

## Chemistry II January 2012 Answer Key

1. E	6. E	11. E	16. D	21. B
2. E	7. E	12. C	17. B	22. D
3. C	8. B	13. A	18. A	23. C
4. B	9. C	14. E	19. D	24. D
5. A	10. D	15. D	20. A	25. B

### CHEMISTRY II

**JANUARY:** matter and measurement, atomic theory(sub-atomic particles, atomic masses), chemical formulas, chemical equations(mole relationships, mass-mass problems), stoichiometry of redox solutions, stoichiometry of molar solutions, electronic structure and periodic table.

**FEBRUARY:** chemical bonding, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization, liquids, solids, vapor pressure, intermolecular forces, phase changes, gases, plus January topics.

**MARCH:** thermochemistry( enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), molecular orbitals, non-metals, metals, solutions, colligative properties, descriptive chemistry of the elements, plus Jan and Feb topics.

**APRIL:** chemical equilibrium, rates of reactions, reaction mechanisms, acids, bases, and salts,  $K_a$ ,  $K_b$ ,  $K_{sp}$ , buffers, coordination compounds, redox, voltaic cells, Nernst equations,  $\Delta S$ ,  $\Delta H$ ,  $\Delta G$ , nuclear chemistry, organic chemistry, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

### TESTING DAYS FOR THE NEW JERSEY SCIENCE LEAGUE 2011 – 2012

**JANUARY TEST: Thursday January 12, 2012**

**FEBRUARY TEST: Thursday February 9, 2012**

**MARCH TEST: Thursday March 8, 2012**

**APRIL TEST: Thursday April 12, 2012**

The April 2012 Exam date may change according to the schools in an area spring break.

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New Jersey Science League  
Chemistry II Exam January 2012

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

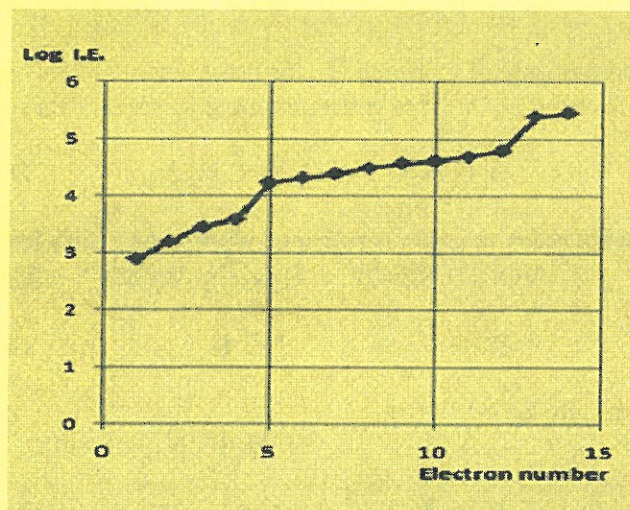
1. Which of the following statements is correct?

- A. The oxidation state of Mn in  $\text{MnO}_4^{2-}$  is +7.
- B. The oxidation state of P in  $\text{P}_2\text{O}_7^{4-}$  is +3.
- C. The oxidation state of Ba in  $\text{BaO}_2$  is +1.
- D. The oxidation state of Cr in  $\text{CrO}_4^{2-}$  is +5.
- E. The oxidation state of O in  $\text{OF}_2$  is +2.

2. 10.0 g of Zn powder is added into a solution of silver nitrate,  $\text{AgNO}_3$ . The total mass of the metallic solid recovered at the end of the reaction is 12.32 g. Assuming that the reaction did not go to completion, how many grams of Zn did react?

- A. 9.0                      B. 8.00                      C. 5.00                      D. 2.00                      E. 1.00

3. The following graph shows the logarithm of successive ionization energies (in kJ/mol) as electrons are removed from the atoms of a particular element.



This particular element belongs to which group of the periodic table?

- A. 2                      B. 3                      C. 14                      D. 16                      E. 18

4. Which of the following atoms has the smallest radius?

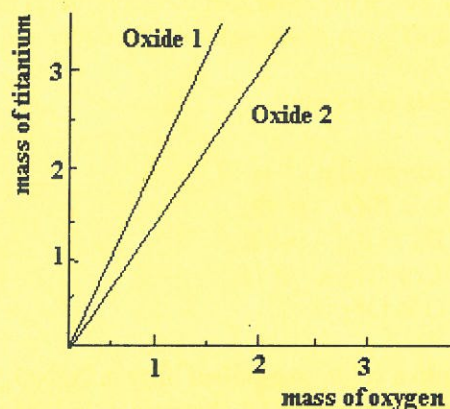
- A. Br                      B. Cl                      C. P                      D. S                      E. Se

5. How many electrons are described by the following quantum set,  $n = 4$ ;  $l = 2$ ;  $m_s = +\frac{1}{2}$ ?

- A. 5                      B. 8                      C. 10                      D. 16                      E. 32



6. A group of researchers did an experiment to determine the mass ratio of titanium to oxygen in two different oxides. Their results are shown below:



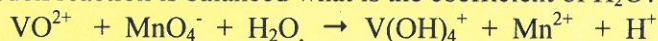
From these results it can be deduced the formulae of the two metal oxides are:

	A.	B.	C.	D.	E.
Oxide 1	TiO	Ti <sub>2</sub> O	Ti <sub>3</sub> O	TiO <sub>2</sub>	Ti <sub>2</sub> O <sub>3</sub>
Oxide 2	Ti <sub>2</sub> O <sub>3</sub>	Ti <sub>3</sub> O	Ti <sub>2</sub> O	TiO <sub>3</sub>	TiO <sub>2</sub>

7. A compound consists only of C, H and N. The combustion of 20.4 mg of this compound releases 44.0 mg of CO<sub>2</sub> and 25.2 mg of H<sub>2</sub>O. What is the empirical formula of this compound?

- A. C<sub>3</sub>H<sub>7</sub>N      B. C<sub>3</sub>H<sub>7</sub>N<sub>2</sub>      C. C<sub>5</sub>H<sub>10</sub>N      D. C<sub>5</sub>H<sub>10</sub>N<sub>2</sub>      E. C<sub>5</sub>H<sub>14</sub>N<sub>2</sub>

8. When the following redox reaction is balanced what is the coefficient of H<sub>2</sub>O?



- A. 20      B. 11      C. 8      D. 5      E. 2

9. Convert 1.2 g/cm<sup>3</sup> into kg/m<sup>3</sup>.

- A. 1.2      B. 0.12      C. 1200      D. 0.012      E. 0.0012

10. Mendeleev's early periodic table was published in 1872. Dmitri Mendeleev named which element "ekasilicon"?

- A. Al      B. Si      C. P      D. Ge      E. Ga

11. Which of the following compounds is NOT correctly named according to IUPAC naming rules?

- |   |  |
|---|--|
| A. KAl(SO <sub>4</sub> ) <sub>2</sub> •12H <sub>2</sub> O         | Potassium aluminum sulfate dodecahydrate |
| B. (NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> | Ammonium dichromate                      |
| C. KSCN   | Potassium thiocyanate                    |
| D. P <sub>4</sub> O <sub>10</sub>                                 | Tetraphosphorus decoxide                 |
| E. K <sub>2</sub> MnO <sub>4</sub>                                | Potassium permanganate                   |



12. A beaker contains 100.0 mL 0.20 M  $\text{AgNO}_3$  solution (colorless). A second beaker contains 200.0 mL 0.15 M  $\text{K}_2\text{CrO}_4$  solution (yellow). These two solutions are mixed in a third beaker and a precipitate is formed. Which of the following set of statements are CORRECT? (Note: solid potassium nitrate is white and solid silver chromate is red-brown).

The color of the supernatant solution

- A. Colorless
- B. Yellow
- C. Yellow
- D. Colorless
- E. Yellow

The color of the precipitate

- Red-Brown
- White
- Red-Brown
- Yellow
- Black

13. Which of the following solutions has the highest concentration of the bromide ion?

- A. 400 mL 0.3 M NaBr
- B. 600 mL 0.2 M NaBr
- C. 400 mL 0.3 M NaBrO
- D. 600 mL 0.3 M  $\text{NaBrO}_2$
- E. 400 mL 0.2 M  $\text{NaBrO}_3$

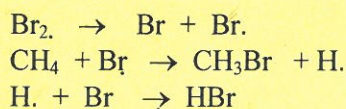
14. The chloride impurity in a 2.00 g sample is determined by precipitating the chloride as silver chloride. If 4.80 mL of 0.250 M  $\text{AgNO}_3$  solution is required, what is the mass percent of chloride in the sample?

- A. 6.25 %
- B. 5.13 %
- C. 4.52 %
- D. 3.17 %
- E. 2.13 %

15. Which of the following transitions is visible to the human eye?

- A.  $n = 6 \rightarrow n = 4$
- B.  $n = 6 \rightarrow n = 1$
- C.  $n = 5 \rightarrow n = 3$
- D.  $n = 4 \rightarrow n = 2$
- E.  $n = 3 \rightarrow n = 1$

16. The organic substitution reactions require the formation of the halogen radical. This is illustrated with the reaction between methane and bromine.



What is the frequency of the visible light that would break the bond between two bromine atoms? Bond energy of  $\text{Br}_2$  is 193 kJ/mol.

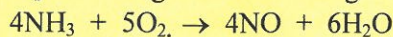
- A.  $7.8 \times 10^{-10} \text{ s}^{-1}$
- B.  $3.6 \times 10^{-15} \text{ s}^{-1}$
- C.  $2.4 \times 10^{-14} \text{ s}^{-1}$
- D.  $4.8 \times 10^{14} \text{ s}^{-1}$
- E.  $2.9 \times 10^{38} \text{ s}^{-1}$

17. Which of the following set of solutions will produce the largest mass of precipitate?

- A. 10 mL 0.1 M  $\text{AgNO}_3$  + 10 mL 0.2 M NaCl
- B. 10 mL 0.1 M  $\text{Pb}(\text{NO}_3)_2$  + 20 mL 0.1 M KI
- C. 10 mL 0.1 M  $\text{AgNO}_3$  + 20 mL 0.2 M NaCl
- D. 10 mL 0.1 M  $\text{AgNO}_3$  + 20 mL 0.1 M NaCl
- E. 10 mL 0.1 M  $\text{Pb}(\text{NO}_3)_2$  + 10 mL 0.1 M KI



18. 1.7 g of  $\text{NH}_3$  reacts with 3.2 g of  $\text{O}_2$  according to the following reaction:



Assuming that the reaction results in 90% yield, what mass of NO will be produced?

- A. 2.2 g    B. 2.4 g    C. 2.7 g    D. 3.0 g    E. 3.3 g

19. You want to determine the density of an irregular solid object. Which of the following is NOT needed in determining the density of the object in a high school lab?

- A. Eye goggles  
B. Balance  
C. Graduated cylinder  
D. A liquid denser than the object  
E. A liquid less dense than the object

20.  $\text{Mg}^{2+}$  ions can be precipitated with aqueous  $(\text{NH}_4)_2\text{HPO}_4$  and positively identified by a magnesium indicator. What is the formula of the precipitate?

- A.  $\text{MgHPO}_4$   
B.  $\text{Mg}_2\text{HPO}_4$   
C.  $\text{Mg}(\text{HPO}_4)_2$   
D.  $\text{Mg}(\text{HPO}_3)_3$   
E.  $\text{Mg}_3(\text{PO}_4)_2$

21. The equation  $\text{Al}^+ (\text{g}) \rightarrow \text{Al}^{2+} (\text{g}) + \text{e}^-$  represents the \_\_\_\_\_ energy of aluminum which \_\_\_\_\_ 1815 kJ/mol.

First blank

Second blank

- |                             |          |
|-----------------------------|----------|
| A. First ionization         | requires |
| B. Second ionization        | requires |
| C. First electron affinity  | requires |
| D. Second electron affinity | releases |
| E. Second ionization        | releases |

22. Which of the following compounds is the *least* soluble in water at 20 °C?

- A.  $\text{Ca}(\text{NO}_3)_2$     B. KI    C.  $\text{KIO}_3$     D.  $\text{MgCO}_3$     E. LiCl

23. 0.250 g of a sample that contains only NaCl (58.5 g/mol) and  $\text{CaCl}_2$  (111 g/mol) yielded 0.633 g of dried AgCl (143.5 g/mol) when reacted with excess silver nitrate solution. Calculate the percent of NaCl in the mixture.

- A. 10.0 %    B. 25.0 %    C. 40.0 %    D. 50.0 %    E. 60.0 %

24. Which of the following equations is NOT an oxidation-reduction reaction?

- A.  $3\text{Cu} (\text{s}) + 8\text{H}^+ (\text{aq}) + 8\text{NO}_3^- (\text{aq}) \rightarrow 3\text{Cu}^{2+} (\text{aq}) + 2\text{NO} (\text{g}) + 4\text{H}_2\text{O} (\text{l})$   
B.  $\text{Cu} (\text{s}) + 2\text{Ag}^+ (\text{aq}) \rightarrow \text{Cu}^{2+} (\text{aq}) + 2\text{Ag} (\text{s})$   
C.  $\text{Zn} (\text{s}) + 2\text{H}^+ (\text{aq}) \rightarrow \text{Zn}^{2+} (\text{aq}) + \text{H}_2 (\text{g})$   
D.  $\text{SiCl}_4 (\text{l}) + 2\text{H}_2\text{O} (\text{l}) \rightarrow 4\text{HCl} (\text{aq}) + \text{SiO}_2 (\text{s})$   
E.  $\text{PbO} (\text{s}) + \text{NH}_3 (\text{g}) \rightarrow \text{N}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) + \text{Pb} (\text{s})$

25. The sides of the Al foil are 10.00 cm and 20.00 cm. The thickness of the foil has  $4.00 \times 10^4$  Al atoms. The diameter of each Al atom is about  $2.50 \times 10^2$  pm. What is the mass of the Al foil? The density of the Al is 2.73 g/cm<sup>3</sup>. Molar mass of Al is 27.0 g/mol.

- A. 0.273 g    B. 0.546 g    C. 2.73 g    D. 5.46 g    E. 0.0546



## CHEMISTRY FORMULAS

<b>GASES, LIQUIDS, SOLUTIONS</b>	$d = \frac{m}{V}$	$P = \text{pressure}$	$R, \text{ Gas constant} = 8.31 \frac{\text{joules}}{\text{mole} \cdot \text{kelvin}}$
$PV = nRT$	$u_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3RT}{M}}$	$V = \text{volume}$	$= 0.0821 \frac{\text{liter} \cdot \text{atm}}{\text{mole} \cdot \text{kelvin}}$
$(P + \frac{n^2a}{V^2})(V - nb) = nRT$	$KE_{\text{per molecule}} = \frac{mv^2}{2}$	$T = \text{Temperature}$	$= 8.31 \frac{\text{volts} \cdot \text{coulombs}}{\text{mole} \cdot \text{kelvin}}$
$P_A = P_{\text{total}} X_A$	$KE_{\text{per mole}} = \frac{3RTn}{2}$	$n = \text{number of moles}$	$Boltzmann's \text{ constant}, k = 1.38 \times 10^{-23} \frac{\text{joule}}{\text{K}}$
$P_{\text{total}} = P_A + P_B + P_C + \dots$	$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$	$d = \text{density}$	$K_f \text{ water} = 1.86 \text{ Kelvin / molal}$
$n = \frac{m}{M}$	$M, \text{ molarity} = \frac{\text{moles solute}}{\text{liter of solution}}$	$m = \text{mass}$	$K_b \text{ water} = 0.512 \text{ Kelvin / molal}$
$\text{Kelvin} = ^\circ\text{C} + 273$	$\text{molality} = \frac{\text{moles of solute}}{\text{kg of solvent}}$	$v = \text{velocity}$	$STP = 0.00^\circ\text{C} \text{ and } 1.00 \text{ atm (101.3 kpa)}$
$P_1V_1 = P_2V_2$	$\Delta T_f = iK_f \cdot \text{molality}$	$\text{where } X_A = \frac{\text{moles A}}{\text{total moles}}$	$1 \text{ faraday } \mathcal{F} = 96,500 \text{ coulombs / mole of electrons}$
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$\Delta T_b = iK_b \cdot \text{molality}$	$u_{rms} = \text{root-mean-square-root}$	
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	$\pi = \frac{nRTi}{V}$	$KE = \text{Kinetic energy}$	
		$r = \text{rate of effusion}$	
		$M = \text{Molar mass}$	
		$\pi = \text{osmotic pressure}$	
		$i = \text{van't Hoff factor}$	
		$K_f = \text{molal freezing point constant}$	
		$K_b = \text{molal boiling point constant}$	
		$Q = \text{reaction quotient}$	
		$I = \text{current in amperes}$	
		$q = \text{charge in coulombs}$	
		$t = \text{time}$	
		$E^\circ = \text{standard reduction potential}$	
		$K = \text{equilibrium constant}$	

## PERIODIC TABLE OF THE ELEMENTS

1 1A	2 2A	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
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 32.07	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 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96
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
55 Cs 132.9	56 Ba 137.3	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4
63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	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)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)
109 Mt (266)	110 (269)	111 (272)	112 (277)	113 (284)	114 (289)	115 (294)	116 (299)
117 (304)	118 (315)	119 (318)	120 (324)	121 (337)	122 (344)	123 (350)	124 (358)
125 (370)	126 (384)	127 (393)	128 (404)	129 (415)	130 (426)	131 (438)	132 (449)
133 (471)	134 (481)	135 (491)	136 (503)	137 (514)	138 (526)	139 (538)	140 (550)
141 (603)	142 (615)	143 (626)	144 (638)	145 (649)	146 (661)	147 (673)	148 (685)
149 (696)	150 (708)	151 (720)	152 (732)	153 (744)	154 (756)	155 (768)	156 (780)
157 (792)	158 (804)	159 (816)	160 (828)	161 (840)	162 (852)	163 (864)	164 (876)
165 (888)	166 (900)	167 (912)	168 (924)	169 (936)	170 (948)	171 (960)	172 (972)
173 (984)	174 (996)	175 (1008)	176 (1020)	177 (1032)	178 (1044)	179 (1056)	180 (1068)
181 (1080)	182 (1092)	183 (1104)	184 (1116)	185 (1128)	186 (1140)	187 (1152)	188 (1164)
189 (1176)	190 (1188)	191 (1200)	192 (1212)	193 (1224)	194 (1236)	195 (1248)	196 (1260)
197 (1272)	198 (1284)	199 (1296)	200 (1308)	201 (1320)	202 (1332)	203 (1344)	204 (1356)
205 (1368)	206 (1380)	207 (1392)	208 (1404)	209 (1416)	210 (1428)	211 (1440)	212 (1452)
213 (1464)	214 (1476)	215 (1488)	216 (1500)	217 (1512)	218 (1524)	219 (1536)	220 (1548)
221 (1560)	222 (1572)	223 (1584)	224 (1596)	225 (1608)	226 (1620)	227 (1632)	228 (1644)
229 (1656)	230 (1668)	231 (1680)	232 (1692)	233 (1704)	234 (1716)	235 (1728)	236 (1740)
237 (1752)	238 (1764)	239 (1776)	240 (1788)	241 (1800)	242 (1812)	243 (1824)	244 (1836)
245 (1848)	246 (1860)	247 (1872)	248 (1884)	249 (1896)	250 (1908)	251 (1920)	252 (1932)
253 (1944)	254 (1956)	255 (1968)	256 (1980)	257 (1992)	258 (2004)	259 (2016)	260 (2028)
261 (2040)	262 (2052)	263 (2064)	264 (2076)	265 (2088)	266 (2100)	267 (2112)	268 (2124)
269 (2136)	270 (2148)	271 (2160)	272 (2172)	273 (2184)	274 (2196)	275 (2208)	276 (2220)
277 (2232)	278 (2244)	279 (2256)	280 (2268)	281 (2280)	282 (2292)	283 (2304)	284 (2316)
285 (2328)	286 (2340)	287 (2352)	288 (2364)	289 (2376)	290 (2388)	291 (2400)	292 (2412)
293 (2424)	294 (2436)	295 (2448)	296 (2460)	297 (2472)	298 (2484)	299 (2496)	300 (2508)
301 (2520)	302 (2532)	303 (2544)	304 (2556)	305 (2568)	306 (2580)	307 (2592)	308 (2604)
309 (2616)	310 (2628)	311 (2640)	312 (2652)	313 (2664)	314 (2676)	315 (2688)	316 (2700)
317 (2712)	318 (2724)	319 (2736)	320 (2748)	321 (2760)	322 (2772)	323 (2784)	324 (2796)
325 (2808)	326 (2820)	327 (2832)	328 (2844)	329 (2856)	330 (2868)	331 (2880)	332 (2892)
333 (2904)	334 (2916)	335 (2928)	336 (2940)	337 (2952)	338 (2964)	339 (2976)	340 (2988)
341 (2992)	342 (3004)	343 (3016)	344 (3028)	345 (3040)	346 (3052)	347 (3064)	348 (3076)
349 (3080)	350 (3092)	351 (3104)	352 (3116)	353 (3128)	354 (3140)	355 (3152)	356 (3164)
357 (3176)	358 (3188)	359 (3200)	360 (3212)	361 (3224)	362 (3236)	363 (3248)	364 (3260)
365 (3272)	366 (3284)	367 (3296)	368 (3308)	369 (3320)	370 (3332)	371 (3344)	372 (3356)
373 (3368)	374 (3380)	375 (3392)	376 (3404)	377 (3416)	378 (3428)	379 (3440)	380 (3452)
381 (3464)	382 (3476)	383 (3488)	384 (3500)	385 (3512)	386 (3524)	387 (3536)	388 (3548)
389 (3560)	390 (3572)	391 (3584)	392 (3596)	393 (3608)	394 (3620)	395 (3632)	396 (3644)
397 (3656)	398 (3668)	399 (3680)	400 (3692)	401 (3704)	402 (3716)	403 (3728)	404 (3740)
405 (3752)	406 (3764)	407 (3776)	408 (3788)	409 (3800)	410 (3812)	411 (3824)	412 (3836)
413 (3848)	414 (3860)	415 (3872)	416 (3884)	417 (3896)	418 (3908)	419 (3920)	420 (3932)
421 (3944)	422 (3956)	423 (3968)	424 (3980)	425 (3992)	426 (4004)	427 (4016)	428 (4028)
429 (4040)	430 (4052)	431 (4064)	432 (4076)	433 (4088)	434 (4100)	435 (4112)	436 (4124)
437 (4136)	438 (4148)	439 (4160)	440 (4172)	441 (4184)	442 (4196)	443 (4208)	444 (4220)
445 (4232)	446 (4244)	447 (4256)	448 (4268)	449 (4280)	450 (4292)	451 (4304)	452 (4316)
453 (4328)	454 (4340)	455 (4352)	456 (4364)	457 (4376)	458 (4388)	459 (4400)	460 (4412)
461 (4424)	462 (4436)	463 (4448)	464 (4460)	465 (4472)	466 (4484)	467 (4496)	468 (4508)
469 (4520)	470 (4532)	471 (4544)	472 (4556)	473 (4568)	474 (4580)	475 (4592)	476 (4604)
477 (4616)	478 (4628)	479 (4640)	480 (4652)	481 (4664)	482 (4676)	483 (4688)	484 (4700)
485 (4712)	486 (4724)	487 (4736)	488 (4748)	489 (4760)	490 (4772)	491 (4784)	492 (4796)
493 (4808)	494 (4820)	495 (4832)	496 (4844)	497 (4856)	498 (4868)	499 (4880)	500 (4892)



# CHEMISTRY FORMULAS 8-20-2012

ATOMIC STRUCTURE	OXIDATION-REDUCTION ELECTROCHEMISTRY
$\Delta E = h \nu$ $c = \nu \lambda$ $\lambda = \frac{h}{m \nu}$ $p = m \nu$ $E_n = \frac{-2.178 \times 10^{-18} \text{ joule}}{n^2}$	$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}$ where $a B + b B \rightleftharpoons c C + d D$ $I = q/t$ $I$ = amperes, $q$ = charge in coulombs, $t$ = time in seconds. $E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT \ln Q}{n\mathfrak{F}} = E_{\text{cell}}^{\circ} - \frac{0.0592 \log Q}{n} @ 25^{\circ}\text{C}$ $\log K = \frac{nE^{\circ}}{0.0592}$ $1 \text{ Faraday } \mathfrak{F} = 96,500 \text{ coulombs/mole}$
$E$ = energy $\nu$ = frequency $\lambda$ = wavelength $p$ = momentum $\nu$ = velocity $n$ = principal quantum number $c$ = speed of light $3.00 \times 10^8 \text{ m/s}$ $h$ = Planck's constant $= 6.63 \times 10^{-34} \text{ Joule s}$ $k$ = Boltzmann's constant $= 1.38 \times 10^{-23} \text{ joule/K}$ Avogador's number $= 6.02 \times 10^{23} \text{ particles/mole}$ $e$ = electron charge $= -1.602 \times 10^{-19} \text{ coulomb}$ $1 \text{ electron volt/atom} = 96.5 \times 10^3 \text{ kJ/mole}$ $1 \text{ Angstrom}(\text{\AA}) = 1 \times 10^{-10} \text{ meters}$	

## EQUILIBRIUM

$$K_w = 1 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$\text{pH} = -\log[\text{H}^+]; \quad \text{pOH} = -\log[\text{OH}^-]$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{pH} = \text{pK}_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

$$\text{pOH} = \text{pK}_b + \log \frac{[\text{HB}^+]}{[\text{B}]}$$

$$\text{pK}_a = -\log K_a, \quad \text{pK}_b = -\log K_b$$

$$K_p = K_c (RT)^{\Delta n}$$

$$\Delta n = \text{moles product gas} - \text{moles reactant gas}$$

## THERMOCHEMISTRY

$$\Delta S^\circ = \sum \Delta S^\circ \text{ products} - \sum \Delta S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H^\circ \text{ products} - \sum \Delta H^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G^\circ \text{ products} - \sum \Delta G^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G^\circ = -RT \ln K = -2.303 RT \log K$$

$$\Delta G^\circ = -n\mathfrak{F}E^\circ$$

$$\Delta G = \Delta G^\circ + RT \ln Q = \Delta G^\circ + 2.303 RT \log Q$$

$$q = m C \Delta T$$

$$C_p = \frac{\Delta H}{\Delta T}$$

$$q = mH_f$$

$$q = mH_v$$

## EQUILIBRIUM TERMS

$K_a$  = weak acid

$K_b$  = weak base

$K_w$  = water

$K_p$  = gas pressure

$K_c$  = molar

concentration

$S^\circ$  = standard entropy

$H^\circ$  = standard enthalpy

$G^\circ$  = standard free energy

$E^\circ$  = standard reduction potential

$T$  = temperature

$q$  = heat

$c$  = specific heat capacity

$C_p$  = molar heat capacity at  
constant pressure

1 faraday  $\mathfrak{F}$  = 96,500  
coulombs/mole

$C_{\text{water}} = \frac{4.18 \text{ joule}}{\text{g K}}$

$H_f = \frac{330 \text{ joules}}{\text{gram}}$  for water

$H_v = \frac{2260 \text{ joules}}{\text{gram}}$  for water

## KINETICS EQUATIONS

$$A_o - A = kt \quad A_o \text{ is initial concentration, amount.}$$

$$\ln \frac{A_o}{A} = kt$$

$$\frac{1}{A} - \frac{1}{A_o} = kt$$

$$\ln (k_2/k_1) = (E_a/R)(1/T_1 - 1/T_2).$$

## METAL ACTIVITY SERIES

Metal	Metal Ion
Lithium	$\text{Li}^{+1}$
Potassium	$\text{K}^{+1}$
Calcium	$\text{Ca}^{+2}$
Sodium	$\text{Na}^{+1}$
Magnesium	$\text{Mg}^{+2}$
Aluminum	$\text{Al}^{+3}$
Manganese	$\text{Mn}^{+2}$
Zinc	$\text{Zn}^{+2}$
Chromium	$\text{Cr}^{+2}, \text{Cr}^{+3}$
Iron	$\text{Fe}^{+2}, \text{Fe}^{+3}$
Lead	$\text{Pb}^{+2}, \text{Pb}^{+4}$
Copper	$\text{Cu}^{+1}, \text{Cu}^{+2}$
Mercury	$\text{Hg}^{+2}$
Silver	$\text{Ag}^{+1}$
Platinum	$\text{Pt}^{+2}$
Gold	$\text{Au}^{+1}, \text{Au}^{+3}$