LESSON 6: NUMBERS AND MEASUREMENTS (adapted from A. Rozkošná materials)

I. Discuss the questions below in your groups/pairs.

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?

II. Read these numbers or fractions:

0.2	3000 000 000
0.05	7000 000 000 000
26	1st
138	2nd
2479 (ordinal number/hotel room)	43rd
503349777 (telephone number)	2000 000
2,053	67th
2.053 (g/kg)	1/3
	3/5

III. Simple arithmetics- say the problems aloud

	$4 + 4 = 8$	
	$9 - 2 = 7$	
	$5 \times 5 = 25$	
	$8 \div 4 = 2$	

2^2		$\sqrt{\ }$	
-2^3		$\sqrt[3]{\ }$	
2^4		π	
$\log_{10}7$		$x=3(a+b)$	

IV. Work in pairs. Solve these maths problems.

a) $12 - 6 = \ldots$
b) $9 \times 5 = \ldots$
c) $30 \div 6 = \ldots$
d) $\sqrt{16} = \ldots$
e) $4 + 7\frac{1}{5} = \ldots$
f) $9^2 = \ldots$
g) $\sqrt[3]{27} = \ldots$
h) $2^4 = \ldots$
i) $\pi = \ldots$

Look at this example:

Add six to seven. Now multiply by four. Subtract four. Divide by twelve. What is the answer?

$6 + 7 = 13$, $13 \times 4 = 52$ $52 - 4 = 48$ $48 \div 12$ = ?

Work in pairs. Write down graphical image of the problems below, then take turns in saying them aloud and finding the answer (one of you should say the equation and the other should give the answers without looking at the paper). See how quickly you can do it.

a) Multiply 7 by 9. Add 9. Divide by 6. Subtract 3.
b) Subtract 8 from 24. Divide by 2. Add two. Multiply by 10.
c) Add six to eight. Multiply by 10.
d) Take 50% of the students in your class. Multiply by 2. Divide by 4.
e) Take the square root of 36. Add 14. Multiply by 5. Subtract 1.
f) Take the average of 20, 24, 26 and 30. Multiply by 10.

V. 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

VI. 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

V. Units of measuremet.

1. Give the names of measurement units missing in the table below:

	QUANTITY	UNIT	ABBR.	NOTES
SI BASE UNITS	length			=39.36 inches/in
	mass			=2.2 pounds/lb
	time			
	temperature		K	

SI DERIVED UNITS	area volume velocity density frequency accelaration force work/energy/heat amount of substance molar concentration			 mol/m^3

Some more measurements and their units:

electric current	ampere (amp)
electric power	watt (W)
electric resistance	ohm (Ω)
electric potential difference	volt (V)
temperature	degrees Centigrade (°C)/ Farenheit (F)

2.Work with a neighbour. Complete the table and then describe these numbers:

Example:

a) One kilometer equals a thousand meters or ten to the power of three

a) kilo-	*one thousand: 1 km = 1000 m*	*10^3*
b) deci-	one tenth: 1 dm = $\frac{1}{10}$m	10
c) centi-	one hundredth: 1 cm = $\frac{1}{100}$ m	10
d) milli-	one thousandth: 1 mm = $\frac{1}{1000}$ m	10
e) micro-	one millionth: 1 μm = $\frac{1}{1000000}$ m	10
f) nano-	one thousand millionth: 1 nm = $\frac{1}{1000000000}$ m	10
g) pico-	one picometer: 1pm	10
h) femto-	one_____ : 1fm	10^{-15}
i)atto-	one _____ : 1__m	10^{-18}

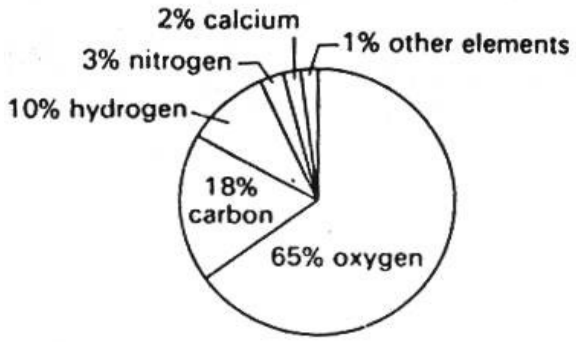
VI. Percentages

65% (per cent) of our body weight is oxygen.

Our body contains 65% of oxygen.

Oxygen represents 65% of our body weight.

Describe the rest of the diagram below using the structures given



VII. 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…

VII. Reading simple equations[1]: here are some common compounds, their names and FORMULAS:

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**	CuO – copper oxide	

These formulas are useful for writing EQUATIONS.

Example: **HCl + NaOH → NaCl + H_2O**

We read as: hydrochloric acid **reacts with** sodium hydroxide **to form** sodium chloride **and** water.
combines with

Complete these equations.

a) → ……
(copper oxide reacts with hydrogen to form copper and water)

b) → ……..
(sodium carbonate reacts with hydrochloric acid to form sodium chloride, carbon dioxide and water)

c) → ……
(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. $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$ .....

VIII. Watch the beginning of the video lecture about pH calculation given by Dr.Goldwhite.[2] Do the calculation, then watch the remaining part of the video and see whether you were right

Useful vocabulary:

acid (n) - kyselina	base (n) – zásada	concentration of a solution (n) – koncentrace roztoku
ion (n) - iont		

IX. Say whether the following statements are true or false. Correct the false statements.

a)	Duration is measured in degrees Centigrade	T/F
b)	The second is a unit of time	T/F
c)	Speed is measured in kilograms per hour.	T/F
d)	The watt is a unit of electrical charge.	T/F
e)	Density is measured in grams per metre cubed.	T/F
f)	The gram is a unit of mass.	T/F
g)	Liquid measurements are made in litres, or cubic decimetres.	T/F

GRAMMAR REVISION: COUNTABLE/ UNCOUNTABLE NOUNS

I. Divide the words below into two categories: countable and uncountable nouns

percentage, metre, science, molecule, nitrogen, information, radius, second, temperature, heat, fraction, chemistry, base, acid, petroleum, research, change, salt, object, ion, water, light, substance, matter, energy, electron, equilibrium, neutron

II. Complete the sentences below with "many"or "much"

1. How _____ electrons does an atom of carbon posses?
2. How _____ elements are there in the periodic table?
3. How _____ liquid does a beaker contain?
4. How _____ chemical elements does the atmosphere contain?
5. How _____ nitrogen does the atmosphere contain?
6. Do you find _____ useful information about chemistry on the Internet?
7. Will we exploit _____ more nuclear energy in the future than we do today? What do you think?

III. Complete the sentences with "little", "a little", "few", "a few"

1. As very _____ research has been done in the field, we still have no antidote to the disease.
2. Doing just _____ research threw up some very useful information.
3. Only _____ scientists were invited to take part in the project. That is probably why it was not successful.
4. The project team consists of _____ well-known chemists.

Week 6 – Numbers and Measurements - Vocabulary	
four and (plus) four is / equals eight	čtyři plus čtyři se rovná osm
nine minus two is seven	devět mínus dva je sedm
beaker	kádinka
five times five is twenty-fine / five multiplied by five is twenty-five	pět krát pět je dvacet pět
eight divided by four is two	osm děleno čtyřmi je dva
two squared	dva na druhou
minus (negative) two cubed	mínus dva na třetí
two to the power of four	dva na čtvrtou
square root of …	druhá odmocnina
cube root of …	třetí odmocnina
three quarters	tři čtvrtiny
a third	třetina
one thousandth/one over a thousand	jedna tisícina / jedna lomeno tisíc
How much is five and four?	Kolik je pět plus čtyři?
one thousand two hundred and fifty-eight	tisíc dvěsta padesát osm
add (v)	přičíst
subtract (v)	odečíst
One kilometre equals nought point six two one miles.	Jeden kilometr se rovná nula celá šedesát dva mil.
7. 65 per cent of our body weight is oxygen.	7,65 procent těledné váhy je kyslík.
Hydrochloric acid reacts with sodium hydroxide to form sodium chloride and water.	Kyselina chlorovodíková reaguje s hydroxidem sodným a vytvoří chlorid sodný a vodu.
sodium chloride	chlorid sodný
carbon dioxide	oxid uhličitý
sulphuric acid	kyselina sírová
sodium hydroxide	hydroxid sodný
sodium carbonate	uhličitan sodný
acid (n) / acidic (adj)	kyselina / kyselý
base (n) / basic (adj)	zásada / zásaditý
obtain a species (v)	získat vzorek
ion (n)	iont
concentration of a solution (n+prep+n)	koncentrace roztoku
surface area (n+n)	povrch
width (n)	šířka
length (n)	délka
square metre (adj+n)	metr čtvereční
cubic metre (metre cubed) (adj+n)	metr krychlový
electric current (adj+n)	elektrický proud
electric power(adj+n)	elektrický výkon
electric resistance (adj+n)	elektrický odpor
temperature (n)	teplota

degree Centigrade (n+n)	stupeň Celsia
kilometres per hour	kilometry za hodinu
Second is a unit of time.	Sekunda je jednotka času.

Sources: Lesson based on Bates, Martin and Dudley-Evans, Tony: *Nucleus of General Science.* Longman 1990.
Adapted from Cihová, Jarmila et al. *Angličtina pre študentov chémie***.** Bratislava: Univerzita Komenského, 2003.
Available at http://www.youtube.com/watch?v=LZk1_yzF9js. Accessed 29th October 2010.