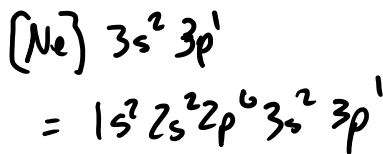
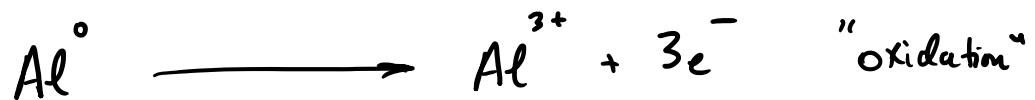
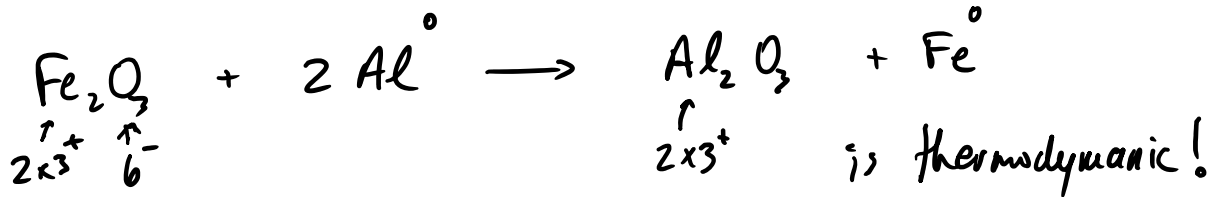


## Section 13:

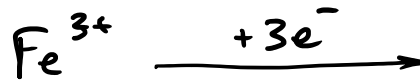
R ? Q: Yes on my notes it was Section 12: "...this chapter is terrible" - so yes it is Section 12  
And for Section 13: "I'm so funny... to discuss a few things... before we can drive into electrochemistry"  
... so sorry I was thinking of that note I had on hand to be related to electrochemistry - but here is the true comments of Section 12 and Section 13....

## Splitting up oxidation and reduction

The aluminothermic reduction of iron reaction (Reaction 10) is a nice stepping stone to transition into the business that this chapter is supposed to be about: electrochemistry! You see, as the name implies, iron is being *reduced*. This means that iron is gaining electrons (perhaps you've heard that LEO the lion says, "GER," reminding us that we Lose Electrons in Oxidation and Gain Electrons in Reduction). We can write out just the most simple thing that is happening to iron in the reaction

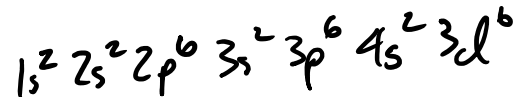


"metal"



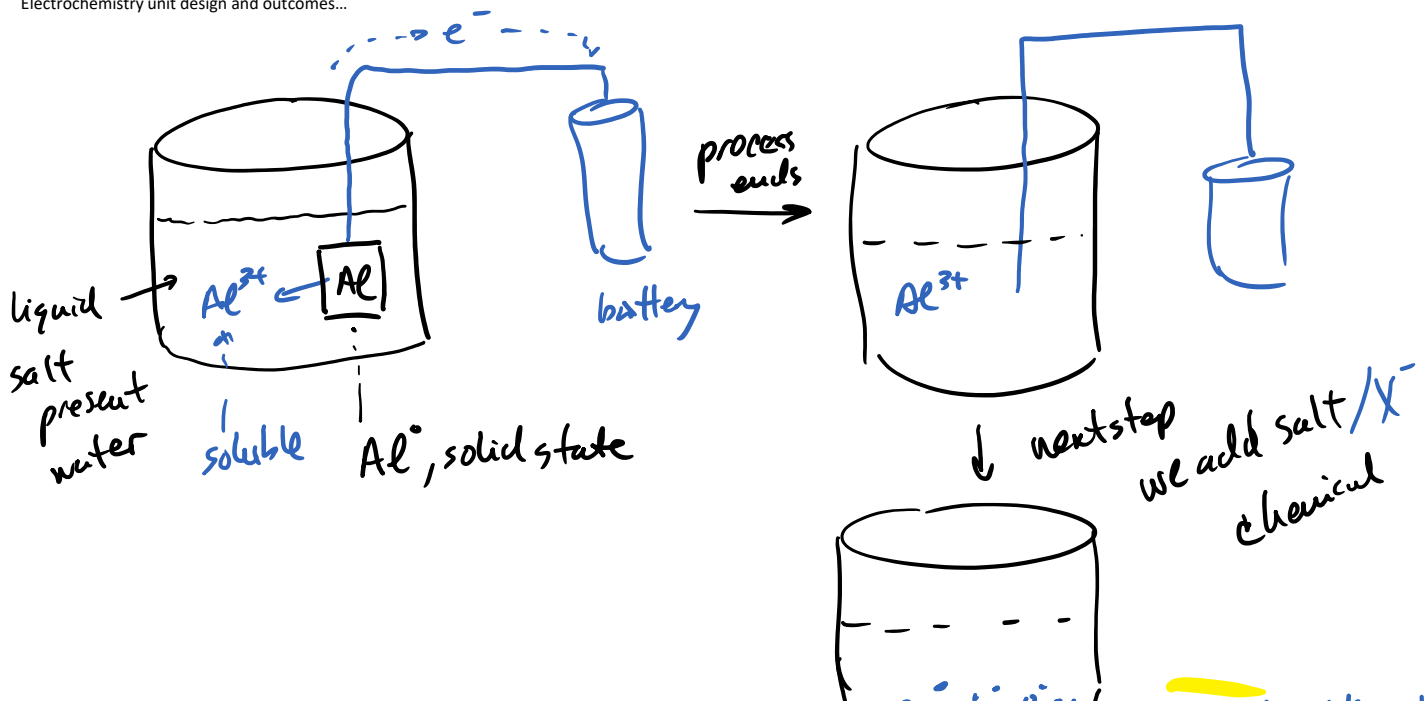
"reduction"

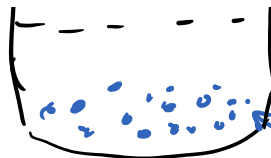
"salt"



Electrochemistry

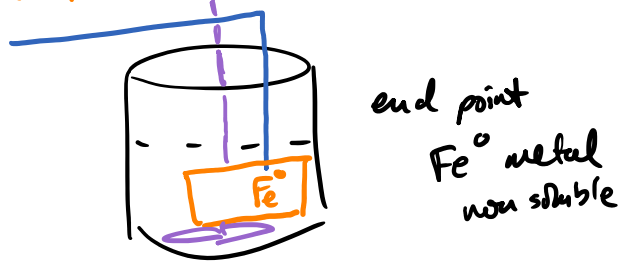
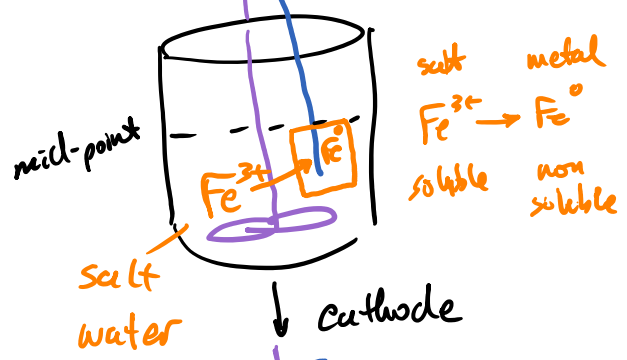
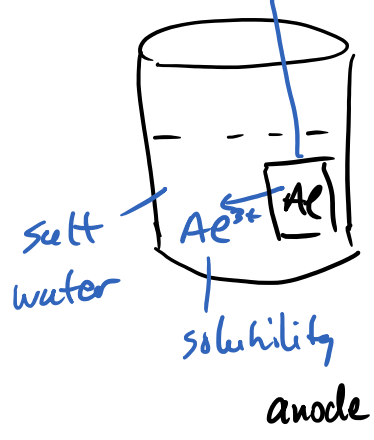
Electrochemistry unit design and outcomes...



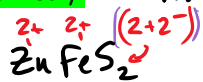


AlX without water solubility

---  $e^-$



# Electrochemistry → Mineral Process



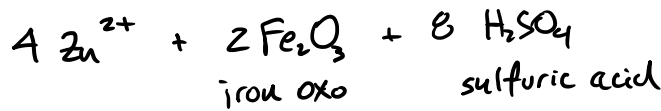
zinc - iron - sulfur

oxygen

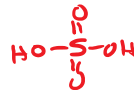
water



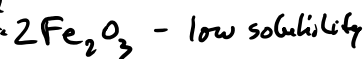
how to mix?  
require heat?



water add

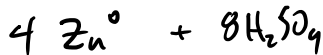


separated



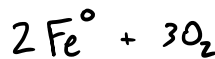
electrochemistry  
0.763V

water  
still present

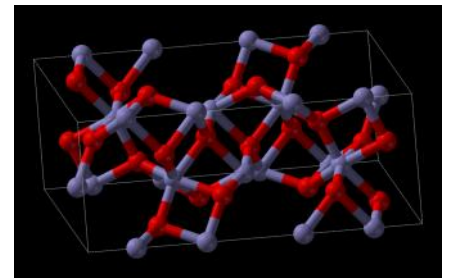


electro  
chemistry

maybe  
solubilize it?



solid



3D

Reduction Reaction	E° (V)
$\text{Li}^+_{(\text{aq})} + \text{e}^- \rightarrow \text{Li}_{(\text{s})}$	-3.045
$\text{Zn}^{2+}_{(\text{aq})} + 2\text{e}^- \rightarrow \text{Zn}_{(\text{s})}$	-0.763
$\text{Fe}^{2+}_{(\text{aq})} + 2\text{e}^- \rightarrow \text{Fe}_{(\text{s})}$	-0.44 <span style="color: red;">—</span>
$2\text{H}^+_{(\text{aq})} + 2\text{e}^- \rightarrow \text{H}_{2(\text{g})}$	0.000
$\text{Cu}^{2+}_{(\text{aq})} + 2\text{e}^- \rightarrow \text{Cu}_{(\text{s})}$ <i>copper</i>	+0.337
$\text{Pt}^{2+}_{(\text{aq})} + 2\text{e}^- \rightarrow \text{Pt}_{(\text{s})}$ <i>platinum</i>	+1.2

Table 1. Standard reduction potentials for a few half-cell reactions.

# PERIODIC TABLE OF ELEMENTS

1  
**H**  
Hydrogen  
1s<sup>1</sup>

2  
**He**  
Helium  
1s<sup>2</sup>

3  
**Li**  
Lithium  
[He]2s<sup>1</sup>

4  
**Be**  
Beryllium  
[He]2s<sup>2</sup>

5  
**B**  
Boron  
[He]2s<sup>2</sup>2p<sup>1</sup>

6  
**C**  
Carbon  
[He]2s<sup>2</sup>2p<sup>2</sup>

7  
**N**  
Nitrogen  
[He]2s<sup>2</sup>2p<sup>3</sup>

8  
**O**  
Oxygen  
[He]2s<sup>2</sup>2p<sup>4</sup>

9  
**F**  
Fluorine  
[He]2s<sup>2</sup>2p<sup>5</sup>

10  
**Ne**  
Neon  
[He]2s<sup>2</sup>2p<sup>6</sup>

11  
**Na**  
Sodium  
[Ne]3s<sup>1</sup>

12  
**Mg**  
Magnesium  
[Ne]3s<sup>2</sup>

13  
**Al**  
Aluminum  
[Ne]3s<sup>2</sup>3p<sup>1</sup>

14  
**Si**  
Silicon  
[Ne]3s<sup>2</sup>3p<sup>2</sup>

15  
**P**  
Phosphorus  
[Ne]3s<sup>2</sup>3p<sup>3</sup>

16  
**S**  
Sulfur  
[Ne]3s<sup>2</sup>3p<sup>4</sup>

17  
**Cl**  
Chlorine  
[Ne]3s<sup>2</sup>3p<sup>5</sup>

18  
**Ar**  
Argon  
[Ne]3s<sup>2</sup>3p<sup>6</sup>

19  
**K**  
Potassium  
[Ar]4s<sup>1</sup>

20  
**Ca**  
Calcium  
[Ar]4s<sup>2</sup>

21  
**Sc**  
Scandium  
[Ar]3d<sup>1</sup>4s<sup>2</sup>

22  
**Ti**  
Titanium  
[Ar]3d<sup>2</sup>4s<sup>2</sup>

23  
**V**  
Vanadium  
[Ar]3d<sup>3</sup>4s<sup>2</sup>

24  
**Cr**  
Chromium  
[Ar]3d<sup>5</sup>4s<sup>1</sup>

25  
**Mn**  
Manganese  
[Ar]3d<sup>5</sup>4s<sup>2</sup>

26  
**Fe**  
Iron  
[Ar]3d<sup>6</sup>4s<sup>2</sup>

27  
**Co**  
Cobalt  
[Ar]3d<sup>7</sup>4s<sup>2</sup>

28  
**Ni**  
Nickel  
[Ar]3d<sup>8</sup>4s<sup>2</sup>

29  
**Cu**  
Copper  
[Ar]3d<sup>10</sup>4s<sup>1</sup>

30  
**Zn**  
Zinc  
[Ar]3d<sup>10</sup>4s<sup>2</sup>

31  
**Ga**  
Gallium  
[Ar]3d<sup>10</sup>4s<sup>2</sup>4p<sup>1</sup>

32  
**Ge**  
Germanium  
[Ar]3d<sup>10</sup>4s<sup>2</sup>4p<sup>2</sup>

33  
**As**  
Arsenic  
[Ar]3d<sup>10</sup>4s<sup>2</sup>4p<sup>3</sup>

34  
**Se**  
Selenium  
[Ar]3d<sup>10</sup>4s<sup>2</sup>4p<sup>4</sup>

35  
**Br**  
Bromine  
[Ar]3d<sup>10</sup>4s<sup>2</sup>4p<sup>5</sup>

36  
**Kr**  
Krypton  
[Ar]3d<sup>10</sup>4s<sup>2</sup>4p<sup>6</sup>

37  
**Rb**  
Rubidium  
[Kr]5s<sup>1</sup>

38  
**Sr**  
Strontium  
[Kr]5s<sup>2</sup>

39  
**Y**  
Yttrium  
[Kr]4d<sup>1</sup>5s<sup>2</sup>

40  
**Zr**  
Zirconium  
[Kr]4d<sup>2</sup>5s<sup>2</sup>

41  
**Nb**  
Niobium  
[Kr]4d<sup>4</sup>5s<sup>1</sup>

42  
**Mo**  
Molybdenum  
[Kr]4d<sup>5</sup>5s<sup>1</sup>

43  
**Tc**  
Technetium  
[Kr]4d<sup>5</sup>5s<sup>2</sup>

44  
**Ru**  
Ruthenium  
[Kr]4d<sup>7</sup>5s<sup>1</sup>

45  
**Rh**  
Rhodium  
[Kr]4d<sup>8</sup>5s<sup>1</sup>

46  
**Pd**  
Palladium  
[Kr]4d<sup>10</sup>

47  
**Ag**  
Silver  
[Kr]4d<sup>10</sup>5s<sup>1</sup>

48  
**Cd**  
Cadmium  
[Kr]4d<sup>10</sup>5s<sup>2</sup>

49  
**In**  
Indium  
[Kr]4d<sup>10</sup>5s<sup>2</sup>5p<sup>1</sup>

50  
**Sn**  
Tin  
[Kr]4d<sup>10</sup>5s<sup>2</sup>5p<sup>2</sup>

51  
**Sb**  
Antimony  
[Kr]4d<sup>10</sup>5s<sup>2</sup>5p<sup>3</sup>

52  
**Te**  
Tellurium  
[Kr]4d<sup>10</sup>5s<sup>2</sup>5p<sup>4</sup>

53  
**I**  
Iodine  
[Kr]4d<sup>10</sup>5s<sup>2</sup>5p<sup>5</sup>

54  
**Xe**  
Xenon  
[Kr]4d<sup>10</sup>5s<sup>2</sup>5p<sup>6</sup>

55  
**Cs**  
Cesium  
[Xe]6s<sup>1</sup>

56  
**Ba**  
Barium  
[Xe]6s<sup>2</sup>

72  
**Hf**  
Hafnium  
[Xe]4f<sup>14</sup>5d<sup>2</sup>6s<sup>2</sup>

73  
**Ta**  
Tantalum  
[Xe]4f<sup>14</sup>5d<sup>3</sup>6s<sup>2</sup>

74  
**W**  
Tungsten  
[Xe]4f<sup>14</sup>5d<sup>4</sup>6s<sup>2</sup>

75  
**Re**  
Rhenium  
[Xe]4f<sup>14</sup>5d<sup>5</sup>6s<sup>2</sup>

76  
**Os**  
Osmium  
[Xe]4f<sup>14</sup>5d<sup>6</sup>6s<sup>2</sup>

77  
**Ir**  
Iridium  
[Xe]4f<sup>14</sup>5d<sup>7</sup>6s<sup>2</sup>

78  
**Pt**  
Platinum  
[Xe]4f<sup>14</sup>5d<sup>9</sup>6s<sup>1</sup>

79  
**Au**  
Gold  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>1</sup>

80  
**Hg**  
Mercury  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>

81  
**Tl**  
Thallium  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>6p<sup>1</sup>

82  
**Pb**  
Lead  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>6p<sup>2</sup>

83  
**Bi**  
Bismuth  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>6p<sup>3</sup>

84  
**Po**  
Polonium  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>6p<sup>4</sup>

85  
**At**  
Astatine  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>6p<sup>5</sup>

86  
**Rn**  
Radon  
[Xe]4f<sup>14</sup>5d<sup>10</sup>6s<sup>2</sup>6p<sup>6</sup>

87  
**Fr**  
Francium  
[Rn]7s<sup>1</sup>

88  
**Ra**  
Radium  
[Rn]7s<sup>2</sup>

104  
**Rf**  
Rutherfordium  
[Rn]5f<sup>14</sup>6d<sup>2</sup>7s<sup>2</sup>

105  
**Db**  
Dubnium  
[Rn]5f<sup>14</sup>6d<sup>3</sup>7s<sup>2</sup>

106  
**Sg**  
Seaborgium  
[Rn]5f<sup>14</sup>6d<sup>4</sup>7s<sup>2</sup>

107  
**Bh**  
Bohrium  
[Rn]5f<sup>14</sup>6d<sup>5</sup>7s<sup>2</sup>

108  
**Hs**  
Hassium  
[Rn]5f<sup>14</sup>6d<sup>6</sup>7s<sup>2</sup>

109  
**Mt**  
Meitnerium  
[Rn]5f<sup>14</sup>6d<sup>7</sup>7s<sup>2</sup>

110  
**Ds**  
Darmstadtium  
[Rn]5f<sup>14</sup>6d<sup>8</sup>7s<sup>2</sup>

111  
**Rg**  
Roentgenium  
[Rn]5f<sup>14</sup>6d<sup>9</sup>7s<sup>2</sup>

112  
**Cn**  
Copernicium  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>

113  
**Nh**  
Nihonium  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>7p<sup>1</sup>

114  
**Fl**  
Flerovium  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>7p<sup>2</sup>

115  
**Mc**  
Moscovium  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>7p<sup>3</sup>

116  
**Lv**  
Livermorium  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>7p<sup>4</sup>

117  
**Ts**  
Tennessine  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>7p<sup>5</sup>

118  
**Og**  
Oganesson  
[Rn]5f<sup>14</sup>6d<sup>10</sup>7s<sup>2</sup>7p<sup>6</sup>

57  
**La**  
Lanthanum  
[Xe]5d<sup>1</sup>6s<sup>2</sup>

58  
**Ce**  
Cerium  
[Xe]4f<sup>1</sup>5d<sup>1</sup>6s<sup>2</sup>

59  
**Pr**  
Praseodymium  
[Xe]4f<sup>3</sup>6s<sup>2</sup>

60  
**Nd**  
Neodymium  
[Xe]4f<sup>4</sup>6s<sup>2</sup>

61  
**Pm**  
Promethium  
[Xe]4f<sup>5</sup>6s<sup>2</sup>

62  
**Sm**  
Samarium  
[Xe]4f<sup>6</sup>6s<sup>2</sup>

63  
**Eu**  
Europium  
[Xe]4f<sup>7</sup>6s<sup>2</sup>

64  
**Gd**  
Gadolinium  
[Xe]4f<sup>7</sup>5d<sup>1</sup>6s<sup>2</sup>

65  
**Tb**  
Terbium  
[Xe]4f<sup>9</sup>6s<sup>2</sup>

66  
**Dy**  
Dysprosium  
[Xe]4f<sup>10</sup>6s<sup>2</sup>

67  
**Ho**  
Holmium  
[Xe]4f<sup>11</sup>6s<sup>2</sup>

68  
**Er**  
Erbium  
[Xe]4f<sup>12</sup>6s<sup>2</sup>

69  
**Tm**  
Thulium  
[Xe]4f<sup>13</sup>6s<sup>2</sup>

70  
**Yb**  
Ytterbium  
[Xe]4f<sup>14</sup>6s<sup>2</sup>

71  
**Lu**  
Lutetium  
[Xe]4f<sup>14</sup>5d<sup>1</sup>6s<sup>2</sup>

89  
**Ac**  
Actinium  
[Rn]6d<sup>1</sup>7s<sup>2</sup>

90  
**Th**  
Thorium  
[Rn]6d<sup>2</sup>7s<sup>2</sup>

91  
**Pa**  
Protactinium  
[Rn]5f<sup>2</sup>6d<sup>1</sup>7s<sup>2</sup>

92  
**U**  
Uranium  
[Rn]5f<sup>3</sup>6d<sup>1</sup>7s<sup>2</sup>

93  
**Np**  
Neptunium  
[Rn]5f<sup>4</sup>6d<sup>1</sup>7s<sup>2</sup>

94  
**Pu**  
Plutonium  
[Rn]5f<sup>6</sup>7s<sup>2</sup>

95  
**Am**  
Americium  
[Rn]5f<sup>7</sup>7s<sup>2</sup>

96  
**Cm**  
Curium  
[Rn]5f<sup>8</sup>7s<sup>2</sup>

97  
**Bk**  
Berkelium  
[Rn]5f<sup>9</sup>7s<sup>2</sup>

98  
**Cf**  
Californium  
[Rn]5f<sup>10</sup>7s<sup>2</sup>

99  
**Es**  
Einsteinium  
[Rn]5f<sup>11</sup>7s<sup>2</sup>

100  
**Fm**  
Fermium  
[Rn]5f<sup>12</sup>7s<sup>2</sup>

101  
**Md**  
Mendelevium  
[Rn]5f<sup>13</sup>7s<sup>2</sup>

102  
**No**  
Nobelium  
[Rn]5f<sup>14</sup>7s<sup>2</sup>

103  
**Lr**  
Lawrencium  
[Rn]5f<sup>14</sup>6d<sup>1</sup>7s<sup>2</sup>

Atomic Number

Symbol

Name

Electron Configuration

PubChem

## Re-Introduction

**Metals**  $\rightarrow$   $\text{Cu}^\circ$ ,  $\text{Fe}^\circ$ ,  $\text{Al}^\circ$  etc.

**Ceramics**  $\rightarrow$   $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{CuO}$  "non-salts"  
 $\xrightarrow{\text{"salt"}}$   $\text{NaCl}$ ,  $\text{LiF}$ ,  $\text{CaF}_2$  etc

**Polymers**  $\rightarrow$  (1) poly ethylene terephthalate  $\left( \text{---} \text{CH}_2\text{---CH}_2\text{---C(=O)---C}_6\text{H}_4\text{---C(=O)---} \right)_n$  not APS110.

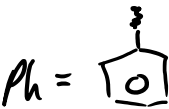
(2) low density poly(ethylene)  $\left( \text{---} \text{CH}_2\text{---CH}_2\text{---} \right)_n$

(3) poly(vinyl chloride)  $\left( \text{---} \text{CH}_2\text{---CHCl---} \right)_n$

(4) high density poly(ethylene)  $\left( \text{---} \text{CH}_2\text{---CH}_2\text{---} \right)_n$

(5) poly(propylene)  $\left( \text{---} \text{CH}_2\text{---CH(CH}_3\text{)---} \right)_n$

(6) poly(styrene)  $\left( \text{---} \text{CH}_2\text{---CH(Ph)---} \right)_n \equiv \left( \text{---} \text{CH}_2\text{---CH(Ph)---} \right)_n$   $n$  - length of polymer



## Chemicals