A level Chemistry Induction Activities 2020

Firstly, welcome to the HSFC Chemistry department and well done for choosing Chemistry!

The Covid lockdown means that you will be missing a number of important experiences in terms of your readiness to start A Levels this autumn. For example, not having to revise for your GCSE exams, could mean you find it harder to access some of the early A Level material in subjects like the sciences. Therefore, in chemistry, we strongly advise you to use your GCSE books, revision guides and websites to **thoroughly revise your GCSE material** to ensure that you are confident in the concepts which form the foundations of the A Level. There is a big step from GCSE to A Level and it is very important that the Higher Tier material from GCSE is secure if you are going to cope well with the A Level material. The transition tasks below will also help you to focus in on some of the most important concepts that you should be comfortable with when you start A level Chemistry. They will also provide a way for you to work out where your strengths and weaknesses are and spend some extra time . Some students will therefore need to spend longer on the tasks than others.

There are five tasks and each one should take about 1 to 1.5 hours,
so you can spread the work out over the summer holidays if you prefer.

A couple of notes:

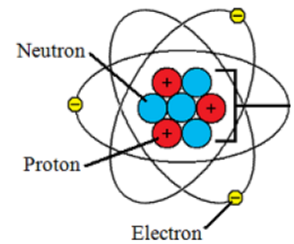
1) An important part of this assignment is to ***LEARN the highlighted definitions and formulae*. You will be tested on these within the first couple of weeks!**
2) Every so often, when you need a little break from the studying, scroll down to the last page and watch some of the great videos we have suggested!
3) You can print out the tasks and write onto the print-outs if you prefer, but this is not necessary – you can just write out the answers on paper.

As well as your GCSE materials, you can use the following websites to help you complete the work and do some extra reading in preparation for the A level classes….

- www.chemguide.co.uk
- www.chemhume.co.uk
- www.chemrevise.org
- www.chemistryclinic.co.uk
- www.ocr.org.uk/qualifications/as-a-level-gce-chemistry-a-h032-h432-from-2015/
- www.rsc.org/learn-chemistry
- MaChemguy www.youtube.com/user/MaChemGuy/playlists
- Allery-Chemistry https://www.youtube.com/channel/UCPtWS4fCi25YHw5SPGdPz0g/playlists?sort=dd&shelf_id=3&view=50
- www.knockhardy.org.uk

TASK 1: Atomic Structure

This section revises the simple ideas about atomic structure that you will have come across in GCSE. You need to be confident about this before you go on to ideas about the atom which under-pin ‘A’ level chemistry.



The sub-atomic particles

Protons, neutrons and electrons. – complete the following table

	relative mass	relative charge	position within the atom
proton			
neutron			
electron			

The nucleus

The nucleus is at the centre of the atom and contains the protons and neutrons.

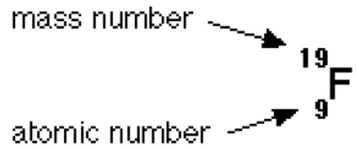
Virtually all the mass of the atom is concentrated in the nucleus, because the electrons weigh so little.

Working out the numbers of protons and neutrons

No of protons = ………….. ……………..…… of the atom

No of protons + no of neutrons = ………. ………….....…. of the atom

This information can be given simply in the form:



Be careful…sometimes the numbers are shown the other way up!

The atomic number gives the number of protons (9). The atomic number is tied to the position of the element in the Periodic Table.

The mass number counts protons + neutrons (19). If there are 9 protons, there must be 10 neutrons for the total to add up to 19.

Your turn

34
Se
selenium
79.0

How many protons are in this atom? ....

How many neutrons are in this atom? ....

How many electrons are in this atom? ....

As the atom is neutral in charge, the number of electrons equal the number of protons. If it is an ion, the number of electrons has to be calculate. *Complete the table below.*

Symbol	Atomic no.	Mass no.	Protons	Neutrons	Electrons
$^{79}_{35}Br$					
			12	**13**	**12**
$^{23}_{11}Na^{+}$					
$^{140}_{59}Pr^{2+}$					
			68	**99**	**69**

Isotopes

The number of neutrons in an atom can vary. For example, there are three kinds of carbon atom ^{12}C, ^{13}C and ^{14}C. They all have the same number of protons, but the number of neutrons varies. *Complete the following table.*

	protons	neutrons	mass number
carbon-12	6	6	
carbon-13			13
carbon-14			

These different atoms of carbon are called ***isotopes***. The fact that they have varying numbers of neutrons makes no difference whatsoever to the chemical reactions of the carbon.

Isotopes are ATOMS of the same element, which have the same number of protons (atomic number) but different numbers of neutrons (different mass numbers).

Nickel exists as a mixture of three isotopes, nickel-58, nickel-60 and nickel-62.

Complete the table below to show the atomic structures of the isotopes in metallic nickel.

isotope	protons	neutrons	electrons
nickel-58			
nickel-60			
nickel-62			

[3]

RELATIVE ISOTOPIC MASS

The relative isotopic mass is the mass of an ISOTOPE compared with $^{1}/_{12}$ of the mass of a carbon-12 atom.

Notice that 'weighted average' is not in this definition. It simply refers to the mass of an atom compared to an atom of carbon -12. It does not take into account the abundance of the isotope.

RELATIVE ATOMIC MASSES

The relative atomic mass of an element is the <u>weighted</u> mean mass of an ATOM of the element compared with $^{1}/_{12}$ of the mass of a carbon-12 atom.

It has no units because it is a ratio of masses.

Notice that that the **mean mass** of the atoms is used, this is because we take into account the abundance of each isotope of the element that occurs naturally.

The average is a **"weighted mean"** which allows for the fact that there will not be equal amounts of the various isotopes. The example coming up should make that clear:

Suppose you had 100 typical atoms of boron.

19 of these would be ^{10}B and 81 would be ^{11}B.

The total mass of these would be (19 x 10) + (81 x 11) = 1081

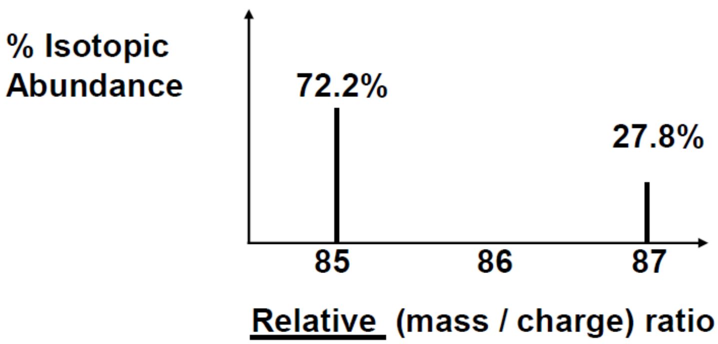
The average mass of these 100 atoms would be 1081/100 = 10.8 (to 3 significant figures).

So 10.8 is the relative atomic mass of boron.

Notice the effect of the "weighted" average. A simple average of 10 and 11 is, of course, 10.5. Our answer of 10.8 allows for the fact that there are a lot more atoms of the heavier isotope of boron.

We can find out the relative isotopic mass and the relative abundances of different isotopes using a MASS SPECTROMETER.

Example 1 : RUBIDIUM



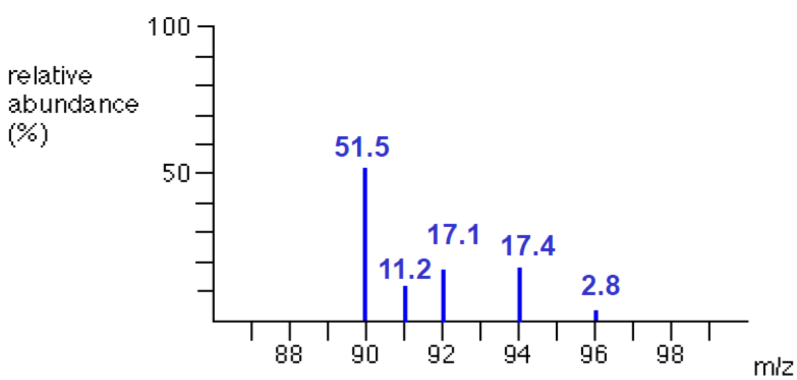
Calculate A_r(Rb) = AVERAGE mass of a Rb atom relative to the mass of a ^{12}C atom

$$= \frac{\text{total relative mass of 100 atoms}}{100}$$

$$= \frac{(72.2 \times 85) + (27.8 \times 87)}{100} = \underline{85.6} \text{ (3sf)}$$

Your turn

Example 2 : ZIRCONIUM



A_r(Zr) =

Calculate the A_r of the following:

a) Chlorine: 75 % ^{35}Cl and 25 % ^{37}Cl

b) Silicon: ^{28}Si, ^{29}Si and ^{30}Si relative abundances 92.18 %, 4.70 % and 3.12 % respectively.

c) Chromium: 4.31 % ^{50}Cr, 83.76 % ^{52}Cr, 9.55 % ^{53}Cr and 2.38 % ^{54}Cr

Exam style question

The antimony in a bullet was analysed by a forensic scientist to help solve a crime. The antimony was found to have the following percentage composition by mass: ^{121}Sb, 57.21%; ^{123}Sb, 42.79%.

Calculate a value for the relative atomic mass of the antimony. Give your answer to 4 significant figures.

TASK 2: Chemical Formulae

You will need to use the formulae of ions to write formulae for ionic compounds. You will use the formulae for ionic compounds and molecules to write balanced symbol equations.

You must **LEARN** the common formulae in **bold**. **You will be tested on them in September.**

TABLE OF COMMON FORMULAE

Elements	
Diatomic	
N_2	**Nitrogen**
O_2	**Oxygen**
F_2	**Fluorine**
Cl_2	**Chlorine**
Br_2	**Bromine**
I_2	**Iodine**
H_2	**Hydrogen**
Others	
P_4	Phosphorus
S_8	Sulphur – in practice it is usual to just use S
Most other elements exist as single atoms	

Molecules	
Gases	
NH_3	**Ammonia**
CO_2	**Carbon dioxide**
CO	**Carbon monoxide**
SO_2	**Sulphur dioxide**
CH_4	**Methane**
C_2H_6	Ethane
C_2H_4	Ethene
O_3	Ozone
HCl	Hydrogen chloride
HCN	Hydrogen cyanide
PH_3	Phosphine
Liquids	
H_2O	**Water**
C_2H_5OH	Ethanol
Common acids	
$HCl_{(aq)}$	**Hydrochloric**
HNO_3	**Nitric**
H_2SO_4	**Sulphuric**
H_3PO_4	**Phosphoric**
CH_3COOH	**Ethanoic**

TABLE OF COMMON IONS

In italics are the formulae you can work out using your periodic table.

CATIONS Positively charged ions		ANIONS Negatively charged ions	
Single positive		**Single negative**	
H^+	*Hydrogen ion*	*F^-*	*Fluoride ion*
Li^+	*Lithium ion*	*Cl^-*	*Chloride ion*
Na^+	*Sodium ion*	*Br^-*	*Bromide ion*
K^+	*Potassium ion*	*I^-*	*Iodide ion*
NH_4^+	**Ammonium ion**	**OH^-**	**Hydroxide ion**
Ag^+	**Silver ion**	**NO_3^-**	**Nitrate ion**
Cu^+	*Copper (I) ion*	**HCO_3^-**	**Hydrogencarbonate ion**
		CN^-	**Cyanide ion**
Double positive		**Double negative**	
Mg^{2+}	*Magnesium ion*	*O^{2-}*	*Oxide ion*
Ca^{2+}	*Calcium ion*	*S^{2-}*	*Sulphide ion*
Sr^{2+}	*Strontium ion*	**SO_4^{2-}**	**Sulphate ion**
Ba^{2+}	*Barium ion*	**CO_3^{2-}**	**Carbonate ion**
Zn^{2+}	**Zinc ion**		
Cu^{2+}	*Copper (II) ion*	**$Cr_2O_7^{2-}$**	**Dichromate (VI) ion**
Fe^{2+}	*Iron (II) ion*		
Hg^{2+}	*Mercury (II) ion*		
Pb^{2+}	*Lead (II) ion*		
Triple positive		**Triple negative**	
Al^{3+}	*Aluminium ion*	**PO_4^{3-}**	**Phosphate ion**
Cr^{3+}	*Chromium (III) ion*	*N^{3-}*	*Nitride ion*
Fe^{3+}	*Iron (III) ion*	*P^{3-}*	*Phosphide ion*

Where there are brackets with roman numerals, this is the positive charge on the ion. For example, Iron (II) ion is Fe^{2+} and Iron (III) ion is Fe^{3+}

Use the ion formulae to write formulas for the ionic compounds in the table. Some examples have been done to help you.

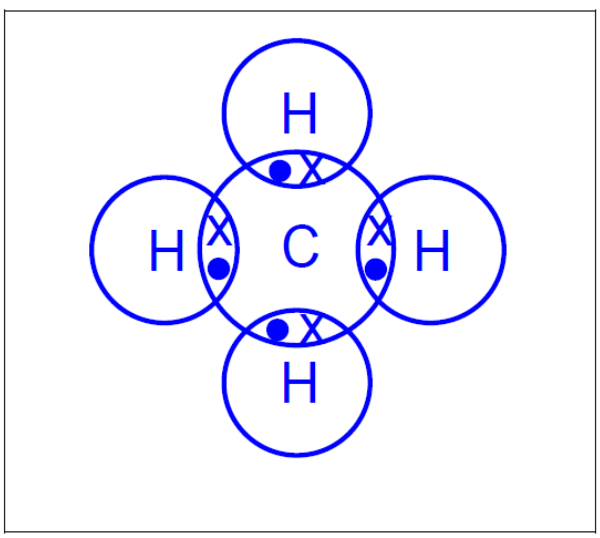
	Chloride Cl^-	Oxide	Hydroxide	Sulfate SO_4^{2-}
Sodium				
Magnesium Mg^{2+}	$MgCl_2$			
Iron (III)				$Fe_2(SO_4)_3$
Ammonium NH_4^+		$(NH_4)_2O$		

Task 3: Bonding

Dot and cross diagrams may be used to show ionic or covalent bonding between atoms.

COVALENT BONDING

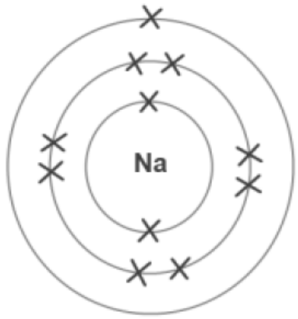
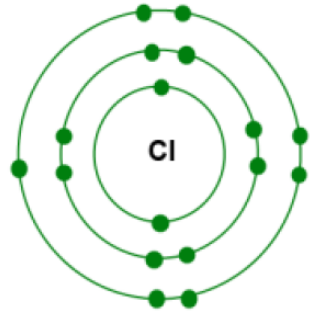
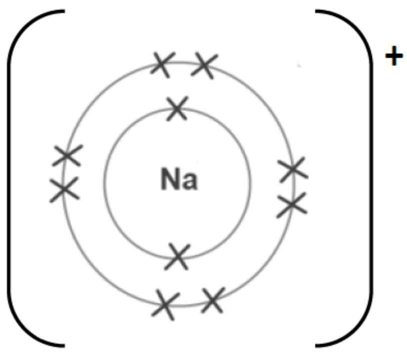
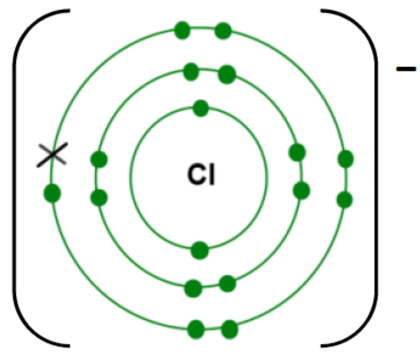
Below is an example to show the **covalent bonding** in methane:



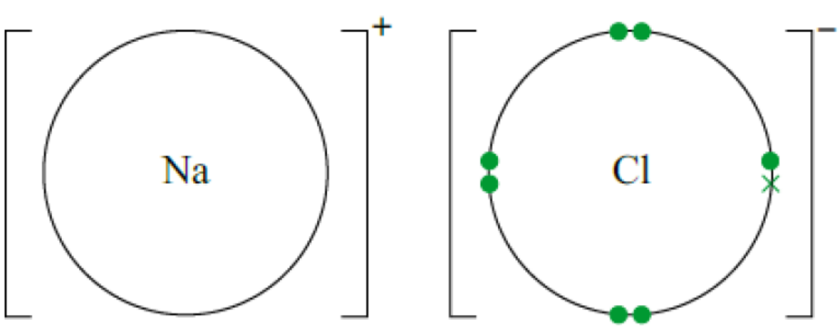
NOTE: Again at A-level only the **outer shell electrons** should be shown. *However, do show all of the outer shell electrons, even those not involved in bonding.*

IONIC BONDING

Below is an example to show the **ionic bonding** in sodium chloride:

A sodium *atom* 2,8,1	A chlorine *atom* 2,8,7
	
A sodium *ion* 2,8	A chloride *ion* 2,8,8
	

NOTE: It is not necessary to show the atoms, **only the ions**. At A-level only the **outer shell electrons** should be shown i.e.



Draw dot-and-cross diagrams showing the bonding in the following compounds:

(a) Lithium Fluoride

(b) Ammonia (a compound of nitrogen and hydrogen)

(c) Magnesium Oxide

(d) Water

Name these substances:
Refer to your table of ions where needed

(i) $Mg(NO_3)_2$

(ii) $CuSO_4$

(iii) K_2CO_3

(iv) NH_4OH

(v) Al_2O_3

(vi) $Ca_3(PO_4)_2$

Complete the following word equations and then write balanced symbol equations (including state symbols) in the spaces below each word equation.

magnesium + sulphuric acid $\longrightarrow$ magnesium sulphate + ______________

zinc oxide + magnesium $\longrightarrow$ magnesium oxide + _______________

copper carbonate + sulphuric acid → copper sulphate + water + ______________

strontium hydroxide + nitric acid → ________________ + ________________

Balance these chemical equations:

$H_2 + Cl_2 \longrightarrow HCl$

$H_2 + O_2 \longrightarrow H_2O$

$H_2SO_4 + NaOH \longrightarrow Na_2SO_4 + H_2O$

$CaCO_3 + HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

$HNO_3 + Mg \longrightarrow Mg(NO_3)_2 + H_2$

$Al_2O_3 + H_2SO_4 \longrightarrow Al_2(SO_4)_3 + H_2O$

Task 4 – Mathematical Skills

Standard Form

- Standard form is very useful for writing very large or small numbers.
- They are written in the form A x 10^n where A is a number between 1 and 10.
- n represents the number of places the decimal point is moved (for +n values the decimal point has been moved to the left, for -n values the decimal point has been moved to the right).

Number	3435	1029000	0.025	23.2	0.0000278
Standard form	3.435 x 10^3	1.029 x 10^6	2.5 x 10^{-2}	2.32 x 10^1	2.78 x 10^{-5}

- To find the value of n:
  - for numbers greater than 1, n = number of places between first number and decimal place
  - for numbers less than 1, n = number of places from the decimal place to the first number (including that number)

Significant figures

Full number	1 sig fig	2 sig fig	3 sig fig	4 sig fig	5 sig fig
9.378652	9	9.4	9.38	9.379	9.3787
4204274	4000000	4200000	4200000	4204000	4204300
0.903521	0.9	0.90	0.904	0.9035	0.90352
0.00239482	0.002	0.0024	0.00239	0.00239	0.002395

Significant figures for calculations involving multiplication / division

- Your final answer should be given to the same number of significant figures as the least number of significant figures in the data used.

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

  average speed = $\frac{1557}{95}$ = 16 m/s (answer given to 2 sig fig as lowest sig figs in data is 2 sig fig for time)

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

  average speed = $\frac{1557}{95}$ = 16.4 m/s (answer given to 3 sig fig as lowest sig figs in data is 3 sig fig for time)

Significant figures for calculations involving addition/subtraction ONLY

- Here the number of significant figures is irrelevant – it is about the place value of the data. For example

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

  Energy released = 263 + 1282 = 1545 kJ (answer is to nearest unit as both values are to nearest unit)

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

  Mass = 0.154 + 0.01234 = 0.166 g (answer is to nearest 0.001 g as least precise number is to nearest 0.001 g)

1) Write the following numbers to the quoted number of significant figures.

a) 345789 4 sig figs ....

b) 297300 3 sig figs ....

c) 0.07896 3 sig figs ....

d) 6.0961 3 sig figs ....

e) 0.001563 3 sig figs ....

f) 0.010398 4 sig figs ....

2) Complete the following sums and give the answers to the appropriate number of significant figures.

a) 6125 x 384 ....

b) 25.00 x 0.010 ....

c) 13.5 + 0.18 ....

d) 7550 ÷ 25 ....

e) 0.000152 x 13.00 ....

f) 0.0125 x 0.025 ....

3) Write the following numbers in non standard form.

a) 1.5×10^{-3} ....

b) 4.6×10^{-4} ....

c) 3.575×10^{5} ....

d) 5.34×10^{2} ....

e) 1.03×10^{6} ....

f) 8.35×10^{-3} ....

4) Write the following numbers in standard form.

a) 0.000167 ....

b) 0.0524 ....

c) 0.000000015 ....

d) 34500 ....

e) 0.62 ....

f) 87000000 ....

5) Complete the following calculations and give the answers to the appropriate number of significant figures.

a) $6.125 \times 10^{-3} \times 3.5$ ....

b) $4.3 \times 10^{-4} \div 7.00$ ....

c) $4.0 \times 10^{8} + 35000$ ....

d) $0.00156 + 2.4 \times 10^{3}$ ....

e) $6.10 \times 10^{-2} - 3.4 \times 10^{-5}$ ....

f) $8.00 \times 10^{-3} \times 0.100 \times 10^{-3}$ ....

Task 5: Mole Calculations

From this point on you need to be using an A level periodic table, not a GCSE one you can view one here: http://bit.ly/pixlpertab
https://secondaryscience4all.files.wordpress.com/2014/08/filestore_aqa_org_uk_subjects_aqa-2420-w-trb-ptds_pdf.png

Now that we have our chemical equations balanced, we need to be able to use them in order to work out masses of chemicals we need or we can produce.

The ***mole*** is the chemists equivalent of a dozen, atoms are so small that we cannot count them out individually, we weigh out chemicals.

For example: magnesium + sulfur → magnesium sulfide

Mg + S → MgS

We can see that one atom of magnesium will react with one atom of sulfur, if we had to weigh out the atoms we need to know how heavy each atom is.

From the periodic table: Mg = 24.3 and S = 32.1

If I weigh out exactly 24.3g of magnesium this will be 1 mole of magnesium, if we counted how many atoms were present in this mass it would be a huge number (6.02×10^{23}!!!!), if I weigh out 32.1g of sulfur then I would have 1 mole of sulfur atoms.

So 24.3g of Mg will react precisely with 32.1g of sulfur, and will make 56.4g of magnesium sulfide.

The relationship between moles, mass and the relative mass of a substance can be shown using the equation:

$$\text{Moles} = \frac{\text{Mass}}{\text{Relative mass}}$$

(Relative mass could be relative atomic mass, relative molecular mass or relative formula mass).

1) **How many moles** are in 22 grams of argon?

2) **How many grams** are in 88.1 moles of magnesium?

3) **How many moles** are in 2.3 grams of phosphorus?

4) **How many grams** are in 11.9 moles of chromium?

5) **How many moles** are in 9.8 grams of calcium?

6) **How many grams** are in 238 moles of arsenic?

7) How many grams are in 0.02 moles of beryllium iodide, BeI_2?

8) How many moles are in 68 grams of copper (II) hydroxide, $Cu(OH)_2$?

9) How many grams are in 3.3 moles of potassium sulfide, K_2S?

10) How many moles are in 1.2×10^3 grams of ammonia, NH_3?

11) How many grams are in 2.3×10^{-4} moles of calcium phosphate, $Ca_3(PO_3)_2$?

12) How many moles are in 3.4×10^{-7} grams of silicon dioxide, SiO_2?

13) How many moles of phosphorus pentoxide (P_4O_{10}) are in 85.2g?

Videos to watch online

10 weird and wonderful chemical reactions
10 good demonstration reactions, can you work out the chemistry of …. any… of them?

http://bit.ly/pixlchemvid3
https://www.youtube.com/watch?v=0Bt6RPP2ANI

Rough science – the Open University – 34 episodes available
Real scientists are 'stranded' on an island and are given scientific problems to solve using only what they can find on the island. Great fun if you like to see how science is used in solving problems.

There are six series in total

http://bit.ly/pixlchemvid1a
http://www.dailymotion.com/playlist/x2igjq_Rough-Science_rough-science-full-series/1#video=xxw6pr
or
http://bit.ly/pixlchemvid1b
https://www.youtube.com/watch?v=lUoDWAt259I

A thread of quicksilver – The Open University
A brilliant history of the most mysterious of elements – mercury. This program shows you how a single substance led to empires and war, as well as showing you come of the cooler properties of mercury.

http://bit.ly/pixlchemvid2
https://www.youtube.com/watch?v=t46lvTxHHTA

Chemistry in the Movies

Dantes Peak 1997: Volcano disaster movie.
Use the link to look at the Science of acids and how this links to the movie.
http://www.open.edu/openlearn/science-maths-technology/science/chemistry/dantes-peak
http://www.flickclip.com/flicks/dantespeak1.html
http://www.flickclip.com/flicks/dantespeak5.html

Fantastic 4 2005 &2015: Superhero movie
Michio Kaku explains the "real" science behind fantastic four
http://nerdist.com/michio-kaku-explains-the-real-science-behind-fantastic-four/
http://www.flickclip.com/flicks/fantastic4.html