SECTIONS D01 & D07

Week 4

DR. MIOY T. HUYNH
YALE UNIVERSITY
CHEMISTRY 161
FALL 2018

www.mioy.org/chem161

NEW OFFICE HOURS

DAY	TIME	LOCATION
Thursday	3:00 – 4:20pm	SCL 155
Friday	11:30am – 12:20pm	SCL 155
Sunday	7:00 – 8:00pm	Bass L72

Open-Door Policy: If I'm in my office, you're welcome to come in.

Or by appointment: mioy.huynh@yale.edu

EXAM 1 RESOURCES

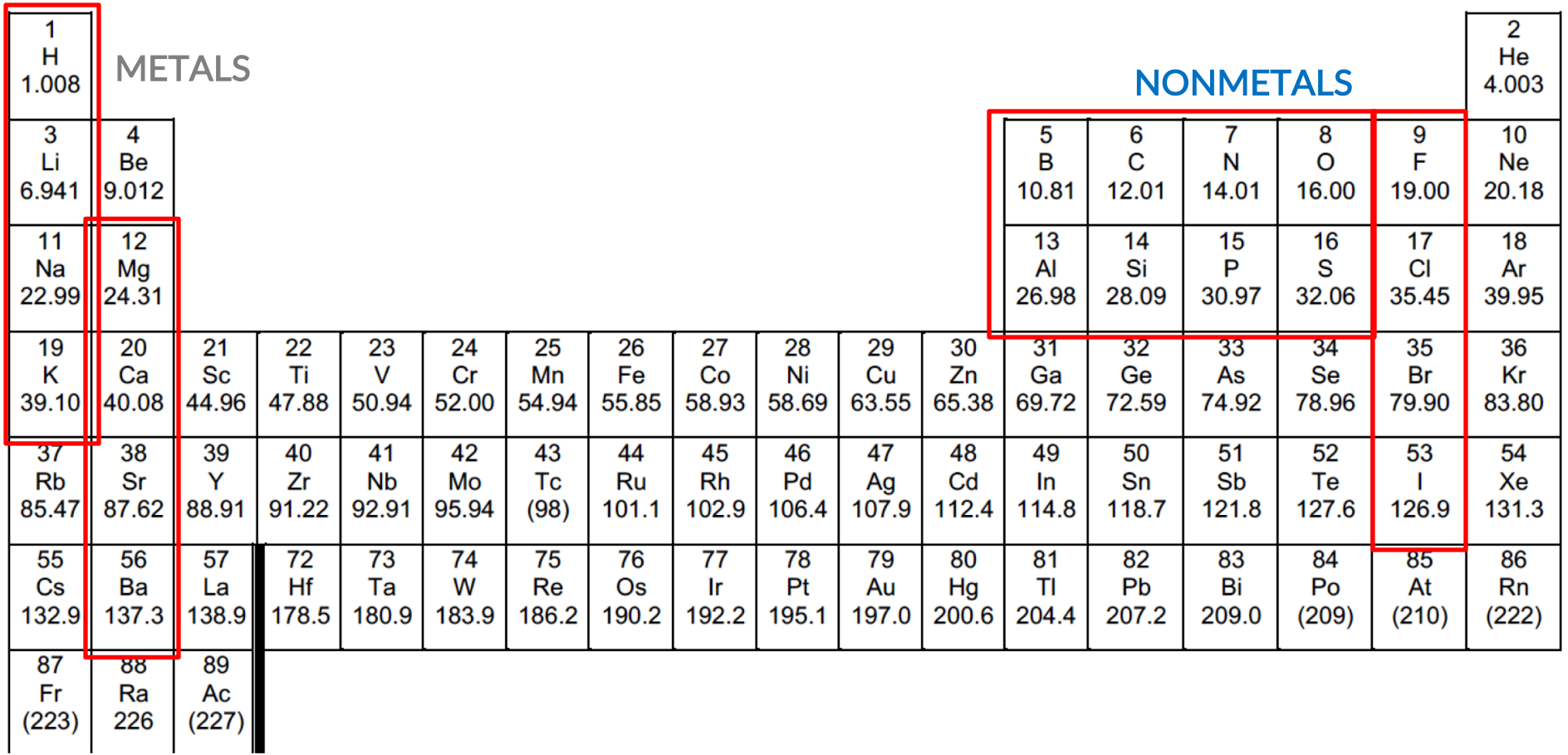
Thanks for taking the survey! REVIEW SESSION TBA

“the worked out problems that you posted were very helpful please keep making them!”
— Thanks! Sure.

“Can you let us know which topics will be heavily featured on the exam?”
— Study guide will be sent out before tomorrow.

“It would be great to get more practice distinguishing homogeneous and heterogeneous mixtures, as well as practice with naming conventions and memorizing where certain elements are on the periodic table (because we will only be given the symbols of the elements).”
— Sure, short tutorial before Thursday.

“make another Practice Exam?”
— Okay, maybe tomorrow or Thursday?


METALS
NONMETALS
1 H 1.008
2 He 4.003
3 Li 6.941
4 Be 9.012
5 B 10.81
6 C 12.01
7 N 14.01
8 O 16.00
9 F 19.00
10 Ne 20.18
11 Na 22.99
12 Mg 24.31
13 Al 26.98
14 Si 28.09
15 P 30.97
16 S 32.06
17 Cl 35.45
18 Ar 39.95
19 K 39.10
20 Ca 40.08
21 Sc 44.96
22 Ti 47.88
23 V 50.94
24 Cr 52.00
25 Mn 54.94
26 Fe 55.85
27 Co 58.93
28 Ni 58.69
29 Cu 63.55
30 Zn 65.38
31 Ga 69.72
32 Ge 72.59
33 As 74.92
34 Se 78.96
35 Br 79.90
36 Kr 83.80
37 Rb 85.47
38 Sr 87.62
39 Y 88.91
40 Zr 91.22
41 Nb 92.91
42 Mo 95.94
43 Tc (98)
44 Ru 101.1
45 Rh 102.9
46 Pd 106.4
47 Ag 107.9
48 Cd 112.4
49 In 114.8
50 Sn 118.7
51 Sb 121.8
52 Te 127.6
53 I 126.9
54 Xe 131.3
55 Cs 132.9
56 Ba 137.3
57 La 138.9
72 Hf 178.5
73 Ta 180.9
74 W 183.9
75 Re 186.2
76 Os 190.2
77 Ir 192.2
78 Pt 195.1
79 Au 197.0
80 Hg 200.6
81 Tl 204.4
82 Pb 207.2
83 Bi 209.0
84 Po (209)
85 At (210)
86 Rn (222)
87 Fr (223)
88 Ra 226
89 Ac (227)

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37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
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TRANSITION METALS

Pb = Plumbum = Plumber = Lead

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”heavy”

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Ag = Argentina = silver

Au = aurum = shiny = gold

Pb = Plumbum = Plumber = Lead

Hg = hydrargyrum = water-silver = Mercury

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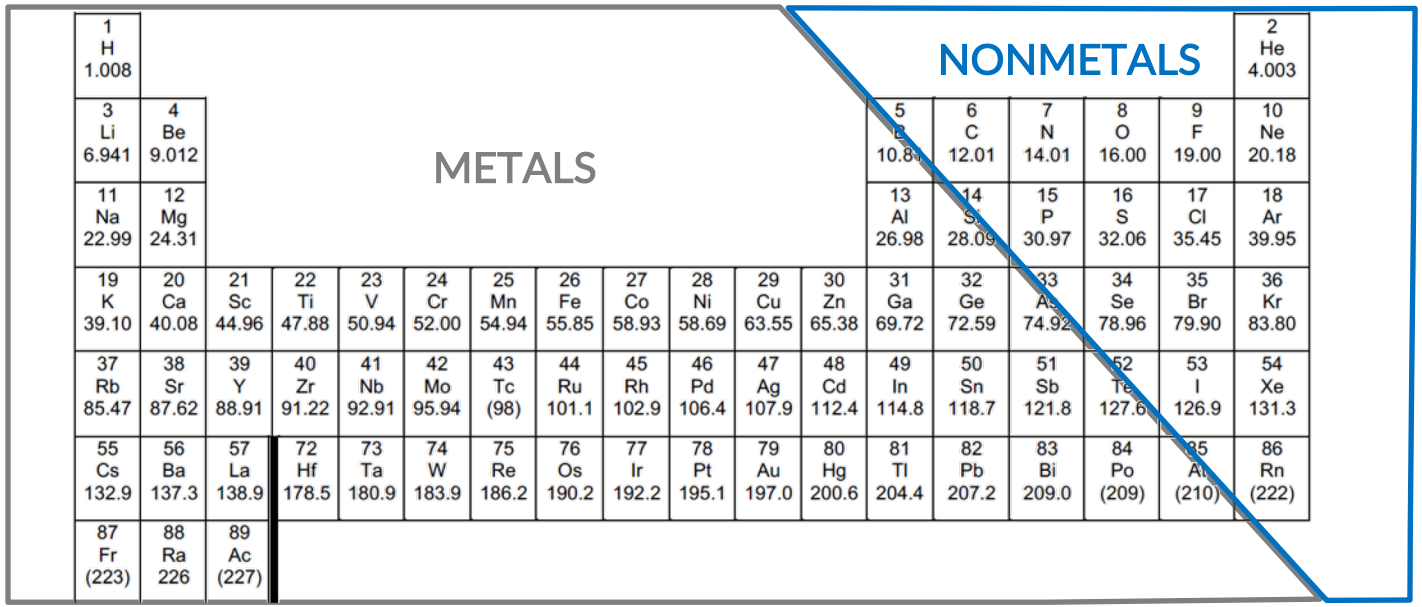
WHAT IS A SALT?

An ionic compound: neutral, METAL + NONMETAL

Be able to *quickly* identify cation and anion for a given salt

→ Helps to know your polyatomics



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Examples)

1. $CuSO_4$ (*aq*) →
2. Fe_2O_3 (*aq*) →
3. Mg_3N_2 (*aq*) →
4. Al_2O_3 (*aq*) →
5. $Co(NO_3)_2$ (*aq*) →
6. Na_3PO_4 (*aq*) →
7. $(NH_4)_2SO_4$ (*aq*) →

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3. $Mg_3N_2\ (aq) \rightarrow$
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2. $Fe_2O_3\ (aq) \rightarrow 2Fe^{3+}\ (aq) + 3O^{2-}\ (aq)$
3. $Mg_3N_2\ (aq) \rightarrow$
4. $Al_2O_3\ (aq) \rightarrow$
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3. $Mg_3N_2\ (aq) \rightarrow 3Mg^{2+}\ (aq) + 2N^{3-}\ (aq)$
4. $Al_2O_3\ (aq) \rightarrow 2Al^{3+}\ (aq) + 3O^{2-}\ (aq)$
5. $Co(NO_3)_2\ (aq) \rightarrow Co^{2+}\ (aq) + 2NO_3^{-}\ (aq)$
6. $Na_3PO_4\ (aq) \rightarrow 3Na^{+}\ (aq) + PO_4^{3-}\ (aq)$
7. $(NH_4)_2SO_4\ (aq) \rightarrow 2NH_4^{+}\ (aq) + SO_4^{2-}\ (aq)$

IS THAT SALT SOLUBLE?

Soluble: Dissolves in water (or *aqueous*) | Soluble salts are called electrolytes.

MEMORIZE THIS SOLUBILITY CHART!

		Exceptions
SOLUBLE	Group 1 cations	
	NH_4^+	
	NO_3^-	
	Halide anions	Ag^+, Hg_2^{2+}, Pb^{2+}
	SO_4^{2-}	Ag^+, Hg_2^{2+}, Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+},

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1. KNO_3 :
2. $PbSO_4$:
3. KOH :
4. $MgSO_4$:
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6. Nickel (II) Hydroxide :
7. Sodium Chloride :
8. Barium Nitrate :
9. Ammonium Bromide :
10. Magnesium Hydroxide :

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9. Ammonium Bromide : *soluble*
10. Magnesium Hydroxide : *insoluble*

PRECIPITATION: DOUBLE EXCHANGE REACTIONS

Mix two salt (aqueous, *aq*) solutions together → a solid/precipitate might form.

Examples)

$NiCl_2$ (*aq*) + $(NH_4)_2SO_4$ (*aq*) →

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Examples)

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	Ni^{2+}	NH_4^+
Cl^-		
SO_4^{2-}		

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	Ni^{2+}	NH_4^+
Cl^-	$NiCl_2$	
SO_4^{2-}		$(NH_4)_2SO4$

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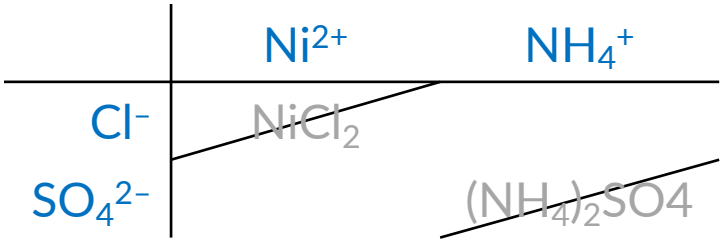

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Cl^-	~~$NiCl_2$~~	NH_4Cl ( )
SO_4^{2-}	$NiSO_4$ ( )	~~$(NH_4)_2SO4$~~

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Cl^-	~~$NiCl_2$~~	$NH_4Cl\ (aq)$
SO_4^{2-}	$NiSO_4\ (aq)$	~~$(NH_4)_2SO4$~~

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Examples)

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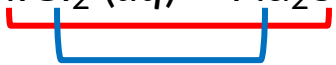

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Examples)

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$NiCl_2\ (aq) + Na_2S\ (aq) \rightarrow NiS\ (s) + NaCl\ (aq)$

	Ni^{2+}	Na^+
Cl^-	~~$NiCl_2$~~	$NaCl\ (aq)$
S^{2-}	$NiS\ (s)$	~~Na_2S~~

PRECIPITATION: DOUBLE EXCHANGE REACTIONS

Mix two salt (aqueous, *aq*) solutions together → a solid/precipitate might form.

Examples)

$NiCl_2$ (*aq*) + $(NH_4)_2SO_4$ (*aq*) → $NiSO_4$ (*aq*) + NH_4Cl (*aq*)

$NiCl_2$ (*aq*) + Na_2S (*aq*) → NiS (*s*) + $NaCl$ (*aq*)

$FeSO_4$ (*aq*) + KOH (*aq*) →

K_2CO_3 (*aq*) + $Ba(NO_3)_2$ (*aq*) →

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MOLECULAR EQUATION

$NiCl_2$ (*aq*) + Na_2S (*aq*) → NiS (*s*) + 2NaCl (*aq*)

Keep everything as neutral molecules.

MOLECULAR EQUATION

$NiCl_2\ (aq) + Na_2S\ (aq) \rightarrow NiS\ (s) + 2NaCl\ (aq)$

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OVERALL IONIC EQUATION

$Ni^+\ (aq) + Cl^-\ (aq) + Na^+\ (aq) + S^{2-}(aq) \rightarrow NiS\ (s) + Na^+\ (aq) + Cl^-\ (aq)$

Break all soluble (aqueous, aq) salts into ions.

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Eliminate spectator ions (ions that appear in reactants and products).

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For each reaction below, write the net ionic equation:

$NiCl_2\ (aq) + (NH_4)_2SO_4\ (aq) \rightarrow NiSO_4\ (aq) + NH_4Cl\ (aq)$

$NiCl_2\ (aq) + Na_2S\ (aq) \rightarrow NiS\ (s) + NaCl\ (aq)$

$Ni^{+}\ (aq) + S^{2-}(aq) \rightarrow NiS\ (s)$

$FeSO_4\ (aq) + KOH\ (aq) \rightarrow Fe(OH)_2\ (s) + K_2SO_4\ (aq)$

$K_2CO_3\ (aq) + Ba(NO_3)_2\ (aq) \rightarrow BaCO_3\ (s) + KNO_3\ (aq)$

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$Fe^{2+}\ (aq) + 2OH^{-}\ (aq) \rightarrow Fe(OH)_2\ (s)$

$K_2CO_3\ (aq) + Ba(NO_3)_2\ (aq) \rightarrow BaCO_3\ (s) + KNO_3\ (aq)$

$Ba^{2+}\ (aq) + CO_3^{2-}\ (aq) \rightarrow BaCO_3\ (s)$

$CaBr_2\ (aq) + KBr\ (aq) \rightarrow CaBr_2\ (aq) + KBr\ (aq)$

NO NET IONIC EQUATION

STRONG ACID + STRONG BASE = NEUTRALIZATION

Same principle as double exchange but makes liquid water:

$HCl\ (aq) + NaOH\ (aq) \rightarrow$

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Same principle as double exchange but makes liquid water:

$HCl\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$

	H^+	Na^+
Cl^-	~~HCl~~	NaCl (*aq*)
OH^-	H_2O (*l*)	~~NaOH~~

MOLARITY: SOLUTION CONCENTRATION

$$\text{Molarity} = \frac{\text{Number of moles}}{\text{Volume (L)}}$$

Units: moles/liter = mol/L = M

REDUCTION-OXIDATION (REDOX) REACTIONS

Oxidation Number:

- Basically like charge

- Pure element has oxidation number of zero (0)
  Ex) N_2, each N is 0
  Ex) Na is 0

- Special cases:
  Peroxide, O_2^{2-} (each O is –1)
  Hydride, H^-

REDUCTION-OXIDATION (REDOX) REACTIONS

Some reaction involve changes in oxidation numbers.

This is usually a gain or loss of an electron (e^-).
Total charge has to balance on left and right.

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LEO = Lose Electron Oxidation

$Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2e^-$

says

GER = Gain Electron Reduction

$Ag^+\ (aq) + e^- \rightarrow Ag\ (s)$

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These are called HALF-REACTIONS because they happen together.

BALANCING REDOX REACTIONS FROM HALF-REACTIONS

LEO = Lose Electron Oxidation $\quad Cu\,(s) \rightarrow Cu^{2+}\,(aq) + 2e^-$

says

GER = Gain Electron Reduction $\quad Ag^+\,(aq) + e^- \rightarrow Ag\,(s)$

Oxidation:				1	$Cu\,(s)$	$\rightarrow$	1	$Cu^{2+}\,(aq)$	+	2 e^-
Reduction:	1	e^-	+	1	$Ag^+\,(aq)$	$\rightarrow$	1	$Ag\,(s)$		
Overall:										

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Oxidation:				1	Cu (*s*)	→	1	Cu^{2+} (*aq*)	+	2 e^-
Reduction:	2	e^-	+	2	Ag^+ (*aq*)	→	2	Ag (*s*)		
Overall:										

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Oxidation:				1	Cu (*s*)	→	1	Cu^{2+} (*aq*)	+	2	e^-
Reduction:	2	e^-	+	2	Ag^+ (*aq*)	→	2	Ag (*s*)			
Overall:	2	Ag^+ (*aq*)	+	1	Cu (*s*)	→	2	Ag (*s*)	+	1	Cu^{2+} (*aq*)

BALANCING REDOX REACTIONS FROM HALF-REACTIONS

Usually, we work backwards though. For example, balance this redox reaction:

$$Fe^{2+}\,(aq) + MnO_4^-\,(aq) \rightarrow Fe^{3+}\,(aq) + Mn^{2+}\,(aq)$$

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Ox

Red

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Ox	1	$Fe^{2+}\ (aq)$	$\rightarrow$	1	$Fe^{3+}\ (aq)$
Red	1	$MnO_4^-\ (aq)$	$\rightarrow$	1	$Mn^{2+}\ (aq)$
Overall					

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Ox				1	$Fe^{2+}\ (aq)$	→	1	$Fe^{3+}\ (aq)$				
Red	8	$H^+\ (aq)$	+	1	$MnO_4^-\ (aq)$	→	1	$Mn^{2+}\ (aq)$	+	4	$H_2O\ (l)$	
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Red	5	e^-	+	8	$H^+\ (aq)$	+	1	$MnO_4^-\ (aq)$	→	1	$Mn^{2+}\ (aq)$	+	4	$H_2O\ (l)$
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6. Balance electrons by multiplying entire half-reactions.

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7. Add the two reactions.

Ox						5	$Fe^{2+}\,(aq)$	$\rightarrow$	5	$Fe^{3+}\,(aq)$	+	5	e^-
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Overall	8	$H^+\,(aq)$	+	1	$MnO_4^-\,(aq)$	+	5	$Fe^{2+}\,(aq)$	→	5	$Fe^{3+}\,(aq)$	+	1	$Mn^{2+}\,(aq)$	+	4	$H_2O\,(l)$					