New Jersey Science League Canary

Chemistry II Exam January 2018 Corrections None

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. Consider the following unbalanced equation: …C_6H_6O + …O_2 → …CO_2 + …H_2O

When 9.40 g of C_6H_6O react with 48.0 g of O_2, the maximum amount of CO_2 produced is (assume no other reactions occurs). Of course balance the reaction.

A. 4.40 B. 8.09 C. 26.4 D. 56.6

2. A 1.00-gram sample of Chlorox®, an aqueous solution of NaClO, is titrated with 0.10 *M* of HCl solution. The titration required 4.90 mL of HCl solution. What is the percent mass composition of NaClO in the sample?

$$NaClO + 2\ HCl \rightarrow Cl_2 + NaCl + H_2O$$

A. 1.8 B. 3.65 C. 4.14 D. 5.24

3. If 21.3 grams of $Sr(NO_3)_2$ react with 21.4 grams of KIO_3 and 4.00 grams of solid are recovered, what is the percent yield of the reaction?

$$Sr^{2+}(aq) + 2\ IO_3^-(aq) \rightarrow Sr(IO_3)_2(s)$$

A. 20.5% B. 18.3% C. 77.3% D. 65.2%

4. A metal, M, forms a compound in the form of $MCd(CN)_4$. What is the formula of the compound formed between the metal M and perchlorate ion?

A. $MClO_4$ B. M_2ClO_4 C. $M(ClO_4)_2$ D. $M(ClO_4)_3$

5. A compound is made of 35.86% K, 29.19% Cu, and 34.95% F. A sample of 1.00 gram of this anhydrous compound is placed in a chamber which is subject to high humidity. The mass of the hydrated sample is 1.33 grams. What is the formula of the hydrate?

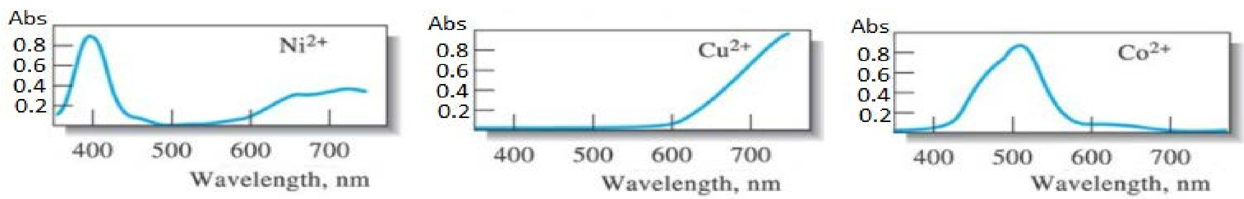
A. $KCuF_2{\bullet}2H_2O$ B. $KCuF_2{\bullet}4H_2O$ C. $K_2CuF_4{\bullet}2H_2O$ D. $K_2CuF_4{\bullet}4H_2O$

6. In the balanced equation below determine the element that is oxidized.

$$6\ FeSO_4 + K_2Cr_2O_7 + 7\ H_2SO_4 \rightarrow 3\ Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + 7\ H_2O$$

A. Fe B. Cr C. K D. S

7. A solution of Co^{2+} ion contains some small impurities of Cu^{2+} and Ni^{2+} ions. The absorption spectrum of each ion's 0.10 *M* solution is given in the figure below. At what optimal wavelength the spectrometer is to be set in order to determine the concentration of the Co^{2+} ions in the unknown solution?



A. 400 nm B. 512 nm C. 600 nm D. 700 nm

8. Which of the following methods is LEAST effective in separating a solid from a liquid?

A. Filtration
B. Sublimation
C. Centrifugation
D. Decantation

9. Addition of small amounts of which solids to 4 M HCl will result in gas evolution?

I. Zn   II. Na_2SO_3.

A. I only   B. II only   C. Both I and II   D. Neither I or II.

10. When the following reaction is balanced using the smallest whole-number coefficients, the coefficient of H^+ will be equal to

$$\_\_\_ Cr_2O_7^{-2} + \_\_\_ C_2H_4O + \_\_\_ H^+ \rightarrow \_\_\_ Cr^{3+} + \_\_\_ C_2H_4O_2 + \_\_\_ H_2O$$

A. 6   B. 8   C. 10   D. 14

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

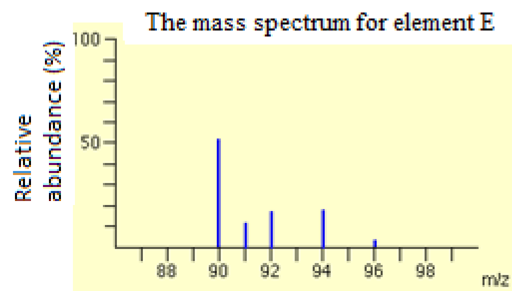
	0.10 *M* of $AgNO_3$	0.20 *M* Na_2SO_4
A.	2.0 mL	1.0 mL
B.	1.0 mL	3.0 mL
C.	2.5 mL	2.0 mL
D.	3.0 mL	1.0 mL

12. In which of the following compounds do the phosphorous atoms have the **lowest oxidation** state?

A. P_2H_4 B. P_4S_{10} C. P_2O_5 D. $Mg_2P_2O_7$

13. Which of the following statements is **NOT correct** for Element E in the mass spectrum below?

A. The mass spectrum belongs to zirconium
B. It has five isotopes
C. The heaviest isotope has a mass number of 50
D. There are six more neutrons between the heaviest and lightest isotopes



14. Which piece of equipment would give the most precise delivery of 25.0 mL of a solution?

A. 25 mL graduated cylinder
B. 25 mL syringe
C. 25 mL beaker
D. 25 mL volumetric pipet

15. The wavelength of one of the spectral lines of helium is 492 nm. What is the energy of a photon with this wavelength?

A. 3.26×10^{-40} J
B. 3.26×10^{-31} J
C. 4.04×10^{-28} J
D. 4.04×10^{-19} J

16. Which of the following gas-phase ions has the largest number of unpaired electrons in its ground state?

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

17. PbI_2 is a yellow solid
KI is a white solid
$Pb(NO_3)_2$ is a white solid
KNO_3 is a white solid

A solution is prepared by mixing 1 liter 0.0010 *M* $Pb(NO_3)_2$ with 1 liter of 0.010 *M* KI solution. Which of the following observations will be made during this reaction?

A. A yellow precipitate and yellow solution
B. A white precipitate and yellow solution
C. A white precipitate and a colorless solution
D. A yellow precipitate and colorless solution

18. A 2.00 g sample of $NaHCO_3$ and NaCl is carefully heated to a constant weight. Only $NaHCO_3$ is decomposed according to the following equation.

$$2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

The molar mass of $NaHCO_3$ is 84 g/mol. The following data is obtained.

	Mass
Beaker	56.00 g
Beaker + Sample	58.00 g
Beaker + Residue after heating	57.50 g

What is the percent mass of NaCl in the mixture? No answer is correct.

A. 32.5% B. 50.0% C. 67.5% D. 80.0%

19. Which of the following reactions is **NOT redox**?
A. $2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$
B. $H_3O^+(aq) + OH^-(aq) \rightarrow 2\ H_2O(l)$
C. $4\ ClO_3^-(aq) \rightarrow 3\ ClO_4^-(aq) + Cl^-(aq)$
D. $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$

20. 100.0 mL of 0.10 *M* NaBr solution and 200.0 mL 0.20 *M* $CaBr_2$ solution are mixed and then subsequently added to 200.0 mL of distilled water. What is the molar concentration of the bromide ions in the final solution?

A. 0.15 B. 0.18 C. 0.25 D. 0.33

21. A student performed an experiment to determine the ratio of H_2O to $CuSO_4$ in a sample of hydrated copper II sulfate by heating it to drive off the water. The substance was heated before and after heating. The formula obtained experimentally was $CuSO_4 \bullet 5.5\ H_20$ but the accepted formula is $CuSO_4.5H_20$. Which error best accounts for the difference in results? Underlined phrase is confusing. Does not change the answer. Remains as letter A.

A. During heating some of the hydrated copper II sulfate was lost
B. The hydrate sample was not heated long enough to drive off all of the water.
C. The student weighed out too much sample at the start.
D. The student used a balance which consistently gave weights to high by a 0.10 g.

22. A group of students run the six-bottle experiment to identify the unknown solutions. They tabulated their observations in two tables. The first table summarizes the data with the known 0.1 *M* solutions and the second one with unknown solutions. *ppt* denotes precipitation. For clarity purpose the cell is left blank when there is no precipitation. Table contains KNO_3 and KNO_2. Both of these do not have any ppts. No change in the answer. Answer remains as letter C.

Solutions	NaBr	$BaCl_2$	NaCl	$AgNO_3$	KNO_2	Na_2SO_4
NaBr				*ppt*		
$BaCl_2$				*ppt*		*ppt*
NaCl				*ppt*		
$AgNO_3$	*ppt*	*ppt*	*ppt*			
KNO_3						
Na_2SO_4		*ppt*		*ppt*		

Table 1. Data summary with the known solutions

Solutions	A	B	C	D	E	F
A						
B					*ppt*	
C					*ppt*	*ppt*
D					*ppt*	
E		*ppt*		*ppt*		*ppt*
F			*ppt*		*ppt*	

Table 2. Data summary with the unknown solutions

Which of the following choices is *possibly* correct?

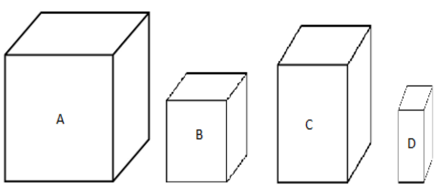
A. Solution A is $AgNO_3$
B. Solution B is KNO_3
C. Solution C is Na_2SO_4
D. Solution F is NaCl

23. Moist air is less dense than dry air at the same temperature and barometric pressure. Which is the best explanation for this observation?

A. H_20 is a polar molecule while N_2 and O_2 are not.
B. H_20 has a higher boiling point than N_2 or O_2 .
C. H_20 has a lower molar mass than N_2 or O_2 .
D. H_20 has a higher heat capacity than N_2 or O_2 .

24. Each cube weighs 10.00 grams. Cube B sinks in water. Which of the cubes will also sink in water?

A. A
B. C
C. D
D. All of them



25. How many **valence electrons** are in a persulfate ion, SO_5^{-2}?

A. 32 B. 34 C. 36 D. 38

Periodic Table and Chemistry Formulae Final copy 12-21-2017

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

$PV = nRT$

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

$P_A = P_{total} \bullet X_A$

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

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

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

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

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = m v$

$E_n = \frac{-2.178 \times 10^{-18}}{n^2}$ 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 ℑ = 96,500 coulombs/mole

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25°C

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

$pH + pOH = 14$

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

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

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

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

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

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

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

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

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

$q = m C\Delta T$

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

$q = mH_f$

$q = mH_v$.

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

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 ℑ = 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: Jan 11, 2018 Corrections None

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

AP 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.

<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), spectroscopy (Beer's Law), Mass Spectroscopy graphs of elements (not compounds), 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, solution stoichiometry, light, photoelectron effect, emission and absorption spectra, electronic structure and periodic table/periodicity.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), 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, energetics of solution formation, kinetics, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

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

<u>Dates for 2018 Season</u>

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

All areas and schools must complete the April exam and mail in the results by April 28th, 2018

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

What is to be mailed back to our office?

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

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

<u>Dates for 2019 Season</u>

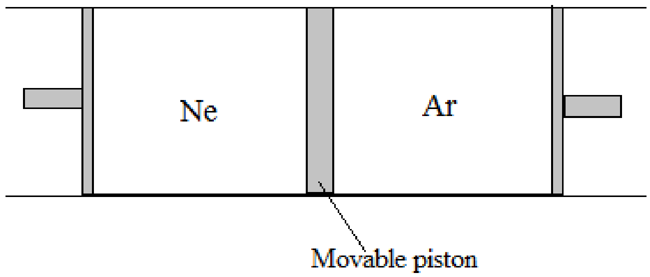
Thursday January 10, 2019 Thursday February 7, 2019
Thursday March 7, 2019 Thursday April 11, 2019

New Jersey Science League **Canary** **Corrections**

Chemistry II Exam February 8, 2018

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 container below contains two gases separated by a movable piston.



The volume of each compartment is 10 L and contains 1 mol of gas as indicated in the figure. The gases are at the same temperature and pressure. Which of the following changes will be able to move the piston?

A. Adding 10.0 g of Ne to the left compartment and 10.0 g of Ar into the right compartment by keeping the temperature constant

B. Increasing the temperature of the entire container

C. Adding 1 mol of Ne to the left compartment and 1 mol of Ar into the right compartment

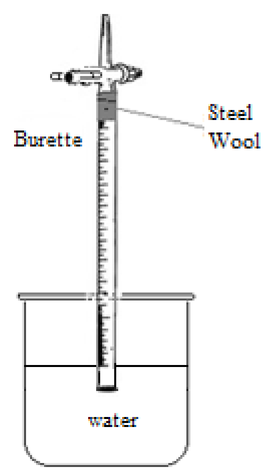
D. Adding 6.02×10^{23} molecules of Ne to the left compartment and 6.02×10^{23} molecules of Ar into the right compartment

2. $\ldots Cu_2S + \ldots HNO_3 \rightarrow \ldots Cu(NO_3)_2 + \ldots CuSO_4 + \ldots NO_2 + \ldots H_2O$

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

A. 2 B. 10 C. 8 D. 6

3. A student in a classroom performed the following experiment to determine the % oxygen in air. The figure on the right represents the initial setup. A piece of steel wool is placed in an *empty* burette. The burette is then inverted. The water level in the burette is then adjusted so that the water level in the beaker is even with the 0.0 ml mark on the burette. A reaction takes place. The iron wool reacts with the molecular oxygen in the air. Which of the following **direct measurements** is necessary to determine the amount of oxygen in the air? Assume that iron reacts with the oxygen in the air only.



A. The rusting of the iron wool

B. The volume of water in the burette

C. The change in water temperature in the beaker

D. The change in vapor pressure of water

4. Generally, the larger contributor to the deviation from ideality of a gas at STP is:

A. The size of the molecules is large compared with the assumption of negligible size.
B. Intermolecular forces exist that are assumed to be nonexistent in an ideal gas.
C. The space between the molecules is larger than that expected for an ideal gas.
D. The kinetic energy of the gas is lower than expected.

5. A gas mixture is made with 2 mol of He, 6.0 mol of Ar, and 2.0 mol of Xe. The partial pressure of He is 200 mmHg. What is the total pressure in mm of Hg?

A. 400 mmHg B. 500 mmHg C. 800 mmHg D. 1000 mmHg

6. The enthalpy of combustion of methanol and latent heat of vaporization of water are given.

$$2\ CH_3OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 4\ H_2O(g) \qquad \Delta H_1$$

$$H_2O(l) \rightarrow H_2O(g) \qquad \Delta H_2$$

What is the value of the enthalpy change, ΔH_3, in kJ, of the following reaction?

$$2\ CH_3OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 4\ H_2O(l)$$

A. $\Delta H_1 - \Delta H_2$ B. $\Delta H_1 + 4\ (\Delta H_2)$ C. $\Delta H_1 - 4\ (\Delta H_2)$ D. $\Delta H_1 + \Delta H_2$

7. In the Marsh test, Arsenic is determined by heating $As_2O_3(s)$ in the presence of solid carbon according to the balanced chemical equation:

$$2\ As_2O_3(s) + 3\ C(s) \rightarrow 3\ CO_2(g) + 4\ As(s)$$

A sample is tested for arsenic. The gas released is collected in a eudiometer. The following data are collected at 60.0^{o}C.

Volume of gas collected:	5.80 mL
Atmospheric pressure:	1.050 atm
Water temperature:	60.0^{o}C
Vapor pressure of water:	38.0 mmHg

What is the mass of Arsenic in the sample assuming that the gas is insoluble in water at this temperature?

A. 0.0110 g B. 0.110 g C. 0.0212 g D. 0.0165 g

8. A 12.8-gram sample of an unknown gas composed of C and H is burned in excess oxygen in a closed 11.2 L rigid container. When the reaction is complete, the temperature is 105^{o}C and the partial pressure ratio of CO_2 to H_2O is 2.5. Determine the **molecular formula** of the gas.

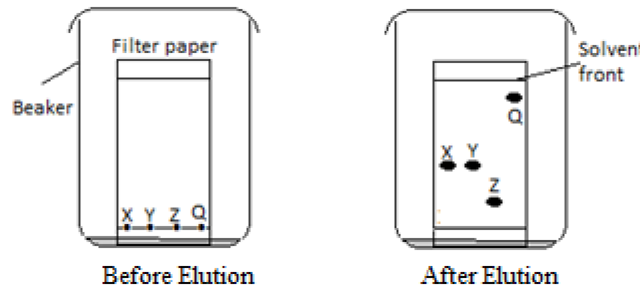
A. C_8H_{10} B. $C_{10}H_8$ C. $C_{10}H_{10}$ D. C_8H_8

9. What is the hybridization of the carbon atom in the carbocation ion, CH_3^+?

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

10. The figure below represents the elution profile of four different compounds. The solvent is pure water. The stationary phase is porous filter paper. Which statement is correct?

A. X and Y have the same molecular weight
B. Z is the most polar substance
C. Q is the most polar substance
D. Z has highest molecular weight

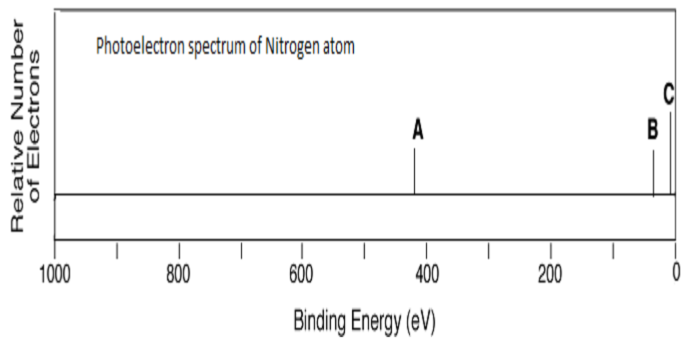


11. A 2.240-gram sample of an unknown element, Q, was completely reacted with excess oxygen to yield 0.0200 mol of oxide, Q_2O_3. What is the identity of the element?

A. Al B. Fe C. Co D. S

12. The photoelectron spectrum of nitrogen atoms is given below. How would the spectrum of oxygen atoms be different?

A. Peak A will be around 300 eV
B. The height of Peak B will be doubled
C. The height of Peak C will be tripled
D. Peak A will be around 550 eV



13. Which of the following species has a trigonal planar shape?

A. BF_4^- B. NF_3 C. CH_3^+ D. SO_2

14. Which of the following molecular compounds has the **highest boiling point**?

A. P_2O_3 B. P_2O_5 C. N_2O_5 D. N_2O_4

15. Which of the following are **isoelectronic**?

I. Ca II. Sr III. K^+ IV. Ti^{2+} V. V^{3+}

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

16. Which of the following species has a heat of formation different than the others?

A. $F_2(g)$ B. $Cl_2(g)$ C. $Br_2(l)$ D. $I_2(g)$

17. Which of the following species has a **different** shape than the others according to the VSEPR model?

A. NO_3^- B. SO_3 C. CO_3^{2-} D. ClO_3^-

18. During the hydrogenation reaction giving below, the hybridization of the carbon atoms change from ___________ to __________ ?

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

A. *sp* , *sp*^{2} B. *sp* , *sp*^{3} C. *sp*^{2} , *sp*^{3} D. *sp*^{2} , *sp*

19. There are two identical rigid containers. The first one contains CH_4 at 300 K at 1.0 atm. The second container contains O_2 at 2.0 atm. What is the temperature in the second container, if the densities of the gases are equal?

A. 120 K B. 300 K C. 600 K D. 1200 K

20. A 100-L cylinder at temperature of 27.0^{o}C and a pressure of 100.0 atm contains how many molecules of Ne gas?

A. 2.45×10^{26} B. 2.45×10^{23} C. 1.22×10^{25} D. 1.48×10^{26}

21. Which is the correct order when the elements Si, P, and S, are arranged in order of **increasing** first ionization energy? Answers A and C are correct.

A. Si, P, and S B. P, Si, and S C. Si, S, and P D. P, S, and Si

22. In which of the following molecules is the Carbon-Nitrogen bond the **shortest**?

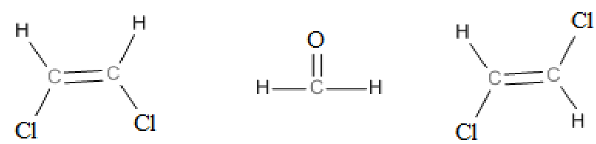
A. CH_3CN B. CH_2NH C. CH_3CONH_2 D. CH_3CHNH

23. A student draws the Lewis dot structure of O_2 as shown: **:O≡O:**

Is the Lewis dot structure of O_2 given above correct along with the reason?
A. Yes, because the oxygen atoms have octet
B. No, because the oxygen atoms lack octet
C. Yes, because there are 12 valence electrons
D. No, because there are less than 12 valence electrons

24. A thin stream of liquid is allowed to flow from a burette. A plastic rod charged with static electricity is held near the stream. Which liquid(s) would be expected to be deflected by the charged rod?

$CHCl_3$



I II III IV

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

25. The following table summarizes the enthalpy of hydration of some of the ammonium salts. Which of the statements is(are) correct?

I. The enthalpy of hydration of ammonium salts is endothermic
II. Within a family of anions the more massive the anion the higher the enthalpy of hydration of the ammonium salt

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

Compound	$\Delta H_{hydration}$
NH_4Cl	14.78
NH_4ClO_4	33.74
NH_4NO_2	19.25
NH_4NO_3	25.69

Periodic Table and Chemistry Formulae Updated 3-12-2018

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

$PV = nRT$

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

$P_A = P_{total} \bullet X_A$

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

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

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

$K_{f\ water}$ = 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 $\leftrightarrow$ c C + d D

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

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

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

$pH + pOH = 14$

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

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

$K_a \times K_b = K_w$ at 25°C

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

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

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
$-P\Delta V$ = 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 Canary test Corrections

Date: Feb 8, 2018

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

AP 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. The two processes are in dynamic competition, sensitive to initial conditions and external perturbations.

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), Mass Spectroscopy graphs of elements (not compounds), 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, solution stoichiometry, light, photoelectron effect, emission and absorption spectra, electronic structure and periodic table/periodicity.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), 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), thermo chemistry (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, energetics of solution formation, kinetics, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

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

Dates for 2018 Season

Thursday February 8, 2018

Thursday March 8, 2018 Thursday April 12, 2018

All areas and schools must complete the April exam and mail in the results by April 28th, 2018

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: http://entnet.com/~personal/njscil/html/

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 for 2019 Season

Thursday January 10, 2019 Thursday February 7, 2019

Thursday March 7, 2019 Thursday April 11, 2019

New Jersey Science League Canary
Chemistry II Exam March 8, 2018 Corrections: 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. Which of the following cations has the **strongest** enthalpy of hydration, that is lowest enthalpy of hydration)?

A. K^+ B. Li^+ C. Ba^{2+} D. Sr^{2+}

2. Which of the following statements is(are) true for the below reaction?

___Cu_2S +___HNO_3 → ___$Cu(NO_3)_2$ + ___$CuSO_4$ + ___NO_2 + ___H_2O

Correct answer is still letter C. B and C are duplicates

I. S atom is oxidized II. S atom is reduced
III. Cu atom is oxidized IV. N atom is reduced

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

3. Consider the following gas phase reaction. $2\ A(g) + B(g) \rightarrow A_2B(g)$

The following data was collected,

Trial	$[A]_o$	$[B]_o$	Rate formation A_2B
1	0.010	0.010	$2.5 \times 10^{-4} M^{-1} \times s^{-1}$
2	0.020	0.020	$5.0 \times 10^{-4} M^{-1} \times s^{-1}$
3	0.020	0.040	$1.0 \times 10^{-3} M^{-1} \times s^{-1}$

What is the overall order of the reaction?

A. 1
B. 2
C. 3
D. 0

4. Which group of elements forms oxides with the general formula M_2O_3?

A. Alkali metals B. Alkaline Earth Metals C. Boron Family D. Halogens

5. In which of the following pairs of species the first compound has **higher boiling point** than the second one?

A. PH_3 and NH_3 B. HI and HCl C. CH_3OH and C_2H_5OH D. HCl and HBr

6. Which of the following **reaction rates** will be increased by an increase in temperature?

I. $S(g) + O_2(g) \rightarrow SO_2(g)$ $\Delta H < 0$
II. $2\ SO_3(g) \rightarrow 2\ SO_2(g) + O_2(g)$ $\Delta H > 0$
III. $2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$ $\Delta H < 0$

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

7. Consider a general reaction $x\text{ A} + y\text{ B} \rightarrow z\text{ C}$ and the following average rate data over sometime Δt:

$$\frac{\Delta A}{\Delta t} = 0.0080\ M\bullet s^{-1} \qquad \frac{\Delta B}{\Delta t} = 0.0120\ M\bullet s^{-1} \qquad \frac{\Delta C}{\Delta t} = 0.0160\ M\bullet s^{-1}$$

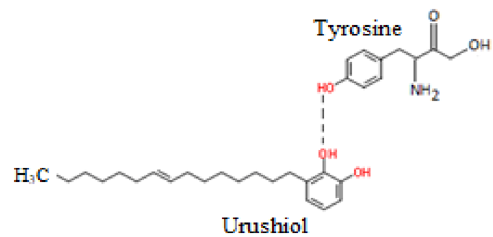
A set of possible coefficients, ***x*, *y*, and, *z*,** to balance this general equation is

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

8. Urushiol is a poisonous compound found in poison ivy. The following figure shows how urushiol interacts with the amino acid tyrosine of keratin, the protein that makes up the hair and skin.

This interaction is best described as

A. Network covalent
B. Hydrogen bonding
C. Dipole-dipole interactions
D. Dipole-Induced dipole



9. A gas mixture of 12.0 grams of He and 20.0 grams of Ne is contained in a rigid container at 25.0°C. The partial pressure of He is 1200 mmHg. While the temperature is held constant 40.0 grams of Ar are added to this mixture. What is the partial pressure of **<u>He</u>** in the **<u>new mixture</u>**?

A. 8.0×10^2 mmHg B. 9.0×10^2 mmHg C. 1.0×10^3 mmHg D. 1.2×10^3 mmHg

10. Which substance has the strongest forces of attraction between its molecules in their **<u>liquid state</u>**?

A. S_8 B. O_3 C. P_4 D. CO_2

11. Tenacity is the measure of a mineral's cohesiveness or toughness. One of the tenacity terms is sectile which means that the mineral can be cut or shaved with a knife. Which of the following elements is **<u>LEAST</u>** sectile, that is cannot be cut?

A. Sulfur B. Phosphorus C. Diamond D. Gold

12. The boiling points of F_2, ClF, and Cl_2 are -188°C, -155°C, and -34°C, respectively. F_2 and Cl_2 are nonpolar and ClF is polar. In general, polar molecules have higher boiling points than nonpolar ones. What is the best explanation in the observed trend of the boiling points?

A. Dispersion forces in liquid ClF are stronger than that of Cl_2 and F_2

B. Dispersion forces in liquid Cl_2 are stronger than the dipole-dipole interactions of ClF and the dispersion forces in F_2 because Cl_2 possess larger electron cloud than ClF and F_2

C. Ionic interactions in ClF are stronger than the dispersion forces exist in F_2 and Cl_2

D. ClF molecules can make intermolecular H-bonding and F_2 and Cl_2 cannot

13. The rate law for the reaction below is determined experimentally and the data collected is summarized in the table below:

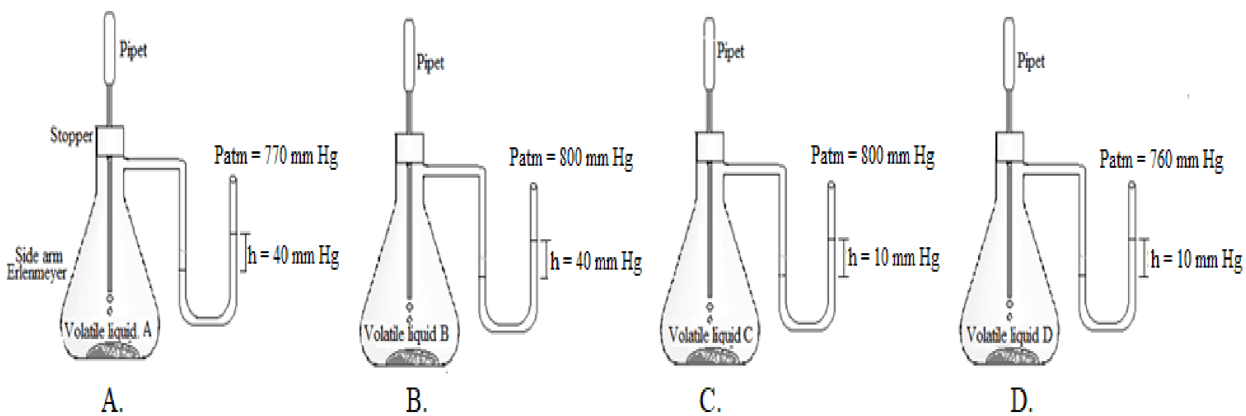
$$A + B + C \rightarrow 3Q$$

Trial	$[A]_o$	$[B]_o$	$[C]_o$	Rate of formation of Q (mol/L×s)
1	0.010 *M*	0.10 *M*	0.0010 *M*	0.000120
2	0.020 *M*	0.20 *M*	0.0010 *M*	0.000120
3	0.020 *M*	0.10 *M*	0.0010 *M*	0.000060
4	0.010 *M*	0.10 *M*	0.0020 *M*	0.000480

What is the **overall order** of the reaction?

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

14. Based on the experimental design shown below, which of the following volatile liquids has the highest vapor pressure at 25°C and specified atmospheric pressures?



15. Nuclear decay reactions are first order. Only 3.13% of the radioactive isotope remained after 1 hour. What is the half-life, in minutes, of the radioactive nuclide?

A. 10 B. 12 C. 15 D. 18

16. Which of the following species is a good electric conductor in its solid and liquid state?

A. HF B. NaCl C. C_3H_7OH D. Cu

17. Which of the following gases cannot be collected by water displacement method?

A N_2 B. O_2 C. NH_3 D. CH_4

18. What is the oxidation state of rhenium in $Fe_3(ReO_4)_2$?

A. +2 B. +3 C. +5 D. +6

19. Which of the following molecules has polar bonds but is nonpolar?

A. N_2H_4 B. CCl_4 C. OF_2 D. CH_2Cl_2

20. Which of the following choices will yield the **<u>largest mass</u>** of $PbI_2(s)$?

A. 1 mL of 0.10 *M* of $Pb(NO_3)_2(aq)$ and 1 mL of 0.10 *M* $KI(aq)$

B. 1 mL of 0.10 *M* of $Pb(NO_3)_2(aq)$ and 2 mL of 0.10 *M* $KI(aq)$

C. 2 mL of 0.10 *M* of $Pb(NO_3)_2(aq)$ and 1 mL of 0.10 *M* $KI(aq)$

D. 3 mL of 0.10 *M* of $Pb(NO_3)_2(aq)$ and 1 mL of 0.10 *M* $KI(aq)$

21. Which of the following combinations of acid-base solutions will produce the largest increase in <u>temperature</u> of the **<u>total final solutions</u>** in an ideal coffee cup calorimeter? The density of each solution is 1.0 g/ml and is constant before and after each reaction.

A. 100 mL 0.10 *M* HCl and 100 mL 0.10 *M* NaOH

B. 50 mL 0.10 *M* HCl and 100 mL 0.10 *M* NaOH

C. 100 mL 0.10 *M* HCl and 50 mL 0.20 *M* NaOH

D. 50 mL 0.20 *M* HCl and 200 mL 0.10 *M* NaOH

22. The rate of the following reaction, at 535 K, depends **<u>only</u>** on the concentration of NO_2.

$$NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$$

The following data were collected and the following graphs were plotted. Determine the value of the rate constant, with units.

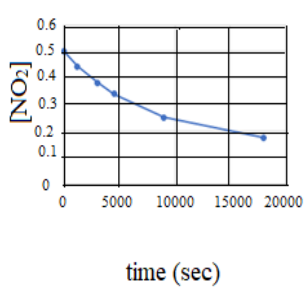
A. $2.2 \times 10^{-4}\ M^{-1} \times s^{-1}$

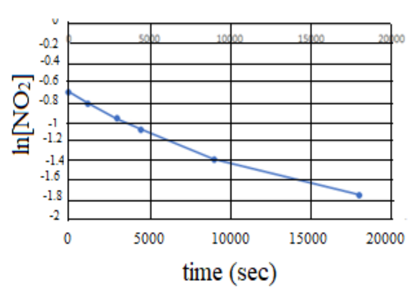
B. $2.2 \times 10^{-3}\ M \times s^{-1}$

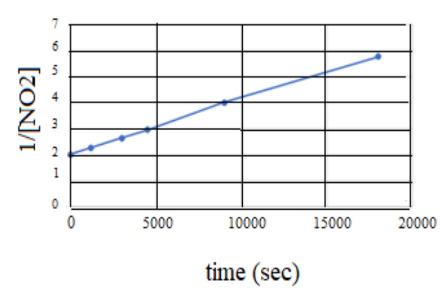
C. $4.5 \times 10^{3}\ M^{-1} \times s^{-1}$

D. $4.5 \times 10^{3}\ M \times s^{-1}$

Time (sec)	$[NO_2]$	$Ln[NO_2]$	$1/[NO_2]$
0	0.500	-0.693	2.000
1200	0.444	-0.812	2.252
3000	0.381	-0.965	2.625
4500	0.340	-1.078	2.941
9000	0.250	-1.386	4.000
18000	0.174	-1.750	5.747







23. Which of the following solutions has the **<u>highest bromide concentration?</u>**

A. 100 mL 0.20 *M* NaBr

B. 200 mL 0.20 *M* NaBr

C. 300 mL 0.10 *M* NaBr

D. 10 mL 0.30 *M* NaBr

24. Which of the following metals has the highest vapor pressure at room temperature?

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

25. Which of the following aqueous solution is <u>not</u> an electrolyte?

A. $NaC_2H_3O_2$ B. $C_3H_5(OH)_3$ C. NH_4Cl D. KCN

Periodic Table and Chemistry Formulae Updated 3-12-2018

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

$$P_1V_1 = P_2V_2$$

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

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

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

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

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

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

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

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

P = pressure
V = volume
T = Temperature
n = number of moles
d = density
m = mass
v = velocity
where $X_A = \frac{moles\ A}{total\ moles}$
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 = $\frac{8.31\ Joules}{Mole\ Kelvin}$
$= \frac{0.0821\ liter\ atm}{mole\ Kelvin}$
$= \frac{8.31\ volts\ coulombs}{mole\ Kelvin}$

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

$K_{f\ water}$ = 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

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = mv$

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

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

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

$pH + pOH = 14$

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

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

$K_a \times K_b = K_w$ at 25°C

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

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

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

$-P\Delta V$ = 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 Canary test No Corrections
Date: March 8, 2018

Deadline: All March exam results must be post marked by March 16th or scan the record sheet and email to newjsl@ptd.net or the scores will not count.

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

AP 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.

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), Mass Spectroscopy graphs of elements (not compounds), 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, solution stoichiometry, light, photoelectron effect, emission and absorption spectra, electronic structure and periodic table/periodicity.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), 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, energetics of solution formation, kinetics, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

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

Dates for 2018 Season
Thursday March 8, 2018 Thursday April 12, 2018
All areas and schools must complete the April exam and mail in the results by April 28th, 2018

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: http://entnet.com/~personal/njscil/html/

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.

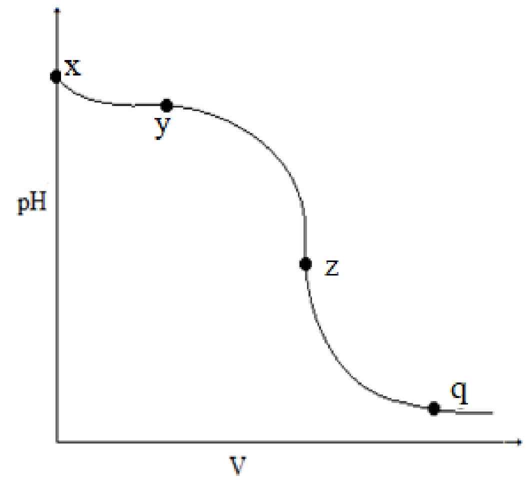
Dates for 2019 Season
Thursday January 10, 2019 Thursday February 7, 2019
Thursday March 7, 2019 Thursday April 11, 2019

New Jersey Science League Canary Corrections:
Chemistry II Exam April 12, 2018

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 following figure represents the titration of a weak base with a strong acid which is given by the following equation.

$B(aq) + H_3O^+(aq) \rightarrow BH^+(aq) + H_2O(l)$



At which point does $[B] = [BH^+]$?

A. x
B. y
C. z
D. q

2. Which of the following choices correctly represents the strength of the acids?

A. HI < HBr < HCl < HF
B. $HClO_4 < HBrO_4 < HIO_4$
C. $H_2S < H_2SO_3 < H_2SO_4$
D. $HF < H_2O < HNO_3 < H_2CO_3$

3. A sample of 10.0 mL of H_2SO_4 solution has a pH = 3.0. What volume of water in mL is needed to dilute this solution to obtain a solution with a pH of 5.0?

A. 1000 mL B. 990 mL C. 900 mL D. 90 mL

4. What is the percent ionization of a 1.2 *M* HF solution? $Ka = 6.6 \times 10^{-4}$

A. 2.4 % B. 4.2 % C. 0.84 % D. 0.082 %

5. Consider the following reaction at 500 K.

$$A(g) + 2\,B(g) \leftrightarrows C(s) + 2\,D(g)$$

The initial pressures of A and B gases are 1.0 atm each. At equilibrium, the partial pressure of D is 50.0 mmHg. What is the value of the equilibrium constant, K_p, at this temperature?

A. 5.1×10^{-3} B. 1.7×10^{4} C. 2.4×10^{-3} D. 2.4×10^{3}

6. A solution contains 0.100 *M* Pb^{2+} and 0.100 *M* Ag^+. What volume of 0.50 *M* NaCl solution in mL is needed to precipitate all the Pb^{2+} and Ag^+ ions present in 500. mL of this solution?
K_{sp} of $PbCl_2 = 4.0 \times 10^{-8}$ and K_{sp} of $AgCl = 1.8 \times 10^{-10}$.

A. 200. mL B. 36.0 mL C. 300. mL D. 240. mL

7. Which of the following reactions is NOT spontaneous at low temperature but becomes spontaneous at higher temperatures?

I.	$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$	$\Delta H > 0$
II.	$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$	$\Delta H < 0$

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

8. A and B react according the following equation:

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

A 10.00-L flask is charged with 0.250 mol of A and 0.250 mol of B. When equilibrium is reached at 1200 K, 0.0500 mol of A remains. What is the value of the equilibrium constant for this reaction?

A. 1.07×10^{2} B. 1.07×10^{-2} C. 1.07×10^{3} D. 1.07×10^{-3}

9. What is the net ionic equation between acetic acid, $HC_2H_3O_2$, and KOH?

A. $HC_2H_3O_2(aq) + KOH(aq) \rightarrow K^+(aq) + C_2H_3O_2^-(aq) + H_2O(l)$
B. $H^+(aq) + C_2H_3O_2^-(aq) + K^+(aq) + OH^-(aq) \rightarrow K^+(aq) + C_2H_3O_2^-(aq) + H_2O(l)$
C. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
D. $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow C_2H_3O_2^-(aq) + H_2O(l)$

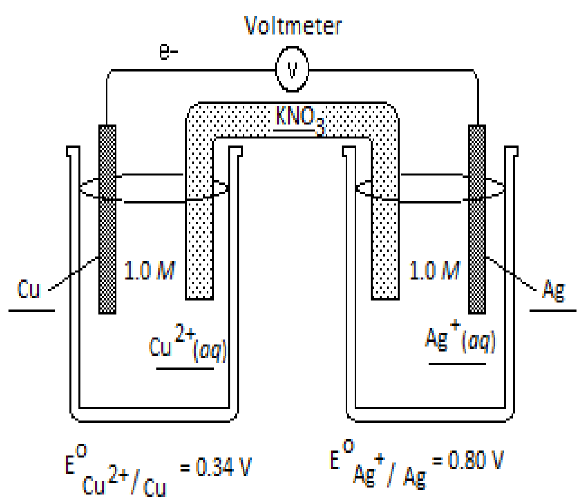
10. The equilibrium constant value for the reaction below is 1.2×10^2. Which species is the strongest base in this system?

$$HC_2H_3O_2(aq) + CN^-(aq) \leftrightarrows HCN(aq) + C_2H_3O_2^-(aq)$$

A. $HC_2H_3O_2(aq)$ B. $CN^-(aq)$ C. $HCN(aq)$ D. $C_2H_3O_2^-(aq)$

11. Based on the figure below, which one of the following choices is correct?

A. Electrons flow from the Cu cathode to the Ag anode
B. Electrons flow from the Ag cathode to the Cu anode
C. $E^o_{cell} = 0.12$ Volt
D. The spontaneous reaction is
$2Ag^+(aq) + Cu(s) \rightarrow 2Ag(s) + Cu^{2+}(aq)$



12. Which would <u>increase</u> the partial pressure of $SO_3(g)$ at equilibrium?

$$2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g) \qquad \Delta H < 0$$

A. decreasing the volume of the system
B. adding a noble gas to increase the pressure of the system
C. removing some $SO_2(g)$ from the system
D. adding an appropriate catalyst

13. What is the pH of 0.010 *M* NH_4Cl aqueous solution? $K_b = 1.80 \times 10^{-5}$.

A. 5.6 B. 5.62 C. 8.4 D. 8.38

14. A chemist wishes to prepare a solution buffered at pH = 4.0. Which weak acid below should be selected?

	Weak acid	K_a
A.	HQ_1	1.0×10^{-4}
B.	HQ_2	4.0×10^{-1}
C.	HQ_3	1.0×10^{-2}
D.	HQ_4	1.0×10^{-6}

15. Consider two solutions:

Solution I. 1.0 *M* HA ($K_a = 1.0 \times 10^{-5}$) and 1.0 *M* NaA
Solution II. 0.10 *M* HA ($K_a = 1.0 \times 10^{-5}$) and 0.10 *M* NaA

Which of the following statements is correct?

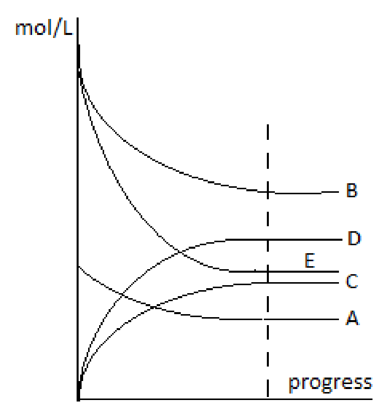
A. Solution I has a pH value higher than that of Solution II
B. Solution II has a pH value higher than that of Solution I
C. Solution I has a greater buffering capacity
D. Solution II has a greater buffering capacity

16. Consider the reaction at 1000 K. $2ClO(g) \leftrightarrows Cl_2(g) + O_2(g)$

The equilibrium constant is 64. In an experiment 0.1 mol of ClO, 0.1 mol of Cl_2, and 0.1 mol of O_2 are mixed in 1-L container. What will be the concentration of ClO when the system has reached equilibrium without a change in temperature?

A. 0.018M B. 0.082M C. 0.048M D. 0.052M

17. The figure below represents the change in concentrations of the reactants and products in time. Which one of the following choices is correct for the system at equilibrium?



A. The coefficient of E is smaller than that of B
B. A is a catalyst
C. The coefficient of D is larger than that of A
D. All the reactants have the same initial molar concentrations

18. Which of the following oxides, when dissolved in water, will produce a strong acid solution?

A. BaO   B. CO_2 C. SO_2 D. N_2O_5

19. 5.00 mL of 0.100 *M* HCl solution is titrated with 0.0500 *M* of NaOH solution. The final pH of the solution is 10.00. How many mL of NaOH solution are added?

A. 25.0   B. 15.0   C. 10.0   D. 5.00

20. The standard reduction potentials are given below:

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

Which one of the following reactions is NOT spontaneous under standard conditions?

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

21. What would be the result of increasing the pressure upon the following equilibrium system?

$$A(g) + 2B(g) + E(g) \leftrightarrows C(g) + 3D(g)$$

A. The amount of A would increase.
B. The amount of C would increase.
C. The amount of D would increase.
D. There would be no change

22. Which of the following choices describes best the change in enthalpy, the change in entropy and the spontaneity of the given reaction? All full credit. No answers are correct.

$$2SO_2(g) + O_2(g) + \text{heat} \rightarrow 2SO_3(g)$$

	ΔH^o	ΔS^o	ΔG^o
A.	–	–	*spontaneous* at low T
B.	–	+	*spontaneous* at any T
C.	+	+	*spontaneous* at high T
D.	+	–	*spontaneous* at low T

23. Which of the following elements can form both ionic and molecular compounds?

A. Fe   B. K   C. Br   D. Xe

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

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

25. 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* NaOH
D. 10 mL 0.10 *M* CH_3COOH + 5.0 mL 0.10 *M* NaOH

Periodic Table and Chemistry Formulae Updated 3-12-2018

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

$PV = nRT$

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

$P_A = P_{total} \bullet X_A$

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

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

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

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = m v$

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

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

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

$K_a \times K_b = K_w$ at 25°C

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

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

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 Canary test Corrections:

Date: April 12, 2018

All schools and areas must finish the April exam and post mark or scan all results by April 30th.

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

AP 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.

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), Mass Spectroscopy graphs of elements (not compounds), 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, solution stoichiometry, light, photoelectron effect, emission and absorption spectra, electronic structure and periodic table/periodicity.

FEBRUARY: chemical bonding, bond order (no molecular orbital theory), 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, energetics of solution formation, kinetics, reaction mechanisms, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, acids, bases, and salts (hydrolysis), pH, K_a, K_b, buffers, titration curves, solution equilibria, redox, voltaic cells, electrochemistry, thermodynamics (ΔS, ΔH, and ΔG) , descriptive chemistry of the elements, plus Jan, Feb., and Mar topics. **Dates for 2018 Season**

Thursday April 12, 2018

All schools and areas must finish the April exam and post mark or scan all results by April 30th.

New Jersey Science League

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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 for 2019 Season

Thursday January 10, 2019 Thursday February 14, 2019

Thursday March 14, 2019 Thursday April 11, 2019