PREDICTING REDOX REACTIONS:

FOR SINGLE DISPLACEMENT REACTIONS WE CAN USE AN ACTIVITY SERIES:

ACTIVITY SERIES	
highest activity	Li
	K
Replace H_2 from H_2O	Ca
	Na
	Mg
	Al
	Zn
	$Cr \rightarrow Cr^{+3}$
Replace H_2 from acids	$Fe \rightarrow Fe^{+2}$
	Cd
	$Ni \rightarrow Ni^{+2}$
	$Sn \rightarrow Sn^{+2}$
	$Pb \rightarrow Pb^{+2}$
	Hydrogen
	$Cu \rightarrow Cu^{+2}$
Will not replace H_2 from acids	Ag
	$Hg \rightarrow Hg^{+2}$
lowest activity	$Au \rightarrow Au^{+3}$

SINGLE DISPLACEMENT:

$$A + BC \rightarrow B + AC$$

IF "A" HAS HIGHER ACTIVITY THAN "B", THE REACTION WILL OCCUR.

FOR EXAMPLE:

$$Zn_{(s)} + CuSO_{4(aq)} \rightarrow$$

$$Cu_{(s)} + ZnSO_{4(aq)} \rightarrow$$

$$Ag_{(s)} + Cu(NO_3)_{2(aq)} \rightarrow$$

$$Na_{(s)} + H_2O_{(l)} \rightarrow$$

$$Cu_{(s)} + HCl_{(aq)} \rightarrow$$

$$Cu_{(s)} + HNO_{3(aq)} \rightarrow$$

WE CAN ALSO USE THE FOLLOWING TABLE:

NOTICE ALL REACTIONS ARE REDUCTIONS

↓

Standard Reduction Potentials (at 25 °C)	E° (volts)
$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	2.87
$O_3(g) + 2H^+(aq) + 2e^- \rightarrow O_2(g) + H_2O(l)$	2.07
$S_2O_8^{2-}(aq) + 2e^- \rightarrow 2SO_4^{2-}(aq)$	2.01
$Co^{3+}(aq) + e^- \rightarrow Co^{2+}(aq)$	1.82
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$	1.78
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$	1.49
$Ce^{4+}(aq) + e^- \rightarrow Ce^{3+}(aq)$	1.44
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	1.36
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	1.33
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$	1.23
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	1.07
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(l)$	0.96
$2Hg^{2+}(aq) + 2e^- \rightarrow Hg_2^{2+}(aq)$	0.90
$Hg^{2+}(aq) + 2e^- \rightarrow Hg(l)$	0.85
$Hg_2^{2+}(aq) + 2e^- \rightarrow 2Hg(l)$	0.80
$Ag^+(aq) + e^- \rightarrow Ag(s)$	0.80
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	0.77
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	0.54
$Cu^+(aq) + e^- \rightarrow Cu(s)$	0.52
$IO^-(aq) + H_2O(l) + 2e^- \rightarrow I^-(aq) + 2OH^-(aq)$	0.49
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	0.34
$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-(aq)$	0.22
$Cu^{2+}(aq) + e^- \rightarrow Cu^+(aq)$	0.16
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	0.15
$Fe^{3+}(aq) + 3e^- \rightarrow Fe(s)$	-0.04
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	-0.13
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	-0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	-0.23
$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$	-0.40
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	-0.41
$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	-0.74
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	-2.38
$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	-2.76
$K^+(aq) + e^- \rightarrow K(s)$	-2.92
$Li^+(aq) + e^- \rightarrow Li(s)$	-3.04

↖ THE MORE POSITIVE, THE MORE SPONTANEOUS IN THIS DIRECTION (REDUCTION)

THE MORE NEGATIVE, THE MORE SPONTANEOUS IN THE REVERSE DIRECTION (OXIDATION) ↙

SO: $Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}$ IS MORE LIKEY TO OCCUR THAN $Fe^{2+}_{(aq)} + 2e \longrightarrow Fe_{(s)}$

HOW DO WE PREDICT REACTIONS

WILL THE FOLLOWING REACTION OCCUR?

$$Ag_{(s)} + Fe(NO_3)_{2(aq)} \longrightarrow \ ?$$

WHAT ARE THE HALF RXNS: (ASSUME NO_3^- IS SPECTATOR)

$Fe^{2+}_{(aq)} + 2e^- \longrightarrow Fe_{(s)}$ ← REDUCTION, SO IN TABLE

$E^\circ = -0.41\ V$

$Ag_{(s)} \longrightarrow Ag^+_{(aq)} + e^-$ ← OXIDATION, SO NOT IN TABLE

$Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$ $E^\circ = 0.80\ V$ (IN TABLE)

$Ag_{(s)} \longrightarrow Ag^+_{(aq)} + e^-$ $E^\circ = -0.80\ V$ ← FLIP RXN, FLIP SIGN

SO WILL REACTION OCCUR?

ADD HALF RXNS TOGETHER:

$Fe^{2+}_{(aq)} + 2e^- \rightarrow Fe_{(s)}$ $E^\circ = -0.41\ V$

$2(Ag_{(s)} \longrightarrow Ag^+_{(aq)} + e^-)$ $E^\circ = -0.80\ V$ ← EVEN THOUGH WE DOUBLE RXN, WE DON'T DOUBLE VALUE

$2Ag_{(s)} + Fe^{2+}_{(aq)} \rightarrow 2Ag^+_{(aq)} + Fe_{(s)}$ $E^\circ_{RXN} = -1.21\ V$

↑ IF NEGATIVE, NO RXN