The Chemistry of Cosmetics

Activity 1: Learning Station- Crazy CHEMunication Game (25 min total)

This game is all about chemistry and cosmetics, but to win this game you don't need to know anything about either topic! All you need is a good imagination and a lot of creativity. By the end of the game all students will have some basic cosmetic chemistry vocabulary down pat!

Group size:

Could be any size of group. For the cosmetic chemistry workshop the group size will be 10-12. It will be best if participants can work with a partner. This will make each round faster and allow the girls to have a friend to bounce ideas off of.

Instructions:

The leader of this game will be the CHEMunication Master. This leader has a list of common words that a cosmetic chemist should know as well as their definitions. In each round, the leader will pick a word from the list that the participants will then try to define. Each participant will make up a definition for that word and then hand in their definitions to the leader. The participants don't need to know what the word really means, they just need to use their creativity and imagination to make up a definition. Once all the participants have finished their fake definitions, the leader will mix the papers up adding the correct definition to the pile as well.

The challenge really starts once all the definitions are in. The leader then reads all the definitions out to the group (including the real one) in a random order. After everyone has heard all the definitions each participant guess which definition is the real one. Here is how the scoring works:

- If a participant A guesses participant B's definition, participant B gets one point
- If participant A guesses the real definition written by the leader, participant A gets one point
- If no one guesses the real definition, the leader gets two points

So the point of the game (for the participants) is to make up a definition that sound good enough to trick the others into believing it. At the end of the game winner will be the student with the most points.

Teaching Component:

In terms of the teaching component, after each round the real definition will be identified and explained (briefly) by the leader. Some of the definitions will be reinforced later because the participants will see them again in the crossword puzzle in their workbooks.

Words and Definitions:

Word	Definition for Game	Longer Definition
Fatty Acid	A type of acid that can be found in beeswax	
Coal Tar	An ingredient that has used in hair dye	In the 1800's coal tar was used in hair dye. It is not used often anymore because it is linked to cancer and is a cause for other health concerns
Esters	Used to add different smells to cosmetics	Some esters smell like mint, grape, pineapple, pear, banana, oranges, and apricot. Many are naturally occurring, but they can also be synthesized in a lab
Boric Acid	Helps blend together oil and water together in bath fizzies	Another name for boric acid is Borax. It is a emulsifier which means it helps blend two or more unbendable liquids (like oil and water)
Witch Hazel	a plant that can be used for making things clean and fresh	Has antioxidant properties. Can be used as a cleanser, deodorant, in shampoo, etc
Redox	A type of reaction	A chemical reaction where molecules, atoms or ions gain or lose electrons
Red Ochre	used in ancient Egypt to color beauty products	A pigment made from naturally tinted clay (iron oxide)
Comedogenic	Clogs pores and can cause pimples	

Safety Considerations

- Participants will be working with pencils and notebooks.

Activity 2: Lip Balm (25 minutes total)

Participants will be making lip balm using the following ingredients: beeswax, coconut oil, jojoba oil, Shea butter (colour from lipstick optional; flavour and essential oils optional).

Intro Teaching points (2-5 minutes)

- Ask participants to work in pairs and write down what sort of things they look for when shopping for lip gloss – i.e., colour, smell, price. Have participants share their ideas with the group.
- Did anyone indicate that they look at the ingredients to see what it's made of?
- It's estimated that a person may ingest more than 10 kilograms (22 pounds) of lipstick over a lifetime!
- So we should want to know what is in our lipstick – because it goes in our bodies.
- Today we are making lip gloss out of:
    - Jojoba oil ("ho-HO-ba") comes from the seeds of the jojoba plant, a shrub native to southern Arizona, southern California and north western Mexico
    - Shea butter is a natural fat extracted from the seed of the African shea tree
    - Coconut oil comes from coconuts
    - Beeswax is a natural wax produced in the bee hive of honey bees

Making the Lip Gloss (15 minutes)

- Give each participant a lip gloss container and have them write their name on the bottom.
- Have participants work in pairs (each recipe fills two lip gloss containers)
- Materials for each pair:
    - measuring utensils
    - beaker
    - oven glove
    - stir stick
    - 2 lip gloss containers
- Have participant pairs measure ingredients into their beaker, and optionally add a flavour, essential oil, or colour (from lipstick, add a very tiny amount about the size of a pebble 1mm in diameter ○).
- Heat burners by turning to medium.
- Have participants **put on an oven glove** before placing their beakers on the burners, and begin stirring with the stir stick. **When stirring, participants need to use a fingered oven glove to stay safe – the beakers can become very HOT**. Total stirring time until all ingredients are melted together should be approximately 4-8 minutes.
- Have participants pour their ingredients into two lip gloss containers – **very carefully, using the glove**.
- Wait for the lip gloss to harden, this should take approximately 8-12 minutes.

Teaching points

- All of the ingredients we used today are **edible oleochemicals**: chemicals that come from plants and animals.
- Lip glosses, lipsticks, and lip balms are mostly fat mixed with colour. Fat and colour can come from many different sources – for example, some red colouring comes from flowers found in the rainforest. Some ingredients that are used or have been used in the past are included in the word scramble.

- **whale blubber:**
  - is the thick layer of fat underneath the skin of a whale, and sometimes makes up more than 50% of the whale's mass!
  - contains high levels of Vitamin E, Vitamin D, omega 3's, selenium, and other antioxidants
  - is eaten by Inuit and Eskimo people - it is very healthy for arteries
- **beetles:**
  - cochineal beetles create a beautiful red colour when they are crushed – the dye is called carmine
  - cochineal beetles live on cacti in tropical and sub-tropical South America and Mexico
- **mineral oil:**
  - is a refined by-product of crude oil
  - is used in many cosmetics including baby lotion, face creams
- **sheep's wool wax:**
  - also known as lanolin, is a greasy yellow coloured substance excreted by the (sebaceous) oil glands of sheep and other wool-bearing animals

Clean-up (allow 5-7 minutes)

After completing the activity at this station participants will:

- Wipe out the inside of the glass beakers using a paper towel/ J-cloth and return them to the area designated by the instructor
- Wash and dry teaspoons, stir sticks and plastic containers
- Wipe down area using J-cloth

Safety Considerations

- Participants will be making lip balm by melting the following edible oleochemical non-toxic ingredients:
  - Beeswax, with a melting point range of 62 to 64 °C (144 to 147 °F)
  - Shea butter, with a melting point range of 30 to 35°C (86 to 95 °F)
  - Coconut oil, with a melting point range of 23 to 26°C (73 – 79 °F)
  - Jojoba oil, which is a liquid at room temperature
- Participants will be using electric hot plates to heat the ingredient solution to a temperature of less than 85 °C (185 °F):
  - Hot plate surfaces are very hot and pose a burn risk
  - Participants will use thermal protective gloves when handling the beaker while it is on the hot plate and while removing the beaker and placing it out of harm's way
  - Hot plates and hot beakers will be set aside out of the way of other working and common areas
  - Participants will turn hot plates off when not working with them
  - Participants will wait for beakers to cool before wiping down the inside
- Participants will be using glassware:
  - Beakers stay at participants' station. Materials will be transported back to station using plastic containers or paper towels.

Activity 3: Fabulous Fizzies (25 minutes total)

Intro Teaching points (2-3 minutes)

- Ask participants what they think the dry ingredients (baking soda, corn starch, citric acid) are normally used for. Or what room in the house do we normally find these ingredients in?
    - We normally see these ingredients in the kitchen for cooking and baking.
    - Citric acid is used as a preservative in jams and other foods.
- As participants if anyone knows why baking soda is used in baking?
    - It provides lift or leavening
    - It does this because it is a base or alkali, and produces gas (air pockets) when it is mixed with moisture and an acid (i.e., honey, chocolate, yogourt).
- Today we'll see how baking soda together with other ingredients can create a lot of gas or bubbles
- Has anyone ever heard of or used a bath fizzie?
- Let's take a close up look at what happens when we put a bath fizzie in water.

Activity: Drop the Fizzie (5 minutes)

- Have participants form themselves into four groups
- Materials for each group:
    - 1 bath fizzie
    - 1 large beaker filled with ~800mL water
    - 1 pH strip
- Have participants drop the fizzy in the beaker.
- Time to see how long the reaction lasts (if possible).
- Test the pH of the water with the fizzie in it.

Activity: Make a Fizzie (12 minutes)

- Have participants work in pairs
- Materials for each pair:
    - 1 plastic bowl
    - 1 small resealable container
    - 1 popsicle stick
    - 1 wooden spoon
    - 1 plastic mould
- Guide participant pairs through the recipe in their notebook.

Teaching points

- Guide participants through the Fill in the Blanks exercise in the notebook:
    - **Effervescence is the formation of gas bubbles in a liquid by a chemical reaction.**
    - **In our bath fizzies, the chemical reaction is produced by the baking soda (sodium bicarbonate) and citric acid reacting to form sodium citrate (a salt) and carbon dioxide gas.**

- **When the bath fizzie is <u>dissolved</u> in water, the acid (citric acid) and the base or alkali (sodium bicarbonate) react vigorously producing carbon dioxide gas** Bath fizzies are fun, but why else would we want to use them? Are they good for our skin?
- The chemical reaction is:
    - $C_6H_8O_{7(aq)} + 3NaHCO_{3(aq)} \rightarrow 3H_2O_{(l)} + 3CO_{2(g)} + Na_3C_6H_5O_{7(aq)}$
    - **citric acid + baking soda → water + carbon dioxide + sodium citrate**
- The resulting sodium citrate is a **salt**. In addition to being alkali, salts change the osmotic balance of the water so that less water is absorbed by the skin via osmosis. This reduces the "pruning" or "wrinkling" effect of prolonged exposure of skin to fresh water

Clean-up (5-7 minutes)

- Participants will wash mixing bowl, spoon, plastic mixing container and teaspoons and return them to the area designated by the instructor
- Participants will wipe down their stations with a cloth

Safety Considerations

- Participants will be making bath fizzies out of the following edible non-toxic ingredients:
    - Sodium bicarbonate
    - Corn starch
    - Sunflower oil
    - Sodium borate
    - Citric acid
        - Contact with dry citric acid or with concentrated solutions can result in skin and eye irritation
        - Participants will be instructed to measure citric acid carefully using measuring instruments which allow them to keep their hands at a safe distance from the citric acid
        - Hand washing and eye flushing stations are available in the Chemistry lab (Science Complex 2101 and 2103)

Activity 4: pH Testing

At this station students will learn all about pH and why it is important for skin. They will have a chance to test the pH of common cosmetic products and plot their results on a graph. The station will be broken down into three segments; an introduction, pH testing and a wrap-up.

Introduction (5-7 min)

What to discuss in the introduction:

1. pH, Acids and Bases:
    - Ask students if they know anything about pH already.
    - Explain that pH is a number tells us if that solution is acidic or basic. Let the students know that we are talking about pH because it is very important for your skin.
    - pH is a way to measure two very special molecules: hydronium and hydroxide
        - Can show models and talk about chemical formulas. The students may be quite young (potentially as young as 10) so chemistry isn't yet a big part of their curriculum. Molecules may be a completely new concept. If you need an idea of how to explain these molecules, I was thinking it may help to compare them to what they know about water. For example, asking if anyone knows another name for water (hopefully they will say H20) and then explaining that these molecules have other names too that correspond to their shape.
- Let them know that the more hydronium, the more acidic a solution is and the more hydroxide the more basic it is.

2. The pH Scale:
    - There is a poster that compares the pH scale to the number of molecules present in 1L of solution. I think it might be fun to try and have the girls say the names of the numbers (like six hundred quadrillion hydronium molecules for example). They probably won't be able to say the names of the numbers, so this is a good opportunity to discuss how useful a pH scale is. For example, asking would you rather read that a solution has 6,022,000,000 molecules or read that the pH is 14? And asking is they can see how this makes it easier? This is basically what is on the poster:

pH	Approximate Number of Hydronium Molecules	Approximate Number of Hydronium Molecules
1	600000000000000000000	Sixty sextillion
2	60000000000000000000	Six sextillion
3	6000000000000000000	Six hundred quintillion
4	600000000000000000	Sixty quintillion
5	60000000000000000	Six quintillion
6	600000000000000000	Six hundred quadrillion
7	60000000000000000	Sixty quadrillion
8	6000000000000000	Six quadrillion
9	600000000000000	Six hundred trillion
10	60000000000000	Sixty trillion
11	6000000000000	Six trillion
12	600000000000	Six hundred billion
13	60000000000	Sixty billion
14	6000000000	Six billion

Testing pH (10-12 min)

Students will test the pH of seven solutions: water, vinegar, baking soda, baby soap, hand soap, astringent, face soap using pH strips. They will record the values in their note book. Leaders will have to explain how to test pH using the pH paper and show how to compare the color to the color chart.

Wrap-up and Discussion (5-7 min)

Regroup students and go over their results:

- Ask students about the results from the pH tests
- Plot the results on the white board (bar graph is probably best)
- Identify which solutions are the acids, bases, neutral
- Discuss why pH is important for skin (could ask students if they have any ideas). Here are some ideas of what you could talk about:
    - One function of skin: to protect our insides from things outside our body (eg. bacteria)
    - Normal healthy skin can range from 4.5 to 6
    - When the oil and sweat in skin is in balance on our skin pH should be about 5.5
    - The outer layer of skin is slightly acidic because this helps stop bacteria growth. This layer is called the acid mantle.

- What would happen if skin was a little more alkaline- bacteria would grow more readily. If it was a lot more alkaline- dry skin, irritation. Example: oven cleaner has a pH around 13 so you have to use gloves when using it because it will irritate your skin
- What would happen if skin was too acidic- too dry, irritation. Imagine cleaning your face with vinegar, it would sting cuts, dry out skin.
- Explain that for this reason the pH of cosmetics and soaps is important. Imagine washing your face with a soap that is too alkaline? Washing only one time with this soap might not be a problem, but imagine washing your face with this soap every day? The acid mantle would not be able to rebalance pH before the next wash and skin would become dry.

pH and acne:

- Acne's real name: *Propionibacterium acnes*, (or just P. Acnes for short)
- This bacteria is found on everyone's skin, but when the levels of P. Acnes are high people are more prone to breaking out in acne.
- P. Acnes growth has been found to be minimal at pH 5.5
- Shifting towards a more alkaline environment would allow P. Acnes to thrive
- Therefore soaps with pH around 5.5 have been found to be best for acne.

Clean-up (2 min)

- Participants will dispose of used pH paper in the waste bins
- Wipe down station if there are any spills

Safety Considerations

- Participants will be using litmus paper to test the pH of the following common household items: water, vinegar, baking soda, hand soap, face soap, baby soap, astringent
  - vinegar is a dilute aqueous solution of acetic acid, and may cause stinging if splashed into the eyes or on an open wound, participants will be reminded to handle these substances with care.

References:

- http://ezinearticles.com/?Importance-of-Your-Skins-pH&id=55208
- http://books.google.com/books?id=MAshluUGiikC&pg=PA279&lpg=PA279&dq=ph+levels+in+skin+cleansers&source=bl&ots=3qD3f4IwbZ&sig=Be5qMihVEmr8fPe3TUx0xKZDRaI&hl=en&ei=wQeXSv2bPIfIMdDChYoD&sa=X&oi=book_result&ct=result&resnum=2#v=onepage&q=ph%20levels%20in%20skin%20cleansers&f=false
- http://www.theopenpress.com/index.php?a=press&id=16033