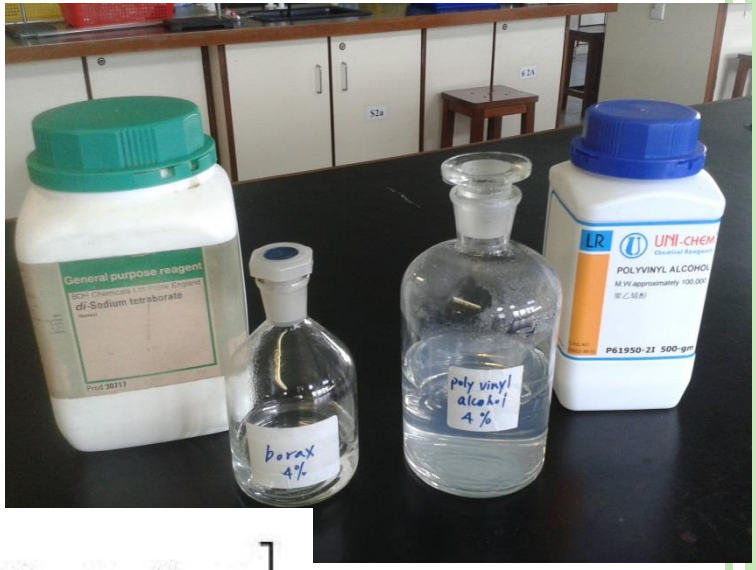
Factors affecting intermolecular forces:

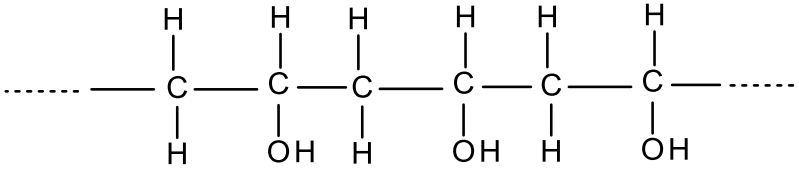
- Molecular masses
- Hydrogen bond

Compare the intermolecular forces among:

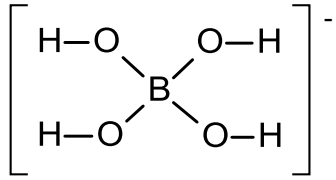
- Alkanes
- Alcohols
- Pentane and butan-1-ol

Preparation of Slime

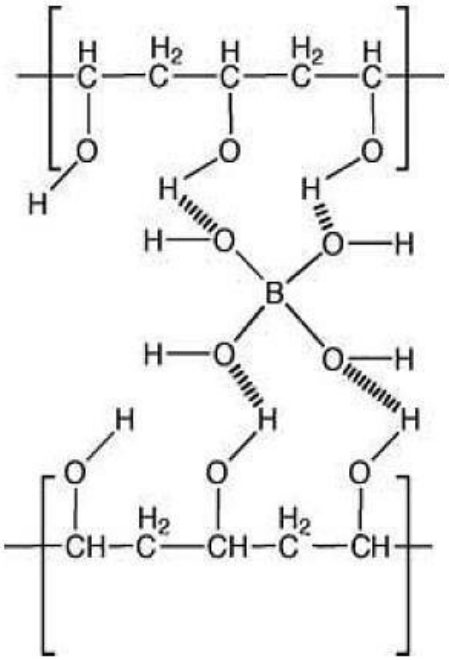




Polyvinyl alcohol (PVA)



Aqueous solution of borax



Slime

Note on preparing PVA and borax solution

- Poly(vinyl alcohol) can be high molecular weight (about 120 000) or low molecular weight (about 15000). If high molecular weight PVA is used, prepare a 4% solution by placing 960 cm^3 of water into a tall 1dm^3 beaker. Measure out 40 g of high molecular weight PVA and sprinkle this slowly to the beaker of water, with stirring. Heat the mixture gently (not higher than 80°C), stirring occasionally, until the solution clears. Avoid boiling the solution.

- Any available solid borax ($Na_2B_2O_7 \cdot 10H_2O$) in powder or crystal form may be dissolved in tap water at room temperature to make a 4% by weight borax solution. Note that the volume of this reagent needed to produce the gel is only 1/10 to 1/5 the volume of 4% PVA solution.

Thank You!

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