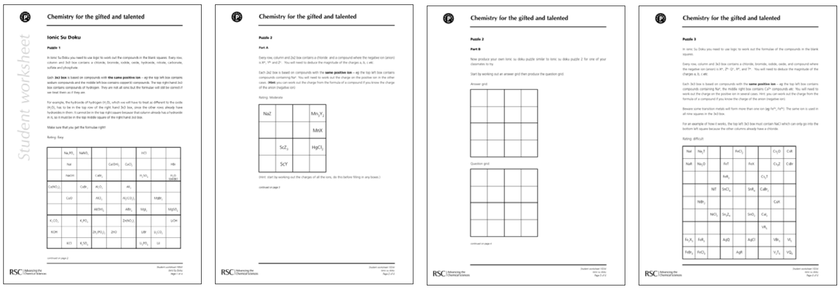
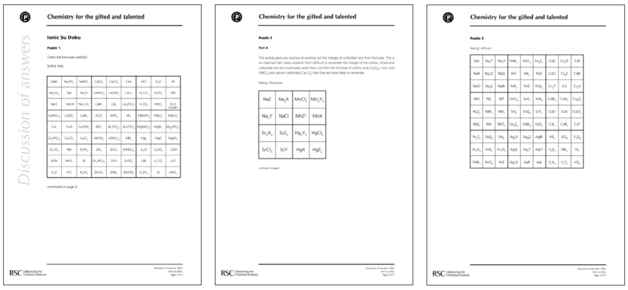
Ionic Su Doku



Student worksheet: CDROM index 15SW



Discussion of answers: CDROM index 15DA

Topics

Working out the charges on ions from formulae and working out formulae from the charges of ions.

Level

Middle to high ability students in the 14–16 age range and post-16 students.

Prior knowledge

How the charges of ions determine formulae of ionic compounds and the charges of some ions.

Rationale

This activity gives students practice at working out formulae in a problem solving context.

In puzzle 1, to avoid any confusion, the O^{2-} ion is assumed for all oxides including the Group 1 metals. Hydrogen is included as one of the cations so the students recall the formulae of the acids.

Puzzle 2 gives the students practice of working out the charges of ions from formulae.

Use

This activity could be used at any time but is best used in conjunction with work on ionic bonding and formulae. Three ionic Su Doku puzzles are given with answers. Students should start with puzzle 1 as this contains the most detailed explanation of how to solve it. Puzzle 3 is the most difficult.

Further puzzles can be readily generated using the Excel® templates in the post-16 sections *DIY Su Doku* CDROM index 35EX and *DIY ionic Su Doku* CDROM index 36EX. Instructions for doing this can be found on pages 71–74.

Ionic Su Doku

Puzzle 1

In *Ionic Su Doku* you need to use logic to work out the compounds in the blank squares. Every row, column and 3x3 box contains a chloride, bromide, iodide, oxide, hydroxide, nitrate, carbonate, sulfate and phosphate.

Each **3x3 box** is based on compounds with the **same positive ion** – *eg* the top left box contains sodium compounds and the middle left box contains copper(II) compounds. The top right hand 3x3 box contains compounds of hydrogen. They are not all ionic but the formulae will still be correct if we treat them as if they are.

For example, the hydroxide of hydrogen (H_2O), which we will have to treat as different to the oxide (H_2O), has to be in the top row of the right hand 3x3 box, since the other rows already have hydroxides in them. It cannot be in the top right square because that column already has a hydroxide in it, so it must be in the top middle square of the right hand 3x3 box.

Make sure that you get the formulae right!

Rating: Easy

	Na_3PO_4	$NaNO_3$				HCl		
	NaI			$Ca(OH)_2$	$CaCl_2$			HBr
	NaOH		$CaBr_2$			H_2SO_4		H_2O (oxide)
$Cu(NO_3)_2$		$CuBr_2$	Al_2O_3		AlI_3			
	CuO		$AlCl_3$		$Al_2(CO_3)_3$		$MgBr_2$	
			$Al(OH)_3$		$AlBr_3$	MgI_2		$MgSO_4$
K_2CO_3		K_3PO_4			$Zn(NO_3)_2$			LiOH
KOH			$Zn_3(PO_4)_2$	ZnO		LiBr	Li_2CO_3	
	KCl	K_2SO_4				Li_3PO_4	LiI	

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Puzzle 2

Part A

Every row, column and 2x2 box contains a chloride and a compound where the negative ion (anion) is X^{a-}, Y^{b-} and Z^{c-}. You will need to deduce the magnitude of the charges a, b, c *etc*.

Each **2x2 box** is based on compounds with the **same positive ion** – *eg* the top left box contains compounds containing Na^+. You will need to work out the charge on the positive ion in the other cases. (**Hint:** you can work out the charge from the formula of a compound if you know the charge of the anion (negative ion).)

Rating: Moderate

NaZ			Mn_3Y_2
			MnX
	ScZ_3		$HgCl_2$
	ScY		

(**Hint:** start by working out the charges of all the ions, do this before filling in any boxes.)

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Puzzle 2

Part B

Now produce your own ionic Su Doku puzzle similar to *Ionic Su Doku puzzle 2* for one of your classmates to try.

Start by working out an answer grid and then produce the question grid.

Answer grid:

Question grid:

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Puzzle 3

In *Ionic Su Doku* you need to use logic to work out the formulae of the compounds in the blank squares.

Every row, column and 3x3 box contains a chloride, bromide, iodide, oxide, and compound where the negative ion (anion) is X^{a-}, Z^{b-}, Q^{c-}, R^{d-}, and T^{e-}. You will need to deduce the magnitude of the charges a, b, c *etc*.

Each **3x3 box** is based on compounds with the **same positive ion** – *eg* the top left box contains compounds containing Na^{+}, the middle right box contains Ca^{2+} compounds, *etc*. You will need to work out the charge on the positive ion in several cases. (**Hint:** you can work out the charge from the formula of a compound if you know the charge of the anion (negative ion).)

Beware some transition metals will form more than one ion (*eg* Fe^{2+}, Fe^{3+}). The same ion is used in all nine squares in the 3x3 box.

For an example of how it works, the top left 3x3 box must contain NaCl which can only go into the bottom left square because the other columns already have a chloride.

Rating: Difficult

NaI	Na_2T			$FeCl_2$			Cs_2O	CsR
NaR	Na_2O		FeT		FeX		Cs_3Z	CsBr
			FeR_2			Cs_2T		
		NiT	$SnCl_4$		SnR_4	$CaBr_2$		
	$NiBr_2$						CaX	
		$NiCl_2$	Sn_3Z_4		SnO_2	CaI_2		
						VR_5		
Fe_2X_3	FeR_3		AgQ		AgCl		VBr_5	VI_5
$FeBr_3$	$FeCl_3$			AgR			V_2T_5	VQ_5

Ionic Su Doku

Puzzle 1

Check the formulae carefully!

Rating: Easy

NaBr	Na_3PO_4	$NaNO_3$	$CaSO_4$	$CaCO_3$	CaO	HCl	H_2O	HI
Na_2SO_4	NaI	Na_2O	$Ca(NO_3)_2$	$Ca(OH)_2$	$CaCl_2$	H_2CO_3	H_3PO_4	HBr
NaCl	NaOH	Na_2CO_3	$CaBr_2$	CaI_2	$Ca_3(PO_4)_2$	H_2SO_4	HNO_3	H_2O (oxide)
$Cu(NO_3)_2$	$CuSO_4$	$CuBr_2$	Al_2O_3	$AlPO_4$	AlI_3	$Mg(OH)_2$	$MgCl_2$	$MgCO_3$
CuI_2	CuO	$Cu(OH)_2$	$AlCl_3$	$Al_2(SO_4)_3$	$Al_2(CO_3)_3$	$Mg(NO_3)_2$	$MgBr_2$	$Mg_3(PO_4)_2$
$Cu_3(PO_4)_2$	$CuCO_3$	$CuCl_2$	$Al(OH)_3$	$Al(NO_3)_3$	$AlBr_3$	MgI_2	MgO	$MgSO_4$
K_2CO_3	KBr	K_3PO_4	ZnI_2	$ZnCl_2$	$Zn(NO_3)_2$	Li_2O	Li_2SO_4	LiOH
KOH	NKO_3	KI	$Zn_3(PO_4)_2$	ZnO	$ZnSO_4$	LiBr	Li_2CO_3	LiCl
K_2O	KCl	K_2SO_4	$ZnCO_3$	$ZnBr_2$	$Zn(OH)_2$	Li_3PO_4	LiI	$LiNO_3$

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Puzzle 2

Part A

This activity gives you practice at working out the charges of unfamiliar ions from formulae. This is an important skill. Many students find it difficult to remember the charges of the sulfate, nitrate and carbonate ions but could easily work them out from the formulae of sulfuric acid (H_2SO_4), nitric acid (HNO_3) and calcium carbonate ($CaCO_3$) that they are more likely to remember.

Rating: Moderate

NaZ	Na_2X	$MnCl_2$	Mn_3Y_2
Na_3Y	$NaCl$	MnZ_2	MnX
Sc_2X_3	ScZ_3	Hg_3Y_2	$HgCl_2$
$ScCl_3$	ScY	HgX	HgZ_2

$X = {}^{-}2$

$Y = {}^{-}3$

$Z = {}^{-}1$

continued on page 3

Puzzle 3

Rating: Difficult

NaI	Na_2T	Na_2X	$FeBr_2$	$FeCl_2$	Fe_3Z_2	CsQ	Cs_2O	CsR
NaR	Na_2O	NaQ	FeT	FeI_2	FeX	CsCl	Cs_3Z	CsBr
NaCl	Na_3Z	NaBr	FeR_2	FeO	FeQ_2	Cs_2T	CsI	Cs_2X
NiO	NiI_2	NiT	$SnCl_4$	SnX_2	SnR_4	$CaBr_2$	CaQ_2	Ca_3Z_2
Ni_3Z_2	$NiBr_2$	NiR_2	SnI_4	SnQ_4	SnT_2	CaO	CaX	$CaCl_2$
NiQ_2	NiX	$NiCl_2$	Sn_3Z_4	$SnBr_4$	SnO_2	CaI_2	CaR_2	CaT
Fe_2T_3	FeQ_3	FeI_3	Ag_2X	Ag_3Z	AgBr	VR_5	VCl_5	V_2O_5
Fe_2X_3	FeR_3	Fe_2O_3	AgQ	Ag_2T	AgCl	V_3Z_5	VBr_5	VI_5
$FeBr_3$	$FeCl_3$	FeZ	Ag_2O	AgR	AgI	V_2X_5	V_2T_5	VQ_5

$X = {}^{-}2$

$Z = {}^{-}3$

$Q = {}^{-}1$

$R = {}^{-}1$

$T = {}^{-}2$