

CASPER Research Experience for Teachers

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Overview of Summer

The RET Project for 2012 was a nice mix of “teacher work” that I am accustomed to, and “scientist work” where I learned a lot.

The educational component laid the groundwork for transitioning the elaborate annual Physics Circus undertaking into a web-based experience. We became familiar with the 2010 Physics Circus, aligned the science content to Texas and national Standards, and developed a 3 tiered curriculum. The 2010 circus had a mystery theme. We organized our work by the five “clues” to solve the mystery. My work covered the fourth clue. I developed a vocabulary list, tiered objectives, curriculum content, and a question bank for my clue.

Our home base was a table in the CASPER Lab, so even as we worked on curriculum we were part of a research environment. There were opportunities to observe multiple experiments and interact with the researchers. I assisted Dr. Angela Douglass as she investigated the vertical interactions of a chain of particles confined in a square glass box. I was involved with causing and breaking the high vacuum, jabbing a particle in the chain with a green laser and operating the side camera.

As a group with Jorge Carmona-Reyes’ help, the four RET teachers conducted our own experiment on Cell 1 to see the effect of lasers on a single layer of gold coated particles. I gained a lot of insight into what a researcher experiences. I learned a lot as I extracted data from 1000 images, by tracking thousands of particle trajectories and using a spreadsheet to make sense of it.

In addition to our curriculum work and research there were other opportunities to interact with the professors and REU students. There were weekly update meetings where we learned the progress REU students were making. Wednesday lunch speakers covered a variety of Baylor research topics. Field trips to the observatory and the Space X rocket testing facility were very interesting and informative. The summer culminated with a lovely final banquet where each participant was recognized.

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STANDARDS

CONTENT STANDARD B:

Chapter 112. Texas Essential Knowledge and Skills for Science □

Subchapter C. High School

(6) Science concepts. The student knows and understands the historical development of atomic theory. The student is expected to:

(E) express the arrangement of electrons in atoms through electron configurations and Lewis valence electron dot structures.

(7) Science concepts. The student knows how atoms form ionic, metallic, and covalent bonds. The student is expected to:

(B) write the chemical formulas of common polyatomic ions, ionic compounds containing main group or transition metals, covalent compounds, acids, and bases;

8) Science concepts. The student can quantify the changes that occur during chemical reactions. The student is expected to:

(D) use the law of conservation of mass to write and balance chemical equations;

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OBJECTIVES

LEV 1 -

- ♦ Identify information provided on a periodic table (atomic number, symbol, atomic mass, name)
- ♦ Explain the difference between the use of subscripts and coefficients
- ♦ Identify 2 element compounds on a mass spectrometer graph & determine the formula
- ♦ State the law of conservation of mass
- ♦ Balance chemical equations

LEV 2 -

- ♦ Use a periodic table to determine valance charge
- ♦ Use STAAR reference material to determine valence charge of polyatomic ions
- ♦ Write formulas for compounds including polyatomic ions
<http://www.usetute.com.au/namiform.html>
- ♦ Identify complicated compounds on a mass spectrometer graph & determine the formula
- ♦ State the law of conservation of mass
- ♦ Balance chemical equations

LEV 3 -

- ♦ Write formulas for compounds including polyatomic ions
- ♦ Identify complicated compounds on a mass spectrometer graph & determine the formula
- ♦ Write a balanced equation for a synthesis, decomposition, single replacement, or double replacement reaction given a mass spectrometer graph of the reactants.

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VOCABULARY:

Atomic number - the number of protons found in the nucleus of an atom

Mass number - the sum of the number of protons and neutrons of an atomic nucleus.

Atomic mass unit - one twelfth of the mass of an unbound atom of carbon-12. It is a unit of mass used to express atomic masses

Subscript – small lower number that shows the ratio of elements present in the compound

Coefficient - the numbers in front of the compounds or molecules in a chemical equation

Mass spectrometer - a scientific instrument used to measure the masses and relative abundances of a vaporized and ionized sample

Law of conservation of mass - the mass of an isolated system (closed to all matter and energy) will remain constant over time

Polyatomic ion - a tightly bound group of atoms that behaves as a unit and has a positive or negative charge

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CURRICULUM:

Level 1

Each chemical element in the universe has unique properties that distinguish it from all of the other chemical elements. Though each is unique, the elements can be still grouped by their commonalities in a useful and meaningful way. The periodic table groups the elements by properties.

Each element has its own box and these boxes make up groups and rows. There are eighteen groups (or families or columns) on the periodic table. Each one represents how many electrons are attached to the elements and correlate to how many valence electrons are present. Electrons are negatively charged subatomic particles that revolve around the nucleus of the element. Valence electrons are electrons that are on the very outside of the atom. There are seven periods (or horizontal rows) that describe electron shells.

Each box on the periodic table has certain informative parts about the element.

Atomic number	14
Symbol	Si
Atomic mass	28.086
Name	Silicon

The "14" on the top is the atomic number, which deals with how many protons, or positive charges, are in the atom.

The "Si" is the symbol for Silicon. All the elements get a one or two letter symbol (there are a couple of exceptions with undeclared elements).

The number under the symbol is the atomic weight or atomic mass. 28.086 represents how many grams are in each mole (6.022×10^{23} entities) of hydrogen.

Compounds are pure substances made up of 2 or more elements. Each compound has a formula showing which elements are present in a molecule and how many of each. A water molecule, H_2O , has two atoms of hydrogen and 1 atom of oxygen. The small **subscript** numbers show the number of each atom. If there is no subscript, it is 1. A molecule of glucose has 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms, so it is written $\text{C}_6\text{H}_{12}\text{O}_6$. If there were 3 molecules of water, we would not change the subscripts, we would add a **coefficient** out in front like this $3\text{H}_2\text{O}$. Four molecules of glucose would be $4\text{C}_6\text{H}_{12}\text{O}_6$. Four molecules of glucose would have a total of 24 atoms of carbon, each molecule has 6 atoms of carbon and there are 4 molecules. $6 \times 4 = 24$

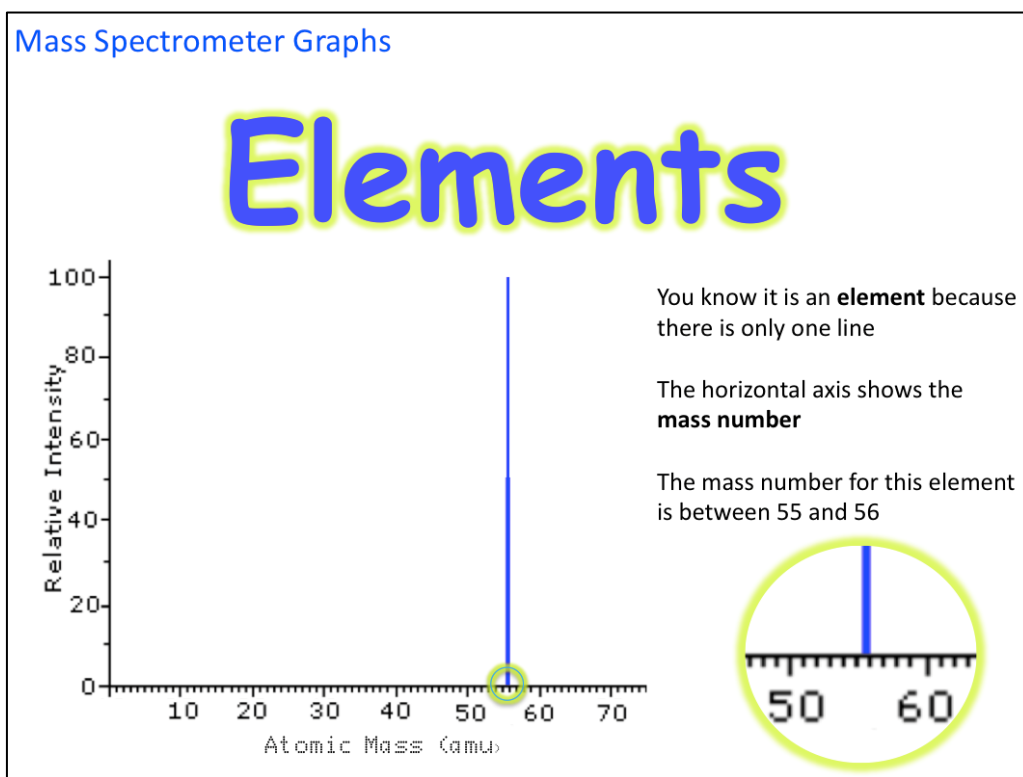
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A **mass spectrometer** can be used to determine the chemical make up of an unknown compound.



The graph from a mass spectrometer identifies the atomic mass and relative ratio of the sample.

To simplify, we will consider the graph of a pure element:



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Look on a periodic table to see what has a mass number between 55 and 56

manganese 25 Mn 54.938		iron 26 Fe 55.845		cobalt 27 Co 58.933	
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← name of element

← atomic number

← symbol

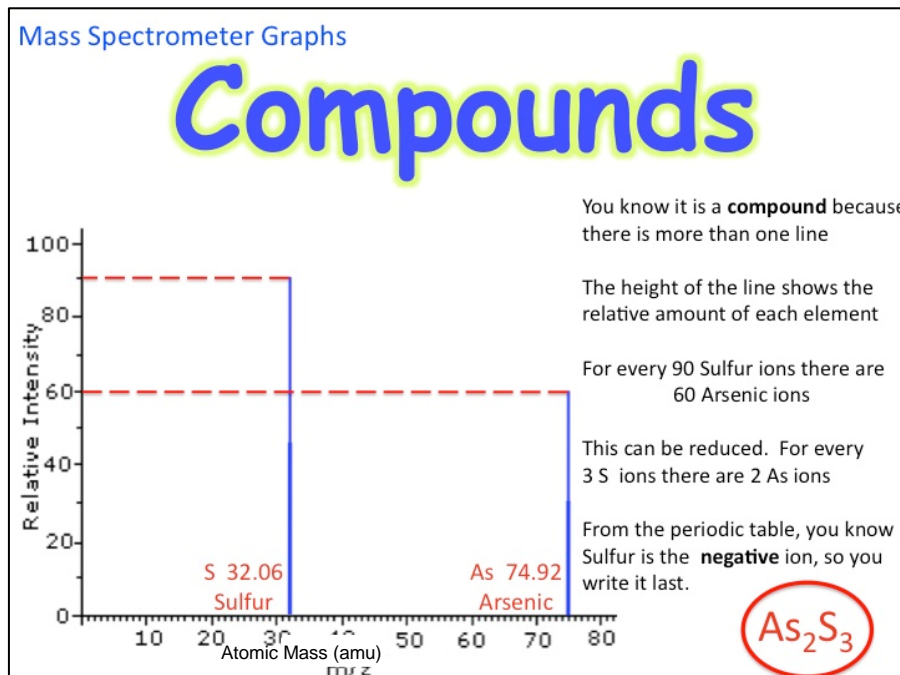
← mass number

hydrogen 1 H 1.0079	beryllium 4 Be 9.0122																	helium 2 He 4.0026	
lithium 3 Li 6.941	magnesium 12 Mg 24.305																	neon 10 Ne 20.180	
sodium 11 Na 22.990	aluminum 13 Al 26.982																	argon 18 Ar 39.948	
potassium 19 K 39.098	silicon 14 Si 28.086	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80		
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29		
cesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 Lanthanide series		lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 Actinide series		lawrencium 103 Lr [260]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	unnilium 111 Uuu [272]	unnilium 112 Uub [277]	unquadium 114 Uuq [289]					
		lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04				
		actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]				

* Lanthanide series

* Actinide series

A mass spectrometer usually wouldn't be used for a pure sample of one element.



Usually whichever element is farther left of the periodic table is written first in the formula.

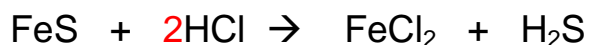
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The **law of conservation of mass**, states that the mass of an isolated system (closed to all matter and energy) will remain constant over time. Even when there are chemical changes, mass must be conserved. In a chemical reaction, the number and types of atoms in the reactants, must equal the number and types of atoms in the products.

Consider this chemical equation: $\text{FeS} + \text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2\text{S}$

Iron(II)sulfide and hydrochloric acid have a double replacement reaction to produce Iron(II)chloride and hydrogen sulfide.

As written, this violates the law of conservation of mass. It starts with one chlorine atom, and ends with two. Changing the subscripts would change the compound. The equation must be “balanced” by adding coefficients, numbers in front of the molecule.



Having 2 molecules of HCl for every 1 molecule of FeS balances the equation. Each side of the equation has 1 Fe, 1 S, 2 H, and 2 Cl.

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Level 2

Positively charged ions are called **cations**. Negatively charged ions are called **anions**.

The cation is always written first when ions form compounds.

You can determine how ions combine if you know the **valency**.

Valency or **valence number**, is a measure of the number of bonds formed by an atom of a given element. For many elements, you can determine the most common valence number by it's placement on the periodic table.

Elements in group 1A have valence number +1

Elements in group 2A have valence number +2

Elements in groups 3A have valence number +3

Elements in group 6A have valence number -2

Elements in group 7A have valence number -1

1 1A	2 2A																	18 8A
1 H 1.008 Hydrogen	4 Be 9.012 Beryllium																	2 He 4.003 Helium
3 Li 6.941 Lithium												13 3A 5 B 10.812 Boron	14 4A 6 C 12.011 Carbon	15 5A 7 N 14.007 Nitrogen	16 6A 8 O 15.999 Oxygen	17 7A 9 F 18.998 Fluorine	10 Ne 20.180 Neon	
11 Na 22.990 Sodium	12 Mg 24.305 Magnesium											13 Al 26.982 Aluminum	14 Si 28.086 Silicon	15 P 30.974 Phosphorus	16 S 32.066 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon	
19 K 39.098 Potassium	20 Ca 40.078 Calcium	21 Sc 44.956 Scandium	22 Ti 47.867 Titanium	23 V 50.942 Vanadium	24 Cr 51.996 Chromium	25 Mn 54.938 Manganese	26 Fe 55.845 Iron	27 Co 58.933 Cobalt	28 Ni 58.693 Nickel	29 Cu 63.546 Copper	30 Zn 65.38 Zinc	31 Ga 69.723 Gallium	32 Ge 72.64 Germanium	33 As 74.922 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.798 Krypton	
37 Rb 85.468 Rubidium	38 Sr 87.62 Strontium	39 Y 88.906 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.906 Niobium	42 Mo 95.96 Molybdenum	43 Tc (98) Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.906 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.868 Silver	48 Cd 112.412 Cadmium	49 In 114.818 Indium	50 Sn 118.711 Tin	51 Sb 121.760 Antimony	52 Te 127.60 Tellurium	53 I 126.904 Iodine	54 Xe 131.294 Xenon	
55 Cs 132.905 Cesium	56 Ba 137.328 Barium	71 Lu 174.967 Lutetium	72 Hf 178.49 Hafnium	73 Ta 180.948 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.217 Iridium	78 Pt 195.085 Platinum	79 Au 196.967 Gold	80 Hg 200.59 Mercury	81 Tl 204.383 Thallium	82 Pb 207.2 Lead	83 Bi 208.980 Bismuth	84 Po (209) Polonium	85 At (210) Astatine	86 Rn (222) Radon	
87 Fr (223) Francium	88 Ra (226) Radium	103 Lr (262) Lawrencium	104 Rf (267) Rutherfordium	105 Db (268) Dubnium	106 Sg (271) Seaborgium	107 Bh (272) Bohrium	108 Hs (270) Hassium	109 Mt (276) Meitnerium	110 Ds (281) Darmstadtium	111 Rg (280) Roentgenium	Mass numbers in parentheses are those of the most stable or most common isotope.							

Lanthanide Series

57 La 138.905 Lanthanum	58 Ce 140.116 Cerium	59 Pr 140.908 Praseodymium	60 Nd 144.242 Neodymium	61 Pm (145) Promethium	62 Sm 150.36 Samarium	63 Eu 151.964 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.925 Terbium	66 Dy 162.500 Dysprosium	67 Ho 164.930 Holmium	68 Er 167.259 Erbium	69 Tm 168.934 Thulium	70 Yb 173.055 Ytterbium
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Actinide Series

89 Ac (227) Actinium	90 Th 232.038 Thorium	91 Pa 231.036 Protactinium	92 U 238.029 Uranium	93 Np (237) Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium
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Some elements you just need to know or look up their valence number, like zinc is +2 and silver is +1. And for some metals that can have more than one charge (valency). the name of the metal is succeeded by the valency in capital Roman numerals in brackets. Copper(I) has a charge of +1 and tin(IV) has a charge of +4.

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A **polyatomic ion** is a charged species (ion) composed of two or more atoms covalently bonded that can be considered as acting as a single unit. A list of common polyatomic ions and their valence numbers are in the STAAR Reference Material.

POLYATOMIC IONS	
Acetate	$\text{C}_2\text{H}_3\text{O}_2^-$, CH_3COO^-
Ammonium	NH_4^+
Carbonate	CO_3^{2-}
Chlorate	ClO_3^-
Chlorite	ClO_2^-
Chromate	CrO_4^{2-}
Cyanide	CN^-
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Hydrogen carbonate	HCO_3^-
Hydroxide	OH^-
Hypochlorite	ClO^-
Nitrate	NO_3^-
Nitrite	NO_2^-
Perchlorate	ClO_4^-
Permanganate	MnO_4^-
Phosphate	PO_4^{3-}
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

The raised superscript shows the charge.

A lone sign is assumed to be 1.

Acetate has a charge of -1.

Carbonate has a charge of -2

When ions or polyatomic ions combine, they form a neutral molecule.

The ions combine in ratios such that the charges all cancel out.

If you want to combine Al^{+3} with Cl^{-1} , you would need **3** chlorines for each Aluminum so the charges cancel. +3 and -1 -1 -1 cancel out.

A subscript in the formula shows how many of each ion is present.

Remember that the cation is always written first in a compound.

Aluminum combining with chlorine would be written AlCl_3

If you combine zinc (+2) with the polyatomic ion nitrate (-1), you would need two nitrates for each zinc. The formula would be $\text{Zn}(\text{NO}_3)_2$

Parenthesis are used whenever there is more than one polyatomic ion.

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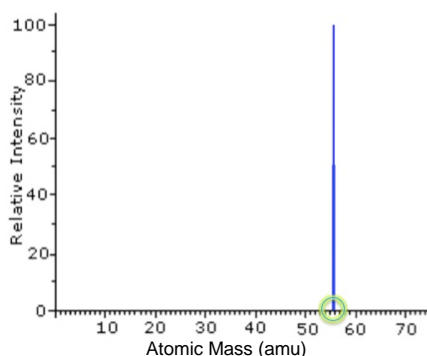
A **mass spectrometer** can be used to determine the chemical make up of an unknown compound.



The graph from a mass spectrometer identifies the atomic mass and relative ratio of the sample.

Mass Spectrometer Graphs

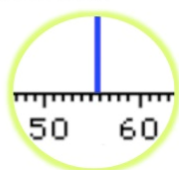
Elements



You know it is an **element** because there is only one line

The horizontal axis shows the **mass number**

The mass number for this element is between 55 and 56



Look on a periodic table to see what has a mass number between 55 and 56

																manganese 25 Mn 54.938			iron 26 Fe 55.845			cobalt 27 Co 58.933																		
																← name of element			← atomic number			← symbol																		
																← mass number																								

hydrogen 1 H 1.008				helium 2 He 4.003																		lithium 3 Li 6.941		beryllium 4 Be 9.012																		boron 5 B 10.811		carbon 6 C 12.011		nitrogen 7 N 14.007		oxygen 8 O 15.999		fluorine 9 F 18.998		neon 10 Ne 20.180																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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127 Lv 306.10		tennessine 128 Ts 307.10		oganesson 129 Og 308.10		livermorium 130 Lv 309.10		tennessine 131 Ts 310.10		oganesson 132 Og 311.10		livermorium 133 Lv 312.10		tennessine 134 Ts 313.10		oganesson 135 Og 314.10		livermorium 136 Lv 315.10		tennessine 137 Ts 316.10		oganesson 138 Og 317.10		livermorium 139 Lv 318.10		tennessine 140 Ts 319.10		oganesson 141 Og 320.10		livermorium 142 Lv 321.10		tennessine 143 Ts 322.10		oganesson 144 Og 323.10		livermorium 145 Lv 324.10		tennessine 146 Ts 325.10		oganesson 147 Og 326.10		livermorium 148 Lv 327.10		tennessine 149 Ts 328.10		oganesson 150 Og 329.10		livermorium 151 Lv 330.10		tennessine 152 Ts 331.10		oganesson 153 Og 332.10		livermorium 154 Lv 333.10		tennessine 155 Ts 334.10		oganesson 156 Og 335.10		livermorium 157 Lv 336.10		tennessine 158 Ts 337.10		oganesson 159 Og 338.10		livermorium 160 Lv 339.10		tennessine 161 Ts 340.10		oganesson 162 Og 341.10		livermorium 163 Lv 342.10		tennessine 164 Ts 343.10		oganesson 165 Og 344.10		livermorium 166 Lv 345.10		tennessine 167 Ts 346.10		oganesson 168 Og 347.10		livermorium 169 Lv 348.10		tennessine 170 Ts 349.10		oganesson 171 Og 350.10		livermorium 172 Lv 351.10		tennessine 173 Ts 352.10		oganesson 174 Og 353.10		livermorium 175 Lv 354.10		tennessine 176 Ts 355.10		oganesson 177 Og 356.10		livermorium 178 Lv 357.10		tennessine 179 Ts 358.10		oganesson 180 Og 359.10		livermorium 181 Lv 360.10		tennessine 182 Ts 361.10		oganesson 183 Og 362.10		livermorium 184 Lv 363.10		tennessine 185 Ts 364.10		oganesson 186 Og 365.10		livermorium 187 Lv 366.10		tennessine 188 Ts 367.10		oganesson 189 Og 368.10		livermorium 190 Lv 369.10		tennessine 191 Ts 370.10		oganesson 192 Og 371.10		livermorium 193 Lv 372.10		tennessine 194 Ts 373.10		oganesson 195 Og 374.10		livermorium 196 Lv 375.10		tennessine 197 Ts 376.10		oganesson 198 Og 377.10		livermorium 199 Lv 378.10		tennessine 200 Ts 379.10		oganesson 201 Og 380.10		livermorium 202 Lv 381.10		tennessine 203 Ts 382.10		oganesson 204 Og 383.10		livermorium 205 Lv 384.10		tennessine 206 Ts 385.10		oganesson 207 Og 386.10		livermorium 208 Lv 387.10		tennessine 209 Ts 388.10		oganesson 210 Og 389.10		livermorium 211 Lv 390.10		tennessine 212 Ts 391.10		oganesson 213 Og 392.10		livermorium 214 Lv 393.10		tennessine 215 Ts 394.10		oganesson 216 Og 395.10		livermorium 217 Lv 396.10		tennessine 218 Ts 397.10		oganesson 219 Og 398.10		livermorium 220 Lv 399.10		tennessine 221 Ts 400.10		oganesson 222 Og 401.10		livermorium 223 Lv 402.10		tennessine 224 Ts 403.10		oganesson 225 Og 404.10		livermorium 226 Lv 405.10		tennessine 227 Ts 406.10		oganesson 228 Og 407.10		livermorium 229 Lv 408.10		tennessine 230 Ts 409.10		oganesson 231 Og 410.10		livermorium 232 Lv 411.10		tennessine 233 Ts 412.10		oganesson 234 Og 413.10		livermorium 235 Lv 414.10		tennessine 236 Ts 415.10		oganesson 237 Og 416.10		livermorium 238 Lv 417.10		tennessine 239 Ts 418.10		oganesson 240 Og 419.10		livermorium 241 Lv 420.10		tennessine 242 Ts 421.10		oganesson 243 Og 422.10		livermorium 244 Lv 423.10		tennessine 245 Ts 424.10		oganesson 246 Og 425.10		livermorium 247 Lv 426.10		tennessine 248 Ts 427.10		oganesson 249 Og 428.10		livermorium 250 Lv 429.10		tennessine 251 Ts 430.10		oganesson 252 Og 431.10		livermorium 253 Lv 432.10		tennessine 254 Ts 433.10		oganesson 255 Og 434.10		livermorium 256 Lv 435.10		tennessine 257 Ts 436.10		oganesson 258 Og 437.10		livermorium 259 Lv 438.10		tennessine 260 Ts 439.10		oganesson 261 Og 440.10		livermorium 262 Lv 441.10		tennessine 263 Ts 442.10		oganesson 264 Og 443.10		livermorium 265 Lv 444.10		tennessine 266 Ts 445.10		oganesson 267 Og 446.10		livermorium 268 Lv 447.10		tennessine 269 Ts 448.10		oganesson 270 Og 449.10		livermorium 271 Lv 450.10		tennessine 272 Ts 451.10		oganesson 273 Og 452.10		livermorium 274 Lv 453.10		tennessine 275 Ts 454.10		oganesson 276 Og 455.10		livermorium 277 Lv 456.10		tennessine 278 Ts 457.10		oganesson 279 Og 458.10		livermorium 280 Lv 459.10		tennessine 281 Ts 460.10		oganesson 282 Og 461.10		livermorium 283 Lv 462.10		tennessine 284 Ts 463.10		oganesson 285 Og 464.10		livermorium 286 Lv 465.10		tennessine 287 Ts 466.10		oganesson 288 Og 467.10		livermorium 289 Lv 468.10		tennessine 290 Ts 469.10		oganesson 291 Og 470.10		livermorium 292 Lv 471.10		tennessine 293 Ts 472.10		oganesson 294 Og 473.10		livermorium 295 Lv 474.10		tennessine 296 Ts 475.10		oganesson 297 Og 476.10		livermorium 298 Lv 477.10		tennessine 299 Ts 478.10		oganesson 300 Og 479.10		livermorium 301 Lv 480.10		tennessine 302 Ts 481.10		oganesson 303 Og 482.10		livermorium 304 Lv 483.10		tennessine 305 Ts 484.10		oganesson 306 Og 485.10		livermorium 307 Lv 486.10		tennessine 308 Ts 487.10		oganesson 309 Og 488.10		livermorium 310 Lv 489.10		tennessine 311 Ts 490.10		oganesson 312 Og 491.10		livermorium 313 Lv 492.10		tennessine 314 Ts 493.10		oganesson 315 Og 494.10		livermorium 316 Lv 495.10		tennessine 317 Ts 496.10		oganesson 318 Og 497.10		livermorium 319 Lv 498.10		tennessine 320 Ts 499.10		oganesson 321 Og 500.10		livermorium 322 Lv 501.10		tennessine 323 Ts 502.10		oganesson 324 Og 503.10		livermorium 325 Lv 504.10		tennessine 326 Ts 505.10		oganesson 327 Og 506.10		livermorium 328 Lv 507.10		tennessine 329 Ts 508.10		oganesson 330 Og 509.10		livermorium 331 Lv 510.10		tennessine 332 Ts 511.10		oganesson 333 Og 512.10		livermorium 334 Lv 513.10		tennessine 335 Ts 514.10		oganesson 336 Og 515.10		livermorium 337 Lv 516.10		tennessine 338 Ts 517.10		oganesson 339 Og 518.10		livermorium 340 Lv 519.10		tennessine 341 Ts 520.10		oganesson 342 Og 521.10		livermorium 343 Lv 522.10		tennessine 344 Ts 523.10		oganesson 345 Og 524.10		livermorium 346 Lv 525.10		tennessine 347 Ts 526.10		oganesson 348 Og 527.10		livermorium 349 Lv 528.10		tennessine 350 Ts 529.10		oganesson 351 Og 530.10		livermorium 352 Lv 531.10		tennessine 353 Ts 532.10		oganesson 354 Og 533.10		livermorium 355 Lv 534.10		tennessine 356 Ts 535.10		oganesson 357 Og 536.10		livermorium 358 Lv 537.10		tennessine 359 Ts 538.10		oganesson 360 Og 539.10		livermorium 361 Lv 540.10		tennessine 362 Ts 541.10		oganesson 363 Og 542.10		livermorium 364 Lv 543.10		tennessine 365 Ts 544.10		oganesson 366 Og 545.10		livermorium 367 Lv 546.10		tennessine 368 Ts 547.10		oganesson 369 Og 548.10		livermorium 370 Lv 549.10		tennessine 371 Ts 550.10		oganesson 372 Og 551.10		livermorium 373 Lv 552.10		tennessine 374 Ts 553.10		oganesson 375 Og 554.10		livermorium 376 Lv 555.10		tennessine 377 Ts 556.10		oganesson 378 Og 557.10		livermorium 379 Lv 558.10		tennessine 380 Ts 559.10		oganesson 381 Og 560.10		livermorium 382 Lv 561.10		tennessine 383 Ts 562.10	

*Lanthanide series

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb

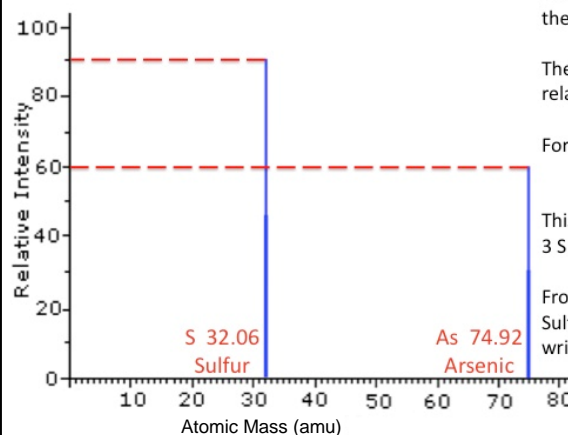
**Actinide series

89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

A mass spectrometer usually wouldn't be used for a pure sample of one element.

Mass Spectrometer Graphs

Compounds



You know it is a **compound** because there is more than one line

The height of the line shows the relative amount of each element

For every 90 Sulfur ions there are 60 Arsenic ions

This can be reduced. For every 3 S ions there are 2 As ions

From the periodic table, you know Sulfur is the **negative** ion, so you write it last.



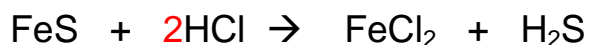
CASPER Research Experience for Teachers

The **law of conservation of mass**, states that the mass of an isolated system (closed to all matter and energy) will remain constant over time. Even when there are chemical changes, mass must be conserved. In a chemical reaction, the number and types of atoms in the reactants, must equal the number and types of atoms in the products.

Consider this chemical equation: $\text{FeS} + \text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2\text{S}$

Iron(II)sulfide and hydrochloric acid have a double replacement reaction to produce Iron(II)chloride and hydrogen sulfide.

As written, this violates the law of conservation of mass. It starts with one chlorine atom, and ends with two. Changing the subscripts would change the compound. The equation must be “balanced” by adding coefficients, numbers in front of the molecule.



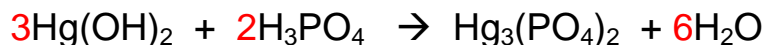
Having 2 molecules of HCl for every 1 molecule of FeS balances the equation. Each side of the equation has 1 Fe, 1 S, 2 H, and 2 Cl.

Be careful when there are polyatomic ions in parenthesis.

Consider this chemical equation: $\text{Hg}(\text{OH})_2 + \text{H}_3\text{PO}_4 \rightarrow \text{Hg}_3(\text{PO}_4)_2 + \text{H}_2\text{O}$

There are 5 hydrogen ions on the left side – 2 from the hydroxide and 3 in the second compound.

On the right side, only water has hydrogen – so it comes in sets of two. An *odd* number of hydrogens on the left will never balance! So a good start is to put a 2 in front of the H_3PO_4 . To make the mercury (Hg) balance, put a 3 in front of the mercury hydroxide. Tally up the number of each ion on the left, and determine what coefficients are needed on the right.



3 Hg		3	3 Hg	3
6 O	8 O	14	8 O	14
6 H	6 H	12	12 H	12
	2 P	2	2 P	2

CASPER Research Experience for Teachers

Level 3 (overlaps some parts of Lev 2)

A **polyatomic ion** is a charged species (ion) composed of two or more atoms covalently bonded that can be considered as acting as a single unit. A list of common polyatomic ions and their valence numbers are in the STAAR Reference Material.

POLYATOMIC IONS	
Acetate	$\text{C}_2\text{H}_3\text{O}_2^-$, CH_3COO^-
Ammonium	NH_4^+
Carbonate	CO_3^{2-}
Chlorate	ClO_3^-
Chlorite	ClO_2^-
Chromate	CrO_4^{2-}
Cyanide	CN^-
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Hydrogen carbonate	HCO_3^-
Hydroxide	OH^-
Hypochlorite	ClO^-
Nitrate	NO_3^-
Nitrite	NO_2^-
Perchlorate	ClO_4^-
Permanganate	MnO_4^-
Phosphate	PO_4^{3-}
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

The raised superscript shows the charge.

A lone sign is assumed to be 1.

Acetate has a charge of -1.

Carbonate has a charge of -2

When ions or polyatomic ions combine, they form a neutral molecule.

The ions combine in ratios such that the charges all cancel out.

If you want to combine Al^{+3} with Cl^{-1} , you would need **3** chlorines for each Aluminum so the charges cancel. +3 and -1 -1 -1 cancel out.

A subscript in the formula shows how many of each ion is present.

Remember that the cation is always written first in a compound.

Aluminum combining with chlorine would be written AlCl_3

If you combine zinc (+2) with the polyatomic ion nitrate (-1), you would need two nitrates for each zinc. The formula would be $\text{Zn}(\text{NO}_3)_2$

Parenthesis are used whenever there is more than one polyatomic ion.

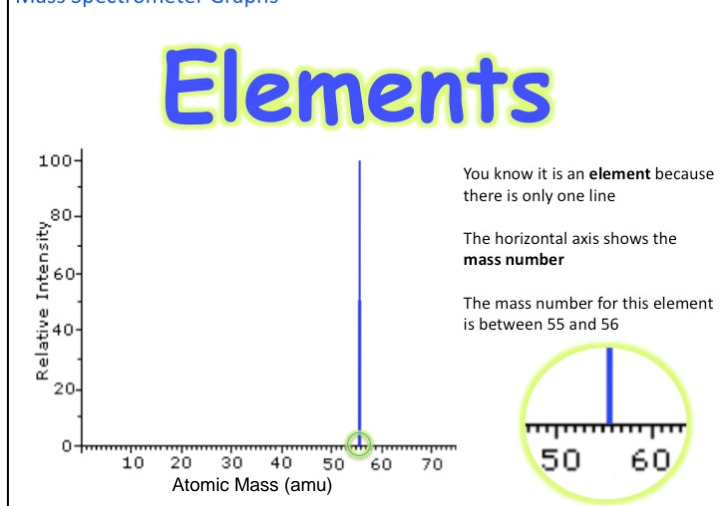
CASPER Research Experience for Teachers

A **mass spectrometer** can be used to determine the chemical make up of an unknown compound.



The graph from a mass spectrometer identifies the atomic mass and relative ratio of the sample.

Mass Spectrometer Graphs

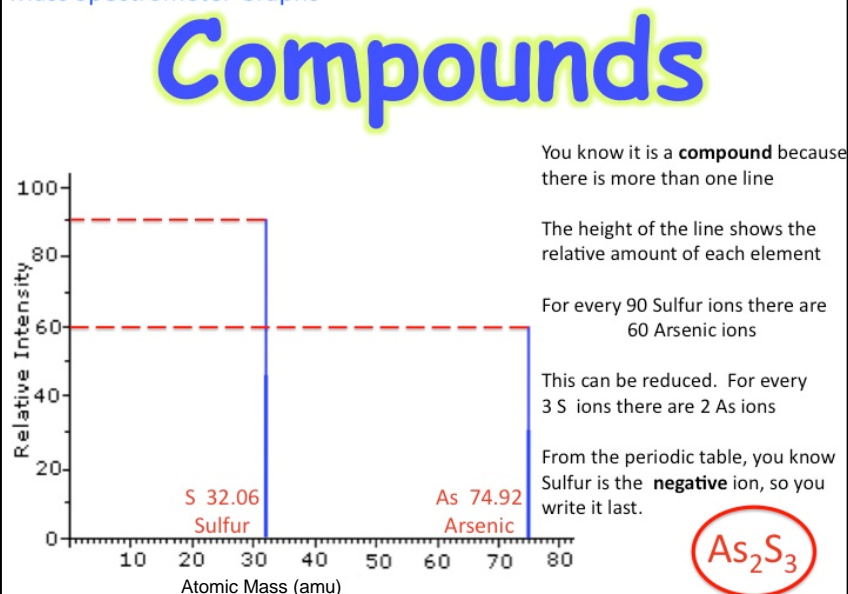


Look on a periodic table to see what has a mass number between 55 and 56

<div style="display: flex; justify-content: space-around;"> <div> manganese 25 Mn 54.938 </div> <div> iron 26 Fe 55.845 </div> <div> cobalt 27 Co 58.933 </div> </div>																← name of element ← atomic number ← symbol ← mass number																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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colspan="10"></td><td>55</td><td>56</td><td>57</td><td>58</td><td>59</td><td>60</td><td>61</td><td>62</td><td>63</td><td>64</td><td>65</td><td>66</td><td>67</td><td>68</td><td>69</td><td>70</td><td>71</td><td>72</td><td>73</td><td>74</td><td>75</td><td>76</td><td>77</td><td>78</td><td>79</td><td>80</td><td colspan="10"></td><td>Ar</td></tr> <tr> <td>Cs</td><td>Ba</td><td>* 57-70</td><td>Lu</td><td>Hf</td><td>Ta</td><td>W</td><td>Re</td><td>Os</td><td>Ir</td><td>Pt</td><td>Au</td><td>Hg</td><td>Tl</td><td>Pb</td><td>Bi</td><td>Po</td><td>At</td><td>Rn</td><td colspan="10"></td><td>Rn</td></tr> <tr> <td>55</td><td>56</td><td colspan="10"></td><td>81</td><td>82</td><td>83</td><td>84</td><td>85</td><td>86</td><td>87</td><td>88</td><td>89</td><td>90</td><td>91</td><td>92</td><td>93</td><td>94</td><td>95</td><td>96</td><td>97</td><td>98</td><td>99</td><td>100</td><td>101</td><td>102</td><td>103</td><td>104</td><td>105</td><td>106</td><td>107</td><td>108</td><td>109</td><td>110</td><td>111</td><td>112</td><td>113</td><td>114</td><td>115</td><td>116</td><td>117</td><td>118</td><td>119</td><td>120</td><td colspan="10"></td><td>Ar</td></tr> <tr> <td>Fr</td><td>Ra</td><td>**</td><td>Lr</td><td>Rf</td><td>Db</td><td>Sg</td><td>Bh</td><td>Hs</td><td>Mt</td><td>Uun</td><td>Uuq</td><td>Uub</td><td colspan="10"></td><td>Uuq</td><td colspan="10"></td><td>Uuq</td></tr> <tr> <td>87</td><td>88</td><td colspan="10"></td><td>101</td><td>102</td><td>103</td><td>104</td><td>105</td><td>106</td><td>107</td><td>108</td><td>109</td><td>110</td><td>111</td><td>112</td><td>113</td><td>114</td><td>115</td><td>116</td><td>117</td><td>118</td><td>119</td><td>120</td><td>121</td><td>122</td><td>123</td><td>124</td><td>125</td><td>126</td><td>127</td><td>128</td><td>129</td><td>130</td><td>131</td><td>132</td><td>133</td><td>134</td><td>135</td><td>136</td><td>137</td><td>138</td><td>139</td><td>140</td><td>141</td><td>142</td><td>143</td><td>144</td><td>145</td><td>146</td><td>147</td><td>148</td><td>149</td><td>150</td><td>151</td><td>152</td><td>153</td><td>154</td><td>155</td><td>156</td><td>157</td><td>158</td><td>159</td><td>160</td><td>161</td><td>162</td><td>163</td><td>164</td><td>165</td><td>166</td><td>167</td><td>168</td><td>169</td><td>170</td><td>171</td><td>172</td><td>173</td><td>174</td><td>175</td><td>176</td><td>177</td><td>178</td><td>179</td><td>180</td><td>181</td><td>182</td><td>183</td><td>184</td><td>185</td><td>186</td><td>187</td><td>188</td><td>189</td><td>190</td><td>191</td><td>192</td><td>193</td><td>194</td><td>195</td><td>196</td><td>197</td><td>198</td><td>199</td><td>200</td><td>201</td><td>202</td><td>203</td><td>204</td><td>205</td><td>206</td><td>207</td><td>208</td><td>209</td><td>210</td><td>211</td><td>212</td><td>213</td><td>214</td><td>215</td><td>216</td><td>217</td><td>218</td><td>219</td><td>220</td><td>221</td><td>222</td><td>223</td><td>224</td><td>225</td><td>226</td><td>227</td><td>228</td><td>229</td><td>230</td><td>231</td><td>232</td><td>233</td><td>234</td><td>235</td><td>236</td><td>237</td><td>238</td><td>239</td><td>240</td><td>241</td><td>242</td><td>243</td><td>244</td><td>245</td><td>246</td><td>247</td><td>248</td><td>249</td><td>250</td><td>251</td><td>252</td><td>253</td><td>254</td><td>255</td><td>256</td><td>257</td><td>258</td><td>259</td><td>260</td><td>261</td><td>262</td><td>263</td><td>264</td><td>265</td><td>266</td><td>267</td><td>268</td><td>269</td><td>270</td><td>271</td><td>272</td><td>273</td><td>274</td><td>275</td><td>276</td><td>277</td><td>278</td><td>279</td><td>280</td><td>281</td><td>282</td><td>283</td><td>284</td><td>285</td><td>286</td><td>287</td><td>288</td><td>289</td><td>290</td><td>291</td><td>292</td><td>293</td><td>294</td><td>295</td><td>296</td><td>297</td><td>298</td><td>299</td><td>300</td><td>301</td><td>302</td><td>303</td><td>304</td><td>305</td><td>306</td><td>307</td><td>308</td><td>309</td><td>310</td><td>311</td><td>312</td><td>313</td><td>314</td><td>315</td><td>316</td><td>317</td><td>318</td><td>319</td><td>320</td><td>321</td><td>322</td><td>323</td><td>324</td><td>325</td><td>326</td><td>327</td><td>328</td><td>329</td><td>330</td><td>331</td><td>332</td><td>333</td><td>334</td><td>335</td><td>336</td><td>337</td><td>338</td><td>339</td><td>340</td><td>341</td><td>342</td><td>343</td><td>344</td><td>345</td><td>346</td><td>347</td><td>348</td><td>349</td><td>350</td><td>351</td><td>352</td><td>353</td><td>354</td><td>355</td><td>356</td><td>357</td><td>358</td><td>359</td><td>360</td><td>361</td><td>362</td><td>363</td><td>364</td><td>365</td><td>366</td><td>367</td><td>368</td><td>369</td><td>370</td><td>371</td><td>372</td><td>373</td><td>374</td><td>375</td><td>376</td><td>377</td><td>378</td><td>379</td><td>380</td><td>381</td><td>382</td><td>383</td><td>384</td><td>385</td><td>386</td><td>387</td><td>388</td><td>389</td><td>390</td><td>391</td><td>392</td><td>393</td><td>394</td><td>395</td><td>396</td><td>397</td><td>398</td><td>399</td><td>400</td><td>401</td><td>402</td><td>403</td><td>404</td><td>405</td><td>406</td><td>407</td><td>408</td><td>409</td><td>410</td><td>411</td><td>412</td><td>413</td><td>414</td><td>415</td><td>416</td><td>417</td><td>418</td><td>419</td><td>420</td><td>421</td><td>422</td><td>423</td><td>424</td><td>425</td><td>426</td><td>427</td><td>428</td><td>429</td><td>430</td><td>431</td><td>432</td><td>433</td><td>434</td><td>435</td><td>436</td><td>437</td><td>438</td><td>439</td><td>440</td><td>441</td><td>442</td><td>443</td><td>444</td><td>445</td><td>446</td><td>447</td><td>448</td><td>449</td><td>450</td><td>451</td><td>452</td><td>453</td><td>454</td><td>455</td><td>456</td><td>457</td><td>458</td><td>459</td><td>460</td><td>461</td><td>462</td><td>463</td><td>464</td><td>465</td><td>466</td><td>467</td><td>468</td><td>469</td><td>470</td><td>471</td><td>472</td><td>473</td><td>474</td><td>475</td><td>476</td><td>477</td><td>478</td><td>479</td><td>480</td><td>481</td><td>482</td><td>483</td><td>484</td><td>485</td><td>486</td><td>487</td><td>488</td><td>489</td><td>490</td><td>491</td><td>492</td><td>493</td><td>494</td><td>495</td><td>496</td><td>497</td><td>498</td><td>499</td><td>500</td><td>501</td><td>502</td><td>503</td><td>504</td><td>505</td><td>506</td><td>507</td><td>508</td><td>509</td><td>510</td><td>511</td><td>512</td><td>513</td><td>514</td><td>515</td><t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A mass spectrometer usually wouldn't be used for a pure sample of one element.

Mass Spectrometer Graphs



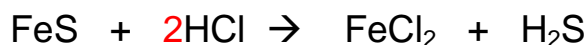
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The **law of conservation of mass**, states that the mass of an isolated system (closed to all matter and energy) will remain constant over time. Even when there are chemical changes, mass must be conserved. In a chemical reaction, the number and types of atoms in the reactants, must equal the number and types of atoms in the products.

Consider this chemical equation: $\text{FeS} + \text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2\text{S}$

Iron(II)sulfide and hydrochloric acid have a double replacement reaction to produce Iron(II)chloride and hydrogen sulfide.

As written, this violates the law of conservation of mass. It starts with one chlorine atom, and ends with two. Changing the subscripts would change the compound. The equation must be “balanced” by adding coefficients, numbers in front of the molecule.



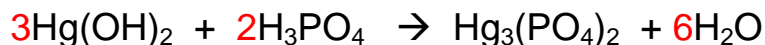
Having 2 molecules of HCl for every 1 molecule of FeS balances the equation. Each side of the equation has 1 Fe, 1 S, 2 H, and 2 Cl.

Be careful when there are polyatomic ions in parenthesis.

Consider this chemical equation: $\text{Hg}(\text{OH})_2 + \text{H}_3\text{PO}_4 \rightarrow \text{Hg}_3(\text{PO}_4)_2 + \text{H}_2\text{O}$

There are 5 hydrogen ions on the left side – 2 from the hydroxide and 3 in the second compound.

On the right side, only water has hydrogen – so it comes in sets of two. An *odd* number of hydrogens on the left will never balance! So a good start is to put a 2 in front of the H_3PO_4 . To make the mercury (Hg) balance, put a 3 in front of the mercury hydroxide. Tally up the number of each ion on the left, and determine what coefficients are needed on the right.



3 Hg		3	3 Hg	3
6 O	8 O	14	8 O	14
6 H	6 H	12	12 H	12
	2 P	2	2 P	2

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The following is adapted from :

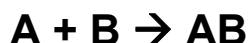
<http://misterguch.brinkster.net/6typesofchemicalrxn.html>

All chemical reactions can be placed into one of six categories.

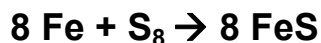
1) **Combustion:** A combustion reaction is when oxygen combines with another compound to form water and carbon dioxide. These reactions are exothermic, meaning they produce heat. An example of this kind of reaction is the burning of naphthalene:



2) **Synthesis:** A synthesis reaction is when two or more simple compounds combine to form a more complicated one. These reactions come in the general form of:



One example of a synthesis reaction is the combination of iron and sulfur to form iron (II) sulfide:



3) **Decomposition:** A decomposition reaction is the opposite of a synthesis reaction - a complex molecule breaks down to make simpler ones. These reactions come in the general form:



One example of a decomposition reaction is the electrolysis of water to make oxygen and hydrogen gas:



4) **Single displacement:** This is when one element trades places with another element in a compound. These reactions come in the general form of:



One example of a single displacement reaction is when magnesium replaces hydrogen in water to make magnesium hydroxide and hydrogen gas:

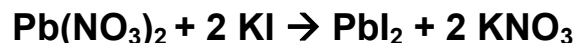


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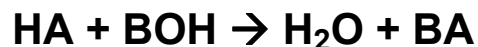
5) **Double displacement:** This is when the anions and cations of two different molecules switch places, forming two entirely different compounds. These reactions are in the general form:



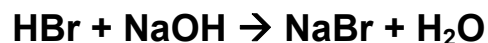
One example of a double displacement reaction is the reaction of lead (II) nitrate with potassium iodide to form lead (II) iodide and potassium nitrate:



6) **Acid-base:** This is a special kind of double displacement reaction that takes place when an acid and base react with each other. The H^+ ion in the acid reacts with the OH^- ion in the base, causing the formation of water. Generally, the product of this reaction is some ionic salt and water:



One example of an acid-base reaction is the reaction of hydrobromic acid (HBr) with sodium hydroxide:



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Question Bank – Clue 4

Level 1

How many sodium ions are in $2\text{Na}_2\text{O}$?

Answer: 4

How many lead ions are in $3\text{Pb}_3\text{N}_2$?

Answer: 9

How many nitrogen ions are in $3\text{Pb}_3\text{N}_2$?

Answer: 6

How many copper ions are in Cu_3P_2 ?

Answer: 3

How many iron ions are in 2FeBr_2 ?

Answer: 2

How many bromine ions are in 2FeBr_2 ?

Answer: 4

How many carbon ions are in $2\text{C}_{12}\text{H}_{22}\text{O}_{11}$?

Answer: 24

How many oxygen ions are in $2\text{C}_{12}\text{H}_{22}\text{O}_{11}$?

Answer: 22

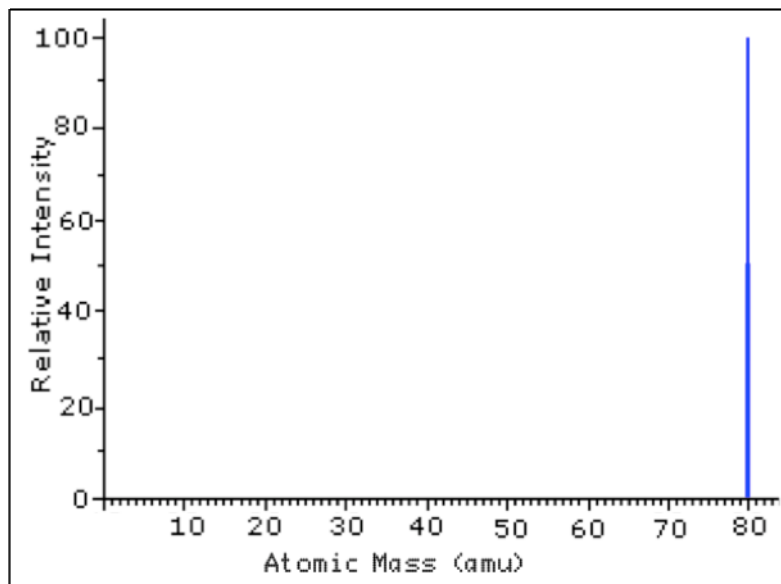
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What is the function of a mass spectrometer?

- A. to measure the mass of an unknown substance
- B. to measure the spectrum of radiation reflected by an unknown substance
- C. to determine the elements that make up an unknown substance

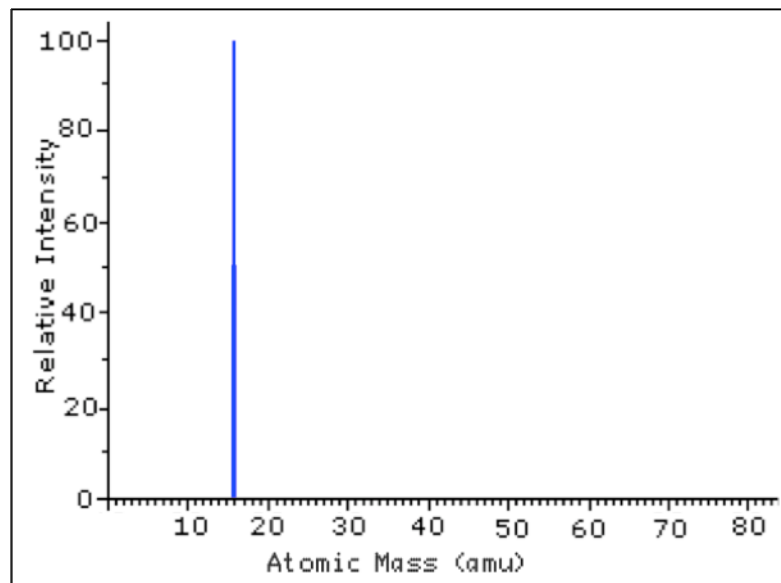
Answer: C

Use a periodic table to identify the element in this mass spectrometer graph:



Answer: sodium

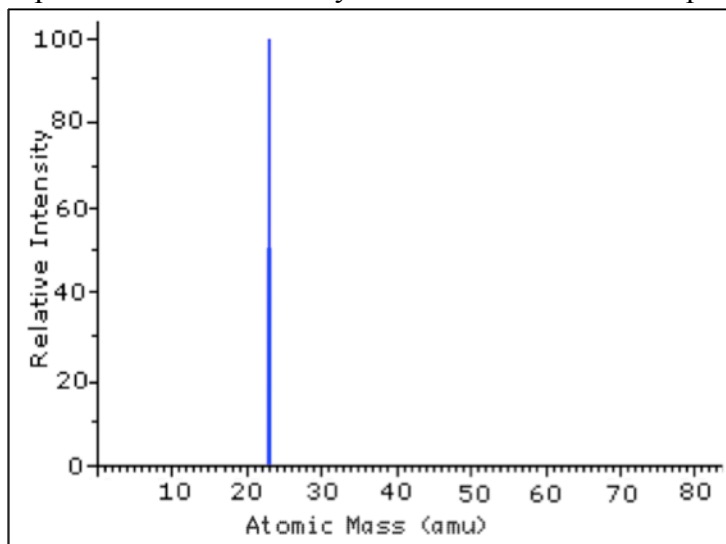
Use a periodic table to identify the element in this mass spectrometer graph:



Answer: oxygen

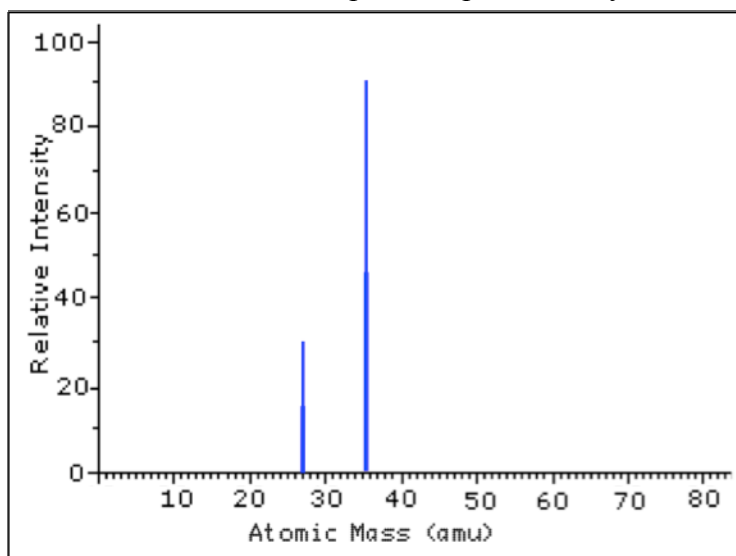
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Use a periodic table to identify the element in this mass spectrometer graph:



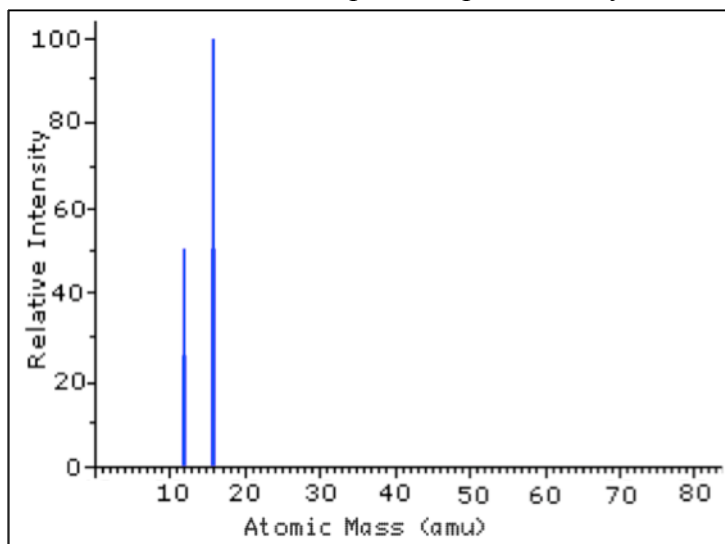
Answer: bromine

Write the formula for the compound represented by this mass spectrum graph:



Answer: H₂O

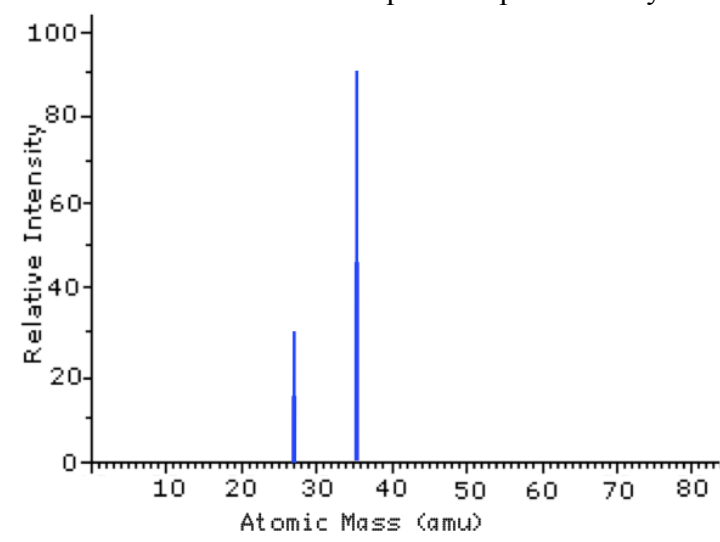
Write the formula for the compound represented by this mass spectrum graph:



Answer: CO₂

CASPER Research Experience for Teachers

Write the formula for the compound represented by this mass spectrometer graph:



Answer: AlCl_3

Directions - Enter coefficients separated by spaces. Type “-” if there is no coefficient

Balance the equation: $\text{NaCl} + \text{BeF}_2 \rightarrow \text{NaF} + \text{BeCl}_2$

Answer: 2 - 2 -

Balance the equation: $\text{Al}_2\text{O}_3 \rightarrow \text{Al} + \text{O}_2$

Answer: 2 4 3

Balance the equation: $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

Answer: - 2 - 2

Balance the equation: $\text{KClO}_3 \rightarrow \text{KCl} + \text{O}_2$

Answer: 2 2 3

Balance the equation: $\text{Mg} + \text{Mn}_2\text{O}_3 \rightarrow \text{MgO} + \text{Mn}$

Answer: 3 - 3 2

Balance the equation: $\text{S}_8 + \text{O}_2 \rightarrow \text{SO}_2$

Answer: - 8 8

CASPER Research Experience for Teachers

Level 2

Do cations have a positive or negative charge?

Answer: positive

Do anions have a positive or negative charge?

Answer: negative

What is the valence number for Beryllium?

Answer: +2

What is the valence number for Sodium?

Answer: +1

What is the valence number for Chlorine?

Answer: -1

What is the valence number for Oxygen?

Answer: -2

What is the valence number for iron(III)?

Answer: +3

What is the valence number for mercury(II)?

Answer: +2

What is the valence number for the polyatomic ion sulfite?

Answer: -2

What is the valence number for the polyatomic ion dichromate?

Answer: -2

What is the valence number for the polyatomic ion ammonium?

Answer: +1

What is the valence number for the polyatomic ion cyanide?

Answer: -1

CASPER Research Experience for Teachers

Write the chemical formula when lithium and sulfur combine?

ANSWER: Li_2S

Write the chemical formula when barium and fluorine combine?

ANSWER: BaF_2

Write the chemical formula when beryllium and nitrogen combine?

ANSWER: Be_3N_2

Write the chemical formula when copper(I) and oxygen combine?

ANSWER: Cu_2O

Write the chemical formula when lead(II) and iodine combine?

ANSWER: PbI_2

Write the chemical formula when magnesium and the polyatomic ion carbonate combine?

ANSWER: MgCO_3

Write the chemical formula when calcium and the polyatomic ion chlorate combine?

ANSWER: $\text{Ca}(\text{ClO}_3)_2$

Write the chemical formula when copper(II) and the polyatomic ion hydroxide combine?

ANSWER: $\text{Cu}(\text{OH})_2$

Write the chemical formula when palladium(II) and the polyatomic ion nitrate combine?

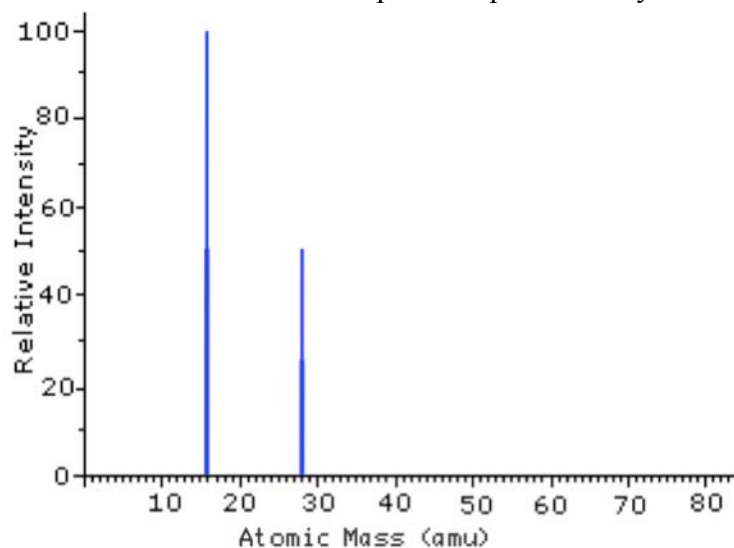
ANSWER: $\text{Pd}(\text{NO}_3)_2$

Write the chemical formula when the polyatomic ions ammonium and chromate combine?

ANSWER: $(\text{NH}_4)_2\text{CrO}_4$

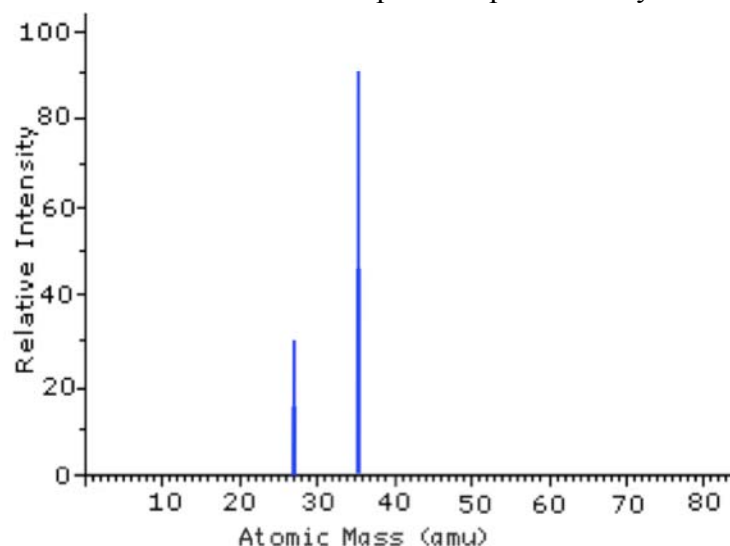
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Write the formula for the compound represented by this mass spectrometer graph:



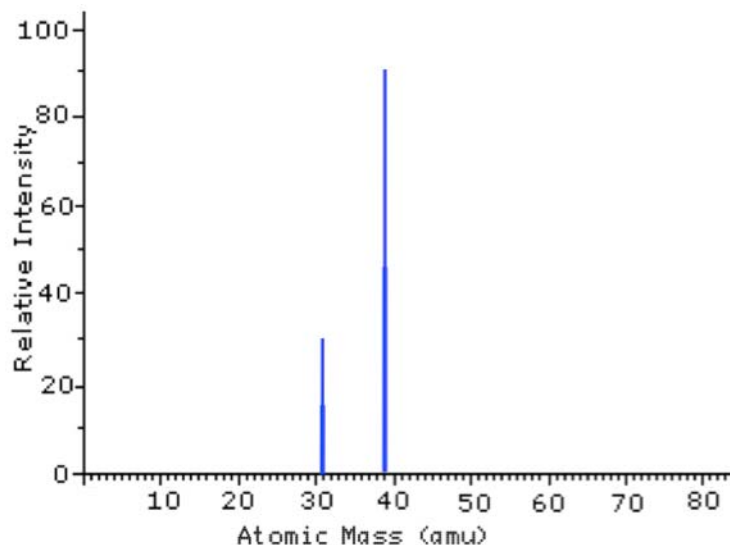
Answer: SiO_2

Write the formula for the compound represented by this mass spectrometer graph:



Answer: AlCl_3

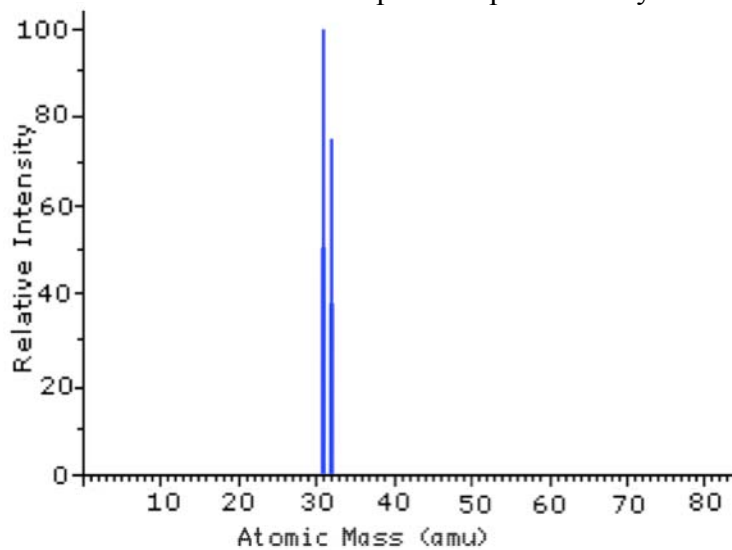
Write the formula for the compound represented by this mass spectrometer graph:



Answer: K_3P

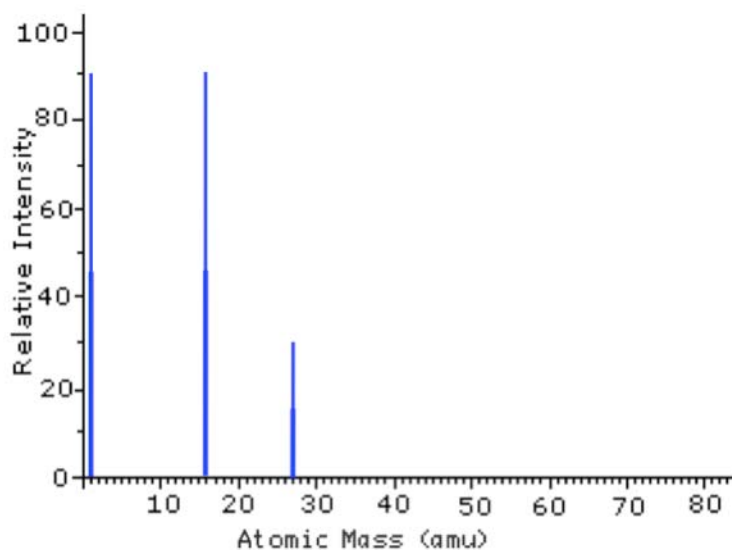
CASPER Research Experience for Teachers

Write the formula for the compound represented by this mass spectrometer graph:



Answer: P_4S_3

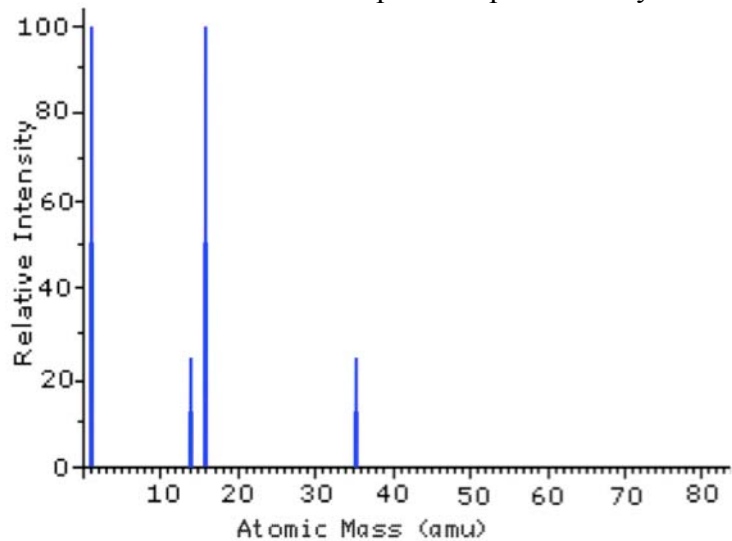
Write the formula for the compound represented by this mass spectrometer graph:



HINT: it contains a polyatomic ion

ANSWER: $\text{Al}(\text{OH})_2$

Write the formula for the compound represented by this mass spectrometer graph:



HINT: it contains polyatomic ions

ANSWER: NH_4ClO_4

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Directions - Enter coefficients separated by spaces. Type “-” if there is no coefficient

Balance the equation: $\text{SnO}_2 + \text{H}_2 \rightarrow \text{Sn} + \text{H}_2\text{O}$

ANSWER: - 2 - 2

Balance the equation: $\text{V}_2\text{O}_5 + \text{HCl} \rightarrow \text{VOCl}_3 + \text{H}_2\text{O}$

ANSWER: - 6 2 3

Balance the equation: $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2 + \text{O}_2 + \text{H}_2\text{O}$

ANSWER: 2 2 - 4

Balance the equation: $\text{N}_2 + \text{O}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3$

ANSWER: 2 5 2 4

CASPER Research Experience for Teachers

Level 3

Write the chemical formula when caesium and carbonate combine?

ANSWER: Cs_2CO_3

Write the chemical formula when chromium(III) and oxygen combine?

ANSWER: Cr_2O_3

Write the chemical formula when germanium(II) and fluorine combine?

ANSWER: GeF_2

Write the chemical formula when magnesium and phosphate combine?

ANSWER: $\text{Mg}_3(\text{PO}_4)_2$

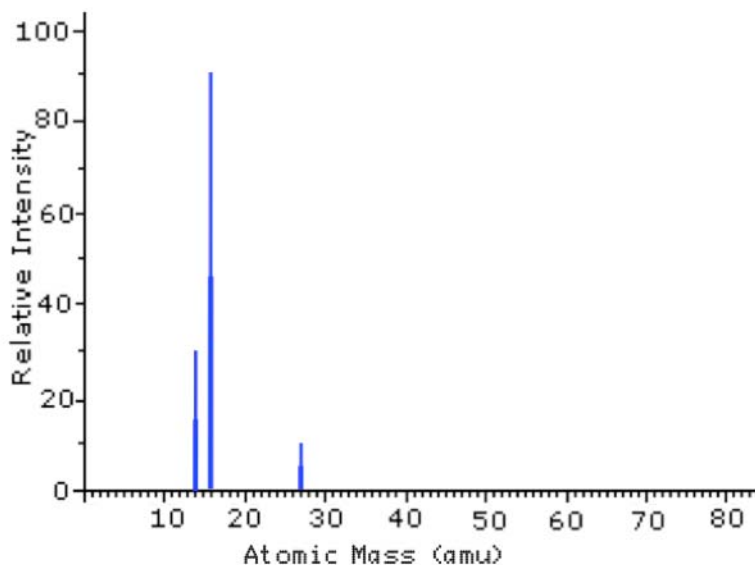
Write the chemical formula when potassium and carbonate combine?

ANSWER: K_2CO_3

Write the chemical formula when lead(II) and nitrate combine?

ANSWER: $\text{Pb}(\text{NO}_3)_2$

Write the formula for the compound represented by this mass spectrometer graph:

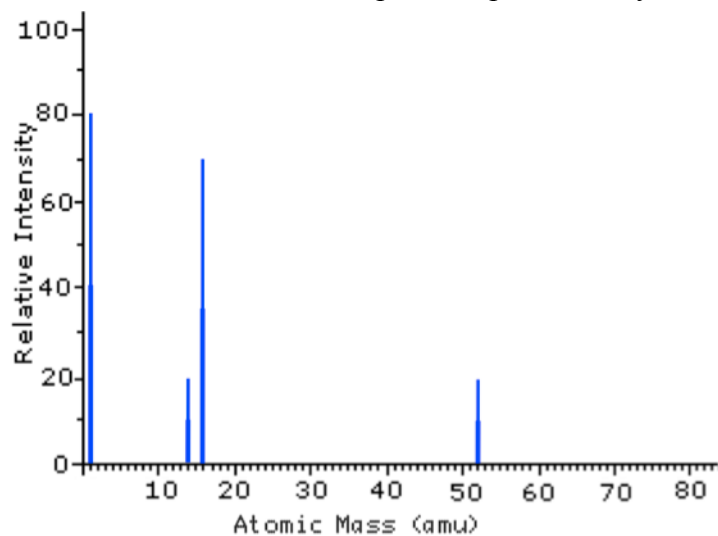


HINT: it contains polyatomic ions

ANSWER: $\text{Al}(\text{NO}_3)_3$

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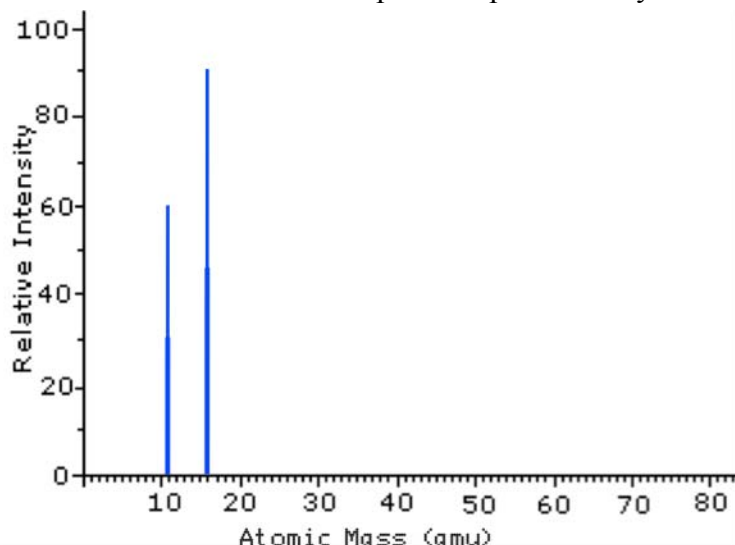
Write the formula for the compound represented by this mass spectrometer graph:



HINT: it contains polyatomic ions

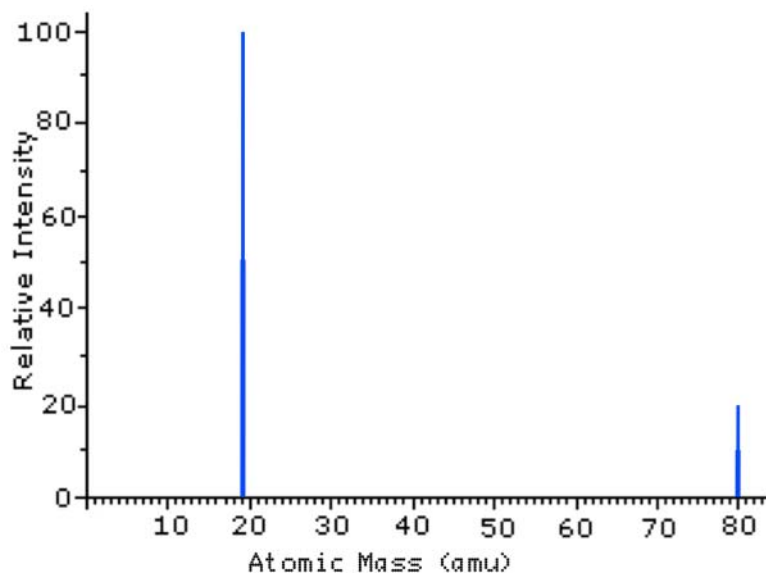
ANSWER: $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$

Write the formula for the compound represented by this mass spectrum graph:



ANSWER: B_2O_3

Write the formula for the compound represented by this mass spectrometer graph:



ANSWER: BrF_5

CASPER Research Experience for Teachers

Directions - Enter coefficients separated by spaces. Type "-" if there is no coefficient

Balance the equation: $\text{AgI} + \text{Fe}_2(\text{CO}_3)_3 \rightarrow \text{FeI}_3 + \text{Ag}_2\text{CO}_3$

ANSWER: 6 - 2 3

Balance the equation: $\text{H}_2\text{SO}_4 + \text{B}(\text{OH})_3 \rightarrow \text{B}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$

ANSWER: 3 2 - 6

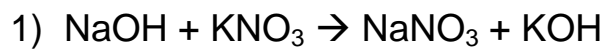
Balance the equation: $\text{Ba}_3\text{N}_2 + \text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 + \text{NH}_3$

ANSWER: - 6 3 2

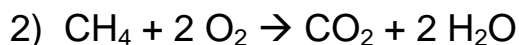
Balance the equation: $\text{FeS} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3 + \text{SO}_4$

ANSWER: 4 7 2 4

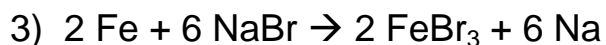
What type of reaction is each?



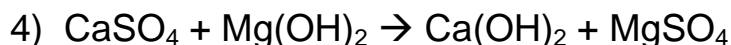
Answer: double replacement



Answer: combustion



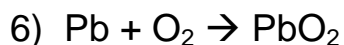
Answer: single replacement



Answer: double replacement



Answer: acid-base



Answer: synthesis



Answer: decomposition

CASPER Research Experience for Teachers

2010 Physics DVD

I made this index when I was converting the DVD into .mp4's to use in my presentation

- 1 DVD Menu Slide
- 2 Text on red wavy background – kinetic energy on door
- 3 Text on red wavy background – thermodynamics of coffee
- 4 Text on red wavy background – density
- 5 Text on red wavy background – balancing equations
- 6 Text on red wavy background – parallel and series circuits
- 7 Text on red wavy background – You're RIGHT! It was the mascot
- 8 1m49s Security camera footage
- 9 1h17m43s ? the whole stage show
- 10 41s CASPER production
- 11 CASPER
- 12 2m34s Crime scene with evidence number markers
- 13 5m25s Opening scene
- 14 9m26s Intro & Breaking the door
- 15 6m48s ?
- 16 12m30s playing with slime
- 17 12m15s rubber duck
- 18 5m14s circuits
- 19 2m35s Scientist in lab coat – Clue 1
- 20 3m14s Scientist in lab coat – Clue 2
- 21 2m46s Scientist in lab coat – Clue 3
- 22 3m33s Scientist in lab coat – Clue 4
- 23 3m1s Scientist in lab coat – Clue 5
- 24 Laser Show
- 25 Credits

CASPER Research Experience for Teachers

Additional files

Presentation Folder – contains the PowerPoint file and movie files that Danielle Moore and I presented about the Physics Circus

Classroom.pptx - the slides I created and discussed in Steve Rapp & Gar Shetler's presentation about RET research

TarmanPoster2012.ppt – the poster to hang in my classroom

LisaJuly11Red.xlsx - data analysis for my 2 seconds of red laser images

LisaJuly12Green.xlsx – data analysis for my 2 seconds of green laser images

CASPER Research Experience for Teachers

Impact on my teaching

I had an amazing summer immersed in a thriving academic setting. I believe my experience translates into enthusiasm that benefits my students more than those of a teacher that spent their summer by the pool. My urban students don't know a scientist or engineer. I am their closest personal link to a STEM career. The pictures I share and stories I tell, give students a feel for what researchers and graduate students do.

Besides my renewed enthusiasm and rich variety of exposure to actual research, I have real data to bring back to my classroom. I plan to explain and use pictures to show the process I used to gather the data and have my students use Excel spreadsheets to perform the same analysis I did. I know CASPER staff would be willing to interact with my class via Skype or email to answer any questions we have.

I'd like to thank all CASPER faculty and staff for the rewarding professional experience from which I have benefitted greatly. Baylor University is a great place to be.