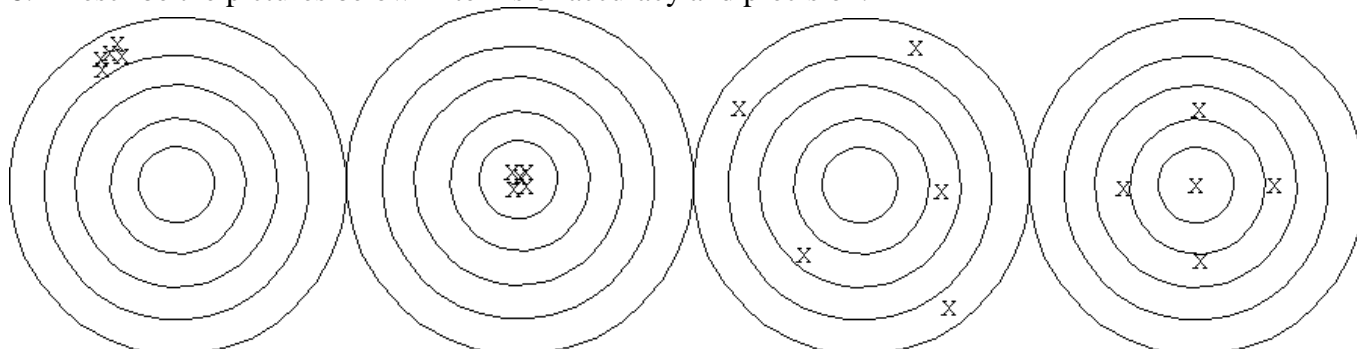


Stage 1 Chemistry

Mid-Year Exam Revision

Topic 1 – Chemistry Skills

- In a lab report what do we write in the hypothesis?
A prediction of what we think will be the results
- What is the most effective way to record the results of an experiment?
As a table
- How many significant figures are in the following
a) 3256000000 b) 0.000736 c) 135.16003
10 sig figs 3 sig figs 8 sig figs
- Write the above numbers to 3 significant figures.
a) 3.26×10^9 b) 7.36×10^{-4} c) 135
- Work out the following to a correct number of significant figures.
a) $5.2835 + 1.6$ b) 13.86×52.391
6.9 726.1
- Describe what random and systematic errors are and give an example of each.
Random errors are often caused by not being able to make the exact same measurement twice or by not being able to read the exact level of a piece of measuring equipment. An example is reading the temperature on a thermometer, we can only record to the nearest degree we cannot get any more accurate than that.
Systematic errors are those that affect all experiments equally, they are out by the same amount. An example is a stretched tape measure that will always give a reading of length longer than the true length
- Define the terms accuracy and precision and state which errors (random or systematic) each are affected by.
Accuracy deals with how close your experimental results are from the true result, accuracy is effected by systematic errors
Precision deals with how closely grouped the results are or their scatter, precision is affected by random errors.
- Describe the pictures below in terms of accuracy and precision.



precise not accurate

accurate and precise

not accurate or precise

accurate not precise

Topic 2 – Elemental Chemistry

1. Complete the following table.

Sub-Atomic Particle	Charge	Relative Mass	Where it is found
Proton	+1	1	Nucleus
Neutron	0	1	Nucleus
Electron	-1	1/1840	Shell/energy level

2. Complete the following table

Name	Symbol	Atomic No	Mass No	No of Protons	No of Neutrons	No of Electrons	Electron Config	Ion Formed	Electron Config of ion
Magnesium	$^{24}_{12}\text{Mg}$	12	24	12	12	12	2,8,2	Mg^{2+}	2,8
Oxygen	$^{16}_8\text{O}$	8	16	8	8	8	2,6	O^{2-}	2,8
Sodium	$^{23}_{11}\text{Na}$	11	23	11	12	11	2,8,1	Na^+	2,8
Nitrogen	$^{14}_7\text{N}$	7	14	7	7	7	2,5	N^{3-}	2,8

3. Explain why electrons are not considered when determining the mass of an atom.

Because they have very little mass and therefore will not greatly influence the mass of the atom.

4. The electrons in the outer shell are known as what?

Valance electrons

5. Explain what an isotope is.

An isotope is when two atoms have the same number of protons but differing numbers of neutrons in the nucleus (same atomic number but different mass number)

6. By referring to the electronic configuration of potassium (2,8,8,1) explain how we can tell which group and period it is in.

The last number tells us the group number (group 1). And the number of numbers tells us the period (period 4)

7. Complete the following table using the words increases or decreases.

	Down a group	Across a period
Atomic Number	Increases	Increases
Atomic Radius	Increases	Decreases
Metallic Nature	Increases	Decreases
Electronegativity	Decreases	Increases

8. Explain the term electronegativity and its effect on the reactivity of that substance.

Electronegative is the strength with which an atom holds it's valance (outer shell) electrons. Atoms that have very high and very low electronegativity are highly reactive whilst those with intermediate electronegativity are not very reactive.

9. Name two physical properties of metals and two chemical properties.

Physical properties: malleable, ductile, lustorous, high mpt/bpt, conductors of heat/electricity, high density, not brittle

Chemical properties: lose electrons to become positive ions, reducing agents, produce hydrogen with acids, form basic oxides, form ionic halides

10. Explain in detail how both ionic and covalent bonds form.

Ionic bonding - **Ionic bonds are between metals and non-metals. The metallic atom will want to lose electrons and become a positive ion and the non-metallic one will gain electrons and become a negative ion. Therefore the metal will transfer the electron(s) to the non-metal. The two ions will then be attracted and held together by electrostatic forces.**

Covalent bonding - **Covalent bonds are between two or more non-metals. Both want to gain electrons and must therefore share electrons. The energy levels/shells of the two atoms overlap allowing for the electrons to exist in both atoms simultaneously and hence achieving 8 in their valence shell.**

11. Name two properties of ionic compounds and two of covalent ones.

Ionic bonding - **High mpt/bpt, not conductive as solid but are as liquid, often soluble, hard, brittle**

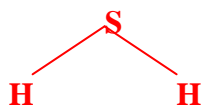
Covalent bonding - **Low mpt/bpt, not conductive in any form, rarely soluble, many flammable**

12. Explain why ionic substances will conduct in a liquid form but not a solid one.

In a solid form there are bonds between the metallic and non-metallic ions they are not free ions and therefore cannot conduct electricity. In a liquid form these ionic bonds have been broken meaning that the ions are free to move and can therefore conduct an electric current.

13. Draw the structure and name the shape of the following.

a) Hydrogen Sulfide (H₂S)



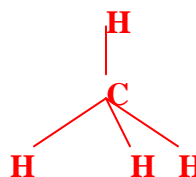
V-Shaped

b) Carbon dioxide (CO₂)



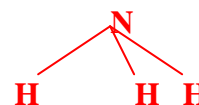
Linear

c) methane (CH₄)



Tetrahedral

d) Ammonia (NH₃)



Trigonal Pyramid

14. Explain how polarity forms in molecules and use it to state which of the above have polar bonds and which are polar molecules.

Polarity is an unequal sharing of electrons caused by differences in electronegativity

a) Polar molecule with polar bonds.

b) Non-polar molecule with polar bonds.

c) Non-polar molecule with polar bonds.

d) Polar molecule with polar bonds.

15. State the correct chemical formula for the following substances.

a) Sodium Oxide



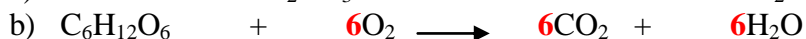
b) Aluminium Oxide



c) Phosphorous Chloride



16. Balance the following chemical equations

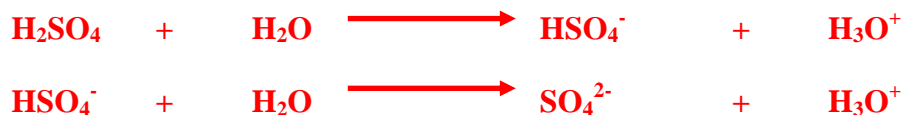


Topic 3 – Acids and Bases

1. State three properties of acids and three of bases.
Acids - Taste sour, corrosive, low pH, hydrogen with active metals, neutralise bases, carbon dioxide with carbonates or hydrogen carbonates, etc
Bases – Taste bitter, corrosive, high pH, neutralise acids, etc
2. Explain why you should never add water to acid, only the other way.
Because the reaction is highly exothermic, and will rapidly ionise. This will generate a lot of heat causing it to instantly boil and therefore spit and splutter.
3. Explain why you should never clean up a strong base with a strong acid. Suggest what you could use to clean up a strong base.
Because if you add too much to neutralise it then you are left with a strong acid on the floor which is just as bad. You should clean a strong base up with a weak acid such as vinegar so that any additional added is harmless.
4. Define acids and bases according to Bronsted-Lowry theory.
Acids are proton donors
Bases are proton acceptors
5. Explain why a hydrogen ion is considered to be a proton.
A hydrogen atom only contains a proton in the nucleus and has one electron in the shells. Therefore by removing the electron to form a hydrogen ion all that is left is a proton.
6. Identify the acid and base in the following reaction
$$\text{HPO}_4^{2-} + \text{NH}_4^+ \longrightarrow \text{NH}_3 + \text{H}_2\text{PO}_4^-$$

Base Acid
7. Identify the conjugate acid-base pairs above.
 $\text{HPO}_4^{2-} / \text{H}_2\text{PO}_4^-$ and $\text{NH}_4^+ / \text{NH}_3$
8. If H_2PO_4^- in the equation above is a strong base, what can you say about the conjugate acid?
It must be a weak acid
9. Define an amphoteric substance.
Amphoteric substances are those which can act as an acid or as a base
10. Show water is an amphoteric substance by showing its reaction with ammonia and hydrochloric acid.
$$\text{H}_2\text{O} + \text{NH}_3 \longrightarrow \text{NH}_4^+ + \text{OH}^-$$
$$\text{H}_2\text{O} + \text{HCl} \longrightarrow \text{Cl}^- + \text{H}_3\text{O}^+$$
11. Explain why sulfuric acid is classed as a diprotic acid.
It is a diprotic acid because it can donate two protons

12. The ionisation of sulfuric acid in water occurs in two steps. Write these equations and explain why it must occur in two steps.



It must occur in this way for two reasons, firstly water cannot accept two protons and secondly two water molecules are not going to hit the acid molecule at the same time.

13. Are all concentrated acids strong acids? Clearly explain your choice.
No not all concentrated acids are strong acid, concentration deals with the acid to water ratio in a solution whereas strength refers to the extent of which it ionises.

14. Is a solution pH 4 twice as acidic as one of pH 2? Clearly explain your choice.
No it is neither stronger nor twice the amount. A solution of pH = 4 would be less acidic than one of pH=2 as it is getting closer to neutral (pH=7) . It is not twice the difference either as the pH scale is logarithmic an increase by 2 will be a change of 100 times the amount

15. Calculate the pH of a solution with a $[\text{H}_3\text{O}^+] = 3 \times 10^{-5}$
 $\text{pH} = -\log [\text{H}_3\text{O}^+]$
 $= -\log (3 \times 10^{-5})$
 $= 4.52$

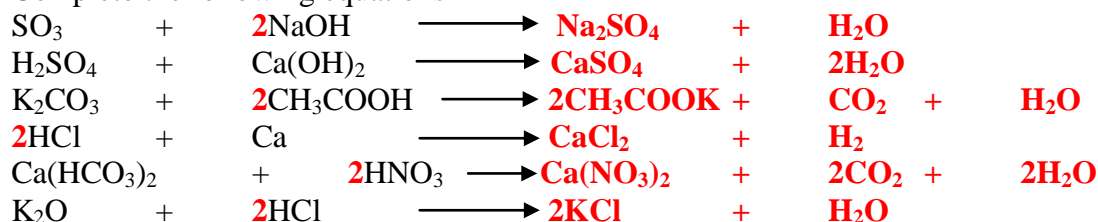
16. Calculate the $[\text{H}_3\text{O}^+]$ if the pH = 9.2
 $[\text{H}_3\text{O}^+] = 10^{-\text{pH}}$
 $= 10^{-9.2}$
 $= 6.31 \times 10^{-10}$

17. A solution has a pH = 2.3. If we dilute it to make it 1000 times less acidic state the new pH.
 $[\text{H}_3\text{O}^+] = 10^{-\text{pH}}$
 $= 10^{-2.3}$
 $= 5.01 \times 10^{-3}$
- OR**
- Since pH is a logarithmic scale an decrease of 1000 times will be a decrease of 10^3 . Hence the pH must change by 3 pH points to make it weaker. Since to make an acid weaker the pH moves towards pH=7 we get $2.3 + 3 = 5.3$**
- $\text{pH} = -\log [\text{H}_3\text{O}^+]$
 $= -\log (5.01 \times 10^{-6})$
 $= 5.3$
- Therefore the new pH is 5.3**

18. Does the colour of an indicator always change according to whether the solution is acidic or basic? Explain.

No it does not change according to acidic or basic nature. Indicators change colour based on pH. This change can occur at pH=7 or it can occur within the acids or within the bases.

19. Complete the following equations

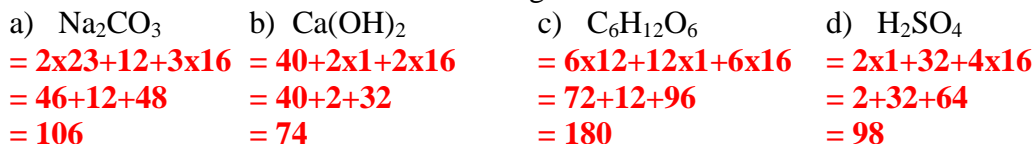


Topic 4 – Analytical Techniques

1. Explain the difference between qualitative and quantitative analysis.

Qualitative analysis deals with determining what substances are present in a sample whereas quantitative analysis deals with determining how much of a particular substance is in a sample.

2. Calculate the molar mass of the following substances



3. Complete the following two tables

n	m	M
0.25	14	56
1.1	101.2	92
0.43	25	58
1.29	9	7

n	c	v
0.1	0.2	04.5
0.004	2	0.002
0.4	0.025	16
3.4	42.5	0.08

4. What is the meaning of concordant titres?

Concordant titres are when the results of a titration are either equal or within 0.1 mL of each other.

5. Why do we need to use an indicator when performing titrations?

We need to use an indicator so that we can tell where the end point is, the point at which all of one substance has been neutralised by the other substance. At this point there will be a colour change.

6. The rinsing procedure is a very important part of all titrations, why is it so important and explain how we should wash the burette, pipette and conical flask.

The rinsing procedure is important in ensuring that none of your reactants are contaminated or neutralised before they are used. Any slight difference in your results caused by impurities can dramatically affect the results.

You should wash a burette using the substance you are going to use in there. You first add a bit of the solution and turn the burette on the side rotating it to clean all surfaces then let it drain through the tap. The pipette should be washed in exactly the same way (except there is no tap). The conical flask and simply be washed out with water ensuring you wash all internal surfaces.

7. For the picture shown what is the liquid line called and where should we take the measurement from? What is the reading on this measuring cylinder?



The line is called the meniscus and the reading is 6.6 mL

8. What mass of sodium hydroxide is required to neutralise a 5 L spill of 1M sulfuric acid?



$$n_{\text{acid}} = C_{\text{acid}} \times V_{\text{acid}} = 1 \times 5 = 5 \text{ mol}$$

$$n_{\text{base}} = 2/1 \times n_{\text{acid}} = 2/1 \times 5 = 10 \text{ mol}$$

$$m_{\text{base}} = n_{\text{base}} \times M_{\text{base}} = 10 \times 40 = 400 \text{ g}$$

9. Below are the results of a titration in which a 20 mL pipette was used to transfer 0.5 M hydrochloric acid to a conical flask and sodium hydroxide of an unknown concentration was added to the pipette. Phenolphthalein was used as the indicator.

	Rough	1	2	3
Final	38.0	36.6	35.6	43.3
Initial	2.1	2.5	1.7	9.3
Titre	35.9	34.1	33.9	34.0

- a) Complete the table.
 b) Determine the concentration of the sodium hydroxide solution.



$$n_{\text{HCl}} = C_{\text{HCl}} \times V_{\text{HCl}} = 0.5 \times 0.02 = 0.01 \text{ mol}$$

$$n_{\text{NaOH}} = 1/1 \times n_{\text{HCl}} = 1/1 \times 0.01 = 0.01 \text{ mol}$$

$$c_{\text{NaOH}} = n_{\text{NaOH}} / V_{\text{NaOH}} = 0.01 / 0.034 = 0.29 \text{ mol L}^{-1}$$

- c) What would be the colour change at the end point? **Clear to pink**

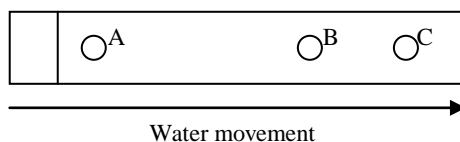
10. Explain the difference between absorption and adsorption.

Adsorption uses polarity to allow the sample to stick to the outside surface of the stationary phase. Absorption is when the sample is drawn into the stationary phase it does not just stick to the outside.

11. Explain the terms and mobile phase and stationary phase. For paper chromatography using water as the solvent state the mobile and stationary phases.

The mobile phase is a solvent that moves up the stationary phase, dissolving the sample and carrying it with it. The water will be the mobile phase. The stationary phase is the surface to which the sample is adsorbed, in this case it is the paper

12. For the picture shown state which was the most polar component A, B, or C given that it is using water as the mobile phase, giving clear reasons for your choice.

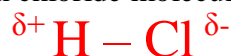


In this case the most polar component is C. Water is the mobile phase and is a polar substance. Since like dissolves like the most polar substance will be the one most soluble in water. C has moved the furthest and therefore must be most soluble in the water.

Exam Style Question

Hydrochloric acid which is made from hydrogen chloride gas, is a very common acid commonly found in the stomach but also used for applications such as cleaning brick work.

- a) Draw the structure of a hydrogen chloride molecule clearly showing any bond polarity



- b) Describe the shape of a hydrogen chloride molecule and use this to determine whether it is a polar molecule, give clear reasons for your choice.

Hydrogen chloride is a linear molecule that has bond polarity, due to the lack of symmetry in this molecule it must therefore be a polar molecule.

- c) What is the pH of a solution of hydrochloric acid that has $[\text{H}^+] = 3.07 \times 10^{-2} \text{ mol L}^{-1}$
pH = $-\log [\text{H}^+]$ = $-\log 3.07 \times 10^{-2}$ = -1.51

- d) Calculate the volume of HCl that could be produced with the concentration above if we start with 3.80 mol of hydrogen chloride gas.

$$\mathbf{V = n/c = 3.8 / 3.07 \times 10^{-2} = 0.117 \text{ L} = 117 \text{ mL}}$$

- e) If the 20 mL of the hydrochloric acid solution above was titrated with 0.2 M calcium hydroxide, what would be the expected titre value



$$\mathbf{n_{\text{HCl}} = cv = 3.07 \times 10^{-2} \times 0.0200}$$

$$\mathbf{n_{\text{Ca(OH)}_2} = \frac{1}{2} \times n_{\text{HCl}} = \frac{1}{2} \times 6.14 \times 10^{-4} = 3.07 \times 10^{-4}}$$

$$\mathbf{V_{\text{Ca(OH)}_2} = n/c = 3.07 \times 10^{-4} \times 0.2 = 1.54 \times 10^{-3} = 1.54 \text{ mL}}$$

- f) Name the apparatus that would be used to transfer the hydrochloric acid

Volumetric pipette

- g) If you perform the experiment and all your results are within 0.2 mL of each other but they are 6 mL from the calculated value, comment upon the accuracy and precision of your result.

The accuracy of the result is quite low as 6 mL is a substantial amount in regards to a titration. The precision is very good, with all results within a very narrow band.

- h) Has your experiment been effected more by random or systematic errors? Give a reason for your choice.

This experiment has been more strongly effected by systematic errors as the accuracy is much lower than the precision in the above results.

- i) Hydrochloric acid is a strong acid define the terms “strong” and “acid”.

Strong: The acid fully ionises

Acid: A chemical substance which donates protons

- j) Explain why water is a liquid at room temperature but hydrogen chloride is a gas.

Water is a liquid at room temperature due to the very strong hydrogen bonds that can form between water molecules. Hydrogen chloride can form dipole-dipole interactions, however these are quite weak and can be easily broken by the temperature in the room.