New Jersey Science League - Chemistry I Exam

January 14, 2016 PINK TEST (Corrections)

SCANTRON INSTRUCTIONS: Please PRINT your **NAME**, **SCHOOL**, **AREA** and which exam (i.e., **CHEM I – Jan '16**) you are taking onto the scan-tron. State if you are an alternate or regular member of your team.

TEST INSTRUCTIONS: Choose the answer that best completes the statements or questions below and fill in the appropriate response on the form. If you change an answer, be sure to completely erase your first choice. You may use the given periodic table and formula sheet as well as a calculator. On the formula sheet is a table of the activity series of some metals.

1. The prefix "nano" is used to indicate a very small quantity. How many times *x* is one (1)"nano"?
   A) 10^{-12} B) 10^{-9} C) 10^{-8} D) 10^{-6} E) 10^{-3}

2. Calcium oxide (quicklime) is prepared by decomposition of Calcium carbonate (limestone) by a chemical roasting process that releases Carbon dioxide as well. If 2.00×10^3 g of the limestone is roasted and only 1.05×10^3 g of CaO is produced what is the percent yield of this process?
   A) 1.12% B) 5.25% C) 9.37% D) 52.5% E) 93.7%

3. Which is/are true for a graph of mass versus volume for a pure substance?
   I. A straight line is formed with a positive slope.
   II. A straight line is formed with a negative slope.
   III. A straight line is formed with a slope of zero.
   IV. The slope of the line formed is the density.

   A) All are true
   B) Only 1 and 4 are true.
   C) 1, 3, and 4 are true
   D) Only number 1 is true.
   E) Only 3 are true.

4. Which formula is correctly matched with its name?
   A) PbO_2 and lead oxide (II)
   B) MnO_2 and Manganese (II) oxide
   C) FeS and iron (II) sulfide
   D) Cu_2S and copper(II) sulfide
   E) $HgCl_2$ and mercury (I) chloride

5. A piece of sulfur weights 113.5 g. When it is submerged in a graduated cylinder containing 50.0 mL of H_2O, the water level rose to 100. mL. What is the density of the sulfur? 8^{th} Grade question.
   A) 2.00 g/mL B) 1.14g/mL C) 0.888 g/mL D) 2.27 g/mL E) 0.441 g/ml

6. Which equation represents a chemical change?
   A) $H_2O_2\,(aq) \rightarrow H_2O(l) + \frac{1}{2}\,O_2(g)$
   B) $HCl\,(aq) \rightarrow HCl(g)$
   C) $H_2O(s) \rightarrow H_2O(l)$
   D) $Br_2(l) \rightarrow Br_2(g)$
   E) $CO_2\,(s) \rightarrow CO_2(g)$

7. A student who was asked to identify a liquid made the following statements.
   I. Bubbling occurred when a strip of zinc was added to the liquid.
   II. A lighted splint popped when held over the bubbling liquid.
   III. Hydrogen gas was formed when the zinc reacted with the liquid.
   IV. Litmus paper turned pink when it was added to the liquid.
   V. The liquid can be identified as an acid.

   WHICH ARE INTERPRETATIONS RATHER THAN OBSERVATIONS?
   A) They are all interpretations.
   B) Only III, IV, and V are interpretations.
   C) They are all observations.
   D) Only II and IV are interpretations.
   E) Only III and V are interpretations.

8. After balancing the following equation, determine the number of moles of oxygen gas needed to completely react with 8.0 moles of ethane gas, C_2H_6:

   $$\_\_C_2H_6\ (g) + \_\_O_2\ (g) \rightarrow \_\_CO_2\ (g) + \_\_H_2O\ (g)$$

   A) 8 B) 7 C) 28 D) 64 E) None of the above

9. Given the following statements.
   A. Mass is conserved.
   B. Atoms are conserved.
   C. Moles are conserved
   D. Volume is conserved
   E. Molecules are conserved

   WHICH IS (ARE) ALWAYS TRUE FOR A CHEMICAL REACTION?
   A) All are true.
   B) Only letter A is true.
   C) Only A and B are true.
   D) A, B, and C are true.
   E) Only A, C, and E are true.

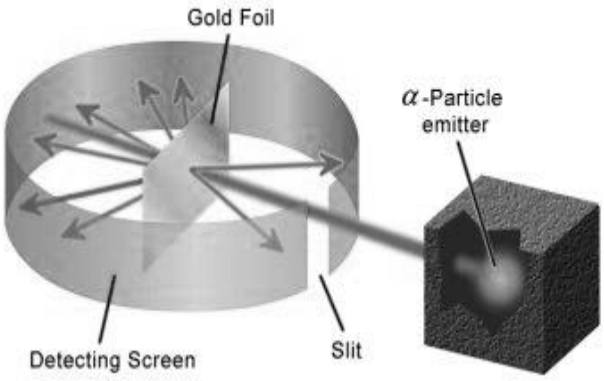
10. An unidentified element (*X*) has four naturally occurring isotopes. In the chart below are their respective atomic masses and percent natural abundance. Calculate the mass number of the element and identify the symbol of the unidentified element. Should have said calculate the average atomic mass. Not mass number. All full credit.

Isotope Designation	Atomic Mass (amu)	Natural Abundance (%)
X_a	31.97	94.93
X_b	32.97	0.76
X_c	33.97	4.29
X_d	35.97	0.02

A) 33.72, S B) 31.97, P C) 32.065, S D) 35.453, Cl

11. If 1.50 grams of $H_2C_2O_4 \bullet 2H_2O$ were heated to drive off the water of hydration, how many grams of anhydrous $H_2C_2O_4$ would remain?
A) 0.34 g B) 0.92 g C) 1.07 g D) 1.50 g

12. Which scientist used the apparatus pictured to the right which lead to his discovery of the nucleus?
A) Neils Bohr
B) JJ Thomson
C) James Chadwick
D) Pierre Curie
E) Ernest Rutherford



13. An atom containing 35 protons, 45 neutrons and 35 electrons is: 8th grade question.
A) Charge neutral.
B) A Chlorine atom.
C) A Potassium ion.
D) A Selenium ion.
E) None of the above.

14. Determine the empirical formula and the molecular formula **respectfully**, of a compound composed of 85.7% C and 14.3% H with a molecular mass of 42 amu. Answers are in the order of empirical then molecular.
A) CH_2, CH_4 B) CH_4, CH_2 C) $CH_{1.5}$, CH_3 D) C_3H_6, CH_2 E) CH_2, C_3H_6

15. Which reaction will **not** take place?
A) $Zn\ (s) + 2HCl(aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$
B) $Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$
C) $Cu\ (s) + H_2SO_4\ (aq) \rightarrow CuSO_4\ (aq) + H_2\ (g)$
D) $Mg\ (s) + Cr(NO_3)_2\ (aq) \rightarrow Mg(NO_3)_2\ (aq) + Cr\ (s)$

16. Given: $Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$. This unbalanced equation shows the reaction between magnesium and nitrogen forming magnesium nitride. When 50.0 grams of magnesium is mixed with 50.0 grams of nitrogen, the reaction produced 50.0 grams of magnesium nitride. What is the % yield?
A) 23.8 B) 27.8 C) 50.0 D) 69.2 E) 72.3

17. If the mass ratio of K to F in a compound is 2.06 : 1.00, then how many grams of F are needed to react with 97.5 g of K?
A) 0.0211 B) 47.3 C) 4.73 D) 2.11

18. Joseph Proust(1754 to 1826) was the chemist to first formally state that: Rejected: because simple memorization. Also, student may not have read about Proust. All full credit.
    A) When two elements combine with each other to form more than one compound, the weights of one element that combine with a fixed weight of the other are in a ratio of small whole numbers.
    B) The rate of any chemical reaction is proportional to the product of the masses of the reacting substances, with each mass raised to a power equal to its coefficient.
    C) During any chemical reaction, nuclear reaction, or radioactive decay in an isolated system, the total mass of the reactants or starting materials must be equal to the mass of the products.
    D) Every chemical compound contains fixed and constant proportions (by weight) of its constituent elements.
    E) None of the above.

19. What is the sulfur-to-oxygen **mass ratio** of sulfur dioxide? (ratios are sulfur-to-oxygen)
    A) 1:0.5 B) 1:1 C) 2:1 D) 8:1 E) 16:1

20. How many of each type of **atom** are in the formula $CuSO_4 \bullet 5H_2O$
    A) Cu=1, S=1, H= 5, O=5
    B) Cu=2, S=2, H= 10, O=4
    C) Cu=1, S=1, H= 10, O=9
    D) $CuSO_4$=1, H_2O =5
    E) Cu=1, S=1, H= 10, O=5

21. In order to obtain the density of aluminum a student measured the volume of a set quantity of aluminum pellets by water displacement. The student then dried off the pellets and obtained their mass. Which one of the following is an experimental error that would be consistent with obtaining a density less than the accepted value?
    A) The pellets were not completely dry when massed.
    B) Water splashed out of the graduate cylinder when the aluminum pellets were added.
    C) Air pockets remained between aluminum pellets during volume measurement
    D) Initial water level was read at top of meniscus while final reading was read at bottom of meniscus.
    E) Student forgot to subtract out the mass of the weighing dish from that of the pellets plus weighing dish

22. Given that sodium chloride is 39.0% sodium by mass, how many grams of sodium chloride are needed to have 750.0 mg of Na present?
    A) 1.92 B) 0.293 C) 1,920 D) 79.9 E) None of the above

23. A 42.7 gram sample of potassium nitrate contains how many grams of potassium?
    A) 16.5 B) 39.1 C) 21.4 D) 8.54

24. Sodium metal reacts with water to form aqueous sodium hydroxide and hydrogen gas. Which equation below best describes the balanced molecular equation for this reaction?
    A) $2Na\ (s) + H_2O\ (l) \rightarrow Na_2OH\ (aq) + H\ (g)$
    B) $Na\ (s) + H_2O\ (l) \rightarrow NaOH\ (aq) + H_2\ (g)$
    C) $2Na\ (s) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + H_2\ (g)$
    D) $2Na + H_2O\ (l) \rightarrow Na_2OH\ (aq) + H_2\ (g)$
    E) None of the above

25. How many **moles** of H atoms are in 3.42 g of $C_{12}H_{22}O_{11}$?
    A) 6.02×10^{21} B) 1.32×10^{23} C) .0100 D) 0.220 E) 22.0

CHEMISTRY I PINK TEST
ANS KEY
January 14, 2016 (Corrected in yellow)

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

CHEMISTRY I (No AP or second year students in this category.)

January Test: Scientific Method, Measurement, Factor label conversions, Properties, Density, Graphing, Mixtures, Compounds, Formulas, Mole, Weight percent, Chemical reactions, Using the Metal and Non-metal activity series for writing Chemical reactions, Types of reactions, Stoichiometry, Atomic structure and history **BUT NOT** Electronic configurations.

February Test: Quantum Theory, Electronic structure, Orbital notation, Dot notation, Periodic behavior, Specific heat, Heat of Phase Changes, Molar heat of fusion, Molar heat of vaporization, plus January topics.

March Test: Chemical bonding, molecular structure, simple isomers, intermolecular attractions, redox **BUT NOT** balancing redox equations, Kinetic Theory, Solids, Liquids, Gases, Gas laws, Gas stoichiometry, Mole fraction as applied to gases , plus January and February topics.

April Test: Solutions, Solubility rules, Reaction rates, Chemical equilibrium, Entropy, Reaction spontaneity, K_{eq}, Acids, Bases, Salts, Net ionic equations, Thermochemistry, ΔH, Hess's law, plus January, February and March 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
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 I – February 11, 2016 **Pink Exam (Corrections)**

SCANTRON INSTRUCTIONS: Please PRINT your **NAME**, **SCHOOL**, **AREA** and which exam (i.e., **CHEM I – Feb '16**) you are taking onto the scan-tron. State if you are an alternate or regular member of your team.

TEST INSTRUCTIONS: Choose the answer that best completes the statements or questions below and fill in the appropriate response on the form. If you change an answer, be sure to completely erase your first choice. You may use the given periodic table and formula sheet as well as a calculator. On the formula sheet is a table of the activity series of the elements.

1. For n = 2, determine:
   a] the maximum number of orbitals in the second energy level,
   b] the maximum number and designations (symbols) for the constituent sublevels, and
   c] the maximum number of orbitals in each of these sublevels.

   A) *a]*2 *b]*2/2s, 2p *c]*s=1,p=3
   B) *a]*4 *b]*2/2s, 2p *c]*s=1,p=3
   C) *a]*4 *b]*2/2s, 2p *c]*s=2,p=6
   D) *a]*2 *b]*2/2s, 2p *c]*s=2,p=6
   E) *a]*6 *b]*2/2s, 2p *c]*s=2,p=6

2. Chlorine is represented by the electron – dot structure 

   The atom that would be represented by an identical electron – dot arrangement has the atomic number of:

   A) 7 B) 18 C) 35 D) 51 E) None of the above

3. Select the element from the following whose atom would show the **greatest affinity** for an additional electron.

   A) Be B) Cl C) C D) Na E) Ne

4. Identify which of the following electron configurations represents an atom in an **excited state**:

   A) $1s^2 2s^2 2p^5$
   B) $1s^2 2s^2 2p^5 3s^2$
   C) $1s^2 2s^2 2p^6 3s^1$
   D) $1s^2 2s^2 2p^6 3s^2 3p^5$
   E) None of the above

5. Below are orbital notations of several elements. Which one will react with water to produce hydrogen gas and a basic solution?

   A) ___ ↑
   B) ↑↓ ↑↓
   C) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓
   D) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ ↑
   E) [Ar] ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ ↑

6. What is the maximum number of electrons that can go into the 3rd energy level?

   A) 2 B) 8 C) 10 D) 18 E) 28

7. What is the expected ground-state electron configuration for Sn^{4+}?

   A) $[Kr]5s^2 5d^{10} 5p^4$
   B) $[Kr]4d^{10}$
   C) $[Kr]5s^2 4d^{10} 5p^6$
   D) $[Kr]5d^{10}$
   E) $[Kr]5s^2 4d^{10} 5p^2$

8. Chemical reactions may involve all of the following ***except*:**
   A) Combining of atoms of elements to form a molecule.
   B) Breaking down compounds into elements.
   C) Mixing a compound and an element that then forms a new compound and element.
   D) Separating the molecules in a mixture.

9. A 15.67 g sample of a hydrate of magnesium carbonate was heated, without decomposing the carbonate, to drive off the water. The mass was reduced to 7.58 g. What is the empirical formula of the hydrate?
   A) $MgCO_3 \cdot 5H_2O$
   B) $MgCO_3 \cdot 2H_2O$
   C) $MgCO_3 \cdot H_2O$
   D) $MgCO_3 \cdot 10H_2O$
   E) $MgCO_3 \cdot 7H_2O$

10. The order in which electrons fill their principal energy levels and orbitals is governed by which of the following:
    I. The Aufbau Principle
    II. Hund's Rule
    III. Pauli's Exclusion Principle
    A) I only B) II only C) III only D) I and II E) I, II, and III.

11. The composition of a typical glass used in many bottles is 12.0% Na_2O, 12.0 % CaO, and 76.0% SiO_2. Which of the following lists the three compounds in order of greatest to least number of moles present in a typical sample of bottle glass.
    A) CaO, Na_2O, SiO_2.
    B) SiO_2, Na_2O, CaO
    C) Na_2O, SiO_2, CaO
    D) Na_2O, CaO, SiO_2
    E) SiO_2, CaO, Na_2O

12. A compound that can be readily decomposed to produce oxygen gas in the laboratory in an open container by simply heating the compound is: A and D are correct. Key has D Not enough research was done in order to eliminate choice letter A.
    A) MnO_2 B) NaOH C) CO_2 D) $KClO_3$ E) H_2O

13. Determine which one of the following metallic elements would be able to replace the other metals ions from their nitrate aqueous solutions?
    A) Aluminum B) Silver C) Lead D) Copper E) Gold

14. A 20.0 g of magnesium is burned in 20.0 g of oxygen gas forming the compound magnesium oxide. What is the quantity of product in grams that is theoretically produced from this reaction?
    A) 40.0 B) 33.2 C) 20.0 D) 80.0

15. What is the mass of manganese dioxide needed to react with an excess of hydrochloric acid so that 200. g of chlorine gas is liberated in the following reaction?

$$\mathbf{MnO_2\,(s) + 4HCl\,(aq) \rightarrow\ MnCl_2(aq) + Cl_2(g) + 2H_2O(l)}$$

    A) 245 g B) 123 g C) 87.0 g D) 70.9 g

16. A 15.0 g lead sinker (fishing weight) at 25.0°C was heated with 45.0 joules of heat. Given the specific heat of lead is 0.128 J/g˙°C, what is the final temperature of the lead weight?
    A) 0.844 °C B) 21.1 °C C) 48.4 °C D) 77.8 °C

17. An element with the electronic configuration of $[Xe]\ 6s^2\ 4f^{14}\ 5d^7$ belongs to which family or group on the periodic table?

A) Alkali metal B) Alkaline Earth metals C) halogen D) Transition metal E) Noble Gas

18. If Zinc oxalate has a formula of ZnC_2O_4, then
A) Oxalic Acid has the formula $H_2C_2O_4$
B) Oxalic Acid has the formula HCO_2
C) Aluminum oxalate has the formula $Al_3C_2O_4$
D) The oxidation number of the Carbon is +2
E) The oxidation number of the Zinc is +4

19. Balance the equation below using the smallest whole numbers for the coefficients. What is the sum of the coefficients of the **products** in the balanced equation?

__$CH_3CH_2OCH_2CH_3$ (g) + __ O_2 (g) → __ CO_2 (g) + __H_2O (g)

A) 16 B) 9 C) 6 D) 5

20. Below an element E has the configuration of $[Ne]4s^2\ 4p^1$. $[Ar]4s^2\ 4p^1$What is the formula of the sulfide with element E? All full credit E_2S_3. Test writer and proof reader did not see the s which should have been a 2.

A) ES B) E_2S C) E_sS_3 E_2S_3 D) ES_2 E) E_3S_4

Questions 21. – 23. Is based upon the following experiment:
A discharge tube filled with only hydrogen gas was electrified. The gas gave off blue light, which was polarized and then passed through a prism. Four (4) narrow, colored bands were observed on a screen behind the prism. The energy of a photon is given by the equation $E = h\nu$.

The data collected during the experiment was:

Band	Color	Wavelength, λ (10^{-9}m)	Frequency, ν (sec^{-1})
1	Violet	410	7.3×10^{14}
2	Blue Violet	434	6.9×10^{14}
3	Blue Green	486	6.2×10^{14}
4	Red	656	4.6×10^{14}

21. Which of the following best explains why hydrogen gas emitted light when electrified?
A) The electrons turned into photons when subjected to an electric field.
B) The electricity caused the gas particles to collide with great kinetic energy, producing photons.
C) The ionized gases produced by the electric current emit photons.
D) Electrons absorbed photons of electricity that provided the energy needed for them to be ejected.
E) For energy to be conserved in an atom, photons are emitted when an electron drops to the ground state after being excited.

22. A photon of red light (see table for #21) is produced by the hydrogen atom. Which of the following expressions accurately calculates its energy?
    A) $(4.6 \times 10^{14}) \times (656)$
    B) $(4.6 \times 10^{14}) \times (6.63 \times 10^{-34})$
    C) $(4.6 \times 10^{14}) \times (3 \times 10^{8})$
    D) $(656) \times (6.63 \times 10^{-34})$
    E) None of the above

23. All of the following are true statements regarding atomic spectra ***except*:**
    A) Line spectra are typical of electrified gases.
    B) The electron configuration of the atom determines the type of spectra that is emitted.
    C) The number of lines in the spectra is directly proportional to the number of electrons in the atom.
    D) Photons with lower wavelengths than those of visible light can be emitted by atoms.
    E) The lines produced in atomic spectra support the quantum mechanical model of the atom that says there are achievable energy states.

24. A cathode ray strikes a detector plate in a straight line. However, when an electric or magnetic field is applied, the path of the ray is deflected. Three interpretations were made. Which, if any, are correct?
    I. Cathode ray particles are charged.
    II. Cathode rays have both wave- and particle- like properties.
    III. Cathode rays are composed of electrons.

    A) I only B) II only C) III only D) I and II E) I and III only

25. The ionization energies for an element are listed in the table below. The unit of measure is the electron volt, eV, which is a measure of the ionization energy.

First	Second	Third	Four	Fifth
8 eV	15eV	80 eV	109 eV	141 eV

Using the table above, which element listed below would most likely have these values?

A. sodium B. Magnesium C. Aluminum D. Silicon E. Phosphorous

Chemistry I Answer Key PINK TEST
February 11, 2016
(Corrections)

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

CHEMISTRY I (No AP or second year students in this category.)

January Test: Scientific Method, Measurement, Factor label conversions, Properties, Density, Graphing, Mixtures, Compounds, Formulas, Mole, Weight percent, Chemical reactions, Using the Metal and Non-metal activity series for writing Chemical reactions, Types of reactions, Stoichiometry, Atomic structure and history **BUT NOT** Electronic configurations.

February Test: Quantum Theory, Electronic structure, Orbital notation, Dot notation, Periodic behavior, Specific heat, Heat of Phase Changes, Molar heat of fusion, Molar heat of vaporization, plus January topics.

March Test: Chemical bonding, molecular structure, simple isomers, intermolecular attractions, redox **BUT NOT** balancing redox equations, Kinetic Theory, Solids, Liquids, Gases, Gas laws, Gas stoichiometry, Mole fraction as applied to gases , plus January and February topics.

April Test: Solutions, Solubility rules, Reaction rates, Chemical equilibrium, Entropy, Reaction spontaneity, K_{eq}, Acids, Bases, Salts, Net ionic equations, Thermochemistry, ΔH, Hess's law, plus January, February and March 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 - Chemistry I Exam
March 10, 2016 PINK TEST (Corrections)

SCANTRON INSTRUCTIONS: Please PRINT your **NAME**, **SCHOOL**, **AREA** and which exam (i.e., **CHEM I – Mar '16**) you are taking onto the scan-tron. State if you are an alternate or regular member of your team.

TEST INSTRUCTIONS: Choose the answer that best completes the statements or questions below and fill in the appropriate response on the form. If you change an answer, be sure to completely erase your first choice. You may use the given periodic table and formula sheet as well as a calculator. On the formula sheet is a table of the activity series of the elements.

1. Which of the following are physical properties?
A) Electronegativity
B) Melting point
C) Density
D) Atomic Radius
E) All are physical properties

2. An atom of an element has a total of 16 electrons. An ion of the same element has a total of 18 electrons. Which statement describes the charge and radius of the ion?
A) The ion is positively charged and its radius is smaller than the neutral atom.
B) The ion is positively charged and its radius is larger than the neutral atom.
C) The ion is negatively charged and its radius is smaller than the neutral atom.
D) The ion is negatively charged and its radius is larger than the neutral atom.
E) The atom is neutral and its radius is the same size.

3. How many structural isomers does the molecular formula C_4H_8 have?
A) one B) two C) three D) four E) five

4. The following gases are each placed in their own 1.0 liter container at the same temperature and pressure. How do their average kinetic energies compare?
I. hydrogen, H_2 II. Neon, Ne III. Carbon dioxide, CO_2 IV. Helium, He

A) I > IV > II > III
B) IV > I > II > III
C) III > II > I > IV
D) II = IV > I > III
E. I = II = III = IV

5. The molecular compound Sulfur trioxide SO_3, is most likely to exhibit which molecular geometry based upon the VSEPR theory?
A) Trigonal planar
B) Trigonal bipyramidal
C) Octahedral
D) Tetrahedral
E) Bent

6. The molecule that contains a central atom with sp hybridization is:
A) C_3H_8 B) C_6H_{14} C) H_2O D) CO_2 E) CH_2O

7. When a reaction occurs between atoms with ground – state electron configurations of 3-1 and 2-6, the predominate type of bond formed is a(n): All full credit. 3-1 and 2-6 were not electronic configurations.
A) Polar covalent bond
B) Non – polar covalent bond
C) Hydrogen bond
D) Ionic bond
E) Metallic bond

8. The table below shows the boiling points for the diatomic elements listed.

Element	Normal Boiling Point (^oC)
Fluorine	-188.1
Chlorine	-34.6
Bromine	+58.8
Iodine	+184.4

Which statement best explains the pattern of boiling points relative to molecular size?
A) Stronger London dispersion forces occur in larger molecules.
B) Weaker London dispersion forces occur in larger molecules.
C) Stronger hydrogen bonds occur in larger molecules.
D) Weaker hydrogen bonds occur in larger molecules.
E) Neither London dispersion forces nor hydrogen bonds are the cause for this phenomenon.

9. For a Carbon atom to form four single bonds with a halide it must have:
A) four δ bonds
B) two σ bonds and two π bonds
C) four π bonds
D) four sp^2 hybrids
E) four sp^3 hybrids

10. Which one of the following has **<u>one pair</u>** of non-bonding electrons on the central bonded atom?
A) BCl_3 B) NH_3 C) CH_4 D) CCl_2Br_2 E) H_2CO

11. The **<u>first hydrocarbon</u>** that can demonstrate isomerization is:
A) Methane, CH_4 B) Ethane, C_2H_6 C) Propane, C_3H_8
D) Butane, C_4H_{10} E) Pentane, C_5H_{12}

12. Below are five chemical equations. Identify the reaction(s) that involve the process of Oxidation &/or Reduction.

I. $\mathbf{H_2O(s) \rightarrow H_2O(gas)}$

II. $\mathbf{2Na(s) + 2H_2O(liq) \rightarrow 2NaOH(aq) + H_2(gas)}$

III. $\mathbf{2AgNO_3(aq) + PbCl_2(aq) \rightarrow Pb(NO_3)_2(aq) + 2AgCl(s)}$

IV. $\mathbf{2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(gas)}$

V. $\mathbf{NaOH(aq) + HCl(aq) \rightarrow H_2O(liq) + NaCl(aq)}$

A) Equation I, only
B) Equation II, only
C) Equation I, II, and III
D) Equation II and IV
E) Equation III and V

13. At the top of a high mountain, water boils at 90^oC in an open container. The boiling point of water at sea level is 100^oC. Which of the following best explains the phenomenon?

A) Water at high altitudes contains a greater concentration of dissolved gases.
B) Water molecules at high altitudes have higher kinetic energies due to the lower pressure on them.
C) The boiling point of water in an open container is dependent upon the air pressure. On top of a mountain the pressure is lower so the boiling point of water is lower.
D) The vapor pressure of water increases with increasing altitude.
E) Water found at high altitudes has fewer solutes and impurities that allows boiling to occur at lower temperatures.

14. A mixture of 6.02×10^{23} molecules of NH_3 (g) and 3.01×10^{23} molecules of H_2O (g) has a total pressure of 6.00 atom. What is the partial pressure of NH_3?

A) 1.00 atm B) 2.00 atm C) 3.00 atm D) 4.00 atm E) 6.00 atm

15. Which increases as a gas is heated at constant volume?

I. Pressure
II. Kinetic energy of molecules
III. Attractive forces between molecules

A) I only B) II only C) III only D) I & II only E) I & III only

16. Methanol, CH_3OH, burns in oxygen to form carbon dioxide and water. What volume of oxygen is required to burn 6.00 L of gaseous methanol measured at the same temperature and pressure?

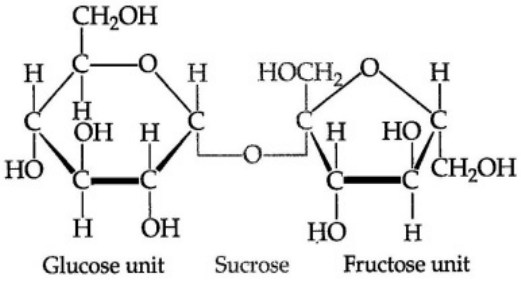
A) 4.00 L B) 8.00 L C) 9.00 L D) 12.0 L E) 18.0 L

17. Helium can be liquified at approximately 4 K because of

A) dipole-dipole attractive forces
B) hydrogen bonding
C) induced dipoles
D) ionic attractions
E) ion-dipole attractions

18. Given the structure of sucrose below, what are the forces that hold a molecule of sucrose to other molecules of sucrose forming a solid? The solid structure of sucrose, shown below, is held together by which of the following forces?

I. Dispersion
III. Hydrogen bonds
II. Dipole – Dipole
IV. Ion – dipole



A) I only B) I & II only C) I, II, & III only D) II & III only E) III & IV only

19. A solid is a poor conductor of electricity. It is very hard, non-brittle and has a high melting point. The solid is therefore probably a(n): No answer is correct. Network solids are brittle as are ionic solids.

A) Metallic solid
B) Network solid
C) Ionic solid
D) Molecular solid
E) All of the above are possible.

20. Based on the ionization energies for Element X listed in the table below, which of the following elements is **X** most likely to be?

Ionization Energies for ***Element X*** (kJ · mol^{-1})

First	Second	Third	Fourth	Fifth
786	1,577	3,228	4,354	16,100

A) Li B) Be C) Al D) Si E) As

21. How is the disparity between the heat of fusion and the heat of vaporization for H_2O best explained?

A) It takes more hydrogen bonds for water to fuse than it does to vaporize.
B) Water molecules are moving farther apart during fusion than during vaporization.
C) Water molecules are moving closer together during fusion and farther apart during vaporization.
D) Vaporization occurs at a higher kinetic energy than fusion.
E) More hydrogen bonds are broken during vaporization.

22. Gases N_2 (g) and H_2 (g) are added to a previously evacuated container and react at a constant temperature according to the following chemical equation:

$$\mathbf{N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)}$$

If the initial pressure of N_2 (g) was 1.2 atm, and that of H_2 (g) was 3.8 am, what is the partial pressure of NH_3 (g) when the partial pressure of N_2 (g) has decreased to 0.9 atm?

A) 0.30 atm B) 0.60 atm C) 0.9 atm D) 1.8 atm E) 3.8 atm

23. The total atmospheric pressure of the laboratory (760 mmHg), as well as the temperature of the water (22^oC) and the volume of gas (502 mL) in a eudiometer are known. If the vapor pressure of the water is 20 mmHg at this temperature, which additional data, if any, is needed to calculate the number of moles of CO_2 gas collected during the experiment?

A) The temperature of the gas collected
B) The mass of the gas in the eudiometer
C) The volume of the H_2O (l) in the eudiometer
D) The vapor pressure of the CO_2 at the temperature
E) No other information is needed for the calculation

24. Calculate the pressure at 16.0 ^oC, of 1.00g of hydrogen gas that occupies 2.54 L.

A) 2.33 atm B) 4.66 atm C) 1.17 atm D) 0.500 atm E) 9.12 atm

25. How many grams of nitrogen gas are there in 0.38 L of gas at 0^oC and 380 mmHg pressure?
A) 2.4g B) 12 g C) 0.24 g D) 1.2 g E) 8.5 x 10^{-3} g

CHEMISTRY I PINK TEST

ANS KEY

March 10, 2016

Record on the area record the % correct (Corrections)

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

CHEMISTRY I (No AP or second year students in this category.)

January Test: Scientific Method, Measurement, Factor label conversions, Properties, Density, Graphing, Mixtures, Compounds, Formulas, Mole, Weight percent, Chemical reactions, Using the Metal and Non-metal activity series for writing Chemical reactions, Types of reactions, Stoichiometry, Atomic structure and history **BUT NOT** Electronic configurations.

February Test: Quantum Theory, Electronic structure, Orbital notation, Dot notation, Periodic behavior, Specific heat, Heat of Phase Changes, Molar heat of fusion, Molar heat of vaporization, plus January topics.

March Test: Chemical bonding, molecular structure, simple isomers, intermolecular attractions, redox **BUT NOT** balancing redox equations, Kinetic Theory, Solids, Liquids, Gases, Gas laws, Gas stoichiometry, Mole fraction as applied to gases , plus January and February topics.

April Test: Solutions, Solubility rules, Reaction rates, Chemical equilibrium, Entropy, Reaction spontaneity, K_{eq}, Acids, Bases, Salts, Net ionic equations, Thermochemistry, ΔH, Hess's law, plus January, February and March 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 I Exam
April 14, 2016 PINK TEST (Corrections)

SCANTRON INSTRUCTIONS: Please PRINT your **NAME**, **SCHOOL**, **AREA** and which exam (i.e., **CHEM I – Apr '16**) you are taking onto the scan-tron. State if you are an alternate or regular member of your team.

TEST INSTRUCTIONS: Choose the answer that best completes the statements or questions below and fill in the appropriate response on the form. If you change an answer, be sure to completely erase your first choice. You may use the given periodic table and formula sheet as well as a calculator. On the formula sheet is a table of the activity series of the elements.

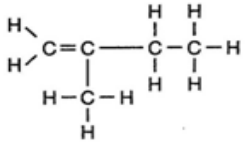
1. Which element of the following list has the **largest** atomic radius?
   A) Fe B) Mg C) Si D) Zn E) K

2. A solution has a pH of 3.25 at 25°C. Which of these statements are true about this solution?
   I. The $[H_3O^{+1}] > [OH^{-1}]$ II. The $[H_3O^{+1}] \times [OH^{-1}] = 1 \times 10^{-14}$.
   III. This solution is an acid IV. The $[OH^{-1}] > [H_3O^{+1}]$
   V. The solution is basic.

   A) I only is true B) I, II, and III only are true C) IV and V only are true
   D) I and III only are true. E) II only is true.

3. Given the formula representing a hydrocarbon determine molecular and empirical formula for this hydrocarbon.

   A) C_5H_{10} & CH_2
   B) C_5H_{10} & CH_3
   C) C_3H_8 & CH_3
   D) C_4H_8 & CH_2
   E) C_4H_8 & CH_3



4. Arrange the nitrogen to nitrogen bonds in order from **shortest to longest**. N_2, N_2H_2, N_2H_4.
   A) $N_2 < N_2H_2 < N_2H_4$ B) $N_2 < N_2H_4 < N_2H_2$ C) $N_2H_2 < N_2 < N_2H_4$. D) $N_2H_4 < N_2H_2 < N_2$

5. Which compounds contain both ionic and covalent bonds?

   I. NH_4NO_3 **II. $KAl(SO_4)_2$** **III. CH_3CH_2OH**

   A) II only B) II & III only C) I & II only D) I & III only E) I, II, & III

6. Rank the following neutral atoms from the largest electronegativity to the least. All full credit Leave out Ar.
   A) Na > Al > P > Cl > Ar D) Ar > Na > Al > P > Cl
   B) Ar > Cl> Al > P > Na E) Na > Cl > Al > P > Ar
   C) Cl > P > Al > Na > Ar

7. A solution of sodium bicarbonate ($NaHCO_3$) is basic because**:**
   A) the sodium reacts with water to form sodium hydroxide.
   B) the sodium ions are hydrated.
   C) it contains hydroxide and hydrogen ions.
   D) the bicarbonate ion reacts with water to produce hydroxide ions.
   E) carbon dioxide is produced.

8. The difference between the two heats of reaction is +5.2 kcal. What does the difference represent?

   I. $K(s) + 1/2\ Br_2(1iq) \rightarrow KBr(s); \quad \Delta H = -94.0$ kcal

   II. $K(s) + 1/2\ Br_2(g) \rightarrow KBr(s); \quad \Delta H = -99.2$ kcal.

   A) the heat required to melt one mole of KBr.
   B) the heat released when two moles of KBr(s) form.
   C) the heat required to vaporize 1/2 mole of liquid Br_2.
   D) the heat released in the overall reaction.

9. Which statement is **true** of a measured pressure of a sample of hydrogen gas **collected over water** at constant temperature?

A) The measured pressure is greater than the pressure of dry hydrogen.
B) The measured pressure is less than the pressure of dry hydrogen.
C) The measured pressure is equal to the pressure of dry hydrogen.
D) The measured pressure varies inversely with the pressure of dry hydrogen.
E) The measured pressure is the same whether it is dry hydrogen or not.

10. For the reaction $2\,HC1(g) \rightleftarrows H_2(g) + Cl_2(g)$ at 1200^0C, $\Delta H = +44.12$ kcal and $K_{eq} = 4.0 \times 10^{-5}$. The **value** of K_{eq} could be increased by

A) adding a catalyst
B) increasing the temperature
C) adding Cl_2(gas)
D) increasing the pressure
E) Keq cannot be changed.

11. The formula for molarity is

A) moles of solute/moles of solution
B) grams of solute/grams of solution
C) moles of solute/volume of solvent
D) moles of solute/volume of solution
E) kg of solute/kg of solvent

12. Given the following equation for the **combustion** of propane gas:

$$C_3H_8g + 5\,O_2g \rightarrow 3\,CO_2g + 4\,H_2Og \quad \Delta H = -2044\ kJ$$

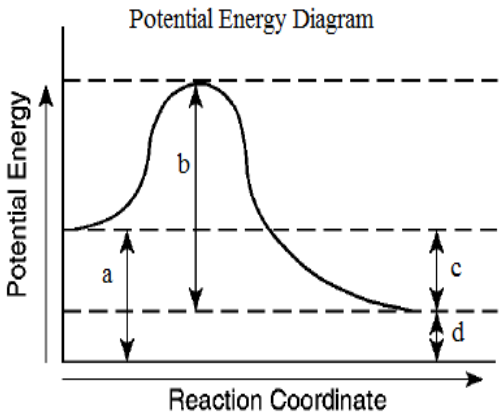
Determine which of the following statements is **true**.

I. This is an endothermic reaction
II. This is a spontaneous reaction.
III. This is an exothermic reaction.
IV The reaction is reversible

A) I and II B) II and III C) III and IV D) III only

13. The following graph represents the energy levels of the reactants and products during a chemical reaction. Which statement is true about the **forward** reaction?

A) An exothermic reaction
B) An endothermic reaction
C) "*a*" represents the energy given off
D) "*b*" is called the activation energy
E) a catalyst will change the length of line c.



14. Which equation represents a redox reaction?

A) $AgNO_3\,(aq) + NaCl\,(aq) \rightarrow AgCl\,(s) + NaNO_3\,(aq)$
B) $H_2CO_3\,(aq) \rightarrow H_2O\,(l) + CO_2\,(g)$
C) $2NaOH\,(aq) + H_2SO_4\,(aq) \rightarrow Na_2SO_4\,(aq) + 2H_2O\,(l)$
D) $Mg\,(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + H_2\,(g)$
E) $H_2O\,(l) + heat \rightarrow H_2O\,(g)$

15. The catalytic converter in an automobile changes gases produced during fuel combustion to less harmful exhaust gases. In the catalytic converter, nitrogen dioxide reacts with carbon monoxide to produce nitrogen and carbon dioxide. In addition, some carbon monoxide reacts with the oxygen, producing carbon dioxide in the converter. These reactions are represented by the balanced equations below.

Reaction 1: $\mathbf{2NO_2\,(g) + 4CO\,(g) \rightarrow N_2\,(g) + 4CO_2\,(g) + 1198.4\ kJ}$

Reaction 2: $\mathbf{2CO\,(g) + O_2\,(g) \rightarrow 2CO_2\,(g) + 566.0\ kJ}$

Determine the change in oxidation number of nitrogen in reaction 1 and carbon in reaction 2.

A) N: +4 → +2; C: +4 → 0
B) N: +4 → +2; C: +4 → +2
C) N: +2 → +4; C: +2 → +4
D) N: +4 → 0; C: +4 → +2
E) N: +4 → 0; C: +2 → +4

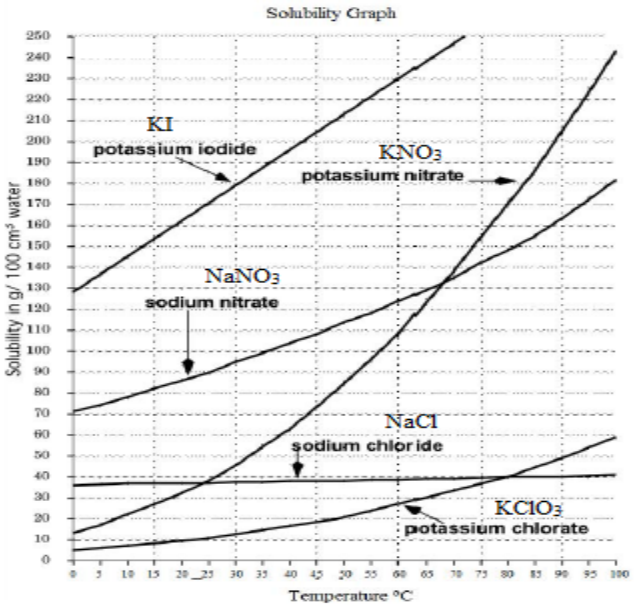
16. Which pairs of substances are completely miscible with each other?

I. $\mathbf{H_2O}$ **II.** $\mathbf{C_6H_6}$ **III.** $\mathbf{CH_3CH_3}$

A) I & II only
B) II & III only
C) I & III only
D) I, II, and III.
E) None will dissolve in each other

17. The graph to the right reflects the solubility of many ionic compounds in water. Based on the graph these ionic compounds dissolve _____, with a(n) _____ in _____.

A) Exothermically, decrease, enthalpy
B) Exothermically, increase, entropy
C) Endothermically, increase, entropy
D) Endothermically, increase, enthalpy
E) Endothermically, decrease, enthalpy



18. If the half-life of ^{14}C is 5730 years. Approximately how many years will it take for **approximately** 94% of the sample to decay?

A) 5730 B) 2 x 5730 C) 3 x 5730 D) 4 x 5730 E) 5 x 5730

19. You are given 5 beakers containing water and other solutes. Which of these 5 beakers are **good** conductors of electricity?

I. Sodium chloride dissolved in water.
II. Sucrose ($C_{12}H_{22}O_{11}$) dissolved in water.
III. Pure water
IV. Nitric acid dissolved in water.
V. Methyl alcohol (CH_3OH) dissolved in water.

A) All are good conductors
B) Only I, II, and III
C) II and V only
D) I and IV only
E) III only

20. Identify the equilibrium expression for the decomposition of ammonium carbonate, according to the following equation.

$$(NH_4)_2CO_3\ (s) \rightleftharpoons 2NH_3\ (g) + CO_2\ (g) + H_2O\ (g)$$

A) $K_{eq} = [NH_3][CO_2][H_2O]$

B) $K_{eq} = [NH_3]^2[CO_2][H_2O]$

C) $K_{eq} = \dfrac{[NH_3][CO_2][H_2O]}{[NH_3]^2[CO_2][H_2O]}$

D) $K_c = \dfrac{[(NH_4)_2CO_3]}{[NH_3]^2[CO_2][H_2O]}$

E) $K_{eq} = \dfrac{[NH_3]^2[CO_2][H_2O]}{[(NH_4)_2CO_3]}$

21. Which of the following statements is true of the reaction represented below?

$$F^-\ (aq) + H_2O\ (l) \leftrightarrow HF\ (aq) + OH^-\ (aq)$$

A) H_2O is the conjugate acid of F^-
B) OH^- is the conjugate acid of H_2O
C) HF is the conjugate base of F^-
D) HF and H_2O are conjugate acid – base pairs
E) HF and H_2O are both Bronsted – Lowry acids

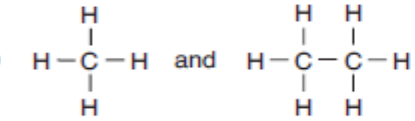
22. The equilibrium constant for a chemical reaction has the value of 1.5 at a specific temperature. This value indicates

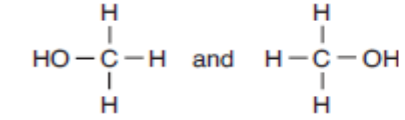
A) Products are slightly favored at equilibrium.
B) Reactants are slightly favored at equilibrium
C) The amounts of products and reactants are equal at equilibrium
D) Products are greatly favored at equilibrium
E) The value by itself has no significance to an equilibrium equation.

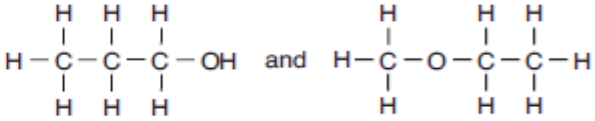
23. Which of the following chemical equations represents the **net ionic equation** for the reaction that occurs when sodium iodide solution is added to a solution of lead (II) acetate?

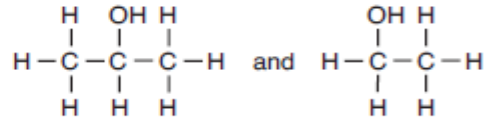
A) $2\ I^- + Pb^{2+} \rightarrow PbI_2$
B) $Na^+\ CH_3COO^- \rightarrow NaCH_3COO$
C) $2\ NaI + Pb(CH_3COO)_2 \rightarrow 2\ NaCH_3COO + PbI_2$
D) $2\ NaI + Pb(CH_3COO)_2 + H_2O \rightarrow 2\ NaOH + Pb(OH)_2 + I_2$
E) $4\ I^- + 2\ Pb^{2+} + 2\ H_2O \rightarrow PbI_2 + Pb(OH)_2 + 2\ HI$

24. Which formulas represent compounds that are **isomers** of each other?

A)  and

B) 

C) 

D) 

25. What **volume** of distilled water should be added to 20 mL of 5M HCl(aq) to prepare a 0.8M solution?

A) 100 mL B) 105 mL C) 125 mL D) 140 mL E) 200 mL

Chemistry I Answer Key PINK TEST
April 14, 2016 (Corrections)

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

CHEMISTRY I (No AP or second year students in this category.)

January Test: Scientific Method, Measurement, Factor label conversions, Properties, Density, Graphing, Mixtures, Compounds, Formulas, Mole, Weight percent, Chemical reactions, Using the Metal and Non-metal activity series for writing Chemical reactions, Types of reactions, Stoichiometry, Atomic structure and history **BUT NOT** Electronic configurations.

February Test: Quantum Theory, Electronic structure, Orbital notation, Dot notation, Periodic behavior, Specific heat, Heat of Phase Changes, Molar heat of fusion, Molar heat of vaporization, plus January topics.

March Test: Chemical bonding, molecular structure, simple isomers, intermolecular attractions, redox **BUT NOT** balancing redox equations, Kinetic Theory, Solids, Liquids, Gases, Gas laws, Gas stoichiometry, Mole fraction as applied to gases , plus January and February topics.

April Test: Solutions, Solubility rules, Reaction rates, Chemical equilibrium, Entropy, Reaction spontaneity, K_{eq}, Acids, Bases, Salts, Net ionic equations, Thermochemistry, ΔH, Hess's law, plus January, February and March topics.

Testing Dates for 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***

Periodic Table and Chemistry Formulas 1-18-2016

Periodic Table of the Elements
amu to 4 significant figures

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.008	2 2A																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	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	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 = $\frac{8.31\ \text{Joules}}{\text{Mole Kelvin}}$
= 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 ^oC, 1.00 atm (101.3 kPa)
= 14.7 psi

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

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

ATOMIC STRUCTURE

$\Delta E = h\nu$

$c = \nu\lambda$

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

$p = m v$

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

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.

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

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

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

EQUILIBRIUM

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

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

$pH + pOH = 14$

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

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

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

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

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

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

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}