Materials Practice Test

**1.** Describe the action of charged particles, such as Al3+ in the water treatment process of flocculation

*Negatively charged particles present in water, such as clay, will not settle out due to their solubility, due to forming ion-dipole bonds with water and the repulsion between particles from the negative charge. Flocculation adds highly positive cations to the water. These cations electrostatically attract the anions present, bringing them together into larger, neutral, insoluble molecules that will settle out of the water.*

**2.** A soap molecule CH3(CH2)4CHCH(CH2)6COO- was produced from a triglyceride

1. Draw the structure of this triglyceride

*CH3(CH2)4CHCH(CH2)6COO-CH2*

 |

*CH3(CH2)4CHCH(CH2)6COO-CH*

|

*CH3(CH2)4CHCH(CH2)6COO-CH2*

1. Describe how you can determine whether this triglyceride will be a fat or an oil

*This triglyceride contains double bonds and is therefore unsaturated. Unsaturated triglycerides are likely to be oils at room temperature*

1. Systematically name the by-product of the reaction that produces soap

*Propan-1, 2, 3-triol*

1. This reaction is an example of a basic hydrolysis, what name is given to this specific reaction?

*saponification*

1. Describe how this soap molecule enables it to dissolve grease

*The soap molecule is made up of a large hydrocarbon chain that is hydrophobic and a charged ionic ‘head’ that is hydrophilic. The hydrophobic ‘tail’ can dissolve in grease due to the secondary interactions, in this case dispersion forces, being similar in strength. The soap molecules will form a coating over the grease with the ionic ‘heads’ exposed.*

*The ionic ‘head’ can dissolve in water as it forms strong ion-dipole bonds. With agitation this allows the grease to be dispersed through the water as micelles. The negatively charged coating keeps the micelles suspended in the water and prevents them from coagulating with each other.*

**3.** Part of a polymer is shown below

 O

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(– C – (CH2)3 – O – )

1. Draw the monomer for this polymer

HOOC – (CH2)3 - OH

1. What type of polymerisation reaction is required to form this polymer

Condensation (esterification)

Another type of monomer is shown below

 NH3 – (CH2)3 – NH3

1. Name the type of monomer that would be required to form an amide polymer with this monomer

di-carboxylic acid

1. Draw a polymer using these two monomers, draw 2 repeating units (assume 1 carbon between functional groups for the monomer from c)

 O O O O

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- NH – (CH2)3 – NH – C – CH2 – C – NH3 – (CH2)3 – NH – C – CH2 – C -

1. This polymer has a melting range of 290 – 300oC, why would it not have a precise melting point

Being such a large molecule, not all of the secondary bonds are going to break at the same temperature. This produces a melting range where the polymer softens from a solid to a liquid

1. Describe why the melting point of this polymer would be higher than polyethylene

The difference in melting points is due to the difference in secondary interactions between the molecules. Polymer (d) would be able to form hydrogen bonds between chains, while polyethylene only has dispersion interactions between the chains. As a consequence of this polymer (d) will have a higher melting point, as the hydrogen bonds will take more energy to break than the dispersion forces present in polyethylene.

1. Polyethylene is a plastic polymer, what does this mean?

Plastic polymers soften when heated and therefore can be melted and reshaped

1. Draw the monomer for polyethylene

CH2=CH2

1. How do the properties of a polymer change with cross linking

Hardness, brittleness, elasticity and other properties all change with the degree and nature of cross linking between the chains. Chains with only dispersion forces tend to be inelastic, but do soften when heated. Chains with hydrogen bonds tend to be more elastic and stronger. Chains with covalent cross links are stronger and harder, but can be prone to brittleness and are not plastic.

**4.** Tripolyphosphates can be used as additives in cleaning products

1. Draw the Linear tripolyphosphate anion P3O105-



1. Write the molecular formula of the magnesium salt of this ion

Mg5(P3O10)2

1. Would this compound be a solid, liquid or gas?

Solid (due to being ionic)

1. State the arrangement of oxygen atoms around each phosphorus atom

tetrahedral

1. Describe 3 advantages of using tripolyphosphates with detergents

Remove Ca2+ and Mg2+ ions from solution, which prevents them from lowering the efficacy of detergents.

By removing cations from solution they act as deflocculating agents, keeping negatively charged particles, such as clay, in suspension.

Are mildly basic as their reaction with water produces hydroxide. This aids in keeping the detergent sulfonate group deprotonated and can form a small amount of soap due to basic hydrolysis of the fat and oil molecules present

1. Describe an environmental concern for the use of tripolyphosphates

Phosphates are potent nutrients for plants. When phosphates get into waterways they provide nutrients for algae. Algae can grow rapidly and completely cover the surface of the water. This stops sunlight from reaching aquatic plants who can no longer photosynthesise. When these plants and algae die they are broken down by aerobic bacteria who use up much of the dissolved oxygen. This in turn causes the death of further plants and animals. Once the dissolved oxygen is depleted, anaerobic bacteria will continue to breakdown the dead organisms. The anaerobic breakdown produces toxic byproducts that further poison the waterways.

Ie algal bloom which leads to eutrophication

**5.** Silicates are the main component of many soils

1. Write the formula for the anion of MgAl2(SiO3)4

SiO32-

1. Calculate the charge on the anion Al3Si2O10.3H2O

+3 x 3 + 4 x 2 -2 x 10 = 0

9 + 8 – 20 = 0

= -3

1. Calculate the percentage of silicon atoms that have been replaced by aluminium in the previous aluminosilicate

There are 3 Al and 2 Si. Therefore there was originally 5 silicons. The fraction that has been replaced is 3/5.

**8.** HOCl is commonly used as a bleach and is much more powerful than elemental chlorine.

1. Name this chemical

Hypochlorous acid

1. With reference to the following equation, describe why chlorine bleaches are more effective at pH > 7.

Cl2(aq) + 2H2O(l) ⇌ HOCl(aq) + H3O+(aq) + Cl-(aq)

Hypochlorous acid is a more effective bleach than elemental chlorine. When the pH is >7, ie when base is present, H3O+ will react and be removed from the equilibrium. According to Le Chattiliers principle this will favour the forwards reaction, thereby increasing the concentration of hypochlorous acid, and therefore the effectiveness of the bleach will also increase.

9. Zeolites are used to soften hard water.

1. Describe how zeolites act as water softeners

*Zeolites are a group of aluminosilicates that remove hardness from water. The aluminosilicate anion forms a porous structure that water can pass through. The charge on the anion is balanced by sodium ions. When calcium and magnesium ions present in hard water pass through the silicate, their greater positive charge causes them to displace the sodium ions on the zeolite. In this way magnesium and calcium ions are replaced in solution by sodium ions.*

1. Describe, using an equation, how the zeolite can be “regenerated” by a strong solution of sodium chloride

2Na+(zeo) + Mg2+(aq) ⇌ 2Na+ + Mg2+(zeo)

By increasing the concentration of sodium ions in solution the equilibrium can be forced to the left, thereby regenerating the zeolite