AQA
Realising potential

Mathematics for Chemistry Students

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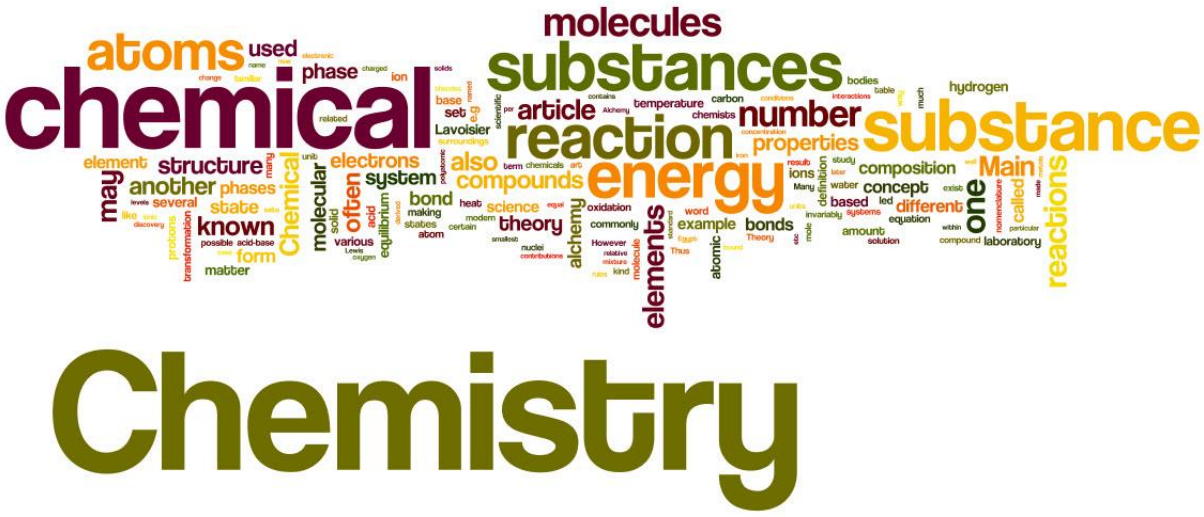

Name:

Mathematical Requirements

6.1 Arithmetic and numerical computation

	Mathematical skills	Exemplification of mathematical skill in the context of chemistry
MS 0.0	Recognise and make use of appropriate units in calculation	Students may be tested on their ability to: • convert between units eg cm^3 to dm^3 as part of volumetric calculations • **give units for an equilibrium constant or a rate constant** • understand that different units are used in similar topic areas, so that conversions may be necessary, eg entropy in J mol^{-1} K^{-1} and enthalpy changes in kJ mol^{-1}.
MS 0.1	Recognise and use expressions in decimal and ordinary form	Students may be tested on their ability to: • use an appropriate number of decimal places in calculations eg for pH • carry out calculations using numbers in standard and ordinary form eg use of Avogadro's number • understand standard form when applied to areas such as (but not limited to) K_w • convert between numbers in standard and ordinary form • understand that significant figures need retaining when making conversions between standard and ordinary form eg 0.0050 mol dm^{-3} is equivalent to 5.0×10^{-3} mol dm^{-3}.

	Mathematical skills	Exemplification of mathematical skill in the context of chemistry
MS 0.2	Use ratios, fractions and percentages	Students may be tested on their ability to: • calculate percentage yields • calculate the atom economy of a reaction • construct and/or balance equations using ratios.
MS 0.3	Estimate results	Students may be tested on their ability to: • **evaluate the effect of changing experimental parameters on measurable values eg how the value of K_c would change with temperature given different specified conditions.**
MS 0.4	Use calculators to find and use power, **exponential and logarithmic functions**	Students may be tested on their ability to: • carry out calculations using the Avogadro constant • **carry out pH and pK_a calculations** • **make appropriate mathematical approximations in buffer calculations.**

6.2 Handling data

	Mathematical skills	Exemplification of mathematical skill in the context of chemistry
MS 1.1	Use an appropriate number of significant figures	Students may be tested on their ability to: • report calculations to an appropriate number of significant figures, given raw data quoted to varying numbers of significant figures • understand that calculated results can only be reported to the limits of the least accurate measurement.
MS 1.2	Find arithmetic means	Students may be tested on their ability to: • calculate weighted means eg calculation of an atomic mass based on supplied isotopic abundances • select appropriate titration data (ie identification of outliers) in order to calculate mean titres.
MS 1.3	Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	Students may be tested on their ability to: • determine uncertainty when two burette readings are used to calculate a titre value.

6.3 Algebra

	Mathematical skills	Exemplification of mathematical skill in the context of chemistry
MS 2.1	Understand and use the symbols: =, <, <<, >>, >, ∝, ~, equilibrium sign	No exemplification required.
MS 2.2	Change the subject of an equation	Students may be tested on their ability to: • carry out structured and unstructured mole calculations **eg calculate a rate constant *k* from a rate equation.**
MS 2.3	Substitute numerical values into algebraic equations using appropriate units for physical quantities	Students may be tested on their ability to: • carry out structured and unstructured mole calculations • **carry out rate calculations** • **calculate the value of an equilibrium constant K_c.**
MS 2.4	Solve algebraic equations	Students may be tested on their ability to: • carry out Hess's law calculations • **calculate a rate constant *k* from a rate equation.**
MS 2.5	**Use logarithms in relation to quantities that range over several orders of magnitude**	Students may be tested on their ability to: • **carry out pH and pK_a calculations.**

6.4 Graphs

	Mathematical skills	Exemplification of mathematical skill in the context of chemistry
MS 3.1	Translate information between graphical, numerical and algebraic forms	Students may be tested on their ability to: • interpret and analyse spectra • **determine the order of a reaction from a graph** • **derive a rate expression from a graph.**
MS 3.2	Plot two variables from experimental or other data	Students may be tested on their ability to: • plot concentration–time graphs from collected or supplied data and draw an appropriate best-fit curve.
MS 3.3	**Determine the slope and intercept of a linear graph**	Students may be tested on their ability to: • **calculate the rate constant of a zero-order reaction by determination of the gradient of a concentration–time graph.**
MS 3.4	**Calculate rate of change from a graph showing a linear relationship**	Students may be tested on their ability to: • **calculate the rate constant of a zero-order reaction by determination of the gradient of a concentration–time graph.**
MS 3.5	**Draw and use the slope of a tangent to a curve as a measure of rate of change**	Students may be tested on their ability to: • **determine the order of a reaction using the initial rates method.**

6.5 Geometry and trigonometry

	Mathematical skills	Exemplification of mathematical skill in the context of chemistry
MS 4.1	Use angles and shapes in regular 2D and 3D structures	Students may be tested on their ability to: • predict/identify shapes of and bond angles in molecules with and without a lone pair(s), for example NH_3, CH_4, H_2O etc.
MS 4.2	Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects	Students may be tested on their ability to: • draw different forms of isomers • **identify chiral centres from a 2D or 3D representation.**
MS 4.3	Understand the symmetry of 2D and 3D shapes	Students may be tested on their ability to: • describe the types of stereoisomerism shown by molecules/complexes • **identify chiral centres from a 2D or 3D representation.**

Indices

(a) Simplify $a^{20} \times a^5$

Answer .....

(b) Simplify $\frac{a^{20}}{a^5}$

Answer .....

(c) Simplify $(a^{20})^5$

(a) Simplify

(i) $y^7 \times y^2$

(ii) $y^7 \div y^2$

(iii) $(y^7)^2$

(b) (i) If $y = -1$ which answer in part (a) is positive?

(ii) If $y = 0.5$ which answer in part (a) has the greatest value?

Put these in order starting with the smallest.
You **must** show the value of each number in your working.

$9^{\frac{1}{2}}$ $\quad$ $(-7)^0$ $\quad$ $\left(\frac{1}{8}\right)^{-\frac{1}{3}}$

Ratio

Here is a list of ingredients.

Serves 4 people	
Bacon	50 g
Minced beef	450 g
Chopped tomatoes	400 g
Button mushrooms	100 g
Beef stock	125 ml

Marco is making a meal for 14 people using these ingredients.

Work out the number of grams of minced beef he needs.

Ali, Beth and Clare take a test.

The ratio of Ali's score to Beth's score is 5 : 3
Ali scored 10 more marks than Beth.

Clare scored 7 more marks than Ali.

Work out each of their scores.

Researchers investigated some characteristics of people from different parts of England. In the north of England they selected 200 people and recorded their phenotypes for three different characteristics.

Their results are shown in the figure below.

Phenotype produced by dominant allele	Number of people	Phenotype produced by recessive allele	Number of people
Tongue roller	131	Non-tongue roller	58
Right-handed	182	Left-handed	14
Straight thumb	142	Hitch-hiker thumb	50

Calculate the ratio of straight thumb to hitch-hiker thumb in this study.

Standard Form

1) Standard Form is a way of writing _____ numbers easily.

2) A number in standard form is made up of _____ parts.

3) The first part must be a number between _____ and _____

4) The second part is _____ to the power of a number.

5) There are 7.2×10^9 pennies in circulation, although 2.1×10^9 of them are missing. Write these numbers out in full.

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6) The number of people unemployed in the UK is 2 100 000. Write this number in standard form.

Decimal	Standard form
199600000	
93 000 000	
3 180 000 000	
	2.6×10^{9}
	3×10^{8}
0.0000022	
0.00000000033	
	7.3×10^{-3}

On July 14 2015, the space probe New Horizons passed by Pluto after travelling 4.7×10^{12} metres from Earth.

a) Write this number in decimal form.

Earlier, the space probe flew past Jupiter, which is 5.88×10^{8} metres from Earth.

b) How many times further did the space probe travel from Earth to Pluto than Earth to Jupiter?

0.0125 moles of a particular substance were dissolved in 2.5 dm^3 of water. What is the concentration of this substance? Give your answer in standard form.

A cross section of an artery contains 9.2×10^{-9} m^3 of blood. If this blood weighs 7.1×10^{-3} g, calculate the density of the blood. Leave your answer in standard form.

Using the formula Density = Mass / Volume

Significant Figures

Calculate the number of moles in 25.0cm^3 of 0.15 mol dm^{-3} HCl

Full number	1sf	2sf	3sf	4sf	5sf
9.378652	9	9.4	9.38	9.379	9.3787
4204274					
0.903521					
0.00239482					

Examples

Calculate the average speed of a car that travels 1557 m in 95 seconds.

Calculate the average speed of a car that travels 1557 m in 95.0 seconds.

Calculate the total energy released when 263 kJ and 1282 kJ of energy are released.

Calculate the total mass of calcium carbonate when 0.154 g and 0.01234 g are mixed.

Units and Prefixes

Conversions

kg **g** **mg**

m^3 **dm^3** **cm^3** **mm^3**

Number		Exponential number	Prefix	
billion		10^9		'giga'
million				'mega'
thousand			k	
tenth		10^{-1}	d	'deci'
hundredth			c	'centi'
thousandth				'milli'
millionth			μ	
billionth				'nano'

Example 1

The length of a DNA nucleotide is 0.6 nm.

a) Convert this number into standard form.

b) If a strand of DNA is 1.6 m long, how many nucleotides is it made up of?

Example 2

a) Calculate the following: $\frac{36\ \text{cm}^3}{12\ \text{cm}^2}$

b) Calculate the following: $\frac{36\ \text{kg cm}^{-3}}{64\ \text{cm}^{-2}}$

Exam paper: Example

(c) The table below shows some features of gas exchange of a fish at rest.

Volume of oxygen absorbed by the gills from each dm^3 of water / cm^3	7
Mass of fish / kg	0.4
Oxygen required by fish / $cm^3\ kg^{-1}\ hour^{-1}$	90

(i) Calculate the volume of water that would have to pass over the gills each hour to supply the oxygen required by the fish. Show your working.

..... dm^3

(2)

Extra Practice

Practice Questions

Q1 Convert the following:

a) 240 g to kilograms. b) 4.1 kJ mol^{-1} to joules per mole. c) 0.5 dm^3 to cubic centimetres.

Q2 A reaction takes 4.6 minutes to go to completion. How many seconds is this?

Q3 During a titration, 31 cm^3 of an alkali is needed to neutralise 0.025 dm^3 of an acid. What is the total volume of the acid and the alkali in cm^3?

Practice Questions

Q1 Write down the following amounts:

a) 0.0272 g s^{-1} to 3 decimal places

b) 11.325 dm^3 to 2 decimal places

c) 23.976 kJ to 1 decimal place

d) 0.9191 V to 2 decimal places

Q2 A certain chemical reaction has one product, which is produced at a rate of 325 g every 80 minutes. Using the formula 'rate = mass ÷ time', find the rate of this reaction in kg $hour^{-1}$. Give your answer to 2 decimal places.

Practice Questions

Q1 How many significant figures are each of these values given to?

a) 221 985 Pa b) 15 200 g c) 39.00 K d) 0.00186 mol

Q2 What is 649.352 kJ to: a) two significant figures? b) three significant figures? c) four significant figures?

Q3 0.175 moles of sodium chloride were dissolved in 1.2 dm^3 of water.
Using the formula, 'concentration (mol dm^{-3}) = number of moles ÷ volume (dm^3)', calculate the concentration of the resulting solution. Give your answer to an appropriate number of significant figures.

Practice Questions

Q1 The concentration of hydrogen ions in a solution is measured as 0.000 035 mol dm^{-3}. Rewrite this in standard form.

Q2 The pressure in a container of gas is measured as 2.15×10^5 Pa. Rewrite this in decimal form.

Q3 Using the formula 'number of moles = (concentration × volume in cm^3) ÷ 1000', find the number of moles of sodium hydroxide in 75 cm^3 of 6.3×10^{-5} mol dm^{-3} sodium hydroxide solution. Give your answer in standard form.

Q4 A reaction produced 6.85×10^{12} dm^3 of sulfur dioxide gas.

a) Convert this volume to m^3. Give your answer in standard form.

b) Convert this volume to cm^3. Give your answer in standard form.

Q5 An atom of sodium has a mass of 3.82×10^{-23} g. Use this information to calculate the number of atoms in 25 g of sodium.

PRACTICE QUESTIONS

1 Give the following in standard form:

a 6000 **b** 400 **c** 80000 **d** 9000
e 400000 **f** 0.007 **g** 0.04 **h** 0.000000005
i 0.0234 **j** 0.0000023

2 Give the following as ordinary numbers:

a 5.5×10^{-6} **b** 6.5×10^{-8} **c** 3.2×10^{5} **d** 2.9×10^{2}
e 3.167×10^{-11} **f** 1.115×10^{4} **g** 1.412×10^{-3} **h** 7.2×10^{1}
i 9.01×10^{-2} **j** 1.17×10^{6}

PRACTICE QUESTIONS

3 Give the following values in the stated number of decimal places (*d.p.*).

a 4.763 (1 d.p.) **b** 0.543 (2 d.p.) **c** 12.89 (1 d.p.)
d 2.956 (2 d.p.) **e** 7.895 (2 d.p.) **f** 1.998 (2 d.p.)
g 1.005 (2 d.p.) **h** 1.9996 (3 d.p.)

4 Give the following values in the stated number of significant figures (s.f.).

a 36.937 (3 s.f.) **b** 2.643 (2 s.f.) **c** 19.6754 (4 s.f.)
d 23139 (3 s.f.) **e** 258 (2 s.f.) **f** 0.04319 (2 s.f.)
g 0.00348 (2 s.f.) **h** 7999032 (1 s.f.)

PRACTICE QUESTION

5 Calculate the following unit conversions.

a 15 kg to g

b 300 μm to m

c 5 MJ to mJ

d 10 GW to MW

e 10 GW to kW