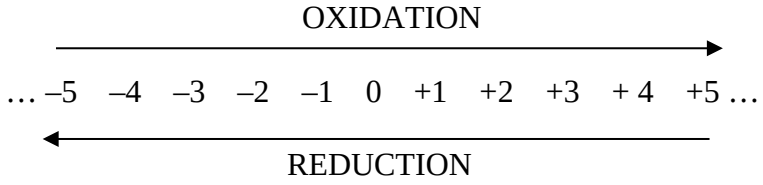
Worksheet 14.1

Oxidation numbers and redox equations

NAME: **CLASS:**

INTRODUCTION

The concept of oxidation numbers (ON) or oxidation states was applied to determine whether or not electrons had moved from one species to another in a chemical reaction. An oxidation–reduction (redox) reaction is one in which one or more atoms change oxidation numbers. Oxidation occurs when an atom's oxidation state becomes more positive, indicating that electrons have been lost. Reduction occurs when an atom's oxidation state becomes less positive, indicating that electrons have been gained.



The oxidation numbers assigned to atoms in covalent compounds are hypothetical charges, and the atoms do not really have these charges within the compound, since they are only sharing electrons. For example, in the compound CO_2 we say that carbon has a +4 ON and each oxygen has a –2 ON, but the atoms do not really have these charges.

Recall that the **oxidant** is the reactant being reduced, so its ON will decrease. The **reductant** is the reactant being oxidised, so its ON will increase.

Rules for assigning oxidation numbers

1 The oxidation number of an element is zero.
2 For a monatomic ion, the oxidation number is the charge on the ion.
3 The oxidation number of combined hydrogen is usually +1.
4 The oxidation number of combined oxygen is usually –2.
5 The sum of all oxidation numbers of atoms in a compound is zero.
6 The sum of all oxidation numbers of atoms in an ion is equal to the charge on that ion.

No.	Question	Answer
1	Write the formula of a substance in which nitrogen has the following oxidation numbers: **a** +3 **b** +5 **c** 0 **d** –3	

Worksheet 14.1

Oxidation numbers and redox equations

No.	Question	Answer
2	What is the oxidation number of the atom in bold type in each of the following? **a** $H_2\mathbf{S}O_4$ **b** $K_2\mathbf{Cr}_2O_7$ **c** $\mathbf{C}O_2$ **d** $H_2\mathbf{O}_2$	
3	For the following equations, determine which are redox processes. For those that are redox reactions, identify the oxidant and the reductant. **a** $2OH^-(aq) + Cr_2O_7^{2-}(aq) \rightarrow 2CrO_4^{2-}(aq) + H_2O(l)$ **b** $I_2O_5(s) + 5CO(g) \rightarrow I_2(s) + 5CO_2(g)$ **c** $PBr_3(l) + 3H_2O(l) \rightarrow H_3PO_3(aq) + 3HBr(aq)$ **d** $2Hg^{2+}(aq) + N_2H_4(aq) \rightarrow 2Hg(l) + N_2(g) + 4H^+(aq)$ **e** $3H_2S(g) + 2H^+(aq) + 2NO_3^-(aq) \rightarrow 3S(s) + 2NO(g) + 4H_2O(l)$ **f** $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$	
4	The highest positive oxidation number possible for any atom is equal to the number of electrons in its valence shell. For example, nitrogen has a maximum oxidation number of +5. What is the maximum oxidation number of: **a** phosphorus? **b** magnesium? **c** chlorine?	
5	Occasionally you will find that an atom in a compound has an oxidation number of zero. What is the oxidation number of each atom in glucose, $C_6H_{12}O_6$?	

Worksheet 14.1

Oxidation numbers and redox equations

Rules for balancing redox half-equations in acidic media

1 Write the species undergoing oxidation or reduction on the left and its conjugate on the right, leaving out any spectator ions.
2 Balance for atoms other than hydrogen and oxygen.
3 Balance for oxygen by adding water, H_2O, to the appropriate side of the equation.
4 Balance for hydrogen ions, H^+, to the appropriate side of the equation.
5 Balance for charge by adding electrons to the side with the greater positive charge.

No.	Question	Answer
6	For each of the following, write the two half-equations, then add them together to get the overall redox equation. Make sure you leave out any spectator ions. **a** Acidified potassium dichromate solution ($K_2Cr_2O_7$) is used to oxidise ethanol (C_2H_5OH) to acetic acid. The dichromate ion is converted to chromium(III) ions. **b** The bromate ion, BrO_3^- may be used in acidic solution to oxidise iodide ions to iodine. The reduction product is the bromide ion. **c** Purple acidified potassium permanganate solution ($KMnO_4$) is decolourised by acidified iron(II) sulfate solution, producing Mn^{2+} and Fe^{3+}. **d** Hydrogen peroxide (H_2O_2) is added to acidified potassium permanganate, and oxygen is evolved (Mn^{2+} is also formed). **e** Hydrogen sulfide (H_2S) gas is bubbled into a solution of acidified potassium dichromate, producing a deposit of sulfur and Cr^{3+}.	