New Jersey Science League
Chemistry II Exam January 2016 (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 , and which test you are taking on the scantron.*

1. Which of the following instrumental techniques is most suitable in determining the concentration of Cr^{6+} ions in aqueous solutions?

A. Visible Spectroscopy
B. X-Ray Crystallography
C. Paper Chromatography
D. Gel Filtration

2. Ammonium ferric sulfate dodecahydrate $NH_4Fe(SO_4)_2{\bullet}12H_2O$ (MW = 482.2 g/mol) is synthesized according to the following two-step reactions:

$$2H^+(aq) + NO_3^-(aq) + Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + NO_2(aq) + H_2O(l)$$

$$NH_4^+(aq) + Fe^{3+}(aq) + 2\,SO_4^{2-}(aq) + 12\,H_2O(l) \rightarrow NH_4Fe(SO_4)_2{\bullet}12H_2O(s)$$

If a student starts with 1.25 g of $FeSO_4{\bullet}7H_2O$ (MW = 278 g/mol) and obtains 1.00 g of dried product, what is the percent yield in the reaction?

A. 32.4 B. 46.1 C. 53.9 D. 78.0

3. Which of the following 10.0 g samples contains the most C atoms?

A. $CaCO_3$ B. CaC_2 C. CO_2 D. CH_4

4. For which pair of species is the difference in radii the greatest?

A. K^+ and Br^- B. Ca^{2+} and S^{2-} C. Na^+ and F^- D. Li^+ and I^-

5. 100.0 mL of a 0.10 M $Pb(NO_3)_2$ aqueous solution is added to 100.0 mL of a 0.30 M NaCl aqueous solution. Which ion has the highest concentration in solution after the chemical reaction is terminated?

A. Pb^{2+} B. NO_3^- C. Na^+ D. Cl^-

6. $$\_\_\,KMnO_4 + \_\_\,Na_2SO_3 + \_\_\,H_2O \rightarrow \_\_\,MnO_2 + \_\_\,Na_2SO_4 + \_\_\,KOH$$

When the above equation is balanced using the smallest whole-number coefficients, the coefficient of H_2O will be equal to

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

7. When heated, 1.20 g of MO_3 react stoichiometrically with 0.648 g of Al according to the following equation:

$$MO_3(s) + 2\,Al(s) \rightarrow 2\,Al_2O_3(s) + M(s)$$

What is the identity of the metal? All full credit. Equation not balanced.

A. Mn B. Mo C. V D. Cr

8. 60.0 mL of a 1.00 M HCl solution is added to a beaker containing 5.00 g of a mixture of NaCl and Na_2CO_3. All the HCl solution is required to complete the reaction. Then, the beaker is heated to dryness to constant weight. What is the mass composition of NaCl in the mixture?

A. 1.17 g B. 1.82 g C. 3.18 g D. 3.51 g

9. What is the correct systematic name of $Pb(CH_3COO)_4$?

A. Lead acetate B. Lead(II) acetate C. Lead(IV) acetate D. Plumbous acetate

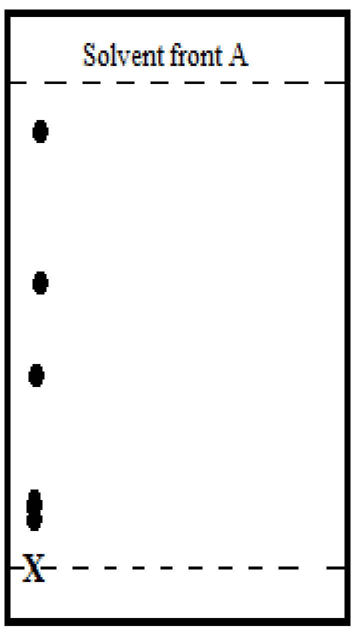
10. In which of the following compounds does the carbon atoms have the highest oxidation state?

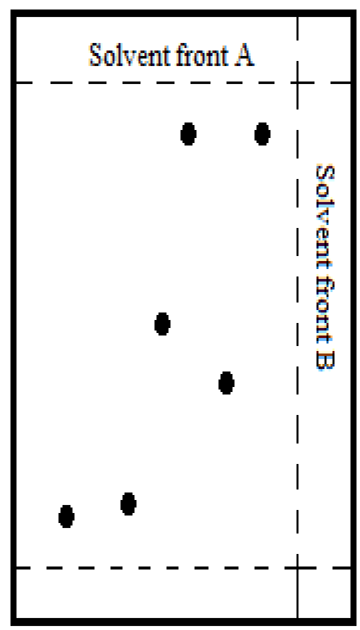
A. CH_4 B. CH_4O C. CH_2O D. CH_2O_2

11. Europium has two stable isotopes. A sample of elemental Eu is found to have 2.83034×10^{23} atoms of Eu-151. If elemental Europium is found to have a mass of 151.96 amu on earth, what is the natural abundance of Eu-153?

A. 48.0% B. 50.0% C. 52.0% D. 54.0%

12. The following figure depicts the two dimensional thin layer chromatography of a sample X. TLC (Thin Layer chromatography) is a technique used to separate a mixture into its constituents based on the different polarities of the compounds present in the mixture. This is done based on the interactions between the polar stationary and less-polar mobile phase. A mixture is placed on the plate at position marked X, then through capillary action solvent A moves up the plate until the point shown (solvent front). The plate is then dried, rotated 90 º to the left and the process repeated with solvent B until the point solvent front B is reached. How many compounds were present in the original mixture?



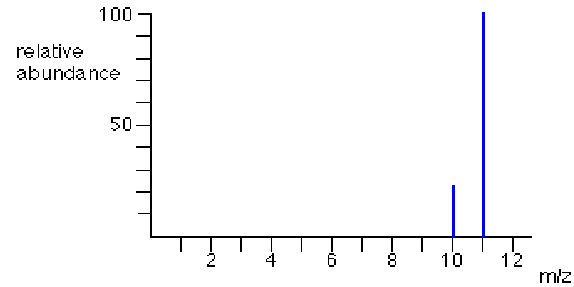


A. 4 B. 5 C. 6 D. 7

13. What is the empirical formula of aspartame, if aspartame is an artificial sweetener that is found to be 57.14% carbon, 6.16% hydrogen, 9.52% nitrogen, and 27.18% oxygen?

A. $C_5H_{10}NO$ B. $C_5H_{10}NO_2$ C. $C_7H_9NO_2$ D. $C_{14}H_{18}N_2O_5$

14. The two peaks in the mass spectrum shows that there are 2 isotopes of boron - with relative isotopic masses of 10 and 11 on the ^{12}C scale. Average atomic mass of the Boron atoms is 10.8 amu. What is the natural abundance of Boron-10?



A. 20.0 B. 23.0
C. 41.7 D. 81.3

15. Which species can act as an oxidizing agent but <u>NOT</u> as a reducing agent?

A. NO_3^- B. Cu^{2+} C. ClO_4^- D. All of these

16. Potassium alum has the formula $KAl(SO_4)_2 \bullet xH_2O$. The molecular weight of $KAl(SO_4)_2$ is 258 g/mol. The following experimental data are collected:

Mass of the empty crucible and cover:	30.000 g
Mass of the crucible, cover and sample:	32.000 g
Mass of the crucible, cover and sample after first heating:	31.246 g
Mass of the crucible, cover and sample after second heating:	31.090 g
Mass of the crucible, cover and sample after third heating:	31.089 g

Which of the following mathematical expressions will be used to determine the value of x?

A. $\dfrac{(\frac{1.089}{258})}{(\frac{0.911}{18})}$ B. $\dfrac{(\frac{0.911}{18})}{(\frac{1.089}{258})}$ C. $\dfrac{(\frac{0.911}{258})}{(\frac{0.911}{18})}$ D. $\dfrac{(\frac{1.089}{18})}{(\frac{0.911}{258})}$

17. Analysis of a brass sample (sample 1) shows that it contains 5 grams of zinc and 20 grams of copper. Another brass sample (sample 2) contains 10 grams of zinc and 10 grams of copper. How will it be possible to prepare 10 grams of a brass sample containing 30% of zinc using these two brass samples? Assume that there is no loss of mass during the process.

A. Take 7 g of sample 1 and 3 g of sample 2.
B. Take 3 g of sample 1 and 7 g of sample 2.
C. Take 5 g of sample 1 and 5 g of sample 2.
D. Take 6 g of sample 1 and 4 g of sample 2.

18. Which of the following ions can precipitate the Ba^{2+} ions but not the Mg^{2+} ions from an aqueous solution containing these two cations?

A. Cl^- B. NO_3^- C. CH_3COO^- D. SO_4^{2-}

19. A mixture of gases of A_2 and B_2 was reacted in a closed container.

$$A_2\,(g) + B_2\,(g) \rightarrow 2AB\,(g)$$

The resulting gas mixture had a molar composition as follows: 40% A_2, 20% B_2 and 40% AB. What was the molar composition of A_2 in the initial mixture?

A. 20% B. 40% C. 60% D. 80%

20. The electron configuration of $[Ar]\ 3d^8\ 4s^2$ belongs to

A. Ni^{2+} B. Ni C. Ni^{3+} D. Co

21. Consider the following substitution reaction represented by the equation:

$$CH_4 + 4\,Cl_2 \rightarrow CCl_4 + 4\,HCl$$

When 32.0 g of CH_4 react with 71.0 g of Cl_2, the maximum amount of HCl produced is (assume no other side reaction occurs)

A. 36.5 g B. 71.0 g C. 103 g D. 308 g

22. Consider the following reactions:

$$QCl_2 + Z \rightarrow \text{no reaction}$$
$$MCl_2 + Q \rightarrow M + QCl_2$$
$$MCl_2 + Z \rightarrow M + ZCl_2$$

What is the correct order of increasing activity for the metals M, Q and Z?

A. M < Q < Z B. M < Z < Q C. Z < Q < M D. Z < M < Q

23. Which sublevel is being filled in the Lanthanides series?

A. 3f B. 4f C. 5f D. 4d

24. Which of the following electron configurations represents an excited state of a Calcium atom?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 7p^1$

25. Which of the following equations correctly represents the net ionic reaction between a solution of cadmium nitrate and a solution of sodium sulfide?

A. $Cd(NO_3)_2\,(aq) + Na_2S(aq) \rightarrow CdS(s)$
B. $Cd^{2+}(aq) + S^{2-}(aq) \rightarrow CdS(s)$
C. $2Cd^{+}(aq) + S^{2-}(aq) \rightarrow Cd_2S(s)$
D. $Cd^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CdSO_4(s)$

Periodic Table and Chemistry Formulas 1-18-2016

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 = $^{o}C + 273$

$P_1V_1 = P_2V_2$

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

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

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

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

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

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

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

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

molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

$\Delta T_f = iK_f \bullet$ molality

$\Delta T_b = iK_b \bullet$ molality

$\pi = \frac{nRTi}{V}$

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 ^{o}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

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = mv$

$E_n = \frac{-2.178 \times 10^{-18}}{n^2}$ 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 $aB + bB \Leftrightarrow cC + dD$

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

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

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

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

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

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

$q = mC\Delta T$

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

$q = mH_f$

$q = mH_v$.

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

METAL ACTIVITY SERIES

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

Chemistry II January 2016 Answer Key Yellow test
Date: Thursday January 14, 2016 (Yellow corrected)

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

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, photon-electron spectroscopy, doping and semiconductors, given molecular orbital diagram determine bond order, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), liquids, solids, vapor pressure, intermolecular forces, thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes, gases, 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, K_a, K_b, K_{sp}, buffers, redox, voltaic cells, ΔS, ΔH, ΔG, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Testing Dates for 2016

Thursday, January 14, 2016 Thursday, February 11, 2016
Thursday, March 10, 2016 Thursday, April 14, 2016*

*All areas and schools must complete the April exam and mail in the results by April 28th, 2016.

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

If you return scantrons of the Alternates, then label them as **ALTERNATES.**

Dates for 2017 Season

Thursday, January 12, 2017 Thursday, February 9, 2017
Thursday, March 9, 2017 Thursday, April 13, 2017

New Jersey Science League

Chemistry II Exam CANARY COLOR

February 11, 2016 (No 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 density of a pure CH_4 sample confined in a rigid container is 1.60 g/L at -73.0 ^oC. What would be the temperature in ^oC in the container, if the pressure is changed to 3.28 atm?

A. 27.0°C B. 73.0°C C. 127°C D. 227°C

2. Suppose that the number of atoms in hydrocarbons (compounds containing C and H only) other than hydrogen is n. If the number of valence electrons in the compound is equal to $6n + 2$, then only _________ bonds exist in the molecule.

A. Single B. Double C. Triple D. Quaternary

3. For the following reactions, the given enthalpy changes are expressed per mole of product formed.

$$H_2\,(g) + ½O_2\,(g) \rightarrow H_2O\,(l) \qquad \Delta H = -285.5\text{ kJ mol}^{-1}$$
$$C\,(s) + O_2\,(g) \rightarrow CO_2\,(g) \qquad \Delta H = -393.5\text{ kJ mol}^{-1}$$
$$C\,(s) + 2H_2\,(g) + ½O_2\,(g) \rightarrow CH_3OH\,(g) \qquad \Delta H = -238.7\text{kJ mol}^{-1}$$

Determine the heat of combustion of methanol?

A. -567.1 kJ/mol B. -725.8 kJ/mol C. -1134.2 kJ/mol D. -1452.8 kJ/mol

4. Solid carbon dioxide is known as dry ice. It sublimes at -80.0 ^oC. The following data are given:

$\Delta H^o_{\text{sublimation}}$ = 25.0 kJ/mol

Specific heat of solid CO_2 = 54.6 J/mol.K

Specific heat of CO_2 gas = 37.0 J/mol.K (assume independent of temperature between the temperatures of -80.0°C and 25.0°C)

How much heat energy is required to bring 18.0 grams of solid CO_2 from -90.0 ^oC to 25.0 ^oC?

A. 1.20×10^4 J B. 2.40×10^4 J C. 3.77×10^4 J D. 5.45×10^4 J

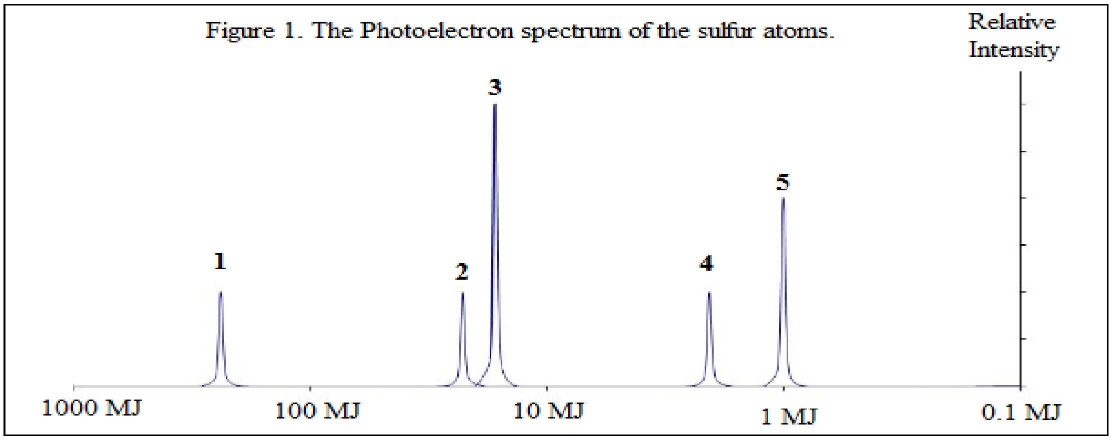
5. A quantity of 100.0 mL of 1.000 M HBr is mixed with 100.0 mL of 0.500 M $Ca(OH)_2$ in a coffee-cup calorimeter that has a heat capacity of 20.0 J/°C. The initial temperature of the HBr and $Ca(OH)_2$ solutions is the same at 23.5 °C. For the following process the heat of neutralization is -56.0 kJ/mol. (Assume that the specific heat of the final solution is 4.20 J/g•K)

$$H^+\,(aq) + OH^-\,(aq) \rightarrow H_2O\,(l)$$

What is the final temperature in ^oC of the mixed solution?

A. 18.0 B. 24.0 C. 30.0 D. 33.0

6. In the photoelectron spectrum below which peak(s) represent the 1s orbital electrons?



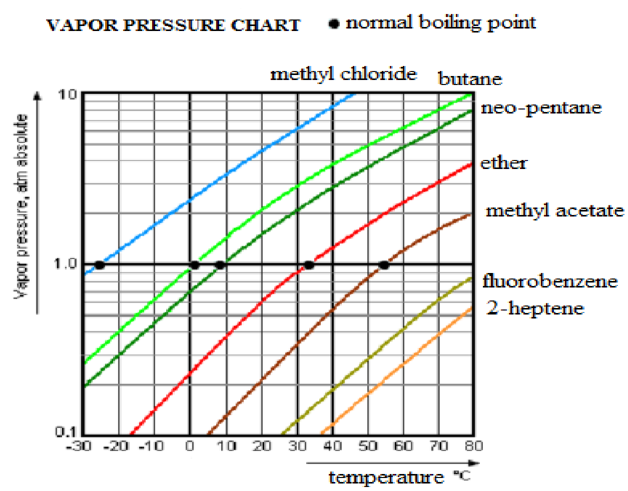
A. 1 B. 2 and 3 C. 4 D. 5

7. Two gases, X and Y, are simultaneously introduced from the opposite ends into a 100-cm glass tube. If the two gases meet at about 40-cm from the end where the gas Y is introduced these two possible gases, X and Y, respectively, are

	Gas X	**Gas y**
A.	CH_4	CO
B.	CO	CO_2
C.	CH_4	SO_2
D.	CO	SO_2

8. Based on the vapor pressure chart, which of the following substances has the <u>weakest</u> intermolecular forces in their liquid state?

A. methyl chloride
B. 2-heptene
C. ether
D. butane



9. Each solution below is added to 10.0 mL 0.10 M $Pb(NO_3)_2$ solution. Which solution will give the largest **<u>mass</u>** of precipitate in grams?

A. 10.0 mL 0.10 M K_2SO_4 (MW = 174 g/mol)
B. 10.0 mL 0.10 M KBr (MW = 119 g/mol)
C. 10.0 mL 0.10 M KCl (MW = 74.5 g/mol)
D. 10.0 mL 0.10 M KI (MW = 166 g/mol)

10. Which of the following molecular compounds has a **no net dipole moment**?

A. NH_3 B. H_2S C. SO_3 D. CH_3F

11. In which of the following compounds is the carbon-nitrogen bond the **shortest**?

A. CH_3CN B. CH_3NH_2 C. H_2CNH D. all have same length

12. Which is the correct order when the elements K, Ca, and Si, are arranged in order of **increasing** first ionization energy?

A. K, Ca, and Si B. K, Si, and Ca C. Si, Ca, and K D. Ca, K, and Si

13. A rigid vessel of volume 0.50 L containing Ar at a pressure of 10.0 atm is connected to a second rigid vessel of volume 0.75 L containing Ne at a pressure of 5.00 atm at the same temperature. A valve separating these two vessels is opened. What is the final pressure in the vessels assuming that the temperature remains constant?

A. 5.0 atm B. 6.0 atm C. 7.0 atm D. 7.5 atm

14. Which of the following species is square planar?

A. SO_4^{2-} B. XeF_4 C. CO_3^{2-} D. NH_4^+

15. Which of the following species has no lone pairs of electrons on their central atoms?

A. I_3^- B. CO_3^{2-} C. ClO^- D. H_3O^+

16. Suppose you have a balloon of given volume, V_1, containing a gas at temperature, T_1. When you place the balloon in a hotter room at temperature, T_2, the balloon's temperature starts to increase at constant pressure. What are the signs of the system's q, w, and ΔE for this process?

A. $-q, +w, -\Delta E$
B. $+q, +w, -\Delta E$
C. $-q, -w, +\Delta E$
D. $+q, -w, +\Delta E$

17. A gas mixture is known to be a mixture of CH_4 (methane) and O_2. A bulb having a capacity of 250-mL is filled with the gas to a pressure of 3.00 atm at 27.0°C. If the weight of the gas in the bulb is 0.676 g. what is the mole fraction of methane in the gas mixture?

A. 0.385 B. 0.614 C. 0.0385 D. 0.0614

18. The enthalpy of formation, ΔH_f^o, equals zero at 25°C for which of the following in their standard states?

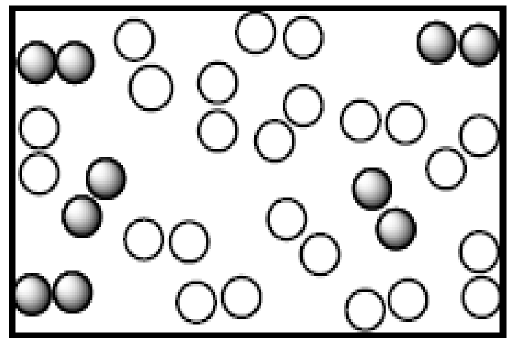
A. Gases
B. solids
C. compounds
D. elements

19. Which statement is correct about the critical point of a phase diagram?

A. Solid, liquid and gas are present at equilibrium.
B. Liquid can be produced by a change in pressure
C. Vapor can be produced by a change in temperature
D. Liquid and vapor are indistinguishable from one another

20. In the diagram below the paired open spheres represent H_2 molecules, while the dark spheres represent N_2 molecules. When the molecules react to form the maximum possible amount of ammonia, NH_3 molecules, what is the limiting reactant and how many molecules of NH_3 can be formed?

A. N_2 is the limiting reactant, while 5 NH_3 molecules are formed.
B. N_2 is the limiting reactant, 10 NH_3 molecules are formed
C. H_2 is the limiting reactant, 8 molecules of NH_3 are formed
D. H_2 is the limiting reactant, 12 molecules of NH_3 are formed.



21. In which of the following pairs is the radius of the first species bigger than the second one?

A. Lu^{3+}, Lu B. Li^{+}, Li C. Ca , Ca^{2+} D. Li^{+} , Ca^{2+}

22. A rigid 1-L container contains He gas at 27ºC. An equal mass of Ne at the same temperature is then introduced to the vessel. The temperature remains constant. What is the value of the new pressure, P_2?

A. $P_2 = P_1$ B. $P_2 = \frac{6}{5} \times P_1$ C. $P_2 = \frac{5}{6} \times P_1$ D. $P_2 = 2 \times P_1$

23. In which of the following reactions are oxygen atoms **oxidized and reduced** at the same time?

A. $2\ H_2 + O_2 \rightarrow 2\ H_2O$
B. $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$
C. $2\ H_2O + O_2 \rightarrow 2\ H_2O_2$
D. $KCl + 3\ KClO_4 \rightarrow 4\ KClO_3$

24. Arrange CH_4, NH_3, PH_3, and H_2O in order from **lowest to highest** **boiling points**?

A. NH_3, PH_3, CH_4, H_2O
B. CH_4, NH_3, PH_3, H_2O
C. CH_4, PH_3, NH_3, H_2O
D. PH_3, NH_3, H_2O, CH_4

25. For which of the following transitions would a hydrogen atom absorb a photon with the longest wavelength?

A. n = 5 to n = 6 B. n = 4 to n = 3 C. n = 1 to n = 2 D. n = 7 to n = 2

Periodic Table and Chemistry Formulas 1-18-2016

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

molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

$\Delta T_f = iK_f \bullet$ molality

$\Delta T_b = iK_b \bullet$ molality

$\pi = \frac{nRTi}{V}$

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

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

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = mv$

$E_n = \dfrac{-2.178 \times 10^{-18}}{n^2}$ 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 a B + b B ⇔ c C + d D

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

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

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

1 Faraday $\mathfrak{I}$ = 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

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

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

$\Delta G^o = -n\mathfrak{I}E^o$

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

$q = m C\Delta T$

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

$q = mH_f$

$q = mH_v$.

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 $\mathfrak{I}$ = 96,500 coulombs/mole

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

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

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

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

Chemistry II Answer Key **CANARY TEST**

Date: Thursday February 11, 2016 (No Corrections)

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

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, photon-electron spectroscopy, doping and semiconductors, given molecular orbital diagram determine bond order, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), liquids, solids, vapor pressure, intermolecular forces, thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes, gases, 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, K_a, K_b, K_{sp}, buffers, redox, voltaic cells, ΔS, ΔH, ΔG, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Testing Dates for 2016

Thursday, February 11, 2016

Thursday, March 10, 2016 Thursday, April 14, 2016*

*All areas and schools must complete the April exam and mail in the results by April 28th, 2016.

New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

Phone #: 908-213-8923 **Fax #:** 908-213-9391 **email:** newjsl@ptd.net

Web address: entnet.com/~personal/njscil/html

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

If you return scantrons of the Alternates, then label them as **ALTERNATES.**

Dates for 2017 Season

Thursday, January 12, 2017 Thursday, February 9, 2017

Thursday, March 9, 2017 Thursday, April 13, 2017

New Jersey Science League **Canary Exam**

Chemistry II Exam March 10, 2016 (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.

QUESTIONS 1 and 2 are related.

1. When 100.0 g of water at 85.0 ^oC is added to 100.0 g of water at 25.0 ^oC in a coffee cup calorimeter the maximum registered temperature is 54.0 ^oC. The specific heat of water is 4.18 J/g.^oC. What is the calorimetric constant of the Styrofoam cup?

A. 28.8 J/^oC B. 12.2 J/^oC C. 14.3 J/^oC D. 36.9 J/^oC

2. The very same calorimeter is used to determine the heat of reaction between calcium chloride and sodium carbonate. When 500.0 mL 0.10 M calcium chloride at 25.0 ^oC is added to 500.0 mL 0.10 M sodium sulfate solution at 25.0 ^oC. The temperature of the mixture in the calorimeter rises to 28.0 ^oC. Determine the heat of reaction in kJ/mol, assuming that the specific heat of the mixture is 4.18 J/g.^oC, the density of the mixture is 1.0 g/mL, and the volumes are additive. All full credit Two different chemicals in statement of the problem.

A. 25.3   B. 253   C. -25.3   D. -253

3. Methane (CH_4), propane (C_3H_8) and butane (C_4H_{10}) are all used as fuels.

$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(l)$ $\Delta H = -890$ kJ

$C_3H_8\,(g) + 5\,O_2\,(g) \rightarrow 3CO_2\,(g) + 4H_2O\,(l)$ $\Delta H = -2044$ kJ

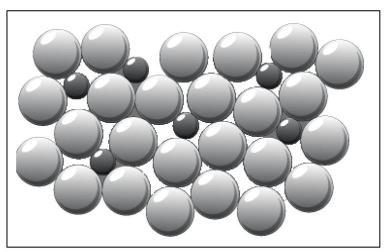
$C_4H_{10}\,(g) + 13/2\,O_2\,(g) \rightarrow 4CO_2\,(g) + 5H_2O\,(l)$ $\Delta H = -2260$ kJ

Which fuel provides more energy per gram?

A. methane   B. propane   C. butane   D. All provide the same heat energy per gram of fuel.

4. What does the figure to the right represent?

A. The crystal structure of NaCl.
B. An alloy of copper and zinc.
C. A master alloy of copper and boron.
D. The atoms of crystalline gold.



5. The rate of decomposition of C is 0.024 mol/L×s. What is the rate of decomposition of A?

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

A. 0.048 mol/L×s   B. 0.018 mol/L×s   C. 0.024 mol/L×s   D. 0.012 mol/L×s

6. A compound decomposes by a second-order process. If 25.0% of the compound decomposes in 33.3 minutes, the half-life of the compound is __________.

A. 66 minutes   B. 12 minutes   C. 50 minutes   D. 100 minutes

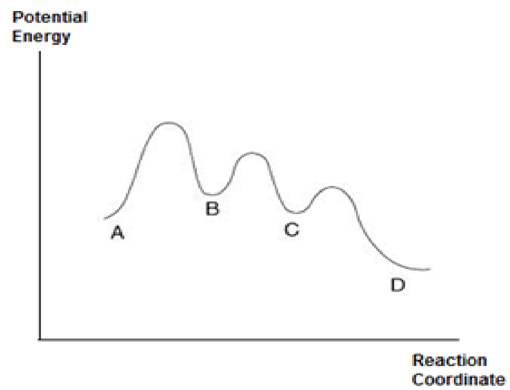
7. The reaction A $\rightarrow$ B is first order in [A]. Consider the following data. What is the half-life of this reaction in seconds?

Time (s)	[A] mM
0	160
10	40
20	10

A. 1.0 B. 10.0 C. 5.0 D. 4.0

8. Below is a graph of potential energy vs reaction coordinate. Based on the graph, which statement is correct?

A. The first step is the rate determining step.
B. C is the catalyst.
C. The overall reaction is endothermic.
D. There are four steps in this reaction?



9. Which of the following will **NOT** result in the formation of a **gaseous product**?

A. Addition of acetic acid to sodium bicarbonate.
B. Addition of dry sodium hydride into water.
C. Heating zinc sulfate heptahydrate in a crucible.
D. Copper metal is added to hydrochloric acid.

10. What volume of 0.0250 M lead(II) nitrate solution is needed to precipitate all the iodide ions present in 25.0 mL of 0.0250 M calcium iodide solution?

A. 25.0 mL B. 50.0 mL C. 12.5 mL D. 100. mL

11. A group of students is trying to determine the concentration of $[Fe(SCN)]^{2+}$ (aq) in the following reaction:

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightarrow [Fe(SCN)]^{2+}(aq)$$
yellow colorless red

The iron(III) nitrate solution is prepared in 0.10 M nitric acid solution in order to keep the iron ion in its 3+ oxidation state. This solution has a yellow color. The complex formed between the two reactants has a red color. Which experimental procedure will introduce the **largest** error?

A. Zeroing the spectrophotometer using distilled water.
B. Setting the wavelength to 675 nm.
C. Not cleaning the outside of cuvettes before putting them into the spectrophotometer.
D. Using 0.10 M KSCN instead of 0.10 M NaSCN.

12. Which element exhibits the greatest number of oxidation states in its compounds?

A. Cl B. Ba C. Cu D. Pb

13. Lithium copper hydride $Li_nCuH_{(n+1)}$ is an important reducing agent in chemistry. A student synthesizes the compound and wants to find the formula of the compound. The newly synthesized compound is purified and reacts with excess HCl according to the following equation:

$$Li_nCuH_{(n+1)} + (2n+1)\ HCl \rightarrow nLiCl + CuCl_2 + \frac{(3n+2)}{2} H_2$$

If 1.00 g of this compound releases 772 mL of H_2 gas at STP, what is the formula of the compound? Li = 7; Cu = 63.5; H = 1.

A. Li_2CuH_3 B. $LiCuH_2$ C. Li_4CuH_5 D. Li_3CuH_4

14. Which of the following is correct if NaCl, KCl, MgO, and CaO are arranged in order of increasing lattice energy?

A. NaCl < KCl < MgO < CaO

B. CaO < MgO < KCl < NaCl

C. KCl < NaCl < CaO < MgO

D. KCl < NaCl < MgO < CaO

15. The complete combustion of 5.2 mg of a hydrocarbon, a compound containing C and H only, gave 17.6 mg of CO_2 and 3.6 mg of H_2O. What is the **molecular formula** of this hydrocarbon?

A. C_6H_6 B. C_6H_{10} C. C_6H_{12} D. C_6H_{14}

16. What is the hybridization of the central atom in triiodide ion, I_3^-? All full credit d sublevels not part chem. II.

A. sp^2 B. sp^3 C. sp^3d D. sp^3d^2

17. Which of the following is **FALSE** regarding enthalpy?

A. Enthalpy is a state function.

B. Enthalpy change of the catalyzed reaction is lower than that of the uncatalyzed reaction.

C. The enthalpy change of the reverse reaction is equal to the enthalpy change of the forward reaction. Only the sign will be reversed.

D. The sign of the magnitude of enthalpy change of an exothermic reaction is negative.

18. Which substance has the **strongest forces** of attraction between its molecules?

A. CCl_4 B. CO_2 C. N_2 D. Xe

19. Which of the following statements is **NOT** correct regarding the Photoelectric Effect?

A. It was first discovered by Hertz and the experimental data are explained by Einstein.

B. The kinetic energy of the photoelectrons is increased by the increased frequency of the light used to emit the electrons.

C. The kinetic energy of the photoelectrons is increased by the increased intensity of the light used in the experiment.

D. It proves the corpuscular nature of the light.

20. Which gas has the same density at 600 °C and 2.04 atm as that of N_2 gas at STP?

A. SO_2 B. O_2 C. CO D. CO_2

21. When elements with electron configuration $1s^2\,2s^2\,2p^3$ and $1s^2\,2s^2\,2p^5$ combine, they form a(n) __________ compound.

A. Ionic B. Covalent C. Metallic D. Network covalent

22. A student finds that an unknown hydrate sample is colorless and contains 51.2% crystal water by mass. Based on the data which hydrate does the student have?

A. $BaCl_2 \bullet 2H_2O$ B. $CuSO_4 \bullet 5H_2O$ C. $ZnSO_4 \bullet 7H_2O$ D. $MgSO_4 \bullet 7H_2O$

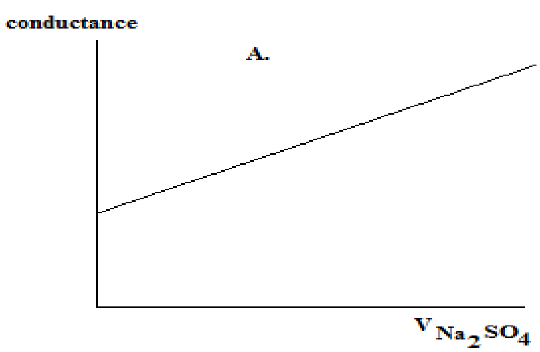
23. Which of the following pure substances exhibit the strongest hydrogen bonding in the liquid state?

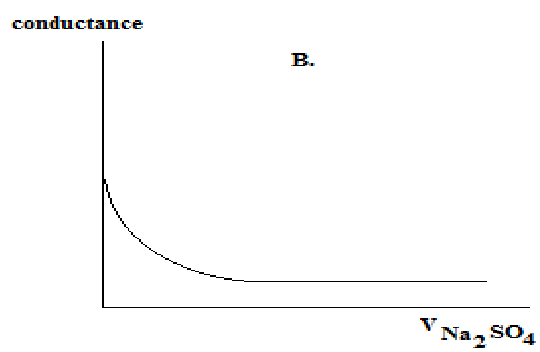
A. CH_4 B. CH_3OH C. CH_3Br D. HCHO

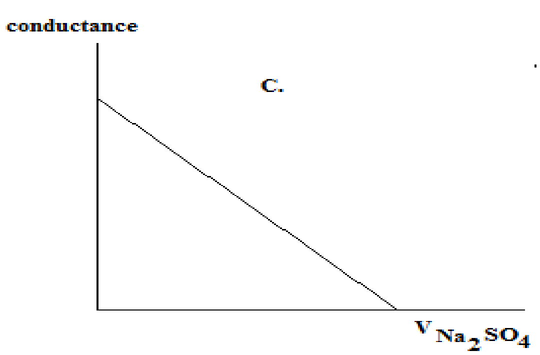
24. A sample of 1.47 g of MX_2 (M is the metal, X is the halogen) is dissolved in enough water and titrated with an excess of $AgNO_3$ solution. The <u>yellow precipitate</u> is washed and dried, and weighs 2.35 g. Which metal halide is the unknown substance?

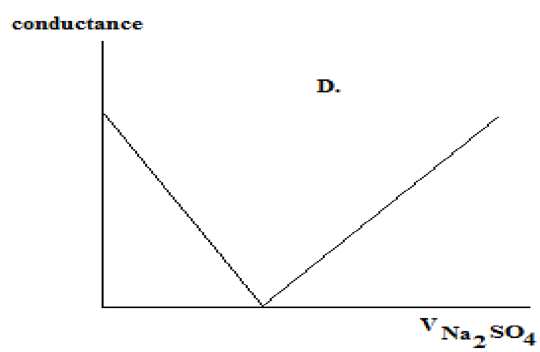
A. CaI_2 B. $CuBr_2$ C. PbF_2 D. $SrCl_2$

25. The electrical conductance of a $Ba(OH)_2$ solution is measured as per the addition of a dilute solution of Na_2SO_4. Which of the following graphs best depicts this observation?









Periodic Table and Chemistry Formulas 1-18-2016

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 = $^oC + 273$

$P_1V_1 = P_2V_2$

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

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

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

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

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

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

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

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

molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

$\Delta T_f = iK_f \bullet$ molality

$\Delta T_b = iK_b \bullet$ molality

$\pi = \frac{nRTi}{V}$

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

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 ^oC, 1.00 atm (101.3 kPa)
= 14.7 psi

1 faraday $\Im$ = 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^oC

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

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

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25^oC

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

$pH + pOH = 14$

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

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

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

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

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

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

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

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

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

$q = mC\Delta T$

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

$q = mH_f$

$q = mH_v$.

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

METAL ACTIVITY SERIES

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

Chemistry II January 2016 Answer Key **Canary Exam**

Date: Thursday March 10, 2016

Record on the area record the % correct (Corrections)

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

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, photon-electron spectroscopy, doping and semiconductors, given molecular orbital diagram determine bond order, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), liquids, solids, vapor pressure, intermolecular forces, thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes, gases, 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, K_a, K_b, K_{sp}, buffers, redox, voltaic cells, ΔS, ΔH, ΔG, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Testing Dates for 2016

Thursday, March 10, 2016 Thursday, April 14, 2016*

*All areas and schools must complete the April exam and mail in the results by April 28th, 2016.

New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

Phone #: 908-213-8923 **Fax #:** 908-213-9391 **email:** newjsl@ptd.net

Web address: entnet.com/~personal/njscil/html

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

If you return scantrons of the Alternates, then label them as **ALTERNATES.**

Dates for 2017 Season

Thursday, January 12, 2017 Thursday, February 9, 2017

Thursday, March 9, 2017 Thursday, April 13, 2017

New Jersey Science League

Chemistry II Exam April 2016 Canary Exam (Corrections)

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 scantron.

1. $[Co(H_2O)_6]^{2+}$ (*aq*) + $4Cl^-$ (*aq*) $\leftrightarrows$ $[CoCl_4]^{2-}$ (*aq*) + $6H_2O$ (*l*)

Red **Blue**

Co(II) ion (Co^{2+}) reacts with concentrated HCl solution to form a blue complex with the formula $[CoCl_4]^{2-}$. The net ionic equation is given above. This reaction is exothermic as written. A student studying this equilibrium begins with an equilibrium mixture that has a red color. Which of the following statements is NOT correct? Correction. The reaction as written is endothermic. All full credit.

A. When the solution is diluted it will turn light red.
B. When the solution is cooled in an ice bath it will turn blue.
C. When a solution of $AgNO_3$ is added to this solution, a precipitate will be observed and the solution will turn red.
D. When a solution of concentrated HCl solution is added dropwise to this solution the solution will turn red.

2. Which of the following solutions will form a **buffer** upon mixing?

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

3. A solution of $KMnO_4$ is standardized against pure sodium oxalate. 0.250 g of sodium oxalate is dissolved in water and then strongly acidified using 4.0 M H_2SO_4 solution. The solution is then heated to 80^oC. The titration required 27.65 mL of $KMnO_4$ solution according to the following reaction:

$$5Na_2C_2O_4 + 2KMnO_4 + 8H_2SO_4 \rightarrow 5Na_2SO_4 + 10CO_2 + K_2SO_4 + 8H_2O + 2MnSO_4$$

This permanganate solution is used to determine the concentration of an unknown commercial peroxide solution. The volume of permanganate required to titrate 10.0 mL of peroxide solution is 15.90 mL.

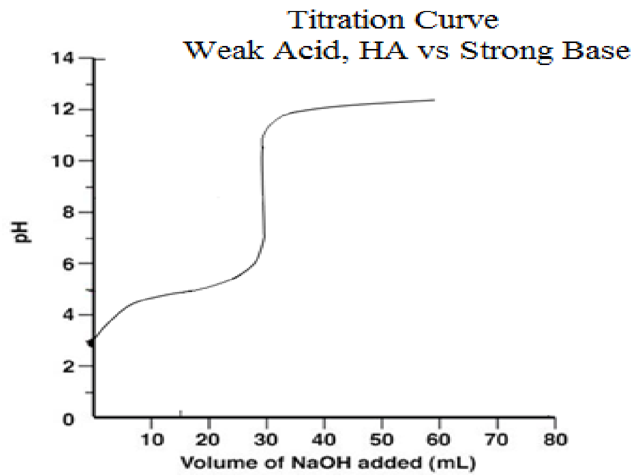
$$5H_2O_2 + 2KMnO_4 + 3H_2SO_4 \rightarrow 2MnSO_4 + 5O_2 + K_2SO_4 + 8H_2O$$

What is the molar concentration of the peroxide solution?

A. 0.107 M B. 0.536 M C. 0.321M D. 0.0987 M

4. A weak monoprotic acid, HA, is titrated with a strong base, NaOH. 25.0 mL of the weak monoprotic acid is titrated with 0.0334 *M* NaOH solution. What is the percent ionization of the weak acid in aqueous solution? Ans is 1.56 % all full credit.

A. 0.250%
B. 2.50%
C. 3.34%
D. 5.00%



5. 25.0 mL of 0.10 *M* HCl solution is added to a 50.0 mL NaOH solution. The final pH of the solution is 12.00. What is the molarity of the NaOH solution?

A. 0.23 M B. 0.12 M C. 0.065 M D. 0.075 M

6. A 75.0 mL 2.0 *M* HCl solution is added to a coffee cup calorimeter containing 50.0 mL of 2.0 *M* NaOH solution at 23.0°C. The temperature is increased to 33.7°C. Determine the molar heat of neutralization. Assume that the volumes are additive. The calorimetric constant of the coffee cup calorimeter is negligible. Specific heat of the mixture is 4.18 J/g×°C.

A. 48 kJ/mol B. 56 kJ/mol C. -48 kJ/mol D. -56 kJ/mol

7. Which of the following reactions is **NOT** a redox reaction?

A. $2CuCl_2 + 4NaI \rightarrow 2CuI + I_2 + 4NaCl$
B. $CuCl_2 \bullet 2H_2O + 2SOCl_2 \rightarrow CuCl_2 + 2SO_2 + 4HCl$
C. $CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$
D. $Cu + Cl_2 \rightarrow CuCl_2$

8. Which of the following ions will be the most strongly hydrated?

A. H^+ B. Cs^+ C. CH_3^+ D. I^-

9. Which of the following interactions between the two species is NOT given correctly?

Species	Type of interactions
A. CH_3OH and $CHCl_3$	dipole-dipole
B. Na^+ and H_2O	ion-dipole
C. CH_3OH and H_2O	hydrogen bonding
D. Cl^- and C_5H_{12}	dispersion forces

10. When the following redox reaction is balanced (using smallest-whole-number coefficients) what is the coefficient of $S_4O_6^{2-}$?

$$Cr_2O_7^{2-} + S_2O_3^{2-} \rightarrow Cr^{3+} + S_4O_6^{2-}$$

A. 3 B. 6 C. 5 D. 10

11. Which of the 0.010 *M* aqueous solutions has the lowest pH?

A. Na_2SO_4 B. K_2S C. LiF D. NH_4Cl

12. The solubility product constant of BaF_2 is 1.5×10^{-6} at 25°C. Which of the following will **increase** the solubility of BaF_2 at 25°C?

A. add 0.1 M $Ba(NO_3)_2$ B. add 0.1 M HNO_3 C. add 0.1 M NaF   D. none of these

13. Strontium-90 has a half-life of 28 years. How long will it take for a sample of 20.0 mg of Sr-90 to disintegrate to 6.25 mg? **Radioactive decay follows 1st order decay kinetics**.

A. 4.44 y   B. 18.9 y   C. 47.9 y   D. 76.3 y

14. The standard reduction potentials are given below:

$$Ag^+ + e^- \rightarrow Ag \qquad E° = +0.80\ V$$
$$Fe^{3+} + e^- \rightarrow Fe^{2+} \qquad E° = +0.77\ V$$
$$Cr^{2+} + 2e^- \rightarrow Cr \qquad E° = -0.41\ V$$

Which of the following ionic species is the strongest oxidizing agent?

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

15. A mixture of $NaHCO_3$ and Na_2CO_3 is dissolved in water and titrated with 1.0 M HCl solution. The titration is terminated when the phenolphthalein turned from pink to colorless. In this step Na_2CO_3 is converted to $NaHCO_3$. The titration continued with a second indicator to titrate the $NaHCO_3$. Which indicator is used for the second titration?

Choice	Indicator	pH range
A.	Thymolphthalein	9.5 – 10.5
B.	Alizarin yellow	10.0 – 12.0
C.	Crystal violet	0.0 – 2.0
D.	Bromocresol Green	3.8 – 5.4

16. Which of the following compounds has ionic bonds **only**?

A. NH_4Cl B. CH_3F C. NaH   D. $AlCl_3$

17. What is the bond angle in the formaldehyde molecule, H_2CO?

A. 180°   B. 120°   C. 109°   D. 90°

18. Which of the following species has the same shape as SeF_4 according to VSPER Theory?

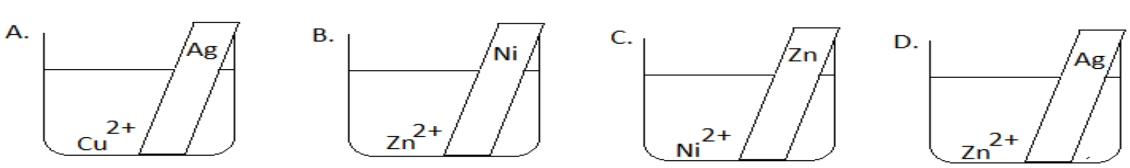
A. SiF_4 B. NH_4^+ C. BF_4^- D. none of these

19. In which of the following species the central atom has an empty *p*-orbital?

A. CH_3^+ B. NO_3^- C. N_3^- D. CO_2^{2-}

20. The following standard reduction potentials are given:

$E°_{Ag^+/Ag} = +0.80\ V$; $E°_{Cu^{2+}/Cu} = +0.34\ V$; $E°_{Ni^{2+}/Ni} = -0.25\ V$; $E°_{Zn^{2+}/Zn} = -0.76\ V$;



In which containers will there be a color change of the solution and the formation of a precipitate?

21. 1.80 g of sugar, $C_6H_{12}O_6$ is dissolved in 50.01 g of water. The freezing point of the solution is -0.37°C. The formula used to calculate the molecular weight (MW) of the sugar is

$$MW = \frac{m \times K_f}{kg\ solvent \times \Delta T}$$

where m = mass of the solute (g)

ΔT = freezing point depression (°C) which is the difference between the freezing point of water(T_i) and the mixture of sugar and water(T_f). $\Delta T = T_f - T_i$.

kg solvent = mass of the solvent (kg)

K_f = freezing point depression constant (-1.86°C/molal)

Which of following measurements will lead to the **largest experimental error** in determining the molecular weight of the sugar?

A. Weighing the mass of the sugar with a centigram balance (± 0.01 g).
B. Measuring the temperature difference with an alcohol thermometer (± 0.1°C).
C. Weighing the solvent with a centigram balance (± 0.01 g).
D. Using deionized water instead of distilled water.

22. When 30.00 mL 0.10 M $CaCl_2$ solution and 40.00 mL 0.20 M Na_3PO_4 solutions are mixed what will be the maximum amount of solid produced?

A. 0.31 g B. 0.62 g C. 0.58 g D. 0.47 g

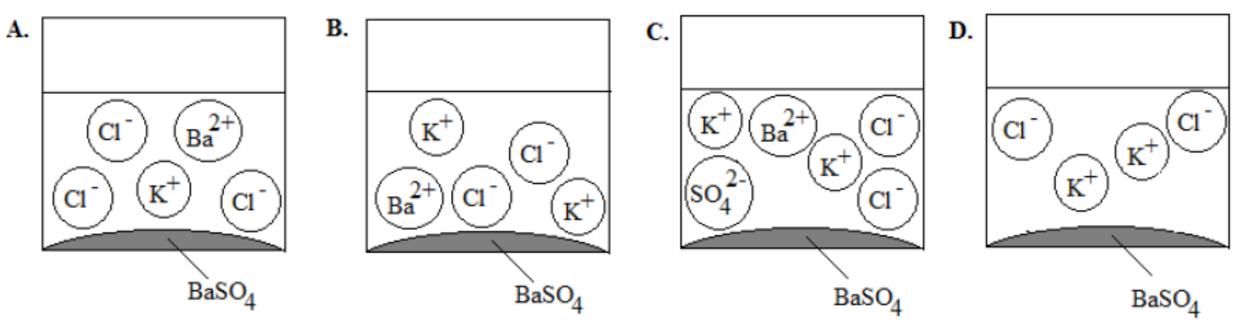
23. What is the geometry of the perchlorate ion, ClO_4^- ?

A. Trigonal Planar B. T-Shaped C. Tetrahedral D. Pyramidal

24. A group of students want to identify an unknown weak monoprotic acid by determining the molecular weight and the pK_a. The titration is done using a standardized 0.10 M NaOH solution. The students calibrate the pH-meter using a pH = 10.0 buffer solution. However, the students mistakenly used a pH-buffer solution of 7.00 for this single point calibration. How will this procedural error of using the buffer of pH 7 affect the values of the MW and pK_a of the monoprotic acid?

	Molecular Weight	pK_a
A.	Too high	Too high
B.	Unchanged	Too low
C.	Too low	Too high
D.	Too high	Too low

25. Which of the following figures correctly represents the **products** of the chemical reaction between 10.0 mL 0.20 M $BaCl_2$ and 10.0 mL 0.20 M K_2SO_4 solutions?



Periodic Table and Chemistry Formulas 1-18-2016

Periodic Table of the Elements
amu to 4 significant figures

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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 = ^{o}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 = $\frac{\text{moles solute}}{\text{liter of solution}}$

molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

$\Delta T_f = iK_f \bullet$ molality

$\Delta T_b = iK_b \bullet$ molality

$\pi = \frac{nRTi}{V}$

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

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 ^{o}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

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = mv$

$E_n = \frac{-2.178 \times 10^{-18}}{n^2}$ 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 $\Leftrightarrow$ c C + d D

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

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

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

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

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

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

$q = m C\Delta T$

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

$q = mH_f$

$q = mH_v$.

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

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

Chemistry II Answer Key <u>Canary test</u>
April 14, 2016 (Corrections)

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

<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, <u>photon-electron spectroscopy</u>, <u>doping and semiconductors</u>, given molecular orbital diagram determine bond order, paramagnetism, and diamagnetism, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization(sp, sp^2, sp^3), liquids, solids, vapor pressure, intermolecular forces, thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), phase changes, gases, 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, K_a, K_b, K_{sp}, buffers, redox, voltaic cells, ΔS, ΔH, ΔG, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

<u>Testing Dates for 2016</u>

Thursday, April 14, 2016*

*All areas and schools must complete the April exam and mail in the results by April 28th, 2016.

New Jersey Science League

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

If you return scantrons of the Alternates, then label them as **<u>ALTERNATES.</u>**

Dates for 2017 Season

Thursday, January 12, 2017 **Thursday, February 9, 2017**

Thursday, March 9, 2017 **Thursday, April 13, 2017**