Chestnut Grove Academy

Chemistry

3. Quantitative Chemistry

Revisiting Booklet

Name:

Chemical measurements

What does the law of conservation state?

_____

_____

Complete the missing masses:

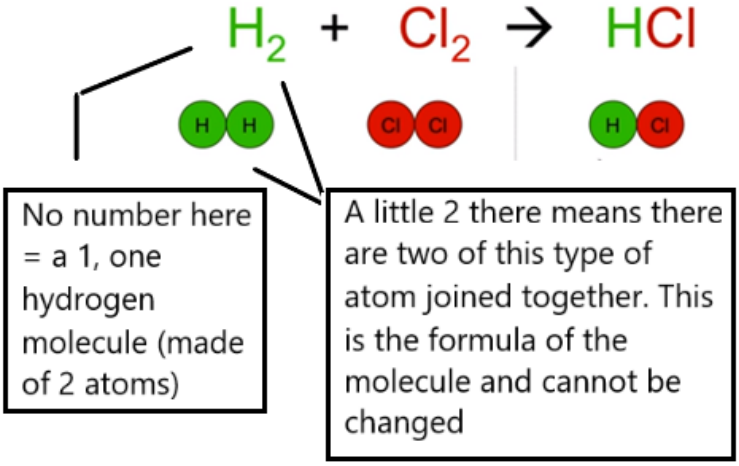
Magnesium + Oxygen → Magnesium oxide

5 g + _____ → 5.6 g

Iron oxide + carbon monoxide → iron + carbon dioxide

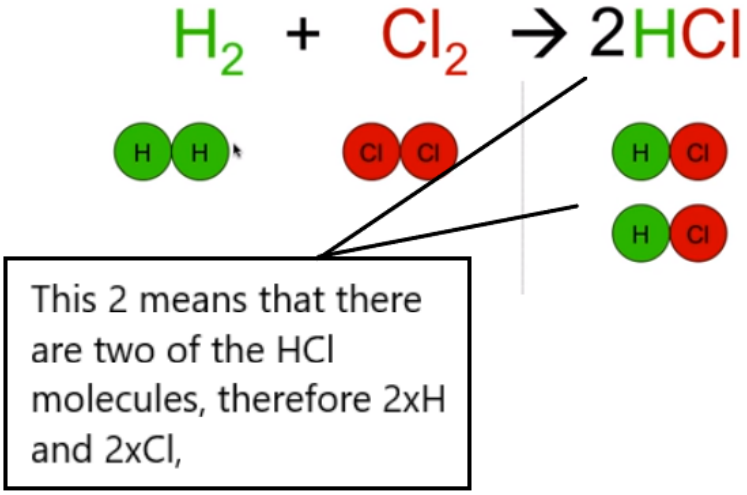
150 g + 20g → 132g + _____ g

It is important to balance symbol equations to represent the law of conservation.



Elements	Left	Right
H	2	1
Cl	2	1

You can only balance an equation by increasing the number of each type of molecule – adding a big number in front. For example:



Elements	Left	Right
H	2	2
Cl	2	2

This equation is now balanced.

<u>How many atoms are in the following:</u>

$KMnO_4$

$Ca(OH)_2$

<u>Try & balance the following equations:</u>

1. $Al + O_2 \rightarrow Al_2O_3$

2. $Fe_2O_3 + CO \rightarrow Fe + CO_2$

3. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

4. $NH_3 + O_2 \rightarrow N_2 + H_2O$

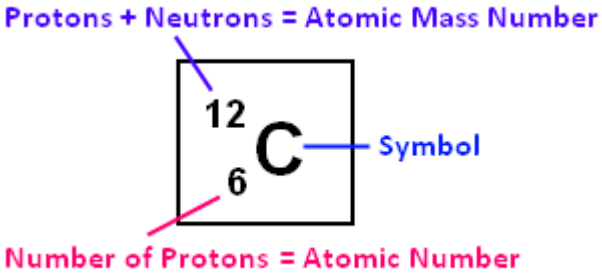
5. $N_2 + H_2 \rightarrow NH_3$

6. $HCl + Fe_2O_3 \rightarrow FeCl_3 + H_2O$

7. $Fe + O_2 \rightarrow Fe_2O_3$

8. $HCl + Mg(OH)_2 \rightarrow MgCl_2 + H_2O$

The relative atomic mass of an element is it's average mass compared to carbon, this mass takes into account the abundance of each isotope. The relative atomic mass of each atom can be found on the periodic table:



Carbon	
Relative atomic mass	
Atomic number	
Number of protons	
Number of neutrons	
Number of electrons	

What is an isotope?

Relative atomic mass of an atom can be calculated using the following equation:

$$\text{Relative Atomic mass of atom} = \frac{(\text{abundance} \times \text{atomic mass of isotope}) + (\text{abundance} \times \text{atomic mass of isotope})}{\text{total abundance}}$$

Calculate the following relative atomic masses:

1. bromine with 50% bromine-79 and 50% bromine-81

2. Magnesium with 79% magnesium-24, 10% magnesium-25 and 11% magnesium-26

What is relative formula mass (Mr)?

Calculate the relative formula mass for the following molecules:

- NaOH
- $CuSO_4$
- NH_3
- $Ba(OH)_2$

In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown _____ the sum of the relative formula masses of the products in the quantities shown.
Why would this reaction appear to involve a mass change?

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Percentage Composition

What is the percentage of:

1. N in NH_3
2. S in $FeSO_4$
3. S in H_2SO_4
4. O in $Al(OH)_3$
5. N in $(NH_4)_2SO_4$

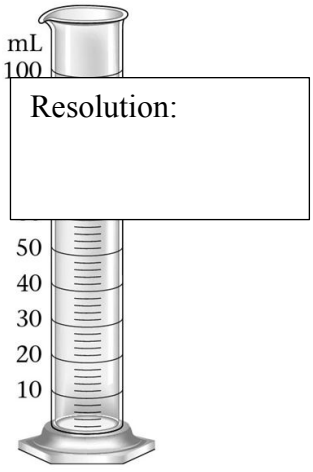
Uncertainty

Whenever a measurement is made there is always some uncertainty about the result obtained. We can estimate uncertainty in two ways:

1. Considering the resolution of measuring instruments
2. From the range of a set of repeat measurements

Resolution of instrument is plus or minus half of the smallest division that it measures to:

Measurement cm^3	Uncertainty cm^3	Minimum Volume cm^3	Maximum Volume cm^3
80.0	±0.05		
75.5	±0.10		
60	±0.20		
120	±0.25		

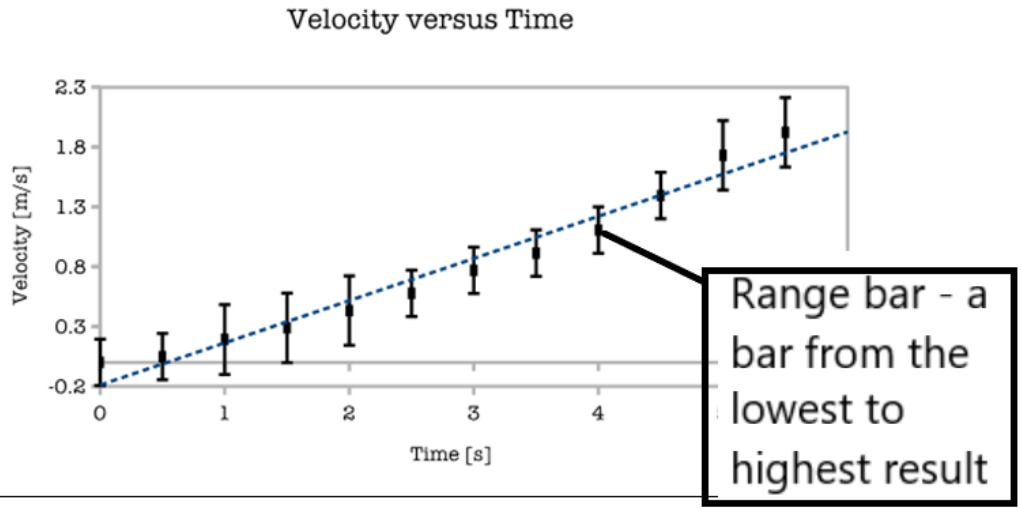


Resolution:

Range of data:

From data we could either calculate the uncertainty of a mean result or draw error/range bars on a graph – the larger the error/range bar to more uncertainty

Uncertainty of a mean result = range/2

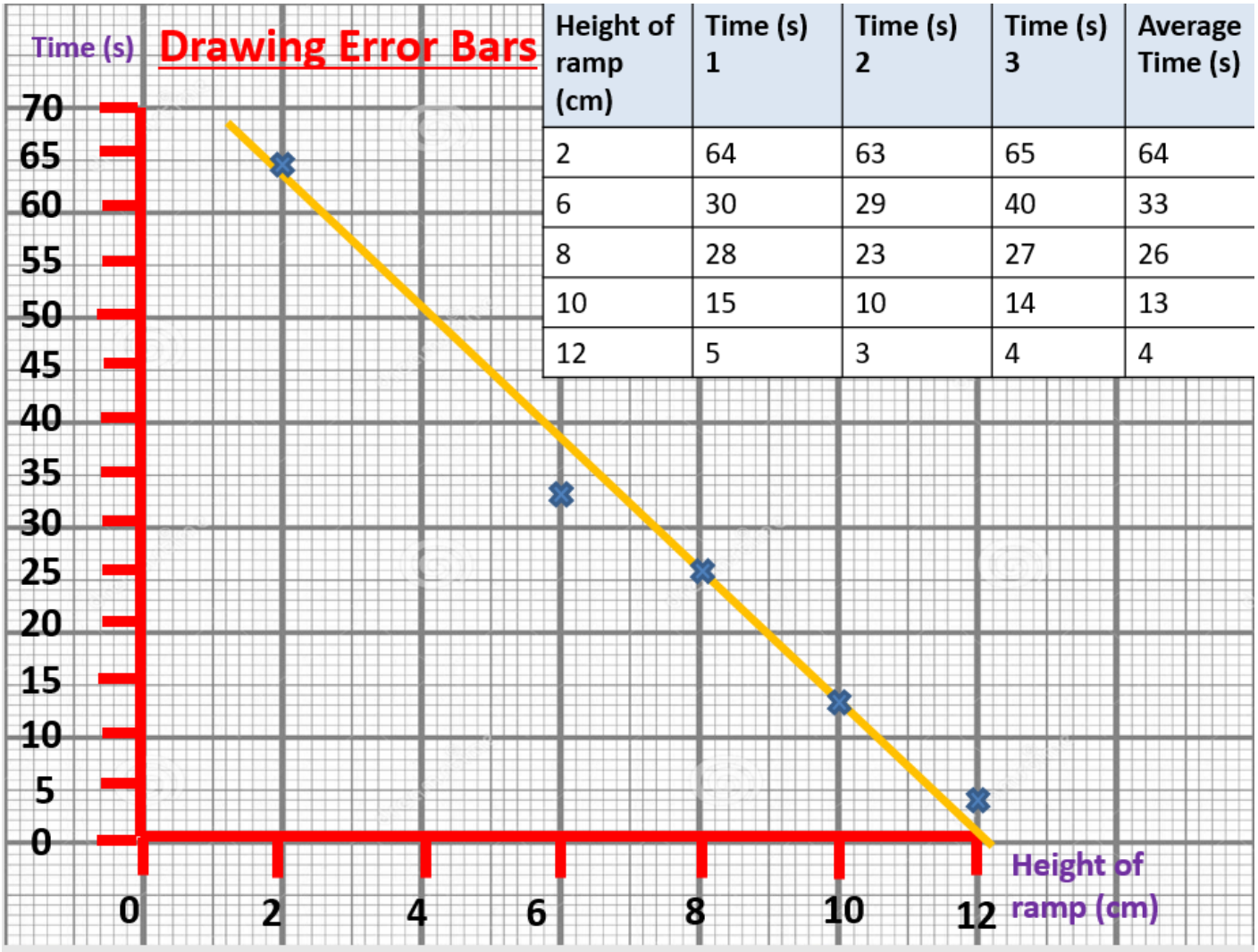


Calculate the missing mean for drop height 40cm.
Give the uncertainty in your answer.

Drop height in cm	Roll height in cm			
	Test 1	Test 2	Test 3	Mean
20	15	14	14	14
40	29	33	32	
60	47	19	46	46
80	65	61	63	63

Mean …….. cm Uncertainty ……. Cm

Practise drawing the error/range bars below:



Height of ramp (cm)	Time (s) 1	Time (s) 2	Time (s) 3	Average Time (s)
2	64	63	65	64
6	30	29	40	33
8	28	23	27	26
10	15	10	14	13
12	5	3	4	4

Higher tier only
Use of amount of substance
What is a mole?

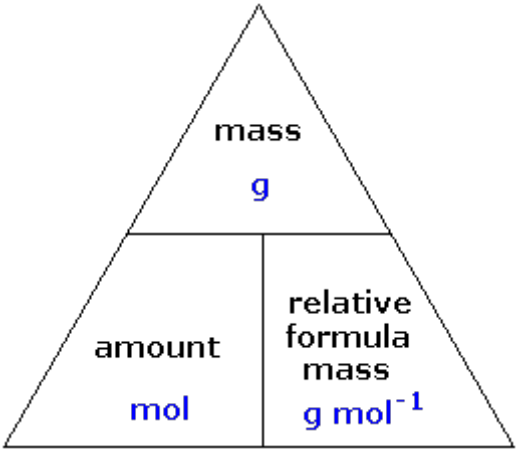
_____

What is Avogadro's constant?
In chemistry we use the term mole – give a different example in another industry

_____

What is the unit for mole?

_____



The mass of one mole of substance in grams is numerically equal to its relative formula mass. E.g. the mass of one mole of water is 18.

1. *How many atoms are in one mole of carbon?*

   _____

2. *How many molecules are in one mole of water?*

   _____

Calculate the number of moles of 4g of MgO.	*Calculate the mass of 2.5 moles of N_2.*
Calculate the number of moles of 0.25g of H_3PO_4.	*Calculate the mass of 0.8 moles of $CuSO_4$.*

What is the molar mass?

_____

Reacting Masses

You can use a balance symbol equation to calculate the mass of a reactant or product:

If 28 g of iron reacts with copper sulphate solution, what mass of copper will be made?

$Fe + CuSO_4 \rightarrow Cu + FeSO_4$

	Fe	Cu
mass	28g	0.5x63.5 = **31.75g**
M_r	56	63.5
moles	28/56 = 0.5	0.5

1. *How much calcium oxide (CaO) is when 100g of calcium carbonate ($CaCO_3$) is heated?*
   $CaCO_3 \rightarrow CaO + CO_2$

2. *What mass of lime (CaO) is created by fully decomposing 200g of calcium carbonate ($CaCO_3$)?*
   $CaCO_3 \rightarrow CaO + CO_2$

3. *Sulphur burns in air to form sulphur dioxide. What mass of sulphur dioxide is created on burning 8g of sulphur?*

$S + O_2 \rightarrow SO_2$

4. *What mass of lime (CaO) is created by fully decomposing 20g of calcium carbonate ($CaCO_3$)?*
   $CaCO_3 \rightarrow CaO + CO_2$

5. *When magnesium is heated in chlorine gas it reacts to form magnesium chloride, $MgCl_2$. What mass of magnesium chloride will be formed from 72g of magnesium?*
   $Mg + Cl_2 \rightarrow MgCl_2$

Using moles to balance equations

Given masses for the following equation; 150g ethane, 560g of oxygen, 440g of carbon dioxide and 270g of water: *Ethane + oxygen → carbon dioxide + water*

1) *Work out moles for each species*

	C_2H_6	O_2	CO_2	H_2O
Mass	*150*	*560*	*440*	*270*
Mr	*30*	*32*	*44*	*18*
Moles	*5*	*17.5*	*10*	*15*
/smallest moles	*1*	*3.5*	*2*	*3*

2) *Use this to get the mole ratio*
   2:7:4:6
3) *Use mole ratio to write the balanced symbol equation*
   $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

Try the following for yourself:

1) *Write the balanced symbol equation for 488g of Sb reacting with 425g of Cl_2 to make 914g of $SbCl_3$*

2) *Write the balanced symbol equation for the 24g of Magnesium (Mg) reacting with 16g of Oxygen (O_2) to produce 40g of Magnesium oxide MgO*

What is a limiting reactant?

When calculating masses of reactants & products, you may need to first find out which moles are limiting and use these rather than any in excess.

1) In the manufacture of the fertiliser ammonium sulphate, what is the maximum mass of ammonium sulphate that can be obtained from 2.00 kg of sulphuric acid and 1.00 kg of ammonia?

$H_2SO_4 + 2\ NH_3 \rightarrow (NH_4)2SO_4$

2) In the Solvay process, ammonia is recovered by the reaction shown. What is the maximum mass of ammonia that can be recovered from 2.00 tonnes of ammonium chloride and 0.500 tonnes of calcium oxide?

$2\ NH_4Cl + CaO \rightarrow CaCl_2 + H_2O + 2\ NH_3$

What is meant by the term concentration?

Give three examples of solutions that need to be diluted and the reason why:

1. _____
2. _____
3. _____

What is the equation for calculating concentration from mass?

Volume is often recorded in dm^3

- 1ml = 1 cm^3
- 1l = 1 dm^3
- 1dm^3 = 1000cm^3

What is 750cm^3 in dm^3?

---

1. 0.5 grams of sodium chloride is dissolved to make 0.05 dm^3 of solution in g/dm^3

2. 0.5 grams of sodium chloride is dissolved to make 0.05 cm^3 of solution in g/dm^3.

3. 6.7 x 10^{-2} grams of $Pb(C_2H_3O_2)_4$ are dissolved to make 3.5 dm^3 of solution in g/dm^3.

Higher tier
If the volume is kept the same and more mass is added, the concentration _____ _____
If water evaporated from a solution of copper sulphate, the concentration _____