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VCE Chemistry ½
Solubility & Precipitation [0.8]
Workshop

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Section A: Recap

Learning Objective: [1.9.1] - Explain the process by which ionic compounds dissolve in water with reference to ion-dipole bonding

_____	_____	_____	_____
Occurs between _____ molecules.	Occurs between _____ molecules.	Occurs between FON and _____ covalently bonded to _____ .	Electrostatic attraction between a **fully** charged [ion] / [dipole] and a [fully] / [partially] charged **dipole**.

- Ionic bonds occur between [full] / [partial] charges whereas ion-dipole bonds include **partial** charges, so [ionic] / [ion-dipole] bonds are stronger.
- _____ is used to describe the process by which ionic compound dissolves.
- A _____ is a **solid** substance which is dissolved in the solvent.
- A _____ is the **liquid** in which the solute is dissolved.
- Solubility is the ability of a [solute] / [solvent] to dissolve in a [solute] / [solvent].
- For **insoluble** compounds, the ion-dipole bonds formed are [strong enough] / [not strong enough] to dissociate the ionic compound:

Ionic Bonds _____ Ion-Dipole Bonds

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Learning Objective: [1.9.2] - Write balanced equations for ionic compounds dissociating/ionising in water

- While one single ion-dipole bond is **not stronger** than the ionic bond in the ionic lattice structure, multiple ion-dipole bonds can _____ the strong ionic bonds within the ionic lattice structure.
- When table salt dissolves: water molecules slowly **pull apart** the Na^+ *and* Cl^- ions from one another, effectively _____ the ionic lattice structure.
- When ionic compounds dissolve, it is also known as _____ , as the compound is split into ions.
- The process is also called _____ as the compound has been broken apart.
- _____ is generally written above the arrow in a dissolution equation.

Learning Objective: [1.9.3] - Identify which compounds will or will not dissolve in water, with reference to SNAPE and/or solubility tables

- A _____ will generally be provided to deduce what is soluble and what is insoluble.
- To determine what is soluble in water, we can also use the acronym SNAPE. *(Label Below):*
  - S -
  - N -
  - A -
  - P -
  - E -

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Learning Objective: [1.9.4] - Write full & ionic equations for precipitation reactions

- _____ is the process where a **solid** is formed from a solution.
- The solid forms due to it being [soluble] / [insoluble] in water.
- Aqueous ions can be _____ as they are merely floating around in solution, and not strictly bound together.
- A (net) ionic equation omits _____ so as to only show the species which are reacting.
- Spectator ions are ions which are present before and after the reaction but _____ in any reaction themselves.
- The _____ equation details everything which is present before and after the reaction is completed.

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Section B: Warm Up (16 Marks)

INSTRUCTION: 16 Marks.11 Minutes Writing.

Question 1 (1 mark)

Rank the following bonds in terms of their strength, from highest to lowest.

A. Hydrogen bonds.

B. Dipole-dipole attractions.

C. Ion-dipole bonds.

D. Dispersion Forces.

_____

Question 2 (2 marks)

Without using solubility tables, identify which of the following substances are soluble and which are insoluble.

$$KCl, Pb(NO_3)_2, BaCl_2, AgNO_3, AgI, Cu(OH)_2, LiO, Mg(NO_3)_2$$

Soluble:	**Insoluble:**

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Question 3 (6 marks)

Write the molecular formula for the following chemicals – including whether or not they are soluble under standard laboratory conditions.

a. Ammonium chloride. (1 mark)

_____

Solubility: [soluble] / [insoluble]

b. Potassium permanganate. (1 mark)

_____

Solubility: [soluble] / [insoluble]

c. Silver oxalate. (1 mark)

_____

Solubility: [soluble] / [insoluble]

d. Lithium sulphate. (1 mark)

_____

Solubility: [soluble] / [insoluble]

e. Sodium hydroxide. (1 mark)

_____

Solubility: [soluble] / [insoluble]

f. Barium ethanoate. (1 mark)

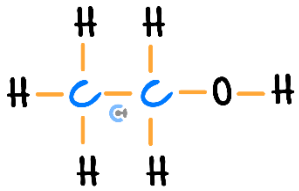
_____

Solubility: [soluble] / [insoluble]

Question 4 (4 marks)

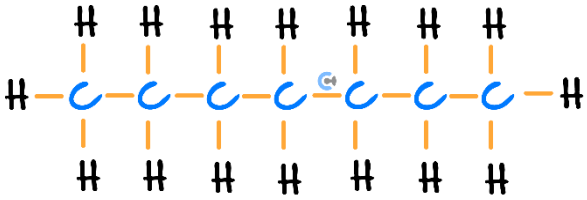
For the following compounds, state their polarity and whether or not they would be miscible in water.

a. (1 mark)



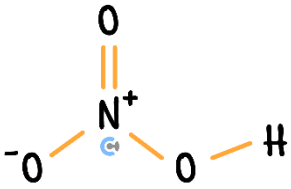
[Polar] / [Non-Polar] [Miscible] / [Immiscible] in water

b. (1 mark)



[Polar] / [Non-Polar] [Miscible] / [Immiscible] in water

c. (1 mark)



[Polar] / [Non-Polar] [Miscible] / [Immiscible] in water

d. (1 mark)

[Polar] / [Non-Polar] [Miscible] / [Immiscible] in water

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Question 5 (3 marks)

Write the ionic equation from the full equation provided and identify any spectator ions.

a. $Pb(NO_3)_2 + 2NaBr \rightarrow 2NaNO_3 + PbBr_2$. (1 mark)

b. $HCl(aq) + ZnO(s) \rightarrow ZnCl_2(aq) + H_2O(l)$. (1 mark)

c. $KNO_3 + NaF \rightarrow NaNO_3 + KF$. (1 mark)

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Section C: Ramping Up (20 Marks)

INSTRUCTION: 20 Marks. 15 Minutes Writing.

Question 6 (1 mark)

Which of the following ionic compounds are insoluble in water?

a. NaCl

b. $PbSO_4$

c. NH_4Br

d. $BaNO_3$

Question 7 (1 mark)

Explain when dispersion forces occur with an example of a molecule in which they are able to occur.

_____

_____

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Question 8 (6 marks)

For each of the following pairs of solutions, determine whether a precipitate will form and if it does, write out its full reaction.

a. $AgNO_3$ and $CaCO_3$. (2 marks)

[Yes] / [No]

b. KCl and CH_3COONa. (2 marks)

[Yes] / [No]

c. HNO_3 and NaOH. (2 marks)

[Yes] / [No]

Question 9 (6 marks)

For each of the following pairs of substances, compare their solubility in H_2O. Explain your answer.

a. HBr and HF. (2 marks)

b. NaCl and AgCl. (2 marks)

_____

_____

_____

_____

c. K_2SO_4 and CH_4. (2 marks)

_____

_____

_____

_____

Question 10 (6 marks)

Complete the equation for the following reactions (ensuring they are balanced and have correct states) and write the ionic equation.

a. $NaOH(aq) + CuSO_4(aq) \rightarrow$

Ionic equation: _____

b. $K_2CO_3(aq) + AgNO_3(aq) \rightarrow$

Ionic equation _____

c. $HCl(aq) + Al(OH)_3(s) \rightarrow$

Ionic equation _____

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Section D: Getting Trickier I (10 Marks)

INSTRUCTION: 10 Marks. 8 Minutes Writing.

Question 11 (1 mark)

Which of the following best describes a precipitation reaction?

A. Two soluble compounds react to form a precipitate which is insoluble.

B. A precipitate as a solute dissolved in a solvent.

C. A precipitate is formed as a result of the insolubility of a compound.

D. A precipitate is formed because of ionic dissociation.

Question 12 (2 marks)

State and explain whether neon gas would be soluble in water.

_____

_____

_____

Question 13 (1 mark)

What is the difference between a partial charge and a full charge?

_____

_____

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Question 14 (6 marks)

While seasoning her food in the kitchen, Esther was confused about which container contained the NaCl (salt) and which container contained AgCl (toxic upon ingestion). To ensure she does not die, Esther runs a test. She takes one spoonful of each and places them into a cup of water.

a. What would Esther expect to see? (1 mark)

b. Explain the observations that Esther would note – ensure to refer to the strength of ionic bonds, ion-dipole bonds and the dissolving process for both chemicals. (3 marks)

c. Esther remembers a reaction in which AgCl was produced as a product with the following equation:

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

Write the ionic equation for the following reaction. (1 mark)

d. What is the general name given to solids which form during a reaction? (1 mark)

Section E: Getting Trickier II (12 Marks)

INSTRUCTION: 12 Marks. 11 Minutes Writing.

Question 15 (1 mark)

Which of the statements below is the most correct regarding miscibility?

A. Miscibility is directly related to the type and strength of intermolecular bonds that the solvent and the solute can form with each other.

B. The more polar a compound is, the more likely it is to be able to dissolve in water.

C. Miscibility is only determined by the solubility rules of ionic compounds.

D. Miscibility of two compounds is directly proportional to the polarity of a compound.

Question 16 (6 marks)

Kanta is extremely intrigued by the process through which compounds such as $NaNO_3$ can dissolve in water so effortlessly.

a. Write the equation for the dissolution of $NaNO_3$. (1 mark)

_____

b. Draw a water molecule with its relevant dipoles, including dipole arrows. (1 mark)

c. With reference to the diagram you have drawn in **part b.**, explain how ion-dipole bonds form between water and $NaNO_3$. (2 marks)

d. Having forgotten her notes from intramolecular bonding, Kanta believes that $NaNO_3$ exists as a covalent molecule in the solid state. Explain why this is, or isn't the case. (2 marks)

Question 17 (5 marks)

Consider a molecule of CO_2.

a. What is the molecular geometry of CO_2? (1 mark)

b. Discuss the polarity of CO_2 within its bonds and overall. (2 marks)

c. Is CO_2 considered to be soluble in water? Justify your answer. (2 marks)

_____

_____

_____

Let's take a BREAK!

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Section F: VCAA-Level Questions I (9 Marks)

INSTRUCTION: 9 Marks. 30 Seconds Reading. 8 Minutes Writing.

Question 18 (9 marks)

Consider an experiment analysing the compounds Copper (II) nitrate and Potassium hydroxide.

a. Write the molecular formulae of both compounds. (1 mark)

_____

b. Describe how Potassium hydroxide would dissolve in water with reference to intermolecular bonding. (2 marks)

_____

_____

_____

c. Which of the two compounds will dissolve in water to a larger extent? Justify your answer. (2 marks)

_____

_____

_____

d. Write a balanced equation for the reaction that occurs between the compounds including states. (2 marks)

_____

e. Suggest a method in which we can extract the precipitate from the above reaction. Justify your answer. (2 marks)

_____

_____

Section G: Multiple Choice Questions (6 Marks)

INSTRUCTION: 6 Marks. 6 Minutes Writing.

Question 19 (1 mark)

Which one of the following is most commonly found in insoluble salts?

A. Na^+

B. K^+

C. Cl^-

D. NO_3^-

Question 20 (1 mark)

Which of the following is not a characteristic of a SNAPE ion?

A. They are soluble in H_2O.

B. They often form precipitates when mixed with certain ions such as Barium ions.

C. They can be identified using solubility rules.

D. They are typically found in ionic compounds.

Question 21 (1 mark)

Which of the following requirements is true for a molecule to dissolve in water?

A. The intermolecular bonds between the solute and the solvent need to be acting in opposite directions to pull the compound apart.

B. The intermolecular bonds within the solute need to be stronger than the intermolecular bonds formed between the solute and the solvent.

C. The intermolecular bonds between the solute and the solvent need to be stronger than the intermolecular bonds within the solute.

D. The compound solute itself needs to be able to ionise when entering the water in order for it to fully dissociate.

Question 22 (1 mark)

When a solution of Barium chloride is mixed with a solution of Sodium sulphate, what is the precipitate formed?

A. NaBr

B. $BaSO_4$

C. NaCl

D. Br_2SO_4

Question 23 (1 mark)

Consider the precipitation reaction between HNO_3 and KOH. Which of the following is true about this reaction?

A. There is no precipitate that is formed between the two compounds as they are all soluble in water.

B. The precipitate formed is going to be KNO_3.

C. The reaction between HNO_3 and KOH is going to be extremely reactive due to the presence of Potassium.

D. There is a precipitate that is formed between HNO_3 and KOH.

Question 24 (1 mark)

Consider the hydroxide ion, OH^-, which of the following statements about the solubility of hydroxide is true:

A. Unless the hydroxide is bonded to a transition metal, it is otherwise soluble.

B. All hydroxides are insoluble.

C. Most hydroxides are soluble except for some group 1 metals and Ammonium.

D. Most hydroxides are insoluble except for some group 1 metals and Ammonium.

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Section H: VCAA-Level Questions II (10 Marks)

INSTRUCTION: 10 Marks. 30 Seconds Reading. 9 Minutes Writing.

Question 25 (10 marks)

Consider the molecule of HCl.

a. What is HCl's molecular geometry? (1 mark)

_____

b. Is HCl considered to be polar? Explain your answer. (2 marks)

_____

_____

_____

c. When HCl is dissolved in water, explain how this process would be different compared to if NaCl were to dissolve in water. (2 marks)

_____

_____

_____

d. Does HCl have stronger intermolecular bonding when placed into water or when it is by itself? Justify your answer. (3 marks)

_____

_____

_____

_____

e. Write the reaction that occurs when drops of Iron (III) hydroxide solution are added to a beaker containing dissolved HCl. (2 marks)

_____

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Section I: Extension Questions (8 Marks)

Question 26 (8 marks)

After a long day at school, Sasen comes home to his lab inside his basement and begins mixing random chemicals together. One of these mixes is Hydrochloric acid and water.

a. As Sasen mixes these two chemicals together, he sees that they are able to mix into each other and are fully miscible. Explain what it means to be miscible, and what this reveals about the polarity of water and HCl. (2 marks)

_____

_____

_____

_____

b. With reference to HCl, explain what intramolecular bonds are as compared to intermolecular bonds. (2 marks)

_____

_____

_____

_____

c. Identify the type of intermolecular bond which forms between HCl and water. (1 mark).

_____

d. After reading his textbook, Sasen is confused as to how HCl as a covalent molecule can turn into H^+ ions in water. With reference to the words "dissociation" and "ionisation", explain what happens when HCl is added to water. (3 marks)

_____

_____

_____

_____

_____

_____

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