## **Stage 2 Chemistry**

## **Birdwood**

HIGH SCHOOL **Topic 5: Materials**

**Silicate Properties, Cleaning Agents: Soaps and Bleaches**

**Review Paper 19**

**DUE DATE:**

1 Detergents are able to remove oil and grease from materials because of their ability to act as a surfactant.

The structure of a typical synthetic detergent compound is shown below:

CH3(CHCH2) 3CH O SO3- Na

CH3 CH3

Detergents are able to dissolve grease and oil from clothes because their anions have two sections.

i Circle the section on the above detergent diagram that attracts water. (1 mark)

ii Describe the section of the detergent molecule that is non-polar. (1 mark)

The large, non-polar hydrocarbon end.

iii Explain why this section of the molecule will be soluble in the oil and grease. (2 marks)

The secondary interactions between the non-polar end of the molecule is of similar strength to those between oil and grease molecules. Because of this the non-polar end will readily dissolve in oil and grease.

iv Explain why detergents do not function well in an acidic environment.

[Make two points in your answer.]

When the detergent is in an acidic environment, the charged group may become protonated. As it will no longer form ion-dipole secondary bonds with water, it will be less soluble in water and will not function as well as a detergent. (2 marks)

2 Chlorine bleaches and disinfectants are produced commercially by bubbling chlorine into sodium hydroxide solution. The resulting solution contains a mixture of hypochlorite ions and chloride ions.

i Write formulae for the hypochlorite ion. (1 mark)

OCl-

ii State the action of hypochlorite ions that enable them to act as a bleach (1 mark)

oxidizing agent

iii State the oxidation number of chlorine in the hypochlorite ion. (1 mark)

-2 + Cl = -1

Cl = +1

iv Write an equation for the reaction of hypochlorite ions with water. (2 marks)

H2O + OCl- -> HOCl + OH-

3 Fats and oils are commonly called tri-esters or triglycerides. The structural formula of one such

triglyceride is shown below:

CH2OOC(CH2) 7CH CH(CH2) 7CH3.

CH2OOC(CH2) 7CH CH(CH2) 7CH3.

CH2OOC(CH2) 7CH CH(CH2) 7CH3.

i Would the triglyceride shown above be a liquid or a solid at room temperature? (1 mark)

Most likely to be a liquid due to double bonds

ii Fats and oils are the raw materials used to manufacture soap.

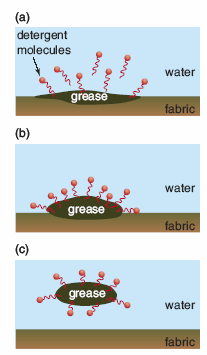
1. Write the structural formula of the soap anion formed when the triglyceride shown above undergoes alkaline hydrolysis with sodium hydroxide. (2 marks)

-OOC(CH2) 7CH=CH(CH2) 7CH3

1. Systematically name the other product formed during this process. (2 marks)

Propan-1,2,3-triol

iii When soap is added to water, soap micelles are formed. The micelles assist in the grease-removing action of soap.

****Use a labeled diagram of a typical soap micelle to help explain the action of soap anions in removing grease from clothing. [*Describe the three phases*.]

Hydrophobic ends of the soap dissolve in the grease due to forming similar strength dispersion forces with the grease molecules

1. The soap molecules form a coating over the grease molecule, while the hydrophilic end forms strong ion-dipole bonds with the water.
2. With agitation the grease and soap micelle is removed from the surface of the fabric and removed with the water.

(3 marks)

iv Soap does not function well in hard water.

1. What is meant by the term ‘hard water’? (1 mark)

High concentrations of Mg2+ and Ca2+

1. Describe and explain, with the aid of an equation, why soap

does not function well in hard water. (2 marks)

2-OOC(CH2) 7CH=CH(CH2) 7CH3 + Ca2+ -> Ca(OOC(CH2) 7CH=CH(CH2) 7CH3)2

1. Sodium perborate is sometimes an ingredient added to detergents, particularly laundry detergents.

i Is sodium perborate likely to be a liquid or a solid? (1 mark)

solid (ionically bonded)

ii Identify the oxidizing agent that is released when sodium perborate dissolves in water.

H2O2 (1 marks)

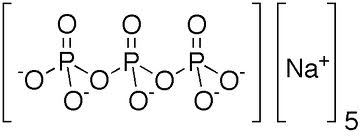
iii How does the action of hot water affect the function of detergents containing sodium perborate? Speeds up the degredation of perborate into oxygen (2 marks)

5 Phosphates and polyphosphates are frequently listed as components of laundry detergents.

i Write the chemical formula for a phosphate ion. (1 mark)

PO43-

ii Draw the structural formula of the linear tripolyphosphate ion. (2 marks)



iii State *two* functions of tripolyphosphate ions in detergents. (2 marks)

Bond to Ca and Mg ions to remove them from hard water. So these do not bond to the detergents and reduce their efficacy.

Deflocculating agents. Binding Ca and Mg does not allow them to flocculate the clay particles present, so these are removed with the water.

Mildly alkaline. Prevents the detergent from being protonated and may hydrolyse some grease into soap.

iv Polyphosphate ions in detergents however, do have unwanted environmental consequences.

State *one* undesirable consequence of a high concentration of phosphates in our waterways.

Provide nutrients to algae in water ways, producing algal bloom and eutrophication (1 mark)

6 The following diagram represents part of the structure of the silicate ion in the mineral jadeite,

O- O- O- O- O-

Si Si Si Si Si

O O O O O O

O- O- O- O- O-

i Write the formula of the repeating unit in this silicate.

SiO32-

ii Analysis of a sample of jadeite showed that the only cations were sodium and aluminium and they were present in equal numbers. Write the formula of jadeite.

Na:Al = 1:1 (NaAl)4+ SiO32-

NaAl(SiO3)2 (3 marks)

7 In some clay minerals, some of the silicon in the silicate anions is replaced by aluminium.

i What special chemical term is given to silicates of this kind?

Aluminosilicates

ii Given that the oxidation state of silicon is +4 and that of aluminium is +3, explain why this substitution causes the clay particles to carry a negative charge.

+4 Si is being replaced by +3 Al, therefore each substitution results in a net loss of +1, hence the negative charge.

iii Explain why clay particles suspended in water cannot be removed by allowing them to settle out.

Clay particles have a negative charge. This causes them to repel each other and also to form strong ion-dipole interactions with water and hence will not settle out.

iv Plant nutrients like potassium ions and calcium ions are commonly adsorbed to the surface of clay particles.

Describe how these nutrients can become available to the plant.

K(clay) <-> K(aq)

The potassium is in equilibrium between being adsorbed onto the clay and dissolved in the water. As the ions are drawn up by the plant roots, the equilibrium is shifted so that more ions will dissolve into the water to be made available for plants.

(7 marks)