18th November 2016

Collaboration in Chemistry

Glen Waverley Secondary College

Deb Brooks

Ivy Lai

Catriona Hoy

Lakshmi Gopal

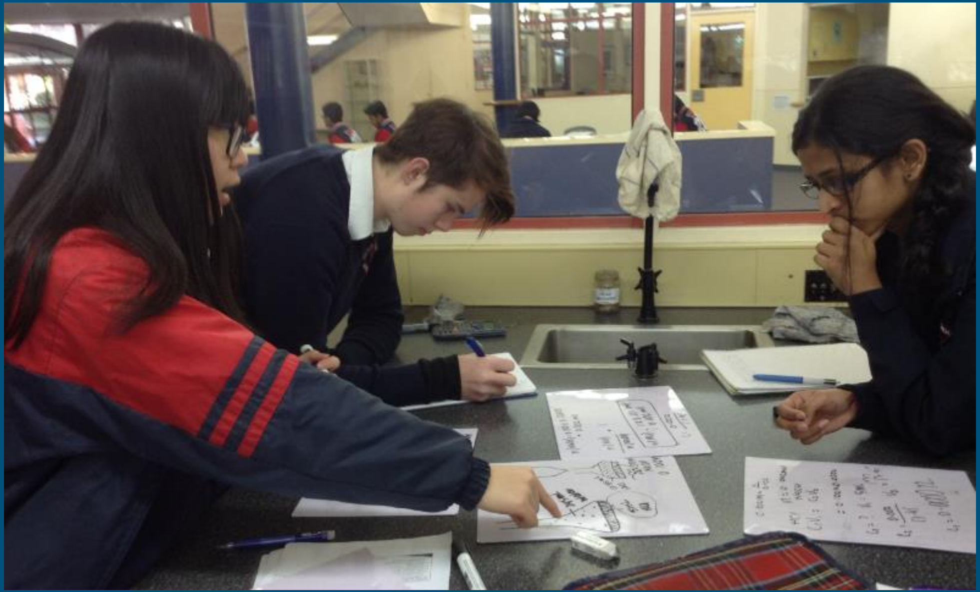
Find someone who...

Knows the chemical formula of glucose	Knows the colour of phenolphthalein in a base	Can predict the products of reaction between sulphuric acid and sodium hydroxide
Can identify 3 different insoluble salts	Can explain which will have the highest melting point: water or methane	Knows the difference between a strong acid and a concentrated acid
Can predict which solution will have the lower pH and why: 2.0 M Ethanoic acid and 2.0 M hydrochloric acid	Knows the chemical formula for propanoic acid	Can draw 2 structural isomers of butanol and name them

Objectives:

To consider the benefits (and challenges) of collaboration in learning.

Share practical ideas and strategies of how to incorporate collaboration in your chemistry classroom at different points of Units 1-4.



Our college, our students, our classes:

Glen Waverley Secondary College

Total student population of approximately 2000 students

Co-educational, non-select entry, local school in Glen Waverley VIC

Year 11 Chemistry in 2016: 8 classes

Year 12 Chemistry in 2016: 6 classes

Typical class size of 20-26 students

Why is collaboration important?

Improve student understanding

- Improve student results
- Increase student engagement
- Increase individual student accountability
- Increase student participation

Reference: Robyn M. Gilles

Challenges Preventing Collaboration

Concerns about getting through content if time is spent on group work

Students talking about things other than chemistry

Some students dominating conversation

Reinforcing incorrect ideas rather than developing understanding

Students need to perform as individuals on the exam and so need to work as individuals

Some students dislike group work or are not able to work effectively in groups

Some students may find it difficult to communicate effectively in groups

Collaborating Effectively

Collaboration as a teaching tool is more than encouraging students to chat with each other about their work.

Effective collaboration activities involve:

- Adopting a structured approach (scaffolding)
- Well-designed tasks
- Requiring students to produce information, produce a piece of work and be accountable
- Allowing the teacher to check for understanding (formative assessment)

Creating a culture of collaboration in your classroom allows you to further develop important 21st Century Skills; communication, critical thinking and problem solving.

If students are to talk about chemical ideas and problem solve together they must be given:

- Worthwhile and interesting things to talk about
- Good reasons for working in this manner
- Ways and tools of working together that involve all group members
- Guidance and feedback from the teacher

What we did:

- Right from the beginning of the program (Head start) we used activities that introduce students to other members of the class and which require collaboration and working together to achieve a goal.
- Began with very structured collaborations and clear goals and outcomes for the task.
- Incorporated accountability into the tasks: eg mini-whiteboards, quality of experimental results, competition between groups, random selection of students to report on the group work, quizzes etc

What we did:

- Peer observation (asked each other to come into our classroom to listen to student conversations and provide feedback to us)
    - What students were talking about
    - Who was talking or not-talking
    - How well, or not, the activity was working
    - How the task could be improved

We deliberately worked on developing a culture of collaboration amongst students and amongst ourselves!

Before the observation

GWSC Peer Feedback Template

Classroom observation protocol: Collaboration

Classroom teacher:

____

Subject and year level:

____

Date of observation:

____

Teacher observing the class:

____

Pre-observation meeting:

What is the goal of the teacher in relation to using collaboration in this lesson? How will this be achieved? Eg. thinking routines/pair work/group task?

During the observation

How are students collaborating to advance their understanding/to practise their skills?

What evidence is there to show that each student takes responsibility for their part of the learning?

Post observation discussion

Clarifying - Classroom teacher and observer discuss clarifying questions about the context of the lesson. How does this fit with what you have been working on?

Interpretation and discussion - The classroom teacher to reflect on the element observed. The observer to sum up and explain their notes from the observation

How did you feel about the lesson/did you achieve the goal?

What worked effectively in the use of collaborative learning?

What could be developed further?

Teacher self-reflection

Classroom teacher to reflect on the discussion and feedback.

What did I learn from this peer feedback?

Ideas to take forward to my next lesson.

Laboratory Work - Lakshmi

Teacher directed student collaboration during practical activities

- Experiment chosen: Back Titration
- Students worked in groups of three
- Each group provided with 2 small white boards and marker pens
- The first 10 minutes of the practical session spent by groups reading and allocating individual responsibilities to each member for the practical
- Summarising their roles on the white boards
- Ensuring every member had a role to play during the practical

What happened?

- All students in the group had an active role to play
- Activity was not dominated by the stronger students.
- Every team member had an understanding of the steps carried out.
- Students completed their roles simultaneously without waiting and wasting time - working more efficiently during the practical.
- Solutions and apparatus clearly labelled and NOT mixed up as is the case in at least some groups otherwise.
- Stronger students helping and supporting weaker students without intimidating them.
- Interesting to see the white board summaries were very different but each one was sensible

Difference from my other class?

- Practical was completed well within time
- All students understood why each step of the procedure was done
- Weaker students felt a lot more confident
- Stronger students helped weaker ones without dominating and completing the work on their own
- Feedback from students at the end of the activity was positive
- Understanding and applying the theory behind the practical in stoichiometric calculations improved
- Weaker students sought help more readily from peers and teacher

Group Activities: Catriona

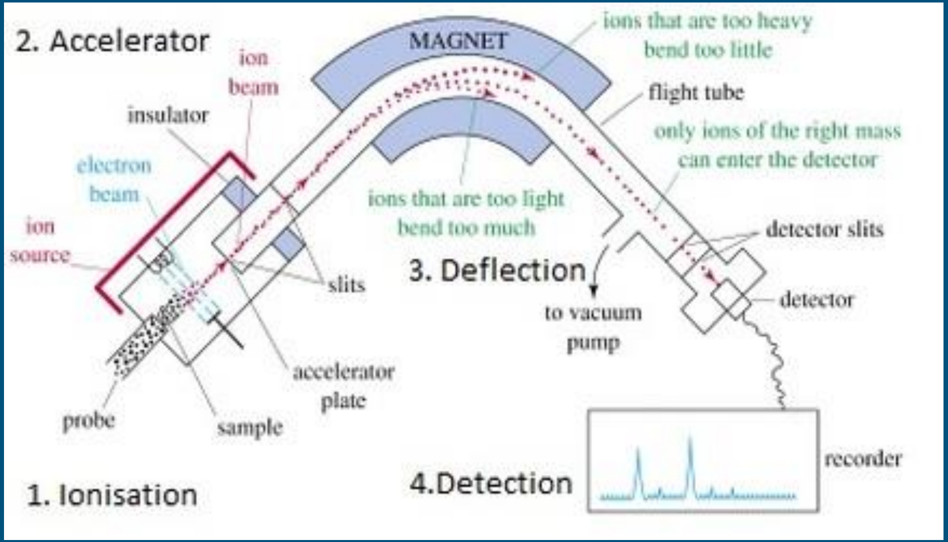
A variety of activities to get students out of their seats and working together.

1. Mass spectrometer: Role play and student collaboration
2. Esters Game
3. Ammonia production: poster production
4. Stoichiometry (Year 11) using mini whiteboards
5. Equilibrium Graphs

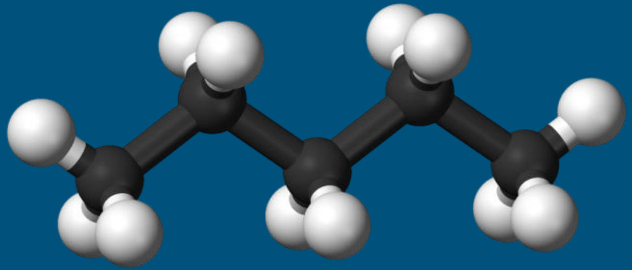
Activity 1
Mass Spectrometer: Role Play & Collaboration

1. Find a partner.

2. Using the molecular modelling kits, build a model of pentane.

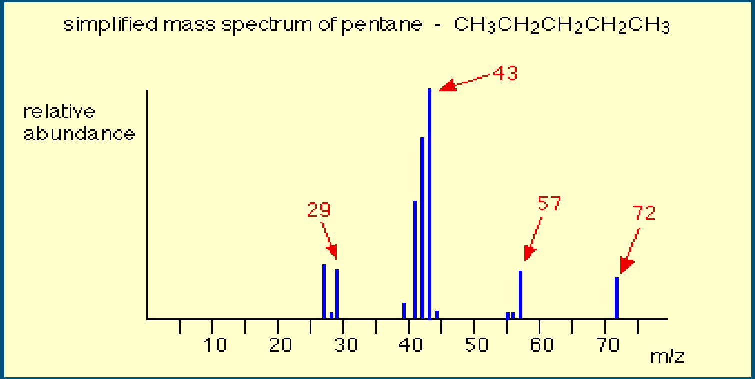


http://chemicalinstrumentation.weebly.com/mass-spectrometry.html



- You and your partner now constitute a molecule of pentane.
- You will be placed in an ionisation chamber.
- When either you or your partner is hit by an electron you will become ionised.
- You are then accelerated toward charged plates.
- As you accelerate, you become unstable. You break apart (or may choose to stay together)….and each take part of your molecule. The person who was ionised retains the 'charge'.

- You will move through a magnetic field
- IF you are uncharged, you will not experience anything and will continue in a straight line. Your journey stops here.
- IF you are charged you will experience a force and be deflected sideways.
- Smaller particles will have a tighter turning circle. You will line up according to size
- If you are the same size as someone else line up behind them.



Ready to be ionised?

Have a ‘recorder’ who collates information.

Find your original partner:

Can you represent the information in a graphical display on the mini whiteboards?

Can you write an equation to show what happened?

Activity 2: Esters Activity

Ester = carboxylic acid + alkanol

You have been given a piece of paper

Form a group with the structural formula and name of each component **and** the final ester.

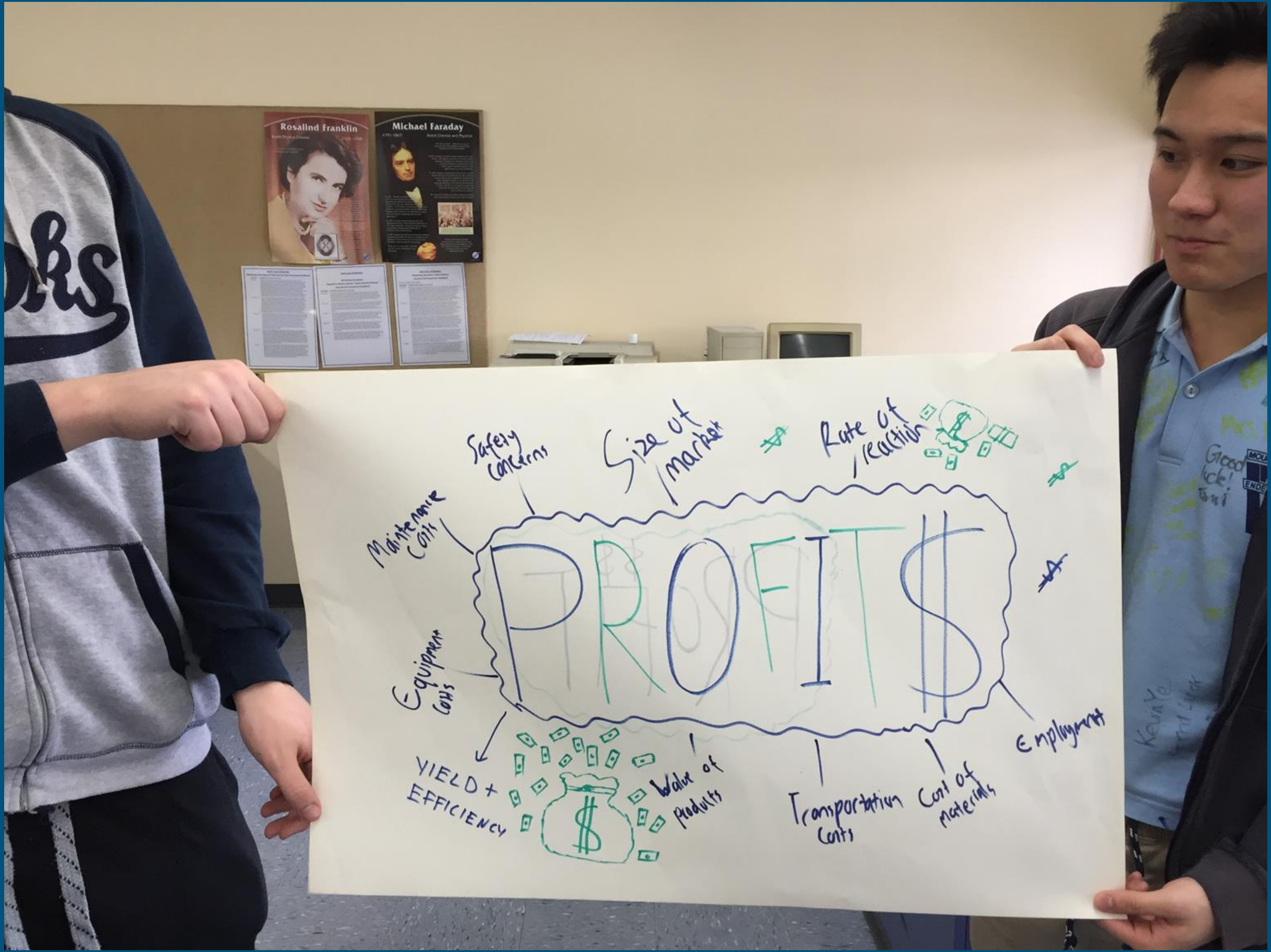
If you can't find the right combination, you may swap with some of the spares out the front!

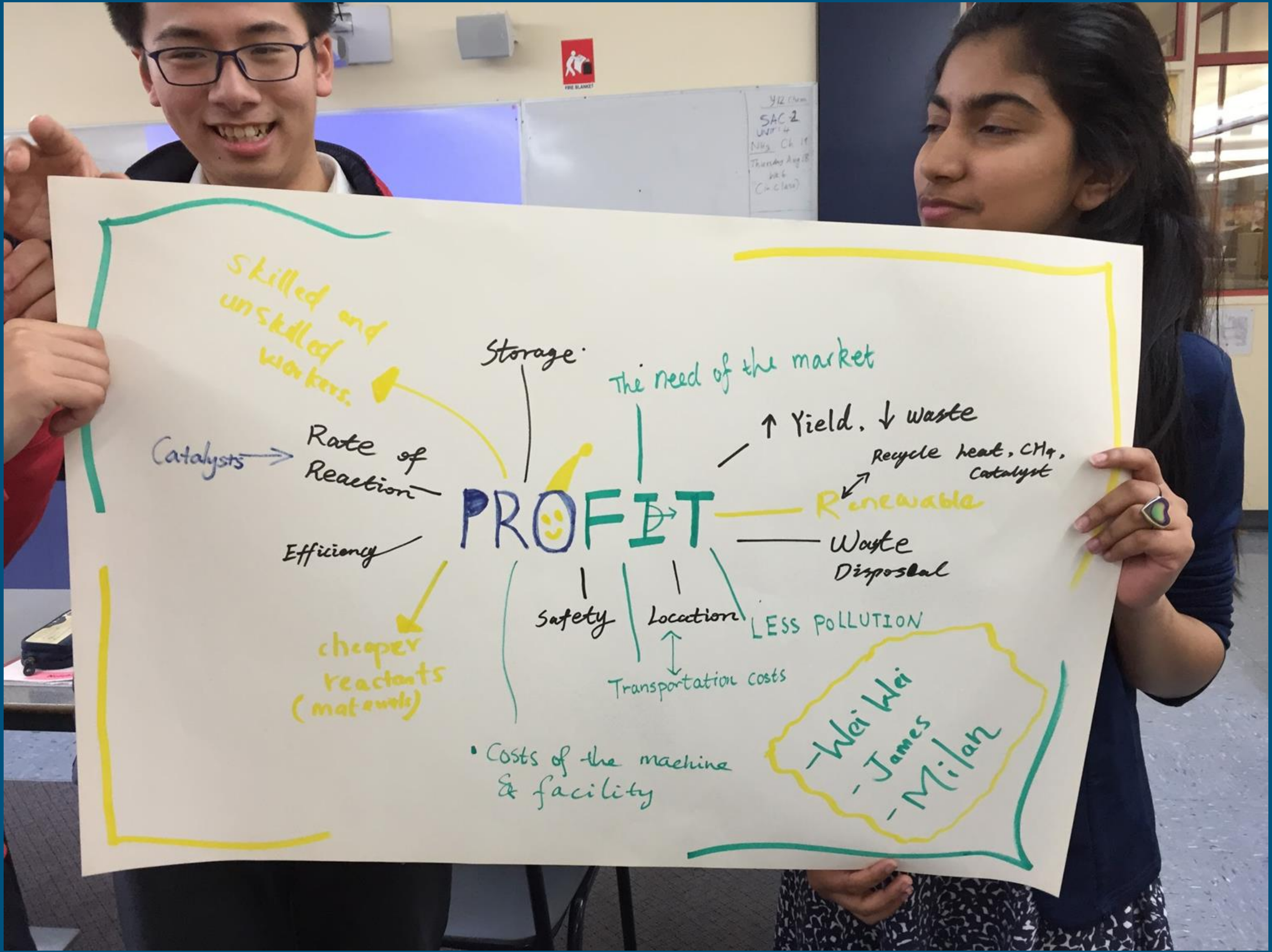
(There are 5 different esters, each needs 6 pieces of paper)

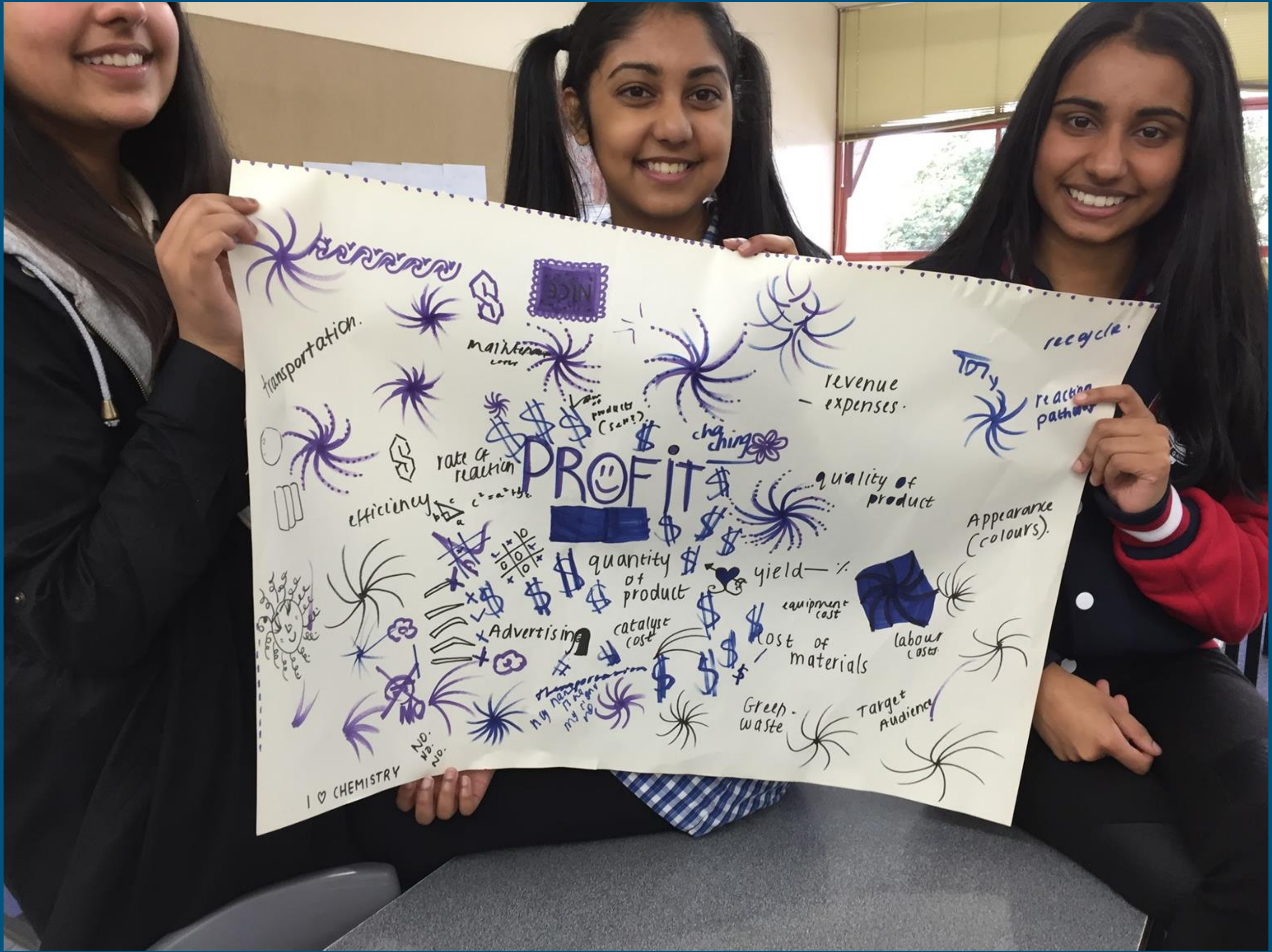
Activity 3: Production of Ammonia

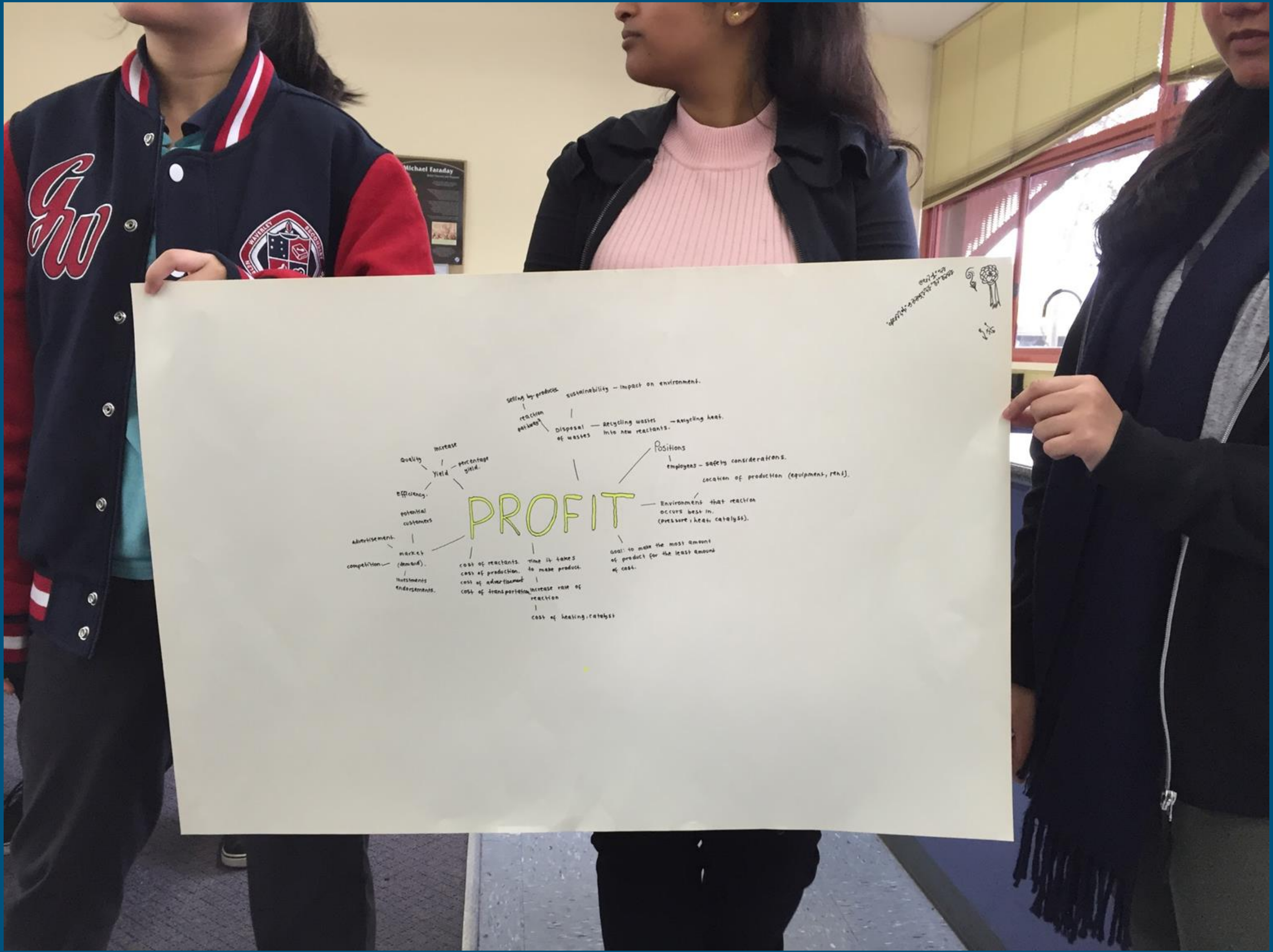
Students were asked to work in groups to produce a poster showing the things which may influence:

PROFIT

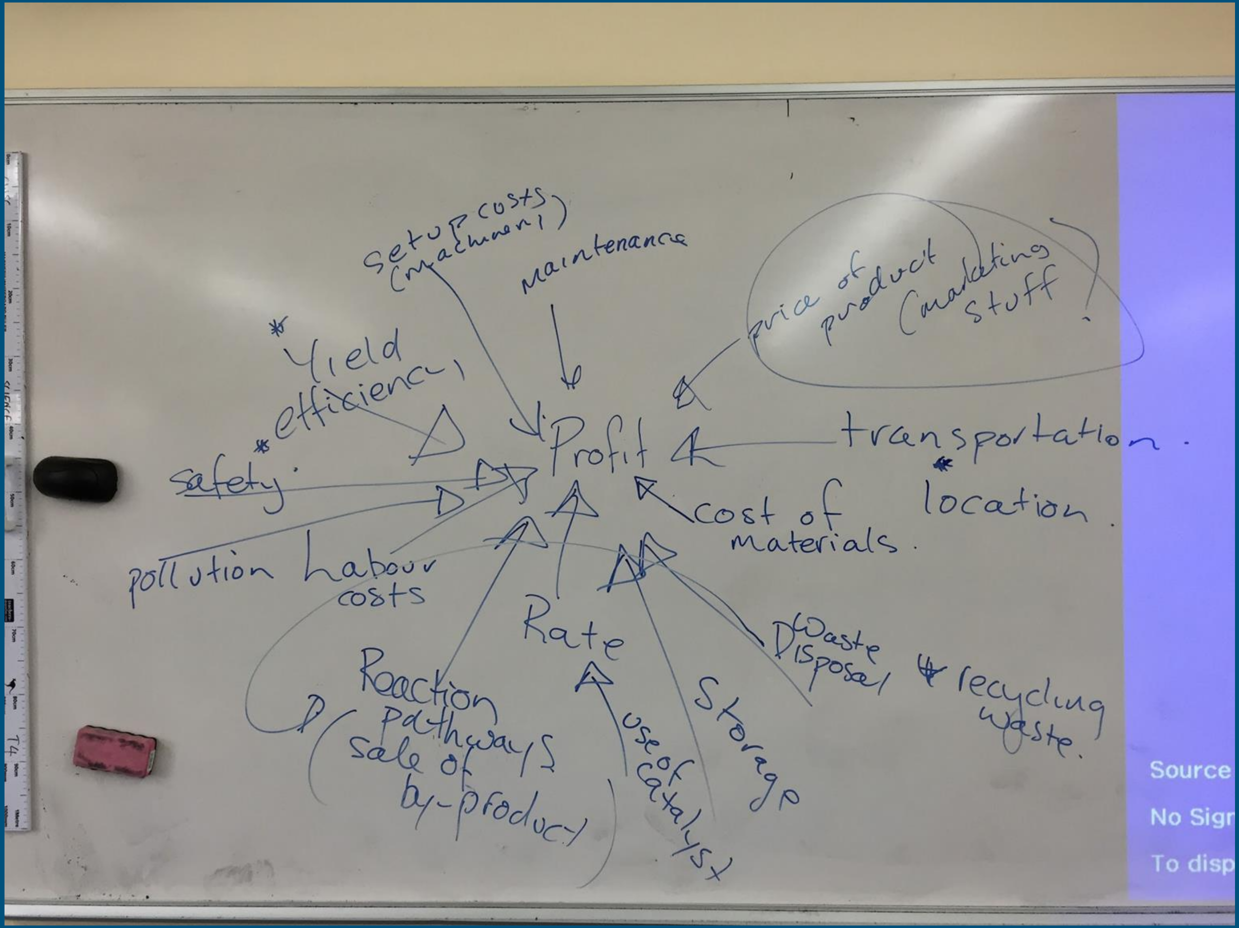

PROFIT$
Safety concerns
Size of market
Rate of reaction
Maintenance costs
Equipment costs
YIELD + EFFICIENCY
Value of products
Transportation costs
Cost of materials
Employment


Skilled and unskilled workers.
Storage.
The need of the market
↑ Yield, ↓ waste
Recycle heat, CH_4, Catalyst
Catalysts
Rate of Reaction
PROFIT
Renewable
Waste Disposal
Efficiency
Safety
Location
LESS POLLUTION
Transportation costs
cheaper reactants (materials)
• Costs of the machine & facility
-Wei Wei
-James
-Milan

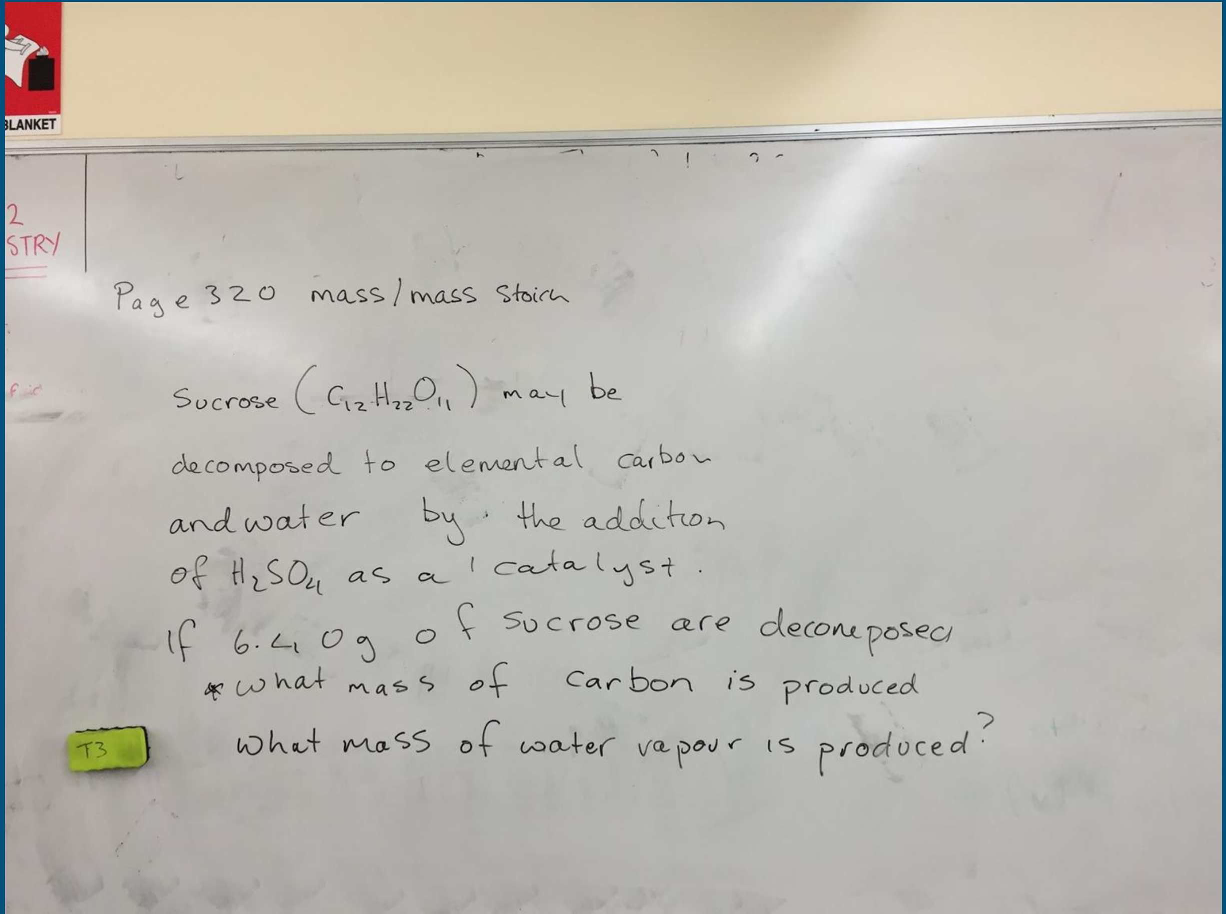

transportation.
recycle.
revenue
- expenses.
reacting pathway
cha ching
rate of reaction
PROFIT
quality of product
efficiency
Appearance
(colours).
quantity of product
yield — %
equipment cost
Advertising
catalyst cost
cost of materials
labour costs
Green waste
Target Audience
NO. NO. NO.
I ♡ CHEMISTRY


PROFIT
selling by-products
sustainability — impact on environment.
reaction pathway
Disposal of wastes — Recycling wastes into new reactants. — Recycling heat.
Positions
employees — safety considerations.
Location of production (equipment, rent).
Environment that reaction occurs best in. (pressure, heat, catalyst).
Goal: to make the most amount of product for the least amount of cost.
Time it takes to make product.
Increase rate of reaction
cost of heating, catalyst
cost of reactants.
cost of production.
cost of advertisement
cost of transportation
market (demand).
advertisement.
competition
investments
endorsements.
potential customers
Efficiency.
Yield
Quality
increase
percentage yield.

Collating the information as a class:



Activity 4: Stoichiometry with Year 11



Students were given a stoichiometry problem to work on in groups.

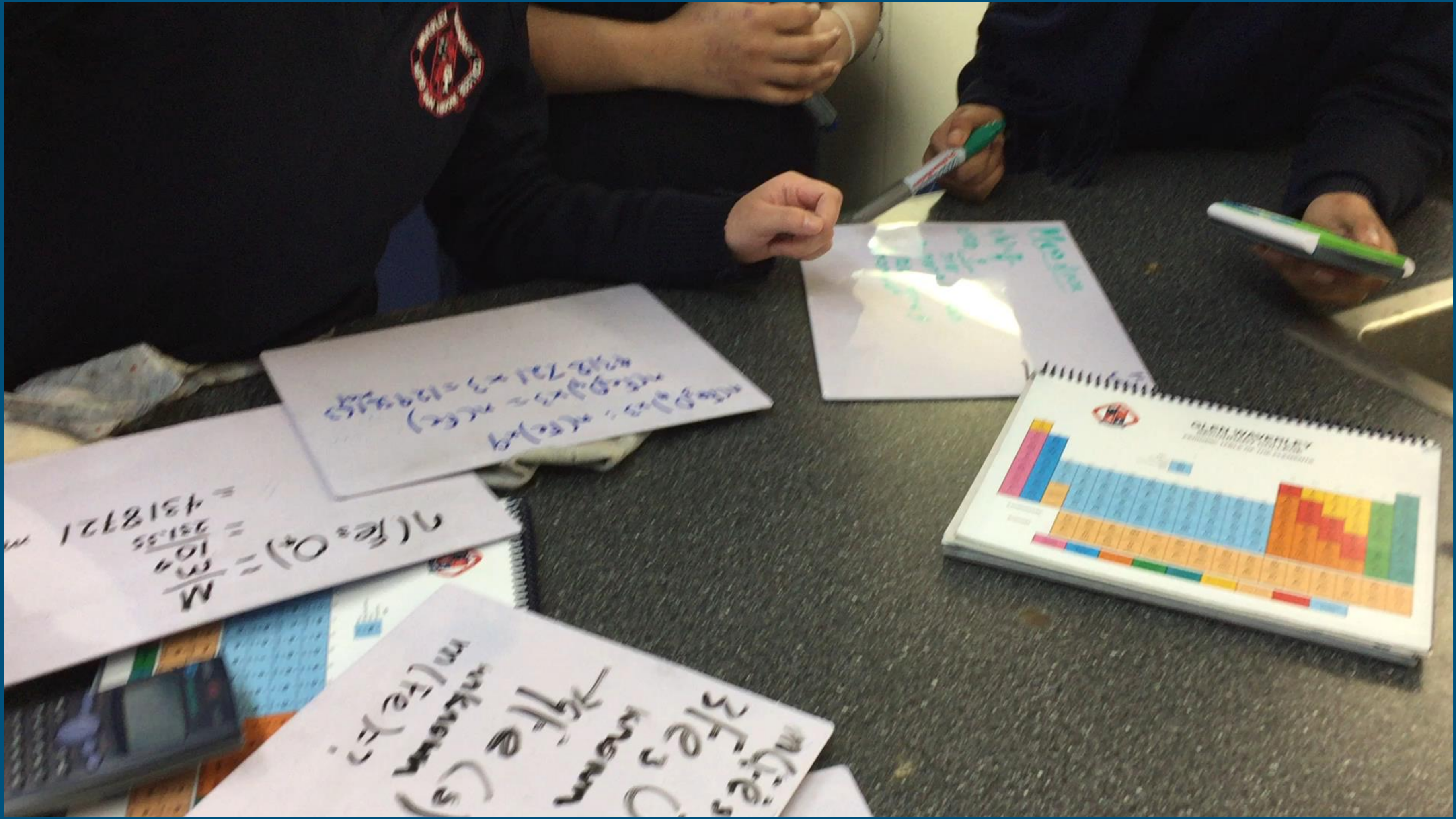
Each student was responsible for performing just one step in order to encourage participation and accountability.

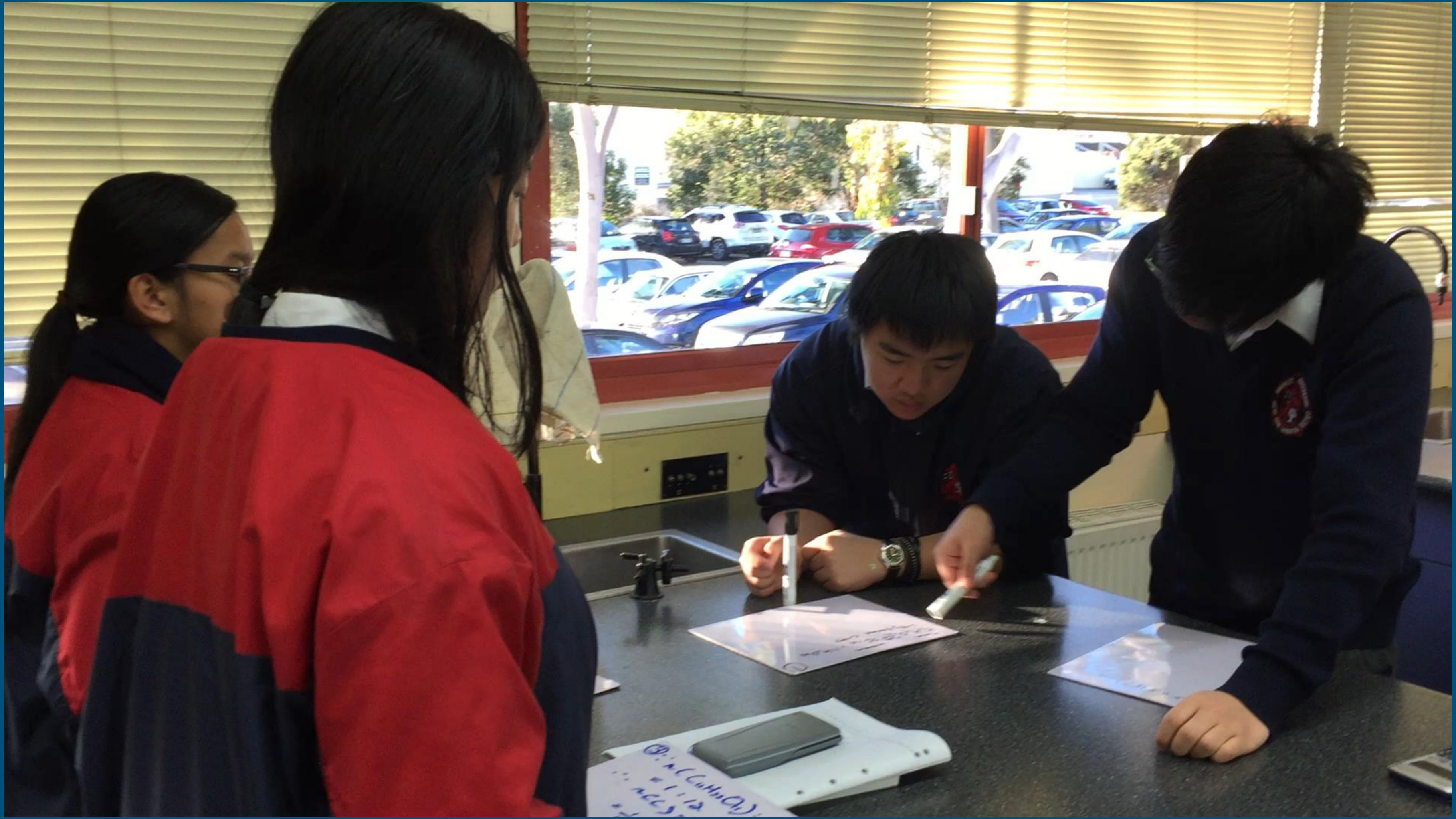
Student 1: Write balanced equation. Identify known and unknown quantities.

Student 2. Determine no. of mol of known quantity.

Student 3. Use equation to determine no. of mol of unknown quantity.

Student 4. Determine mass of unknown quantity.



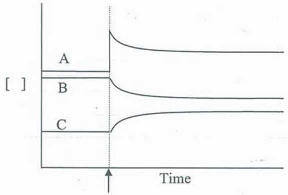


Activity 5: Equilibrium Graphs

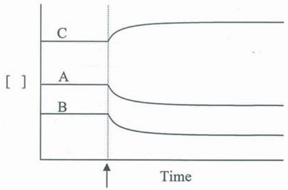
Students were given an equation and graphs.

In groups, they had to work out what would cause the changes in each situation.

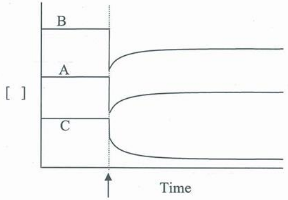
Reaction : A + B $\rightleftharpoons$ C $\Delta H = -256\ kJ.mol^{-1}$



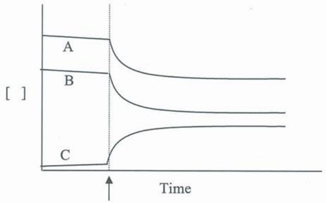
Description : ....
....
....
....



Description : ....
....
....
....



Description : ....
....
....
....



Description : ....
....
....

DRAW concentration vs time diagrams for the following situations.

A. In the reaction $A + B \rightleftharpoons C + 2D$

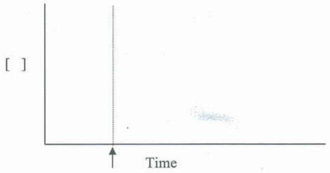
solutions containing A and B are mixed at

time 0 (arrowed)

In the same equilibrium mixture, at the

indicated time, an amount of C is removed by

precipitation.



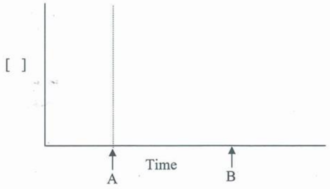
In the reaction mixture

$A \rightleftharpoons B + C \quad \Delta H = +172\ kJ.mol^{-1}$

The temperature is reduced by 25° C at point A,

and then subsequently increased again by 50° C

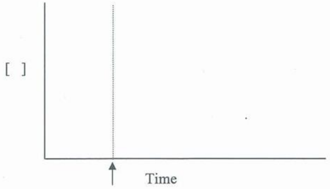
at point B

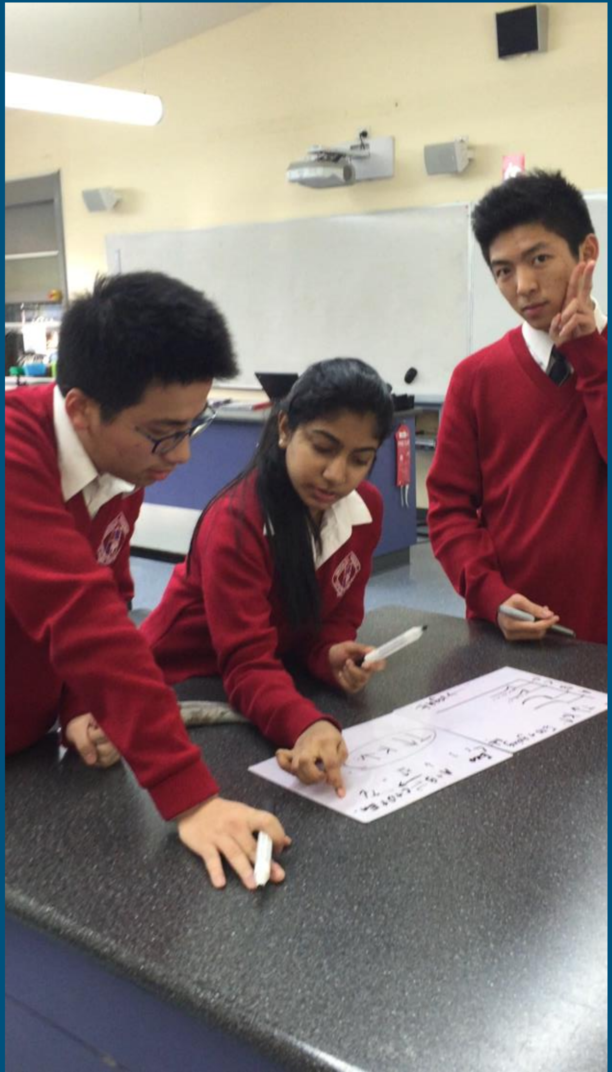


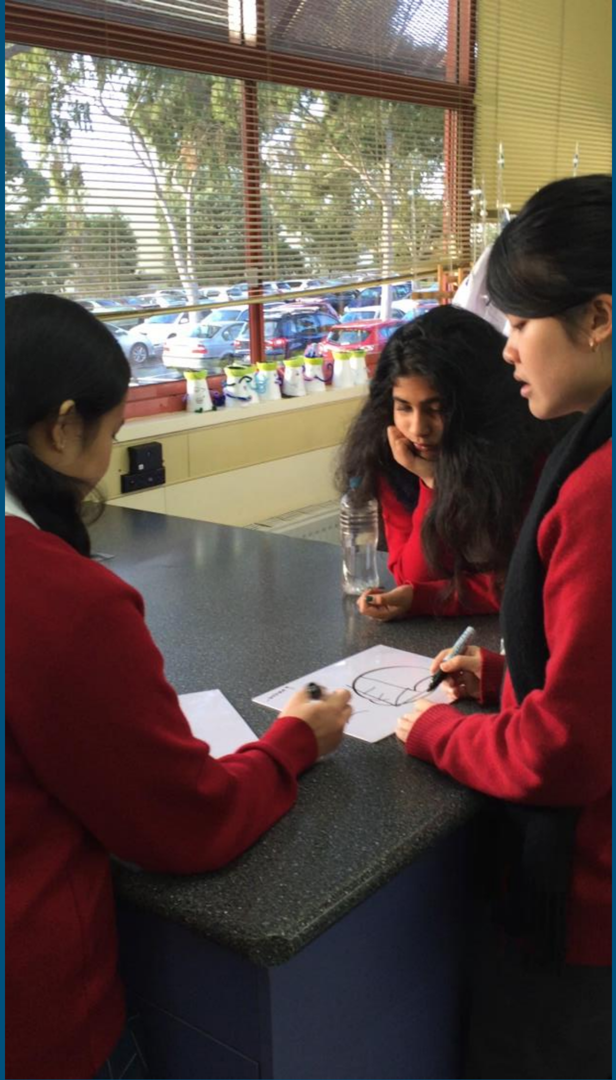
In the reaction $F_{(g)} + G_{(g)} \rightleftharpoons H_{(g)}$

The volume of the container is increased at the

indicated time.







Benefits

- Students enjoyed working together collaboratively.
- Engagement increase for weaker students as they were involved in the development of thinking through solutions.
- Student couldn’t ‘hide’ !
- Learning improved as students questioned each others ideas and explored options.
- Students can use whiteboards to work through things and rub things out. Some students are reluctant to write things down until they know the right answer...

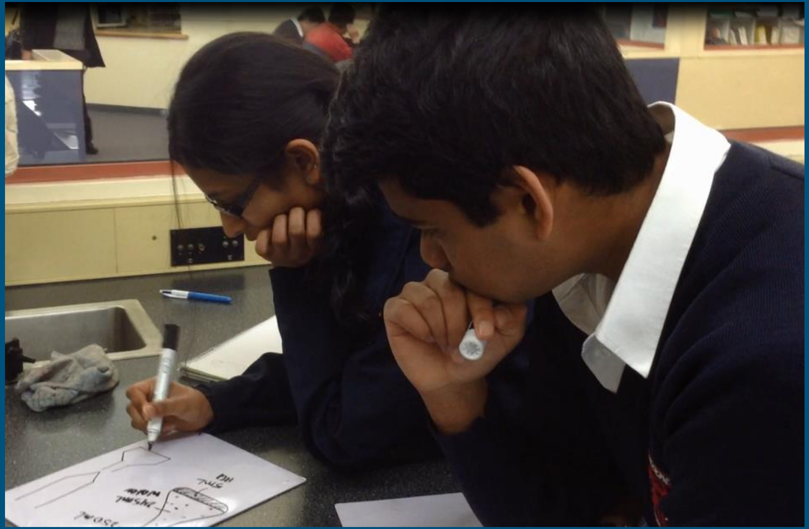
Activities - Ivy

1. Comic Strip Activity
2. Games (Guess-Who, Articulate, Taboo, Kahoot)
3. Modelling (Protein Modelling)
4. Quick classroom strategies for collaboration:
    - Team Challenges
    - Think-pair-share
    - Jigsaws

5. You Be the Teacher

Setting up your classroom:

- Tables can be arranged to promote and facilitate positive collaboration (groups of tables rather than rows).
- Always allocate students to groups when completing laboratory work - this will allow further extension activities post-laboratory work to take place.
- Use lab benches in science classrooms for group work stations.
- Use mini-whiteboards and markers as tools to facilitate collaboration.



Conversation Starters

Give these conversation starters to groups whenever they are involved in group work, including practical work.

Assists students to have productive and meaningful conversations with each other.

Assists students to develop skills in using language (useful for SACs and examinations).

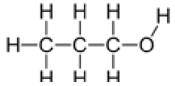
Summarise  Restate the ideas of a previous speaker in your own words.	So you are saying that… Am I right is saying that you think… Just to clarify, you think that…? What I heard you say is… I think it is helpful to look at… Let’s consider what … said by…

These are very useful for EAL students - especially when working with non - EAL students!

Before practical work	• The colour appears to be … • The texture appears to be … • I predict that … because … • This experiment is about … • We should divide up the method by …. • We can work more effectively by …	**Support your idea**	• For example … • Evidence includes when … • It's like… • This is shown when…. • According to ….. • I believe in this because…. • This idea is valid as I have found that…
During practical work to make observations	• The colour is changing by … • Signs of reaction I can see are … • The rate of the reaction appears to be … • The reaction that I think is happening is … • This relates to our class theory work because …. • I wonder why … • Why do you think that …	**Link Ideas Together**	• For example … • Evidence includes when … • It's like… • This is shown when…. • According to ….. • I believe in this because…. • This idea is valid as I have found that…

1.Comic Strip Activity

- Activity which can be used to help students digest information about processes.
- Requires them to think about the content and produce work that requires them to think about analogies, modelling and creatively.
- Ideas: mass spectroscopy, organic reaction pathways, synthesis of Aspirin, movement of electrons through a galvanic cell.



The Amazing Adventures of

PROPANOL

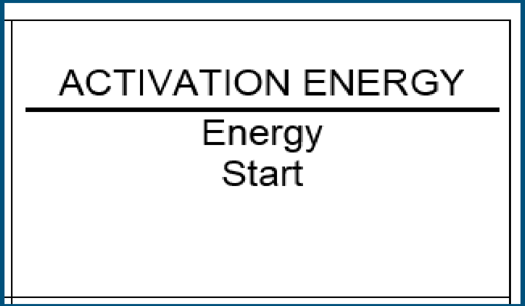
Task: Show how a molecule such as 1-propanol can be analysed using mass spectroscopy!

In pairs, read the descriptions below and illustrate the described processes to produce a comic strip!

The sample of propanol is injected into the MS and vapourised into a gas. It has a mass of 60 g/mol.	The propanol is bombarded with electrons and loses an electron to form positively charged molecular ions. It has a m/z ratio with the same mass as the original molecule.	Some molecular ions are stable. Some molecular ions are unstable and will then fragment into smaller more stable fragments.
The smaller fragments have a lower m/z ratio but all have the same charge. They move through the MS at different paths.	The fragments with smaller m/z ratio reaches the detector first. The fragments with larger m/z ratio reach the detector later. Any molecular ions which did not fragment will reach the detector last.	Each of the collected fragments/molecular ions will appear as peaks on the spectrum.

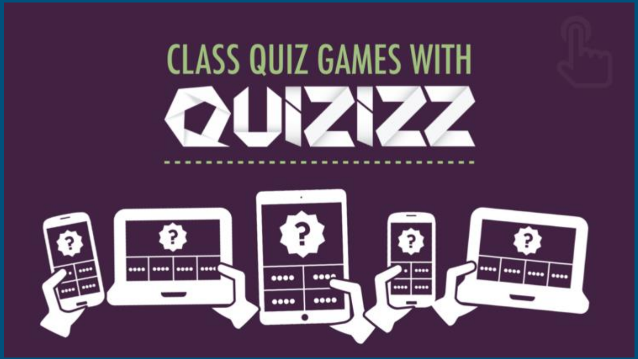
2. Games!

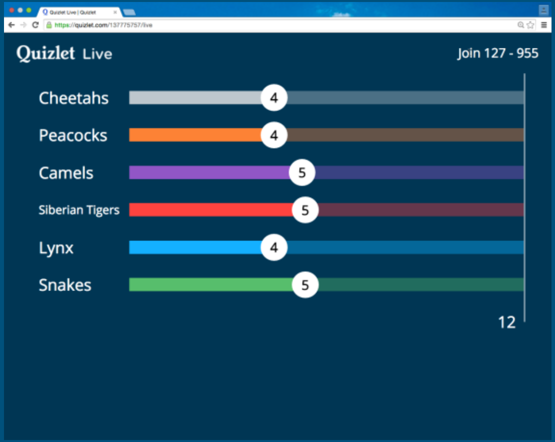
Taboo & Articulate



- Literacy based activities
- Fantastic revision tools and excellent for EAL students
- Great for creating a positive culture for collaboration and students having meaningful conversations
- Inexpensive and easy to prepare.
- A great way to get your class talking about the content in a non-threatening and fun way!
- Great to have it prepared and used when you have 10 minutes spare or to change the pace in the class.

Online gaming/quiz tools: Kahoot, Quizlet Live and Quizziz





- Students love it
- Live play in class
- Public quiz database
- Team mode available

- Student timed/paced
- Can set it as homework
- Students receive immediate feedback
- Collects data
- More individual in terms of player mode however students can work in groups to create the quiz

- Great for learning terms
- Team based game
- Students can create their own games and notes
- Live in-class

Guess Who

The concept of this game is similar to the classic family board game:

1. Students select one of the substances/molecules and write it on a piece of paper without showing it to their opponent

2. Students ask yes/no questions in an attempt to identify the molecule their opponent has selected

3. Use whiteboard markers to eliminate and deduce the correct answer.

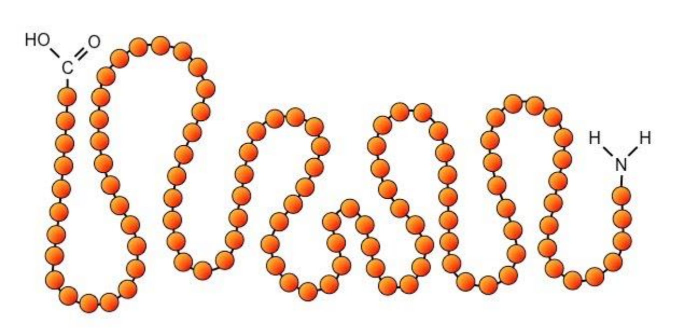
Great tool for students to practice analytical skills, questioning skills and review properties of different molecules/substances.

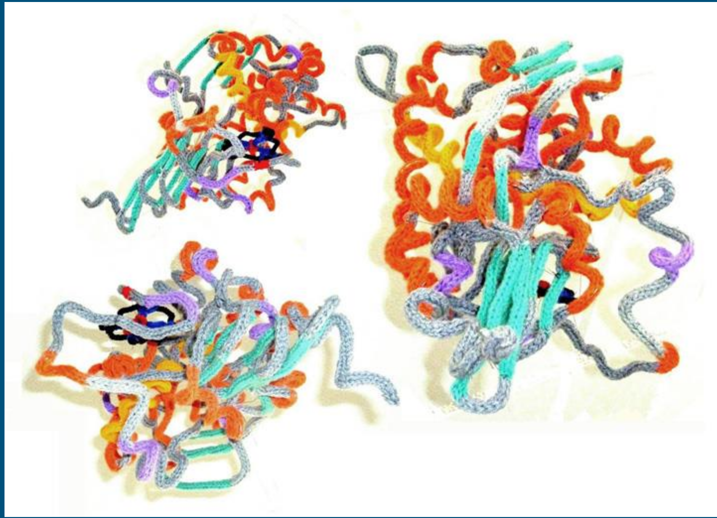
Can be used to reinforce:

- Chiral and Achiral
- Polarity
- Functional groups
- Solubility
- Intermolecular bondng
- Classification of substances
- Molecular geometry

3. Protein Modelling

- Helps students to understand differences in primary, secondary and tertiary structure of proteins.
- Requires simple materials which are inexpensive.
- Scaffold with worksheet.
- Great as there may not be a lot of practicals which can address this.
- Teachers may need to provide a model for students to refer to.





4. Quick Classroom Activities

Group Challenge

Three metals; R, S and T were investigated for their reactivity.

Consider the following information when 3 experiments were carried out:

- T (s) + R^{2+} (aq) = a spontaneous reaction occurred
- T^{2+} (aq) + S (s) = no reaction occurred
- S (s) + R^{2+} (aq) = no reaction occcured

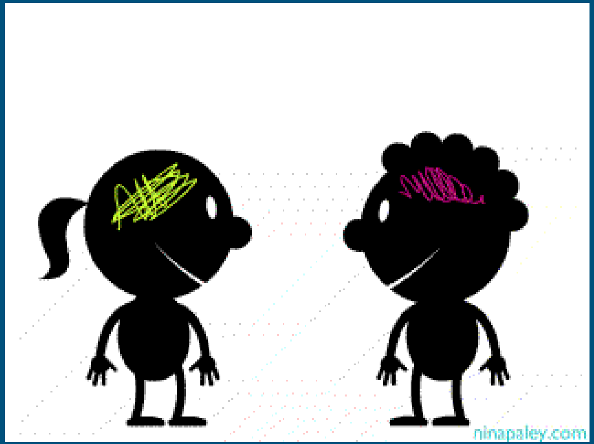
Determine the order of reactivity of the three metals from least reactive to most reactive.

Think, Pair, Share

- Use this strategy as often as you like/need.
- Really reinforces the culture of collaboration in the classroom.
- 10 seconds to think, 20 seconds to share and then feed back to the class.

Can be used for easy or difficult questions, examples:

- How many significant figures is this value?
- Predict the observations of this reaction.
- After watching that YouTube video ...



Jigsaw

- Students are assigned an Expert Group and a Learner Group.
- In Learner Groups, students research, learn, find out about a specific topic eg. Addition Reactions
- In their Expert Groups, students share back to the group what they have learned.
- A well structured jigsaw task scaffolds students and directs them towards information and essential knowledge.
- Students must have shared accountability in both groups, to thoroughly know their Learner Group topics and to listen during the Expert Group sharing time (a quiz after, where the team score is an average of individual grades).

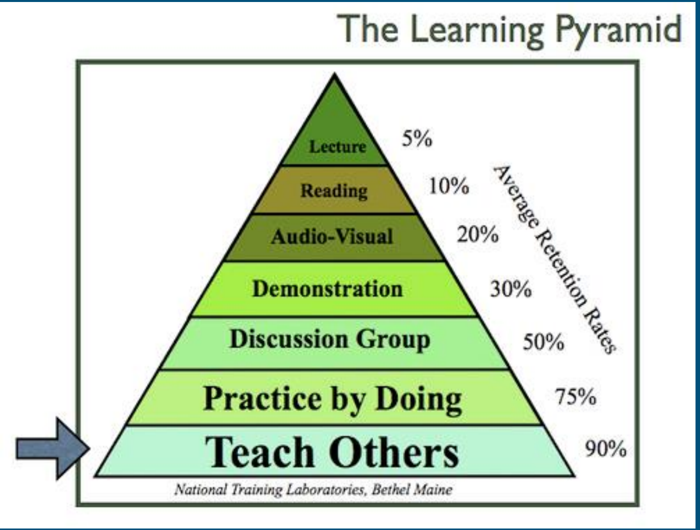
Jigsaws can be quick tasks!

Ideas:

- Analytical chemistry and instruments
- Classes of organic reactions
- Classes of functional groups
- Factors influencing reaction rates

5. You Be the Teacher

- Suitable as an end of the unit/topic revision tool.
- Students are assigned an area to prepare a mini-lesson to present to the class.
- Each area needs to be scaffolded by specific tasks or instructions.
- Students enjoy listening to each other and presenting to each other in a non-threatening and also helpful way.
- Powerful reinforcement, learning tool.



Esters

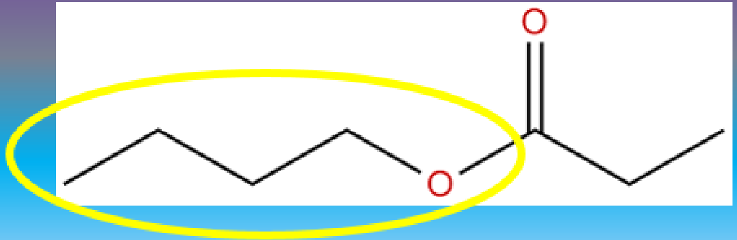
Explain what reactions produce esters (what conditions are needed)
Show how to draw an ester from the name
Show how to name an ester from the drawing
Show how to identify the reactants which were used to make an ester

Provide 1 question for the class to solve (you work through the solutions!)

☺ How to name esters ☺

2. The side **NOT** attached to the =O is the _ ALCOHOL _ side of the molecule.

This is named But yl and is at the start of the name.



Ester's name is : ***but***yl-______oate

Lead-Acid Cell - Deb

- Collaboration activity to follow up a laboratory practical class
- Students had their prac sheet with instructions and theory, mini-whiteboards, textbooks etc
- Groups were based on lab groups
- The product was the diagram drawn on the mini-whiteboards
- Student understanding was checked through question and answer at the end of the lesson (and throughout the lesson)

Instructions for Students:

Draw two diagrams of the lead-acid cell, one for discharge and one for recharge. Label the diagram with the following:

- Electrode polarity
- Chemical species in the cell
- Anode, cathode, direction of electron flow and ion movement
- Equations at each electrode

Annotate the diagram with any other information that you wish to convey

Feedback from peer observer:

Observations by ILA:

- Students were engaged with the task and started it quickly
- Students referred back to the instructions on the whiteboard to assist them in starting the task
- Students used the prac sheet, text book to assist them in the task
- Students were talking to each other about the task a fair bit, there were a lot of questions posed such as
    - Is this discharging or recharging?
    - How do you know where the electrons are going?
    - Is it one beaker or two beakers?
    - “AN OIL CAT RIG” was mentioned in a few conversations

- A lot of the conversation was dominated by students asking questions of each other rather than providing answers or explaining the chemistry to each other
- Some groups were stuck at the beginning and slow to get started, this seemed to be because they didn't remember what they did in the experiment and had to read through the procedure again eg. Wui and Lily – they read it together and added things into the diagram as they went but this was a slow process
- One group (Tony and Ben's group) talked a lot at the start, however, once they were on track, the talking subsided and they sort of just got on with it. Tony explained the process of electrolysis to Ben quite well at the start of the activity through the aid of a diagram

Lead-Acid Cell activity - Improvements

Introduced a more structured set of questions when the activity was repeated with a different class

Greater sense of purpose and fewer questions from students about what to do in the repeat class with a more structured activity.

Activity Two

The discharge reaction (the reaction which produced energy) is:

$$Pb(s) + PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) \longrightarrow 2PbSO_4(s) + 2H_2O(l)$$

1. What is being oxidised?
2. What is being reduced?
3. What is the oxidant?
4. What is the reductant?
5. Write the half-equation for the reaction at the anode.
6. Write the half-equation for the reaction at the cathode.
7. Identify the electrolyte.

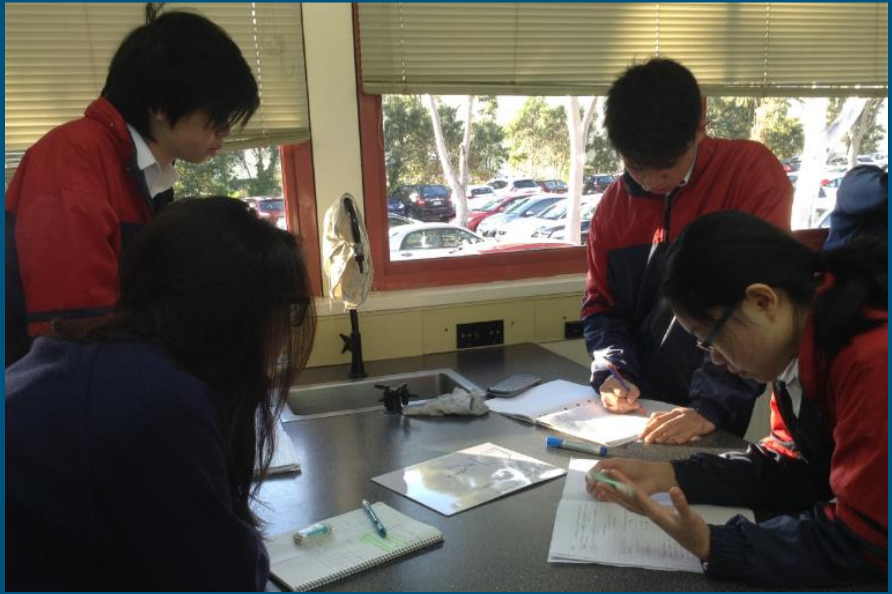
Activity Three

We started the prac with the recharge reaction. We supplied the energy to the cell.

1. What was the appearance of the electrode that was connected to the negative terminal?
2. What process, oxidation or reduction, was occurring here? Explain.
3. Write equations for the reaction or reactions that were occurring here.
4. What was the appearance of the electrode that was connected to the positive terminal?
5. What process, oxidation or reduction, was occurring here? Explain.
6. Write equations for the reaction or reactions that were occurring here.

What our students have reported:

- Student enjoyment and engagement increased with no apparent detraction from performance on SACs and other assessed tasks
- Better retention of information, concepts and relationships
- Improved relationships in the classroom
- Improved outcomes for EAL students (some of our top performers)



What we have learnt as a team:

- Creating a culture of collaboration is critical to its success
- Structured and scaffolded tasks are essential, particularly at the beginning when classroom culture is being developed
- Teacher involvement during the lessons is vital for guidance, correcting misunderstandings and for asking leading questions
- Some form of product or performance resulting from the collaboration is necessary to hold students to account and to check their understanding

- Collaboration is not just an ‘add-on’ but an integral part of teaching and learning and how we can teach the content of the subject
- High quality formative feedback from our classes allowed us to adapt teaching and lesson content based on student progress
- We as teachers have improved due to collaborating with each other
- Don’t be afraid to experiment and try new things

Thoughts?
Questions?
Feedback?

Thanks to:

Dr Lars Anderson, Director of Pedagogy, Glen Waverley SC

Melissa Perera, Head of English, Glen Waverley SC

References

Developments in Cooperative Learning: Review of Research

Robyn M. Gilles

Anales de Psicologia

2014, vol.30, no 3, 792-801

Meta-analysis of research in cooperative learning.

Beautiful Failures

Lucy Clark

Penguin Australia

2016

Journalist and parent: her take on the education system for general readership. Critique of competition in education.

Thank you!
Good luck!

Deb Brooks

Lakshmi Gopal

Ivy Lai

Catriona Hoy

Glen Waverley Secondary College