

How were notebook pages graded?

6 pts for the content comparing to the Notebook Guidelines; 2 pts were deducted for each missing item not to exceed 6 pts.

4 pts for quality and organization of the notebook pages

4 pts = excellent

3 pts = good

2 pts = average

1 pt = below average

Two points were deducted for each violation such as:

- Using pencils, red pen, or white-outs
- Scribbling
- Wrong/missing ChemID/Unknown #

Some graders are more straight than others

If you have doubt of your unknown identification in Exp 2, please see me during my office hours.

Redox Reactions --- a reaction that involves transferring of electrons

Oxidation is the process of losing electrons (LEO).

Reduction is the process of gaining electrons (GER).

Reducing agent is being oxidized (losing electrons). Those that can lose electrons easily are good reducing agents.

Oxidizing agent is being reduced (gaining electrons). Those that gain electrons easily are good oxidizing agents.



Reducing agent
was oxidized (O.N. ↑)



Oxidizing agent
was reduced (O.N. ↓)

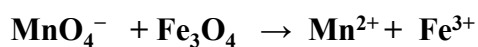
Recap of Exp 3

What is the color of Fe_3O_4 ?

Can you change a molecular equation to a **net** ionic equation?



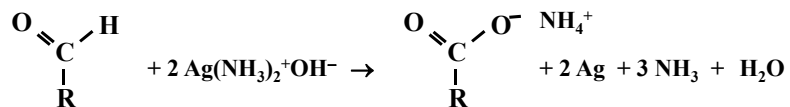
Balancing Redox Equation:



Oxidation:

Reduction:

Identify the reducing agent



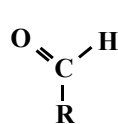
Glucose

Tollen's reagent

ammonium salt of
gluconic acid

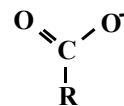
Acceptable answers:

The O.N. of an atom in a molecule can be obtained from the structural formula (Lewis dot formula) of the molecule



C: $[\] 2s^2 2p^2$

Assume the shared e^- are
claimed by the more
electronegative atom



Carbon can claim 3 e^- in the
molecule, but since a C
atom has 4 v.e., O.N. = ●



Carbon can claim 1
 e^- in the molecule.
O.N. = ●

Chem 151 Lecture 5
Exp 4
Relative Strength of Oxidizing / Reducing Agents

In this experiment, you will

- Prepare and extract the halogens Cl_2 , Br_2 , I_2
- Study the reactions of permanganate and hydrogen peroxide with bromide ions and iodide ions
- Study the relative strengths of **halogens** and **halides** as **oxidizing agents** and **reducing agents**

Except for fluorine, halogens have many stable oxidation numbers

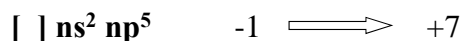


Table 1: The oxidation numbers of halogen-containing substances

(X=Cl, Br, I)	Name	O.N. of X
XO_4^-	perhalate (e.g. ClO_4^- = perchlorate)	+7
XO_3^-	halate (e.g. IO_3^- = iodate)	+5
XO_2^-	halite (e.g. ClO_2^- = chlorite)	+3
XO^-	hypohalite (e.g. BrO^- = hypobromite)	+1
X_2	chlorine, bromine, iodine	0
X^-	halide (chloride, bromide, iodide)	-1

Which species is/are possible oxidizing agent(s)? (O.N. ↓)

Which species is/are possible reducing agent(s)? (O.N. ↑)

A. Preparation of the Halogens

Cl_2 : from HCl and bleach solution (containing 5% NaClO)
 $(\text{Cl}^- + \text{ClO}^- \rightarrow \text{Cl}_2)$

Oxidation: $\text{Cl}^- \rightarrow \text{Cl}_2$

Reduction: $\text{ClO}^- \rightarrow \text{Cl}_2$

These are the only halogen containing products.

Br_2 : from NaBr and NaBrO_3 ($\text{Br}^- + \text{BrO}_3^- \rightarrow \text{Br}_2$)

I_2 : from I_3^- ($\text{I}_3^- \rightleftharpoons \text{I}_2 + \text{I}^-$)

$-1/3$

$0 \quad -1$

Is this a redox reaction?



The halogens will be separated from the ions by extraction.

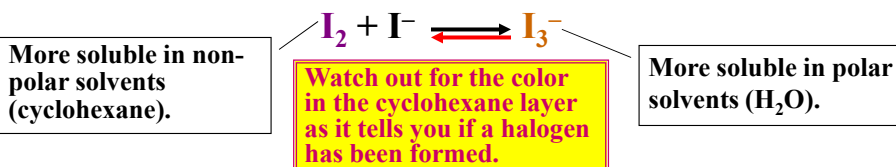
Halogen Extractions

Cyclohexane (C_6H_{12}) and water are immiscible.

Cyclohexane molecules are nonpolar and water are polar.

Polar molecules (ionic cpds) are more soluble in polar solvents (water).

Nonpolar molecules (halogens) are more soluble in nonpolar solvents (C_6H_{12}).



You will use the extraction technique to remove the halogen products (Cl_2 , Br_2 , I_2) from the aqueous solution, which contains ions such as Cl^- , BrO_3^- , or Br^- .

You should use only the halogens in the cyclohexane layer to run the reactions.

The colors of the halogens in cyclohexane are same as the elements.

B. Reaction of MnO_4^- and H_2O_2 with Br^- and I^-



H_2SO_4
 KMnO_4
 NaBr



H_2SO_4
 KMnO_4
 KI



H_2SO_4
 H_2O_2
 NaBr



H_2SO_4
 H_2O_2
 KI

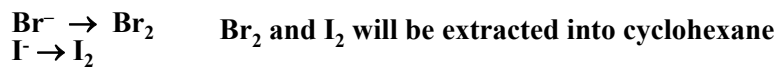
Step 14: Add 0.75 mL 2M H_2SO_4 and KMnO_4 or H_2O_2

Step 15: Add 0.5 mL NaBr solution to a KMnO_4 vial and a H_2O_2 vial

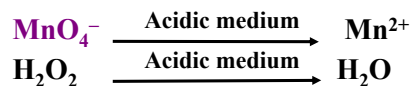
Step 16: Add 0.5 mL KI solution to a KMnO_4 vial and a H_2O_2 vial

Step 17: Add 0.5 mL cyclohexane to all vials and shake

How does one tell if there is a reaction?



What do MnO_4^- and H_2O_2 become?



Can you write a balanced equation to illustrate the reduction half-reaction?

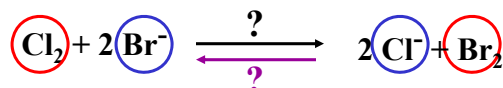
C. Relative Oxidizing Strengths & Reducing Strengths



A redox reaction is a “tug of war” for electrons!

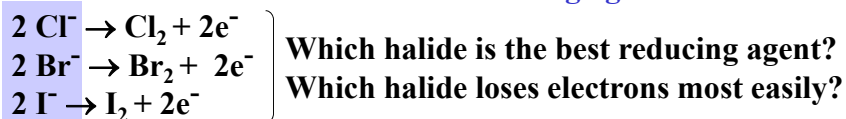
Cl₂ is a better oxidizing agent than Br₂

Br⁻ is a better reducing agent than Cl⁻.

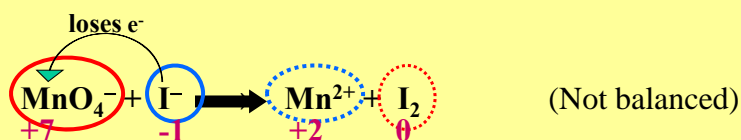


Br₂ is a better oxidizing agent than Cl₂

Cl⁻ is a better reducing agent than Br⁻.



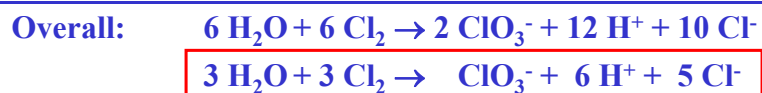
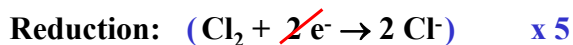
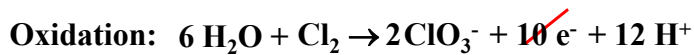
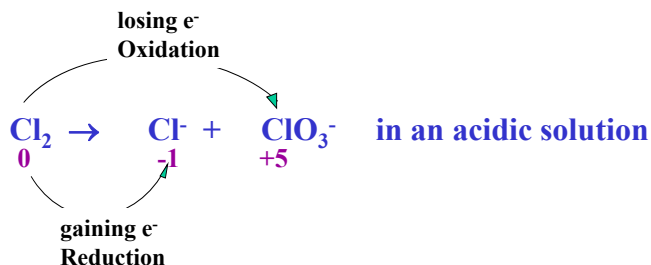
C. Relative Oxidizing Strengths & Reducing Strengths



Which substance is the stronger reducing agent?

Which substance is the stronger oxidizing agent?

Disproportionation — self oxidation-reduction



Which of the following would disproportionate when under appropriate experimental conditions?

(X=Cl, Br, I)	Name	O.N. of X
XO ₄ ⁻	perhalate (e.g. ClO ₄ ⁻ = perchlorate)	+7
XO ₃ ⁻	halate (e.g. IO ₃ ⁻ = iodate)	+5
XO ₂ ⁻	halite (e.g. ClO ₂ ⁻ = chlorite)	+3
XO ⁻	hypohalite (e.g. BrO ⁻ = hypobromite)	+1
X ₂	chlorine, bromine, iodine	0
X ⁻	halide (chloride, bromide, iodide)	-1

Possible oxidizing agent(s) (O.N. ↓)

Possible reducing agent(s) (O.N. ↑)

Be prepared for the calculations in Report

Help Session today at 5 pm in LS250

Midterm Exam is Oct. 14 (Wed) from 6:30 - 8:30 pm

Check the course web (Exam Info page) for

- Exam room assignments
- Rules of midterm exam
- Midterm exam of last year and its answer key

No lab next week (10/13 – 10/17)

Next Monday's lecture is "Midterm Review", followed by Help Session at 5 pm in LS250.

Exp. 4 reports will be placed in racks of LS 136 by 5 pm Monday. Grading Guidelines will be posted on Tuesday.

Students needing special accommodations must submit a copy of the verification form ASAP no later than Friday (10/9).