A-Level Chemistry – Summer Bridging Work

Questions to be completed and handed in on your first lesson.

Read-through the accompanying documents first: "Exam Hints for Students"; "Language of Measurement in Context – Chemistry".

Introduction

The transition from GCSE Science to A Level can be daunting – it's a bigger step up than many expect it to be, and if you're not on the front foot, you can get left behind very quicky and spend a term or two catching up.

You must get organised. You'll be expected to remember a lot more facts, equations, definitions, and new concepts. You will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

You won't be given a book to write your notes in, that's up to you. Most students choose loose leaf A4 paper and maintain a series of folders for separate chapters or key learning groups such as definitions, mechanisms, calculation equations, etc...

The aim of these worksheets is to give you a head start by helping you to pre-learn or consolidate some basic, foundation knowledge and skills.

Part 1 – Key Terms for Science Practicals

When is a result accurate?	
What is precision?	
What is resolution?	
What is repeatability?	
What is reproducibility?	
What is the uncertainty of a piece of measuring apparatus?	
How do you calculate % uncertainty (or "% error")? i.e. what's the equation...	
In terms of uncertainty, what's the basic difference between taking a volume reading from a measuring cylinder versus the volume added from a burette?	
What is an anomalous result?	

How would you treat an anomalous result?	
What is a “human error”?	
What is a “random error”?	
What can you do to reduce the effect of human and random errors?	
What is a “systematic error”?	
What is a “zero error”?	
What can you do to reduce the effect of systematic and zero errors?	
Which variable is changed (or allowed to change) by the investigator?	
Which variable is a measured response to the changes made to the experiment by the investigator?	
Which type of variable must be kept the same by the investigator?	
What is “a fair test”?	

Part 2 – Significant Figures ("s.f.", "sig.fig.") and Decimal Places ("d.p.")

The word significant is used to assign the values that 'have meaning'. A number that is expressed in significant figures will only have digits that are important to the number's precision.

It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

For example, 6.9301 becomes 6.93 if written to three significant figures.

Likewise, 0.000 434 56 is 0.000 435 to three significant figures.

Notice that the zeros before the figure are *not* significant – they just show you how large the number is by the position of the decimal point. Here, a 5 follows the last significant digit, so just as with decimals, it must be rounded up.

Any zeros between the other significant figures are significant.

For example, 0.003 018 is 0.003 02 to three significant figures.

Sometimes numbers are expressed to a certain number of decimal places instead. The decimal point is a place holder and the number of digits afterwards is the number of decimal places.

For example, the mathematical number pi is...

3 to zero decimal places,

3.1 to one decimal place,

3.14 to two decimal places, and

3.142 to three decimal places.

In chemistry, you are often asked to express numbers to a specific number of significant figures (usually 2 or 3 if it's stated), or a specific number of decimal places (usually 2, but not always).

However, it's not so straight forward when it says to "an appropriate number of significant figures". When this is asked, your answer should be quoted to the least number of decimal places or significant figures that features in any one of the data values used to calculate your answer.

Practice Questions

1 From the following values, adjust your answer in line with the number of significant figures (s.f.) stated in the brackets:

a 36.937 (3 s.f.)

b 258 (2 s.f.)

c 0.043 19 (2 s.f.)

d 7 999 032 (1 s.f.)

2 From the following values, adjust your answer in line with the number of decimal places (d.p.) stated in the brackets:

a 4.763 (1 d.p.)

b 0.543 (2 d.p.)

c 1.005 (2 d.p.)

d 1.9996 (3 d.p.)

Part 3 – Converting Units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard "SI" units (*Système International*).

If you convert between units and round numbers properly it allows quoted measurements to be understood within the scale of the observations.

Multiplication factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

Unit conversions are common.

For example, you could be converting an enthalpy change of 488 889 J mol^{-1} into kJ mol^{-1}. A kilo is 10^3 so you need to divide by this number (i.e. 1000) or move the decimal point three places to the left.

488 889 J mol^{-1} $\div 10^3$ = 488.889 kJ mol^{-1}

Converting from mJ mol^{-1} to kJ mol^{-1}, you need to go from 10^3 to 10^{-3}, or move the decimal point six places to the left.

333 mJ mol^{-1} is 0.000 333 kJ mol^{-1}

If you want to convert from 333 mJ mol^{-1} to nJ mol^{-1}, you would have to go from 10^{-9} to 10^{-3}, or move the decimal point six places to the right.

333 mJ mol^{-1} is 333 000 000 nJ mol^{-1}

Practice Questions

1 Calculate the following unit conversions.

a 300 μm to m

b 5 MJ to mJ

c 10 GW to kW

Part 4 – Calculating Percentage Uncertainty in Apparatus

The percentage uncertainty of a measurement is calculated from the maximum error for the piece of apparatus being used (based on its “uncertainty” or “error range”) and the value measured:

$$\text{percentage error} = \frac{\text{maximum error}}{\text{measured value}} \times 100\%$$

For example, in an experiment to measure temperature changes, an excess of zinc powder was added to 50 cm^3 of copper(II) sulfate solution to produce zinc sulfate and copper.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

The measuring cylinder used to measure the copper(II) sulfate solution has a maximum error of ±5 cm^3.

First, calculate the percentage error.

$$\text{percentage error} = (5/50) \times 100\% = 10\%$$

Secondly, consider that the thermometer has a maximum error of ±0.05 °C.

Calculate the percentage error when the thermometer is used to record a temperature rise of 3.9 °C. Give your answer to 3 significant figures.

$$\text{percentage error} = (\mathbf{2} \times 0.05)/3.9 \times 100\% = 2.56\%$$

[Note that **two** measurements are required to calculate the temperature change, so the maximum error is doubled.]

Practice Questions

1 A gas syringe has a maximum error of ±0.5 cm^3.

Calculate the maximum percentage error when recording these values. Give your answers to 3 significant figures.

a 21.0 cm^3

b 43.0 cm^3

2 A thermometer has a maximum error of ±0.5 °C.

Calculate the maximum percentage error when recording these temperature rises. Give your answers to an appropriate number of significant figures.

a 12.0 °C

b 37.6 °C