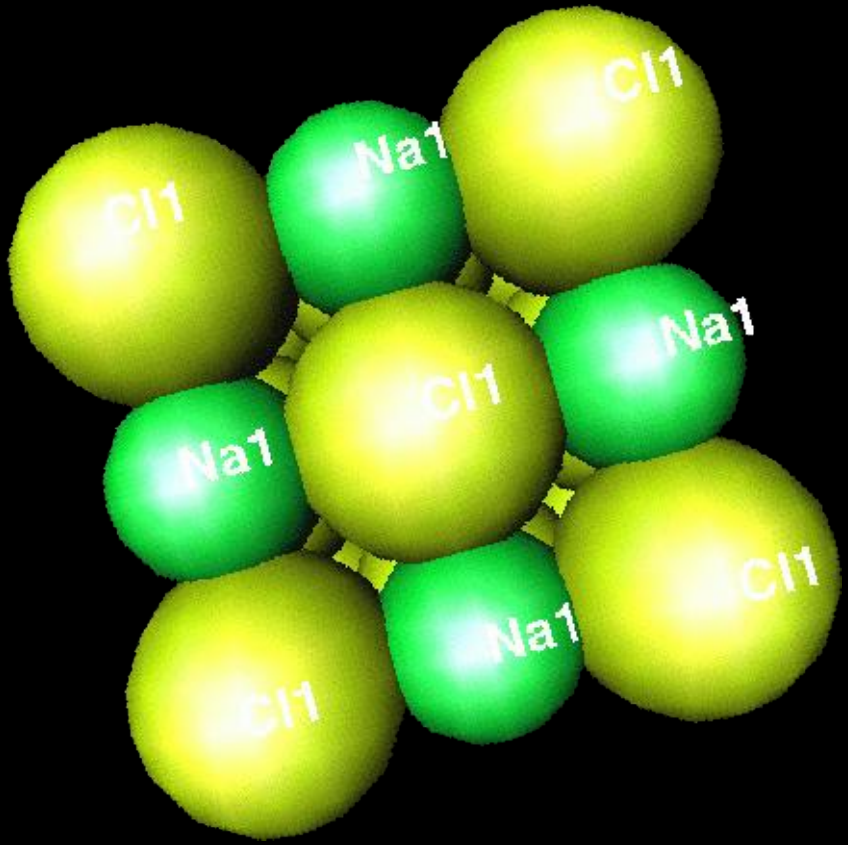
All about Ionic Bonding



Modified for the

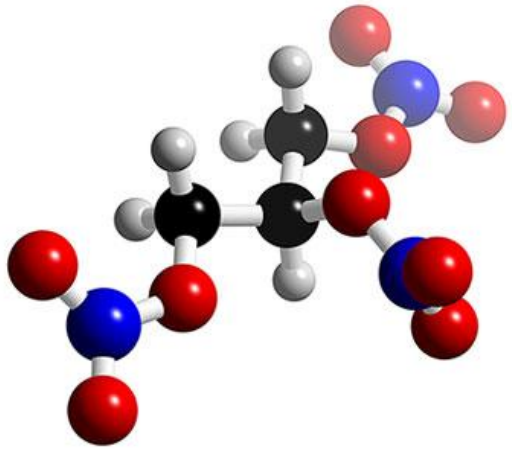
Internet

Please ensure you have all extra

Class notes

Suggested Study (Fri 15th Feb)

- Physics group please catch up!
- Exp 1 report due Tues 19th Feb
- Please look up and learn some common ions
- Text book review questions
- Glossary of all new terms



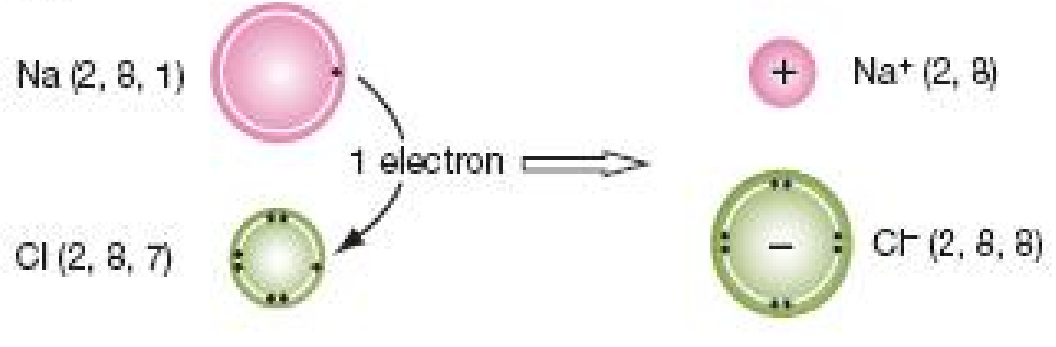
FORMATION OF IONS

The formation of ions and the *ionic bonding* that it leads to are best explained by considering a specific example.

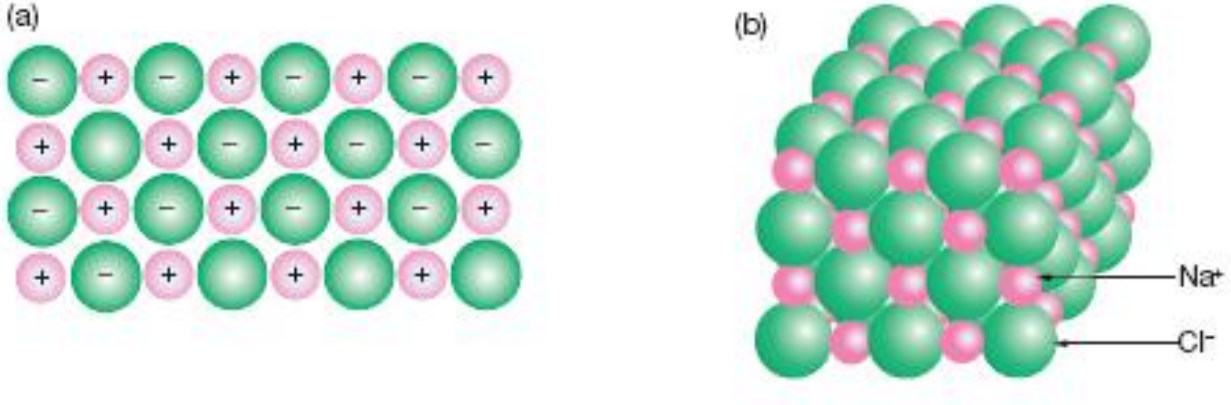
Sodium chloride

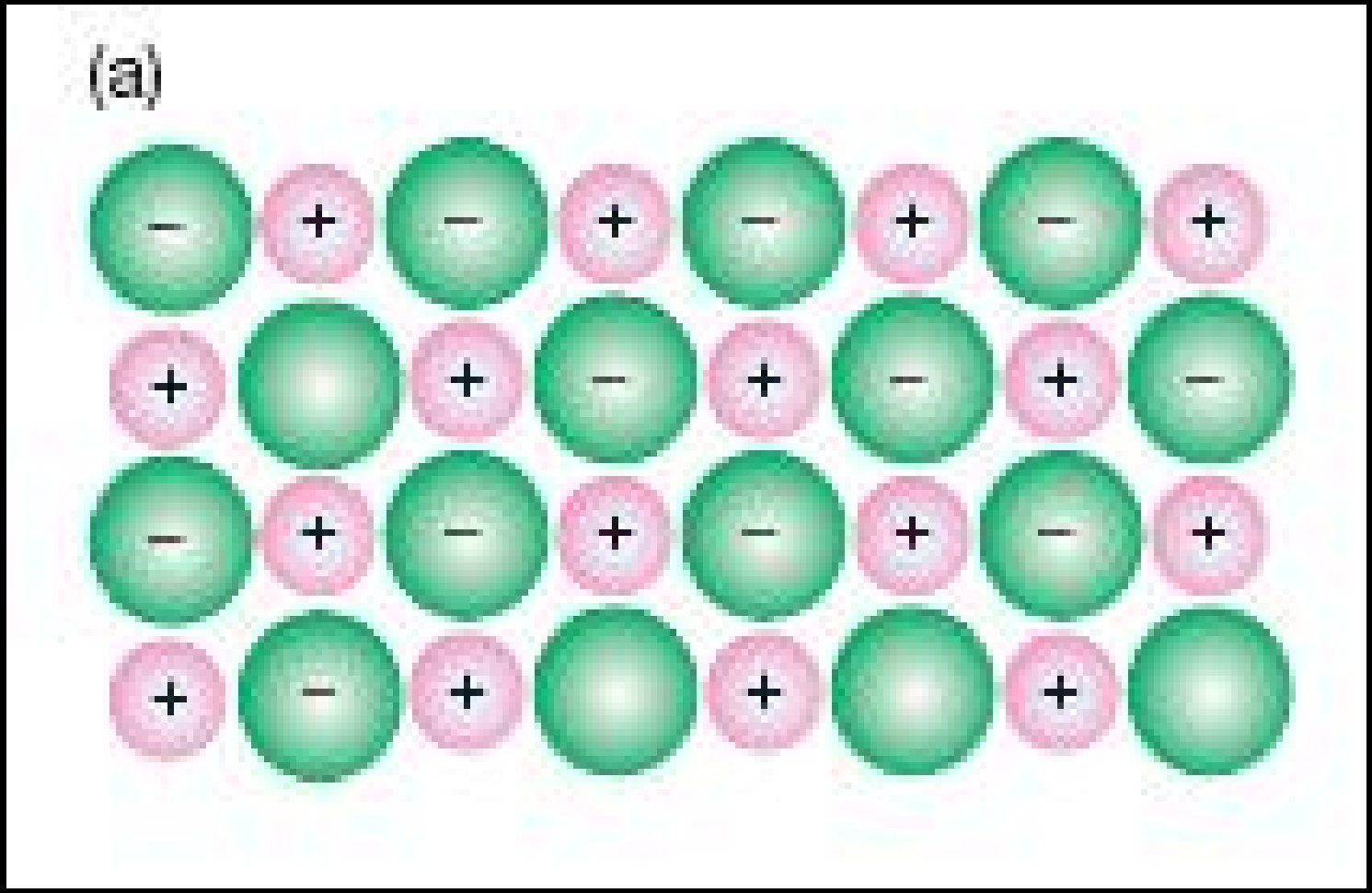
Sodium and chlorine combine to form the compound, sodium chloride.
The sodium atom, with electron confi guration (2, 8, 1) (see Table 1.9 on p. 189), has a tendency to lose one electron to become like neon (2, 8); the chlorine atom, with electron confi guration (2, 8, 7), tends to gain one electron to become like argon (2, 8, 8). Hence one electron is transferred from a sodium atom to a chlorine atom. When the neutral sodium atom loses one electron it becomes positively charged: we call it a *positive ion*. When the neutral chlorine atom gains an electron, it becomes negatively charged: it is a *negative ion*. We call it the *chloride ion*.

Schematically:



Ions *are positively or negatively charged particles*. The simplest ions form when atoms lose or gain electrons (as with sodium and chlorine here).
There is strong electrostatic attraction between positive and negative ions. This is what holds the ions together in ionic bonding. Sodium chloride is therefore NaCl (one sodium atom per chlorine atom, because that is the way to balance charges).
Crystals of sodium chloride consist of sodium ions and chloride ions packed in an orderly fashion. The electrostatic attraction between pairs of oppositely charged ions extends throughout the whole crystal. This is shown in Figure 2.1. *There are no separate molecules of NaCl*—just an extremely large array of positive *I*—and negative ions held tightly together.



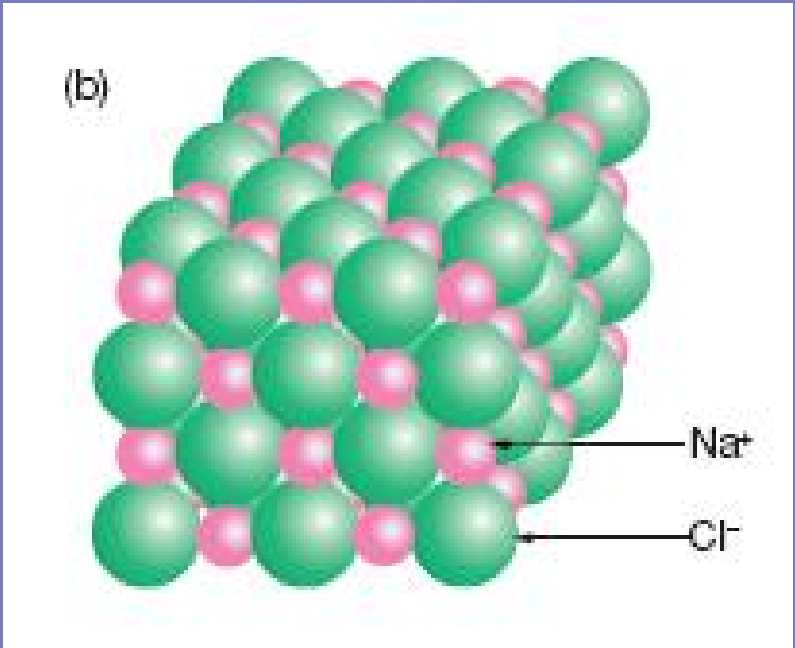

(a)

Ionic bonding is that type of chemical bonding which involves the outright transfer of electrons from one atom to another. The bonding consists of electrostatic attraction between the positive and negative ions formed by this transfer of electrons.

http://chemistry.about.com/library/glossary/bldef540.htm

Definition: A chemical link between two atoms caused by the electrostatic force between oppositely-charged ions in an ionic compound.

Note carefully that in ionic compounds there are no discrete molecules—just an infinite array of positive and negative ions.

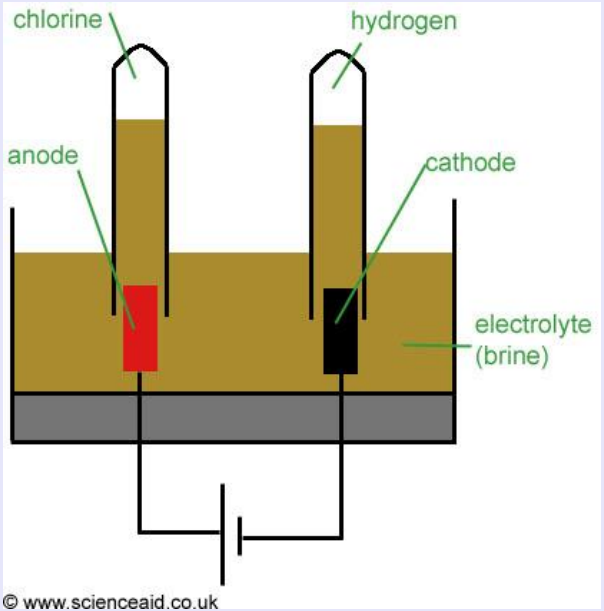


Meaning of the formula of an ionic compound

For an ionic compound, the formula (for example NaCl) specifies the *ratio* in which the atoms (or ions) are present, *not* the composition of discrete molecules. Such a formula that gives the ratio by atoms of elements in a compound rather than the actual numbers of atoms in a molecule is called an **empirical formulae**. Formulae for ionic compounds are therefore always empirical formulae (because there are no molecules).

Cations and anions

Positive ions are called **cations**. Negative ions are called **anions**.



During electrolysis cations (+) move towards the cathode(-)

anions(-) move to the anode(+)

http://www.scienceaid.co.uk/chemistry/industrial/images/electrolysis%20brine.jpg

IONIC BONDING AND THE PERIODIC TABLE

Elements that can attain noble gas electron configurations by losing or gaining one
or two electrons commonly form ions. This means that we can use the Periodic
Table to predict which elements will form ions—generally those that are only one
or two elements away from a noble gas. In particular:

1 *Group 1 metals* (Li, Na, K, Rb, Cs) all tend to lose one electron and therefore
form singly charged positive ions: Li+, Na+, K+, Rb+, Cs+.

2 *Group 2 metals* (Be, Mg, Ca, Sr, Ba) tend to lose two electrons and therefore
form doubly charged positive ions:† Be2+, Mg2+, Ca2+, Sr2+, Ba2+.

3 *Group 7 elements* (non-metals, F, Cl, Br and I) all tend to gain one electron and
therefore they *form singly charged negative ions*: F–, Cl–, Br–, I–.

4 *Group 6 elements* (non-metals, O, S, Se, Te) tend to gain two electrons and thus
form doubly charged negative ions: O2–, S2–, Se2–, Te2–.

EXERCISES

1 Show (in terms of electron configurations of the atoms involved and the ions formed) how the following pairs of elements form ionic compounds. Deduce the formulae of the compounds formed:

a potassium and fluorine
b calcium and bromine
*c‡ sodium and oxygen
*d magnesium and oxygen

2 Explain why:

a potassium bromide is KBr and not K_2Br or KBr_2
*b barium chloride is $BaCl_2$ and not Ba_2Cl or $BaCl_3$

3 Which of the following elements would you expect to form positive ions and which negative ions and which not form ions at all? What charge would you expect each ion to carry? Si, Rb, I, Mg, S, Ga, K, C, Br, Ar, Se, B, P, Ba, Cs, F

4 a Give the electron configuration of the following atoms and ions, taking atomic numbers from the Periodic Table if necessary:

i magnesium atom, magnesium ion
ii sulfur atom, sulfide ion
*iii chlorine atom, chloride ion
*iv potassium atom, potassium ion

b What do you expect for the formula of each of the following compounds?

i magnesium sulfide
*ii potassium chloride
iii magnesium chloride
*iv potassium oxide