Activity 7D: Common oxidants and reductants and their identification

1. Complete the table below.

Substance	Oxidant or reductant	Half-equation	Observation(s)
oxygen gas	O	$O_2 + 4e \rightarrow 2O^{2-}$	none
hydrogen gas	R	$H_2 \rightarrow 2H^+ + 2e$	none
acidified potassium permanganate solution	O	$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$	purple → colourless
potassium iodide solution	R	$2I^- \rightarrow I_2 + 2e^-$	colourless → brown
hydrogen peroxide solution	O	$H_2O_2 + 2H^+ + 2e \rightarrow 2H_2O$	none
	R	$H_2O_2 \rightarrow O_2 + 2H^+ + 2e$	bubbles
sodium hydrogen sulfite solution	R	$HSO_3^- + H_2O \rightarrow HSO_4^- + 2H^+ + 2e$	none
potassium dichromate solution	O	$Cr_2O_7^{2-} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$	orange → green
zinc metal	R	$Zn \rightarrow Zn^{2+} + 2e^-$	grey metal → solution
iron(II) sulfate solution	R	$Fe^{2+} \rightarrow Fe^{3+} + e$	pale green soln → orange/red brown
iodine solution	O	$I_2 + 2e \rightarrow 2I^-$	brown soln becomes colourless

2. Identify the solution (**in brown bold text**), stating whether it is an oxidant or reductant, and write the half-equation for this substance acting as an oxidant or reductant.

   a. Acidified potassium permanganate solution is decolourised by a **pale-green solution** which goes orange-red brown.

   $Fe^{2+} \rightarrow Fe^{3+} + e$ Reductant

   b. Acidified potassium permanganate solution is decolourised by a **colourless solution** which goes brown.

   $2I^- \rightarrow I_2 + 2e$ Reductant

c. Acidified hydrogen peroxide solution converts a **colourless solution** to an orange solution.

$2Br^- \rightarrow Br_2 + 2e$ Reductant

d. A colourless solution of potassium iodide converts an **orange-red brown solution** to a black solid (and a very light green solution).

$Fe^{3+} + e \rightarrow Fe^{2+}$ Oxidant

3. Explain the following observations, writing half-equations and an overall equation where appropriate.

a. A pale-green gas passed over moist starch-iodide paper produces a blue-black stain on the paper.

$Cl_2 + 2e \rightarrow 2Cl^-$

green gas

$2I^- \rightarrow I_2 + 2e^-$ I_2 + starch → blue/black

iodide

$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$

b. A gas, which appears in the air as white fumes, with a choking smell, is passed over acidified potassium permanganate paper and the paper is decolourised.

~~SO~~ $MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$

$2H_2O + SO_2 \rightarrow SO_4^{2-} + 4H^+ + 2e^-$

$2MnO_4^- + \cancel{16}H^+ + \cancel{10}\,2\,H_2O + 5SO_2$
$\rightarrow 2Mn^{2+} + \cancel{8H_2O} + 5SO_4^{2-} + \cancel{20}\,4\,H^+$

Halogens as oxidants

The halogens are the elements of Group 17, namely fluorine, chlorine, bromine and iodine. These elements are oxidants:

$$F_2(g) + 2e^- \rightarrow 2F^-$$
$$Cl_2(g) + 2e^- \rightarrow 2Cl^-$$
$$Br_2(\ell) + 2e^- \rightarrow 2Br^-$$
$$I_2(s) + 2e^- \rightarrow 2I^-$$

The oxidising strength decreases moving down Group 17 (ie as atomic numbers increase):

strongest oxidant $F_2 > Cl_2 > Br_2 > I_2$ weakest oxidant

Reactions of halogens with other elements

Halogens reacting with metals

Halogens have vigorous/violent reactions with most metals, producing ionic compounds.