NAME: _____SECTION #: _____

Chemistry 111 EXAM 2-Fall 2013 10/25/2013/12:00PM/Odago

Fill in your A00 number and name correctly on the scantron. Attempt all the questions and fill in the bubbles with your answers.

Use the speed of light $c = 3.00 \times 10^{8}\ \mathrm{m/s}$, and Planck's constant $h = 6.63 \times 10^{-34}\ \mathrm{J \cdot s}$ where necessary. The periodic table, and the solubility table are attached.

1. What is the percentage by mass of sulfur in copper(I) sulfide, Cu_2S?
   a) 20.1%
   b) 28.4%
   c) 38.4%
   d) 46.7%
   e) 59.4%

2. When solutions of barium chloride and sodium sulfate are mixed, the spectator ions in the resulting reaction are
   a) only Ba^{2+}
   b) only SO_4^{2-}
   c) only Na^{+}
   d) only Cl^{-}
   e) both Na^{+} and Cl^{-}

3. What is the net ionic equation for the neutralization of sulfuric acid with potassium hydroxide?
   a) $H^{+}(aq) + OH^{-}(aq) \rightarrow H_2O(l)$
   b) $2H^{+}(aq) + 2KOH(aq) \rightarrow 2H_2O(l) + 2K^{+}(aq)$
   c) $H_2SO_4(aq) + 2KOH(aq) \rightarrow 2H_2O(l) + K_2SO_4(aq)$
   d) $H_2SO_4(aq) + 2OH^{-}(aq) \rightarrow 2H_2O(l) + SO_4^{2-}(aq)$
   e) $H_2S(aq) + 2KOH(aq) \rightarrow 2H_2O(l) + K_2S(aq)$

4. What is the balanced oxidation half-reaction for the following reaction?
   $Cu^{2+}(aq) + Fe(s) \rightarrow Cu(s) + Fe^{2+}(aq)$
   a) $Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$
   b) $Fe^{2+}(aq) + 2e^{-} \rightarrow Fe(s)$
   c) $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^{-}$
   d) $Cu(s) + 2e^{-} \rightarrow Cu(s)$
   e) $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^{-}$

5. All of the following reactions are described as decomposition reactions <u>except</u>
   a) $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$
   b) $2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$
   c) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
   d) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$
   e) $BaCl_2 \bullet 2H_2O(s) \rightarrow BaCl_2(s) + 2H_2O(g)$

6. In order to prepare a standard 1.00 *M* solution of oxalic acid from $H_2C_2O_4 \cdot 2H_2O$ (127.07 g/mol), 8.260 g of oxalic acid dihydrate should be dissolved in
   a) 65.0 cm^3 of water
   b) 65.0 g of water
   c) 56.740 g of water
   d) enough water to make 65.0 g of solution
   e) enough water to make 65.0 mL of solution

7. The reaction of HCl with NaOH is represented by the equation

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

   What volume of 0.252 *M* HCl is required to titrate 45.1 mL of 0.424 *M* NaOH?
   a) 45.1 mL
   b) 26.8 mL
   c) 4.82 mL
   d) 75.9 mL
   e) 3.97 mL

8. The relationship among the speed, wavelength, and frequency of electromagnetic radiation in vacuum is
   a) $\nu = \frac{c}{\lambda}$
   b) $\nu = \frac{\lambda}{c}$
   c) $c = \nu + \lambda$
   d) $c = \frac{\lambda}{\nu}$
   e) $\lambda = c\nu$

9. What is the wavelength of a photon having a frequency of 3.00×10^{15} Hz?

   ($c = 3.00 \times 10^8$ m/s, $h = 6.63 \times 10^{-34}$ J·s)
   a) 100 nm
   b) 1.99×10^{-9} nm
   c) 0.596 nm
   d) 6.00×10^{-32} nm
   e) 9.99×10^{-3} nm

10. A photon of blue light has a _____ frequency and a _____ wavelength than a photon of red light.
    a) lower, longer
    b) higher, longer
    c) lower, lower
    d) higher, shorter
    e) lower, shorter

11. What is the wavelength of a photon that has an energy of 4.28×10^{-18} J?

($c = 3.00 \times 10^{8}$ m/s, $h = 6.63 \times 10^{-34}$ J • s)

a) 1.28×10^{0} nm
b) 6.46×10^{15} nm
c) 46.4 nm
d) 4.28×10^{-9} nm
e) 1.00×10^{9} nm

12. Which type of electromagnetic radiation has the lowest frequency?

a) ultraviolet
b) infrared
c) microwaves
d) radio waves
e) visible

13. When a hydrogen electron makes a transition from $n = 3$ to $n = 1$, which of the following statements is(are) true?

I. Energy is emitted.
II. Energy is absorbed.
III. The electron loses energy.
IV. The electron gains energy.
V. The electron cannot make this transition.

a) I, IV
b) I, III
c) II, III
d) II, IV
e) V

14. Which quantum number distinguishes the different shapes of the orbitals?

a) n
b) l
c) m_s
d) m_l
e) any of these

15. Which of the following sets of quantum numbers (n, l, m_l, m_s) refers to a 3d orbital?

a) 2 1 0 +½
b) 3 2 2 +½
c) 4 2 -2 +½
d) 4 3 2 +½
e) 5 4 3 +½

16. Which of the following combinations of quantum numbers is permissible?
    a) $n = 3, l = 3, m_l = 1, m_s = -½$
    b) $n = 4, l = 3, m_l = 4, m_s = -½$
    c) $n = 3, l = 2, m_l = 1, m_s = +½$
    d) $n = 1, l = 2, m_l = 0, m_s = -½$
    e) $n = 2, l = 1, m_l = -1, m_s = 0$

17. An orbital with the quantum numbers $n = 5, l = 2, m_l = 2$ may be found in which subshell?
    a) 5s
    b) 5p
    c) 5d
    d) 5f
    e) 5g

18. Which of the following is a representation of a 2p orbital?
    a) 
    b) 
    c) 
    d) 
    e) 

19. Which of the following have 10 electrons in the d orbitals?
    a) Mn
    b) Fe
    c) Cu
    d) Zn
    e) Both Cu and Zn

20. The total number of electrons in p orbitals in a ground-state nickel atom is
    a) 6
    b) 12
    c) 18
    d) 24
    e) 30

21. An element that has the same valence-shell configuration as tin is
    a) antimony
    b) tellurium
    c) indium
    d) selenium
    e) germanium

22. How many unpaired electrons does Fe have in its d orbitals in its ground state electron configuration.
    a) 1 electron
    b) 2 electrons
    c) 3 electrons
    d) 4 electrons
    e) none of these

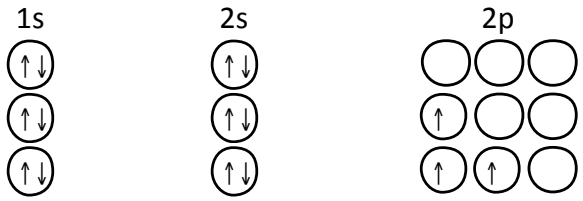
23. Which of the following properties, in general, decreases from left to right across a period in the periodic table?
    a) atomic radius
    b) orbital energy
    c) metallic character
    d) ionic raduis
    e) density

24. What is the ground-state electron configuration of Cr?
    a) $[Ar]3d^4 4s^2$
    b) $[Ar]3d^5 4s^1$
    c) $[Ar]3d^8$
    d) $[Ar]3d^2 4s^2$
    e) $[Ar]3d^4 4s^1$

25. The maximum number of electrons that can be accommodated in an f subshell is
    a) 1
    b) 2
    c) 14
    d) 6
    e) 10

26. All of the following species are isoelectronic except
    a) N^{3-}
    b) F^-
    c) Ne
    d) O^-
    e) Mg^{2+}

27. Which of the following orbital diagrams represent(s) a paramagnetic atom?



a) 1 only
b) 2 only
c) 3 only
d) 1 and 2 only
e) 2 and 3 only

28. The ground-state electron configuration of a Cr^{2+} ion is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$. Therefore, Cr^{2+} is

a) diamagnetic
b) paramagnetic with one unpaired electron
c) paramagnetic with five unpaired electrons
d) paramagnetic with four unpaired electrons
e) paramagnetic with three unpaired electrons

29. A section of the periodic table with all identification features removed is shown below.

V	W	X
	Y	Z

Which element has the smallest atomic radius?

a) V
b) W
c) X
d) Y
e) Z

30. What is the maximum number of electrons that can occupy one p orbital?

a) 1
b) 2
c) 6
d) 10
e) 14

_____ END_____

Solubility Rules

SOLUBLE COMPOUNDS	EXCEPTIONS
Almost all salts of Na^+, K^+, NH_4^+	
Salts of nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Compounds containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Ag^+

INSOLUBLE COMPOUNDS	EXCEPTIONS
Most salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-}	Salts of NH_4^+ and the alkali metal cations Na^+, K^+ are exceptions for all of these
Most metal sulfides, S^{2-}	BaS is soluble
Most metal hydroxides OH^- and oxides O^{2-}	$Ba(OH)_2$ is soluble

all acids are soluble

Strong Acids	Strong Bases
HCl	LiOH
HBr	NaOH
HI	KOH
HNO_3	$Ca(OH)_{2\,(s)}$
$HClO_4$	$Ba(OH)_{2\,(s)}$
H_2SO_4	

Weak Acids	Weak Bases
CH_3COOH	CH_3COO^-
NH_4^+	NH_3
H_2CO_3	CO_3^{2-}
$H_2C_2O_4$	$C_2O_4^{2-}$
H_2SO_3	SO_3^{2-}
H_2S	S^{2-}
H_3PO_4	PO_4^{3-}
HCN	CN^-
HF	F^-
NHO_2	NO_2^-
HClO	ClO^-

Gas Forming Reactions:

$2\,H^+ + CO_3^{2-} \rightarrow H_2O(l) + CO_2(g)$

$2\,H^+ + S^{2-} \rightarrow H_2S(g)$

$2\,H^+ + SO_3^{2-} \rightarrow H_2O(l) + SO_2(g)$

$2\,H^+ + M \rightarrow M^{2+} + H_2(g)$

M = a metal atom

Strong Electrolytes:
Soluble ionic compounds
Strong acids and strong bases

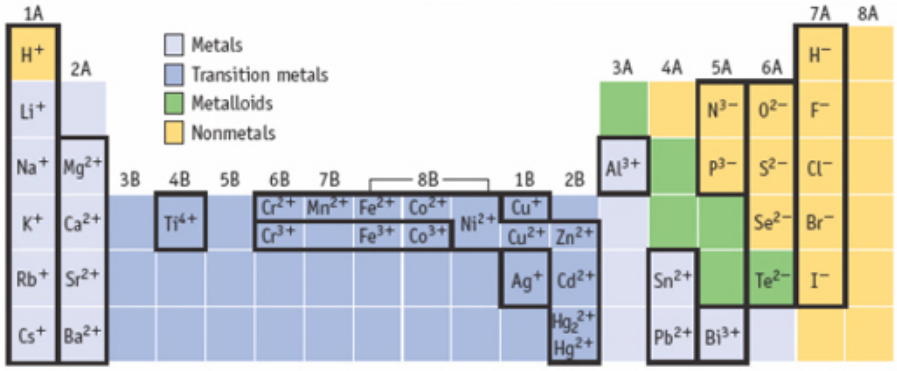


Table 3.1 Formulas and Names of Some Common Polyatomic Ions

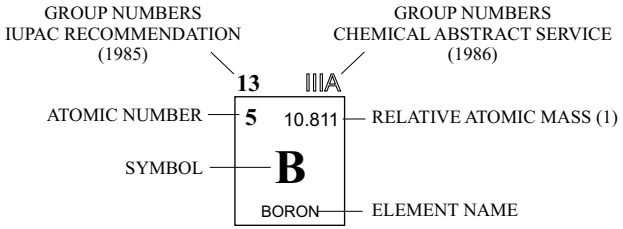
Formula	Name	Formula	Name
CATION: Positive Ion			
NH_4^+	ammonium ion		
ANIONS: Negative Ions			
Based on a Group 4A element		**Based on a Group 7A element**	
CN^-	cyanide ion	ClO^-	hypochlorite ion
$CH_3CO_2^-$	acetate ion	ClO_2^-	chlorite ion
CO_3^{2-}	carbonate ion	ClO_3^-	chlorate ion
HCO_3^-	hydrogen carbonate ion (or bicarbonate ion)	ClO_4^-	perchlorate ion
Based on a Group 5A element		**Based on a transition metal**	
NO_2^-	nitrite ion	CrO_4^{2-}	chromate ion
NO_3^-	nitrate ion	$Cr_2O_7^{2-}$	dichromate ion
PO_4^{3-}	phosphate ion	MnO_4^-	permanganate ion
HPO_4^{2-}	hydrogen phosphate ion		
$H_2PO_4^-$	dihydrogen phosphate ion		
Based on a Group 6A element			
OH^-	hydroxide ion		
SO_3^{2-}	sulfite ion		
SO_4^{2-}	sulfate ion		
HSO_4^-	hydrogen sulfate ion (or bisulfate ion)		

Determining Net Ionic Equations

1. Write out all reactants as they exist in solution
2. Identify acids and bases
   - 2a. If both an acid and a base are present, an acid-base reaction occurs
   - 2b. Be sure to look for hidden bases that are anions in other ionic compounds, such as CO_3^{2-} in $CaCO_3$.
3. Look for ions that will form an insoluble compound. If so, they form a precipitate.
4. Look for one of the known gas-forming reactions.
5. Write out products as they exist in solution.
6. Cancel spectator ions. Note: ions that are "always soluble" will be spectator ions in acid-base or precipitation reactions.

PERIODIC TABLE OF THE ELEMENTS

http://www.ktf-split.hr/periodni/en/



PERIOD	GROUP 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 **H** HYDROGEN																	2 4.0026 **He** HELIUM
2	3 6.941 **Li** LITHIUM	4 9.0122 **Be** BERYLLIUM											5 10.811 **B** BORON	6 12.011 **C** CARBON	7 14.007 **N** NITROGEN	8 15.999 **O** OXYGEN	9 18.998 **F** FLUORINE	10 20.180 **Ne** NEON
3	11 22.990 **Na** SODIUM	12 24.305 **Mg** MAGNESIUM											13 26.982 **Al** ALUMINIUM	14 28.086 **Si** SILICON	15 30.974 **P** PHOSPHORUS	16 32.065 **S** SULPHUR	17 35.453 **Cl** CHLORINE	18 39.948 **Ar** ARGON
4	19 39.098 **K** POTASSIUM	20 40.078 **Ca** CALCIUM	21 44.956 **Sc** SCANDIUM	22 47.867 **Ti** TITANIUM	23 50.942 **V** VANADIUM	24 51.996 **Cr** CHROMIUM	25 54.938 **Mn** MANGANESE	26 55.845 **Fe** IRON	27 58.933 **Co** COBALT	28 58.693 **Ni** NICKEL	29 63.546 **Cu** COPPER	30 65.39 **Zn** ZINC	31 69.723 **Ga** GALLIUM	32 72.64 **Ge** GERMANIUM	33 74.922 **As** ARSENIC	34 78.96 **Se** SELENIUM	35 79.904 **Br** BROMINE	36 83.80 **Kr** KRYPTON
5	37 85.468 **Rb** RUBIDIUM	38 87.62 **Sr** STRONTIUM	39 88.906 **Y** YTTRIUM	40 91.224 **Zr** ZIRCONIUM	41 92.906 **Nb** NIOBIUM	42 95.94 **Mo** MOLYBDENUM	43 (98) **Tc** TECHNETIUM	44 101.07 **Ru** RUTHENIUM	45 102.91 **Rh** RHODIUM	46 106.42 **Pd** PALLADIUM	47 107.87 **Ag** SILVER	48 112.41 **Cd** CADMIUM	49 114.82 **In** INDIUM	50 118.71 **Sn** TIN	51 121.76 **Sb** ANTIMONY	52 127.60 **Te** TELLURIUM	53 126.90 **I** IODINE	54 131.29 **Xe** XENON
6	55 132.91 **Cs** CAESIUM	56 137.33 **Ba** BARIUM	57-71 **La-Lu** Lanthanide	72 178.49 **Hf** HAFNIUM	73 180.95 **Ta** TANTALUM	74 183.84 **W** TUNGSTEN	75 186.21 **Re** RHENIUM	76 190.23 **Os** OSMIUM	77 192.22 **Ir** IRIDIUM	78 195.08 **Pt** PLATINUM	79 196.97 **Au** GOLD	80 200.59 **Hg** MERCURY	81 204.38 **Tl** THALLIUM	82 207.2 **Pb** LEAD	83 208.98 **Bi** BISMUTH	84 (209) **Po** POLONIUM	85 (210) **At** ASTATINE	86 (222) **Rn** RADON
7	87 (223) **Fr** FRANCIUM	88 (226) **Ra** RADIUM	89-103 **Ac-Lr** Actinide	104 (261) **Rf** RUTHERFORDIUM	105 (262) **Db** DUBNIUM	106 (266) **Sg** SEABORGIUM	107 (264) **Bh** BOHRIUM	108 (277) **Hs** HASSIUM	109 (268) **Mt** MEITNERIUM	110 (281) **Uun** UNUNNILIUM	111 (272) **Uuu** UNUNUNIUM	112 (285) **Uub** UNUNBIUM		114 (289) **Uuq** UNUNQUADIUM				

LANTHANIDE

57 138.91 **La** LANTHANUM	58 140.12 **Ce** CERIUM	59 140.91 **Pr** PRASEODYMIUM	60 144.24 **Nd** NEODYMIUM	61 (145) **Pm** PROMETHIUM	62 150.36 **Sm** SAMARIUM	63 151.96 **Eu** EUROPIUM	64 157.25 **Gd** GADOLINIUM	65 158.93 **Tb** TERBIUM	66 162.50 **Dy** DYSPROSIUM	67 164.93 **Ho** HOLMIUM	68 167.26 **Er** ERBIUM	69 168.93 **Tm** THULIUM	70 173.04 **Yb** YTTERBIUM	71 174.97 **Lu** LUTETIUM

ACTINIDE

89 (227) **Ac** ACTINIUM	90 232.04 **Th** THORIUM	91 231.04 **Pa** PROTACTINIUM	92 238.03 **U** URANIUM	93 (237) **Np** NEPTUNIUM	94 (244) **Pu** PLUTONIUM	95 (243) **Am** AMERICIUM	96 (247) **Cm** CURIUM	97 (247) **Bk** BERKELIUM	98 (251) **Cf** CALIFORNIUM	99 (252) **Es** EINSTEINIUM	100 (257) **Fm** FERMIUM	101 (258) **Md** MENDELEVIUM	102 (259) **No** NOBELIUM	103 (262) **Lr** LAWRENCIUM

(1) Pure Appl. Chem., **73**, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

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