4. Numbers and calculations

1. WARM-UP

Questions about mathematics

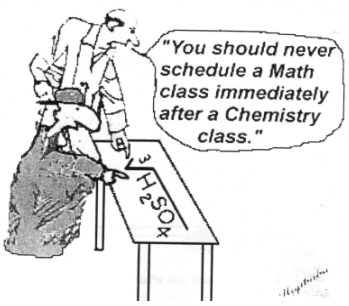
('maths' – the British English pronunciation and spelling, or 'math' the American version)

1. What springs to mind when you hear the word 'mathematics'?
2. *"Everything in science has its origin in mathematics." "Mathematics is the most primary science."* Do you agree?
3. Finish this sentence: People who like maths are…
4. Are all intelligent people good at maths?
5. How often do you use maths in a normal day?
6. Did you have a favourite or hated maths teacher?
7. Do you have a maths horror story?
8. Are you superstitious about numbers?

Read aloud:

a) 23-6=17 b) 32÷8=4 c) 8×9=72

d) $\sqrt[3]{9}=3$ e) -5¼ f) 2^4



Now solve these problems:

1. Take the square root of 36. Add 14. Multiply by 5. Subtract 1.
2. Take the average of 20, 24, 26 and 30. Multiply by 10.
3. Take 50% of the students in your class. Multiply by 2. Divide by 4.
4. Multiply 7 by 9. Add 9. Divide by 6. Subtract 3.

2. READING

Pre-reading questions

a. What number system comprises both rational and irrational numbers?

b. What names are used for basic arithmetic operations?

c. Give the opposite of *exponentiation.*

d. When do you work with proportions in chemistry?

e. What is *percent yield*?

f. Explain the statistical terms *mean, error, deviation.*

g. When is logarithm used in chemistry?

h. What do *square brackets* indicate in chemistry?

Discuss with a partner, then check your answers with the text.
Mathematics in Chemistry

Read the text and complete the gaps with the following words.

average	*absolute*	*constituent*	*fraction*	*equality*	*addition*	*integers*
proportions		*brackets*	*yield*	*ratio*	*power*	

In high school, you explored the **real number system**. This is a set of numbers that includes the **1**_____ or counting numbers, all the rational numbers (numbers that can be represented as a ratio of two whole numbers, such as 1/3 or 3/7) and the irrational numbers (numbers that cannot be represented as a ratio of two whole numbers, such as π, e, and sqrt(2)).
You learned about combining numbers using basic operations like **2**_____ (+), subtraction (-), multiplication (× or *) and division (/). You have also been introduced to several other mathematical functions including: exponentiation (^) -- raising something to a **3**_____ -- and square root ($\sqrt{}$).

Knowing how to work with ratios and proportions is very handy in chemistry classes, especially when working with different units of measurement. Let's start with some dictionary definitions:

Ratio: The relative size of two quantities expressed as the quotient of one divided by the other; the ratio of a to b is written as a/b.
Proportion: An **4**_____ between two ratios.

So what are these things really? Consider the following situation.
In 1995, 78 women were enrolled in chemistry at a certain high school while 162 men were enrolled. What was the **5**_____ of women to men?
Let's answer the questions using the definition of ratio.
women: men is 78:162 or 78/162
We could divide both numbers in the first ratio by six to get the second ratio - so the ratios are equal as well, i.e.,
78/162 = 13/27
These two equalities are examples of **6**_____ (equal ratios); it is as simple as that.

Percents
The word percent comes from the Latin per centum meaning "out of one hundred," so we can think of 22% as "22 out of 100." A percent must be changed to a number (**7**_____ or decimal) before we can compute with it.

- When measuring a sample for its **8**_____ parts, the amounts of each part are often stated as %s -- you'll see this in percent abundance of isotopes and in percent composition of compounds. For example: A sample of lead was tested in a mass spectrometer, and four isotopes were found along with their % abundances: 204 at 1.4%, 206 at 24.1%, 207 at 22.1% and 208 at 52.4%.
- When conducting an experiment to synthesize a chemical compound, you'll compare the amount you should get (according to the theory of how chemicals bind together) to the actual amount you did get from your experiment -- percent **9**_____ = experiment / theory.

Simple statistics
So what else do you need to know to be ready for chemistry? Of all of the terms below, you are probably most familiar with "arithmetic mean", otherwise known as an **10**_____ .
Mean -- add all of the values and divide by the total number of data points
Error -- subtract the theoretical value (usually the number the professor has as the target value) from your experimental data point.
Percent error -- take the **11**_____ value of the error divided by the theoretical value, then multiply by 100.
Deviation -- subtract the mean from the experimental data point
Percent deviation -- divide the deviation by the mean, then multiply by 100

Logarithms, or "logs", are a way of expressing one number in terms of a "base" number that is raised to some power. Common logs are done with base ten, but some logs ("natural" logs) are done with the constant "e" (2.718 281 828) as their base. The log of any number is the power to which the base must be raised to give that number.
Logs are commonly used in chemistry. The most prominent example is the pH scale. The pH of a solution is the –log ([H+]), where square **12** _____ mean concentration.

http://www.shodor.org/unchem/index.html

3. QUANTITIES AND UNITS
http://physics.nist.gov/cuu/Units/units.html

1. What are some quantitative properties that can be measured in this classroom?

2. Complete the missing names of units and number symbols for prefixes:

SI quantity	**unit**	**symbol**	***factor***	***prefix***	***factor***	***prefix***
Length	…….	m	…….	*tera*	…….	*deci*
Mass	…….	kg	…….	*giga*	…….	*centi*
Time	…….	s	…….	*mega*	…….	*milli*
Electric current	…….	A	…….	*kilo*	…….	*micro*
Thermodynamic temperature	…….	K	…….	*hecto*	…….	*nano*
Amount of substance	…….	mol	…….	*deka*	…….	*pico*
Units outside SI system	°C	(*degree centigrade / degree Celsius*)				
	l	*(litre)*				

In pairs, make a few sentences according to the example:
One kilometre equals ten to the power of three meters.

3. Write formulas for these relationships:

1. Velocity is calculated by dividing distance by time.
2. The volume of a cube is calculated by multiplying the length times the width and the height.
3. The circumference of a circle equals π times the diameter.

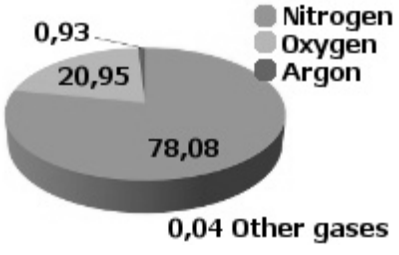
4. Examples of derived units of measurement.
Put these names of quantities in the right place:

Quantity	**unit**	**unit symbol**
1. …….	Square meter	m2
2. …….	Cubic meter	m3
3. …….	Meter per second	m/s
4. …….	Meter per second squared	m/s2
5. …….	Kilogram per cubic meter	kg/m3
6……..	Mole per cubic decimeter	mol/dm3

5. Give names and units of chemical quantities defined as:

- the ratio of the number of particles to a constant?
- the ratio of the mass of substance to the amount of substance?
- the ratio of amount of substance to total volume of the solution?

6. Percents: Describe chemical composition of the air.
http://www.aga.com/international/web/lg/aga/like35agacom.nsf/docbyalias/career_gas_school



4. LISTENING

https://www.youtube.com/watch?v=UXRSHplX-zo

Pre-listening.
When speaking about calculations, what do the following expressions mean?

- Problem
- Equation
- Significant figures
- Round a number

Listening. Tick the phrases that you hear.

A calculate the volume of oxygen
B this is a diatomic molecule
C I can go from grams to liters
D I'm on the right track
E you're worried about significant figures
F I should end with three sig figs
G round in the middle… it will make your answer be good

Post-listening. This is an extract from the automatic script. There are about 10 mistakes. Try to correct them.

…the second thing I guess we want to do is we want to check and make sure its balance, for aluminum, spore low minimums, six oxygen, six oxygen, so I'm good. Now I know these are massive volume problems, so I'm going to read the problem – it says – calculate the volume oxygen gas we need packs number of leaders, that's a volume requires to react with 50 grams of aluminum…

5. FORMULAS and EQUATIONS**:**

NaCl – sodium chlor**ide**	H_2SO_4 – sulphur**ic** acid	$ZnSO_4$ – zinc sulph**ate**	C_6H_6 - benzene
ZnO – zinc ox**ide**	HCl – hydrochlor**ic** acid	Na_2CO_3 – sodium carbon**ate**	NH_3 - ammonia
CO_2 - carbon **di**ox**ide**	NaOH – sodium hydrox**ide**		

These formulas are used in writing EQUATIONS.

Example: **HCl** + **NaOH** → **NaCl** + **H_2O**

We spell as: H Cl **plus** Na OH **gives** Na Cl **plus** H_2O
We read as: hydrochloric acid **reacts with** sodium hydroxide **to form** sodium chloride **and** water.
combines with

Complete these equations.
a) $CuO + H_2 \rightarrow$ ……
(copper oxide reacts with hydrogen to form copper and water)

b) $Na_2CO_3 + 2\ HCl \rightarrow$ ……..
(sodium carbonate reacts with hydrochloric acid to form sodium chloride, carbon dioxide and water)

c) $Zn + 2HCl \rightarrow$ ……
(zinc reacts with hydrochloric acid to form zinc chloride and hydrogen)

Express these equations in words:

1. $2\ Na + Cl_2 \rightarrow 2\ NaCl$ .....
2. $ZnO + H_2SO_4 \rightarrow 2\ ZnSO_4 + H_2O$ .....
3. $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$ .....

Watch the beginning of the video lecture about pH calculation given by Dr.Goldwhite.
http://www.youtube.com/watch?v=LZk1_yzF9js

Useful vocabulary:

acid (n) - kyselina	base (n) – zásada	obtain (v) – získat
strongly acidic (adv+adj) – silně kyselé	basic (adj) - zásadité	species (n) - vzorek
concentration of a solution (n) – koncentrace roztoku		ion (n) - iont

Watch again and check.
Do the following calculation, then watch the remaining part of the video and see whether you were right.

Key ex.4 *area, volume, velocity, acceleration, molar, density, concentration*

HOMEWORK

Information System – please do Revision „odpovědník“