

Topic 9: Oxidation + Reduction

9.1

Oxidation \rightarrow gain of O_2 / loss of H^+ / loss of e^-

reduction \rightarrow loss of O_2 / gain of H^+ / gain of e^-

Lose

E^-

Oxidised

Gain

E^-

Reduced

Oxidation

Is

Loss

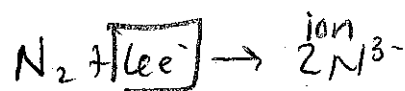
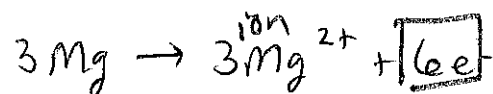
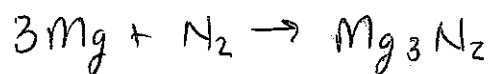
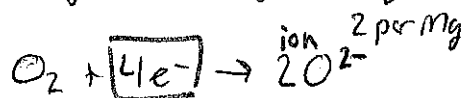
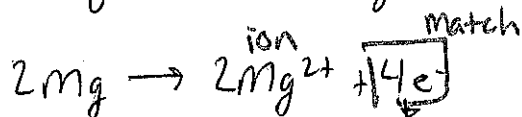
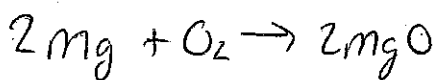
Reduction

Is

Gain

Redox Rxns
one cannot occur
w/o other

Half rxns: what happens to one reactant in terms of e^-



Oxidation state (number):

Value to each atom \rightarrow measures e^- control / possession
it has relative to the atom in pure element
(apparent charge of atom)

ionic compd \rightarrow predict based off charge

covalent compd \rightarrow exaggerate unequal sharing (based off
electronegativity) \rightarrow gain/loss track relative
 e^- density in compd

Signs: + : atom has lost e^- control
 - : atom has gained e^- control

Value: number of e^- over which control has changed

($2+ \rightarrow$ charge of atom / $+2 \rightarrow$ oxidation state)

Assigning oxidation states:

1) Atoms in elemental state = \emptyset
 Mg, O_2, N_2

2) Simple ions, oxidation state = charge on ion
 Mg^{2+} O^{2-} N^{3-}
 $+2$ -2 -3

3) oxidation state of all atoms in neutral compd
 must = \emptyset $H_2SO_4 = \emptyset$

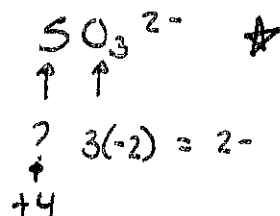
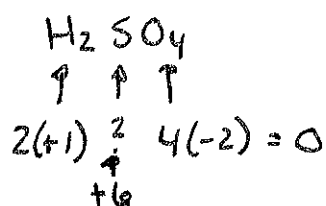
4) oxidation state of all atoms in polyatomic ion
 must = charge of ion $SO_4^{2-} = -2$

5) usual oxidation state \rightarrow charge of most common ion
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(e) Some elements ox states vary in diff. compds \rightarrow
 depends on other elements
 ex: N, P, S, all transition, Sn, Pb

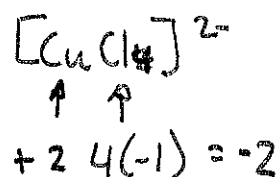
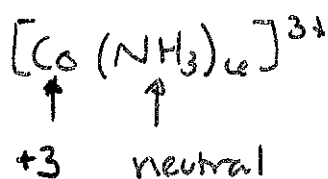
* Best to identify 'easy' ox states 1^+ , then
 variable species

ex: Which compound does S have more e⁻ control?

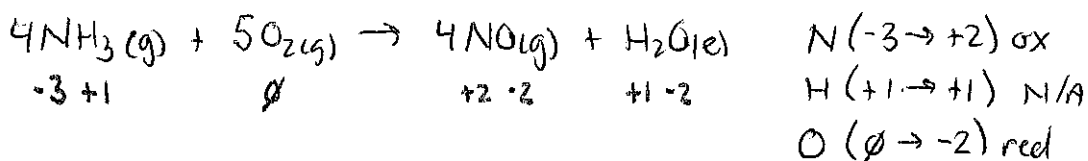
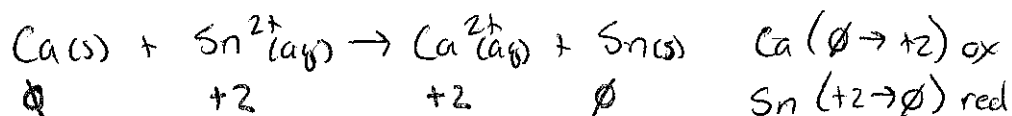
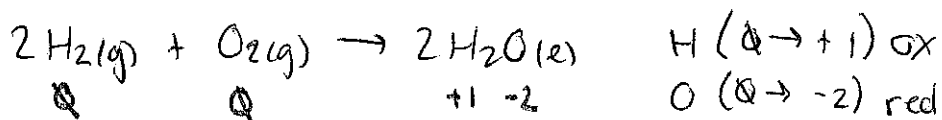


Transition metal in complex ion:

- 1) charge of ligand
- 2) overall charge



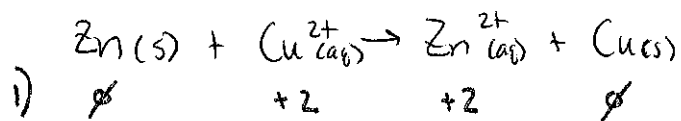
During rxn, ox state may change in value
 more (-), more reduced, more control
 more (+), more oxidized, less control



* Roman numerals for transition metal represent ox state
 Table pg 411

V2

Writing half equations

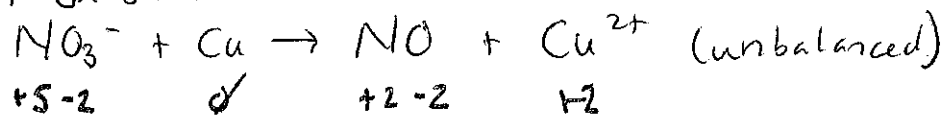


Must be equal # of e^- in $\frac{1}{2}$ eq so when added together they cancel out (like intermediates)

Writing redox equations from $\frac{1}{2}$ eq
 make sure it is balanced for atoms / charges
 most rxns occur in acidified solns \therefore use $\text{H}_2\text{O}/\text{H}^+$ to balance $\frac{1}{2}$ rxns

ex: NO_3^- + Cu react together in acidic soln
 to NO + Cu^{2+}

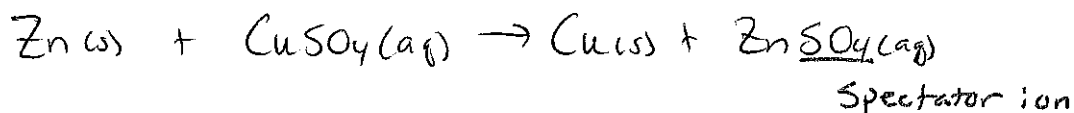
1) assign ox state:



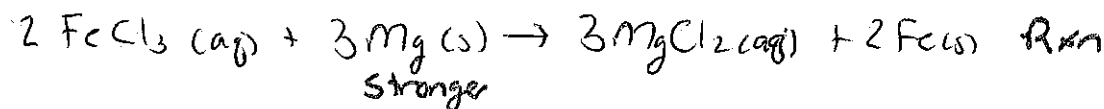
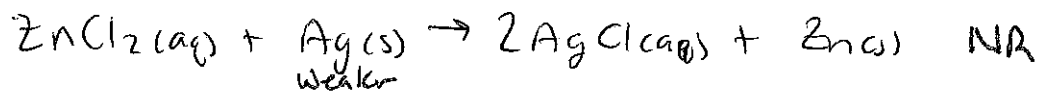
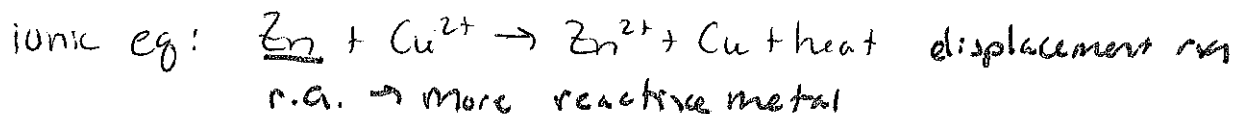
N (+5 \rightarrow +2) red

Cu ($\emptyset \rightarrow$ +2) ox

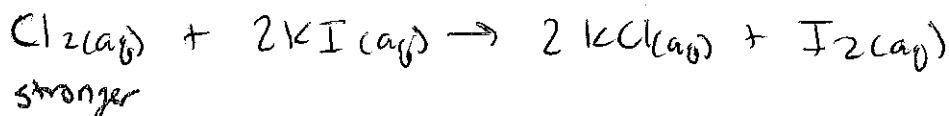
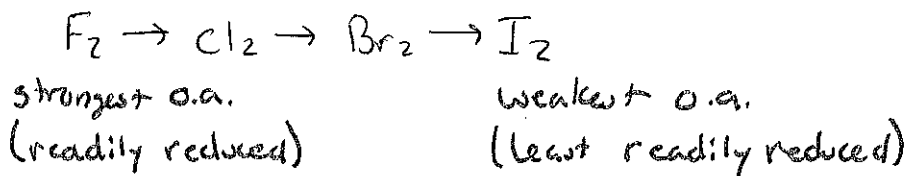
O (-2 \rightarrow -2) spectator



Cu^{2+} ion being displaced from soln as Zn is reducing them.



More reactive non-metals stronger o.a.
b/c non-metals gain e^- (electron affinity)



Redox Titrations

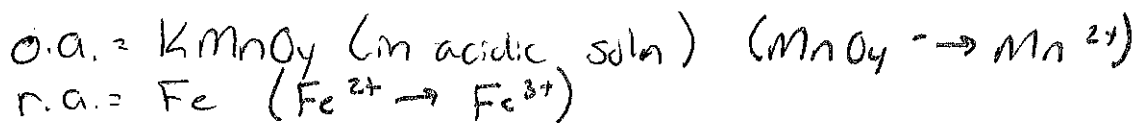
- used to determine unknown conc. of substance in soln
- eg pt: reacted stoichiometrically by transferring e^-

A / B	Vs.	Redox
• neutralization b/w A + B		• redox b/w o.a. + r.a.
• H^+ transfer from A \rightarrow B		• e^- transfer from r.a. \rightarrow o.a.

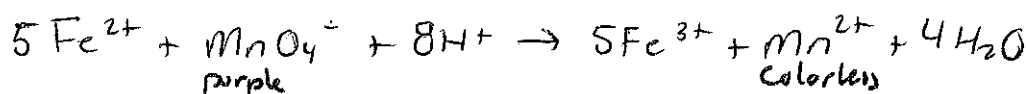
Same method

- burette / pipette (Vol) against std soln
- indicator for eq. pt (maybe)
- from volume of titre used \rightarrow conc. of unknown can be determined using $\frac{1}{2}$ eq.

1. Analysis of Fe w/ Manganate (VII) (pg 420)



(get through $\frac{1}{2}$ eq)



Known: 2.000 (g) Fe tablet
 27.50 cm^3 of 0.100 mol dm^{-3} KMnO_4

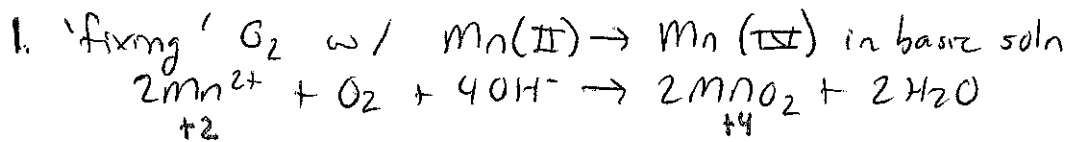
1. $n(\text{MnO}_4^-) = 0.100 \times 0.02750 \text{ dm}^3 = 0.00275 \text{ mol MnO}_4^-$

2. $\text{MnO}_4^- : \text{Fe}^{2+} = 1 : 5$
 $n(\text{Fe}^{2+}) = 0.00275 \text{ mol MnO}_4^- \times 5 = 0.01375 \text{ mol Fe}^{2+}$

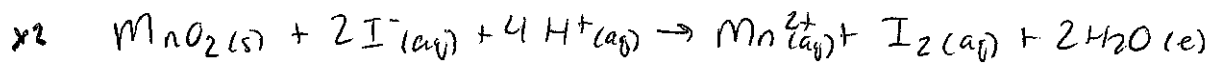
3. $n = \frac{m}{M}$ $m(\text{Fe}) = 0.01375 \text{ mol} \times 55.85 \text{ g mol}^{-1} = \boxed{0.768 \text{ g}}$

4. $\% \text{ Fe in tablet} = \frac{0.768 \text{ g}}{2.000 \text{ g}} \times 100 = \boxed{38.4 \%}$

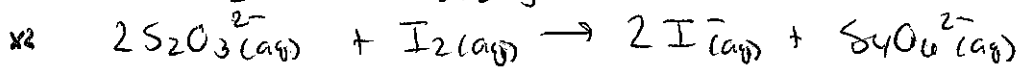
5. obs: MnO_4^- purple in burette, colorless in flask (as Mn^{2+}),
 after eq. pt. purple in flask



2. Add acidified I^-



3. Titrate I_2 w/ $Na_2S_2O_3$



1 mol O_2 : 4 mol $S_2O_3^{2-}$ used

Known: 500 cm³ H₂O sample

12.50 cm³ of 0.0500 mol dm⁻³ $Na_2S_2O_3$

? g dm⁻³ DO of H₂O

$$1. \quad n(S_2O_3^{2-}) = 0.0500 \text{ mol dm}^{-3} \times 0.01250 \text{ dm}^3 = 6.25 \times 10^{-4} \text{ mol}$$

$$2. \quad S_2O_3^{2-} : I_2 = 2:1$$

$$n(I_2) = 6.25 \times 10^{-4} \text{ mol} \div 2 = 3.175 \times 10^{-4} \text{ mol } I_2$$

$$3. \quad MnO_2 : I_2 = 1:1$$

$$n(MnO_2) = 3.175 \times 10^{-4} \text{ mol } MnO_2$$

$$4. \quad MnO_2 : O_2 = 2:1$$

$$n(O_2) = 3.175 \times 10^{-4} \text{ mol} \div 2 = 1.5875 \times 10^{-4} \text{ mol } O_2$$

$$5. \quad m(O_2) = n \times M = 1.5875 \times 10^{-4} \text{ mol} \times 32.00 \text{ g mol}^{-1} = 5.080 \times 10^{-3} \text{ g}$$

in 500 cm³

$$6. \quad DO = 0.0102 \text{ g dm}^{-3}$$