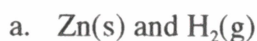Name _____   Block: _____   Date: _____
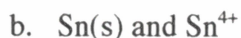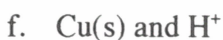
~KEY~
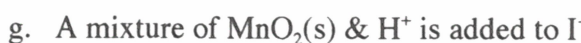
Chemistry 12
SPONTANEOUS & NON-SPONTANEOUS REDOX REACTIONS

Describe each reaction as spontaneous or non-spontaneous.

1. $Au^{3+} + Fe^{3+} \rightarrow Fe^{2+} + Au$ *non-spont (2 ox agents)*

2. $Pb + Fe^{3+} \rightarrow Fe^{2+} + Pb^{2+}$ *spont*

3. $Cl_2 + F^- \rightarrow F_2 + 2Cl^-$ *non-spont*

4. $S_2O_8^{2-} + Pb \rightarrow 2SO_4^{2-} + Pb^{2+}$ *spont*

5. $Cu^{2+} + 2Br^- \rightarrow Cu + Br_2$ *nonspont*

6. $Sn^{2+} + Br_2 \rightarrow Sn^{4+} + 2Br^-$ *spont*

7. $Pb^{2+} + Fe^{2+} \rightarrow Fe^{3+} + Pb$ *non·spont*

8. Which member of each of the following pairs is the **stronger oxidizing agent**?
    a) (Zn²⁺) or Ca²⁺   b) Cr³⁺ or (Cu²⁺)   c) (Br₂) or I₂
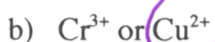
9. Which member of each of the following pairs is the **stronger reducing agent**?
    a) (Mn) or Pb   b) Cu⁺ or (Sn²⁺)   c) (Cr²⁺) or Fe²⁺

10. Predict whether a spontaneous reaction is expected when the following are mixed, and state the product of any spontaneous reactions.

    a. $Zn(s)$ and $H_2(g)$ *no reaction*

    b. $Sn(s)$ and Sn^{4+} *spon: $Sn(s) + Sn^{4+} \rightarrow 2Sn^{2+}$*

    c. H^+ is added to $Mn(s)$ *spon: $2H^+ + Mn \rightarrow H_2 + Mn^{2+}$*

    d. Fe^{2+} is added to $Cr_2O_7^{2-}$ *no rxn (req. H+)*

    e. Fe^{2+} is added to acidic $Cr_2O_7^{2-}$ *spon: $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^+ + 7H_2O + 6Fe^{3+}$*

    f. $Cu(s)$ and H^+ *no rxn*

    g. A mixture of $MnO_2(s)$ & H^+ is added to I^- *spon: $MnO_2 + 4H^+ + 2I \rightarrow Mn^{2+} + 2H_2O + I_2$*

    h. SO_4^{2-} is added to $Sn(s)$ *no rxn (req. H+)*

11. An electrochemical cell was made by joining a half-cell containing 1 M $Pb(NO_3)_2$ and a lead electrode to half cell consisting of 1 M $Zn(NO_3)_2$ and a zinc electrode. As the cell continues to operate, what happens to the $[Pb^{2+}]$? What happens to the $[Zn^{2+}]$?

    rxn must be

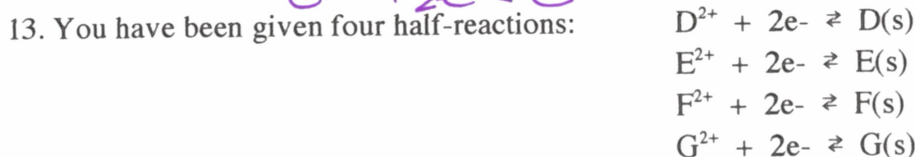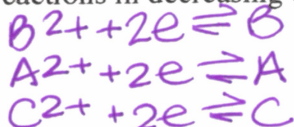 $Pb^{2+} + Zn \rightarrow Pb + Zn^{2+}$

    $[Pb^{2+}]\downarrow$ & $[Zn^{2+}]\uparrow$

12. You have been given three half-reactions:

$$A^{2+} + 2e^- \rightleftarrows A(s)$$
$$B^{2+} + 2e^- \rightleftarrows B(s)$$
$$C^{2+} + 2e^- \rightleftarrows C(s)$$

The reactions are not in any order of tendency to reduce. The following experimental data if found:
A^{2+} reacts with C(s) but not with B(s)

Arrange the half-reactions in decreasing order of tendency to reduce (greatest tendency first).

$$B^{2+} + 2e \rightleftarrows B$$
$$A^{2+} + 2e \rightleftarrows A$$
$$C^{2+} + 2e \rightleftarrows C$$

13. You have been given four half-reactions:

$$D^{2+} + 2e^- \rightleftarrows D(s)$$
$$E^{2+} + 2e^- \rightleftarrows E(s)$$
$$F^{2+} + 2e^- \rightleftarrows F(s)$$
$$G^{2+} + 2e^- \rightleftarrows G(s)$$

Experimentally, it was found that: F^{2+} reacts with D(s), E(s) and G(s)

no reaction occurs between D^{2+} and any of the metals

G^{2+} only reacts with D(s)

Arrange the half-reactions in decreasing strength of oxidizing agents (greatest strength first).

$$F^{2+} > E^{2+} > G^{2+} > D^{2+}$$

14. Determine the oxidation number for the element underlined.

Pb$\underline{S}$O$_4$	6+	$\underline{Cl}$O$_3^-$	5+
H$\underline{P}$O$_3^{2-}$	3+	Na$_2$$\underline{O}_2$	1-
Ca$\underline{H}_2$	1-	Al$_2$($\underline{S}$O$_4$)$_3$	6+
Na$\underline{I}$O$_3$	5+	$\underline{C}_4$H$_{12}$	3-

15. Al^{3+} + Zn $\rightarrow$ Al + Zn^{2+}

Substance oxidized __Zn__   Oxidizing agent __Al^{3+}__

16. $\overset{6+}{Cr_2O_7^{2-}}$ + ClO_2^- $\rightarrow$ Cr^{3+} + ClO_4^-

Substance reduced __$Cr_2O_7^{2-}$__ Oxidizing agent __$Cr_2O_7^{2-}$__

17. O_3 + H_2O + $\overset{4+}{SO_2}$ $\rightarrow$ $\overset{6+}{SO_4^{2-}}$ + O_2 + $2H^+$

Substance oxidized __SO_2__ Reducing agent __SO_2__

18. $3\overset{3+}{As_2O_3}$ + $4\overset{5+}{NO_3^-}$ + $7H_2O$ + $4H^+$ $\rightarrow$ $6\overset{5+}{H_3AsO_4}$ + $4\overset{2+}{NO}$

Substance reduced __NO_3^-__ Reducing agent __As_2O_3__