Year 12 Chemistry
Tutorial 9.3.A – Acid/Base Synthesis

Module	9.3 – The Acidic Environment
Topic	9.3.B – Acid/Base Synthesis
Name	**Date**

Set 1 – Acidic and Basic Oxides

1. Identify where on the Periodic Table you would find those elements whose oxides are acidic and those whose oxides are basic. Name an example of an acidic oxide and a basic oxide.

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2. Identify one property of sulfur dioxide that is similar to a property of nitrogen oxides. Identify one property where the two oxides differ.

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3. Write word equations and balanced formula equations for the following reactions:

   a) sulfur dioxide reacting with water to produce sulfurous acid.

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   b) potassium oxide reacting with water.

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c) calcium oxide reacting with water.

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4. Beryllium is a Group IIA (alkaline earth) element; however, it is not very metallic. It resembles aluminium in many of its properties. For example, its oxide, BeO, is also amphoteric as shown by the two equations below.

i) $BeO\ (s) + HCl\ (aq) + H_2O\ (l) \rightarrow Be(H_2O)_4^{2+}\ (aq) + Cl^-\ (aq)$

ii) $BeO\ (s) + NaOH\ (aq) + H2O\ (l) \rightarrow Be(OH)_4^{2-}(aq) + Na^+\ (aq)$

a) What does amphoteric mean in this context?

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b) Balance both equations.

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c) Write net ionic equations for i) and ii).

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d) State whether BeO is acting as an acid or a base in each case.

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Set 2 – Acidic Oxides in the Atmosphere

5. Outline evidence that indicates that atmospheric concentrations of oxides of sulfur and nitrogen have increasing since the industrial revolution.

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6. Describe, using equations, examples of chemical reactions that release oxides of sulfur and nitrogen into the atmosphere. Classify these sources as naturally occurring or not.

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Set 3 – Acid Rain

7. Write a balanced equation for the reaction of nitrogen dioxide with water including all states.

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8. Write balanced chemical equations to show the reactions of sulfur dioxide with water.

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9. Even in the early 1980s the CSIRO reported that summer rain in Sydney was acidic. Normally unpolluted rainwater has a pH of 5.6, whereas acid rain has a pH less than this.

   a) Write the formulas of two pollutant gases that could account for these pH values that are associated with acid rain.

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   b) Write equations to show how the pollutant gases in a) cause acid rain.

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c) Describe one problem arising from acid rain.

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d) Suggest one way of identifying whether or not rainwater is acid rain.

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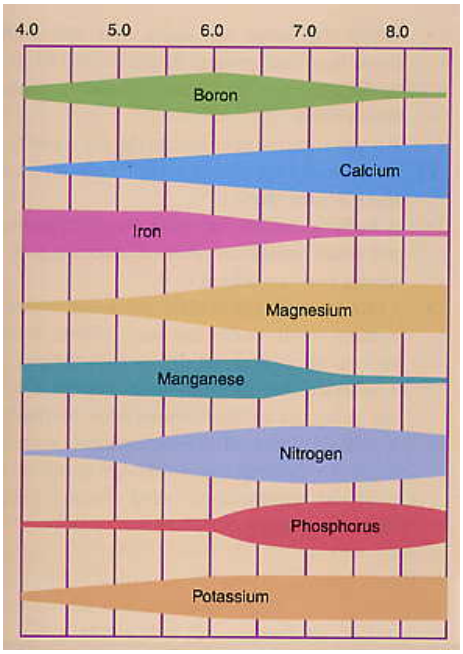
10. The uptake of certain elements from the soil depends on the pH of the soil. This is shown in the diagram below. The broader the bar, the easier it is for a plant to take up that particular element.



a) Which elements cannot be taken up easily at a pH of 7.5?

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b) Azaleas require high levels of boron, iron and manganese. Give the optimum pH range of soil for successful azalea growth.

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c) In strongly acidic soils of pH 4.0 to 5.0, levels of calcium and magnesium are deficient. Give two reasons why the addition of dolomite, $CaCO_3.MgCO_3$, might fix this problem.

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Set 4 – Calculating Gas Volumes

11. If zinc metal is treated with either hydrochloric acid, hydrogen gas is produced. If 50.0 g of zinc metal was used:

    a) How many moles of hydrochloric acid are required?

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    b) What volume of a 1.0 mol L^{-1} solution of hydrochloric acid would be required?

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    c) What volume of hydrogen gas would be produced at 25°C and 100 kPa?

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12. Consider the following reaction:

    $Na_2SO_3\,(s) + 2HCl\,(l) \rightarrow 2NaCl\,(s) + H_2O\,(l) + SO_2\,(g)$

    What volume of sulfur dioxide would be produced from 25.2 g of sodium sulphite at 25°C and 100 kPa?

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13. What mass and volume of hydrogen and oxygen can be produced at room temperature from the electrolysis of 25 g water?

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14. 30 g of sodium chloride is electrolysed to give sodium metal and chlorine gas. How much chlorine gas will be produced at 25°C and 100 kPa?

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15. If very hot zinc is treated with steam it will form hydrogen and zinc oxide. What volume of steam would be required for 40 g of zinc and what volume of hydrogen would be produced at 25°C and 100 kPa?

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16. What volume of oxygen is needed to completely oxidise 125 L of carbon monoxide? How many litres carbon dioxide is produced?

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17. What volume of ammonia will be required to neutralise 200 g of nitric acid at 25°C and 100 kPa?

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18. 50 L of nitrogen gas and 100 L of oxygen gas are exploded to form nitrogen dioxide. How much nitrogen dioxide is formed and how much oxygen is left over if the volumes were measured at room temperature?

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19. A can of soft drink undergoes a decrease in mass of 3.02 g after it is opened. This mass is converted to carbon dioxide and lost to the atmosphere. What volume of gas was produced by the soft drink?

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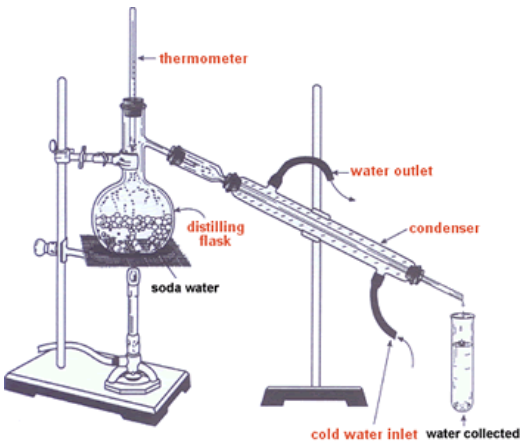
20. A student decided to try removing bubbles from soda water, which is carbonated water, and calculate the mass of bubbles in it. The equipment set-up is shown in the diagram below.



The student boiled away all of the soda water and collected the water in the flask as shown. There were no bubbles left in the water collected. Several measurements were made to collect the following data:

Mass of soda water and round-bottom flask = 440.00 g
Mass of empty round-bottom flask = 269.11 g
Mass of water collected = 170.20 g

a) What is the main gas in soda water bubbles?

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b) What was the mass of the soda water sample tested?

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c) Assuming that all the change in mass was due to the bubbles of gas that boiled away, what was the mass of gas in the soda water sample?

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d) What volume would this gas occupy at 25°C and 100 kPa?

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