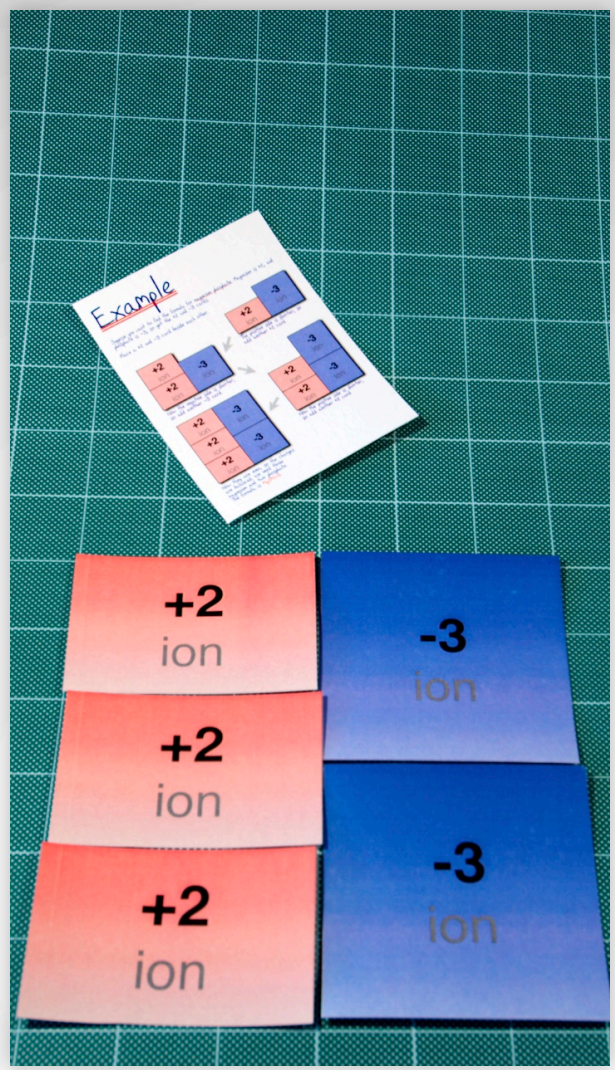
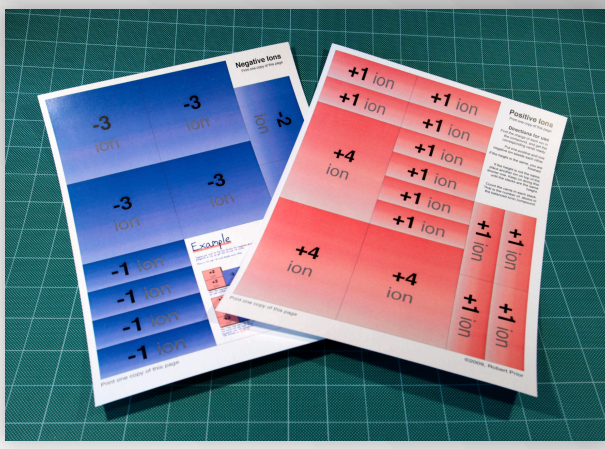
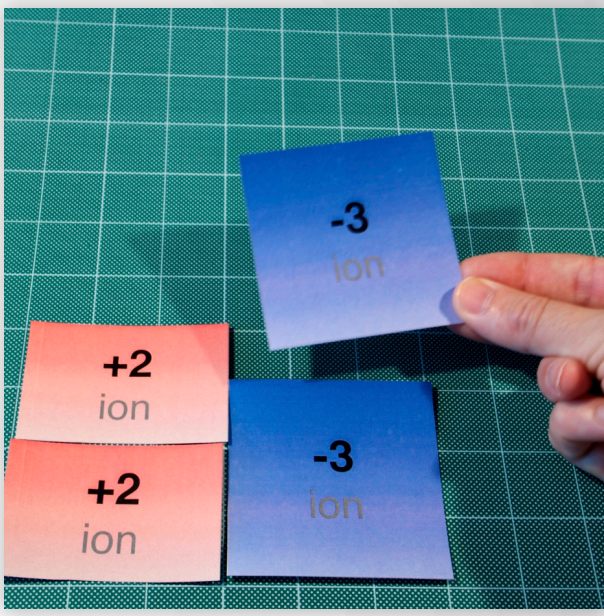




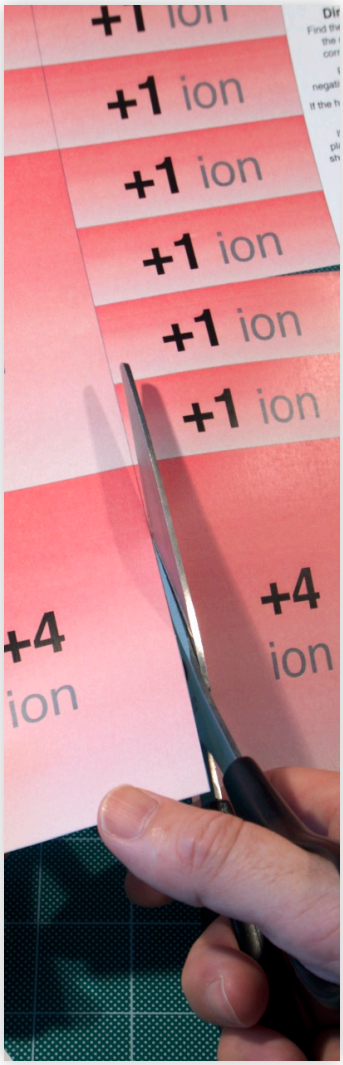


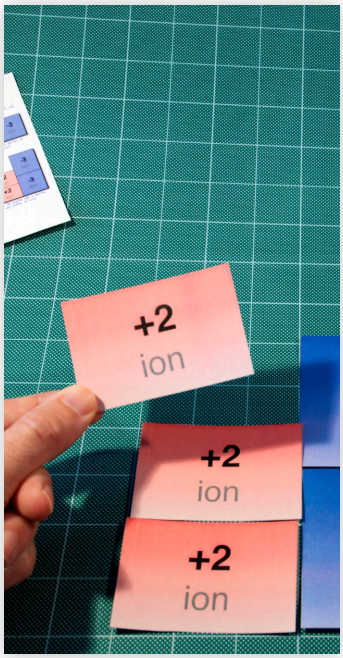
Ionic Bonding **Manipulatives**

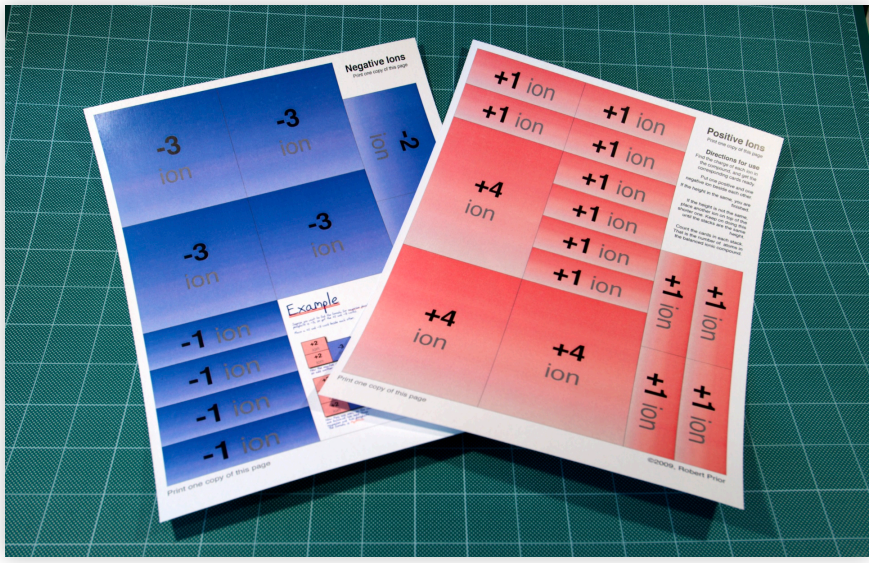
by **Robert Prior**

Chemical bonding can be a very abstract subject for students. Atoms and compounds are too small to see; for kinesthetic and visual learners this can be a barrier. This booklet contains a set of cards students can use to balance ionic compounds.

Grade 10 Science: **Chemistry**







Printing Instructions

This booklet contains two versions of the ionic bonding cards: full colour in red and blue, and outline suitable for photocopying onto coloured cardstock. Each version makes three complete sets.

Printing Colour Cards

Pages 4-6 can be printed straight into cardstock, if your printer can handle it. Most modern printers can, but consult the printer manual to be certain. For best results, you will generally have to change a setting in the print dialogue to “Cardstock”.

Photocopying Cards

Print pages 7-9 on a good printer. Make one copy of page 7 and three copies of page 8 on one colour cardstock, and three copies of page 9 on another colour of cardstock.

Using the Cards

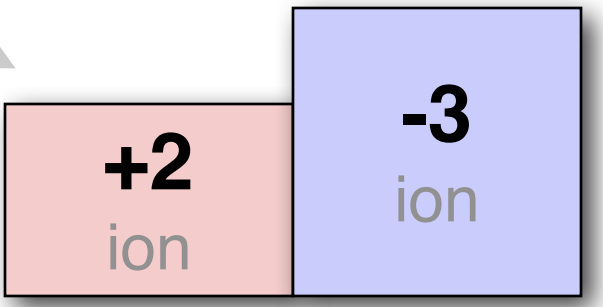
The cards are quite simple to use. There is an example on the next page. Additionally, a short video animation is included with the electronic version of this document, available at

- web.me.com/robertprior/science/

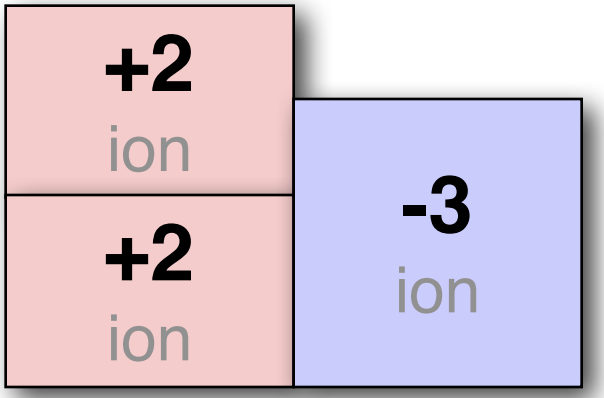
Example

Suppose you want to find the formula for magnesium phosphate. Magnesium is +2, and phosphate is −3, so get the +2 and −3 cards.

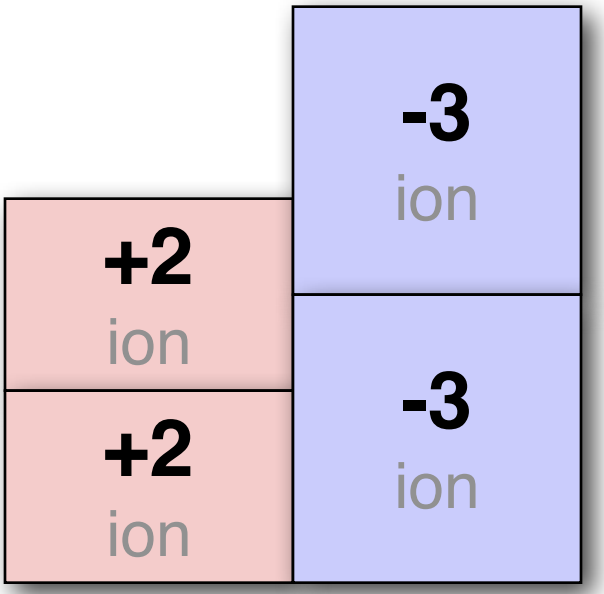
Place a +2 and −3 card beside each other.



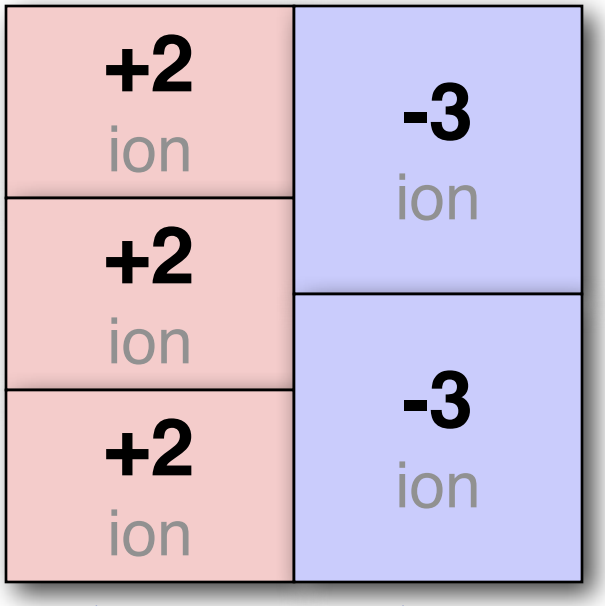
The positive side is shorter, so add another +2 card



Now the negative side is shorter, so add another −3 card.



Now the positive side is shorter, so add another +2 card



Now they are even, so the charges are balanced. We need three magnesium and two phosphate. The formula is $Mg_3(PO_4)_2$.

1 **H** 1.01																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.8	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.2
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.9
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.41	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.90	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (99)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57-71 see below	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89-103 see below															

57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (147)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
89 **Ac** (227)	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (242)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Polyatomic Ions		
bicarbonate	HCO_3^-	–1
carbonate	CO_3^-	–1
chlorate	ClO_3^-	–1
hydroxide	OH^-	–1
nitrate	NO_3^-	–1
nitrite	NO_2^-	–1
phosphate	PO_4^{3-}	–3
sulfate	SO_4^{2-}	–2
sulfite	SO_3^{2-}	–2
ammonium	NH_4^+	+1
acetate	CH_3COO^-	–1
permanganate	MnO_4^-	–1
thiocyanate	SCN^-	–1
chromate	CrO_4^{2-}	–2
peroxide	O_2^{2-}	–2
thiosulfate	$S_2O_3^{2-}$	–2

Multivalent Metals		
Symbol	**Most common charge**	**Other charge**
Cu	2+	1+
Hg	2+	1+
Au	3+	1+
Fe	3+	2+
Co	2+	3+
Ni	2+	3+
Pb	2+	4+
Sn	4+	2+

Other Metals	
Ag	1+
Zn	2+

+1 ion

+1 ion

+4 ion

+1 ion

+1 ion

Positive Ions

+3 ion	+3 ion	+2 ion
+3 ion	+3 ion	+2 ion
+4 ion	+4 ion	+2 ion

Negative Ions

-3 ion

-3 ion

-3 ion

-3 ion

-2 ion

-2 ion

-2 ion

-1 ion

-1 ion

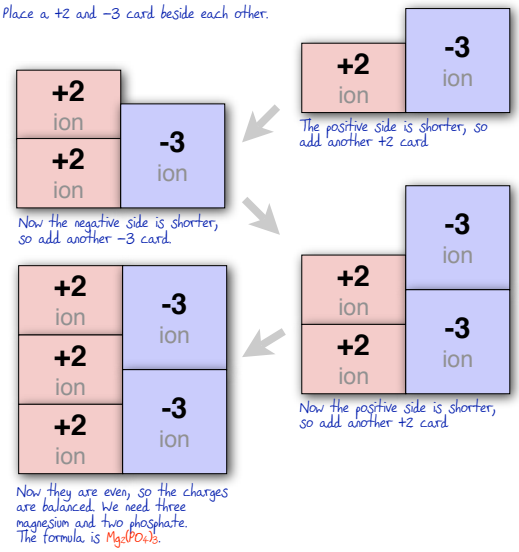
-1 ion

-1 ion

Example

Suppose you want to find the formula for magnesium phosphate. Magnesium is +2, and phosphate is −3, so get the +2 and −3 cards.

Place a +2 and −3 card beside each other.



+1 ion

+1 ion

+1 ion

+1 ion

+1 ion

+1 ion

+1 ion

+1 ion

+4 ion

+4 ion

+4 ion

+1 ion

+1 ion

+1 ion

+1 ion

Positive Ions

Print one copy of this page

Directions for use

Find the charge of each ion in the compound, and get the corresponding cards ready.

Put one positive and one negative ion beside each other.

If the height in the same, you are finished.

If the height is not the same, place another ion on top of the shorter one. Keep on doing this until the stacks are the same height.

Count the cards in each stack. That is the number of atoms in the balanced ionic compound.

Print one copy of this page

Positive Ions

Print three copies of this page

+3 ion	**+3** ion	**+2** ion
+3 ion	**+3** ion	**+2** ion
+4 ion	**+4** ion	**+2** ion

Print three copies of this page

Negative Ions

Print three copies of this page

-3 ion

-3 ion

-3 ion

-3 ion

-3 ion

-3 ion

-1 ion

-1 ion

-1 ion

-1 ion

ion **-2**

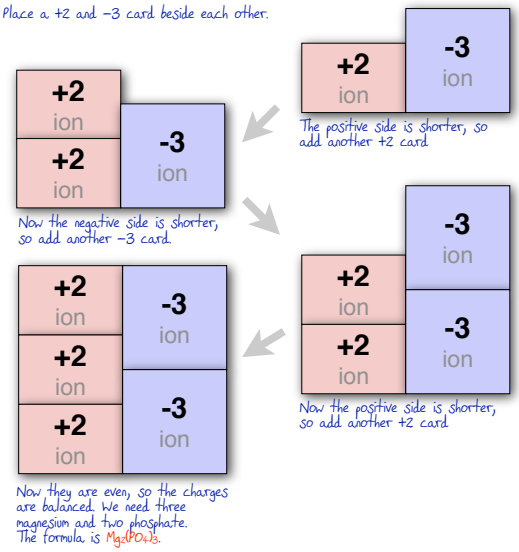
ion **-2**

ion **-2**

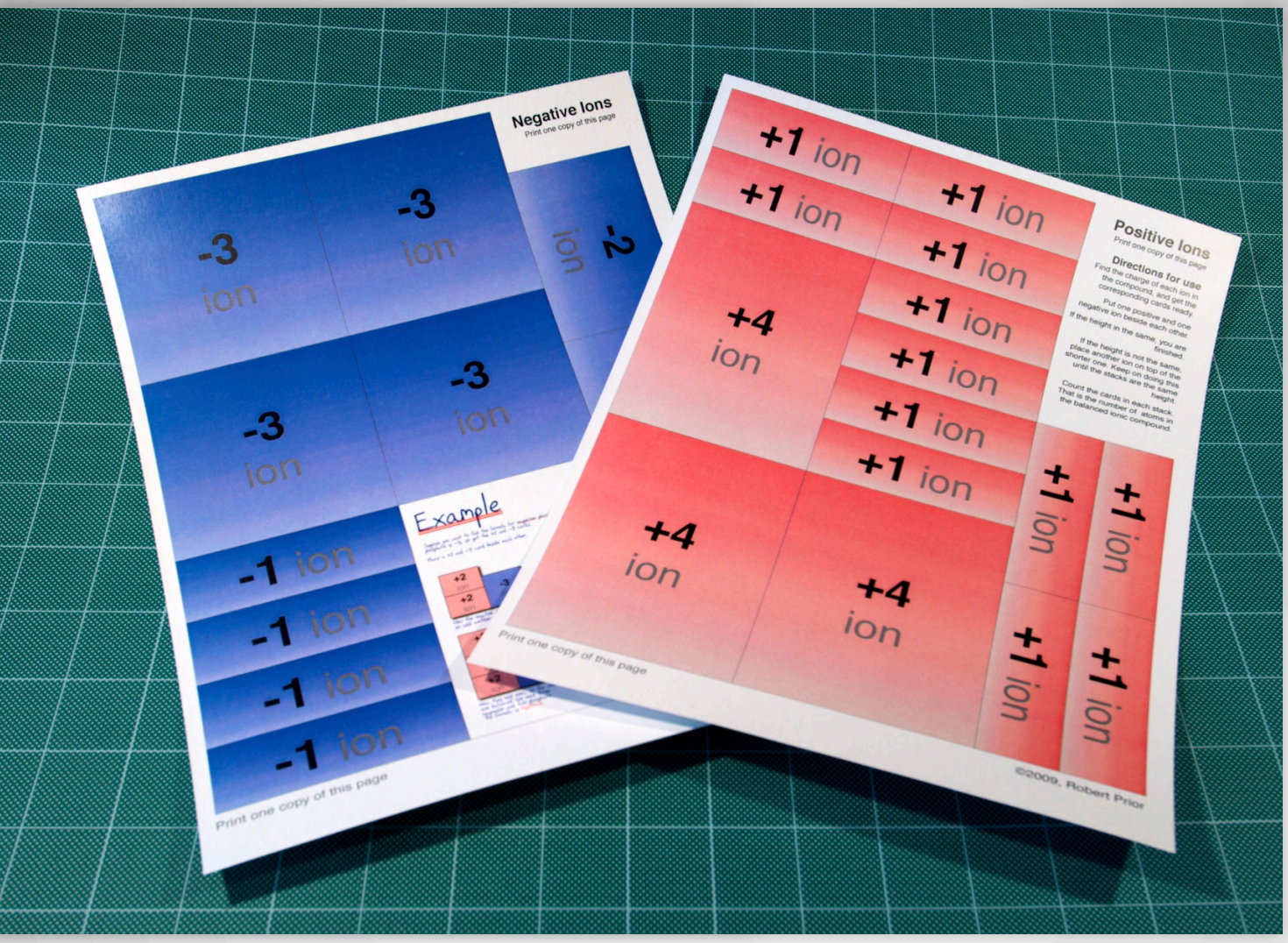
Example

Suppose you want to find the formula for magnesium phosphate. Magnesium is +2, and phosphate is −3, so get the +2 and −3 cards.

Place a +2 and −3 card beside each other.



Print three copies of this page



Science is the great antidote to the poison of enthusiasm and superstition.

Adam Smith,
The Wealth of Nations, 1776.