New Jersey Science League - Chemistry I Exam
January 2015 PINK TEST

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 sheets is a table of the activity series of the elements. Please PRINT your name, school, area, and which test you are taking onto the scan-tron.

1. A pure metal is made up of atoms that are held together by all valence electrons that are not held exclusively by any particular atoms, but move freely around them. This statement is best described as
   A. a correct definition of a chemical term or expression, either in terms of experimental behavior or of sound scientific theory.
   B. a specific experimental fact.
   C. an opinion not based on evidence.
   D. a scientific law expressing the directly observable results of many different experiments.
   E. a scientific theory, which, while it cannot be directly measured or observed, is in accord with and explains the results of experiments.

2. How could you decide **most easily** if a gas is hydrogen or oxygen?
   A. Determine its solubility in water
   B. pass an electric spark through the gas
   C. place a piece of glowing charcoal in the gas
   D. determine the molar mass
   E. smell the gas.

3. A student was given a copper penny, a block of wood, and a plastic pan full of water. She was instructed to measure the mass and volume of each object respectively, and then to place each in the pan of water. The measurements were entered into a table below:

Object	mass	volume
copper penny	3.12 g	0.36 cm^3
block of wood	200.00 g	312 cm^3

When both objects were placed in the water, the penny dropped to the bottom of the pan, while the block of wood floated at the surface of the water in the pan. All this can **best** be explained by the following statement:

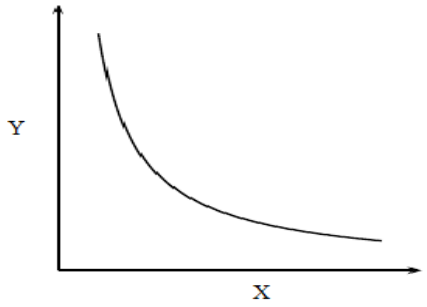
   A. Copper is heavier than wood.
   B. Wood is heavier than copper.
   C. Copper is lighter than wood.
   D. Wood is lighter than copper
   E. Copper is denser than wood.

4. Consider the **unbalanced** equation $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$ which represents the combustion of methane gas. What is the number of moles of H_2O that will formed when 5 moles of CH_4 is burned?
   A. 2 B. 4 C. 10 D. 20 E. 45

5. When a solid piece of aluminum is added to a dilute solution of sulfuric acid, a solution of aluminum sulfate and bubbles of hydrogen gas are formed. Write and balance this reaction reducing all coefficients to their lowest value. What is the coefficient of the hydrogen gas?
   A. 1 B. 3 C. 5 D. 6 E. None of these

6. If barium hypochlorite has the formula $Ba(ClO)_2$, then what is the formula for chromium (III) hypochlorite?
   A. CrC1O B. $Cr(ClO)_3$ C. $Cr_2(ClO)_3$ D. $Cr_3(ClO)_2$ E. $Cr(ClO)_2$

7. Data was collected in the laboratory for quantities X and Y. Then the data were plotted on the graph at the right. Which statement correctly expresses the relationship between the quantities X and Y?



A. X and Y are directly proportional to each other.
B. X and Y are inversely proportional to each other.
C. X ÷ Y = constant
D. Y ÷ X = constant
E. X = Y

8. Incandescent carbon particles cause a Bunsen burner gas flame to be yellow. To obtain a hotter blue flame you should:

A. close the air holes
B. open the air holes
C. open the needle valve at the base of the burner to increase the gas flow
D. partly close the supply valve at the gas jet
E. place a beaker of cold water over the flame to cool the flame.

9. A student heated a sample of solid sugar in a test tube over a Bunsen burner flame. He observed that, at first, sugar changed into colorless liquid, then began to change color to yellow, then brown, and finally black solid (carbon) was left inside the tube. Droplets of colorless liquid were found on the inside of the tube that were determined to be water. Based on this evidence, the student concluded that

A. sugar is an element, because no new substances were formed during heating.
B. sugar is a mixture, because it could be separated into two separate substances by physical means.
C. sugar is a compound, because heating sugar produced two new substances that have not present before.
D. sugar's identity cannot be determined by this procedure.

10. Magnesium metal reacts with hydrochloric acid forming a solution of magnesium chloride and hydrogen gas. When a small single piece of magnesium ribbon is dropped into a test tube filled with dilute hydrochloric acid, the metal soon floats to the surface of the liquid. The density of magnesium is 1.79 $g \cdot cm^{-3}$, and the density of the HCl solution is 1.048 $g \cdot cm^{-3}$. The best explanation for the metal floating on the liquid is that

A. the metal is less dense than the acid.
B. gas bubbles formed adhere to the metal and buoy it to the top.
C. convection currents set up in the acid solution carry the metal to the top.
D. the magnesium chloride formed increases the density of the solution.
E. due to the exothermic nature of this reaction the metal gets hot and less dense.

11. Which procedure can be used to **<u>demonstrate experimentally</u>** that the reaction

$2\ Mg + O_2 \rightarrow 2\ MgO$ obeys the law of Conservation of Mass?

A. Take a mass of 1.000 gram of Mg ribbon, burn it in pure O_2, then compare the mass of the product with the original mass of the Mg.
B. Show that the sum of 2 molar masses of Mg plus 1 molar mass of O_2 is equal to 2 molar masses of MgO.
C. Determine the mass of a sealed flask containing magnesium and oxygen, ignite the mixture, cool, and compare the final mass of the flask plus contents with the original mass of the flask and contents.
D. Burn 1.000 g of Mg ribbon in a tall beaker filled with air, scrape out all of the MgO formed, and compare with the original mass of Mg.

12. The reaction: $2\ K(s) + Br_2(l) \rightarrow 2\ KBr(s)$ can be classified as a(n)

A. both synthesis and oxidation-reduction reaction
B. both single replacement and synthesis reaction
C. both decomposition and single replacement reaction
D. oxidation-reduction reaction only
E. synthesis reaction only

13. A chloride ion **<u>differs</u>** from a chlorine atom in that the **<u>chloride ion</u>**

A. is more reactive B. has more electrons C. is an isotope of chlorine
D. exists only in solution E. has a negative charge on its nucleus

14. If **E** is the symbol for an element, then which two of the following particles are isotopes of element E?

1. $^{239}_{90}E$ 2. $^{241}_{92}E$ 3. $^{238}_{93}E$ 4. $^{239}_{93}E$ 5. $^{239}_{94}E$

A. 1 & 2 B. 1 & 3 C. 4 & 5 D. 2 & 3 E. 3 & 4

15. The molar mass of $Na_2SO_4 \cdot 10H_2O$ is closest to

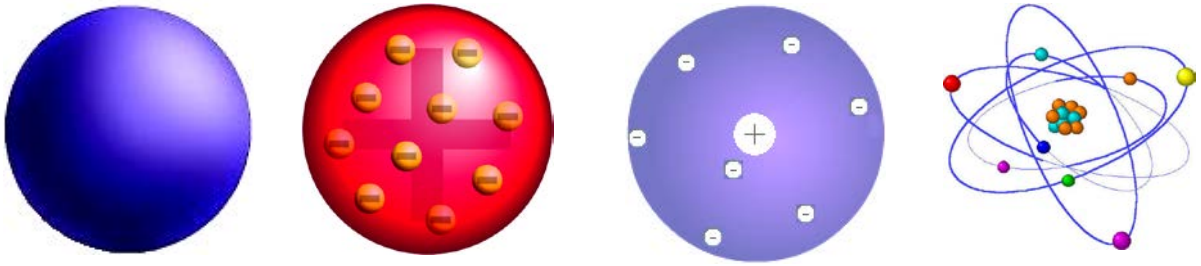
A. 310. g B. 161 g C. 322 g D. 170. g E. 142 g

16. The table below contains names of scientists that made discoveries which led to the modern understanding of matter and its particles. Which scientist(s) is(are) **all** paired correctly with his(their) contribution(s)?

	Scientist or Philosopher	**Contribution**
1	J. J. Thompson	first atomic theory
2	Democritus	everything is composed of atoms
3	Niels Bohr	electrons move in orbits with specific energies
4	Aristotle	atom is mostly empty space
5	Ernest Rutherford	discovered a neutron
6	John Dalton	"plum pudding" atomic model
7	James Chadwick	water, air, fire, earth

A. 2,3 only B. 1,4,5 only C. 1,3,7 only D. 2,5 only E. 2,4,7 only

17. The diagrams below represent the development of atomic model from the beginning of the nineteen century to the early part of the twentieth century. Which model represents Ernest Rutherford's model of the atom?



A. B. C. D.

18. The density of ethanol (alcohol) is 0.798 g/ml. The mass of alcohol present in 1 L of 45- proof (22.5% by volume) gin is closest to

A. 0.798 g B. 45.0 g C. 22.5 g D. 225 g E. 180. g

19. A perfect cube of aluminum metal was found to have a mass of 21.3 g. If the density of aluminum is 2.7 g/cm^3, what is the length of each side of the aluminum cube?

A. 79 cm B. 2.0 cm C. 4.3 cm D. 2.7 cm E. 7.9 cm

20. Determine the formula for a hydrate containing 76.9% $CaSO_3$ and 23.1% H_2O.

A. $CaSO_3 \cdot H_2O$ B. $CaSO_3 \cdot 2H_2O$ C. $CaSO_3 \cdot 3H_2O$
D. $CaSO_3 \cdot 4H_2O$ E. $CaSO_3 \cdot 5H_2O$

21. What is the **<u>total number of ions</u>** in 20.4 g of $BaCl_2$?

A. 3.00 ions B. 2.00 ions C. 6.02×10^{23} ions
D. 2.08×10^{23} ions E. 1.77×10^{23} ions

22. Anne finds a lump of silvery gray metal in an unlabeled container in the chemistry laboratory. In order to identify the metal, she proceeds to measure its density as follows. First, she weighs the lump and finds its mass to be 48.73 g. Next, she pours some water into a graduated cylinder and reads its volume as 83.1 mL. Then, she drops the metal into the water in the cylinder and reads the new volume as 90.0 mL. Which choice is the metal?

A. aluminum 2.70 g/cm^3 B. zinc 7.13 g/cm^3 C. lead 11.4 g/cm^3
D. cadmium 8.65 g/cm^3 E. iron 7.86 g/cm^3.

23. A student performed an experiment in a laboratory to determine the mole mass of zinc sulfate which he found to be 169.78 grams. If the "book value" (accepted value) for the mole mass of this compound is 161.43 grams, then calculate the % error in the student's work.

A. 0.951% B. 5.17% C. 1.05% D. 19.3% E. 4.92%

24. When ethane (C_2H_6) reacts with chlorine (Cl_2), the product is chloroethane (C_2H_5Cl) and hydrogen chloride (HCl). In a certain experiment, 165 g of C_2H_6 reacts with 245 g of Cl_2. What is the percent yield of chloroethane, if the reaction produced 166 g of C_2H_5Cl?

A. 74.5% B. 70.9% C. 64.5% D. 46.8% E. 23%

25. What is the mass in grams of a brass cylinder having a length of 2.02 cm and a diameter of 0.492 cm, if the composition of the brass is 67.0% copper and 33.0% zinc by mass. The density of copper is 8.92 g/cm^3, and the density of zinc is 7.14 g/cm^3. Assume that the density of the brass varies linearly with composition.

A. 0.670 g B. 3.16 g C. 0.330 g D. 8.92 g E. 7.14 g

Chemistry I Answer Key PINK TEST
Date: Thursday January 15, 2015

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

New Jersey Science League PINK TEST
Chemistry I Exam
February 12, 2015 (Correction)

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 sheets is a table of the activity series of the elements. Please PRINT your name, school, area, and which test you are taking onto the scan-tron. When balancing chemical equations, reduce all coefficients to the lowest whole numbers.

1. A photon of light of 300 nm, when compared to light of wavelength 450 nm, has
[Note: 1 nm (nanometer) = 10^{-9} m]
A. lower energy. B. a greater velocity. C. a higher frequency. D. a longer wavelength.

2. The characteristic light spectrum of an element is produced when
A. the energy level of the nucleus is increased. B. electrons drop back to lower energy levels.
C. electrons are raised to higher energy levels. D. electrons are emitted by an atom.
E. electrons are losing their charge.

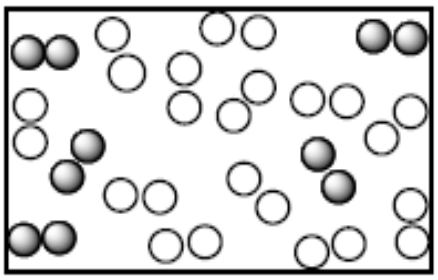
3. Helium, $^{4}_{2}He$, has two electrons in the 1*s* orbital. It can become singly ionized by losing one electron, giving He^{+}. Which statement about this ion is true?
A. It has lost one atomic mass unit.
B. The nuclear charge has decreased by one.
C. The remaining electron is easier to remove.
D. Its spectrum then resembles the hydrogen spectrum.
E. The remaining electron must remain in the n = 1 quantum level.

4. Consider the number of "*p*" electrons in the **last** energy level of both aluminum (atomic number 13) and fluorine (atomic number 9). Fluorine has how many **more** electrons than aluminum in this "*p*" region?
A. 1 B. 2 C. 3 D. 4 E. 5

5. The electron configuration of a cobalt atom is $[Ar]3d^{6}4s^{2}$. How many **unpaired** electrons would there be in the Co^{3+} ion?
A. 1 B. 2 C. 3 D. 4 E. 5

6. In the ground state, Al and Mg atoms both have the same number of electrons in the
A. 3*p* subshell B. 3*s* subshell C. 3rd principal energy level D. outermost energy level

7. The diagram to the right has paired open spheres representing H_2 molecules and paired solid spheres representing N_2 molecules. The molecules in the box react forming the maximum amount of NH_3. After the reaction has completed determine the limiting reactant and how many molecules of NH_3 are produced.



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

8. The nucleus of which atom contains seventeen neutrons?

Atom **A**	$n = 1$	$n = 2$	$n = 3$
M = 24, Z = 12	2 e^-	8 e^-	2 e^-

Atom **B**	$n = 1$	$n = 2$	$n = 3$
M = 15, Z = 7	2 e^-	5 e^-	

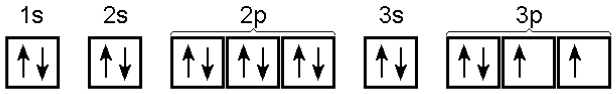
Atom **C**	$n = 1$	$n = 2$	$n = 3$
M = 17, Z = 10	2 e^-	8 e^-	

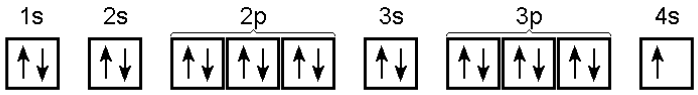
Atom **D**	$n = 1$	$n = 2$	$n = 3$
M = 7, Z = 3	2 e^-	1 e^-	

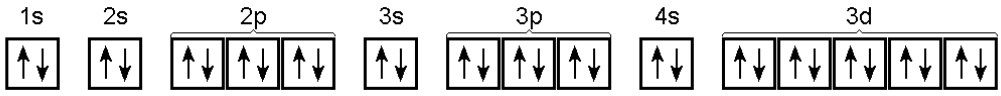
Atom **E**	$n = 1$	$n = 2$	$n = 3$
M = 34, Z = 17	2 e^-	8 e^-	7 e^-

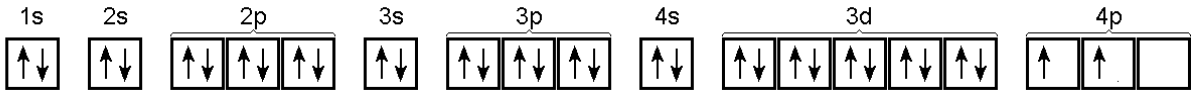
A. A B. B C. C D. D E. E

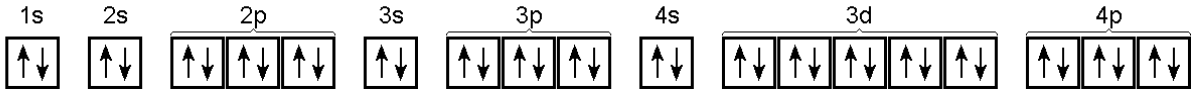
9. Which ground state orbital diagram will most likely produce a plus two ion?

A. 

B. 

C. 

D. 

E. 

10. A neutral sulfur atom (#16) in its ground state has how many <u>orbitals</u> with at least one electron?
A. 2 B. 7 C. 8 D. 9

11. Which group listed below **<u>best</u>** illustrates the transition from non-metallic to metallic behavior with increasing atomic number?
A. Be, Mg, Ca, Sr B. N, P, As, Sb C. F, Cl, Br, I D. Fe, Ru, Os, Hs

12. The atom which has a pair of electrons in **<u>each</u>** of its outer-most orbitals has the atomic number of:

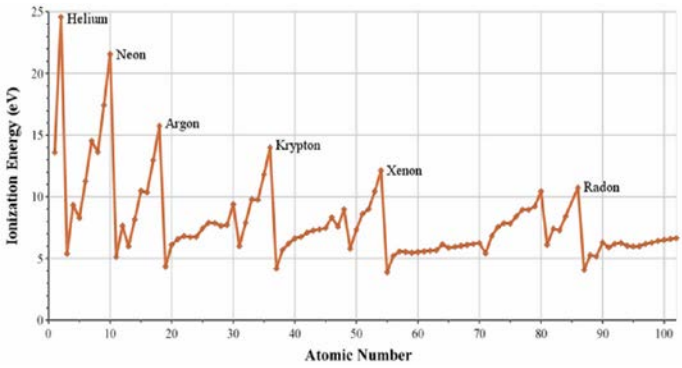
A. 8 B. 10 C. 14 D. 16

13. As we proceed from left to right in period 3 of the Periodic Table of the elements, we note a **decrease** in the **atomic radius**. Which statement correctly explains this phenomenon?
   A. The number of valence electrons increases, causing an increased attraction between the nucleus and valence electrons.
   B. The number of electron shells decreases, causing an increased attraction between the nucleus and the valence electrons.
   C. The number of neutrons increases, causing an increased attraction between the nucleus and the valence electrons.
   D. The tendency to gain electrons increases, causing a decreased attraction between the nucleus and the valence electrons.
   E. The number of protons in the nucleus increases, causing an increased attraction between the nucleus and the valence electrons.

14. Among the Halogen Family, Fluorine reacts more rapidly than iodine. To what may this be **directly** ascribed?
   A. The valence electrons in Fluorine are at a shorter average distance from the nucleus.
   B. Fluorine has a lower nuclear charge.
   C. Fluorine has less neutrons.
   D. Fluorine has a lower atomic mass.
   E. Fluorine has less electrons.

15. A German chemist, Johann Döbereiner in 1829 contributed to the formation of the modern Periodic Table by:
   A. discovering that properties of known elements arranged in order of the increasing atomic masses repeated every eighth element.
   B. observing that groups of three elements with similar properties existed which, when arranged in order of increasing atomic masses, the average of the first and third of those masses equaled the mass of the middle element.
   C. arranging the elements in rows according to increasing atomic mass, and in columns according to similar properties in the Periodic Table.
   D. performing experiments that led him to suggest that increasing atomic number be used instead of atomic mass to arrange elements in rows of the Periodic Table.

16. The graph below represents the changes in the ionization energy of elements as their atomic number increases. The labeled elements belong to the noble gas family. Which statement best explains the decrease in ionization energy of each successive noble gas as its atomic number increases? As the atomic number of each successive noble gas increases,



   A. the attraction between the nucleus and the valence electrons increases.
   B. the distance between the valence shell and nucleus increases.
   C. the ability to lose electrons decreases.
   D. the ability to gain electrons increases.

17. For which of the following transitions would a hydrogen atom absorb a photon with the longest wavelength
A. n = 1 to n = 2 B. n = 3 to n = 2 C. n = 5 to n = 6 D. n = 7 to n = 6

18. Which of the following isoelectronic species has the largest radius? (all not isoelectronic)
A. K^{1+} B. Ca^{2+} C. P^{3-} D. S^{2-} E. Al^{3+}

19. Complete and balance the equation for the reaction, where the reactants are in aqueous solution:
? $K_3PO_4(aq)$ + **?** $Ca(NO_3)_2(aq) \rightarrow$ **?** + **?**
The number of moles and formula of the product containing Ca ions is
A. $CaPO_4$ B. $Ca(PO_4)_2$ C. Ca_2P_3 D. $Ca_3(PO_4)_2$

20. If zinc arsenate has the formula $Zn_3(AsO_4)_2$, then
A. Arsenic acid has the formula H_2AsO_4
B. Arsenic hydride formula would be AsH_7
C. rubidium arsenate has the formula $RbAsO_4$
D. Magnesium arsenate has the formula $Mg_3(AsO_4)_2$
E. The oxidation number of As in this compound is +7

21. The energy of the hydrogen atom in the ground state (n = 1) is -2.179×10^{-18} J. The frequency of a photon that will ionize a hydrogen atom in the ground state is:
A. $3.29 \times 10^{15}\ s^{-1}$ B. $6.63\ s^{-1}$ C. $2.18 \times 10^{16}\ s^{-1}$ D. $2.98 \times 10^{11}\ s^{-1}$

22. The specific heat capacity of glycerin ($C_3H_8O_3$) is 243 $kJ \cdot Kg^{-1} \cdot °C^{-1}$. How much heat (in joules) is required to raise the temperature of 42.0 g of glycerin by 15.0°C rounded to the correct number of significant figures?
A. 92.1 J B. 153,000 J C. 224 J D. 243 J E. 45.6 J

23. The molar heat of fusion of an unknown solid compound was found to be 284 J/mol. If 53.7 J is required to melt 75.0 g of this substance at its melting point at constant temperature, what is its mole mass?
A. 750. g/mol B. 397 g/mol C. 130. g/mol D. 625 g/mol E. 220. g/mol

24. A compound containing carbon and hydrogen was analyzed and found to consist of 83.65% carbon by mass. What is the empirical formula of the compound?
A. CH_2 B. CH_3 C. C_7H_{16} D. CH E. C_3H_7

25. In one experiment, 70.0 g of liquid nitrogen (boiling point = –196 °C) is poured into a Styrofoam cup containing 2.00×10^2 g of water at 57.6 °C. Calculate the molar heat of vaporization of liquid nitrogen in kJ/mol, if the final temperature of the water is 41.0 °C. [Specific heat capacity of water is 4.186 $J \cdot g^{-1} \cdot °C^{-1}$.]
A. 2.50 kJ/mol B. 3.32 kJ/mol C. 5.56 kJ/mol D. 1.13 kJ/mol E. 4.19 kJ

Chemistry I Answer Key PINK TEST
Date: Thursday February 12, 2015 (Correction)

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

New Jersey Science League
Chemistry I Exam PINK TEST
March 2015

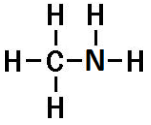
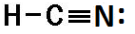
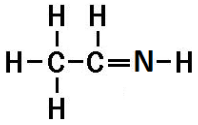
Choose the answer that best completes the statements or questions below and fill in the appropriate response on the form. If you change an answer, be sure to completely erase your first choice. You may use the given periodic table and formula sheet as well as a calculator. On the formula sheets is a table of the activity series of the elements. Please PRINT your name, school, area, and which test you are taking onto the scan-tron. When balancing chemical equations, reduce all coefficients to the lowest whole numbers.

1. The characteristic of metallic bonding that distinguishes it from other bonds is the
   A. freedom of movement of valence electrons. B. directional nature of the bonds formed.
   C. polar property of substances with metallic bonds. D. fixed position of the valence electrons.

2. Which statement describes the bonds in NH_4Cl?
   A. The $NH_4 - Cl$ bond is covalent and the $N - H$ bonds are ionic. B. All bonds are ionic
   C. The $N - H$ bonds are covalent and the $NH_4 - Cl$ bond is ionic. D. All bonds are covalent.

3. Consider the electron configuration $1s^2\ 2s^2\ 2p_x^2\ 2p_y^2\ 2p_z^1$. If this atom received one electron from another atom, it would become
   A. charged positively B. more chemically reactive C. more stable D. much heavier

4. Which of the following statements describing fluorine is **not** correct?
   A. It is the smallest halogen atom.
   B. It forms a covalent diatomic molecule.
   C. Its ionic radius is larger than its covalent radius.
   D. It has the highest ionization energy of the halogen elements.
   E. It has a positive oxidation state when combined with oxygen.

5. Which molecule contains the **shortest** carbon-to-nitrogen bond?
   A.  B.  C.  D. **All are equal.**

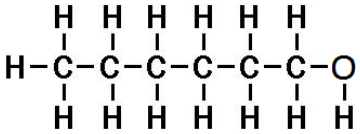
6. An unknown white crystalline compound was found to be quite soluble in water. Its crystals did not conduct electric current, but its solution did. When this compound was heated until it melted, its molten form also conducted electricity. This evidence indicates that the bonding within the compound is
   A. metallic B. polar covalent C. ionic D. non-polar covalent E. coordinate covalent

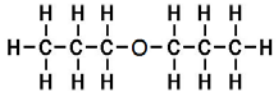
7. Which pair are geometrically similar?
   A. SO_2 and CO_2 B. PH_3 and BF_3 C. CO_2 and OF_2 D. SO_2 and O_3 E. H_2O and CO_2

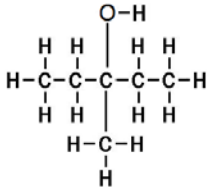
8. Which type of orbital hybridization is used by carbon in CO_2?
   A. sp^1 B. sp^2 C. sp^3 D. d^1sp^3 E. d^2sp^3

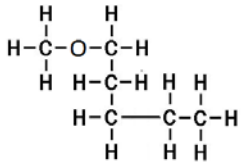
9. Substances whose molecules have a high degree of symmetry will have
   A. a low specific heat. B. a high melting point. C. a high heat of fusion.
   D. a low heat of vaporization. E. strong van der Waals forces.

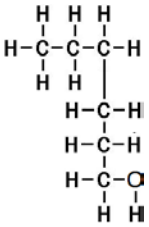
10. Which is **not** an isomer of the molecule pictured to the right?



A. 

B. 

C. 

D. 

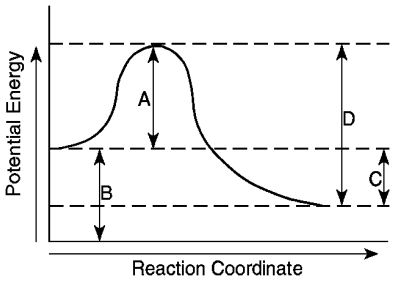
11. The process of dissolving table salt (NaCl) crystals in water is primarily caused by the presence of
A. van der Waals forces B. molecule-ion attractions C. dipole-dipole attraction
D. metallic bonding E. hydrogen bonding

12. Which of the following list of substances is in order of **increasing** boiling points?
A. $N_2 < NH_3 < H_2$ B. $H_2 < N_2 < NH_3$ C. $N_2 < H_2 < NH_3$
D. $NH_3 < N_2 < H_2$ E. $H_2 = N_2 < NH_3$

13. Which group in the Periodic Table of the Elements contains the most powerful **oxidizing agents**?
A. the halogen family B. the noble gases C. the alkali family
D. the alkaline earth family E. the oxygen family

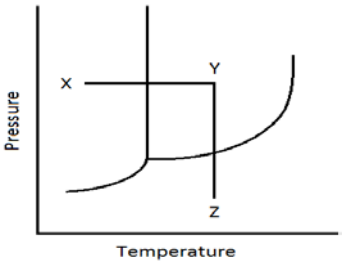
14. A rigid 1-L container is filled with a mixture of oxygen and helium gases at room temperature. Which statement correctly describes the average kinetic energy and average velocity of molecules of each gas in this container?
A. Oxygen molecules have the same average kinetic energy, and the same average velocity as helium molecules.
B. Oxygen molecules have higher average kinetic energy, and higher average velocity than helium molecules.
C. Oxygen molecules have lower average kinetic energy, and lower average velocity than helium molecules.
D. Oxygen molecules have the same average kinetic energy as helium molecules, but lower average velocity.
E. Oxygen molecules have the same average kinetic energy as helium molecules, but higher average velocity.

15. Which line in the diagram on the right, represents the heat of reaction for the forward reaction?
A. A B. B
C. C D. D



16. The normal boiling point of SO_2 is 263.1 K and that of NH_3 is 239.7 K. At -40^oC which would you predict?
A. The vapor pressures would be equal.
B. Ammonia has the greater vapor pressure.
C. The vapor pressure of NH_3 is 760 mm Hg.
D. Sulfur dioxide has the greater vapor pressure.
E. The relative vapor pressures are not predictable from the data given.

17. Given a phase diagram for a pure substance on the right. The substance freezes when the temperature or pressure changes from
A. X to Y B. Y to Z C. Z to Y D. Y to X



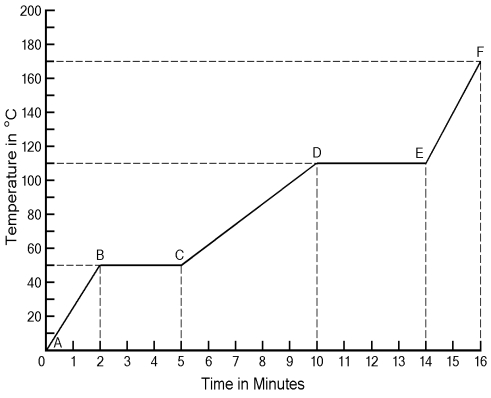
18. Which element in this Periodic Table below has the **least tendency** to form ionic compounds?
*Note: This Periodic Table contains only the "A" groups and does not include transition elements. The letters used in the table are **not** the actual symbols of the elements they represent.*

	Main Groups							
Group Numbers	1 A	2 A	3 A	4 A	5 A	6 A	7 A	8 A
First Period	D							E
Second Period	G		J		K	L	M	
Third Period	Q	R		T	X		Z	

A. E B. J C. M D. T E. X

19. Based upon Avogadro's Hypothesis, which statement is true?
A. A mole of molecules or formula units of any substance at standard temperature and pressure would have the same mass.
B. A gram-formula mass of any pure substance contains the same number of molecules or formula units.
C. 18.0 g of H_2O contains the same number of molecules as 18.0 g of CO_2.
D. One mole of MgO and one mole of He at room temperature would have the same volume.

20. The graph on the right represents 5.0 grams of a substance being heated at the rate of 100. calories per minute. The specific heat capacity of this substance in its liquid phase is closest to
A. 0.40 cal/g·^oC B. 1.67 cal/g·^oC C. 0.83 cal/g·^oC
D. 30.0 cal/g·^oC E. 40.0 cal/g·^oC



21. An 11.2 L container is filled with H_2 at STP. Then liquid Br_2 is added at 101^oC driving the reaction to completion according to the following equation: $H_2(g) + Br_2(g) \rightarrow 2\ HBr(g)$ How many grams of HBr are present after the reaction occurs?
A. 40.5 g B. 20.02 g C. 79.9 g D. 80.9 g E. 160. g

22. A 7.65-g sample of a particular gas in a 4.50 L bulb at 25°C has a pressure of 262 torr. What is the molar mass of this compound?
A. 273 g/mol B. 450 g/mol C. 262 g/mol D. 765 g/mol E. 121 g/mol

23. Given a mixture of gases: 4.00 g of helium, 34.1 g of ammonia(NH_3), and 132.0 g of carbon dioxide, in a 20.0 L steel container. Which answer is closest to the total pressure inside the container at 65.0^{o}C?
A. 8.32 atm B. 1.39 atm C. 2.78 atm D. 4.16 atm E. 0.999 atm

24. 1.00 L of a gas mixture at 0°C and 102.26 kPa contains 250. g/m^3 of H_2S. What is the partial pressure of H_2S?
A. 16.7 kPa B. 0.164 kPa C. 0.250 kPa D. 7.34 kPa

25. Hydrogen gas and oxygen gas are mixed in a 2.00 liter container so that the ratio of their pressures is three to one, respectively. The temperature inside the container is 35.5^{o}C, and the total pressure is 1,000. torr. What is the number of moles of each gas?
A. 0.0779 mol H_2 and 0.0260 mol O_2
B. 59.2 mol H_2 and 19.7 mol O_2
C. 0.677 mol H_2 and 0.226 mol O_2
D. 3.00 mol H_2 and 1.00 mol O_2

Chemistry I Answer Key PINK EXAM
Date: Thursday March 12, 2015
Record onto the area record the # correct (Corrected)

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

New Jersey Science League
Chemistry I Exam PINK TEST
April 2015

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 sheets is a table of the activity series of the elements. Please PRINT your name, school, area, and which test you are taking onto the scan-tron. When balancing chemical equations, reduce all coefficients to the lowest whole numbers.

1. Given the following unbalanced equation: $N_2H_4 + N_2O_4 \rightarrow N_2 + H_2O$
When the equation above is balanced with all coefficients reduced to the lowest whole numbers, then the sum of the coefficients in the balanced equation is
A. 9 B. 10 C. 12 D. 15 E. 20

2. Which element's atoms have the least tendency to gain electrons?
A. nitrogen B. phosphorus C. arsenic D. antimony E. bismuth

3. To determine experimentally that a substance may contain ionic bonds is to
A. show that its melting point is high.
B. show that the substance is soluble in polar solvents.
C. show that the substance is soluble in nonpolar solvents.
D. show that the substance when dissolved in water will elevate the boiling point of the water.
E. show that the substance conducts electric current both when molten and when dissolved in water.

4. Which conditions favor the **low** solubility of a gas in a liquid?
A. high pressure, high temperature
B. high pressure, low temperature
C. low pressure, high temperature
D. low pressure, low temperature

5. If a salt is dissolved in water under conditions that the solution becomes supersaturated, then the solution
A. must be hot.
B. must be cold.
C. must be above room temperature.
D. contains some undissolved solute.
E. has an ion product greater than the solubility product constant of the salt.

6. The rate law expression for the reaction: $2\ NO(g) + 2\ H_2(g) \rightarrow N_2(g) + 2\ H_2O(g)$ is
Rate = $k[NO]^2[H_2]$. If both [NO] and $[H_2]$ are doubled, by what factor will the rate change?
A. 2 B. 3 C. 4 D. 8 E. 16

7. Arrange these solutes in order of increasing solubility in benzene (C_6H_6).
NaI, C_2H_5OH, C_6H_{14}.

A. $NaI < C_2H_5OH < C_6H_{14}$
B. $C_6H_{14} < NaI < C_2H_5OH$
C. $NaI = C_2H_5OH = C_6H_{14}$
D. $C_2H_5OH < C_6H_{14} < NaI$
E. $C_6H_{14} < C_2H_5OH < NaI$

8. What is the equilibrium constant expression for the gas phase oxidation of CO to CO_2 by means of O_2 ?

A. $K_{eq} = \frac{[CO_2]^2}{[CO]\,[O_2]}$ B. $K_{eq} = \frac{[CO]^2\,[O_2]}{[CO_2]}$ C. $K_{eq} = \frac{[CO_2]^2}{[CO]^2\,[O_2]}$ D. $K_{eq} = \frac{[CO]\,[O_2]}{[CO_2]}$

9. Consider this reaction: $NO_{(g)} + CO_{(g)} \rightleftarrows {}^1/_2N_{2(g)} + CO_{2(g)}$ $\Delta H = -374$ kJ

What conditions of temperature and pressure will cause the reaction to make more CO_2 ?

A. high temperature and high pressure
B. low temperature and high pressure
C. high temperature and low pressure
D. low temperature and low pressure

10. Which process increases the entropy of the system?

A. crystallizing sugar from water solution
B. liquefying oxygen gas
C. dissolving carbon dioxide gas in a liquid
D. melting ice

11. Gibbs free energy is used to predict if a reaction at a certain temperature is spontaneous or not. The formula is $\Delta G = \Delta H - T\Delta S$, where ΔS is the change in entropy and T is the temperature in Kelvin. If ΔG is < 0, then the reaction is spontaneous. What sign (+ or –) of ΔH and ΔS are needed for a reaction to be spontaneous at **any** temperature?

A. ΔH is positive and ΔS is positive
B. ΔH is negative and ΔS is negative
C. ΔH is positive and ΔS is negative
D. ΔH is negative and ΔS is positive

12. A solution has a pH of 3.25 at 25°C. Which statement(s) is(are) true about this solution?

A. This solution is an acid. B. The $[H_3O^+] > [OH^{-1}]$. C. The $[H_3O^+] \times [OH^{-1}] = 1 \times 10^{-14}$.
D. A and B are both true. E. A, B, and C are all true.

13. The pH of a solution is 8. If the pH of this solution is increased to 12, by what factor does the concentration of hydrogen ion change?

A. 1 ½ B. 4 C. 100 D. 1,000 E. 10,000

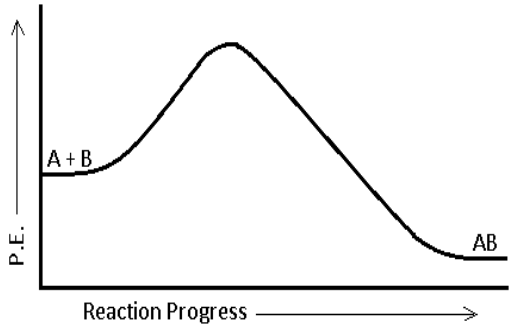
14. When 0.30 moles of HCl(*aq*) is added to 0.60 moles of NaOH(*aq*)

A. an acidic solution results. B. a basic solution results. C. a neutral solution results.
D. a precipitate results. E. bubbles of hydrogen gas are formed

15. Which is the correct **complete ionic equation** for the reaction between iron (III) nitrate and potassium hydroxide that produces a precipitate, iron (III) hydroxide?

A. $Fe^{3+}(aq) + 3\ NO_3^-(aq) + 3\ K^+(aq) + 3\ OH^-(aq) \rightarrow Fe(OH)_3(s) + 3\ K^+(aq) + 3\ NO^{3-}(aq)$
B. $FeNO_3(aq) + 3\ KOH(aq) \rightarrow Fe(OH)_3(s) + 3\ KNO_3(aq)$
C. $Fe^{3+}(aq) + 3\ OH^-(aq) \rightarrow Fe(OH)_3(s)$
D. $K^+(aq) + NO_3^-(aq) \rightarrow K^+NO_3^-(aq)$
E. $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(aq)$

16. Given the potential energy diagram at the right.
With reference to energy, the reaction $A + B \rightarrow AB$ can best be described as
A. endothermic, having a $+\Delta H$.
B. exothermic, having a $+\Delta H$.
C. endothermic, having a $-\Delta H$.
D. exothermic, having a $-\Delta H$.



17. Given the following data:

$2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(l)$ $\quad \Delta H = -3119.4$ kJ

$C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(l)$ $\quad \Delta H = -1410.9$ kJ

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$ $\quad \Delta H = -571.66$ kJ

Calculate ΔH for the reaction: $C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g)$

A. +1,136.84 kJ B. +274.06 kJ C. +568.42 kJ D. –2,551.0 kJ E. +137.0 kJ

18. A gas mixture with a total pressure of 2,100 torr is used by a scuba diver. The mixture contains 1.2 mol of helium and 7.2 mol of oxygen. What is the partial pressure of helium?

A. 1,800 torr B. 300 torr C. 2,100 torr D. 250 torr

19. What is the Ksp expression for Ag_2CrO_4 solid dissolving in water at 25°C?

A. $Ksp = [Ag_2CrO_4]$
B. $Ksp = [Ag^+]^2\,[CrO_4^-]$
C. $Ksp = 1/[Ag^+]^2\,[CrO_4^-]$
D. $Ksp = [Ag_2CrO_4]\,/[Ag^+]^2[CrO_4\text{-}]$
E. $Ksp = [Ag^+]^2[CrO_4^-]/\,[Ag^2CrO_4]$

20. 20.0 dm^3 of hydrogen chloride gas was dissolved in 100. cm^3 of water at STP. What was the concentration of the hydrochloric acid formed in moles per Liter? Assume HCl(gas) is 100 % soluble in water.

A. 0.100 mol/L B. 0.893 mol/L C. 0.200 mol/L D. 8.93 mol/L E. 2.00 mol/L

21. The reaction of HCl aq with NaOH aq is an exothermic reaction. Which combination of solutions of HCl and NaOH would produce the largest ΔT? All at 25^oC and 1 Atm.

A. 100 mL of 0.1 M HCl with 100 mL of 0.1 M NaOH
B. 100 mL of 0.4 M HCl with 100 mL of 0.4 M NaOH
C. 200 mL of 0.1 M HCl with 100 mL of 0.2 M NaOH
D. 200 mL of 0.1 M HCl with 200 mL of 0.1 M NaOH

22. What volume in Liters of 0.230 M potassium hydroxide solution would just neutralize 105.4 ml of 0.108 M H_2SO_4 solution according to the following equation:

$2\ KOH(aq) + H_2SO_4(aq) \longrightarrow K_2SO_4(aq) + 2\ H_2O(l)$?

A. 0.230 L B. 0.216 L C. 0.108 L D. 0.0540 L E. 0.0990 L

23. The standard enthalpy of formation, ΔH_f, for liquid methanol (CH_3OH) is shown by which equation?

A. $C(s) + 2\ H_2(g) + 1/2\ O_2(g) \rightarrow CH_3OH(liq)$
B. $2C(s) + 4\ H_2(g) + O_2(g) \rightarrow 2\ CH_3OH(liq)$
C. $CH_3OH(liq) \rightarrow C(s) + 2\ H_2(g) + 1/2\ O_2(g)$
D. $C(s) + 2\ H_2(g) + O(g) \rightarrow CH_3OH(liq)$
E. $C(s) + H_2O(liq) + H_2(g) \rightarrow CH_3OH(liq)$

24. A 3.4 g sample of an unknown organic compound containing carbon, hydrogen, and oxygen was completely burned in excess oxygen gas, producing 4.40 g of carbon dioxide gas and 3.60 g of water vapor. What is the empirical formula of this unknown compound?

A. CHO B. CH_2O C. CHO_2 D. CH_4O E. C_2HO

25. At a particular temperature, the equilibrium constant $K_{eq} = 4.0 \times 10^{-7}$ for the following reaction: $N_2O_4(g) \rightleftarrows 2\ NO_2(g)$. In an experiment, 1.0 mol N_2O_4 is placed in a 20.0 L vessel. Calculate the concentrations of N_2O_4 and NO_2 when this reaction reaches equilibrium.

A. $[N_2O_4] = 4.4 \times 10^{-4}$ M and $[NO_2] = 5.0 \times 10^{-2}$ M
B. $[N_2O_4] = 4.0 \times 10^{-7}$ M and $[NO_2] = 2.5 \times 10^{-8}$ M
C. $[N_2O_4] = 5.0 \times 10^{-2}$ M and $[NO_2] = 1.4 \times 10^{-4}$ M
D. $[N_2O_4] = 2.5 \times 10^{-8}$ M and $[NO_2] = 4.0 \times 10^{-7}$ M

Chemistry I Answer Key PINK EXAM

Date: Thursday April 9, 2015

Record onto the area record the # correct (Corrected)

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