US 110 Exam 2, Wednesday October 21

Name Key

54

By submitting this exam, I certify that I have neither given nor received unauthorized aid on this assignment.

Useful information: c = 3.00 x 10^8m/s, $\lambda\nu$ = c, E=hv, $\lambda = \frac{h}{mv}$, h = 6.626 x 10^{-34} Js, 6.626 x 10^{-34} kgm^2/s, N_A = 6.022 x 10^{23}1/mole

(1) Write the definitions for the following

(a) Arrhenius Acid: produces H^+ in water

(b) Arrhenius Base: produces H_3O^+ in water

(c) Brønstead-Lowry Acid H^+ donor

(d) Brønstead-Lowry Base H^+ acceptor

(2)(4 points) Write the balanced ionic and net ionic equations for the following reactions

(a) 3Ca(ClO4)2(aq) + 2(NH4)3PO4(aq)-------> $Ca_3(PO_4)_2$ (s) + 6NH_4ClO_4

Ca^{2+} ClO_4^-

ionic $3Ca^{2+}_{(aq)} + 6ClO_{4(aq)}^- + 6NH_{4(aq)}^+ + 2PO_4^{3-} \rightarrow Ca_3(PO_4)_{2(s)} + 6NH_{4(aq)}^+ + 6ClO_{4(aq)}^-$

net ionic $3Ca^{2+}_{(aq)} + 2PO_4^{3-} \rightarrow Ca_3(PO_4)_2$ (s)

(b) $2NaOH_{(aq)} + SrCl_{2(aq)} \dashrightarrow 2NaCl_{(aq)} + Sr(OH)_{2(aq)}$ both products soluble

ionic $2Na^{+}_{(aq)} + 2OH^{-}_{(aq)} + Sr^{2+}_{(aq)} + 2Cl^{-}_{(aq)} \rightarrow 2Na^{+}_{(aq)} + 2OH^{-}_{(aq)} + Sr^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$

no net ionic rxn

(3)(2 points) Classify the following as weak electrolytes, strong electrolytes, or nonelectrolytes

(a) HF weak electrolyte

(b) CF_4 non electrolyte

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

(a) $HF_{(aq)} + KOH_{(aq)} \dashrightarrow H_2O_{(l)} + KF_{(aq)}$

(b) $NH_{3(aq)} + H_2SO_4 \dashrightarrow$

$2NH_{3(aq)} + H_2SO_{4(aq)} \rightarrow (NH_4)_2SO_{4(aq)}$

(5)(2 points) Write the ground state electron configurations (ie $1s^2 2s^2 2p^6$...) for the following species. Don't use the noble gas formalism.

(a) S $1s^2 2s^2 2p^6 3s^2 3p^4$

(b) Ti $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$

(6)(4 points) List the oxidation state for each element in the following compounds

(a) PbO_2

$Pb + 2(0) = 0$

$Pb + 2(-2) = 0$

$Pb = +4$

$Pb = +4$

$O = -2$

(b) $Cr_2O_7^{2-}$

$2Cr + 7(0) = -2$

$2Cr + 7(-2) = -2$

$2Cr = +12$

$Cr = +6$

$Cr = +6$

$O = -2$

(8)(8pts) Balance the following half-reactions in base

(a) Cr^{3+} ----> $Cr_2O_7^{2-}$

↓balance Cr

$2Cr^{3+} \rightarrow Cr_2O_7^{2-}$

↓balance ox state

$2Cr^{3+} \rightarrow Cr_2O_7^{2-} + 6e^-$

$6+$ ↓balance total charge $8-$

$14OH^- + 2Cr^{3+} \rightarrow Cr_2O_7^{2-} + 6e^-$

↓balance H

$14OH^- + 2Cr^{3+} \rightarrow Cr_2O_7^{2-} + 6e^- + 7H_2O$

$2Cr^{3+} \rightarrow 2Cr^{6+}$

$2Cr^{3+} \rightarrow 2Cr^{6+} + 6e^-$

(b) PbO_2 ------> PbO

Pb balance

↓balance ox state

$2e^- + PbO_2 \rightarrow PbO$

↓balance charge

$2e^- + PbO_2 \rightarrow PbO + 2OH^-$

↓balance H

$H_2O + 2e^- + PbO_2 \rightarrow PbO + 2OH^-$

$2e^- + Pb^{4+} \rightarrow Pb^{2+}$

(9)(4 pts) Balance the following reaction in base (see the previous question).

$Cr^{3+} + PbO_2 \text{ -------> } Cr_2O_7^{2-} + PbO$

$14OH^- + 2Cr^{3+} \rightarrow Cr_2O_7^{2-} + 6e^- + 7H_2O$

$+ \; 3(H_2O + 2e^- + PbO_2 \rightarrow PbO + 2OH^-)$

$14OH^- + 2Cr^{3+} + 3H_2O + 6e^- + 3PbO_2 \rightarrow Cr_2O_7^{2-} + 6e^- + 7H_2O + 3PbO + 6OH^-$

$8OH^-$

$4H_2O$

$8OH^- + 2Cr^{3+} + 3PbO_2 \rightarrow Cr_2O_7^{2-} + 4H_2O + 3PbO$

A radio station broadcasts at 101.1 MHz (1 MHz = 10^6 1/s). What's

(10)(2 pts) ~~Light with a wavelength of 700 nm appears red. What is the frequency of this light?~~ the wavelength?

$\nu\lambda = c$

$\lambda = \frac{c}{\nu}$

$\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{1.011 \times 10^8 \text{ 1/s}}$

$\lambda = 2.967 \text{ m}$

$101.1 \text{ MHz} \times \frac{10^6 \text{ 1/s}}{1 \text{ MHz}} = 1.011 \times 10^8 \text{ 1/s}$

(11)(4 pts) Put the following atoms in order from smallest to largest:

P, Cs, Cl, Sr, He

He < Cl < P < Sr < Cs

(12) (4 pts) Define the following:

(a) Hund's Rule

in the textbook

(b) The Aufbau Principle

(12)(4 points) Answer the following questions about quantum numbers.

(a) If l=2, how many electrons can the subshell hold?

if $l=2$ $m_l = -2, -1, 0, 1, 2$ 5 orbitals, ∴ 10 electrons

(b) What is the first shell that can have a g subshell and why?

$l=0$ s $l=3$ f $n=5$, because $l = 0 \ldots n-1$, so n must be at
$l=1$ p $l=4$ g
$l=2$ d least 5.

(13)(2 points) Draw a picture of the orbital with the following quantum numbers: n=4, l=1, m_l=0.

4p orbital

(14)(6 points) Using the following reactivity data, construct an activity series for Ru, Au, Al, and Fe.

Strips of each metal were placed in solutions of each metal nitrate. The results for the reactions are shown below in table 1.
Example: $Fe(NO_3)_3$ + Au ---> NR

Table 1. Reactivity results

Salt\metal	**Ru**	**Au**	**Al**	**Fe**
$Ru(NO_3)_3$	NR	NR	Ru + Al^{3+}	Ru + Fe^{3+}
$Au(NO_3)_3$	Au + Ru^{3+}	NR	Au + Al^{3+}	Au + Fe^{3+}
$Al(NO_3)_3$	NR	NR	NR	NR
$Fe(NO_3)_3$	NR	NR	Fe +Al^{3+}	NR

$Al \rightarrow Al^{3+} + 3e^-$

$Fe \rightarrow Fe^{3+} + 3e^-$

$Ru \rightarrow Ru^{3+} + 3e^-$

$Au \rightarrow Au^{3+} + 3e^-$