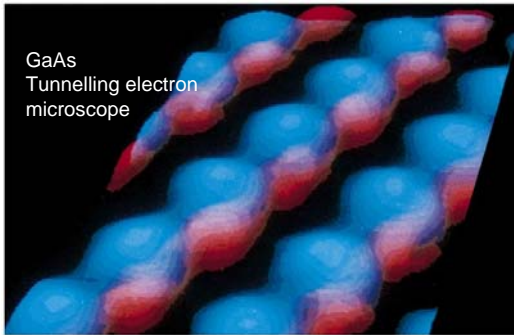


Some Things are Very Small:  
Atomic Theory and Bonding



Bridging atomic

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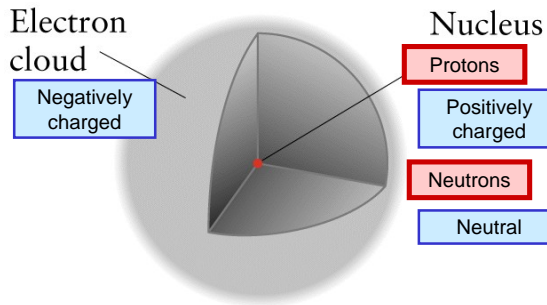
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1: Composition of atom



Bridging atomic

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2: Atomic Number, Atomic Mass

1A 1 H	2A 2 He											3A 13 B	4A 14 C	5A 15 N	6A 16 O	7A 17 F	8A 18 Ne								
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne								
11 Na	12 Mg	3B 3 Al	4B 4 Si	5B 5 P	6B 6 S	7B 7 Cl	8B 8 Ar	9B 9 K	10B 10 Ca	11B 11 Sc	12B 12 Ti	13B 13 V	14B 14 Cr	15B 15 Mn	16B 16 Fe	17B 17 Co	18B 18 Ni	19B 19 Cu	20B 20 Zn	21B 21 Ga	22B 22 Ge	23B 23 As	24B 24 Se	25B 25 Br	26B 26 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe								
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn								
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112	113	114	115	116										
Metals		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb										
Metalloids		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No										
Nonmetals																									

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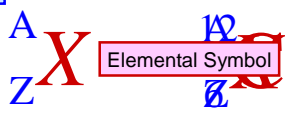
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## 2: Elemental Symbols

Atomic mass  
= protons + neutrons

If  $Z = 6$  and  $N = 6$ , what is the element and its atomic mass?

Atomic number  
= # of protons



Defines the element

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## 2: Elemental symbols continued

If the Atomic Number ( $Z$ ) = 12 and the Atomic mass ( $A$ ) = 24,

then

- (a) what is the element and
- (b) list the number of protons, neutrons and electrons it contains.



# protons = 12

# electrons = 12

# neutrons = 12

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## 3: Isotopes

Recall: All atoms of a particular element always have the same number of protons and electrons.

However: Some atoms of some elements are found to have *different numbers of neutrons*.



Isotopes

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#### 4: Molecules

Most atoms do not naturally exist in isolation.  
Atoms combine in fixed ratios of whole numbers to form molecules.

Molecule: an electrically neutral assembly of two or more atoms bound tightly together.

Bridging atomic

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#### 5: Ions – charged particles

But..... the world is not just neutral !

An atom or a molecule can lose or gain electrons to form ions

Electrons lost, ion positively charged = **CATION**

Bridging atomic

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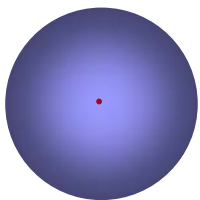
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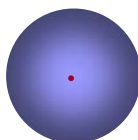
#### 5: Cations – positively charged particles

Sodium (Na): 11 protons



11 e<sup>-</sup>

Sodium atom: Na



10 e<sup>-</sup>

Sodium ion: Na<sup>+</sup>

Bridging atomic

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5: Ions – charged particles

An atom or a molecule can lose or gain electrons to form ions

Electrons lost, ion positively charged = **CATION**

Electrons gained, ion negatively charged = **ANION**

Bridging atomic

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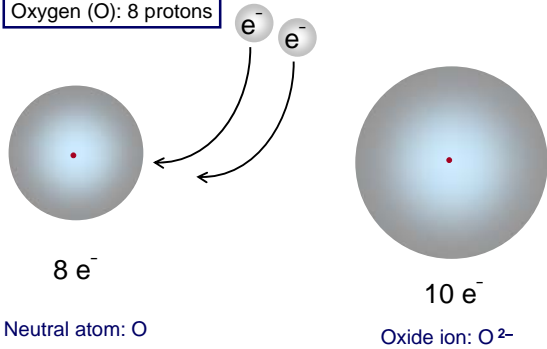
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5: Anions – negatively charged particles

Oxygen (O): 8 protons



Bridging atomic

11

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5: Ions – charged particles

Atom	Electrons gained or lost on forming ion	Ion formed
H	1 e <sup>-</sup> lost	<input type="text"/>
Mg	2 e <sup>-</sup> lost	<input type="text"/>
Cl	1 e <sup>-</sup> gained	<input type="text"/>

Bridging atomic

12

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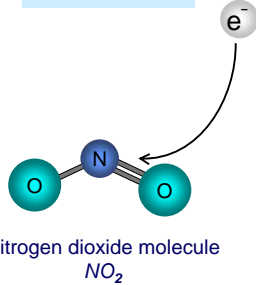
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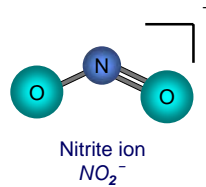
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## 5: Polyatomic ions – charged particles

Neutral Molecule



Charged Polyatomic Ion



Bridging atomic

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## 6: Chemical bonds

What holds these molecules or polyatomic ions together?

**Chemical bonds** are formed  
by **transferring of electrons** from one atom to another  
**or**  
by **sharing of electrons** between two atoms

Bridging atomic

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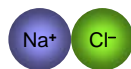
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## 6: Ionic Bond

Electrons are **completely transferred from one atom to another**

A metal loses electrons to form a cation, e.g.  $Na^+$

A non-metal gains electrons to form an anion, e.g.  $Cl^-$



- The resulting electrostatic attraction between opposite charges is an **IONIC BOND**
- Usually **forms between metals** on LHS of periodic table **and non-metals** on RHS of periodic table

Bridging atomic

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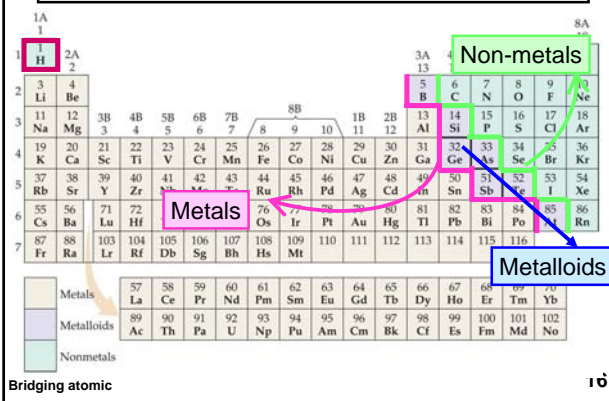
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## 6: Using the Periodic Table




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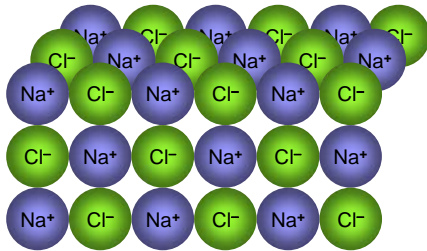
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## 6: Ionic Bond

Ionic compounds consist of tightly packed array of cations & anions with overall charge neutrality.



Bridging atomic

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## 6: Covalent bonding, Metallic bonding

**Covalent Bonding:** electrons are **shared**, not transferred, and usually occurs **between non-metals** e.g., NO, Cl<sub>2</sub>, O<sub>3</sub>

**Metallic Bonding:** Type of bonding found in **metals and alloys** e.g., Iron, Brass

Bridging atomic

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## 7: Naming Chemical Compounds and Formulae

- Each chemical compound has a name and a formula.
- No two compounds have the same name
- The formula shows the number and identity of the atoms that are combined to form a molecule of the compound



Bridging atomic

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## 7: Using the Periodic Table: Groups 1-3

**Group 1 (IA)**  
lose 1 electron  
→ 1+ ion

**Group 2 (IIA)**  
lose 2 electrons  
→ 2+ ion

**Group 3 (IIIA)**  
lose 3 electrons  
→ 3+ ion

1	2A	2											3A	13																																																																																
1	H	2											B	5	C	N	O	F	Ne																																																																											
2	Li	3	Be	4											Al	13	Si	14	P	15	S	16	Cl	17	Ar																																																																					
3	Na	11	Mg	12											Ga	31	Ge	32	As	33	Se	34	Br	35	Kr																																																																					
4	K	19	Ca	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																																																																										
5	Rb	37	Sr	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																																																																										
6	Cs	55	Ba	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																																																																										
7	Fr	87	Ra	88	103	104	105	106	107	108	109	110	111	112	113	114	115	116																																																																												
			<table border="1"> <tr> <td>Metals</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> </tr> <tr> <td></td> <td>La</td> <td>Ce</td> <td>Pr</td> <td>Nd</td> <td>Pm</td> <td>Sm</td> <td>Eu</td> <td>Gd</td> <td>Tb</td> <td>Dy</td> <td>Ho</td> <td>Er</td> <td>Tm</td> <td>Yb</td> </tr> <tr> <td>Metalloids</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> </tr> <tr> <td></td> <td>Ac</td> <td>Th</td> <td>Pa</td> <td>U</td> <td>Np</td> <td>Pu</td> <td>Am</td> <td>Cm</td> <td>Bk</td> <td>Cf</td> <td>Es</td> <td>Fm</td> <td>Md</td> <td>No</td> </tr> <tr> <td>Nonmetals</td> <td colspan="14"></td> </tr> </table>																	Metals	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	Metalloids	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	Nonmetals														
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Nonmetals																																																																																														

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## 7: Using the Periodic Table: Groups 7 & 8

**Group 17 (VIIA)**  
Halogens gain 1 electron  
to form 1- ion

**Group 18 (VIIIA)**  
Noble Gases  
Few compounds

1A	1	2A	2											7A	17	8A	18																																																				
1	H	2											F	9	He	2																																																					
2	Li	3	Be	4											Cl	17	Ne	10																																																			
3	Na	11	Mg	12											Br	35	Ar	18																																																			
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Metals	57	58	59	60	61	62	63	64	65																																																												
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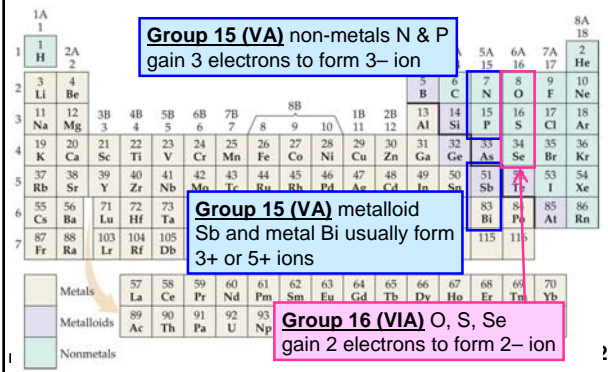
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7: Using the Periodic Table: Groups 5 & 6




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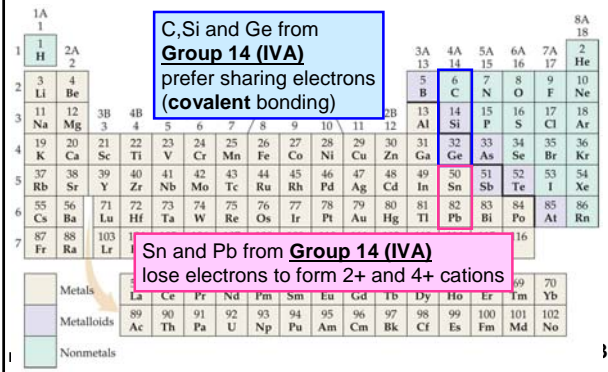
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7: Using the Periodic Table: Group 4




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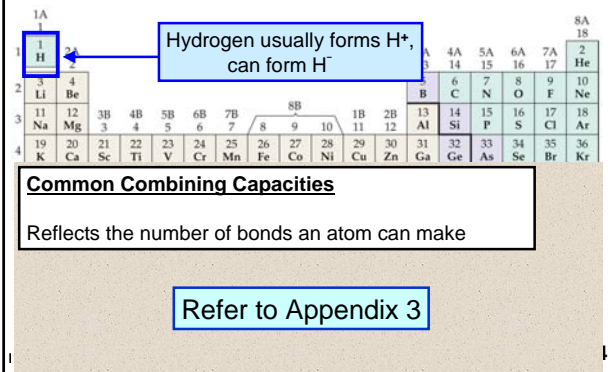
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7: Hydrogen: All on its own




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## 8: Binary Ionic Compounds

Ionic compounds are formed from the reaction of metallic elements with non-metallic elements

E.g. sodium chloride  
calcium oxide  
aluminium bromide

Metal first

Non-Metal second

### RULE for naming

most metallic element / space / anion with suffix -ide

Bridging atomic

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## 8: Binary Ionic Compounds

Ionic compounds are formed from the reaction of metallic elements with non-metallic elements

E.g. sodium chloride  
calcium oxide  
aluminium bromide

### RULE for formula

Ionic compounds: Match the number of cations and anions so there is no overall charge

Bridging atomic

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## 8: Binary Ionic Compounds: Constructing Formulae

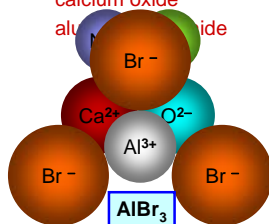
### RULE for formula

Ionic compounds: Match the number of cations and anions so there is no overall charge

E.g. sodium chloride  
calcium oxide  
aluminium bromide

NaCl

CaO



Bridging atomic

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8: Binary Ionic Compounds: Constructing Formulae

**RULE for formula**

Ionic compounds: Match the number of cations and anions so there is no overall charge

Potassium Sulfide



Bridging atomic

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