Chem 105 Exam 3. November 17, 2004
Name Key
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(1)(4 points) Define the following
(a) Arrhenius acid a substance that forms H_3O^+ in water

(b) Arrhenius base a substance that forms OH^- in water

(c) Brønstead-Lowry acid an H^+ donor

(d) Brønstead-Lowry base an H^+ acceptor

(2)(2 points) Name the following acids and bases

(a) $HClO_2$ chlorous acid

(b) NH_3 ammonia

(c) KOH potassium hydroxide

(c) HI hydroiodic acid

(3)(4 points) Write the net acid-base reactions for the following neutralizations

(a) $H_3PO_4(aq) + NaOH(aq)$ ---->

$H_3O^+ + OH^- \rightarrow 2H_2O$

(b) $HF(aq) + Ca(OH)_2(aq)$ ----->

$HF + OH^- \rightarrow H_2O + F^-$

(4)(4 points) Write the molecular, ionic and net ionic equations for the following reactions

(a) $K_2SO_4(aq) + CoCl_2(aq)$ ----> if no reaction write no react NR

(b) $2NaCl(aq) + Pb(NO_3)_2(aq)$ ----> $PbCl_{2(s)} + 2\,NaNO_{3(aq)}$ molecular

$2Na^+_{(aq)} + 2Cl^-_{(aq)} + Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow PbCl_{2(s)} + 2Na^+_{(aq)} + 2NO_3^-{}_{(aq)}$ ionic

$Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)}$ net ionic

(4)(4 points) Complete the following neutralization reactions and balance them for complete neurtralization (all acidic protons neutralized, all basic units neutralized).

(a) $H_3PO_4(aq) + 3NaOH(aq)$ ----> $Na_3PO_4 + 3H_2O$

(b) $2HF(aq) + Ca(OH)_2(aq)$ ----> $2H_2O + CaF_2$

(5)(4 points) A 25.00 mL sample of cola was titrated with 0.100 M NaOH according to the equation below. If it took 16.11 mL of the NaOH to neutralize the cola, what was the concentration of H_3PO_4 in the cola?

$H_3PO_4(aq) + 3\ NaOH(aq) \rightarrow Na_3PO_4(aq) + 3H_2O(l)$

$$\frac{0.100\ \text{moles NaOH}}{L} * 0.01611\ L = 1.611 \times 10^{-3}\ \text{moles NaOH}$$

$$\frac{1.611 \times 10^{-3}\ \text{moles NaOH}}{1} \times \frac{1\ \text{mole } H_3PO_4}{3\ \text{moles NaOH}} = 5.37 \times 10^{-4}\ \text{moles } H_3PO_4$$

$$\frac{5.37 \times 10^{-4}\ \text{moles } H_3PO_4}{0.02500\ L} = 2.15 \times 10^{-2}\ M\ H_3PO_4$$

(6)(2 points) Label the following strong electrolytes, weak electrolytes, or nonelectrolytes

(a) SF_6 nonelectrolyte

(b) HBr strong electrolyte

(c) NaBr strong electrolyte

(d) $CaBr_2$ strong electrolyte

(7)(4 points) List the oxidation state for each element in the following compounds

(a) NH_4Cl NH_4^+ + Cl^-

$N = -3$
$H = +1$
$Cl = -1$

$N + 4(H) = +1$
$N + 4(+1) = +1$
$N = -3$

(b) ~~(b)~~ CaS_2O_3 Ca^{2+} $S_2O_3^{2-}$

$S = +2$
$Ca = +2$
$O = -2$

$2(S) + 3(O) = -2$
$2S + 3(-2) = -2$
$2S = +4$
$S = +2$

(8)(4 points) Break the following reaction into an oxidation and a reduction 1/2 reaction. Show all work and the oxidation states of the species being oxidized and reduced. You don't have to balance the 1/2 reactions.

O^0 O^{2-}

$O_2(g) + Ca(s) \text{ ----> } OH^-(aq) + Ca^{2+}(aq)$

$O_2 \longrightarrow OH^-$ reduction

$Ca \rightarrow Ca^{2+}$ oxidation

(9)(8 points) Balance the following half-reactions in acid

(a) $Mn^{2+}(aq)$ ------> Mn^{+1}

$Mn^{2+} + e^- \rightarrow Mn^{+1}$ balanced

(b) $SO_3^{2-}(aq) \text{-----> } SO_4^{2-}(aq)$

$$SO_3^{2-} \rightarrow SO_4^{2-} + 2e^-$$

$$SO_3^{2-} \rightarrow SO_4^{2-} + 2e^- + 2H^+$$

$$H_2O + SO_3^{2-} \rightarrow SO_4^{2-} + 2e^- + 2H^+$$

(10)(4 points) Balance the following oxidation-reduction reaction in acid

$$Mn^{2+}(aq) + SO_3^{2-}(aq) \text{----> } Mn^{+1}(aq) + SO_4^{2-}(aq)$$

$$2\left(Mn^{2+} + e^- \rightarrow Mn^{+1}\right)$$

$$+ \quad H_2O + SO_3^{2-} \rightarrow SO_4^{2-} + 2e^- + 2H^+$$

$$H_2O + 2Mn^{2+} + SO_3^{2-} + \cancel{2e^-} \rightarrow SO_4^{2-} + \cancel{2e^-} + 2Mn^{+1} + 2H^+$$

$$H_2O + 2Mn^{2+} + SO_3^{2-} \rightarrow SO_4^{2-} + 2Mn^{+1} + 2H^+$$

(11)(4 points) Construct an activity series based on the following experimental results

$Fe^{2+}(aq) + Cu(s) \text{ ----> } NR$ Fe more reactive than Cu

$Li^{+}(aq) + Cu(s) \text{ -----> } NR$ Li more reactive than Cu

$Fe^{2+}(aq) + Li(s) \text{ -----> } Li^{+}(aq) + Fe(s)$ Li more reactive than Fe

$Li^{+} + e^{-} \rightarrow Li$

$Fe^{2+} + 2e^{-} \rightarrow Fe$

$Cu^{+} + e^{-} \rightarrow Cu$

Extra Credit: Name a reagent that you could use to separate the Ca^{2+} and Fe^{2+} from a solution of $Ca(NO_3)_2$ and $Fe(NO_3)_2$ by a precipitation. Write out the precipitation reaction and list which metal will be in the precipitate and which will be left in solution.

OH^{-}

$Ca^{2+} + 2OH^{-} \rightarrow Ca(OH)_{2(aq)}$ Ca^{2+} remains in solution

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