New Jersey Science League Canary Exam
Chemistry II Exam January 12, 2017 Corrections 15, 16, 17.

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses 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 scantron.

1. Which of the following analytical techniques is **most suitable** in determining the concentration of Ca^{2+} ions in aqueous solutions of $Ca(N0_3)_2aq$? Calcium is a solid which reacts slowly with water. A flame test of calcium ions is red. Calcium ions in aqueous solutions are clear.

A. Visible Spectroscopy
B. Flame Test
C. Paper Chromatography
D. Titration

2. Natural gallium is a mixture of only two stable isotopes. One of the isotopes has 31 protons, 38 neutrons and a relative abundance of 60.11%. If the average atomic mass of gallium is 69.72 amu, how many neutrons must there be in the second isotope?

A. 38 B. 39 C. 40 D. 41

3. Which of the following 10.0 g samples contains the most Ca ions by mass?

A. $CaCO_3$ B. $CaSO_4$ C. $Ca(NO_3)_2$ D. CaC_2O_4

4. Which of the following cations has the smallest ionic radius?

A. Al^{3+} B. Ca^{2+} C. Na^{+} D. Mg^{2+}

5. The following reaction is an example of _____________ reaction.

$$ClO_3^-(aq) \rightarrow ClO_4^-(aq) + Cl^-(aq)$$

A. Ion-exchange
B. Ion-pairing
C. Precipitation
D. Oxidation-Reduction

6. If the correct systematic name of ammonium perchlorate is NH_4ClO_4, then what is the formula of ammonium oxalate ?

A. $NH_4C_2O_3$ B. $(NH_4)_2C_2O_4$ C. $(NH_4)_2C_2O_3$ D. $NH_4C_2H_3O_2$

7. First ionization energies (IE) of some elements are given below:

IE1 of Ne = 2081 kJ/mol
IE1 of Na = 495 kJ/mol
IE1 of Mg = 738 kJ/mol
IE1 of Al = ?
IE1 of Si = 786 kJ/mol

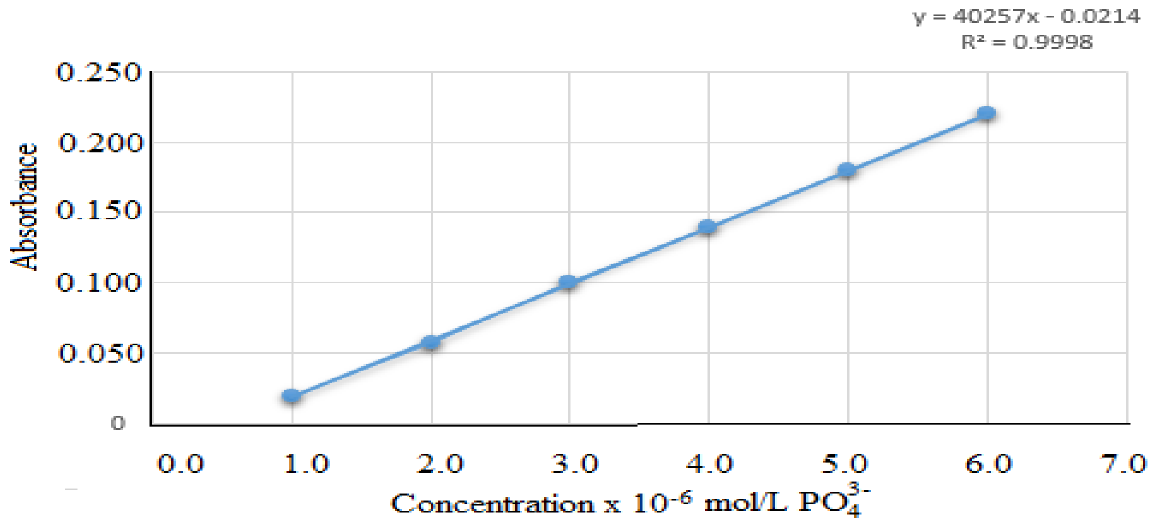
Which of the following can be the first ionization energy of Aluminum?

A. 578 kJ/mol B. 759 kJ/mol C. 498 kJ/mol D. 802 kJ/mol

8. Which of the following pairs of quantities contain the largest difference in mass?

A. 1.0 mol of carbon-13 and 1.0 mol of carbon-12
B. 1.0 mol of copper-63 and 1.0 mol of copper-65
C. 6.02×10^{23} atoms of nitrogen-14 and 3.01×10^{23} atoms of nitrogen-15
D. 10.0 mg of sodium-23 and 10.0 mg of potassium-39

9. A scientist wants to determine the concentration of phosphate in wastewater. She generates a calibration curve represented in the figure below.



The scientist takes 1.00 mL of the sample and dilutes with distilled water in 10.00 mL volumetric flask. Subsequently, she takes 1.00 mL from this latter solution and makes another 100-fold dilution. The final sample has an absorbance of 0.150. What is the concentration of phosphate in the original sample in mg per liter?

A. 117 mg/liter B. 182 mg/liter C. 318 mg/liter D. 409 mg/liter

10. A sample of 1.87 grams of an unknown metal carbonate, M_2CO_3, is strongly heated. The decomposition reaction is represented by the following balanced equation:

$$M_2CO_3(s) \rightarrow M_2O(s) + CO_2(g)$$

If only 1.43 grams of M_2O are produced, what is the identity of the unknown metal?

A. Cu B. Au C. Na D. K

11. Sulfuric acid is prepared by four successive chemical reactions (unbalanced).

$$S_8(s) + O_2(g) \rightarrow SO_2(g)$$
$$SO_2(g) + O_2(g) \rightarrow SO_3(g)$$
$$SO_3(g) + H_2O(g) \rightarrow H_2SO_4(g)$$
$$H_2SO_4(g) \rightarrow H_2SO_4(l)$$

If each of the four reactions has a percent yield of 80%, how many grams of sulfuric acid will be produced from 256 grams of sulfur?

A. 321 B. 784 C. 520 D. 642

12. A compound is made of 10.22% of N, 2.92% of H, 46.72% of O, and the rest is a metal. What is this compound? N = 14; H = 1; O = 16; V = 51; Mn = 55; Cr = 52.

A. ammonium vanadate
B. manganese(II) nitrate
C. ammonium permanganate
D. ammonium dichromate

13. A metal oxide, M_2O_3, gives the following chemical reactions when heated with different reactants.

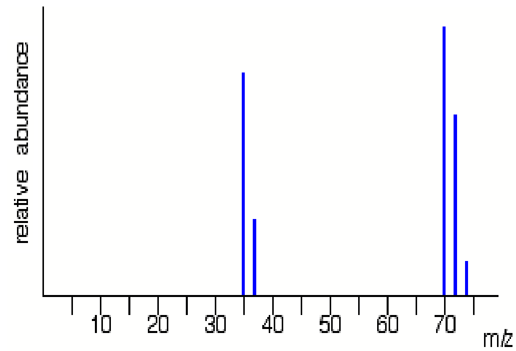
I. $M_2O_3(s) + 3\ CO(g) \rightarrow 2\ M(s) + 3\ CO_2(g)$
II. $M_2O_3(s) + 2\ Al(s) \rightarrow 2\ M(s) + Al_2O_3(s)$
III. $3\ M_2O_3(s) + H_2(g) \rightarrow 2\ M_3O_4(s) + H_2O(l)$
IV. $M_2O_3(s) + ZnO(s) \rightarrow Zn(MO_2)_2(s)$

Which of the above reactions is **not** redox?

A. I B. II and III C. IV D. III and IV

14. The five peaks in the mass spectrum shows that there are 2 isotopes of chlorine atoms with relative isotopic masses of 35 and 37 on the ^{12}C scale. Average atomic mass of the chlorine atoms is 35.45 amu. Which of the following choices is NOT correct for the mass spectrum of the chlorine sample?

A. Chlorine exists in nature as a diatomic molecule.
B. Chlorine-35 is approximately 3 times more abundant than chlorine-37.
C. Peak m/z = 72 caused by Cl_2^+ molecular ions that contain one chlorine-35 and one chlorine-37 atom.
D. Peak m/z = 74 is called the "base peak".



15. Which species can act as a reducing agent but **NOT** as an oxidizing agent? No longer part of the AP Chem curriculum.

A. Br_2 B. Li C. Au^{3+} D. F_2

16. When the following reaction is balanced using the smallest whole-number coefficients, the coefficient of H_2O will be equal to all full credit. Water left out There needs to be some statement about adding water to the equation. Otherwise students and teachers will think this equation is missing water not realizing that water is implied.

$$\_\_\_\ MnO_4^- + \_\_\_\ SO_3^{2-} \rightarrow \_\_\_\ MnO_2 + \_\_\_\ SO_4^{2-}$$

A. 1 B. 2 C. 3 D. 6

17. Consider the following equation:

$$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$$

When 22.8 grams of C_8H_{18} react with 90.0 grams of O_2, what will be the maximum amount of CO_2 produced? No answer is correct. All full credit. An is 70.2 grams.

A. 40.0 grams B. 79.2 grams C. 140. grams D. 160. grams

18. When mixed, which of the following set of solutions will produce the **largest** mass of precipitate?

0.10 *M* of $BaCl_2$	0.20 *M* Na_2SO_4
A. 2.0 mL	1.0 mL
B. 1.0 mL	3.0 mL
C. 2.5 mL	2.0 mL
D. 3.0 mL	1.0 mL

19. In which of the following compounds the nitrogen atoms have the highest oxidation state?

A. NH_3 B. CH_3NH_2 C. HCN D. N_2O

20. The electron configuration of [Ar]$3d^{10}$ belongs to _________ ion.

A. Ni^{2+} B. Fe^{2+} C. Cu^{+} D. Cu^{2+}

21. A compound consists of C, H, and S. Which compounds will be produced during the complete combustion of this compound with stoichiometric amount of O_2?

A. CO and H_2O
B. CO, H_2, and SO_2
C. CO_2, H_2O, and SO_2
D. CO_2, H_2, and SO_2

22. The density of the sugar solutions at various concentrations is tabulated below. A student determined the density of degassed (flat soda) Sprite® to be 1.060 g/mL. What is the sugar content in a 12-oz can of Sprite®. (1 US fluid ounce is 28 mL).

A. 20.0 grams
B. 28.0 grams
C. 50.4 grams
D. 67.2 grams

Density (g/mL)	% by weight (w/v)
0.998	0
1.018	5
1.038	10
1.059	15
1.081	20
1.104	25
1.127	30
1.151	35
1.176	40

23. Which sublevel is being filled in the Actinides series?
A. 5*f* B. 4*f* C. 3*f* D. 4*d*

24. Which of the following electron configurations represents an **<u>excited state</u>** of a potassium atom?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 6s^1$

C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

25. A mixture of gases, X_2 and Y_2, was reacted in a closed container according to the following equation:

$$X_2(g) + Y_2(g) \rightarrow 2\ XY(g)$$

The resulting gas mixture had a molar composition as follows: 30% X_2, 20% Y_2, and 50% XY.
What was the molar composition of X_2 in the initial mixture?

A. 40% B. 50% C. 55% D. 60%

Periodic Table and Chemistry Formulae Final copy 1-20-2017

Periodic Table of the Elements
amu to 4 significant figures

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	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	35 **Br** 79.90	36 **Kr** 83.80
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	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	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 **Ds** (281)	111 **Rg** (272)	112 **Cn** (285)	113 (Uut) (284)	114 **Fl** (289)	115 (Uup) (288)	116 **Lv** (293)	117 (Uus) (294)	118 (Uuo) (294)

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	**Lanthanide Series**
90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)	**Actinide Series**

CHEMISTRY FORMULAS

GASES, LIQUIDS, SOLUTIONS

$PV = nRT$

$\frac{(P + n^2a)(V - nb)}{V^2} = nRT$

$P_A = P_{total} \bullet X_A$

$P_{total} = P_A + P_B + P_C +$

$n = \frac{m}{M}$

Kelvin = °C + 273

$P_1V_1 = P_2V_2$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$d = \frac{m}{V}$

$u_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3RT}{M}}$

$KE_{per\ molecule} = \frac{mv^2}{2}$

$KE_{per\ mole} = \frac{3RT}{2}$

$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

M, molarity = $\frac{\text{moles solute}}{\text{liter of solution}}$

P = pressure
V = volume
T = Temperature
n = number of moles
d = density
m = mass
v = velocity
where $X_A = \frac{\text{moles A}}{\text{total moles}}$
u_{rms} = root-mean-square-root
KE = Kinetic energy
r = rate of effusion
M = Molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing point constant
K_b = molal boiling point constant
Q = reaction quotient
I =current in amperes
q = charge in coulombs
t = time
E^o = standard reduction potential
Keq = equilibrium constant

R, Gas constant = $\frac{8.31 \text{ Joules}}{\text{Mole Kelvin}}$
$= 0.0821 \frac{\text{liter atm}}{\text{mole Kelvin}}$
$= 8.31 \frac{\text{volts coulombs}}{\text{mole Kelvin}}$

Boltzmann's constant,
$k = 1.38 \times 10^{-23} \frac{\text{Joule}}{\text{K}}$

$K_{f\ water}$ = 1.86 Kelvin /molal
$K_{b\ water}$ = 0.512 Kelvin /molal

STP = 0.00 °C, 1.00 atm (101.3 kPa) = 14.7 psi

1 faraday ℑ = 96,500 coulombs/ mole of electrons

°C x 9/5 + 32 = °F
(°F - 32) x 5/9 = °C

ATOMIC STRUCTURE

$\Delta E = h\nu$

$c = \nu\lambda$

$\lambda = \dfrac{h}{m v}$

$p = m v$

$E_n = \dfrac{-2.178 \times 10^{-18}}{n^2}$ joule

E = energy
ν = frequency
λ = wavelength
p = momentum
v = velocity
n = principal quantum number
c = speed of light 3.00×10^{8} m/s
h = Planck's constant = 6.63×10^{-34} Joule s
k = Boltzmann constant = 1.38×10^{-23} joule/K
Avogadro's number = 6.02×10^{23} molecules/mole
e = electron charge = -1.602×10^{-19} coulomb
1 electron volt/atom = 96.5×10^{23} kj/mole

OXIDATION-REDUCTION ELECTROCHEMISTRY

$Q = \dfrac{[C]^c[D]^d}{[A]^a[B]^b}$

where a B + b B $\leftrightarrow$ c C + d D

I = q/t I = amperes, q = charge in coulombs, t = time in seconds.

$E_{cell} = E^o_{cell} - \dfrac{RT}{n\Im}\ln Q = E^o_{cell} - \dfrac{0.0592}{n}\log Q$ @ 25°C

$\log K = \dfrac{nE^o}{0.0592}$

1 Faraday $\Im$ = 96,500 coulombs/mole

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25°C

$pH = -\log[H^+]$; $pOH = -\log[OH^-]$

pH + pOH = 14

$pH = pK_a + \log\dfrac{[A^{-1}]}{[HA]}$

$pOH = pK_b + \log\dfrac{[HB^+]}{[B]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

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

Δn = moles product gas – moles reactant gas

EQUILIBIRUM TERMS

K_a = weak acid
K_b = weak base
K_w = water
K_p = gas pressure
K_c = molar concentration

KINETICS EQUATIONS

$A_o - A = kt$ A_0 is initial concentration, amount.

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

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

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

THERMOCHEMISTRY

$\Delta S^o = \sum\Delta S^o$ products – $\sum\Delta S^o$ reactants

$\Delta H^o = \sum\Delta H^o$ products – $\sum\Delta H^o$ reactants

$\Delta G^o = \sum\Delta G^o$ products – $\sum\Delta G^o$ reactants

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

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

$\Delta G^o = -n\Im E^o$

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

$q = mC\Delta T$

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

$q = mH_f$

$q = mH_v$.

$\Delta U = \Delta H - P\Delta V$

S^o = standard entropy
H^o = standard enthalpy
G^o = standard free energy
E^o = standard reduction potential
T = temperature
q = heat
c = specific heat capacity

C_p = molar heat capacity at constant pressure
1 faraday $\Im$ = 96,500 coulombs/mole

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

Water $H_f = \dfrac{330 \text{ joules}}{\text{gram}}$

Water $H_v = \dfrac{2260 \text{ joules}}{\text{gram}}$

ΔU = change internal energy of a system
ΔH= change in energy of a system
$-P\Delta V$ = work of gases
1liter-atm = 101.325 J

Metal Activity Series

Metal	Metal Ion
Li	Li^{+1}
K	K^{+1}
Ba	Ba^{+2}
Ca	Ca^{+2}
Na	Na^{+1}
Mg	Mg^{+2}
Al	Al^{+3}
Mn	Mn^{+2}
Zn	Zn^{+2}
Cr	Cr^{+3}
Fe	Fe^{+2}
Co	Co^{+2}
Ni	Ni^{+2}
Sn	Sn^{+2}
Pb	Pb^{+2}
H_2	$2\ H^{+1}$
Cu	Cu^{+2}
Ag	Ag^{+1}
Hg	Hg^{+2}
Pt	Pt^{+2}
Au	Au^{+3}

Chemistry II Answer Key <u>Canary test</u>

Date: Jan 12, 2017 Corrections #15 not an ap topic

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

<u>CHEMISTRY 11</u> FOR ALL SECOND YEAR AND AP LEVEL STUDENTS. 25 MULTIPLE CHOICE QUESTIONS PER EXAM.

JANUARY: matter and measurement, atomic theory (sub-atomic particles, atomic masses), <u>spectroscopy (Beer's Law)</u> chemical formulas, chemical equations (precipitation reactions, ionic equations, solubility, acid-base reactions, gas forming reactions, oxidation reduction reactions, balancing redox reactions by oxidation state method, activity series, mole relationships, mass-mass problems¸ stoichiometry of redox solutions, solutions stoichiometry, electronic structure and periodic table/<u>periodicity</u>.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), <u>photon-electron spectroscopy</u>, <u>doping and semiconductors</u>, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), intermolecular forces (van der Waals forces, relations between boiling point and vapor pressure), thermochemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes (not PT diagrams), gases and gas laws, plus January topics.

MARCH: non-metals, metals (not unit cells), solutions, rates of reactions, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, acids, bases, and salts (hydrolysis), K_a, K_b, buffers, solution equilibria, redox, voltaic cells, thermodynamics (ΔS, ΔH, and ΔG) , descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Dates for 2017 Season
Thursday January 12, 2017 Thursday February 9, 2017
Thursday March 9, 2017 Thursday April 13, 2017
All areas, schools must complete the April exam and mail in the results by April 28th, 2017

New Jersey Science League
PO Box 65 Stewartsville, NJ 08886-0065
phone # 908-213-8923 fax # 908-213-9391 email: <u>newjsl@ptd.net</u>
Web address: <u>http://entnet.com/~personal/njscil/html/</u>

What is to be mailed back to our office?

PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS (ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).

If you return scantrons of alternates, then label them as ALTERNATES.

Dates 2018 Season

Thursday January 11, 2018 Thursday February 8, 2018

Thursday March 8, 2018 Thursday April 12, 2018

New Jersey Science League **Canary test**

Chemistry II Exam February 9, 2017 Corrections:

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses 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 scantron.

1. The boiling point of pure water at 1 atm is 100°C. The boiling point of CH_3OH and C_2H_5OH are 66°C and 77°C, respectively. Which statement below is true for these substances?

A. CH_3OH has the lowest vapor pressure
B. H_2O has the lowest vapor pressure
C. H_2O boils lower than 100°C at 1.1 atm
D. They all have the same vapor pressures under the same conditions

2. Which cation is colorless in aqueous solutions?

A. Fe^{2+} B. Fe^{3+} C. Cr^{3+} D. Zn^{2+}

3. Consider the following thermo chemical equations:

$2\,A_2 + B_2 \rightarrow 2\,A_2B$	$\Delta H = -550$ kJ
$C + A_2B \rightarrow 2\,D$	$\Delta H = -100.$ kJ
$A_2 + E + 3\,B_2 \rightarrow 2\,D$	$\Delta H = -350$ kJ

What is the value of ΔH for the following reaction? $2\,E + 5\,B_2 \rightarrow 2\,C$

A. 50. kJ B. -75 kJ C. -50. kJ D. -150 kJ

4. Which of the following species will conduct electricity in either liquid or solid state?

A. NaCl B. Ag C. $C_6H_{12}O_6$ D. I_2

5. A sample of volatile liquid is placed in 125 mL container and volatilized. The vapor exerts a pressure of 2.5 atm at a temperature of 100.0 °C. The mass of the vapor is 1.03 grams. What might be the identity of the volatile liquid?

A. $CH_3COC(CH_3)_3$
B. CH_3CH_2COOH
C. CH_3COCH_3
D. $CH_3CHCHCOOH$

6. Which of the following pairs of species will have largest difference in their photoelectron spectra?

A. Na^+ and Mg^{2+} B. Mg^{2+} and Ne C. K^+ and Na^+ D. Al^{3+} and Mg^{2+}

7. The first compound isolated during the fractional distillation of a mixture containing CH_3OH, C_2H_5OH, $OHCH_2CH_2OH$, and CH_3COOH is

A. CH_3OH B. C_2H_5OH C. $OHCH_2CH_2OH$ D. CH_3COOH

8. The safe level of Pb^{2+} ions in drinking water supplies is established by EPA to be less than 15 ppb. A town located downstream from a car battery manufacturing plant was concerned about lead II ions leaking into the water streams. A chemist analyzed the water sample and determined that a 100-mL sample contains 8.213 nmol of Pb^{2+} ions. What is the concentration of lead in the water sample?

A. 1.70 ppb B. 17.0 ppb C. 170. ppb D. 1700 ppb

9. Calculate the lattice energy of KBr by use of the following thermodynamic data.

Enthalpy of formation of KBr(s)	-394 kJ/mol
Enthalpy of sublimation of K (s)	89 kJ/mol
Ionization energy of K (g)	419 kJ/mol
Enthalpy of dissociation of Br_2 (g)	192 kJ/mol
Electron affinity of Br (g)	-325 kJ/mol
Heat of vaporization of Br_2	30 kJ/mol

A. 688 kJ B. -688 kJ C. 799 kJ D. -799 kJ

10. In the determination of the heat of neutralization of an aqueous HCl with a NaOH solution, all of the following laboratory equipment is required <u>**EXCEPT**</u>

A. Calorimeter
B. Graduated cylinder
C. Thermometer
D. Evaporating dish

11. The strongest type of intermolecular forces in CHF_3 molecule is

A. Hydrogen bonding
B. Dipole-dipole
C. Covalent
D. London dispersion

12. SO_2 will dissolve in water to produce sulfurous acid. During this process, the geometry around the sulfur atom changes from

A. Linear to trigonal planar
B. Bent to trigonal pyramidal
C. Linear to tetrahedral
D. Bent to trigonal planar

13. CO_2 is a nonpolar molecule. The symmetry in the molecule is due to the presence of the two symmetric stretching forces pulling one another in opposite directions. However, the asymmetric stretching vibrational mode can be detected. Photons causing vibrational but not electronic transitions have energies in which region of the electromagnetic spectrum?

A. γ-rays B. X-rays C. UV D. IR

14. Calculate the work involved in the following reaction when 2.70 grams of aluminum react with excess hydrochloric acid to generate hydrogen gas at STP? Al = 27. Work formula in heat formulae at end of the exam.

$$2\ Al(s) + 6\ HCl(aq) \rightarrow 2\ AlCl_3(s) + 3\ H_2(g)$$

A. 340. J B. 170. J C. -170. J D. -340. J

15. What is the nitrate ions concentration when 10.0 mL of 0.50 M calcium nitrate is added to 40.0 mL 0.50 M of ferric nitrate solution?

A. 0.50 M B. 0.70 M C. 1.4 M D. 2.8 M

16. Which of the following would have the lowest heat of vaporization?

A. CH_3CH_2COOH
B. CH_3CH_2OH
C. $OHCH_2CH_2OH$
D. $CH_3CH_2CH_2CH_2CH_3$

17. Copper(II) salt hydrates are used in water of hydration experiments. Moderate heating makes the salt lose its crystal water according to the following equation:

$$CuSO_4\bullet 5H_2O(s) \rightarrow CuSO_4(s) + 5\ H_2O(g)$$

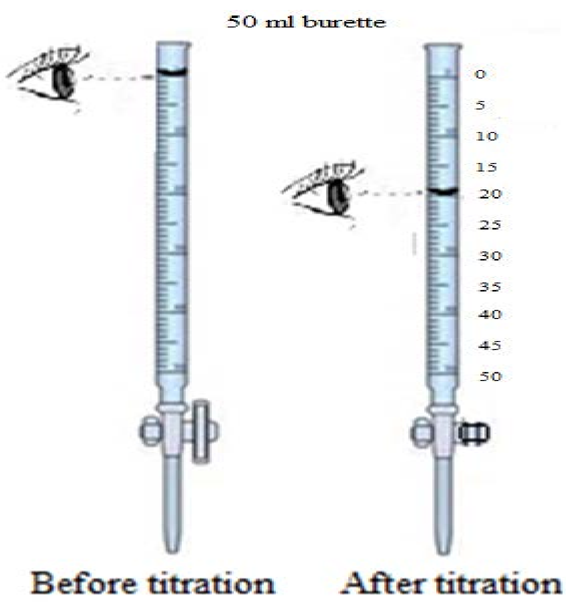
However, excessive heating may decompose the anhydrous salt further and give off toxic fumes according to the equation below:

$$CuSO_4(s) \rightarrow CuO(s) + SO_3(g)$$

If $Cu(NO_3)_2\bullet 3H_2O$ is heated excessively, which of the following gases will be produced in this redox reaction? One of the gases produced has a reddish brown color.

A. H_2O, NO_2 and O_2
B. O_2 and H_2O
C. H_2O only
D. NO_2, and O_2

18. A burette is a piece of laboratory glassware to precisely measure the volume of solution delivered. The figures below show the volumes of the titrant in the burette before and after the titration process. What is the volume of the titrant delivered during the experiment? Markings to 1 ml therefore estimate to nearest 0.1 ml C is correct, not D.



A. 20 mL
B. 20. mL
C. 20.0 mL
D. 20.00 mL

19. Which of the following pairs of entities have the same shape according to the VSEPR model?

A. CO_3^{2-} and NO_3^- B. CO_2 and SO_2 C. NO_3^- and NH_3 D. XeO_3 and SO_3

20. In which of the following pairs is the first species closest in size to the second one? All Full credit. B is actually the best choice. D is not correct. Using periodic trends can only give a best guess, not an absolute answer.

A. Mg^{2+}, Na B. Mg^{2+}, Li^{+} C. Mg^{2+}, Na^{+} D. Mg^{2+}, Li

21. A rigid 1-L container contains Ne gas at 27°C. An **equal mass** of Ar is then introduced to the vessel. The temperature remains constant. What is the value of the new pressure?

A. The pressure will remain unchanged
B. The pressure will double
C. The pressure will be halved
D. The new pressure will be 1.5 times higher

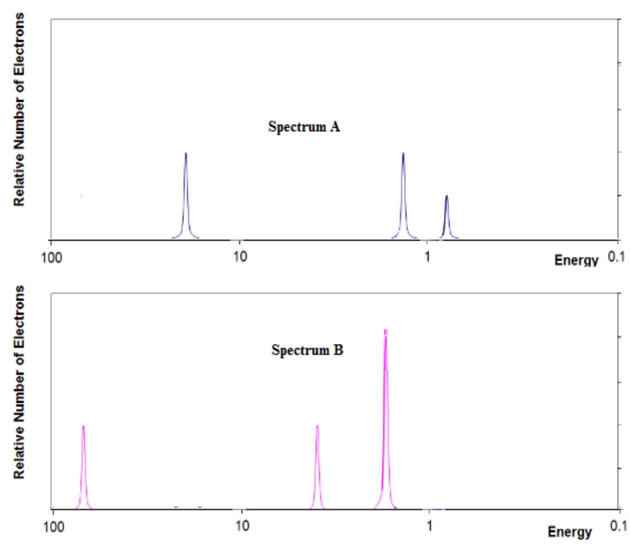
22. A student wanted to identify the presence of the iodide ions in an aqueous sample. The student oxidized the iodide ions to iodine (I_2) using Fe^{3+} ions in acidic solution. Then extracted the iodine, (I_2) using ______________. The student then positively identified the iodine (I_2) by its color in the new phase above the aqueous solution (upper layer) being ________.

A. hexane, yellow
B. mineral oil, yellow
C. hexane, purple
D. mineral oil, orange

23. The Photo Electron Spectra of two different elements are given in the figure below.

Which **one** of the following statements is NOT correct?

A. Both elements belong to second period of the periodic table.
B. Element A has higher ionization energy than element B
C. Element B has higher ionization energy than element A
D. Element B has more electrons on its *p* orbitals



24. Which of the following statements is **correct** for the second period elements of the periodic table?

A. The all have the same effective nuclear charges
B. They all have the same number of core electrons
C. Their atomic size increases from left to right
D. Collectively, they are called alkali earth metals

25. Which compound below would be expected to be the least soluble in water?

A. $CH_3CH_2CH_2CH_2F$
C. CH_3OH

B. $CH_3CH_2NH_2$ D. CH_3COOH

Periodic Table and Chemistry Formulae Final copy 2-17-2017

Periodic Table of the Elements
amu to 4 significant figures

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	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	35 **Br** 79.90	36 **Kr** 83.80
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	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	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 **Ds** (281)	111 **Rg** (272)	112 **Cn** (285)	113 (Uut) (284)	114 **Fl** (289)	115 (Uup) (288)	116 **Lv** (293)	117 (Uus) (294)	118 (Uuo) (294)

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	**Lanthanide Series**
90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)	**Actinide Series**

CHEMISTRY FORMULAS

GASES, LIQUIDS, SOLUTIONS

$PV = nRT$

$\frac{(P + n^2a)(V-nb)}{V^2} = nRT$

$P_A = P_{total} \bullet X_A$

$P_{total} = P_A + P_B + P_C +$

$n = \frac{m}{M}$

Kelvin = °C + 273

$P_1V_1 = P_2V_2$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$d = \frac{m}{V}$

$u_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3RT}{M}}$

$KE_{per\ molecule} = \frac{mv^2}{2}$

$KE_{per\ mole} = \frac{3RT}{2}$

$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

M, molarity = $\frac{\text{moles solute}}{\text{liter of solution}}$

P = pressure
V = volume
T = Temperature
n = number of moles
d = density
m = mass
v = velocity
where $X_A = \frac{\text{moles A}}{\text{total moles}}$
u_{rms} = root-mean-square-root
KE = Kinetic energy
r = rate of effusion
M = Molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing point constant
K_b = molal boiling point constant
Q = reaction quotient
I =current in amperes
q = charge in coulombs
t = time
E^o = standard reduction potential
Keq = equilibrium constant

R, Gas constant = $\frac{8.31 \text{ Joules}}{\text{Mole Kelvin}}$
$= 0.0821 \frac{\text{liter atm}}{\text{mole Kelvin}}$
$= 8.31 \frac{\text{volts coulombs}}{\text{mole Kelvin}}$

Boltzmann's constant,
$k = 1.38 \times 10^{-23} \frac{\text{Joule}}{\text{K}}$

$K_{f\ water}$ = 1.86 Kelvin /molal
$K_{b\ water}$ = 0.512 Kelvin /molal

STP = 0.00 °C, 1.00 atm (101.3 kPa = 760 mm of Hg = 760 Torr)
= 14.7 psi

1 faraday ℑ = 96,500 coulombs/ mole of electrons

°C x 9/5 + 32 = °F
(°F - 32) x 5/9 = °C

ATOMIC STRUCTURE

$\Delta E = h\,\nu$

$c = \nu\,\lambda$

$\lambda = \frac{h}{m\,v}$

$p = m\,v$

$E_n = \frac{-2.178 \times 10^{-18}}{n^2}$ joule

E = energy

ν = frequency

λ = wavelength

p = momentum

v = velocity

n = principal quantum number

c = speed of light 3.00×10^{8} m/s

h = Planck's constant = 6.63×10^{-34} Joule s

k = Boltzmann constant = 1.38×10^{-23} joule/K

Avogadro's number = 6.02×10^{23} molecules/mole

e = electron charge = -1.602×10^{-19} coulomb

1 electron volt/atom = 96.5×10^{23} kj/mole

OXIDATION-REDUCTION ELECTROCHEMISTRY

$Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$

where a B + b B ↔ c C + d D

$I = q/t$ I = amperes, q = charge in coulombs, t = time in seconds.

$E_{cell} = E^o_{cell} - \frac{RT}{n\Im}\ln Q = E^o_{cell} - \frac{0.0592}{n}\log Q$ @ 25°C

$\log K = \frac{nE^o}{0.0592}$

1 Faraday $\Im$ = 96,500 coulombs/mole

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25°C

$pH = -\log[H^+]$; $pOH = -\log[OH^-]$

$pH + pOH = 14$

$pH = pK_a + \log\frac{[A^{-1}]}{[HA]}$

$pOH = pK_b + \log\frac{[HB^+]}{[B]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

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

Δn = moles product gas – moles reactant gas

EQUILIBIRUM TERMS

K_a = weak acid

K_b = weak base

K_w = water

K_p = gas pressure

K_c = molar concentration

KINETICS EQUATIONS

$A_o - A = kt$ A_0 is initial concentration, amount.

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

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

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

THERMOCHEMISTRY

$\Delta S^o = \sum\Delta S^o$ products $- \sum\Delta S^o$ reactants

$\Delta H^o = \sum\Delta H^o$ products $- \sum\Delta H^o$ reactants

$\Delta G^o = \sum\Delta G^o$ products $- \sum\Delta G^o$ reactants

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

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

$\Delta G^o = -n\Im E^o$

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

$q = mC\Delta T$

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

$q = mH_f$

$q = mH_v$.

$\Delta U = \Delta H - P\Delta V$

S^o = standard entropy

H^o = standard enthalpy

G^o = standard free energy

E^o = standard reduction potential

T = temperature

q = heat

c = specific heat capacity

C_p = molar heat capacity at constant pressure

1 faraday $\Im$ = 96,500 coulombs/mole

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

Water $H_f = \frac{330 \text{ joules}}{\text{gram}}$

Water $H_v = \frac{2260 \text{ joules}}{\text{gram}}$

ΔU = change internal energy of a system

ΔH= change in energy of a system

-PΔV = work of gases

1liter-atm = 101.325 J

Metal Activity Series	
Metal	Metal Ion
Li	Li^{+1}
K	K^{+1}
Ba	Ba^{+2}
Ca	Ca^{+2}
Na	Na^{+1}
Mg	Mg^{+2}
Al	Al^{+3}
Mn	Mn^{+2}
Zn	Zn^{+2}
Cr	Cr^{+3}
Fe	Fe^{+2}
Co	Co^{+2}
Ni	Ni^{+2}
Sn	Sn^{+2}
Pb	Pb^{+2}
H_2	$2\ H^{+1}$
Cu	Cu^{+2}
Ag	Ag^{+1}
Hg	Hg^{+2}
Pt	Pt^{+2}
Au	Au^{+3}

Chemistry II Answer Key <u>Canary test</u>

Date: Feb 9, 2017 Corrections

1	**B**	**6**	**C**	**11**	**B**	**16**	**D**	**21**	**D**
2	**D**	**7**	**A**	**12**	**B**	**17**	**A**	**22**	**C**
3	**A**	**8**	**B**	**13**	**D**	**18**	**~~D~~ (C)**	**23**	**B**
4	**B**	**9**	**B**	**14**	**D**	**19**	**A**	**24**	**B**
5	**A**	**10**	**D**	**15**	**C**	**20**	**~~D~~ (all full credit)**	**25**	**A**

<u>CHEMISTRY 11</u> SECOND YEAR AND AP LEVEL STUDENTS. 25 MULTIPLE CHOICE QUESTIONS PER EXAM.

Chemistry Big Ideas:

1. The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reaction.

2. Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.

3. Changes in matter involve the rearrangement and /or reorganization of atoms and/or the transfer of electrons

4. Rates of chemical reactions are determined by details of the molecular collisions.

5. The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.

6. Any bond or intermolecular attraction that can be formed can be broken. There two processes are in dynamic competition, sensitive to initial conditions and external perturbations.

JANUARY: matter and measurement, atomic theory (sub-atomic particles, atomic masses), <u>spectroscopy (Beer's Law)</u> chemical formulas, chemical equations (precipitation reactions, ionic equations, solubility, acid-base reactions, gas forming reactions, oxidation reduction reactions, balancing redox reactions by oxidation state method, activity series, mole relationships, mass-mass problems¸ stoichiometry of redox solutions, solutions stoichiometry, electronic structure and periodic table/<u>periodicity</u>.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), <u>photon-electron spectroscopy</u>, <u>doping and semiconductors</u>, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), intermolecular forces (van der Waals forces, relations between boiling point and vapor pressure), thermochemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes (not PT diagrams), gases and gas laws, plus January topics.

MARCH: non-metals, metals (not unit cells), solutions, rates of reactions, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, acids, bases, and salts (hydrolysis), K_a, K_b, buffers, solution equilibria, redox, voltaic cells, thermodynamics (ΔS, ΔH, and ΔG) , descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Dates for 2017 Season

Thursday January 12, 2017 Thursday February 9, 2017

Thursday March 9, 2017 Thursday April 13, 2017

All areas, schools must complete the April exam and mail in the results by April 28th, 2017

New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

phone # 908-213-8923 fax # 908-213-9391 email: <u>newjsl@ptd.net</u>

Web address: <u>http://entnet.com/~personal/njscil/html/</u>

What is to be mailed back to our office?

PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS (ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).

If you return scantrons of alternates, then label them as ALTERNATES.

Dates 2018 Season

Thursday January 11, 2018 Thursday February 8, 2018
Thursday March 8, 2018 Thursday April 12, 2018

New Jersey Science League Corrections

Chemistry II Exam March 9, 2017 Canary

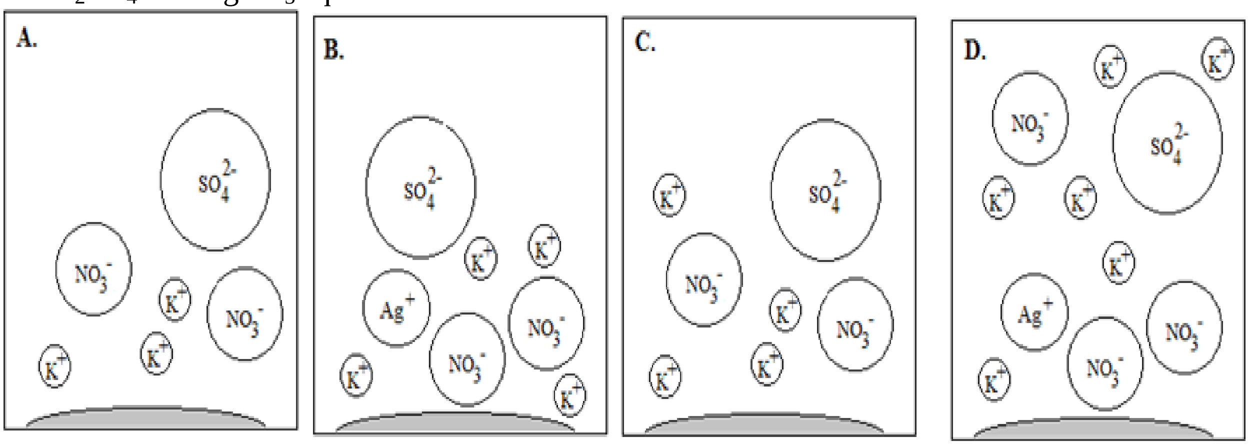
Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which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

1. Which of the following experimental mistakes will NOT introduce any error in the determination of the heat of neutralization of 50.0 mL of 0.10 *M* HCl and 50.0 mL of 0.10 *M* NaOH solutions?

I. Using a thermometer which is calibrated, but reading 1.0^oC for melting point of ice.
II. Using the same graduated cylinder for the acid and the base.
III. Neglecting the heat capacity of the calorimeter.

A. Only I B. Only II C. II and III D. I and III

2. Which one of the following figures below bests represents the reaction between 50.0 mL of each K_2SO_4 and $AgNO_3$ equimolar solutions?



A. A B. B C. C D. D

3. Which of the following elements can be found in nature in its elemental state?

A. Na B. Tc C. Mg D. Au

4. Which is of the following statements is NOT correct for semiconductor materials?

A. Group 15 elements are used as dopants to produce n-type semiconductors, because they have one more electron than the original Group 14 elements.
B. Group 13 elements are used as dopants to produce p-type semiconductors, because they have one less electron than the original Group 14 elements.
C. Band gap structure explains why semiconductors have different electric properties than the metals.
D. the conductivity in pure semiconductors increases as temperature goes down.

5. The rate of decomposition of A is 0.015 mol/L×s. What is the rate of appearance of B?

$$3\ A(g) + C(g) \rightarrow 2\ B(g)$$

A. 0.030 mol/L×s B. 0.0075 mol/L×s C. 0.050 mol/L×s D. 0.010 mol/L×s

6. A compound decomposes by a first-order process. If 87.5% of the compound decomposes in 20.0 minutes, the half-life of the compound is __________.

A) 5.00 minutes B) 6.65 minutes C) 7.50 minutes D) 10.00 minutes

7. Calculate the value of ΔH^o, in kJ, for the following reaction using the listed thermochemical equations:

$$P_4O_{10}(g) + 6\ PCl_5(g) \rightarrow 10\ POCl_3(g)$$

$1/4\ P_4(s) + 3/2\ Cl_2(g) \rightarrow PCl_3(g)$	$\Delta H^o = -300$ kJ
$P_4(s) + 5\ O_2(g) \rightarrow P_4O_{10}(g)$	$\Delta H^o = -3000$ kJ
$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$	$\Delta H^o = -100$ kJ
$PCl_3(g) + ½\ O_2(g) \rightarrow POCl_3(g)$	$\Delta H^o = -200$ kJ

A. -800 kJ B. +400 kJ C. +800 kJ D. -1600 kJ

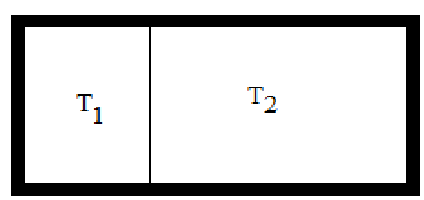
8. Which cation binds to the water molecules the strongest?

A. Cu^{2+} B. Li^+ C. Na^+ D. Zn^{2+}

9. Which of the following processes is **<u>endothermic</u>**?

A. $2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$
B. $Ca(s) + 2\ H_2O(liq) \rightarrow Ca(OH)_2(s) + H_2(gas)$
C. $I_2(s) \rightarrow I_2(g)$
D. $K(g) + ½\ Cl_2(g) \rightarrow KCl(s)$

10. Two gases are interacting thermally through a very thin barrier shown in the figure below. The rigid container is insulated. Which of the following statements is(are) correct?



I. Heat is the energy transferred via collisions between the warmer atoms on one side and cooler atoms on the other.
II. Thermal equilibrium occurs when the systems have the same average transitional kinetic energy and thus the same temperature.

A. Only I B. Only II C. I and II D. Neither I nor II

11. A sample of 0.97-gram sample of ZnS is reacted with 6.0 grams of oxygen and 1.2 grams of carbon according to equation:

$$2\ ZnS(s) + 3\ O_2(g) + 2\ C(s) \rightarrow 2\ Zn(s) + 2\ CO(g) + 2\ SO_2(g)$$

What is the mass of solid remained after the reaction? All full credit. No correct answer.

A. 0.65 g B. 1.3 g C. 6.5 g D. 3.8 g

12. Based on the following data given below, determine the overall order of the reaction between the ferric and iodide ions.

Fe^{3+} (0.10 *M*)	**I^- (0.10 *M*)**	**Starch (2%)**	**DI Water**	**time (seconds)**
4.0 mL	4.0 mL	1 mL	11 mL	22
2.0 mL	4.0 mL	1 mL	13 mL	89
1.0 mL	4.0 mL	1 mL	14 mL	357
4.0 mL	2.0 mL	1 mL	13 mL	43

A. 4 B. 3 C. 2 D. 1

13. Which of the following equations correctly represents the **net ionic** reaction between aqueous solutions of potassium oxalate and iron(III) chloride?

A. $Fe^{+2}(aq) + C_2O_4^{-2}(aq) \rightarrow Fe(C_2O_4)(s)$

B. $2\ Fe^{3+}(aq) + 3\ CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s)$

C. $Fe^{3+}(aq) + C_2O_4^{3-}(aq) \rightarrow FeC_2O_4(s)$

D. $2\ Fe^{3+}(aq) + 3\ C_2O_4^{2-}(aq) \rightarrow Fe_2(C_2O_4)_3(s)$

14. Which of the following has the highest melting point?

A. NaCl B. MgO C. CaO D. KCl

15. The complete combustion of 24 mg of a compound containing C, H, and O only, gave 35.2 mg of CO_2 and 14.4 mg of H_2O. What is the molecular formula of this compound?

A. $C_6H_{12}O_6$ B. $C_5H_{10}O$ C. $C_4H_8O_2$ D. $C_6H_6O_3$

16. What is the hybridization of the central atom in triiodide ion, BF_4^-? All full credit. Key has B

A. sp^2 B. sp^3 C. sp D. s^3p

17. Given the following bond energies, calculate the molar heat of combustion of acetylene, C_2H_2, in kJ/mol?

A. -998 B. +1384
C. -1384 D. +2645

Bond Dissociation Enthalpies (kJ/mol)	
C – H	413
C = O	745
C = C	610
C ≡ C	837
O = O	498
H – O	463
C – C	346

18. Which substance has the strongest forces of attraction between its molecules in their liquid state?

A. H_2S B. SO_3 C. SF_6 D. S_2F_{10}

19. Which of the following species is planar?

A. NH_4^+ B. ClO_3^- C. CO_3^{2-} D. SO_3^{2-}

20. $H^+(aq) + Mn^{2+}(aq) + NaBiO_3(s) \rightarrow H_2O(l) + MnO_4^-(aq) + Bi^{3+}(aq) + Na^+(aq)$
Balance the above reaction using the smallest-whole number coefficients. When balanced what is the coefficient of H^+?

A. 8 B. 10 C. 12 D. 14

21. When the element with electron configuration $1s^2\ 2s^2\ 2p^4$ combines with another element of electron configuration $1s^2\ 2s^2\ 2p^5$, what is the molecular shape of the molecule according to the VSEPR theory?

A. Tetrahedral B. Bent C. trigonal pyramidal D. trigonal planar

22. Which concentration value of a solution varies the most with a change in temperature?

A. Mass Percent B. Molarity C. Mol fraction D. All of these

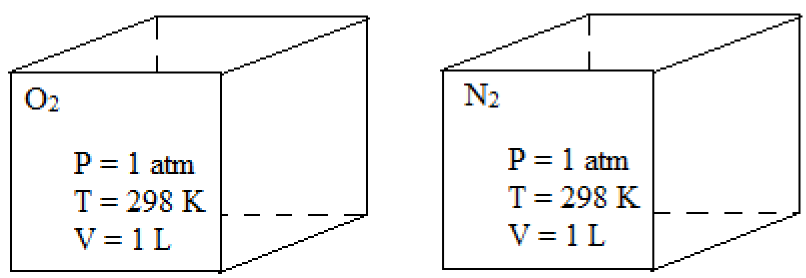
23. A sample of 1.04 grams of $BaCl_2$ dissolved in enough water and titrated with an excess of $AgNO_3$ solution. The precipitate is washed and dried, and weighs 1.11 grams. What is the percent yield of the reaction?

A. 19.3% B. 38.7% C. 77.4% D. 85.0%

24. For a particular reaction the activation energy is +150 kJ/mol and the activation energy of the reverse reaction is + 230 kJ/mol. What is the value of the enthalpy change,ΔH, for the forward reaction?

A. -80 kJ/mol B. +230 kJ/mol C. +80 kJ/mol D. +380 kJ/mol

25. Consider these two gases under the given physical conditions.



Which of the following statements is correct?

A. The number of moles of O_2 is smaller than that of N_2.

B. The average speed of O_2 molecules is higher than the average speed of the N_2 molecules.

C. The average kinetic energy of the N_2 molecules are equal to the average kinetic energy of the O_2 molecules.

D. The mass of the O_2 present in the first container is equal to the mass of the N_2 present in the second container.

Chemistry II Answer Key Canary test Corrections

Chemistry II March 9, 2017 Answer Key

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

CHEMISTRY 11 **FOR ALL SECOND YEAR AND AP LEVEL STUDENTS. 25 MULTIPLE CHOICE QUESTIONS PER EXAM.**

JANUARY: matter and measurement, atomic theory (sub-atomic particles, atomic masses), spectroscopy (Beer's Law) chemical formulas, chemical equations (precipitation reactions, ionic equations, solubility, acid-base reactions, gas forming reactions, oxidation reduction reactions, balancing redox reactions by oxidation state method, activity series, mole relationships, mass-mass problems¸ stoichiometry of redox solutions, solutions stoichiometry, electronic structure and periodic table/periodicity.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), photon-electron spectroscopy, doping and semiconductors, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), intermolecular forces (van der Waals forces, relations between boiling point and vapor pressure), thermochemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes (not PT diagrams), gases and gas laws, plus January topics.

MARCH: non-metals, metals (not unit cells), solutions, rates of reactions, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, acids, bases, and salts (hydrolysis), K_a, K_b, buffers, solution equilibria, redox, voltaic cells, thermodynamics (ΔS, ΔH, and ΔG) , descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Dates for 2017 Season

Thursday March 9, 2017 Thursday April 13, 2017

All areas, schools must complete the April exam and mail in the results by April 28th, 2017

New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

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If you return scantrons of alternates, then label them as ALTERNATES.

Dates 2018 Season

Thursday January 11, 2018 Thursday February 8, 2018

Thursday March 8, 2018 Thursday April 12, 2018

New Jersey Science League **Canary Color Corrections**

Chemistry II Exam April 2017

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses 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 scantron.

1. Which is the best analytical method in separating two water soluble food coloring compounds having different polarities?

A. Column chromatography
B. Gas chromatography
C. Fractional distillation
D. Evaporation

2. Which of the solution will form a buffer upon mixing?

A. 10 mL 0.10 *M* HF + 10 mL 0.10 *M* NaOH
B. 10 mL 0.10 *M* H_2SO_4 + 10 mL 0.10 *M* Na_2SO_4
C. 10 mL 0.10 *M* HCl + 10 ml 0.10 *M* NaCl
D. 20 mL 0.10 *M* CH_3COOH + 15.0 mL 0.10 *M* NaOH

3. At 500 K, 1 mol of Q, 1 mol of R, 1 mol of T, and 1 mol of Z are introduced into a 1-liter rigid container. At this temperature, the equilibrium constant is 4.9×10^3 for

$$2\ Q(g) + R(g) \leftrightarrows 2\ T(g) + Z(g)$$

Which of the following species has the <u>lowest concentration</u> when equilibrium is established at 500 K?

A. Q B. R C. T D. Z

4. Which of the following changes will <u>NOT</u> make the reaction between a sample of solid calcium carbonate and binary acid faster?

A. Use powdered calcium carbonate sample.
B. Use 50.0 mL 0.10 *M* HF instead of 50.0 mL 0.10 *M* HCl.
C. Use 50.0 mL 1.0 *M* HCl solution instead of 50.0 mL 0.10 *M* HCl.
D. Use 25.0 mL of 0.10 *M* HCl at 50°C instead of 25.0 mL of 0.10 *M* HCl at room temperature.

5. Which solution has the best buffering capacity?

A. 10 mL 0.10 *M* HF + 10 mL 0.10 *M* NaF
B. 100 mL 0.010 *M* HF + 100 mL 0.010 *M* NaF
C. 10 mL 1.00 *M* HF + 10 mL 0.10 *M* NaF
D. 10 mL 1.00 *M* CH_3COOH + 5 mL 0.10 *M* CH_3COONa

6. Which types of compounds Mendeleyev experienced with when he studied the arrangement of the elements according to their increasing atomic masses? Should be experimented with. Ans remains the same.

A. oxalates B. oxides C. thiocyanates D. chlorates

7. How many grams of ice at -8.5°C is needed to cool 50.0 grams of water from 40.0°C to 30.0°C. C_{ice}= 2.0 J.g^{-1}.°C^{-1}; C_{water} = 4.2 J.g^{-1}.°C^{-1}; ΔH_{fusion} = 333 J.g^{-1}.

A. 12 g B. 6.0 g C. 18 g D. 4.4 g

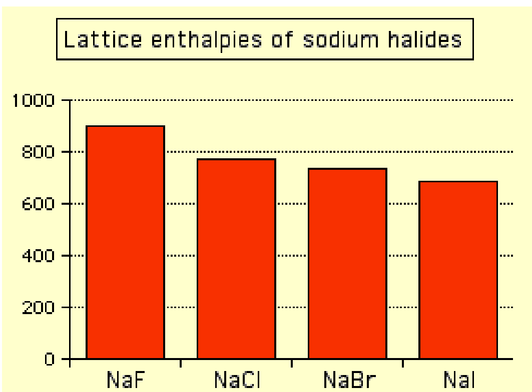
8. The reaction between H_2S and SO_2 is represented by the equation below.

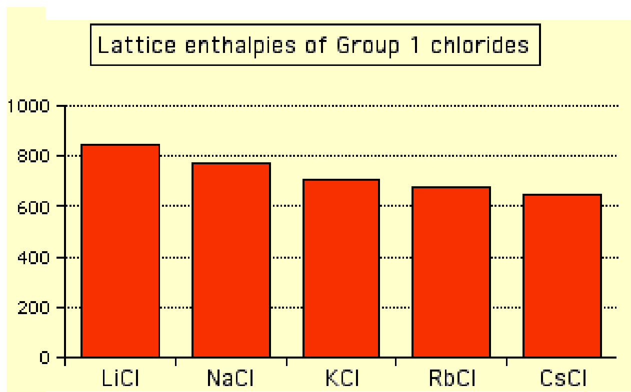
$$SO_2(g) + 2\ H_2S(g) \leftrightarrows 3\ S(s) + 2\ H_2O(g)$$

The initial pressures of SO_2 and H_2S are both equal to 1 atm. The vapor pressure of H_2O is 30. mmHg at 300 K. Determine the value of the equilibrium constant, if the equilibrium total pressure of the system is 870 mmHg at 300 K. Ans is 1.8 x 10^{-5}. All full credit.

A. 1.9×10^{-5} B. 1.9×10^{5} C. 0.28 D. 2.8

9.





Based on the above graphs, it can be deduced that:

A. The lattice energies of the alkali chlorides increase with the increasing size of the alkali cations.
B. The lattice energies of sodium halides increase with the increasing size of the halide anion.
C. The lattice energy of NaF is smaller than that of the NaI
D. The lattice energy of KI is less than 700 kJ/mol.

10. What are the electrolysis products of an aqueous solution of Li_2SO_4?
A. Solid lithium at the anode and sulfur dioxide gas at the cathode
B. Solid lithium at the cathode and oxygen gas at the anode
C. Hydrogen gas at the cathode and oxygen gas at the anode
D. Hydrogen gas at the anode and oxygen gas at the cathode

11. 0.039 gram of $Ca(OH)_2$ is dissolved completely in distilled water to make 1.0-liter solution. What is the pH of the solution?

A. 3.00 B. 3.30 C. 10.70 D. 11.02

12. What is the solubility(Molarity) of $Al(OH)_3$ in pure water? $K_{sp} = 5.4 \times 10^{-38}$

A. 4.8×10^{-10} B. 2.1×10^{-10} C. 1.6×10^{-19} D. 1.6×10^{-10}

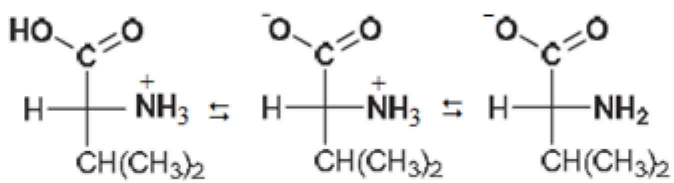
13. $BaSO_4$ is the most soluble in which of the following solutions?

A. 0.010 *M* $Ba(NO_3)_2$
B. 0.010 *M* Na_2SO_4
C. 0.010 *M* $NaHSO_4$
D. 0.010 *M* $Ba(OH)_2$

14. Of the elements 1to18, how many of them have two unpaired electrons?

A. 2 B. 4 C. 6 D. 8

15. Valine, an amino acid, exits in different molecular forms at different pHs. They are represented by the following equation. The pKa values of valine's acidic and basic groups are 2.26 and 9.62, respectively.



Species 1 Species 2 (zwitterion) Species 3

Which form is the major species present at pH = 4.0?

A. Only 1 B. Only 2 C. Only 3 D. Only 1 and 2

16. Which of the following acidic solutions will require the least volume to neutralize 25 mL 0.10 M NaOH solution?

A. 0.10 *M* HCl
B. 0.10 *M* HF
C. 0.20 *M* $HC_2H_3O_2$
D. 0.20 *M* H_2SO_4

17. Which of the following choices is needed to increase the life of a galvanic cell?

A. A larger anode
B. A larger cathode
C. Highly concentrated anodic compartment solution
D. Less concentrated cathodic compartment solution

18. The addition of a catalyst will have which of the following effects on a chemical reaction?

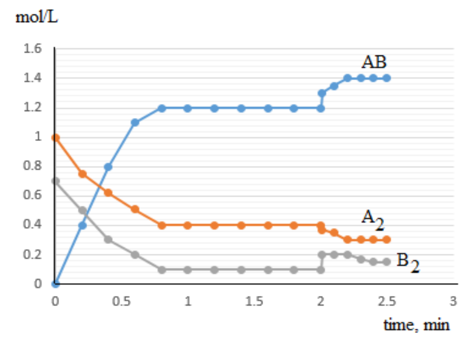
I. The enthalpy change will decrease
II. The entropy change will decrease
III. the activation energy will decrease.

A. I only B. II only C. III only D. I, II, and III

19. The rate law of a chemical reaction is Rate = $k\,[A]^3[B]^2$. What is the unit of the rate constant?

A. $mol^4 \times L^{-4} \times s^4$ B. $mol^{-4} \times L^{-4} \times s^{-1}$ C. $mol^4 \times L^{-4} \times s^{-1}$ D. $mol^{-4} \times L^4 \times s^{-1}$

20. The equation for the endothermic reaction in the figure is $A_2(g) + B_2(g) \leftrightarrows 2\ AB(g)$.



At time 2 min, what change was imposed?

A. The pressure was increased.
B. The temperature was increased.
C. A_2 gas was added to the system at equilibrium.
D. B_2 gas was added to the system at equilibrium.

21. Consider the following reaction:

$$2\ Al(s) + 3\ Cu^{2+}(aq) \rightarrow 3\ Cu(s) + 2\ Al^{3+}(aq)$$

The reduction potentials are given: $E^o_{Cu^{2+}/Cu} = +0.36$ V and $E^o_{Al^{3+}/Al} = -1.66$ V. Which of the following statements is <u>correct</u>?

A. The standard cell potential is -1.30 V.
B. Cu is the anode.
C. When calculating the standard cell potential, the coefficients are not taken into account.
D. At equilibrium, the cell voltage is +1.30 V.

22. The compound A partially decomposes according to the following equilibrium:

$$2\ A(g) \leftrightarrows B(g)$$

A 10.00-L flask is charged with 0.250 mol of A. When equilibrium is reached at 1000 K, 0.0250 mol of A remains. What is the value of the equilibrium constant for this reaction?

A. 1.80×10^2 B. 1.80×10^{-2} C. 1.80×10^3 D. 18.0

23. Which of the following is the strongest acid?

A. HClO B. HIO_2 C. $HBrO_3$ D. HCN

24. Which of the following conjugate bases is the strongest in aqueous solutions at 25°C?

A. CN^- pK_a of HCN = 9.4
B. $C_2H_5O^-$ pK_a of C_2H_5OH = 25
C. OH^- pK_a of H_2O = 15.7
D. F^- pK_a of HF = 4.0

25. Consider the system in equilibrium $2\ SO_2(g) + O_2(g) \leftrightarrows 2\ SO_3(g)$ $\Delta H = -198$ kJ

Which of the following changes will increase the quantity of SO_3?

A. Introducing a catalyst
B. Increasing the pressure of the system
C. Increasing the temperature of the system
D. Adding He to the system

Periodic Table and Chemistry Formulae Final copy 2-17-2017

Periodic Table of the Elements
amu to 4 significant figures

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	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	35 **Br** 79.90	36 **Kr** 83.80
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	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	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 **Ds** (281)	111 **Rg** (272)	112 **Cn** (285)	113 (Uut) (284)	114 **Fl** (289)	115 (Uup) (288)	116 **Lv** (293)	117 (Uus) (294)	118 (Uuo) (294)

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	**Lanthanide Series**
90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)	**Actinide Series**

CHEMISTRY FORMULAS

GASES, LIQUIDS, SOLUTIONS

PV = nRT

$$\frac{(P + n^2a)(V-nb)}{V^2} = nRT$$

$$P_A = P_{total} \bullet X_A$$

$$P_{total} = P_A + P_B + P_C +$$

$$n = \frac{m}{M}$$

Kelvin = °C + 273

$$P_1V_1 = P_2V_2$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$d = \frac{m}{V}$$

$$u_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3RT}{M}}$$

$$KE_{per\ molecule} = \frac{mv^2}{2}$$

$$KE_{per\ mole} = \frac{3RT}{2}$$

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

M, molarity = $\frac{\text{moles solute}}{\text{liter of solution}}$

P = pressure
V = volume
T = Temperature
n = number of moles
d = density
m = mass
v = velocity
where $X_A = \frac{\text{moles A}}{\text{total moles}}$
u_{rms} = root-mean-square-root
KE = Kinetic energy
r = rate of effusion
M = Molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing point constant
K_b = molal boiling point constant
Q = reaction quotient
I =current in amperes
q = charge in coulombs
t = time
E^o = standard reduction potential
Keq = equilibrium constant

R, Gas constant = $\frac{8.31 \text{ Joules}}{\text{Mole Kelvin}}$
= $\frac{0.0821 \text{ liter atm}}{\text{mole Kelvin}}$
= $\frac{8.31 \text{ volts coulombs}}{\text{mole Kelvin}}$

Boltzmann's constant,
$k = 1.38 \times 10^{-23} \frac{\text{Joule}}{\text{K}}$

$K_{f\ water}$ = 1.86 Kelvin /molal
$K_{b\ water}$ = 0.512 Kelvin /molal

STP = 0.00 °C, 1.00 atm (101.3 kPa = 760 mm of Hg = 760 Torr)
= 14.7 psi

1 faraday ℑ = 96,500 coulombs/ mole of electrons

°C x 9/5 + 32 = °F
(°F - 32) x 5/9 = °C

ATOMIC STRUCTURE

$\Delta E = h\nu$

$c = \nu\lambda$

$\lambda = \dfrac{h}{mv}$

$p = mv$

$E_n = \dfrac{-2.178 \times 10^{-18}}{n^2}$ joule

E = energy
ν = frequency
λ = wavelength
p = momentum
v = velocity
n = principal quantum number
c = speed of light 3.00×10^8 m/s
h = Planck's constant = 6.63×10^{-34} Joule s
k = Boltzmann constant = 1.38×10^{-23} joule/K
Avogadro's number = 6.02×10^{23} molecules/mole
e = electron charge = -1.602×10^{-19} coulomb
1 electron volt/atom = 96.5×10^{23} kj/mole

OXIDATION-REDUCTION ELECTROCHEMISTRY

$Q = \dfrac{[C]^c[D]^d}{[A]^a[B]^b}$

where $aB + bB \leftrightarrow cC + dD$

$I = q/t$ I = amperes, q = charge in coulombs, t = time in seconds.

$E_{cell} = E^o_{cell} - \dfrac{RT}{n\Im}\ln Q = E^o_{cell} - \dfrac{0.0592}{n}\log Q$ @ 25°C

$\log K = \dfrac{nE^o}{0.0592}$

1 Faraday $\Im$ = 96,500 coulombs/mole

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25°C

$pH = -\log[H^+]$; $pOH = -\log[OH^-]$

$pH + pOH = 14$

$pH = pK_a + \log\dfrac{[A^{-1}]}{[HA]}$

$pOH = pK_b + \log\dfrac{[HB^+]}{[B]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

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

Δn = moles product gas – moles reactant gas

EQUILIBIRUM TERMS

K_a = weak acid
K_b = weak base
K_w = water
K_p = gas pressure
K_c = molar concentration

KINETICS EQUATIONS

$A_o - A = kt$ A_0 is initial concentration, amount.

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

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

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

THERMOCHEMISTRY

$\Delta S^o = \sum\Delta S^o$ products – $\sum\Delta S^o$ reactants

$\Delta H^o = \sum\Delta H^o$ products – $\sum\Delta H^o$ reactants

$\Delta G^o = \sum\Delta G^o$ products – $\sum\Delta G^o$ reactants

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

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

$\Delta G^o = -n\Im E^o$

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

$q = mC\Delta T$

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

$q = mH_f$

$q = mH_v$.

$\Delta U = \Delta H - P\Delta V$

S^o = standard entropy
H^o = standard enthalpy
G^o = standard free energy
E^o = standard reduction potential
T = temperature
q = heat
c = specific heat capacity

C_p = molar heat capacity at constant pressure
1 faraday $\Im$ = 96,500 coulombs/mole

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

Water $H_f = \dfrac{330 \text{ joules}}{\text{gram}}$

Water $H_v = \dfrac{2260 \text{ joules}}{\text{gram}}$

ΔU = change internal energy of a system
ΔH= change in energy of a system
$-P\Delta V$ = work of gases
1liter-atm = 101.325 J

Metal Activity Series

Metal	Metal Ion
Li	Li^{+1}
K	K^{+1}
Ba	Ba^{+2}
Ca	Ca^{+2}
Na	Na^{+1}
Mg	Mg^{+2}
Al	Al^{+3}
Mn	Mn^{+2}
Zn	Zn^{+2}
Cr	Cr^{+3}
Fe	Fe^{+2}
Co	Co^{+2}
Ni	Ni^{+2}
Sn	Sn^{+2}
Pb	Pb^{+2}
H_2	$2\ H^{+1}$
Cu	Cu^{+2}
Ag	Ag^{+1}
Hg	Hg^{+2}
Pt	Pt^{+2}
Au	Au^{+3}

Chemistry II Answer Key <u>Canary test</u> Corrections

Chemistry II April 2017 Answer Key

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

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FEBRUARY: chemical bonding, bond order (no molecular orbital theory), <u>photon-electron spectroscopy</u>, <u>doping and semiconductors</u>, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), intermolecular forces (van der Waals forces, relations between boiling point and vapor pressure), thermochemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes (not PT diagrams), gases and gas laws, plus January topics.

MARCH: non-metals, metals (not unit cells), solutions, rates of reactions, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, acids, bases, and salts (hydrolysis), K_a, K_b, buffers, solution equilibria, redox, voltaic cells, thermodynamics (ΔS, ΔH, and ΔG) , descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Dates for 2017 Season

Thursday March 9, 2017 Thursday April 13, 2017

All areas, schools must complete the April exam and mail in the results by April 28th, 2017

New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

phone # 908-213-8923 fax # 908-213-9391 email: <u>newjsl@ptd.net</u>

Web address: <u>http://entnet.com/~personal/njscil/html/</u>

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Thursday March 8, 2018 Thursday April 12, 2018