Section 1

Properties and Uses of Substances
9.2.1 Properties and Uses of substances

9.2.1 The use of a substance depends on its physical and chemical properties

9.2.1.a Identify that a wide range of substances are used daily as part of our food, our hygiene, our entertainment and maintenance of our health

9.2.1.b Identify that solutions, colloids and suspensions occur in a wide range of consumer products

9.2.1.c Explain that mixtures can be
- Solutions that contain dissolved substances & are uniform throughout
- Suspensions containing particles that settle out, or form layers, quickly
- Colloids with particles that remain suspended for long periods of time & include: liquid-in-liquid (emulsion - oil-in-water, water-in-oil), gas-in-liquid (foams)

9.2.1.d Explain surface tension in terms of the forces experienced by particles at the surface of liquid

9.2.1.e Describe surfactants as substances that affect the surface tension of a liquid

9.2.1.i Process and analyse information to identify the range of chemicals used in every day living including: detergent, lubricant, pesticide, solvent, metal cleaner, body hygiene, chemicals, cosmetic, and outline any precautions that may be needed in the use and handling of these chemicals.

9.2.1.ii Use first-hand or secondary sources to gather, process, analyse and present information to identify examples of suspensions and colloids and outline one advantage of a mixture being in each form

9.2.1.iii Plan, select appropriate equipment or resources for and perform a first-hand investigation to produce a range of suspensions and colloids that
are used by consumers including beaten or whisked eggs, salad dressing (oil/ vinegar), mayonnaise

9.2.1.iv Perform first-hand investigations to demonstrate the effect of surface tension on the shape of liquid drops, the formation of menisci, the ability of some insects to walk in water

9.2.1.v Process and present diagrammatic information to describe the effects of soaps, skin cleansers and shampoos on the solubility of oil

THE RANGE OF EVERYDAY CHEMICALS

There is a wide range of chemicals used in every day living. These include surfactant cleaners, degreasers, lubricants, pesticides, solvents, metal cleaner, body hygiene chemicals and cosmetics. These chemicals have a wide variety of physical and chemical properties that are useful.

This wide range of chemicals gives rise to a wide range of products used by people on a daily basis. There is a huge range of substances used by people on a daily basis. These substances have a range of physical and chemical properties to suit their particular use. The variety of chemicals includes acids, alkalis, oils, fats, emulsions, solutions, surfactants and hydrocarbons. Physical properties result in a range of substances such as creams, solids, liquids and gases. Various pieces of information can be found on the labels of products (eg Kleen Up).

Products like the one shown below have labels that contain a lot of information.

White Lily

*Kleen Up*

**Powerful Cream Cleanser**

- Antibacterial
- Removes stains
- Contains biodegradable surfactants

The chemical industry plays a vital role in the production of many manufactured goods. The industry provides a tremendous variety of materials to other manufacturers. Major products of the industry include detergents, drugs, dyes,
fertilisers, food preservatives and flavours, glass, metal alloys, paper products, plastics and synthetic fibres [World book].

**Notes Questions**

1. Define each of the terms below
   - detergent, lubricant, pesticide, solvent, metal cleaner,
   - body hygiene chemicals, cosmetics

2. Name two places where detergents would be found in most homes.

3. Name two cosmetics sold at a chemist shop.

4. Where is a degreaser used?

| 9.2.1.i | Process and analyse information to identify the range of chemicals used in everyday living including: detergent, lubricant, pesticide, solvent, metal cleaner, body hygiene chemicals & cosmetics, and outline any precautions that may be needed in the use and handling of these chemicals. |
| 9.2.1.a | Identify that a wide range of substances are used daily as part of our food, our hygiene, our entertainment and maintenance of our health |

**Activity    Class display of Everyday Products**

**Aim**

To identify the range of chemicals used in every day living including: detergent, lubricant, pesticide, solvent, metal cleaner, body hygiene chemicals, and cosmetics.

To outline any precautions that may be needed when using and handling these chemicals.

**Method**

1. Collect containers or labels of products (chemicals) used in every day living.
   - The containers or labels need to have information about the chemicals in the products
   - Have samples from a range of products used in everyday living. These products might come from the kitchen, garage, bathroom etc. They could be food products, hygiene products, entertainment products or health products.

2. Read these labels &/or find other sources of information and identify the name of the chemical or type of chemical used in the product.

Processing and analysing display

3. Create a classroom display, using the products or labels.
4. Sort (classify) the products into groups of similar chemicals. detergent, lubricant, pesticide, solvent, metal cleaner, body hygiene, chemicals, cosmetic

5. Describe the main chemicals related to each group.

6. Outline precautions needed when handling or using these products.

7. Complete a table similar to the one below for each chemical group.

<table>
<thead>
<tr>
<th>Chemical group</th>
<th>Product examples</th>
<th>Precautions needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contains biodegradable surfactants</td>
<td>Kleen Up (Cream cleanser)</td>
<td>None indicated</td>
</tr>
</tbody>
</table>

Discussion questions

1. What does outline mean?
2. What does analyse mean?
3. Suggest one change or improvement that could be made to the suggested method for this experiment.

4. Research What is a cosmetic?

<table>
<thead>
<tr>
<th>Marking Criteria</th>
<th>Mark range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gathering information (12.2) [3]</td>
<td>Sufficient Collected 3</td>
</tr>
<tr>
<td>• Collect a variety of containers or products</td>
<td></td>
</tr>
<tr>
<td>• Record information in accessible form (table)</td>
<td></td>
</tr>
<tr>
<td>• Outline precautions for some chemicals</td>
<td></td>
</tr>
<tr>
<td>Process information (12.4) [3]</td>
<td>Mostly 2</td>
</tr>
<tr>
<td>• Use appropriate methods to illustrate patterns</td>
<td></td>
</tr>
<tr>
<td>Present Information (13.1) [2]</td>
<td>Completely 2</td>
</tr>
<tr>
<td>• Use laboratory Report Scaffold</td>
<td></td>
</tr>
<tr>
<td>Analyse information (14.1) [2]</td>
<td>Completely 2</td>
</tr>
<tr>
<td>• Identify trends, patterns in data</td>
<td></td>
</tr>
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</table>

9.2.1.c Explain that mixtures can be
- Solutions that contain dissolved substances & are uniform throughout
- Suspensions containing particles that settle out, or form layers, quickly
- Colloids with particles that remain suspended for long periods of time
& include: liquid-in-liquid (emulsion - oil-in-water, water-in-oil), gas-in-liquid (foams)
**Suspensions, Colloids, Solutions**

Many substances used on a daily basis are mixtures. Mixtures contain two (or more) pure substances that can be separated by physical means (eg filtration, evaporation). Mixtures take a variety of forms and each has particular physical or chemical properties.

**Suspensions**

Most people could recognise a suspension. When shaken together the particles of one substance are spread throughout the other (a liquid or a gas).

A suspension is
- a mixture
- that contains particles that settle out, or form layers, quickly.

Also,
- The particles are relatively large (can be seen with the naked eye).
- The particles of one substance are suspended in the other.
- The particles can be removed from the suspension by filtering.

Since the particles in a suspension are not spread evenly throughout the liquid or gas medium they are called non-homogeneous mixtures. An example of a suspension is muddy water. If left for some time most of the soil particles (dirt) will quickly fall to the bottom of the liquid.

**Solutions**

A liquid solution is a mixture in which a solid, liquid or gas (the solute) dissolves in a liquid substance (the solvent).

A solution is
- a mixture
- that contains dissolved substances
- and are uniform throughout.

Also,
- The particles are extremely small (cannot be seen with the naked eye).
- The particles can remain suspended indefinitely.
- The particles cannot be separated by filtration.

Since the particles in a solution are spread evenly throughout the liquid solvent they are called homogeneous mixtures. Examples of solutions include vinegar (acetic acid dissolved in water) and syrup (sugar dissolved in water).

**Colloids**

Colloids are a special type of suspension. The substances in a colloid do not normally mix (eg oil and water). They are mixtures in which one substance is divided...
into very small particles (called colloidal particles) spread evenly throughout a second substance.

**A colloid is**
- A mixture
- That contains particles that remain suspended for long periods of time.

Also,
- The particles are relatively small (cannot be seen with the naked eye).
- The particles of one substance are suspended in the other.
- The particles of one substance are evenly spread throughout the other.
- The particles are not normally separated by filtration.

Since the particles in a colloid are spread evenly throughout the solid, liquid or gas medium they are called **homogeneous** mixtures. There are many common examples of colloids and they include bread, ceramics, clouds, detergent, dried clay, egg yolk, milk, paint, paper, plastic and soap.

In colloids it is usual to refer to phases – a dispersed phase spread throughout a dispersion medium. Colloids are grouped according to the state of the dispersed phase (solid, liquid or gas) and the state of the dispersion medium (solid, liquid or gas). The table below gives the common names for the various types of colloids.

*For example an emulsion is the dispersion (spread) of droplets of one liquid in another, immiscible liquid.*

<table>
<thead>
<tr>
<th>Name</th>
<th>Dispersed phase</th>
<th>Dispersion medium</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foam</td>
<td>Gas</td>
<td>Gas</td>
<td>Whipped cream</td>
</tr>
<tr>
<td>Solid foam</td>
<td>Gas</td>
<td>Liquid</td>
<td>Styrofoam</td>
</tr>
<tr>
<td>(Liquid) aerosol</td>
<td>Liquid</td>
<td>Gas</td>
<td>Fog, cloud, aerosols</td>
</tr>
<tr>
<td>Emulsion</td>
<td>Liquid</td>
<td>Liquid</td>
<td>Latex, Paint</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oil-in water Water-in-oil</td>
</tr>
<tr>
<td>Gel</td>
<td>Liquid</td>
<td>Solid</td>
<td>Jelly, Opal</td>
</tr>
<tr>
<td>Solid aerosol</td>
<td>Solid</td>
<td>Gas</td>
<td>Smoke</td>
</tr>
<tr>
<td>Sol</td>
<td>Solid</td>
<td>Liquid</td>
<td>Ink</td>
</tr>
<tr>
<td>Solid sol</td>
<td>Solid</td>
<td>Solid</td>
<td>Some alloys</td>
</tr>
</tbody>
</table>

The properties of colloids can make them difficult to distinguish from solutions. The particles in a colloid are smaller than those in a suspension but bigger than those in a solution. The features that distinguishes colloids from solutions are:
- Colloids cannot diffuse through a semipermeable membrane (eg cellophane).
- The Tyndall effect - when a beam of light shines through a colloid the path of light forms a cone. This does not occur with solutions because the particles are too small.
- Also, colloids tend to be cloudy whereas solutions are clear or transparent.
• Finally, solutions form crystals when they dry out whereas most colloids do not.

When two different liquids such as oil and water form a colloid, it is known as an emulsion. Many foods such as mayonnaise, milk butter and ice cream are emulsions. Most emulsions contain an emulsifier that prevents the oil and water from forming separate layers. In milk and cream, a protein known as casein acts as an emulsifier.

**Notes Questions**

5. What is a mixture?
6. Identify a key feature of suspensions.
7. Draw a diagram showing a non-homogeneous mixture.
8. Name two important properties of a solution
9. Vinegar is a solution. Name the solute and the solvent in vinegar.
10. Draw a diagram of a homogeneous mixture.
11. Name two common examples of a colloid.
12. The diagram opposite shows a colloid. Copy and then label the diagram indicating the dispersed phase and the dispersion medium.
13. A colloid is described as a water-in-oil emulsion.
   a. Name the dispersed phase. [1 mark]
   b. Name the dispersion medium. [1 mark]
14. Name the two types of colloids that consist of a gas and solid.
15. Read the following sentence.
   A foam consists of a gas (the dispersed phase) evenly spread throughout a liquid (the dispersion medium).
   Complete the following sentences
   a. An emulsion consists of a ___ (the dispersed phase) evenly spread throughout a ___ (the dispersion medium).
   b. A gel ________________________________
16. Draw a labeled diagram of a solid aerosol.
17. Which mixture has the smallest particles – colloids or suspensions?
18. Research Draw a diagram of the Tyndall effect.
19. Which mixture is cloudy – colloids or solutions?

| 9.2.1.iii | Plan, select appropriate equipment or resources for and perform a first-hand investigation to produce a range of suspensions and colloids that are used by consumers including beaten or whisked eggs, salad dressing (oil/ vinegar), mayonnaise |
Producing Suspensions And Colloids

Activity  Making Mayonnaise

Aim  To make a mixture of oil-in-water using an emulsifying agent
     To make a mixture of oil-in-water without using an emulsifying agent
     To compare the two mixtures

<table>
<thead>
<tr>
<th>Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>What to do</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>From the list below select the materials needed to make mayonnaise</td>
</tr>
<tr>
<td>2 egg-yolks</td>
</tr>
<tr>
<td>2 x 10mL measuring cylinders</td>
</tr>
<tr>
<td>2.5mL (by volume) dry mustard</td>
</tr>
<tr>
<td>7.5mL vinegar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read the instructions below. Put them into a logical order.</td>
</tr>
<tr>
<td>1. When all the oil has been added stir in the lemon juice.</td>
</tr>
<tr>
<td>2. Then slowly pour in another 1mL of oil, a few drops at a time, beating continually.</td>
</tr>
<tr>
<td>3. Repeat the above steps without using the egg yolks.</td>
</tr>
<tr>
<td>4. Determine how much of the 200mL of oil is needed.</td>
</tr>
<tr>
<td>5. Let each jar stand for 5 minutes.</td>
</tr>
<tr>
<td>6. Rinse a clean container with hot water; then dry well.</td>
</tr>
<tr>
<td>7. While still beating, add remaining vinegar.</td>
</tr>
<tr>
<td>8. While still beating, add 1mL of oil, <strong>a drop at a time</strong>.</td>
</tr>
<tr>
<td>9. Then slowly pour in another 1mL of oil, a few drops at a time, beating continually.</td>
</tr>
<tr>
<td>10. Put in egg-yolks, salt, mustard and 5mL of vinegar.</td>
</tr>
<tr>
<td>11. Beat the substances vigorously with a beater.</td>
</tr>
</tbody>
</table>
Discussion

1. Is mayonnaise a suspension, a colloid or a solution? Explain.  [3 marks]

The emulsifying agent in this investigation is the egg yolks. One mixture of oil-in-water is made using an emulsifying agent. The other mixture of oil-in-water is made without using an emulsifying agent.

Explain why the two mixtures are different.  [3 marks]

2. Outline any problems or issues that arose during the practical.  [2 marks]

3. Would you suggest any changes to your method? Explain your answer.  [2 mks]

4. Is the salt in solution or suspension? Explain your answer.  [2 marks]

Write up  
Use a laboratory report scaffold to write up the investigation

1. Copy the heading for the investigation.
2. Copy the aim for the investigation.
3. List possible risks and other factors
4. Make a list of equipment needed.
5. Write a method for the investigation.
   □ List the instructions to be followed for each test, in point form.
6. Results  Describe each of the two mixtures
7. Write a conclusion
8. Answer the discussion questions

<table>
<thead>
<tr>
<th>Marking Criteria</th>
<th>Mark range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning investigation (11.2) [3]</td>
<td></td>
</tr>
<tr>
<td>• Procedures listed in logical steps; reliable</td>
<td></td>
</tr>
<tr>
<td>• Each step is numbered and in a sentence</td>
<td>All criteria</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Perform planned practical (12.1) [3]</td>
<td></td>
</tr>
<tr>
<td>• Carry out planned procedure efficiently</td>
<td></td>
</tr>
<tr>
<td>• Use safe working practices</td>
<td>At all times</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Present Information (13.1) [2]</td>
<td></td>
</tr>
<tr>
<td>• Use laboratory Report Scaffold</td>
<td>Completely</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Results (13.1) [2]</td>
<td></td>
</tr>
<tr>
<td>• Describe one mixture</td>
<td></td>
</tr>
<tr>
<td>• Describe the other mixture</td>
<td>3–4 features</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
The advantages of suspensions and colloids

In colloids or suspensions one substance is spread throughout another. These substances normally do not mix.

Mayonnaise could be made as a suspension in which the oil floated on top of the water. This mixture would need to be shaken when used. Such a product does not look inviting to use and the oil droplets formed by shaking would be much bigger than in the colloid. The advantage of the mayonnaise emulsion is that it looks better than oil floating on top of the water and probably tastes better.

In the case of homogenised milk the even spread of milk fat means the milk tastes “richer”. The advantage is that milk as a colloid means it tastes better. A machine that forces raw milk through small holes produces homogenised milk. The process reduces the size of the fat globules in milk. There are over 100 million globules in one drop and these are evenly spread throughout the milk liquid. In milk straight from the cow some of the fat globules rise to produce a layer of cream on top. While some people like this creamy layer, many do not.

Skin creams are another group of products that are colloids or suspensions. They overcome problems of applying substances to the skin that are insoluble in water. The advantages include:

- A very thin layer (oil) can easily be spread over the skin. The water carries with it the oil that is important to condition the outer layer of the skin.
- Chemicals that are insoluble in water can be easily carried into the skin. The chemicals are dissolved in the oil phase.

Paint is another product where the even spread of pigments are important. Paint basically contains three substances.

- Resins - these are sticky substances that affect drying time, hardness and gloss.
- Solvents - which dissolve the resins eg water
- Pigments - which are solid suspended in the solvent and determine paint colour.

Once stirred the pigment is evenly spread over the surface being painted.
Notes Questions

20. Milk is homogenised. Explain what this means.

21. Homogenised and non-homogenised milk were both left to stand overnight.
   a. Outline the difference in what would be observed the next day.
   b. Draw two diagrams showing two differences between non-homogenised milk
      and homogenised milk.

22. Write a complete sentence [Match the advantage (listed below) to the product]
   Tastes richer, Looks better, Easily spread
   a. Advantage of mayonnaise as an emulsion. ___
   b. Advantage of homogenised milk over non-homogenised milk ___
   c. Advantage of skin cream as an emulsion ___

23. Is paint a solution, colloid or a suspension? Explain your answer.

24.

25. A student observed TWO liquids – milk and seawater.
   a. Explain why milk is a colloid. [2 marks]
   b. Explain why seawater is a solution. [2 marks]

Activity    Examples of suspensions and colloids

What to do

1. Collect several examples of suspensions, colloids and solutions that occur in a
   range of consumer products. Collect samples that allow the table below to be
   completed.

2. Use the information on the previous page to start the table. [Two examples have
   been done for you]

<table>
<thead>
<tr>
<th>Product</th>
<th>Type of mixture</th>
<th>Advantage of mixture being in that form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint pigments</td>
<td>Suspension</td>
<td>Once stirred the pigment is evenly spread over the surface being painted.</td>
</tr>
<tr>
<td>Paint solvents</td>
<td>Solution</td>
<td>Allow resins to be evenly spread over the surface being painted.</td>
</tr>
</tbody>
</table>

TO BE \text{COMPLETED} \\
TO BE \text{COMPLETED}
Surface Tension

Why is it that certain insects can walk on water? Why is a raindrop circular in shape? It is due to the surface tension. Surface tension is a force that acts at the surface of water. The tension is due to the forces of attraction between water molecules. Surface tension causes water to behave as if it has a thin “skin” over its surface. This “skin” or surface tension can support small objects carefully placed on the water surface.

Activity  Floating on water

Aim  To observe small objects floating on water.
To observe the effect of detergent on surface tension

Method

1. Try these simple experiments (A, B & C)
2. Describe what happens in each case.
3. Repeat these experiments using water with some detergent.
4. Describe what happens in each case.

A. Place a needle or a razor blade on a small metal hook.
   Gently lower the needle onto the surface of some water.
   Can you cause the needle to float on the water.

B. Carefully place a drop of water onto a smooth flat surface. Try Teflon and glass surfaces. Describe the shape of the drops.

C. See how many drops of water can be placed carefully on the top of a clean 5-cent piece.
Now try these two experiments just with detergent.

D. Place a wire loop in a petri dish with detergent in water and form a bubble or film across the loop. Then burst one side of the film divided by the thread.

E. Place three matches in a container so they form a triangle. Place a drop of detergent in the middle of the triangle. The matches will move away from each other because the water surface is spreading out. Repeat the experiment using a drop of water.

Results

Describe what happened in each experiment

[For A, B and C describe the difference between the result when water alone was used compared with when water and detergent was used]

Conclusion and discussion

Copy and complete the following paragraph using the words below.

Attract, Weight, Broken, Fewer, Surface, Walk, Round, Detergent, Reduce, Added, Skin, Flatter, Reduced, Forces, Strong enough, Pin, Large

Water particles ___ each other. These ___ of attraction cause surface tension. Surface tension is a force that acts at the ___ of water. Surface tension causes water to behave as if it has a thin ___ over its surface. This skin means small objects, such as a ___, can float on the water surface. A drop of water tends to be ___ because of surface tension. It also means a ___ number of water drops can be placed on a coin before the water flows off.

Detergents ___ reduce surface tension. Once detergent is ___ to water it is no longer possible for a pin to float on water. Drops of water with detergent are ___ than drops of pure water. A coin will hold ___ drops of water with detergent added. This occurs because the ___ reduces surface tension. The forces of attraction between water particles have been ___. The ‘skin’ has been ‘___’.

In a similar way, insects can ___ on water. The forces of attraction between the water particles are ___ to support the ___ of the insects. The ‘skin’ is not broken.

Activity

Use the previous activity to consider the effect of surface tension and the shape of liquid drops, the formation of menisci, the ability of some insects to walk in water.
Discussion Questions

See how many drops of distilled water can be placed on the top of a clean 5-cent piece. Repeat this experiment using distilled water with a few drops of detergent added.

1. Identify the independent variable in this experiment.
2. Identify the dependent variable in this experiment.
3. Name TWO variables that should be controlled in this experiment.

In this experiment TWO groups are being compared – the experimental group and the control group. In this experiment the Control group is the ‘Distilled water’ group.

4. Suggest a name for the experimental group.
5. Explain which of the two groups would be called the Control group.
6. Identify what is different about the two groups.

7. Identify what is being measured in this experiment.
8. What type of measurement is used in this experiment – qualitative or quantitative?

When performing an experimental investigation it is important for the data to be reliable.

9. State how a scientist knows data is reliable.
10. In this experiment how many times should the experiment be repeated to be sure the data is reliable?
11. Suggest any safety issues for this experiment.

<table>
<thead>
<tr>
<th>Marking Criteria - Syllabus Outcome</th>
<th>Mk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laboratory Report Scaffold</strong></td>
<td></td>
</tr>
<tr>
<td>Used - 2</td>
<td></td>
</tr>
<tr>
<td>Partially -1</td>
<td></td>
</tr>
<tr>
<td>Not used - 0</td>
<td></td>
</tr>
<tr>
<td><strong>13.1 Present Information</strong></td>
<td></td>
</tr>
<tr>
<td>Tabulate data (Ruled lines, Headings, Units, Correct data)</td>
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</tr>
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<td>Most Criteria 2 - 3</td>
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<td>Some Criteria 1</td>
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<td>Describe observations</td>
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<tr>
<td><strong>11.2 Analysing the method using VGMANS</strong></td>
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<tr>
<td>Discussion questions</td>
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<tr>
<td>All ques well ans 4</td>
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</tr>
<tr>
<td>Some ques well ans 2 - 3</td>
<td></td>
</tr>
<tr>
<td>Few ques answered 1</td>
<td></td>
</tr>
<tr>
<td>Total = /10</td>
<td></td>
</tr>
</tbody>
</table>
Surfactants And Surface Tension

Water molecules attract each other because they have a positive end and a negative end. They are polar molecules. The positive end of one molecule attracts the negative end of the other molecule. These forces of attraction between the water molecules cause surface tension.

Surface tension results in the surface of water behaving as if a thin 'skin' covers it (a). The pin can float on water because forces holding the water particles together are strong enough to withstand the weight of the pin (b). This is just like a piece of plastic on top of the water - it would be strong enough to support quite large objects.

When detergent is added to water the situation changes. Detergents reduce the surface tension of water. The surface molecules are no longer pulling on each other with the same force. The pin will fall through the weaker water “skin” (c).

A detergent is a surfactant. Surfactant is short for surface-active agent. Surfactants work at the boundary layer (interface) between the solvent (water) and other surfaces. A surfactant molecule is made up of two parts – a water loving head (hydrophilic) and a water hating tail (hydrophobic). When surfactants are added to water, ‘the tails try to get away from the water molecules’. They do this by moving to the water surface with the tails pointing out of the water or forming tight balls, called micelles. When surfactant molecules spread over the water surface, the forces of attraction between water molecules are reduced.

A drop of water is round. The reason for this is because the forces between the water particles are pulling the drop into this shape. The droplet is formed with the lowest possible surface area – ie a sphere.

The effect of surface tension can also be seen in the formation of soap bubbles. A soap bubble will not form using pure water. The surface tension is too great. Bubbles will form when air is trapped within a film of soap solution. Again, the surface tension pulls the bubble into the smallest surface area, which is usually an almost perfect sphere.
Oil, Water and Surfactants

Oil will not dissolve in water. Water will not dissolve in oil. The two liquids are immiscible – they do not form a solution. How is it possible for these two liquids to be permanently mixed? If the two liquids – oil and water – are shaken together they will form a suspension. Tiny droplets of one liquid will form suspended in the other. However over a fairly short period of time the two liquids will separate into layers.

A more or less permanent mixture of oil and water may be produced, by adding a substance called a surfactant. Surfactants are surface-active agents. They act at the boundaries of two substances. Soaps, skin cleaners and shampoos all contain surfactants.

A surfactant is a molecule that has two parts. One part (the tail – hydrophobic) is chemically similar to oil. This part will dissolve in oil. The other part (the head – hydrophilic) is chemically similar to water. This part will dissolve in water. When a surfactant, oil and water are stirred, the surfactant molecules are drawn to the surfaces between the oil and water. The “tails” attach to the oil and the “heads” attach to the water. The result is an oil in water colloid (emulsion).

Oil will not dissolve in water. However, oil and water are “glued” together by the surfactant molecules. Continued stirring of the mixture produces smaller and smaller oil droplets. Surfactant molecules coat each droplet. The heads, because of their slightly positive nature tend to repel one another. For this reason the oil droplets remain separated.
The feature of surfactants is particularly useful in cleaning products like soap, shampoo and skin cleaners.

1. The oil is attached to the surface

2. The cleaning action is due to the surfactants attaching onto the oil and dirt embedded in various surfaces that need to be cleaned.

3. As the mixture is stirred the water molecules pull the surfactants and their attached oil and dirt out of whatever they are attached to.

4. The oil-dirt droplets remain suspended in the water. When the water is drained away the oil and dirt are removed as well. This leaves the surface (material) clean.

**Solubility of Oil**

Solubility is the number of grams of a solute that dissolves in 1 litre of a solvent at 25°C.

To describe the effects of soaps, skin cleaners and shampoos on the solubility of oil:
- Add a certain volume of oil (say 5 mL) to a certain volume of water (say 200 mL) [The result will be a layer of oil on a layer of water]
- To this suspension add a very small quantity (say 10 drops) of soap or skin cleaners or shampoo to the oil/water mixture.
- Stir the oil/water mixture and the added cleaning agent.
- Continue to add the cleaning agent (in small quantities) until all the oil has ‘dissolved’.
Notes Questions

26. Draw a water molecule showing why it is a polar molecule.
27. Explain why water molecules attract each other.
28. How do detergents affect surface tension?
29. **Research** Draw a surfactant micelle.
30. What shape has the smallest surface area?
31. Outline the sequence of events that occurs when a mixture of oil and water is vigorously shaken.
32. What is meant by ‘hydrophobic’?
33. A mixture of a surfactant (detergent), water and oil forms an emulsion. In this emulsion identify the dispersed phase and the dispersion medium?
34. Outline how a surfactant molecule joins water and oil droplets to form an emulsion.
35. Why do the oil droplets remain separated in an emulsion?

HSC Style questions - Low Band Questions

36. Describe a suspension. **[2 marks]**
37. Identify what is the same about suspensions, colloids and solutions. **[1 mark]**
38. Describe the difference(s) between a colloid and a solution. **[2 marks]**
39. Outline one precaution needed when handling or using a pesticide.

HSC Style questions - Mid Band Questions

40. Explain why is it sometimes difficult to distinguish between a solution and a colloid? **[2 marks]**
41. The diagram below was labeled SOLUTION in a senior science textbook.
   a. Describe a solution. **[2 marks]**
   b. Explain why the diagram could represent a solution **[2 mks]**

42. Explain surface tension in terms of the forces experienced by particles at the surface of a liquid. **[3 marks]**

HSC Style questions - High Band Questions

43. Draw diagram(s) showing how an emulsion is produce when surfactant molecules are stirred into a mixture of oil and water. **[4 marks]**