**Unit 3 and 4 VCE Chemistry 2015**
**Introduction – Transition Week 2014**

**Preparation for Unit 3 and 4 Chemistry Booklet**

The Year 12 course builds on the skills and knowledge you have developed in Year 11. It is important that you have sufficiently mastered the Year 11 Chemistry material to ensure a successful entry into Year 12 Chemistry. The following booklet contains a number of practice questions to improve your performance in Year 12.

## SKILLS REQUIRED FOR YEAR 12 CHEMISTRY:

**You should be able to (tick those skills below which you currently feel competent about):**

- write balanced full, ionic and half equations and general reaction types
- draw and interpret graphs
- use valencies to write chemical formula
- Know chemical formulae of the common molecules including, carbon monoxide, carbon dioxide, ammonia, methane, ethane, propane, butane, octane, ethanol, ethene, hydrogen peroxide, and the oxides of nitrogen and sulfur.
- chemical formulae of the common acids such as hydrochloric, nitric, sulfuric, phosphoric and acetic acids. Be able to identify a specific acid or base as either strong or weak.
- effectively use a periodic table to obtain RAMs, and determine no. of protons, neutrons and electrons present and be able to interpret the symbol of an isotope
- calculate molar mass
- substitute into and transpose relevant formulas (stoichiometry) to calculate quantities
- solve limiting reagent problems
- carry out unit conversions
- draw and correctly label a galvanic cell (including polarities of electrodes, anode and cathode, salt bridge, direction of ion movement, direction of electron flow, constituents of half-cells)
- use an electrochemical series to predict if a reaction is spontaneous or non-spontaneous
- name or draw organic structures and recognise key functional groups

## Knowledge Required for Year 12 Chemistry:

**You should be able to (tick those skills below which you currently feel competent about):**

- acid-base chemistry
- pH
- volumetric analysis
- redox reactions
- galvanic cells
- gas laws particularly $n=V/V_M$ and $PV = nRT$
- bonding (ionic, covalent and metallic)
- solubility
- formulas relating to mass, concentration, volume and pH
- organic chemistry including hydrocarbons and functional groups
- types of reactions
- empirical and molecular formulas

**Chemistry language**

The following is a basic list of very commonly used terms in Unit 3 Chemistry which we expect that you fully understand before you start the year. These terms will need more than just copying out the glossary terms in the back of the textbook. *It is recommended that you not only put an explanation into your own words but also support its use in an example.*

**Tick those keywords below which you currently understand:**

Hydrocarbons
Alkane
Alkene
Alkyne
Saturated
Unsaturated
Functional group
Structural formula
Semi-structural formula

Solute
Solvent
Solution
Spectator ions
Ionisation
Dissociation

Chemical formula
Empirical formula
Molecular formula
% Abundance
Relative isotopic mass
Relative atomic mass
Isotope

Conjugate acid/base
Strength of acid/base
Neutralisation
pH

Kinetic theory of gases
Ideal Gas

Intermolecular attraction
Intramolecular attraction
Covalent bonding
Ionic bonding
Metallic bonding
Dispersion forces
Hydrogen bonding
Dipole – dipole bonding
Electronegativity

Isomers
Polymer
Monomer
Polymerisation

Avogadro's number
Amount
Concentration
Molarity

Acid
Base
Burette
Pipette
Aliquot
Titre

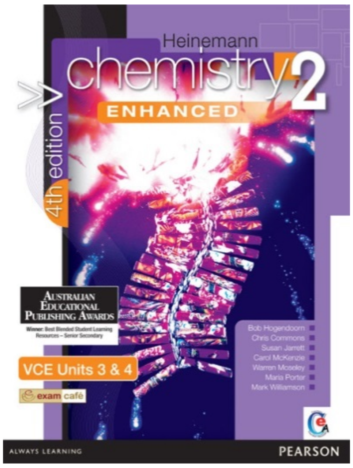
Limiting reactant
Excess reactant

Oxidant
Reductant
Oxidising agent
Reducing agent
Oxidation
Reduction
Oxidation numbers
Half-equation

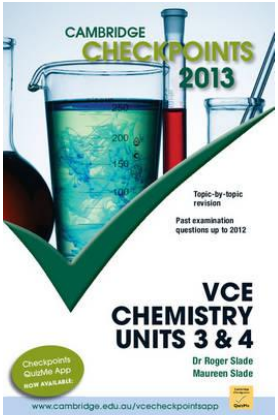
# Unit 3 and 4 VCE Chemistry 2015

**BOOKS YOU REQUIRE**:

**Equipment**: Textbook: Chemistry 2 (Heinemann)
Checkpoints
Scientific calculator (**not** a graphics calculator)
Notebook for class notes
Notebook for textbook chapter questions
Plastic pocket folder to put worksheets/handouts into




Heinemann Chemistry
(it does not matter if it is the Enhanced version or not)
VCE Units 3 & 4: Student Book
Bob Hogendoorn, Chris Commons, Susan Jarrett, Carol McKenzie, Warren Moseley, Maria Porter and Mark Williamson




Chemistry Checkpoints
VCE Units 3 and 4
Roger Slade and Maureen Slade

*Other useful textbooks/reference books:*

- NEAP Smartstudy Guides
- Other textbooks for wider general reading
- Online videos/animations

Welcome to Yr12 VCE Chemistry!

The following link will take you directly to the Study Design (Accreditation period: 2013 – 2016) for Units 1-4 for VCE Chemistry. It contains all of the knowledge, skills and outlines of assessment tasks which make up the course.

http://www.vcaa.vic.edu.au/Documents/vce/chemistry/ChemistrySD-2013.pdf (relevant pages: 7-12, 20-30 + 60-61)

**Where to go online for help?**
Explanations: www.chemguide.co.uk/
Forum: www.atarnotes.com/forum/

It is highly recommended that students have their teacher notes separate to their summaries and textbook questions. This is easier for the student when studying, and for the teacher when checking work. As outlined on the previous page students are expected to have separate work/note-books. Students are expected to bring to every class, unless told otherwise by the teacher, all necessary items eg. scientific calculator, paper, pens, textbook, notebook etc.

**Authentication**: While outside help is encouraged to provide assistance to students, work submitted must be the student's own, with the majority of it done in class.

**Timelines:** Deadlines must be met for all tasks and especially for SACs (School Assessed Coursework). Not meeting deadlines without a legitimate reason can lead to a UG -> zero, for the unit.

**Homework:** To keep up with the amount of material to be covered, at least 4 hours of homework per week is suggested. Handing in homework for marking regularly will assist in staying current with material covered in class.

**Satisfactory completion**: For satisfactory completion of each unit the student must demonstrate achievement of the outcomes specified for the unit. This is based on the teacher's assessment of the student's overall understanding on different tasks for the unit such as textbook questions, tests, practical reports, homework, contribution to class discussion and, of course, exams.

| Unit Three | Unit Four |
|---|---|
| **Area of Study (AOS 1) Outcome 1:** On completion of this unit the student should be able to evaluate the suitability of techniques and instruments used in chemical analyses.<br>To achieve this outcome the student will draw on key knowledge outlined in AOS 1 below and key skills listed above.<br><br>*Textbook (Heinemann) relevant chapters:*<br>'Chemical Analysis' = 1-8 | **AOS 1 Outcome 1:** On completion of this unit the student should be able to analyse the factors that affect the extent and rate of chemical reactions and apply this analysis to evaluate the optimum conditions used in the industrial production of the selected chemical.<br><br>*Textbook (Heinemann) relevant chapters:*<br>'Industrial Chemistry' = 15-22 |
| **AOS 2 Outcome 2:** On completion of this unit the student should be able to identify and explain the role of functional groups in organic reactions and construct reaction pathways using organic molecules. To achieve this outcome the student will draw on key knowledge outlined in area of study 2 and key skills listed above.<br><br>*Textbook (Heinemann) relevant chapters:*<br>'Organic Chemical Pathways' = 9-14 | **AOS 2 Outcome 2:** On completion of this unit the student should be able to analyse chemical and energy transformations occurring in chemical reactions. To achieve this outcome the student will draw on key knowledge outlined in area of study 2 and key skills listed on the previous page.<br><br>*Textbook (Heinemann) relevant chapters:*<br>'Supplying and using energy' = 23-28 |

I have read the above information for Year 12 Chemistry and understand what is required for satisfactory completion.

***PARENT/GUARDIAN***

Name ___________________________________ Signature ___________________ Date _________

***STUDENT***

Name ___________________________ Signature ___________________ Date _________

**Some formulas that you need to be familiar with. Read the description on the right side and then write in the appropriate formula on the left.**

| Formula | When to use |
|---|---|
| | Used to find the number of mol of a substance when given the actual number of particles. |
| | Used to find the number of mole of a substance when given the mass in grams. |
| | Used to find the number of mol of solution when given it concentration (in M) and volume (in litres) |
| | Used to calculate the concentration or volume of a diluted solution knowing the original concentration and volume. |
| | Used to determine the RAM of an element when given the Relative isotopic mass and % abundance of each isotope. |
| | Known as the Combined Gas Law. Used to find the pressure, volume or temperature of a gas, knowing its original pressure, volume and temperature and two out of three new conditions. |
| | Known as the Ideal Gas Equation. Used to find either the pressure, volume, number of mol or temperature of a gas when given the other condition.<br>NB - Pressure (kPa)<br>-Temperature (Kelvin)<br>- Volume (Litres)<br>- R = 8.31 J / K / mol |
| | Used to find the number of mol of a gas given its volume in litres at STP. |
| | Used to find the number of mol of a gas given its volume in litres at SLC. |

Worksheet 1.2

# Calculations involving gases and solutions

| Formula | What it means |
|---|---|
| $n = \frac{m}{M}$ | Amount (mol) = $\frac{\text{mass of sample (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$ |
| $n = \frac{N}{N_A}$ | Amount (mol) = $\frac{\text{number of particles}}{\text{Avogadros number (mol}^{-1}\text{)}}$ |
| $n = c \times V$ | **For solutions**<br>Amount (mol) = concentration (mol $L^{-1}$) × volume (L) |
| $n = \frac{V}{V_M}$ | **For gases at standard temperatures and pressures**<br>Amount (mol) = $\frac{\text{volume of gas (L)}}{\text{molar volume (L mol}^{-1}\text{)}}$<br>where molar volume, $V_M$, is<br>22.4 L $mol^{-1}$ at STP (0°C and 1.0 atm)<br>24.5 L $mol^{-1}$ at SLC (25°C and 1.0 atm) |
| $pV = nRT$<br>and<br>$pV = \frac{m}{M}RT$ | **For gases**<br>Pressure (kPa) × volume (L)<br>= amount (mol) × gas constant (8.31 J $K^{-1}$ $mol^{-1}$) × temperature (K) |
| $\frac{pV}{T} = k$ or<br>$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ | **For a fixed amount of a gas**<br>$\frac{\text{pressure of gas} \times \text{volume of gas}}{\text{temperature of gas (K)}}$ = a constant |

| Unit of concentration | What it means |
|---|---|
| % m/m | Mass of solute (in g) in 100 g of solution |
| % m/v | Mass of solute (in g) in 100 mL of solution |
| % v/v | Volume of solute (in mL) in 100 mL of solution |
| ppm | Mass of solute (in g) in $10^6$ g of solution<br>(equivalent to mg $L^{-1}$ for dilute solutions) |
| ppb | Mass of solute (in g) in $10^9$ g of solution<br>(equivalent to μg $L^{-1}$ for dilute solutions) |

For dilution of a solution: $c_1 \times V_1 = c_2 \times V_2$
where $c_1$ = initial concentration, $V_1$ = initial volume, $c_2$ = final concentration, $V_2$ = final volume.

| No. | Question | Answer |
|---|---|---|
| **1** | **a** What amount (in mol) of oxygen is present in 5.00 g of glucose, $C_6H_{12}O_6$?<br>**b** How many atoms are present in 8.36 g of hydrogen peroxide, $H_2O_2$? | |
| **2** | What volume of water should be added to 35.0 mL of 0.30 M $H_2SO_4$ in order to produce a 0.090 M solution? | |
| **3** | What pressure does 0.49 mol of $SO_3$ exert in a sealed 3.0 L vessel at 54ºC? | |
| **4** | The heaviest known atom has a mass of about $4 \times 10^{-22}$ g. What would be the mass of one mole of these atoms? | |
| **5** | 2.5 g of a gas initially occupying a volume of 600 mL, at 260 K, is heated to 325 K at constant pressure. What would its new volume be? | |
| **6** | What volume will 62.0 g of carbon dioxide gas occupy at a temperature of 124°C and 210 kPa? | |
| **7** | What volume of water must be added to 1.0 L of a solution containing 70.2 g of NaCl to produce a solution of 0.67 M NaCl? | |
| **8** | 2.06 g of a hydrocarbon occupies 16 L at 27ºC and 20 kPa. Find the molar mass of this compound, and so identify the hydrocarbon. | |

| No. | Question | Answer |
|---|---|---|
| **9** | **a** What volume of 5.00% m/v cloudy ammonia cleaning solution is needed to make 250 mL of a 1.50% m/v solution?<br>**b** What mass of ammonia is present in 150 mL of the 1.50% solution? | |
| **10** | 3.0 g of carbon dioxide occupies 687 mL at 143 800 Pa. What volume does it occupy at a pressure of 199 kPa, assuming temperature is constant? | |
| **11** | 0.778 g of one of the halogens (Group 17) was found to occupy a volume of 122 mL at a pressure of 99.8 kPa and a temperature of 26°C. Which halogen was it? | |
| **12** | A sample of water from a waterway is found to contain 600 ppm mercury. What is this concentration in ppb? | |
| **13** | 3.5 g of $Pb(NO_3)_2$ is added to 60 mL of distilled water in a beaker and stirred to dissolve the solid. 10 mL of this solution is then transferred to another beaker and mixed with 20 mL of distilled water. What are the concentrations (in mol $L^{-1}$) of these two solutions? | |
| **14** | 30 mL of a sodium carbonate solution is made up to a total volume of 300 mL with distilled water. The resultant solution has a sodium carbonate concentration of 0.108 M. What mass of sodium carbonate was present in the original solution? | |
| **15** | 50 mL of a 2.0% m/v glucose solution is mixed with 50 mL of a 6.0% m/v glucose solution. The solution is made up to a total of 300 mL with distilled water. What is the concentration of the final solution? | |
| **16** | A sample of $N_2$ gas collected at 25°C and 750 mmHg pressure occupies 190 mL. What volume will it occupy at STP? | |

| No. | Question | Answer |
|---|---|---|
| **17** | 50 mL of a 16% m/v silver nitrate solution is added to an equal volume of distilled water. What is the concentration of the dilute solution in ppm? | |
| **18** | A solution of silver nitrate ($AgNO_3$) is made by dissolving 2.33 g of solid in 398 mL of distilled water. What is the concentration of this solution in<br>**a** % m/v?<br>**b** M? | |

# Worksheet 1.3
# Stoichiometry

Chemistry Dimensions 2

Stoichiometric problems can be tackled by remembering five basic steps.

*Step 1:* Write a balanced chemical equation for the reaction.

*Step 2:* List all data given, including relevant units. Remember to also write down the symbol of the unknown quantity.

*Step 3:* Convert the data given to moles, using the relevant formulas:

$$n = \frac{m}{M} \quad n = c \times V \quad n = \frac{N}{N_A} \quad n = \frac{pV}{RT} \quad n = \frac{V}{V_M}$$

*Step 4:* Use the chemical equation to determine the mole ratio of the unknown quantity to the known quantity. This ratio enables calculation of the number of moles of the unknown quantity.

*Step 5:* Finally, convert this number of mole back into the relevant units of the unknown.

In all calculation questions, take care to show all steps in your working, including reacting ratios where relevant. Also, take care to add the correct unit to your answer (e.g. mol, L) and give your answer to the correct number of significant figures.

**1.** Find the empirical formula of an alkane extracted from natural gas if, upon complete combustion, a sample of the alkane produces 7.75L of carbon dioxide, measured at SLC and 7.59g of water. Name the alkane. **$C_3H_8$ (propane)**

**2.** An organic compound formed by fermentation of sugar is known to contain only the elements carbon, hydrogen and oxygen. It is analysed by burning a 1.00g sample in air. If 1.91g of carbon dioxide and 1.17g of water are produced, determine the empirical formula of the compound. Name and draw the compound. **$C_2H_6O$ (ethanol)**

**3.** The active ingredient of an antacid powder is magnesium carbonate. When treated with excess hydrochloric acid, a 3.50g sample of the antacid produced 714mL of carbon dioxide, measured at 22.0$^{O}$C and 101.3kPa pressure. Calculate the percentage of magnesium carbonate in the powder. **71.1% $MgCO_3$ in the antacid powder**

**4.** Calculate the mass of silver bromide that can be formed if a solution containing 15.0g of silver nitrate is allowed to react with a solution containing 10.0g of calcium bromide. **16.6g AgBr**

| No. | Question | Answer |
|---|---|---|
| **1** | $SO_2$ in the atmosphere contributes to acid rain. The equation for formation of the acid is represented by the equation:<br>$2SO_2(g) + O_2(g) + 2H_2O(l) \rightarrow H_2SO_4(aq)$<br>What mass of sulfuric acid will form from 50.0 L of sulfur dioxide at SLC? | |
| **2** | Phosphoric acid can be generated by the oxidation of phosphorus with nitric acid according to the following equation:<br>$P(s) + 5HNO_3(aq) \rightarrow H_3PO_4(aq) + H_2O(l) + 5NO_2(g)$<br>If sufficient reactants are available to produce 1.00 kg of phosphoric acid ($H_3PO_4$), what mass of nitrogen dioxide will also be generated in the reaction? | |
| **3** | 23.8 mL of sulfuric acid is just neutralised by 29.9 mL of 2.86 M sodium hydrogen carbonate solution, according to the equation:<br>$2NaHCO_3(aq) + H_2SO_4(aq) \rightarrow Na_2CO_3(aq) + CO_2(g) + H_2O(l)$<br>Determine the concentration of the sulfuric acid solution used. | |
| **4** | In a car accident, the impact triggers ignition of a detonator cap in the air bag, which causes sodium azide ($NaN_3$) to decompose explosively.<br>**a** Write the equation to show the decomposition of sodium azide into solid sodium and nitrogen gas.<br>**b** If the bag contained 75 g of sodium azide, what volume of gas would form at 30ºC and 101.3 kPa? | |
| **5** | Sodium thiosulfate reacts with bromine in alkaline solution according to the equation:<br>$Na_2S_2O_3(aq) + 4Br_2(l) + 10NaOH(aq) \rightarrow 2Na_2SO_4(aq) + 8NaBr(aq) + 5H_2O(l)$<br>In order to completely react with 10.0 mL of bromine of density 3.12 g $mL^{-1}$, 239 mL of NaOH was added along with excess $Na_2S_2O_3$. Determine the concentration of the sodium hydroxide solution required. | |

| No. | Question | Answer |
|---|---|---|
| **6** | Ammonium sulfate, an important fertiliser, can be prepared by the reaction of ammonia with sulfuric acid according to the equation:<br>$2NH_3(g) + H_2SO_4(l) \rightarrow (NH_4)_2SO_4(aq)$<br>Calculate the volume of $NH_3$ needed to react with 19.56 g of $H_2SO_4$ at 87°C and 2.99 atm. | |
| **7** | When magnesium carbonate is heated strongly, it decomposes to magnesium oxide and carbon dioxide gas.<br>What volume of carbon dioxide would be produced at STP when 100 g of magnesium oxide was generated in this reaction? | |
| **8** | When solid calcium carbonate reacts with nitric acid solution, neutralisation takes place.<br>**a** Write the equation for this reaction.<br>**b** If 10.0 g of calcium carbonate reacts with 100 mL of 0.500 M nitric acid, what volume of carbon dioxide is formed at SLC? | |
| **9** | Arsenic undergoes oxidation by a hot, concentrated solution of sodium hydroxide to produce sodium arsenate and hydrogen gas according to the equation:<br>$2As(s) + 6NaOH(aq) \rightarrow 2Na_3AsO_3(s) + 3H_2(g)$<br>6.57 g of arsenic is reacted with 250 mL of 0.779 M sodium hydroxide solution. Calculate the mass of hydrogen gas evolved in the process. | |
| **10** | 8.00 g of barium hydroxide is dissolved in 120 mL of 1.886 M hydrochloric acid to produce barium chloride solution and water.<br>**a** Write an equation to represent this neutralisation reaction<br>**b** Determine the concentration of the barium chloride solution that results. | |

**REVISION QUESTIONS:**

1. Write the formulas for compounds composed of the following ions

a. Tin (II) and acetate ___________________

b. Copper(I) and oxide ___________________

c. Iron (III) and carbonate __________________

d. Hydrogen and sulphate ___________________

e. Potassium and nitrite ___________________

f. Calcium and phosphate ___________________

2. Complete the table, filling in each box with the proper formula

| | | ANIONS | | | | |
|---|---|---|---|---|---|---|
| | | $Br^-$ | $O^{2-}$ | $NO_3^-$ | $PO_4^{3-}$ | $CO_3^{2-}$ |
| CATIONS | $K^+$ | | | | | |
| | $Mg^{2+}$ | | | | | |
| | $Al^{3+}$ | | | | | |
| | $Zn^{2+}$ | | | | | |
| | $H^+$ | | | | | |

3. Write the formula of the compound formed from the following ions

a. Na and Br __________________

b. Ba and F __________________

c. Al and O __________________

d. K and S __________________

e. Sr and Br __________________

4. Write formulas for the following compounds

a. Carbon monoxide ___________

b. Sulfur trioxide ___________

c. Carbon tetrabromide ___________

d. Nitrogen dioxide ___________

e. Nitrogen monoxide ___________

f. Hydrogen peroxide ___________

g. Sodium nitrate ___________

h. Barium hydroxide ___________

i. Silver carbonate ___________

j. Potassium dihydrogen phosphate ___________

k. Sodium oxalate ___________

l. Potassium thiocyanate ___________

m. Sodium hypochlorite ___________

n. Chromium (III) sulfite ___________

o. Potassium permanganate ___________

p. Cobalt (II) hydrogen carbonate ___________

q. Sodium chromate ___________

r. Potassium dichromate ___________

5. Write formulas for these acids

a. Nitric acid ___________

b. Carbonic acid ___________

c. Phosphoric acid ___________

6. Name these compounds

a. $CuCl_2$ ___________________________

b. $SnF_2$ ___________________________

c. $BaCO_3$ ___________________________

7. Name these compounds

a. $Ag_2SO_4$ ___________________________

b. $NH_4Br$ ___________________________

c. $BaCrO_4$ ___________________________

8. Name these acids

a. $HCl$ ______________________________

b. $HF$ ______________________________

c. $H_2SO_4$ ______________________________

d. $HBr$ ______________________________

e. $HNO_2$ ______________________________

f. $HClO_4$ ______________________________

g. $HIO_3$ ______________________________

h. $HNO_3$ ______________________________

9. $X_2Y$ is a stable compound. What ionic charge would you predict for X and Y?

X: _________ Y: _________

10. Balance these equations:

a. $MnO_2 + CO \longrightarrow Mn_2O_3 + CO_2$

b. $Mg_3N_2 + H_2O \longrightarrow Mg(OH)_2 + NH_3$

c. $Al + H_2SO_4 \longrightarrow Al_2(SO_4)_3 + H_2$

d. $SO_2 + O_2 \longrightarrow SO_3$

11. Complete and balance the following equations (include states)

a. $C + O_2 \longrightarrow$

b. $Mg + H_2SO_4 \longrightarrow$

c. $Na_2O + HCl \longrightarrow$

12. Use the electrochemical series to predict which reactions will happen. Complete and balance the equations. Where no reaction will occur, write "no reaction".

a. $Ag_{(s)} + H_2SO_{4(aq)} \longrightarrow$

b. $Cl_{2(g)} + NaBr_{(aq)} \longrightarrow$

c. $I_{2(s)} + Cu_{(s)} \longrightarrow$

d. $Cu_{(s)} + FeCl_{3(aq)} \longrightarrow$

13. If, in a balanced equation, $7Al_2(SO_4)_3$ appears.

a. How many atoms of aluminium are represented? _______________

b. How many atoms of sulphur are represented? _______________

c. How many atoms of oxygen are represented? _______________

d. How many atoms of all kinds are represented? _______________

14. Write balanced equations for the combustion of the following hydrocarbons (include states)

a. Ethane: ____________________________________________________________________

b. Octane: ____________________________________________________________________

c. Butane: ____________________________________________________________________

15. Calculate the mass of substance for the following question

a. 2.52mol of $Fe(OH)_3$

c. 0.24L of 0.34M NaCl

b. $4.50 \times 10^{25}$ molecules of glucose

d. 17mL of $O_2$ at 34°C and 1atm

16. Calculate the amount (number of mol) for the following questions

a. 25.0g of $KNO_3$

b. 20mL of 0.012M NaOH

c. $9.8 \times 10^{24}$ molecules of $CO_2$

d. 50mL of $N_2$ at SLC conditions

e. $23.4dm^3$ of sulfur dioxide at $15^{o}C$ and 745mmHg

17. How many mole of $CO_2$ can be produced from the combustion of 7.85mol of ethanol ($C_2H_5OH$)?

18. How many grams of sodium hydroxide can be produced from 500g of calcium hydroxide according to this equation:

$$Ca(OH)_2 + Na_2CO_3 \longrightarrow 2NaOH + CaCO_3$$

19. How many grams of iron and steam must react to form 375g of magnetic iron oxide, $Fe_3O_4$?

$$3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$$

20. 16.0g of potassium hydroxide and 12.0g of nitric acid were reacted to form potassium nitrate and water. Write an equation and determine which reactant is the limiting reactant and which reactant is in excess.

Equation: ________________________________________________________

Limiting reactant: __________________

Excess reactant: __________________

21. When a certain non-metal whose formula is $X_8$ burns in air $XO_3$ forms. Write a balanced equation for this reaction. If 120.0g of oxygen gas is consumed completely, along with 80.0g of $X_8$, identify element X (name and symbol).

Equation: ________________________________________________________

Identity of X: __________________

22. Calculate the empirical and molecular formulas of a compound that contains 80.0% C, 20.0% H, and has a molar mass of 30.00$gmol^{-1}$.

Empirical formula: _____________

Molecular formula: _____________

23. What is the percentage composition of $MgP_2O_7$?

| |
|---|
| |

24. Define each of the following:

a. Oxidant: ____________________________________________________________

b. Reductant: __________________________________________________________

c. Oxidation number: ____________________________________________________

d. Oxidation: ___________________________________________________________

e. Reduction: ___________________________________________________________

25. What is the oxidation number of the underlined element in each compound?

a. $\underline{N}O_2^-$ ________

b. $K\underline{Cl}O_3$ ________

c. $K\underline{Mn}O_4$ ________

d. $H_2\underline{S}O_3$ ________

26. Balance the following half-equations and determine if the initial species was acting as either an oxidant OR as a reductant

a. $MnO_4^-{}_{(aq)} \longrightarrow Mn^{2+}{}_{(aq)}$ oxidant/reductant (circle)

b. $Br^-{}_{(aq)} \longrightarrow Br_2$ oxidant/reductant (circle)

27. Balance the following equation by constructing half-equations.

$$MnO_4^-{}_{(aq)} + ClO_2^-{}_{(aq)} \longrightarrow MnO_{3(s)} + ClO_4^-{}_{(aq)}$$

Half-equation 1: ______________________________________________________

Half-equation 2: ______________________________________________________

28. A 10.0mL sample of $HNO_3$ was diluted to a volume of 100.0mL. 25mL of the dilute solution was needed to neutralise 50.0mL of a 0.60M KOH solution. What was the concentration of the original nitric acid?

29. If 3.0g of NaOH is added to 500mL of 0.10M HCl, will the resulting solution be acidic or basic? What will the pH be?

30. What volume of 0.124M HCl is needed to neutralise 2.00g of $Ca(OH)_2$?

| Worksheet 1.2 Calculations involving gases and solutions - answers | Chemistry Dimensions 2 |
|---|---|

| No. | Answer |
|---|---|
| **1** | **a** $n(C_6H_{12}O_6) = \frac{m}{M} = \frac{5.00}{180.0}$ mol<br>$n(O) = 6 \times n(C_6H_{12}O_6) = 6 \times \frac{5.00}{180.0} = 0.167$ mol<br>**b** $n(H_2O_2) = \frac{m}{M} = \frac{8.36}{34.0}$ mol<br>$n(\text{atoms}) = 4 \times n(H_2O_2)$<br>$N(\text{atoms}) = n \times N_A = 4 \times \frac{8.36}{34.0} \times 6.02 \times 10^{23} = 5.92 \times 10^{23}$ |
| **2** | $c_1 \times V_1 = c_2 \times V_2,\ \therefore\ V_2 = \frac{c_1 \times V_1}{c_2} = \frac{0.30 \times 35.0}{0.090} = 117$ mL<br>$\therefore\ V(H_2O)$ added = 117 – 35 = 82 mL |
| **3** | $pV = nRT\ \therefore\ p = \frac{0.49 \times 8.31 \times 327}{3.0} = 4.4 \times 10^2$ kPa |
| **4** | $M = 4 \times 10^{-22} \times 6.02 \times 10^{23} = 2 \times 10^2$ g mol$^{-1}$ |
| **5** | $\frac{V}{T}$ = constant $\therefore\ \frac{V_1}{T_1} = \frac{V_2}{T_2}\ \therefore\ V_2 = \frac{V_1 \times T_2}{T_1} = \frac{600 \times 325}{260} = 750$ mL |
| **6** | $pV = nRT$ and $n = \frac{m}{M}\ \therefore\ pV = \frac{m}{M}RT\ \therefore\ V = \frac{mRT}{pM} = \frac{62.0 \times 8.31 \times 397}{210 \times 44.0} = 22.1$ L |
| **7** | $c(\text{NaCl}) = \frac{n}{V} = \frac{m}{M \times V} = \frac{70.2}{58.5 \times 1.0} = 1.2$ M<br>$V_2 = \frac{c_1 \times V_1}{c_2} = \frac{1.2 \times 1.0}{0.67} = 1.79$ L<br>$\therefore$ 0.79 L of water must be added. |
| **8** | $pV = nRT$ and $n = \frac{m}{M}\ \therefore\ pV = \frac{m}{M}RT\ \therefore\ M = \frac{mRT}{pV} = \frac{2.06 \times 8.31 \times 300}{20 \times 16} = 16$ g mol$^{-1}$<br>The gas is methane. |
| **9** | **a** $V_1 = \frac{c_2 \times V_2}{c_1} = \frac{1.50 \times 250}{5.00} = 75$ mL<br>**b** 1.50% m/v means 1.5 g of ammonia in 100 mL of solution<br>We require *x* g of ammonia in 150 mL.<br>$\therefore\ x = 1.50 \times \frac{150}{100} = 2.25$ g |

| No. | Answer |
|---|---|
| **10** | $p \times V = \text{constant} \therefore p_1V_1 = p_2V_2 \therefore V_2 = \frac{p_1 \times V_1}{p_2} = \frac{143.8 \times 687}{199} = 496$ mL |
| **11** | $pV = \frac{mRT}{M} \therefore M = \frac{mRT}{pV} = \frac{0.778 \times 8.31 \times 299}{99.8 \times 122 \times 10^{-3}} = 159$ g mol$^{-1}$<br>The halogen must be bromine ($Br_2$). |
| **12** | 600 ppm = 600 mg in 1.0 L = 600 000 μg in 1.0 L = 600 000 ppb |
| **13** | $n(Pb(NO_3)_2) = \frac{m}{M} = \frac{3.5}{331.2} = 0.0106$ mol<br>$c(Pb(NO_3)_2) = \frac{n}{V} = \frac{0.0106}{0.060} = 0.177$ M<br>$c_2 = \frac{c_1 \times V_1}{V_2} = \frac{0.177 \times 10}{30} = 0.059$ M |
| **14** | $c_1 = \frac{c_2 \times V_2}{V_1} = \frac{0.108 \times 300}{30} = 1.08$ M<br>$n(Na_2CO_3) = c \times V = 1.08 \times 0.030 = 0.0324$ mol<br>$m(Na_2CO_3) = n \times M = 0.0324 \times 106.0 = 3.4$ g |
| **15** | 2.0% m/v means 2.0 g of glucose in 100 mL of solution.<br>∴ in 50 mL of solution, 0.50 × 2.0 g<br>Total *m*(glucose) = (0.50 × 2.0) + (0.50 × 6.0) = 4.0 g<br>4.0 g of glucose in a volume of 300 mL gives a concentration of $\frac{4.0}{300} \times 100 = 1.3\%$ m/v |
| **16** | $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2} \therefore V_2 = \frac{p_1V_1T_2}{T_1p_2} = \frac{750 \times 190 \times 273}{298 \times 760} = 172$ mL |
| **17** | $c_2 = \frac{c_1 \times V_1}{V_2} = \frac{16 \times 50}{100} = 8\%$ m/v<br>8% m/v = 8 g/100 mL = 80 g L$^{-1}$ = 80 000 mg L$^{-1}$ = $8.0 \times 10^4$ ppm |
| **18** | **a** 2.33 g in 398 mL ∴ $2.33 \times \frac{100}{398}$ in 100 mL = 0.585% m/v<br>**b** $n(AgNO_3) = \frac{m}{M} = \frac{2.33}{169.9}$ mol<br>$c(AgNO_3) = \frac{n}{V} = \frac{2.33}{169.9 \times 0.398} = 3.45 \times 10^{-2}$ M |

# Worksheet 1.3
# Stoichiometry – answers

Chemistry Dimensions 2

| No. | Answer |
|---|---|
| **1** | $n(SO_2) = \frac{V}{V_M} = \frac{50.0}{24.5} = 2.04$ mol<br>$n(H_2SO_4) = n(SO_2)$<br>$m(H_2SO_4) = n \times M = 2.04 \times 98.1 = 2.00 \times 10^2$ g |
| **2** | $n(H_3PO_4) = \frac{m}{M} = \frac{1000}{98.0} = 10.2$ mol<br>$n(NO_2) = 5 \times n(H_3PO_4) = 51.0$ mol<br>$m(NO_2) = n \times M = 51.0 \times 46.0 = 2.35 \times 10^3$ g |
| **3** | $n(NaHCO_3) = c \times V = 2.86 \times 0.0299 = 0.0855$ mol<br>$n(H_2SO_4) = \frac{1}{2} \times n(NaHCO_3) = 0.0428$ mol<br>$c(H_2SO_4) = \frac{n}{V} = \frac{0.0428}{0.0238} = 1.80$ M |
| **4** | **a** $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$<br>**b** $n(NaN_3) = \frac{m}{M} = \frac{75}{65.0}$<br>$n(N_2) = \frac{3}{2} \times n(NaN_3)$<br>$V(N_2) = \frac{nRT}{p} = \frac{3}{2} \times \frac{75 \times 8.31 \times 303}{65.0 \times 101.3} = 43$ L |
| **5** | $m(Br_2)$ = density × volume = 3.12 × 10.0 = 31.2 g<br>$n(Br_2) = \frac{m}{M} = \frac{31.2}{159.8} = 0.195$ mol<br>$n(NaOH) = \frac{10}{4} \times n(Br_2) = 0.488$ mol<br>$c(NaOH) = \frac{n}{V} = \frac{0.488}{0.239} = 2.04$ M |
| **6** | $n(H_2SO_4) = \frac{m}{M} = \frac{19.56}{98.1} = 0.1994$ mol<br>$n(NH_3) = 2 \times n(H_2SO_4) = 2 \times 0.1994 = 0.3988$ mol<br>$V(NH_3) = \frac{nRT}{p} = \frac{0.3988 \times 8.31 \times 360}{2.99 \times 101.3} = 3.94$ L |
| **7** | $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$<br>$n(MgO) = \frac{m}{M} = \frac{100}{40.3} = 2.48$ mol<br>$n(CO_2) = n(MgO) = 2.48$ mol<br>$V(CO_2) = n \times V_M = 2.48 \times 22.4 = 55.6$ L |

| No. | Answer |
| --- | --- |
| **8** | **a** $CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + CO_2(g) + H_2O(l)$<br>**b** $n(CaCO_3) = \frac{m}{M} = \frac{10.0}{100.1} = 0.100$ mol<br>$n(HNO_3) = c \times V = 0.500 \times 0.100 = 0.0500$ mol<br>0.100 mol of $CaCO_3$ will react with 0.200 mol of $HNO_3$, $\therefore$ $HNO_3$ is the limiting reagent.<br>$n(CO_2) = \frac{1}{2} \times n(HNO_3) = 0.0250$ mol<br>$V(CO_2) = n \times V_M = 0.0250 \times 24.5 = 0.613$ L |
| **9** | $n(As) = \frac{m}{M} = \frac{6.57}{74.9} = 0.0877$ mol<br>$n(NaOH) = c \times V = 0.779 \times 0.250 = 0.195$ mol<br>1 As: 3 NaOH, $\therefore$ 0.0877 mol of arsenic would react with 0.263 mol of sodium hydroxide<br>$\therefore$ NaOH is the limiting reagent.<br>$n(H_2)$ produced $= \frac{1}{2} \times n(NaOH) = 0.0975$ mol<br>$m(H_2) = n \times M = 0.0975 \times 2.0 = 0.195$ g |
| **10** | **a** $Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$<br>**b** $n(Ba(OH)_2) = \frac{m}{M} = \frac{8.00}{171.3} = 0.0467$ mol<br>$n(HCl) = c \times V = 1.886 \times 0.120 = 0.226$ mol<br>0.0467 mol of $Ba(OH)_2$ would react with 0.0934 mol of HCl, $\therefore$ HCl is in excess<br>$n(BaCl_2) = n(Ba(OH)_2) = 0.0467$ mol<br>$c(BaCl_2) = \frac{n}{V} = \frac{0.0467}{0.120} = 0.389$ M |

**You may use this page for working out.**