Y11 Chem – Term 3 – Worksheet 1

1. (a) List the following acids in order of strength, starting with the weakest:
   hydrochloric acid
   citric acid
   acetic acid

   (b) Deduce which of these acid would be the best conductor of electricity. Justify your choice.

2. Ionisation of sulfuric and carbonic acids can be shown by the following equations.

   $$H_2SO_4 \rightarrow H^+(aq) + HSO_4^-(aq)$$

   $$H_2CO_3 \Leftrightarrow H^+(aq) + HCO_3^-(aq)$$

   (a) Which of these two acids is the stronger?
   (b) Explain why different arrows are used in these two equations.

3. (a) Define molarity.
   (b) Which solution would be more concentrated, a 3mol L^{-1} or 6 mol $^{-1}$ solution of sodium hydroxide?

4. Some acids can release more than one hydrogen ion per molecule; these are termed polyprotic acids. Sulfuric, carbonic and phosphoric acids are all polyprotic.
   (a) Write the formula for each of these acids.
   (b) One of these acids is said to be triprotic and the other two are described as diprotic. Identify the triprotic acid. Justify your choice.
   (c) Name and write the formulas for two anions that could be produced as sulfuric acid loses its two protons.

5. Phosphoric acid usually undergoes 10–20% ionisation, whereas hydrobromic acid undergoes 100% ionisation.
   (a) Use a diagram to show all the species that would be present in a beaker containing
      (i) dilute phosphoric acid
      (ii) dilute hydrobromic acid
   (b) Which solution would be a better conductor of electricity than a 2 mol L^{-1} solution of phosphoric or hydrobromic acid? Explain your choice.

6. Pure ethanoic (acetic) acid does not conduct electricity; however, a dilute solution does conduct electricity. Explain.

7. During this topic you performed a first-hand investigation to measure the pH of identical concentrations of strong and weak acids.
   (a) Which acids did you use?
   (b) What was the concentration of these acids?
   (c) Describe how you measured the pH of these acids.
   (d) Describe and justify conclusions made from your data.

8. Describe how you modelled the molecular nature of acids.

9. Describe the difference between a strong and a weak acid in terms of an equilibrium between the intact molecules and its ions.

10. How could you determine, in the laboratory, the strength of a number of acids?

11. Distinguish between the terms
   (a) base and alkali
   (b) dilute and concentrated

12. Rank these solutions from lowest to highest pH:
   0.001 mol L^{-1} acetic acid
   0.1 mol L^{-1} hydrochloric acid
   0.1 mo L^{-1} sodium hydroxide
   0.01 mol L^{-1} sulfuric acid
   0.01 mol L^{-1} ammonia solution
   0.5 mol L^{-1} potassium hydroxide

13. Rank these solutions in order from best to poorest conductor of electricity and justify your answer.
   0.1 mol L^{-1} citric acid
   0.1 mol L^{-1} sodium hydroxide
   0.5 mol L^{-1} sulfuric acid
   0.05 mol L^{-1} hydrochloric acid
   0.1 mol L^{-1} calcium hydroxide

14. Account for the occurrence of only weak acids in foods and identify two examples.

15. Construct equations to show the ionisation of the following acids:
   (a) hydrobromic acid
   (b) acetic acid
   (c) sulfuric acid
   (d) phosphoric acid

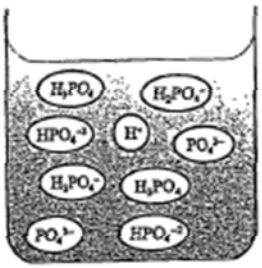
16. Check your knowledge with this quick quiz.
   (a) Identify each of the following substances as either strong or weak and as an acid or a base.
      (i) ammonia
      (ii) hydrochloric acid
      (iii) carbonic acid
      (iv) sodium hydroxide
   (b) Write an equation for the reaction of ammonia gas with water.
   (c) Write the formula for a diprotic acid.
   (d) Which sodium hydroxide solution is more dilute, 0.01 mol L^{-1} or 0.02 mol L^{-1}?
   (e) The strong acid H_2SO_4 can be made up as a concentrated or as a dilute solution. Identify which of the following solutions is more dilute, 0.1 mol L^{-1}, 0.01 mol L^{-1} or 1.0 mol L^{-1}.

12 Calculations of pH

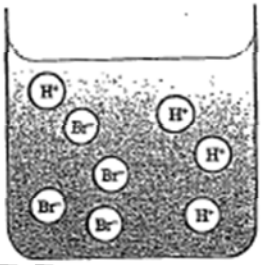
1. (a) 2.30
   (b) 4.21
   (c) 2.59
2. (a) 2.0
   (b) 3.0
3. (a) 1.70
   (b) 2.70
4. (a) 2.70
   (b) 3.0
   (c) 3.22
   (d) 12.70
   (e) 11.98
5. (a) 1.56
   (b) 12.40
   (c) 1.24

13 Strong/Weak, Concentrated/Dilute

1. (a) Acetic acid; citric acid; hydrochloric acid.
   (b) Hydrochloric acid; it ionises completely so in solutions of the same concentration, hydrochloric acid solution would have the most ions. This would allow it to conduct electricity best.
2. (a) Sulfuric acid.
   (b) Sulfuric acid ionises completely; the reaction goes to completion so a single arrow is used. Carbonic acid is a weak acid; it does not ionise completely and an equilibrium is established, so the equilibrium arrow pointing in both directions is used.
3. (a) The number of moles of a substance in 1 litre of solution.
   (b) 6 mol L^{-1} solution.
4. (a) H_2SO_4, H_2CO_3, H_3PO_4
   (b) Phosphoric acid; it releases three moles of protons per mole of acid, while the other two each release two.
   (c) Hydrogen sulfate ion, HSO_4^-. Sulfate ion, SO_4^{2-}.
5. (a) (i) Species present in dilute phosphoric acid:



(ii) Species present in dilute hydrobromic acid:



(b) Phosphoric acid (H_3PO_4) — this provides three times the number of hydrogen ions (protons) per mole of acid as hydrobromic acid (HBr). More ions in the same concentration solution would make H_3PO_4 a better conductor.

6. Concentrated acid contains only molecules, no ions, so cannot conduct electricity. Dilute solution has partially ionised; ions are present so it can conduct electricity.
7. (a) and (b) Various, e.g. you may have used 0.1 mol L^{-1} solutions of ethanoic (acetic), carbonic acid, hydrochloric and sulfuric acids.
   (c) E.g. you may have used indicators such as methyl orange or a pH meter or probe.
   (d) E.g. rank the acids in order of acidity according to your measurements — the lower the pH, the greater the $[H^+]$ concentration — and based on these results you should be able to draw conclusions as to the degree of ionisation, and thus the strength, of the acids you tested.
8. Various — perhaps diagrams as in Question 1 or ball-and-stick models. You could use plasticene, smarties, marbles or any other similar objects with objects such as toothpicks to show the bonds.
9. Strong acid, e.g. HCl — the equilibrium lies far to the right; all molecules ionise.

$$HCl \rightarrow H^+(aq) + Cl^-(aq)$$

Weak acid, e.g. ethanoic acid — the equilibrium lies to the left; only a small percentage ionises; most remains as molecules.

$$CH_3COOH \Leftrightarrow H^+(aq) + CH_3COO^-(aq)$$

10. Compare the pH of the acids each at the same concentration. Use a pH meter to do this. The strongest acid would have the lowest pH. You could also measure conductivity.
11. (a) An alkali is a base that is soluble in water.
    (b) Dilute solution has fewer molecules dissolved in it per volume than a concentrated solution.
12. 0.01 mol L^{-1} sulfuric acid
    0.1 mol L^{-1} hydrochloric acid
    0.001 mol L^{-1} acetic acid
    0.1 mol L^{-1} sodium hydroxide
    0.5 mol L^{-1} potassium hydroxide
    0.01 mol L^{-1} ammonia solution
13. 0.5 mol L^{-1} sulfuric acid
    0.1 mol L^{-1} calcium hydroxide
    0.1 mol L^{-1} sodium hydroxide
    0.05 mol L^{-1} hydrochloric acid
    0.1 mol L^{-1} citric acid
    Substances producing the highest concentrations of ions are the best conductors of electricity. Sulfuric acid produces 1 mol H^+ and 0.5 mol SO_4^{2-} per litre. Calcium hydroxide produces 0.1 mol Ca^+ and 0.2 mol OH^- per litre. Sodium hydroxide produces 0.1 mol Na^+ and 0.1 mol OH^- per litre. Hydrochloric acid produces 0.05 mol H^+ and 0.05 mol Cl^- per litre. Citric acid produces < 0.05 mol H^+ and < 0.05 mol CH_3COO^- per litre (weak acid, little ionisation).