Name: ____________________

Preliminary Chemistry

Lesson 6
Water

In Theory. This booklet is your best friend.

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Summary of Key Words

Account
Account for: state reasons for, report on. Give an account of: narrate a series of events or transactions

Analyse
Identify components and the relationship between them; draw out and relate implications

Apply
Use, utilise, employ in a particular situation

Assess
Make a judgement of value, quality, outcomes, results or size

Calculate
Ascertain/determine from given facts, figures or information

Clarify
Make clear or plain

Classify
Arrange or include in classes/categories

Compare
Show how things are similar or different

Construct
Make; build; put together items or arguments

Contrast
Show how things are different or opposite

Deduce
Draw conclusions

Define
State meaning and identify essential qualities

Demonstrate
Show by example

Describe
Provide characteristics and features

Discuss
Identify issues and provide points for and/or against

Distinguish
Recognise or note/indicate as being distinct or different from; to note differences between

Evaluate
Make a judgement based on criteria; determine the value of

Examine
Inquire into

Explain
Relate cause and effect; make the relationships between things evident; provide why and/or how

Extract
Choose relevant and/or appropriate details

Extrapolate
Infer from what is known

Identify
Recognise and name

Interpret
Draw meaning from

Investigate
Plan, inquire into and draw conclusions about

Justify
Support an argument or conclusion

Outline
Sketch in general terms; indicate the main features of

Predict
Suggest what may happen based on available information

Propose
Put forward (for example a point of view, idea, argument, suggestion) for consideration or action

Recall
Present remembered ideas, facts or experiences

Recommend
Provide reasons in favour

Revision

Question 1

Explain the concept of ‘like dissolves like’. (2 marks)

Question 2

Identify two conditions for solubility. (2 marks)

Question 3

Explain why large molecules are unable to dissolve in water.

Lesson Dotpoints

By the end of the lesson, you should understand the following concepts:

Covalent Network Lattices

- Explain changes, if any, to particles and account for those changes when the following types of chemicals interact with water:
  - A covalent network structure substance such as silicon dioxide

Polymers

- Explain changes, if any, to particles and account for those changes when the following types of chemicals interact with water:
  - A substance with large molecules, such as cellulose or polyethylene

Precipitation Reactions

- Explain changes, if any, to particles and account for those changes when the following types of chemicals interact with water:

Ion Movement

- Describe a model that traces the movement of ions when solution and precipitation occur
- Identify the dynamic nature of ion movement in a saturated dissolution

Precipitation Equations

- Construct ionic equations to represent the dissolution and precipitation of ionic compounds in water
- Present information in balanced chemical equations and identify the appropriate phase descriptors (s), (l), (g) and (aq) for all chemical species

1. Covalent Network Lattices

CHECKPOINT:

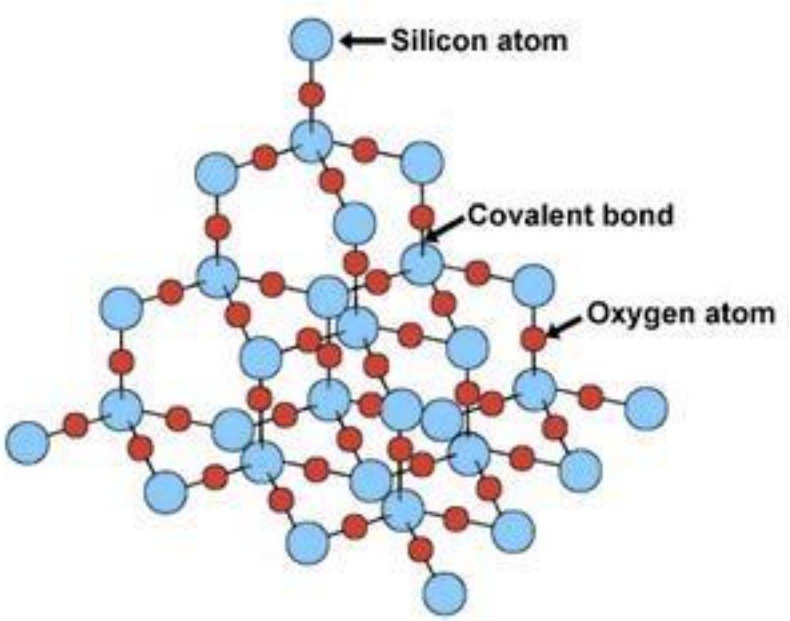
- Explain changes, if any, to particles and account for those changes when the following types of chemicals interact with water:
  - A covalent network structure substance such as silicon dioxide

What are Covalent Lattices?

- Covalent Network Solids are giant covalent substances like diamond, graphite and silicon dioxide
- How are atoms held together in a covalent lattice?

- Covalent bonds are extremely strong, so covalent solids are very hard
- Are covalent solids soluble or insoluble?

⚙ Silicon Dioxide



- Describe the covalent bonds that occur in silicon dioxide.

- What type of intermolecular forces will silicon dioxide exert on water molecule?

- Silicon dioxide is used in industry to make glass due to its many properties. Explain why.

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2. Polymers

CHECKPOINT:

- Explain changes, if any, to particles and account for those changes when the following types of chemicals interact with water:
  - A substance with large molecules, such as cellulose or polyethylene

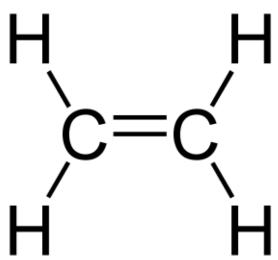
What is a Polymer?

- A polymer is made up of individual unit molecules called ________________
- Monomers bind together other monomers to form a repeating chain molecule called a polymer
- The process of making polymers is called __________________________
- Cellulose and polyethylene are two examples of polymers

Addition Polymerisation - Polyethylene

- Polyethylene is formed through a process called addition polymerisation
- What is the monomer in polyethylene called?

- Below is an example of the ethylene molecule:



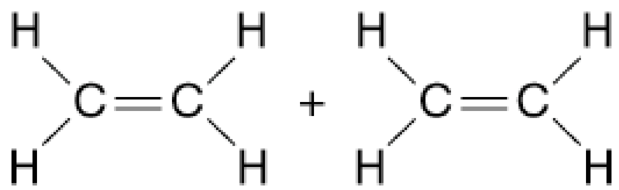
- **Label** the double bond on the ethylene molecule
- Addition polymers are formed by adding double bonded molecules together

- Explain the process of addition polymerisation.

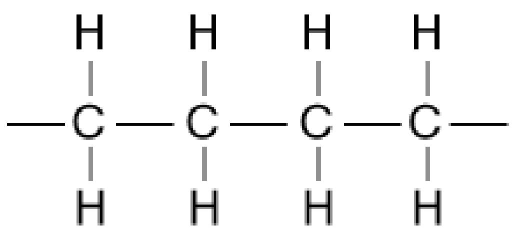
- Polymers through addition polymerisation are called ____________________ polymers as they do not occur naturally

- During the polymerisation process:

1	Double bond breaks apart
2	Extra electrons allow formation of single bonds
3	Ethene molecules join together to form polyethylene



ethene + ethene

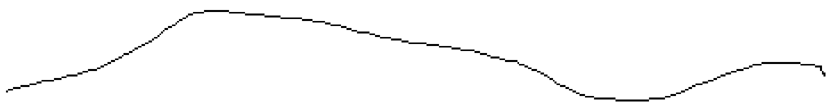


polythene

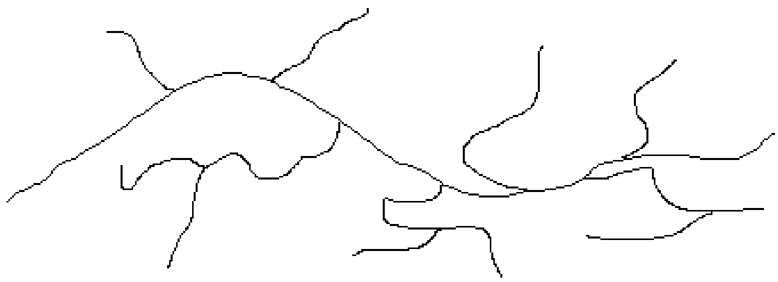
- What type of intramolecular forces bond the polymer together?

⚙ Properties of Polyethylene

- There are two types of polyethylene as shown below:



A molecule of linear polyethylene, or HDPE



A molecule of branched polyethylene, or LDPE

- HDPE is known as High Density Polyethylene. Why is it given this name?

- LDPE is known as High Density Polyethylene. Why is it given this name?

- Uses of polyethylene include squeeze bottles, piping and credit cards etc
- Identify the type of intermolecular forces between polyethylene

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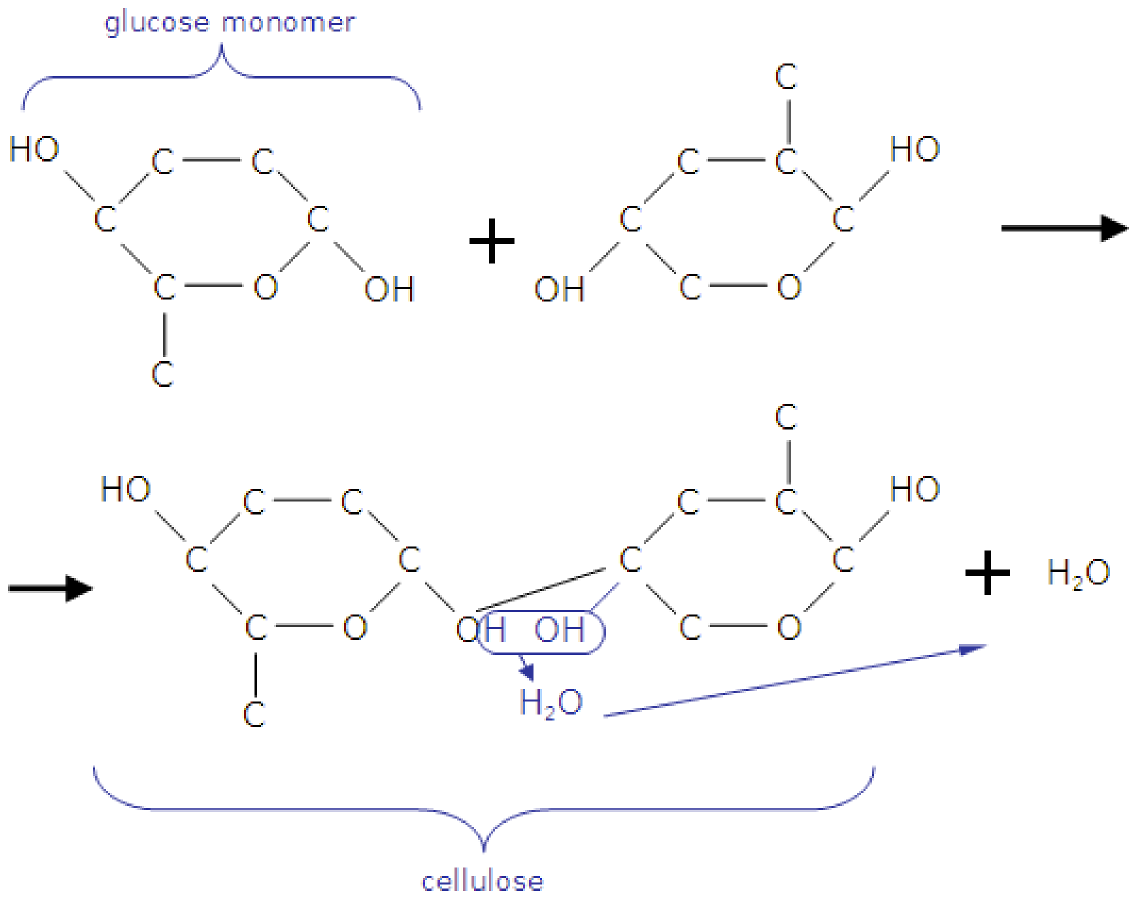
- Polyethylene is ____________________ in water.

- Based on the above information, explain why it is a preferred material.

Condensation Polymerisation - Cellulose

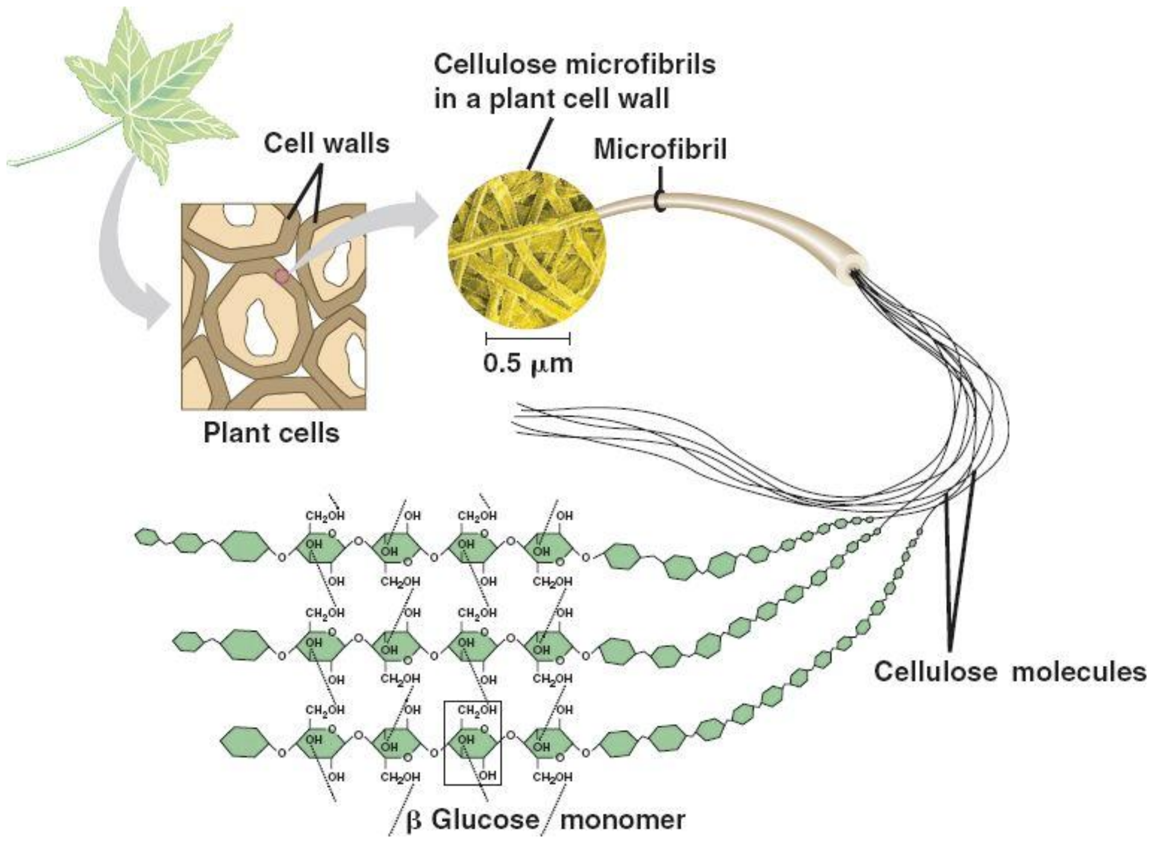
- A condensation polymer is a **naturally occurring** polymer
- It is formed by two or more molecules joining together and a small molecule is eliminated during the process
- For the case of cellulose a ____________ molecule is eliminated
- Cellulose is formed by joining glucose _______________ together as shown below:



- **Label** the eliminated molecule in the diagram above

Properties of Cellulose

- Cellulose is created by plants to form fibres that hold the plants together



- Cellulose is able to align with each other have the ability to cross link with each other
- The repeating unit in cellulose contains numerous ________________________
- Is cellulose water soluble? Explain.

- Therefore, cellulose is able to align and crosslink into water insoluble crystalline lattices or _________

Applications 2.1

Question 1

Using an example of a large covalent network and explain why it is insoluble in water. (3 marks)

Question 2 (James Ruse Trial 2004 – Qu 24 Modified)

Discuss the potential as a raw material for making plastic with reference to its structure and water solubility potential. (3 marks)

Question 3 (Independent 2006 – Qu 22 Modified)

Compare the structure of an ionic substance with that of polyethylene. (3 marks)

3. Precipitation Reactions

CHECKPOINT:

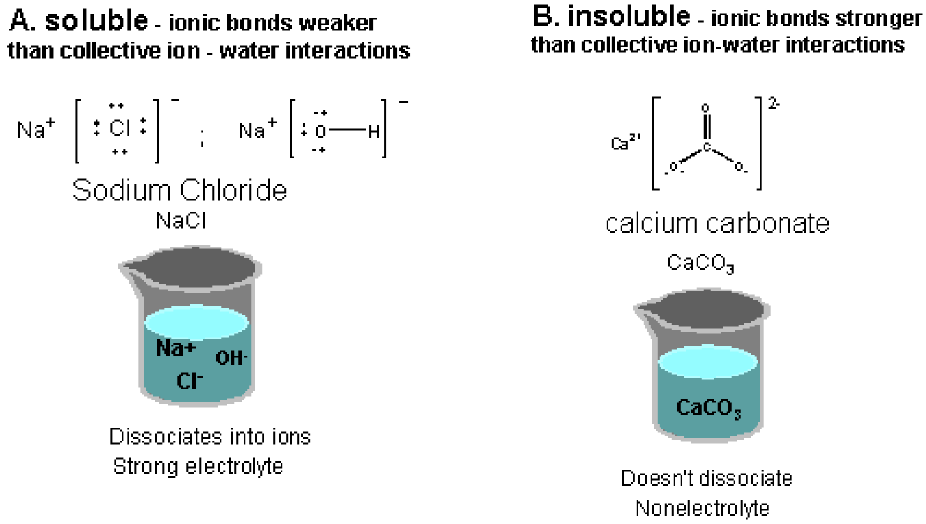
- Identify some combinations of solutions which will produce precipitates, using solubility data

What is Precipitation?

- Precipitation reactions occur when **cations** and **anions** in aqueous solution combine to form an:

- A cation is a ________________ charged ion
- An anion is a _________________ charged ion
- A solution with cations and anions in it are also called __________________.
- Whether or not such a reaction occurs can be determined by using the **solubility rules** for common ionic solids.
- Can precipitation reactions occur if there is only one substance in solution?

- The solubiity of ionic salts is dependent on the intermolecular forces between ionic bonds and water as shown below:



⚙ Soluble Salts

- All **fully soluble** salts are listed below (fill in the table):

Ion	Chemical Formula
Group 1 Cations	(N/A)
Ammonium	
	NO_3^-
	CH_3COO^-
Bicarbonate	HCO_3^-

- All **soluble salts with exceptions** are listed below (fill in the table):

Ion	Chemical Formula	Slightly Soluble	Insoluble
Halides			
	SO_4^{2-}		

⚙ Insoluble Salts

- All **insoluble salts with exceptions** are listed below (fill in the table):

Ion	Chemical Formula	Slightly Soluble	Always Soluble
	SO_3^{2-}	N/A	Group 1 and NH_4^+
	CO_3^{2-}	N/A	
	PO_4^{3-}	N/A	Group 1 and NH_4^+
Sulfur		N/A	Group 1, Group 2 and NH_4^+ sulfides
Oxygen		N/A	
Hydroxide	OH^-		Group 1 and NH_4^+

4. Ion Movement

CHECKPOINT:

- Describe a model that traces the movement of ions when solution and precipitation occur
- Identify the dynamic nature of ion movement in a saturated dissolution

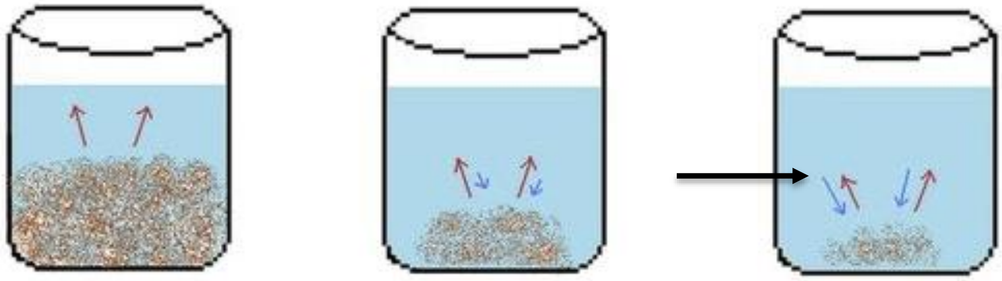
⚙ Movement of Ions

- Ionic substances dissolve in water, it breaks up into ions which move __________________ in solution

- When a solution is fully saturated, ions continue to break away from the crystal lattice

  - What does it mean for a solution to be fully saturated?

- Even though a solution is fully saturated ions can continue to break away. **Explain** this phenomenon.



- There are many ways to track the dissolving and precipitation process of a substance
- By using a radioactive substance that emits beta radiation the substance can be tracked
- Substances like lead can be radioactive

⚙ Model of Moving Ions

- An experiment using radioactive lead can be used to track ion movement
- Radioactive lead emits beta radiation
- Lead by itself will not dissolve in water, however **lead nitrate** can form a saturated solution in water
- **Describe** what you might observe if you tracked the movement of radioactive lead ions.

- Eventually the same amount of lead ions in the solution is radioactive as in the solid

⚙ Dynamic Nature of Ions

- Using radioactive lead nitrate as an example it can be clearly seen that lead ions move back from solution the solid as solid lead ion is dissolved
- A **dynamic balance** occurs when dissolution and precipitation occur at ____________________
  - Are there any changes to concentration?

- We call this overall process called a **dynamic equilibrium**
- Write a chemical equation for lead nitrate undergoing a dynamic equilibrium.

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5. Precipitation Equations

CHECKPOINT:

- Construct ionic equations to represent the dissolution and precipitation of ionic compounds in water
- Present information in balanced chemical equations and identify the appropriate phase descriptors (s), (l), (g) and (aq) for all chemical species

Writing Precipitation Equations

- Equations that represent precipitation reactions can be written in one of three ways:

1 **Molecular Equation**

- This is your normal chemical equation in which the reactants and products are written as if they are **molecules**

2 **Ionic Equations**

- In this case all reactants and products are written as soluble (aqueous) ions, only the **precipitate** is written as if it were a molecule

- Can gases or liquids be written as aqueous in ionic equations?

- Spectator ions are also written in ionic equations, what are they?

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3 **Net Ionic Equation**

- This equation shows the reactants and products that explicitly take part in the reaction

- Why are spectator ions NOT included in this type of equation?

Case Study – Sodium Chloride and Silver Nitrate

- Consider the reaction between two solutions which have sodium chloride ($NaCl_{(aq)}$) in one and silver nitrate ($AgNO_{3(aq)}$) in the other

- What are the possible products for this precipitation reaction?

  Sodium Nitrate -> NaNO3
  Silver chloride -> AgCl

- Using the solubility rules we determine that ______________________ is soluble

- Silver chloride is insoluble. Explain why.

- Write the **Molecular Equation** for the reaction:
  - **Remember that** species in solution must include the (aq), the precipitate must include the (s)

- Write the **Ionic Equation** for the reaction:

- Write the **Net Ionic Equation** for the reaction:
  - **Remember that** spectator ions are NOT included in the equation

Applications 4.1

Question 1

Write molecular, complete ionic, and net ionic equations for the following reactions that may produce precipitates. Use NR to indicate that no reaction occurs.

a) Potassium iodide and silver nitrate

b) Ammonium phosphate and sodium sulfate

c) Aluminum chloride and sodium hydroxide

d) Lithium sulfate and calcium nitrate

e) Iron(II) sulfate and barium hydroxide

Question 2

For the following solutions determine whether a precipitation reaction will occur. If a reaction does occur write a balanced neutral species equation for the reaction.

a) Potassium chloride and zinc nitrate

b) Ammonium bromide and lead nitrate

c) Ammonium sulphide and magnesium acetate

d) Strontium chloride and zinc sulfate

Question 2

Determine the solutions that you would mix to produce the following precipitates.

a) Lead Sulfate

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b) Iron(II) sulfide

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c) Magnesium hydroxide
