# Using differentiated instructional strategies in whole-class teaching to cater for the learning needs of gifted/ more able students in S4 Chemistry

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Homantin Government Secondary School

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# Gifted Education at HGSS

- **In 2021/2022,**

| | School level / Subject level | Gifted Education Team |
|---|---|---|
| **Level 1: School-based whole-class teaching** | - major concern<br>- staff development day programme<br>- designing tiered assignments | - EDB Gifted Education School Network (STEM) 2021/22<br>- talent pool |
| **Level 2: School-based pull-out programmes** | - courses / competitions; arranged by various subjects | - workshops for more able students |
| **Level 3: Off-school support** | - courses / competitions; arranged by various subjects | - nomination for HKAGE membership & online courses<br>- summer programme at tertiary institute |

# About the class

| | |
|---|---|
| **Subject** | Chemistry (EMI) |
| **Level** | Secondary 4 |
| **Class size** | 32 students |
| **Composition** | ~1/4 studied IS(Chem) in CMI in S3 |
| **Learning diversity** | (1) Adaptation to using EMI in learning<br>(2) More able students |
| **Lesson time** | 6 lessons/ week; 25 mins/ lesson (half-day)<br>(1 more lesson from this school year) |

# Lesson planning

| | |
|---|---|
| **Subject** | Chemistry (EMI) |
| **Level** | Secondary 4 |
| **Topic** | Unit 2 Atmosphere: Candle Investigation |
| **Lesson Duration** | 1 hour (double lesson) |
| **Date of lesson try-out** | 30 November 2021 |
| **Learning Objectives** | (1) To explain a phenomenon in an unfamiliar setting<br>(2) To evaluate the relevancy of the physical and chemical properties of gases to the given experimental setting |

# Lesson planning

| | |
|---|---|
| **Prior knowledge of students** | **(1) Composition of air**<br>**(2) Tests for oxygen and carbon dioxide**<br>**(3) Conditions required for burning**<br>**(4) Word equation of burning fuel** |
| **Highlights of the lesson design** | Cooperative learning (experts groupings & jigsaw groupings) and construction of evidence card which helps nurture the creativity and higher-order thinking skills of gifted/more able students |
| **Differentiation Strategies employed** | (1) Tiered assignment<br>(2) Learning stations |

# Lesson planning

## Engage students by setting the scene

- **Part 1 – The Experiment of 3 Candles**

**S4 Chemistry**
**Chapter 2 – The atmosphere**
**Experiment Worksheet**

Name: _____ ( ) Class: 4 _____ Date: _____

Part 1 – The experiment of three burning candles

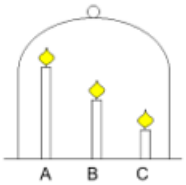
1. What are the THREE essential conditions for burning?

   _____, _____ and _____

2. Complete the word equation for complete combustion (burning).

   fuel + oxygen → _____ + _____

Refer to the experiment of three burning candles below and predict which candle(s) will go off firs




3. Which candle(s) will go off first? ☐
   A. Candle A
   B. Candle B
   C. Candle C
   D. The three candles go out at the same time

4. Explain your answer to question 3.

   _____

   _____

Revising basic concepts from junior Science:
- conditions for burning
- fuel / hydrocarbon
- word equation

Making a prediction: Students' answers:
A: 2
B: 0
C: 0
D: most students

# Lesson planning

## Setting the scene

- **Part 1 – The Experiment of 3 Candles**

Now, your teacher will show you a video of the experiment of three burning candles.

5. In the video, which candle(s) went off first? How much time did it take for it/them to go off?

_____

Does the experimental result agree with your prediction in questions 3 and 4?

Why does the longest candle go out first?

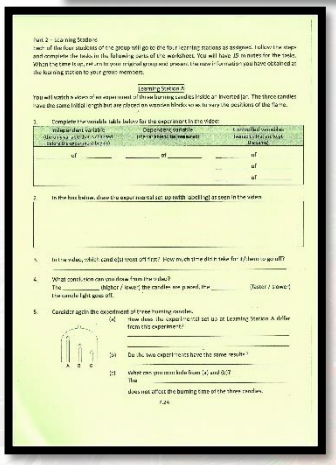
Students' answers:
Oxygen was used up

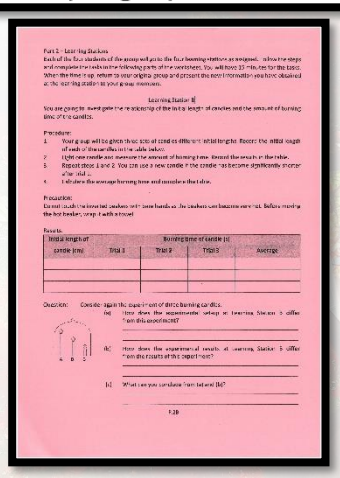
# Lesson planning

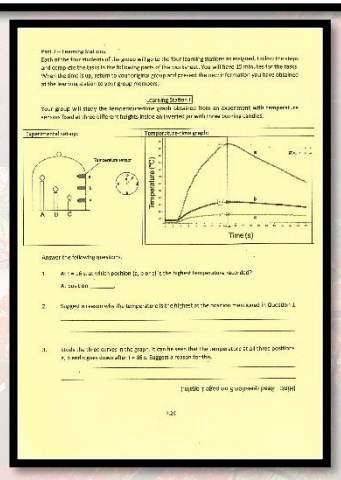
## Design of tiered assignments and flexible groupings

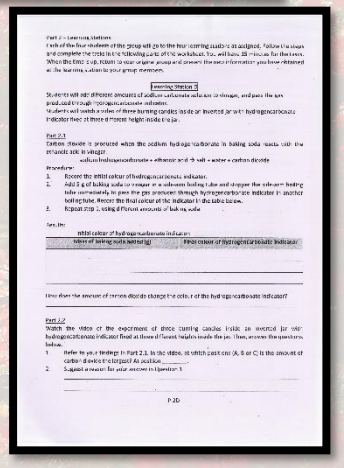
- **Part 2 – Expert Groups - The 4 Learning Stations**

Part 2 – Learning Stations
Each of the four students of the group will go to the four learning stations as assigned. Follow the steps and complete the tasks in the following parts of the worksheet. You will have 15 minutes for the tasks. When the time is up, return to your original group and present the new information you have obtained at the learning station to your group members.









| | |
|---|---|
| A | A |
| A | A |

| | |
|---|---|
| B | B |
| B | B |

| | |
|---|---|
| C | C |
| C | C |

| | |
|---|---|
| D | D |
| D | D |

*Low* cognitive demand task ⟷ *High* cognitive demand task

For average students

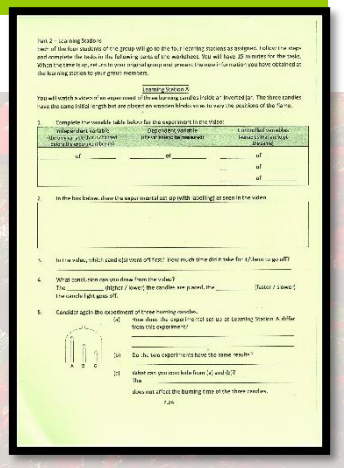
For more able students

# Lesson planning

## Design of tiered assignments – Learning Station A

- **Part 2 – The 4 Learning Stations**
- **Task(s):**
  - To watch a video of another experiment of three burning candles
- **Expected outcome:**
  - To complete a variable table
  - To draw the experimental set-up
  - To compare the similarities/differences between the two experiments
  - To come to the conclusion that “the length of candles does not affect the burning time of the three candles”

| | |
|---|---|
| A | A |
| A | A |

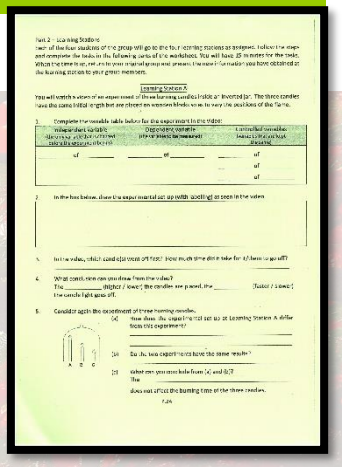


# Lesson planning

## Design of tiered assignments – Learning Station A

- **Part 2 – The 4 Learning Stations**
- **Students' works:**

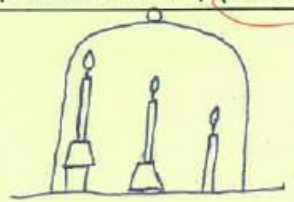
| | |
|---|---|
| A | A |
| A | A |



1. Complete the variable table below for the experiment in the video:

| Independent variable (the only variable that is changed before the experiment begins) | Dependent variable (the variable to be measured) | Controlled variables (variables that are kept the same) |
|---|---|---|
| height of candle | time of candles goes out | length of candle<br>brand of candle<br>size of jar |

2. In the box below, draw the experimental set-up (with labelling) as seen in the video.



3. In the video, which candle(s) went off first? How much time did it take for it/them to go off?

Candle A, 20 seconds

4. What conclusion can you draw from the video?

The higher (higher / lower) the candles are placed, the faster (faster / slower) the candle light goes off.

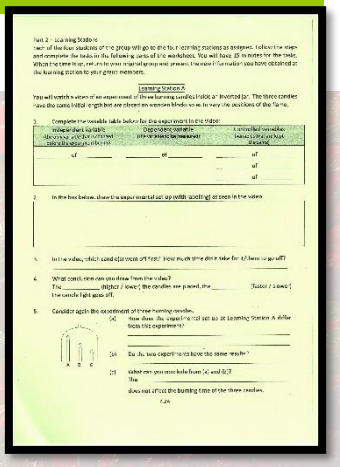
- able to complete variable table
- incomplete drawing
- able to draw conclusion from video

# Lesson planning

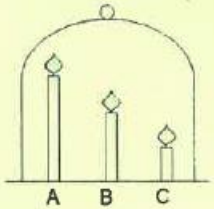
## Design of tiered assignments – Learning Station A

- **Part 2 – The 4 Learning Stations**
- **Students' works:**

| | |
|---|---|
| A | A |
| A | A |



5. Consider again the experiment of three burning candles.




(a) How does the experimental set-up at Learning Station A differ from this experiment?

There is no wooden blocks place under the candle, the length of candle ~~are~~ not the same.

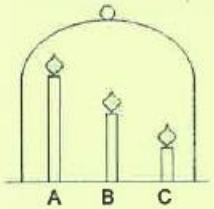
(b) Do the two experiments have the same results?

Yes.

(c) What can you conclude from (a) and (b)?

The length of candle does not affect the burning time of the three candles.

5. Consider again the experiment of three burning candles.




(a) How does the experimental set-up at Learning Station A diffe from this experiment?

The bottom of the candle is replaced to stopper instead of the candle.

(b) Do the two experiments have the same results?

Yes

(c) What can you conclude from (a) and (b)?

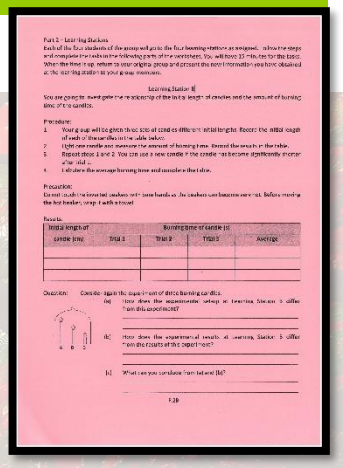
The length of the candle does not affect the burning time of the three candles.

- most were able to express ideas effectively
- (drawing of set-up could help the weaker ones)
- all were able to compare the two experiments and draw conclusion

# Lesson planning

## Design of tiered assignments – Learning Station B

| | |
|---|---|
| B | B |
| B | B |

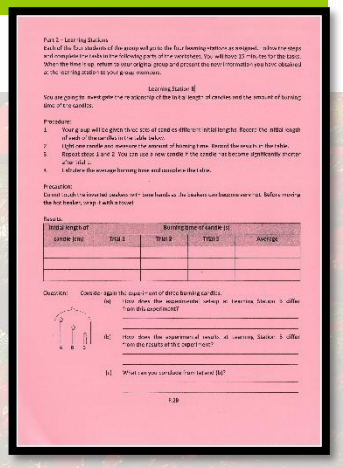


- **Part 2 – The 4 Learning Stations**
- **Task(s):**
  - To investigate the relationship between the initial length of candles and the burning time of candles
- **Expected outcome:**
  - To complete a mini experiment
  - To compare the similarities/differences between the two experiments
  - To come to the conclusion that “the length of candles does not affect the burning time of the three candles”

# Lesson planning

## Design of tiered assignments – Learning Station B

| | |
|---|---|
| B | B |
| B | B |



- **Part 2 – The 4 Learning Stations**
- **Students' works:**

Results:

| Initial length of candle (cm) | Burning time of candle (s) | | | |
|---|---|---|---|---|
| | Trial 1 | Trial 2 | Trial 3 | Average |
| 4 | 23 | 23.4 | 21 ~~23.3~~ | 22.5 |
| 6 | 15 | large discrepancy 28.8 | 23.3 | 22.4 |
| 8.5 | 15.5 | 23.8 | 11.25 | 16.9 |

- discrepancy between some sets of data
- source of errors: $CO_2$ accumulated in beaker

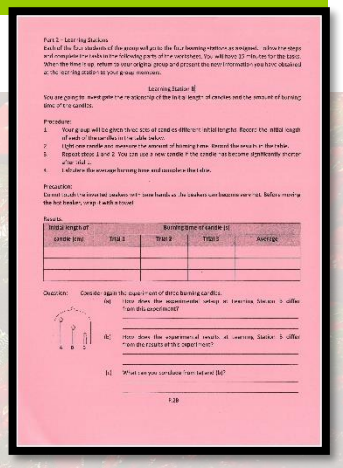
Remedy:
- showing video of the experiment

# Lesson planning

## Design of tiered assignments – Learning Station B

- **Part 2 – The 4 Learning Stations**
- **Students' works:**

| | |
|---|---|
| B | B |
| B | B |



(a) How does the experimental set-up at Learning Station B differ from this experiment?

In this experiment, the three candles are covered at the same time in the same beaker while at learning station B the candles are covered by a beaker separately.

(b) How does the experimental results at Learning Station B differ from the results of this experiment?

In this experiment, candle A will goes out first. However, in learning station B, all the candles will goes out almost at the same time..

(c) What can you conclude from (a) and (b)?

The candles will goes out at the same time if they burn separately.

(a) How does the experimental set-up at Learning Station B differ from this experiment?

Station B set-up is one candle one jar but the experimental set-up are three candles in one jar

(b) How does the experimental results at Learning Station B differ from the results of this experiment?

In the station B experiment, three candles go out almost at the same time.

(c) What can you conclude from (a) and (b)?

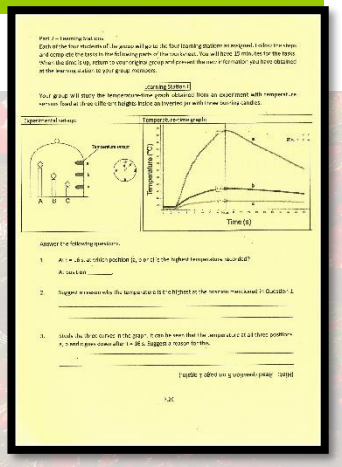
The lengths of the candles is not the reason for the different duration of burning.

- all were able to express ideas with some details
- all were able to compare the two experiments and draw conclusion

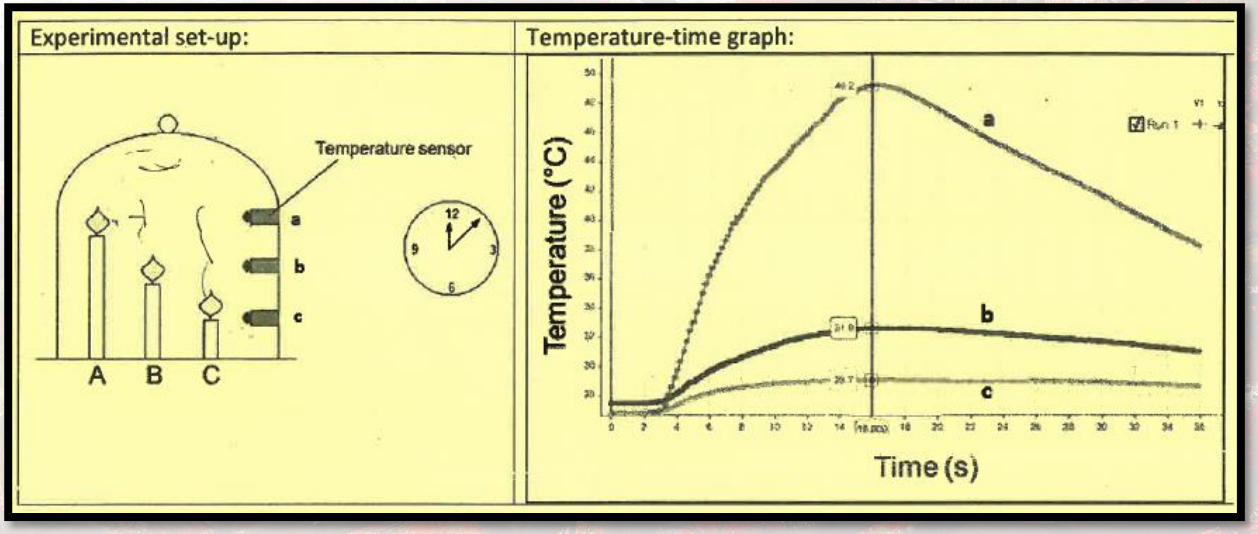
# Lesson planning

## Design of tiered assignments – Learning Station C

| | |
|---|---|
| C | C |
| C | C |



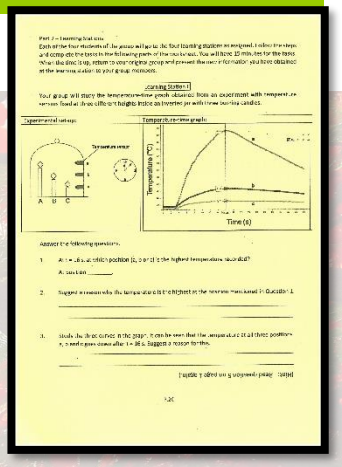
- **Part 2 – The 4 Learning Stations**
- **Task(s):**
  - To interpret the temperature-time graph from the experiment
- **Expected outcome:**
  - To realise the temperature of the upper part of the inverted jar was higher than that of the lower part
  - To deduce that hot gas rose to the upper part of the jar
  - To, possibly, deduce that the upper part of the jar had a higher amount (concentration) of $CO_2$ during the burning of the candles



# Lesson planning

## Design of tiered assignments – Learning Station C

| | |
|---|---|
| C | C |
| C | C |



- **Part 2 – The 4 Learning Stations**
- **Students' works:**

2. Suggest a reason why the temperature is the highest at the position mentioned in Question 1.

Hot air rises, carbon dioxide rises.

2. Suggest a reason why the temperature is the highest at the position mentioned in Question 1.

Hot carbon dioxide rises due to convection. The top of temperature sensor d is higher.

2. Suggest a reason why the temperature is the highest at the position mentioned in Question 1.

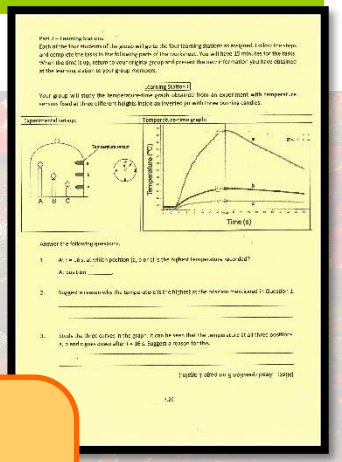
Because carbon dioxide goes up, and the colder air goes down, so it will occur convection, so the a part will have the most higher temp.

- all were able to explain the graph with their prior knowledge that hot air rises

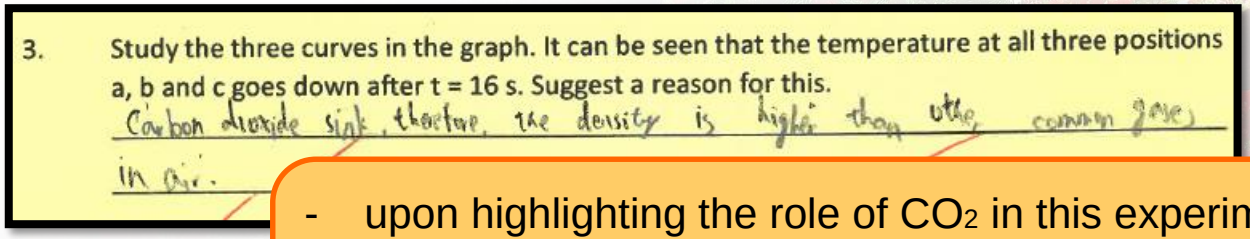
# Lesson planning

## Design of tiered assignments – Learning Station C

| | |
|---|---|
| C | C |
| C | C |



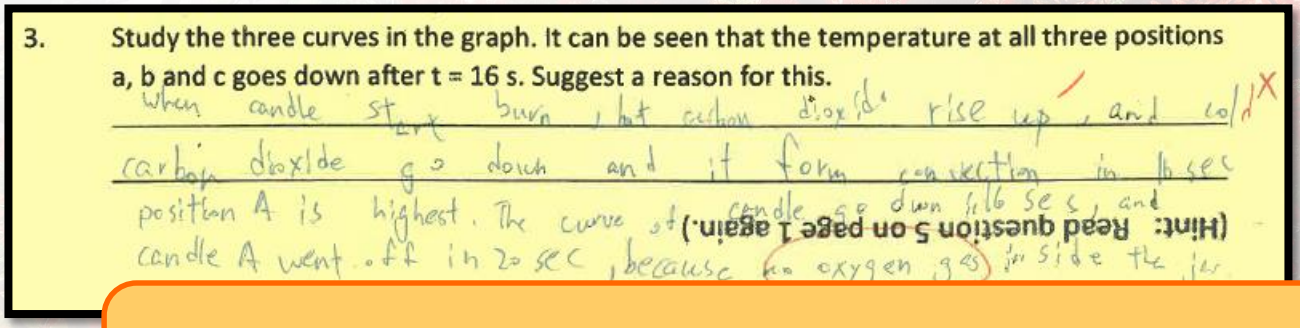
- **Part 2 – The 4 Learning Stations**
- **Students' works:**



3. Study the three curves in the graph. It can be seen that the temperature at all three positions a, b and c goes down after t = 16 s. Suggest a reason for this.

Carbon dioxide sink, therefore, the density is higher than other common gases in air.

- upon highlighting the role of $CO_2$ in this experiment, a few students managed to retrieve their prior knowledge of density of the gas, which would help explaining the results from Learning Station D



3. Study the three curves in the graph. It can be seen that the temperature at all three positions a, b and c goes down after t = 16 s. Suggest a reason for this.

When candle start burn, hot carbon dioxide rise up, and cold carbon dioxide go down and it form convection in jar sec position A is highest. The curve of candle go down 16 sec, and candle A went off in 20 sec, because no oxygen gas inside the jar

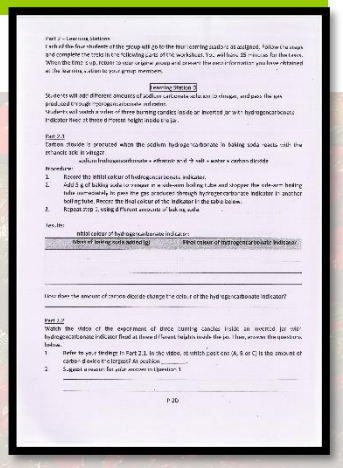
(Hint: Read question 5 on page 1 again.)

- a few students tried to explain the experimental results with lack of $O_2$
- yet, this can only be proven/ disproved in another experiment

# Lesson planning

## Design of tiered assignments – Learning Station D

| | |
|---|---|
| D | D |
| D | D |



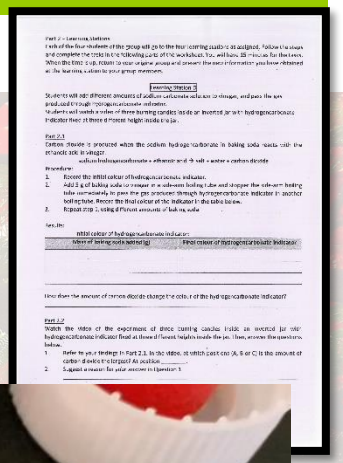
- **Part 2 – The 4 Learning Stations**
- **Task(s):**
  - To find out the colour change of hydrogencarbonate indicator at different concentration of $CO_2$
  - To find out the concentration of $CO_2$ at different positions of the inverted jar
- **Expected outcome:**
  - To complete a mini experiment
  - To realise that more $CO_2$ is produced when a larger mass of baking soda is used (Note: Students have not yet learnt reacting masses.)
  - To deduce that the upper part of the jar had a higher amount (concentration) of $CO_2$ during the burning of the candles

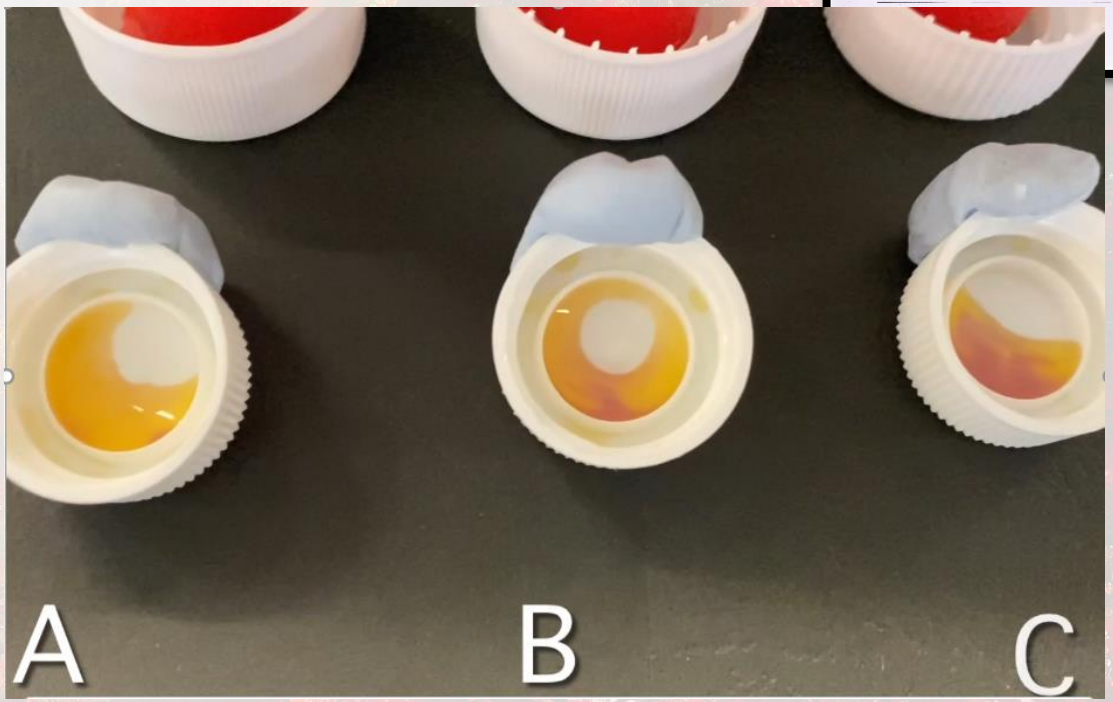
# Lesson planning

## Design of tiered assignments – Learning Station D

| | |
|---|---|
| D | D |
| D | D |

Bottle cap filled with hydrogencarbonate indicator



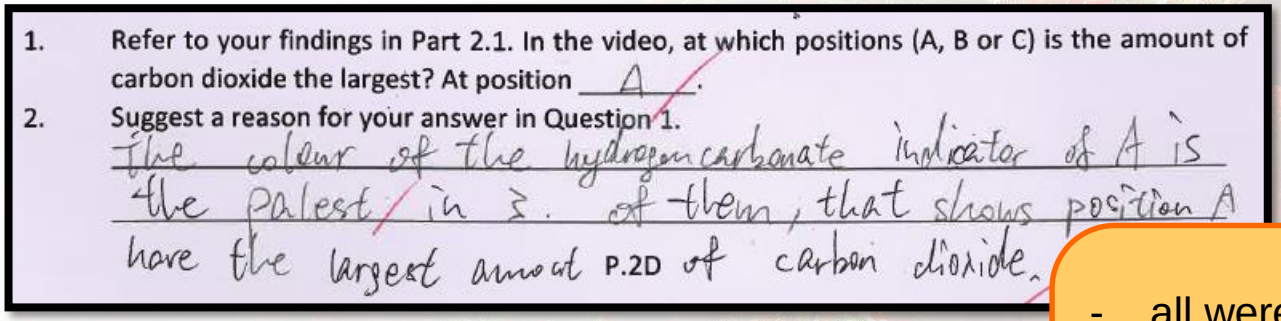


# Lesson planning

## Design of tiered assignments – Learning Station D

| | |
|---|---|
| D | D |
| D | D |

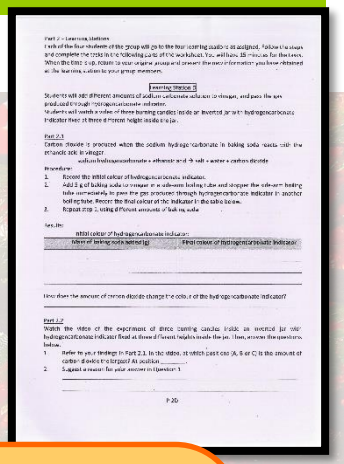
- **Part 2 – The 4 Learning Stations**
- **Students' works:**



1. Refer to your findings in Part 2.1. In the video, at which positions (A, B or C) is the amount of carbon dioxide the largest? At position A.
2. Suggest a reason for your answer in Question 1.

The colour of the hydrogen carbonate indicator of A is the palest in 3. of them, that shows position A have the largest amount of carbon dioxide.

P.2D

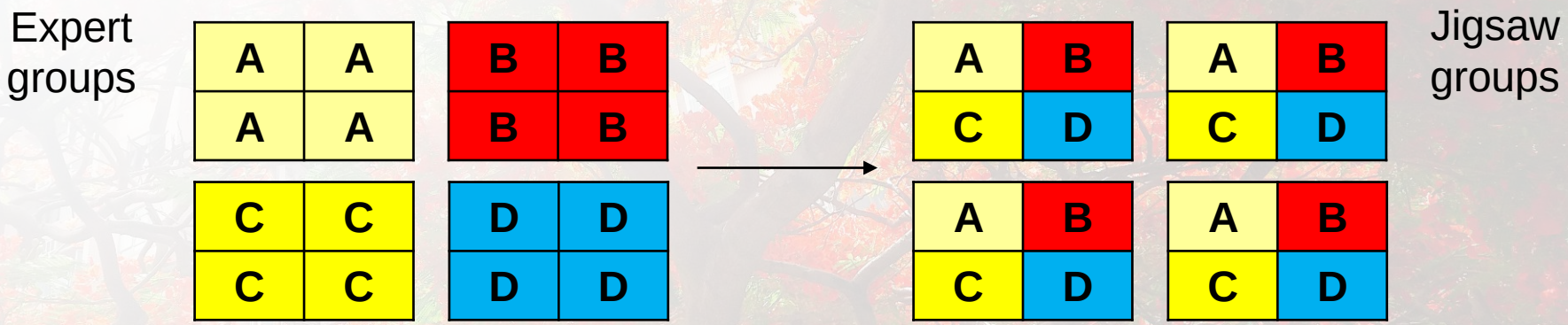


- all were able to point out the different amount (concentration) of $CO_2$ at different positions of the inverted jar

# Lesson planning

## Design of tiered assignments – Cooperative Learning

- **Part 3 – Presenting New Information, completing Evidence Card and Reasoning**
- **Tasks:**
  - To report discussion results / experiment findings back in original groups
  - To complete the evidence card
  - To explain the experimental results of the 3 burning candles with the help of the evidence card




- Students of different expert groups had the chance to share their findings to other students
- Discussion was not dominated by certain students

# Lesson planning

## Design of tiered assignments – Cooperative Learning

- **Part 3 – Presenting New Information, completing Evidence Card and Reasoning**
- **Students' works:**

| Learning Stations (with student's name) | Findings / New information from the Learning Stations |
|---|---|
| A ( ) | The higher the candles are placed, the faster the candle light goes off The (only) independent variable (what is it to be changed?) is the position of the flames. → The burning time is not affected by the length of candles (but the position) |
| B ( ) | Different length of candle take different time to goes out. When the 2 candles are put in seperate beakers, the flames go off at the same time → the length of the candle is not the reason for the different duration of burning |
| C ( ) | When the candle start burning hot $CO_2$ raise up, cold $CO_2$ go down and hot $CO_2$ turn up and form convertion and it will be no oxygen inside the jar. Hot air (carbon dioxide) goes up → carbon dioxide : higher density than other common gas in air carbon dioxide sinks (a→b→c) |
| D ( ) | The colour of the hydrogencarbonate indicator at position H is the palest, that's mean there are more carbon dioxide at position H |

- More able students helped the others to refine the presentation of their ideas

# Lesson planning

## Design of tiered assignments – Cooperative Learning

- **Part 3 – Presenting New Information, completing Evidence Card and Reasoning**
- **Students' works:**

**Evidence Card**

| | | |
|---|---|---|
| The burning time is not affected by the length of candles | The length of the candle is not the reason for the different duration of burning | Carbon dioxide have higher density than other common gas in air |
| Independent variable is the factor that is set to be different before the experiment starts. (Given) | More carbon dioxide is at the higher position | Controlled variables are factors that are kept the same in the experiment. (Given) |
| Fire triangle: Oxygen, fuel, high temperature | Carbon dioxide puts out fire. (Given) | Air contains 21% of oxygen. (Given) |

Relevant evidence was chosen to explain the phenomenon

# Lesson planning

## Design of tiered assignments – Cooperative Learning

- **Part 3 – Presenting New Information, completing Evidence Card and Reasoning**
- **Students' works:**

Since carbon dioxide get a higher density than other common gas in air, it sinks when candles are burning while hot air goes up. Therefore, the highest candle - Candle A went off first.

Three burning candles are releasing hot carbon dioxide together, hot air rises therefore carbon dioxide goes to the top. When it gradually cools down, its density is higher than oxygen, therefore sinks. In a result, the uppest candle goes out first, the lowest candle finally goes out.

With the help of the completed Evidence card, explain

Burning candles produce carbon dioxide, carbon dioxide raises to the top of the bell jar so that there are more carbon dioxide at higher position. Carbon dioxide puts out fire so the Candle A with a largest height went off first in the experiment.

# After the lessons…

- **Teacher's observations:**

Students' higher-order thinking skills and communication skills were nurtured

By infusing several GE elements, all students had the opportunity of receiving gifted education

Students were provided with the chance to solve a Chemistry problem in an unfamiliar situation

All students were engaged in the learning tasks throughout the lessons

Students at all 4 Learning Stations completed their tasks more or less at the same time

More able students, in particular, enjoyed the challenging tasks

- **Students' feedback:**

Group D students liked the tasks and discussion

Group C students wanted to conduct experiments as well

# Thank you!