New Jersey Science League - Chemistry I Exam
January 2013

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 student who was asked to identify a liquid made the following statements.
a) Bubbling occurred when a strip of zinc was added to the liquid.
b) A lighted splint popped when held over the bubbling liquid.
c) Hydrogen gas was formed when the zinc reacted with the liquid.
d) Litmus paper turned pink when it was added to the liquid.
e) The liquid is an acid.

WHICH ARE INTERPRETATIONS RATHER THAN OBSERVATIONS?
A. They are all interpretations.
B. Only c, d, and e are interpretations.
C. a and b are the only interpretations.
D. Only b and d are interpretations.
E. Only c and e are interpretations.

2. Given the following statements:
I. Mass is conserved II. Moles is conserved III. Molecules are conserved
IV. Atoms are conserved V. Volume is conserved.

Which of the above statements are always true for chemical reactions?
A. Only I and IV are true B. Only I is true C. I and III are true
D. II and III are true.

3. Which of the following statements is (are) true for isotopes of an element?
I. They are atoms of the same mass with different atomic numbers
II. The only difference in composition between isotopes of an element is the number of neutrons.
III. The atomic weight of an element is an average of the weights of its isotopes, in the proportions in which they naturally occur in nature.

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

4. In Thomson's famous "cathode ray tube" experiment, he determined several things about electrons:

A. They are negatively charged, their mass/charge ratio, and that they are part of all matter.
B. They are negatively charged, their mass, and that they are part of all matter
C. They are negatively charged, their mass/charge ratio.
D. They are negatively charged.
E. Thomson did not perform the "cathode ray experiment."

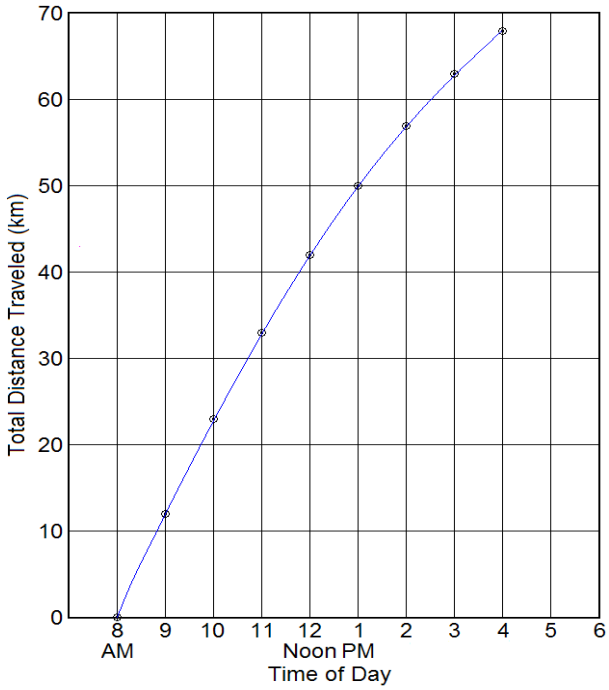
5. In order to obtain the density of aluminum a student measured the volume of a set quantity of aluminum pellets by water displacement. The student then dried off the pellets and obtained their mass. Which one of the following is an experimental error that would be consistent with obtaining a density 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.

6. A solution of sodium chloride in water is a mixture not a compound because

A. the salt and the water can easily be separated by evaporation.
B. one can easily tell which substance is which by simple observation.
C. the mixture is heterogeneous.
D. the salt and water are chemically bonded together forming a new substance.

7. The following graph represents the distance covered by a student riding a bicycle starting at his home at 8:00 am and arriving at his destination at 4:00 pm the same day.



Which statement represents the correct interpretation of the graph?

A. The time traveled is directly proportional to the distance covered.
B. The speed of the bicycle remained constant throughout the entire duration of the trip.
C. The distance travelled per hour is constant.
D. The student rested for one hour half way through the trip.
E. The graph is a curve rather than a straight line because the speed of the bicycle decreased as the time of day increased.

8. When Rutherford bombarded gold foil with positively charged alpha particles, most of the particles went through, but some were deflected back. Rutherford concluded that atoms

A. are solid spheres.
B. have negative charges.
C. contain neutral particles.
D. have positive nuclei

9. Two pure substances A and B react to form a new pure substance C. From this we may conclude that

A. A and B are both elements
B. C is a compound, A and B may or may not be elements
C. C is an element, A and B are compounds
D. A, B and C are all compounds.

10. Which formula is followed by its correct name?
A. FeS and Iron (II) sulfide
B. Cu_2S and copper (II) sulfide
C. MnO_2 and Manganese (II) oxide
D. $HgCl_2$ and mercury (I) chloride
E. PbO_2 and lead (II) oxide

11. Sodium citrate has the formula $Na_3C_6H_5O_7$. What is the formula for magnesium citrate?
A. $Mg_2C_6H_5O_7$
B. $Mg_3C_6H_5O_7$
C. $MgC_6H_5O_7$
D. $Mg_2(C_6H_5O_7)_3$
E. $Mg_3(C_6H_5O_7)_2$

12. The information in the Table below is for the three naturally occurring isotopes of element X.

Isotope	Atomic Mass (amu)	Natural Abundance (%)
1	23.9850	78.99
2	24.9858	10.00
3	25.9826	11.01

What is the atomic weight of element X?
A. 23.99 B. 24.00 C. 24.30 D. 24.98 E. 75.00

13. Ammonia combines with oxygen to produce nitrogen and water. Which set of coefficients correctly balances this reaction?
A. 2, 3, 1, 7 B. 1, 3, 7, 2 C. 4, 1, 1, 1 D. 3, 2, 2, 3 E. none of these

14. Given the following changes: souring of milk, evaporation of water, rusting of iron, tarnishing of silver, dissolving of sugar in water.
Which statement below is completely correct?
A. Souring of milk is a physical change because no new substances are formed in the reaction.
B. Rusting of iron is a chemical change because iron changes its phase only.
C. Dissolving sugar in water is a physical change because the sugar and water molecules do not produce any new molecules, but merely mixes with one another.
D. Evaporation of water is a chemical change because the properties of water change making it a new substance.

15. Which of the following chemical reactions represents a double replacement as well as a neutralization reaction?
A. $2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$
B. $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$
C. $H_2SO_4(aq) + 2\ NaOH(aq) \rightarrow 2\ H_2O(l) + Na_2SO_4(aq)$
D. $Pb(NO_3)_2(aq) + 2\ KI(aq) \rightarrow PbI_2(s) + 2\ KNO_3(aq)$
E. $C_{12}H_{22}O_{11}(s) \rightarrow C(s) + H_2O(g)$

16. How many moles of iron ions are in 1.0 mole of iron(III) sulfate?
A. 1 B. 2 C. 3 D. 6.0×10^{23} E. 1.2×10^{24}

17. A student performed a laboratory procedure to determine the relative reactivity of elements bromine, chlorine, and iodine. To do this, she prepared a water solution of each element, as well as a solution of sodium salt (bromide, chloride, iodide) of each of these elements. In separate test tubes, she added a sample of the solution of each element to the solution of a salt of the other two elements. She also added a small amount of mineral oil to each test tube. After that, she stoppered each test tube, shook it thoroughly, and then allowed the contents to settle. She recorded the color of the top mineral oil layer in the table below:

	NaBr	NaCl	NaI
Br_2		Mineral oil layer was orange	Mineral oil layer was pink.
Cl_2	Mineral oil layer was orange.		Mineral oil layer was pink
I_2	Mineral oil layer was pink.	Mineral oil layer was pink.	

Based on the above data, which of the following statements is completely **true**?
A. Bromine was able to displace chlorine from its compound, but could not do the same to iodine.
B. Chlorine was able to displace iodine from its compound, but could not do the same to bromine.
C. Chlorine was able to displace both bromine and iodine from their respective compounds.
D. Bromine was able to displace both chlorine and iodine from their respective compounds.

18. Which of the following reactions occur spontaneously?
(1) $Zn + CuSO_4 \rightarrow Cu + ZnSO_4$ (2) $LiOH + Na \rightarrow NaOH + Li$
(3) $NaCl + Li \rightarrow LiCl + Na$ (4) $NaNO_3 + K \rightarrow KNO_3 + Na$
(5) $2\ Al + 3\ ZnCl_2 \rightarrow 2\ AlCl_3 + 3\ Zn$ (6) $2\ Ag + Pb(NO_3)_2 \rightarrow 2\ AgNO_3 + Pb$

A. 1 and 6 B. 1 and 5 C. 2 and 3 D. 2 and 6 E. 2 and 4

19. Which of the following postulates of Dalton's atomic theory are now known to be correct?
I. Matter is made up of atoms.
II. Atoms are indivisible and indestructible
III. All atoms of a given element are identical
A. I only is correct today B. I and II are correct today C. II and III are correct today
D. I and III are correct. E. All have been proven to be correct.

20. A sample of alcohol, C_2H_5OH, has a mass of 1.0 gram. The density of alcohol is 0.768 g/ml at 20°C. Which of the following quantities is less than one?
I. The number of molecules of alcohol in the sample.
II. The number of moles of alcohol in the sample.
III. The number of moles of oxygen atoms in the sample.
IV. The volume (in cm^3) of the sample.

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

21. Vitamin C is composed of 40.9% C, 4.58% H, and 54.52% O by mass. If the molar mass of vitamin C is 176.1 g/mole, then what is the molecular formula?

A. $C_2H_3O_2$ B. $C_3H_4O_3$ C. $C_4H_6O_4$ D. $C_6H_8O_6$ E. $C_4H_{10}O_3$

22. Calculate the empirical formula for hydrated lithium nitrate based on mole ratios determined from the following laboratory data:

Mass of hydrated lithium nitrate: 17.00 g

Mass of anhydrous lithium nitrate: 9.53 g

A. $LiNO_3 \cdot H_2O$ B. $LiNO_3 \cdot 2H_2O$ C. $LiNO_3 \cdot 3H_2O$

D. $LiNO_3 \cdot 4H_2O$ E. $LiNO_3 \cdot 5H_2O$

23. A pure titanium cube has an edge length of 3.75 inches. Titanium has a density of 4.50 g/cm^3. How many titanium atoms does it contain?

[Note: 1 inch = 2.54 cm]

A. 1.37×10^{24} atoms B. 1.72×10^{23} atoms C. 4.89×10^{25} atoms

D. 6.02×10^{25} atoms E. 1.72×10^{25} atoms

24. One of the steps in the commercial process for converting ammonia to nitric acid is the conversion of ammonia to nitrogen monoxide according the equation below:

$$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$$

If 3.15 g of NH_3 of reacts with 4.98 g of O_2, how many grams of NO is produced?

A. 2.82 g B. 3.74 g C. 4.81 g D. 17.0 g E. 30.0 g

25. Aspirin is prepared from the reaction of salicylic acid ($C_7H_6O_3$) and acetic anhydride ($C_4H_6O_3$) to produce aspirin, also known as acetylsalicylic acid ($C_9H_8O_4$) and acetic acid ($HC_2H_3O_2$). The following is the balanced equation for this reaction:

$$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + HC_2H_3O_2$$

What was the **percent yield** of aspirin produced, if 4.12 g of salicylic acid was used and 1.89 g of aspirin was obtained?

A. 53.7% B. 65.5% C. 39.4% D. 35.2% E. 95.3%

Chemistry I Answer Key
Date: January 10, 2013 yellow changed answers

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

New Jersey Science League - Chemistry I Exam
February 2013

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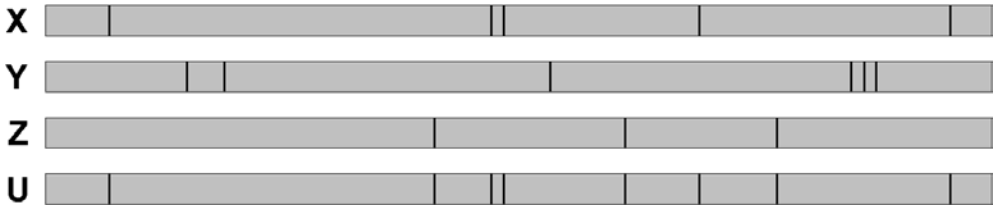
1. Which of the following statements are true?
   I. Electromagnetic waves must be propagated through solid, liquid, or gas particles.
   II. Electromagnetic waves are generated over a range of frequencies.
   III. Electromagnetic waves do not require a medium through which to travel.
   IV. All electromagnetic waves travel at the speed of light through a vacuum.
   A. I and IV only B. I, II, and IV only C. II, III, and IV only D. II and III only

2. In modern atomic theory, bright-line spectra are explained by the movement of electrons between
   A. energy levels only B. sublevels only C. orbitals only
   D. sublevels and orbitals . E. energy levels, sublevels, or orbitals

3. The "bright lines" making up the spectra of excited gaseous atoms help to identify the various energy levels of these atoms. Which statement does **NOT** help to explain the observed line spectra?
   A. Electrons tend to drop to the lowest available energy levels in an atom.
   B. Each frequency of light corresponds to a particular quantity of energy per photon.
   C. Giving a certain quantity of energy to an electron shifts it from one orbital to another of higher energy.
   D. Electrons continuously radiate energy.
   E. When electron moves to a lower energy level, light of a characteristic frequency is emitted by the atom.

4. The following diagrams represent bright-line spectra of elements **X**, **Y**, and **Z**. Diagram **U** represents a bright-line spectrum of an unknown sample. Which of the above elements are contained in the unknown sample?



   A. **X** and **Y** only B. **X** and **Z** only C. **Y** and **Z** only D. **X**, **Y**, and **Z** only E. **Y** only

5. The statement that "**there is a fundamental limitation to just how precisely we can know both the position and momentum of a particle at a given time**" is called
   A. Einstein Theory of Relativity
   B. Pauli Exclusion Principle
   C. Schrödinger Cat Paradox
   D. Heisenberg Uncertainty Principle
   E. deBroglie Hypothesis

6. Of the following, the model that best represents the path of an electron in the wave mechanical model of the atom is an
A. electron cloud diagram B. electron dot diagram C. electron shell diagram
D. energy level diagram E. planetary orbital diagram.

7. The Pauli exclusion principle indicates that the 3*s* orbital can hold a maximum of
A. 2 electrons with opposite spins B. 2 electrons with identical spins
C. 3 electrons with identical spins D. 3 electrons with variable spins
E. none of these

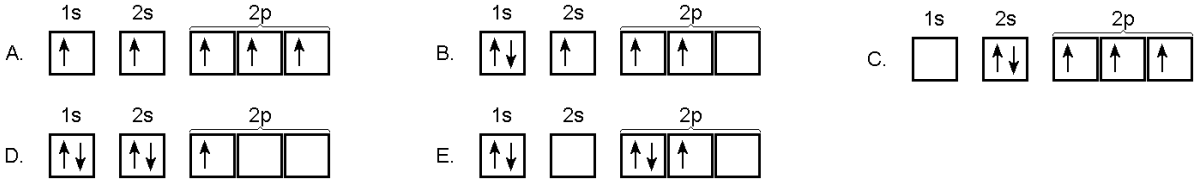
8. Which of the following electron configurations would correctly represent the valence shell of a phosphorus atom in its lowest energy state?
A. $3s^2$
B. $3s^2\ 3p_x^{\ 1}3p_x^{\ 2}3p_y^{\ 2}3p_z^{\ 2}$
C. $3s^1\ 3p_x^{\ 1}3p_y^{\ 1}3p_z^{\ 1}$
D. $3s^2\ \ 3p_x^{\ 1}3p_y^{\ 1}3p_z^{\ 1}$
E. $3s^2\ \ 3p_x^{\ 2}3p_y^{\ 1}$

9. Which of the following atoms has the greatest number of unpaired electrons?
A. $_{22}$Ti B. $_{47}$Ag C. $_{8}$O D. $_{26}$Fe E. $_{19}$K

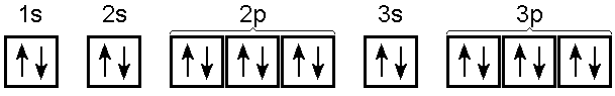
10. Consider a neutral atom with the electron configuration $1s^2\ 2s^2 2p^5\ 3s^1$. Which of the following is false?
A. The atom has atomic number 10. B. The atom is in the most stable configuration.
C. The 1*s* and 2*s* orbitals are filled. D. The atom must lose energy to change to $1s^2\ 2s^2 2p^6$.

11. Which electronic configuration is that of Mn?
A. [Ar] $4s^2\ 3d^3$ B. [Ar] $4s^2\ 3d^5$ C. [Ar] $4s^1\ 3d^7$ D. [Ar] $4s^2\ 3d^6$ E. [Kr] $5s^1\ 4d^{10}$

12. Which orbital notation correctly represents an atom of boron in the ground state?

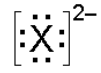


13. Which of the following atoms or ions correctly represents the orbital notation below?



A. S^0 B. S^{2-} C. Al^0 D. Mg^0 E. Mg^{2+}

14. Which Lewis electron-dot diagram correctly represents an **ion** of an element whose **atom** contains 16 electrons, 16 protons, and 16 neutrons?

A. X^{2+} B.  C.  D.  E. X^-

15. Consider the energy level identified by the principal quantum number n= 3. Of the following statements which **ONE** is not true?

A. This energy level can hold 18 electrons
B. There are seven 3f orbitals
C. There are three 3 p orbitals
D. There is one 3s orbital
E. There are 3 sublevels

16. Which configuration (s) would form a –1 ion?

I. $[Ne]3s^2\ 3p^5$ II. $[Ar]\ 4s^2$ III. $[Kr]\ 5s^2\ 4d^6$

IV. $[Kr]\ 5s^2\ 4d^5$. V. $[Kr]5s^2\ 4d^{10}\ 5p^4$

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

17. Which of the following statements is correct and provides the best explanation for what happens when the first two electrons are removed from a calcium atom?

A. Energy is released when either electron comes off since calcium is a metal and not very electronegative.
B. It takes less energy to remove the second electron from calcium as compared to the first because calcium wants to have eight electrons in its outer shell (and thus have a noble gas configuration).
C. It takes less energy to remove the first electron as compared to the second because it is in a higher energy level than the second electron.
D. It takes more energy to remove the second electron as compared to the first, because the nucleus binds the electrons more tightly as each electron is removed.
E. Electrons cannot be removed from calcium since it is a metal and only wants to gain electrons to become more stable.

18. Order the following species from smallest to largest ionization energy: Ca, Ca^+, Ca^{2+}

A. $Ca^+ < Ca < Ca^{2+}$
B. $Ca^{2+} < Ca^+ < Ca$
C. $Ca < Ca^+ < Ca^{2+}$
D. $Ca^{2+} < Ca < Ca^+$
E. $Ca < Ca^{2+} < Ca^+$

19. Which choice shows the elements arranged in the order of increasing number of **valence electrons**?

A. Ge, O, Cs, B, I, Mg, Bi
B. In, Te, K, F, Ba, N, Pb
C. Li, Br, Ga, As, S, C, Ra
D. Cl, Se, P, Sn, Al, Be, Na
E. Rb, Sr, Tl, Si, Sb, Po, At

20. Which choice shows the elements arranged in order of their **increasing** atomic radii?

A. S, Mg, Cl, Na, Si
B. O, S, Se, Te, Po
C. Sn, I, Rb, Sb, Sr
D. Xe, Kr, Ar, Ne, He

21. A German chemist, Johann Döbereiner (1780-1849) contributed to the formation of the modern Periodic Table by
   A. observing 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 weights 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.

22. A line spectrum of red light has a wavelength of 7.09×10^{-7} meters. What is its frequency?
   A. 4.23×10^{14} Hz B. 2.33×10^{1} Hz C. 2.10×10^{15} Hz D. 1.00×10^{10} Hz

23. How many O_2 molecules are needed to react with 7.32 g of S according to the following equation which needs to be balanced:

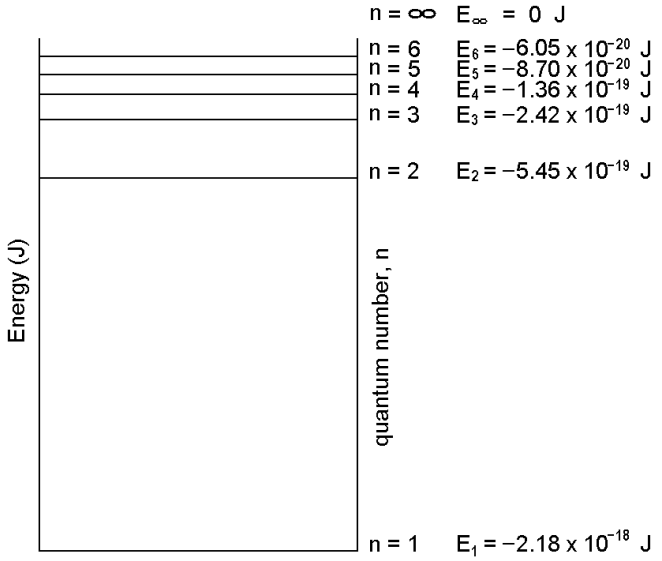
$$S + O_2 \rightarrow SO_3 \ ?$$

   A. 6.02×10^{23} B. 1.53×10^{23} C. 2.06×10^{23} D. 1.80×10^{24} E. 4.12×10^{23}

24. A 15.0-g sample of C_2H_5OH undergoes complete combustion in air. How many grams of H_2O are formed?

   A. 17.6 g B. 11.7 g C. 4.61 g D. 1.50 g E. 18.0 g

25. Which transition of an electron will release a photon of radiant energy of the shortest wavelength?
   A. 6^{th} level to 5^{th} level
   B. 4^{th} level to 2^{nd} level
   C. 3^{rd} level to 2^{nd} level
   D. 2^{nd} level to 1^{st} level
   E. 1^{st} level to 2^{nd} level



Energy Levels in the Bohr Atom

Chemistry I Answer Key: <u>Pink test</u>
Date: Thursday February 14, 2013

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

New Jersey Science League - Chemistry I Exam
March 2013

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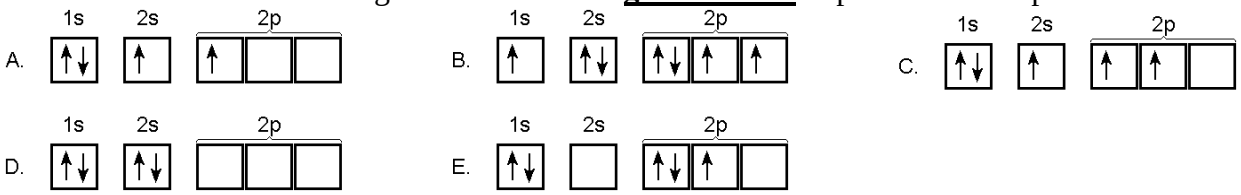
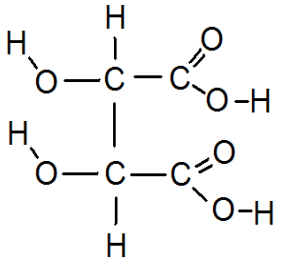
1. Which orbital notation belongs to an element in **ground state** in period 2 of the periodic table?



2. Which of the following molecules contains an sp^3-hybridized carbon atom?
A. CH_3CCH B. CH_2CH_2 C. CH_2CCH_2 D. CHCH E. none of them

3. Acetylene gas with a molecular formula of C_2H_2 burns with one of the hottest natural chemical flame, and may be used in welding torches. What kind of hybridization of orbitals is found in each of the carbon atoms in this molecule?
A. sp^1 B. sp^2 C. sp^3 D. sp^3d^1 E. sp^3d^2

4. The diagram at the right is a structural representation of a tartaric acid molecule, the organic acid found in grapes. How many **sigma** and **pi** bonds are present in this molecule?
A. 2 sigma bonds and 15 pi bonds B. 6 sigma bonds and 4 pi bonds
C. 15 sigma bonds and 2 pi bonds D. 4 sigma bonds and 6 pi bonds
E. 16 sigma bonds and 0 pi bonds



5. Which of the following molecules contains a triple covalent bond?
A. H_2 B. O_2 C. N_2 D. CO_2 E. H_2O

6. What are the shapes of BF_3 and NF_3 molecules respectively?
(1) planar (2) linear (3) bent (4) trigonal pyramidal (5) trigonal planar
A. 1 and 2 B. 4 and 3 C. 5 and 4 D. 4 and 2 E. 2 and 3

7. Based on its Lewis diagram, what is the correct shape of an SO_2 molecule?
A. bent B. trigonal planar C. trigonal pyramidal D. Linear E. tetrahedral

8. An acceptable Lewis dot structure for N_2O is

9. Which compound is an isomer of CH_3CH_2OH?
A. CH_3COOH B. $CH_3CH_2CH_3$ C. CH_3OCH_3 D. CH_3COCH_3
E. None of these

10. Molecular substances such as HCl, CO_2, H_2S, and N_2O are gases at room temperature. Water is a liquid at room temperature mostly because of its
A. ionic bonds B. hydrogen bonds C. dipole-dipole attractions
D. covalent bonds E. London dispersion forces

11. Attractive forces between real gas molecules become strongest
A. at low pressures and low temperatures. B. at low pressures and high temperatures.
C. at high pressures and high temperatures. D. at high pressures and low temperatures.
E. as the molecular masses decrease.

12. Given the following examples of intermolecular attractive forces:

Which choice(s) contain(s) **only** London dispersion forces?
A. 1 and 2 only B. 4 only C. 2 and 3 only D. 3 and 4 only E. 2 only

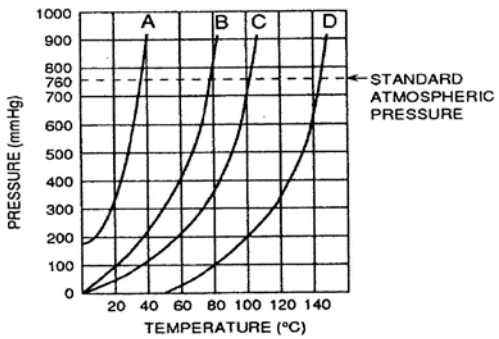
13. For the red-ox reaction given, determine the reducing agent.
$Mg(s) + Sn^{2+}(aq) \rightarrow Sn(s) + Mg^{2+}(aq)$
A. Mg B. Sn^{2+} C. Sn D. Mg^{2+}

14. Molecules of four gases, H_2, NH_3, SO_2, and CO_2, are released simultaneously from their respective containers on one side of a room: What is the order in which the gas molecules will reach the opposite side of the room(list from first to last)?
A. CO_2, SO_2, NH_3, and H_2 B. NH_3, CO_2, H_2, and SO_2 C. SO_2, NH_3, CO_2, and H_2
D. H_2, NH_3, CO_2, and SO_2 E. All gas molecules will reach the other side of the room at the same time.

15. One mole of molecules of three different gases, He, NO_2, and N_2, are contained in three sealed identical balloons respectively at the same temperature and pressure. Which of the following statements is/are **all completely correct**?
(1) All three balloons have the same mass.
(2) Molecules of each gas have the same average kinetic energies.
(3) All three balloons have the same volume.
(4) Molecules of each gas move with different average velocities.
(5) Each balloon contains a different number of gas molecules.
(6) All three balloons have different masses.

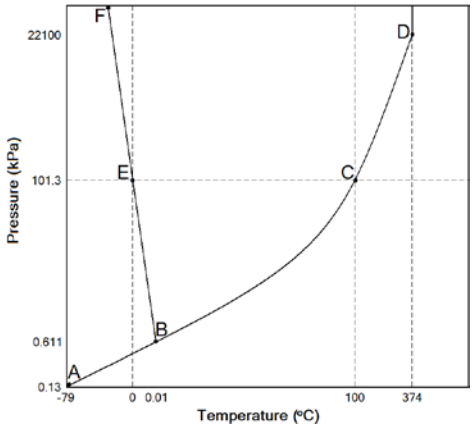
A. 1, 4, only B. 3, 4, and 5 only C. 2, 3, 4, and 6 only
D. 2, 3, and 5 only E. 1, 5, only

16. The vapor pressure curves of four liquids, A, B, C and D are shown on the graph at the right. Which liquid(s) is/are completely vaporized at 400 mm Hg and 100°C?
A. liquid A only
B. liquids A and B only
C. liquids A, B, and C only
D. liquid D only
E. All four liquids are completely vaporized



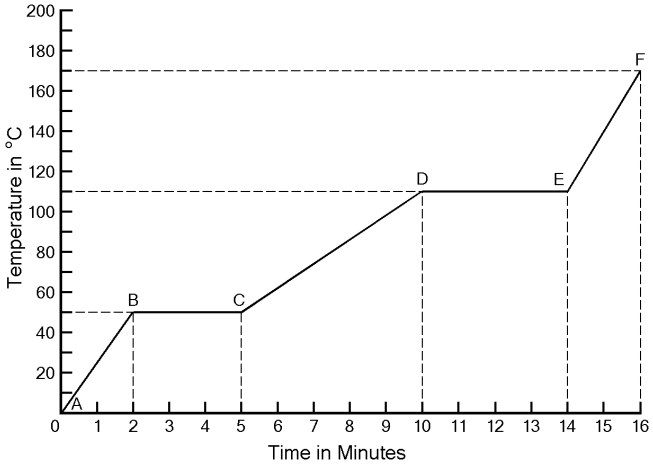
17. Given the Temperature-Pressure Phase diagram for water at the right. Which lettered point represents the **triple point**?

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



18. A sample of substance X was heated uniformly for 16 minutes at standard pressure. Which statements below are correct regarding the graph and substance X?

(1) Substance X is water.
(2) Substance X boils at 50°C.
(3) Two phases of substance X exist simultaneously at the same temperature between points D and E.
(4) Substance X exists as a solid between points A and B.
(5) Substance X exists primarily as a liquid between points C and D.
(6) Substance X is completely vaporized after 10 minutes of heating.



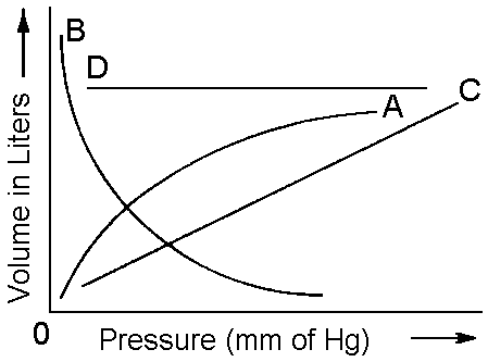
A. Statements 1, 2, and 3 are all correct.
B. Statements 4, 5, and 6 are all correct.
C. Statements 1, 3, and 5 are all correct.
D. Statements 3, 4, and 5 are all correct.
E. All of the above statements are correct.

19. At standard conditions one molar mass of any gas will occupy 22.4 liters. Therefore,

A. the molar mass of any gas is the same.
B. the molecules of all gases have the same velocity at standard conditions
C. their will be the same number of molecules in one molar mass of any gas.
D. all gases are diatomic
E. the molecules of all gases are in rapid motion.

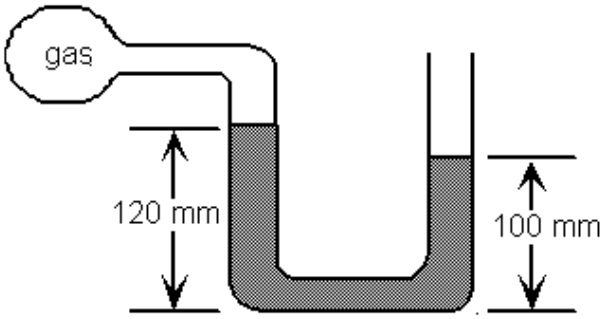
20. Which of the lines or curves on the right correctly represents the relationship between the pressure and volume of a sample of an ideal gas.

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



21. The height of the mercury in the right arm open to the atmosphere(760 mm) is 100mm, while the height in the left arm is 120 mm of Hg. What is the pressure of the gas?

A. 780 mm B. 740 mm C. 640 mm D. 20 mm.



22. A 209-mL sample of an unknown gas was collected by downward water displacement at 23°C, at atmospheric pressure of 268 torr. The mass of the gas was determined to be 0.16 g. The vapor pressure of water at 23°C is 21.1 torr. What is the mole mass of this gas?

A. 16 g/mol B. 114 g/mol C. 57 g/mol D. 4.4 g/mol E. 44 g/mol

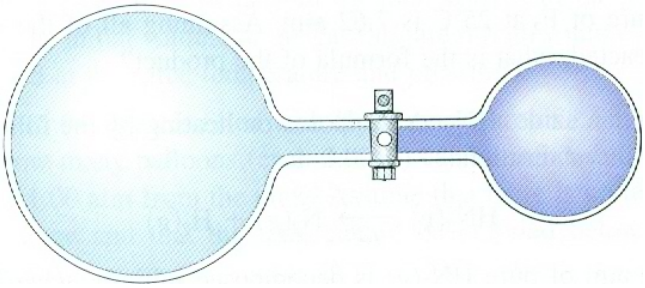
23. A particular tank can safely hold gas up to a pressure of 54.8 atm. When the tank contains 52.3 g of O_2 at 25°C, the gas exerts a pressure of 40.0 atm. What is the highest temperature up to which the gas sample can be heated safely?

A. 408°C B. 298 K C. 100°C D. 135°C E. 135 K

24. 15.0 g of Sr is added to 150. mL of distilled water at STP. What volume of H_2 can be produced?

A. 22.4 L B. 15.0 L C. 150. L D. 18.0 L E. 3.83 L

25. The diagram at the right represents two connecting flasks with the closed stopcock between them. The volume of the flask on the **left** is 3.00 Liters and it contains hydrogen gas at a pressure of 538 torr. The volume of the flask on the **right** is 1.50 L, and it contains nitrogen gas at a pressure of 0.300 atm. When the stopcock is opened, the gases are allowed to mix. What will be the total pressure of the mixture assuming constant temperature? (Assume that the volume of each flask includes its neck respectively.)



A. 572 torr B. 0.100 atm C. 435 torr D. 359 atm E. 359 torr

Chemistry I Answer Key **PINK TEST**
Date: Thursday March 14, 2013

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

New Jersey Science League - Chemistry I Exam
April 2013

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. The ratio of carbon to hydrogen to oxygen atoms in a compound is 4:8:12. The **empirical formula** of this compound is
   A. CHO B. $C_4H_8O_{12}$ C. $C_2H_4O_6$ D. CH_3O_2 E. CH_2O_3

2. A single molecule of a certain compound weighs 3.40×10^{-22} g. Which figure comes nearest to the gram formula mass of the substance?
   A. 250. g/mol B. 50.0 g/mol C. 100. g/mol D. 150. g/mol E. 205 g/mol

3. 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

4. Which molecule has sp^3 hybrid orbitals?
   A. CO_2 B. CH_4 C. C_2H_2 D. C_2H_4 E. N_2

5. According to the table of electronegativities below, which molecule has polar bonds, but is a non-polar molecule?

Element	H	B	C	O	P	S	Cl	Br
Electronegativity	2.2	2.0	2.6	3.5	2.2	2.6	3.2	2.9

   A. BCl_3 B. H_2CO C. PH_3 D. CS_2 E. Br_2

6. Use the section of a symbolic periodic table below to determine the type of bond that will form between atoms of elements "W" and "E". (Note that the letter symbols are **not** the actual symbols of the elements they represent.)

	Main Groups							
	I A	II A	III A	IV A	V A	VI A	VII A	VIII A
First Period								
Second Period	X	Q	M	T	U	V	D	J
Third Period	Y	R	N			W	E	K
Fourth Period	Z	S					G	L

   A. covalent B. electronic C. ionic D. metallic E. van der Waals

7. Consider the equilibrium reaction: $2\ A(g) + B(g) \rightleftarrows 2\ C(g)$. At constant temperature and volume, what is the effect of doubling the concentration of C?
   A. The concentration of A increases more than that of B.
   B. The concentration of A decreases more than that of B.
   C. The concentrations of A and B remain the same.
   D. The concentrations of A and B decrease equally.
   E. The concentration of B decreases more than that of A.

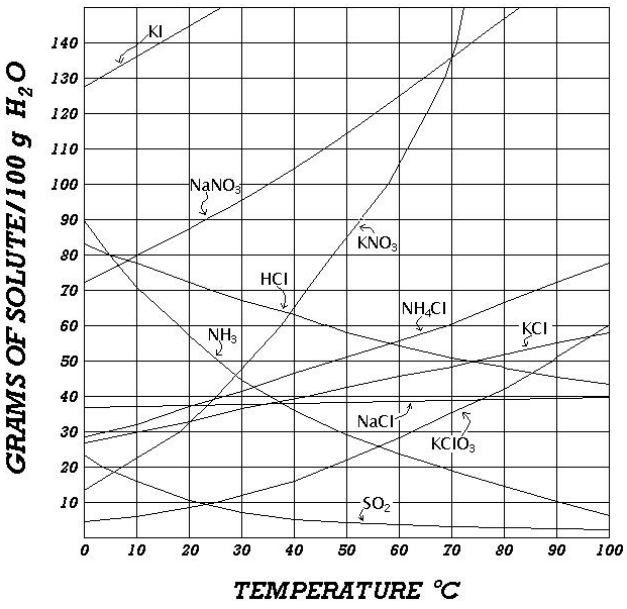
8. Consider 0.1 M aqueous solutions of HCl, NH_3, and $C_6H_{12}O_6$. The first is a strong electrolyte, the second is a weak electrolyte, and the third is a non-electrolyte. What test could be done to determine experimentally the electrolyte nature of these substances?
   A. Measure the pH value of each solution using a pH sensor.
   B. Test the action of each solution on zinc metal.
   C. Test the action of each solution on copper wire.
   D. Test the electrical conductivity of each solution.
   E. Remove the water and test each solute with a mass spectrograph.

9. Consider the equilibrium: energy + 2 $H_2O \rightleftarrows H_3O^+ + OH^-$. As the temperature of a sample of pure water is increased
   A. the number of moles of water present will increase.
   B. the ionization constant for water will decrease.
   C. both the number of hydrogen ions and hydroxide ions will increase.
   D. the hydrogen ion concentration will increase and the hydroxide ion concentration will decrease.
   E. the ionization constant for water remains unchanged.

10. The equilibrium law $K_{eq} = \{[A]^2[B]\} / \{[C][D]^2\}$ represents which of the following reactions?
   A. $A + B \rightleftarrows C + D$ B. $C + 2\ D \rightleftarrows 2\ A + B$ C. $2\ A + B \rightleftarrows C + 2\ D$
   D. $C + D \rightleftarrows A + B$ E. $A^2 + B \rightleftarrows C + D^2$

11. The equilibrium constant, K_{eq}, for the gaseous reaction $A + B \rightleftarrows C + D$ is
   A. independent of the initial concentrations and dependent on the fixed temperature of the system.
   B. independent of both the initial concentrations and the temperature of the system.
   C. dependent on both the initial concentrations and the temperature of the system.
   D. dependent on the initial concentrations of the system and independent of the fixed temperature of the system.

12. 100 g of water at 65°C has 100. g of KNO_3 dissolved in it. According to the solubility curves at the right, which statement is correct?
   A. This solution is saturated at the given temperature.
   B. The solution is supersaturated at the given temperature.
   C. No more KNO_3 can be dissolved in this solution at the given temperature.
   D. The solution can be made saturated by raising the temperature to about 70°C.
   E. The solution can be made saturated by the addition of 20. grams of KNO_3.



13. Using solubility rules as a guide, which of the following pairs of aqueous solutions, when mixed, will **not** produce a precipitate?
   A. $MgCl_2(aq)$ and $AgNO_3(aq)$ B. $Ba(NO_3)_2(aq)$ and $CuSO_4(aq)$
   C. $KNO_3(aq)$ and $NH_4Cl(aq)$ D. $Mg(NO_3)_2(aq)$ and $NaOH(aq)$
   E. $PbBr_2(aq)$ and $(NH_4)_3PO_4(aq)$

14. Which chemical reaction will have the greatest **increase** in entropy?
A. $N_2O(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$
B. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
C. $CO_2(s) \rightarrow CO_2(g)$
D. $H_2O(g) \rightarrow H_2O(l)$

15. The spontaneous evaporation of water is evidence of
A. a natural tendency toward minimum potential energy.
B. a natural tendency toward increasing randomness.
C. strong repulsive forces between water molecules.
D. the existence of a state of equilibrium.
E. a high activation energy for the reaction.

16. If an acid with a concentration of 0.10 M has a pH of 4.0, this acid **must** be
A. a strong acid B. a weak acid C. a monoprotic acid D. a diprotic acid

17. The table at the right contains ionization constants (K_a) of four acids. Which choice contains the acids whose 1.0 M solutions have pH values arranged from smallest to largest?

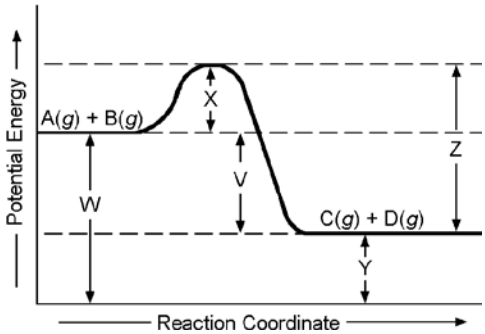
Acid	**K_a**
HBrO	2.5×10^{-9}
HF	6.6×10^{-4}
HNO_2	4.6×10^{-4}
$HC_2H_3O_2$	1.8×10^{-5}

A. HBrO, $HC_2H_3O_2$, HNO_2, HF
B. $HC_2H_3O_2$, HF, HNO_2, HBrO
C. $HC_2H_3O_2$, HNO_2, HF, HBrO
D. HNO_2, $HC_2H_3O_2$, HBrO, HF
E. HF, HNO_2, $HC_2H_3O_2$, HBrO

18. The net ionic equation for the reaction between silver nitrate and potassium chloride is
A. $Ag^+(aq) + Cl^-(aq) \rightleftarrows AgCl(s)$
B. $Ag^+(aq) + K^+Cl^-(aq) \rightleftarrows Ag^+Cl^-(aq) + K^0(s)$
C. $AgNO_3(aq) + KCl(aq) \rightleftarrows AgCl(s) + KNO_3(aq)$
D. $Ag^+NO_3^-(aq) + Cl^-(aq) \rightleftarrows AgCl(s) + NO_3^-(aq)$
E. $Ag^+(aq) + NO_3^-(aq) + K^+(aq) + Cl^-(aq) \rightleftarrows AgCl(s) + K^+(aq) + NO_3^-(aq)$

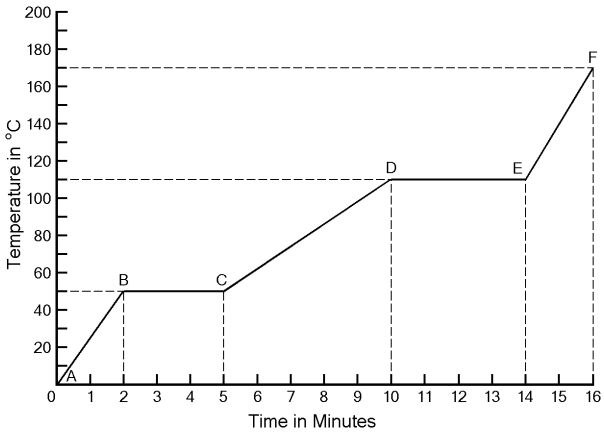
19. Which statement is true regarding the following chemical reaction at standard pressure and 25°C?
$H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g) + 44.2$ kcal
A. ΔH of formation for HCl is = – 44.2 kcal
B. ΔH of formation for HCl is = – 22.1 kcal
C. ΔH of formation for HCl is = +22.1 kcal
D. The heat content of the products is greater than the heat content of the reactants.

20. According to the potential energy diagram at the right, representing a chemical reaction:
$A(g) + B(g) \rightarrow C(g) + D(g)$
which expression correctly represents the **ΔH** for this reaction:
A. Y – W B. W – Y C. W + X
D. W – X E. X + Y



21. Which formula is possible for a completely dissociated salt, if an aqueous 0.10 molal solution of that salt has a freezing point of –0.74°C? (Molal freezing point constant of water is 1.86°C/m)
A. MX B. M_2X C. M_2X_3 D. MX_3

22. The diagram on the right represents a sample of substance **X** being heated on top of a hot plate from 20°C to 140°C. The temperature of the substance is recorded every minute for 16 minutes. Which choice contains **only** parts of the graph during which the heat energy supplied by the hot plate is changed into potential energy of the substance?



A. AB and BC B. CD and DE
C. AB and CD D. BC and DE
E. AB and EF

23. Given the following data:

$2\ O_3(g) \rightarrow 3\ O_2(g)$ $\Delta H = -427$ kJ
$O_2(g) \rightarrow 2\ O(g)$ $\Delta H = +495$ kJ
$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$ $\Delta H = -199$ kJ

Calculate ΔH for the reaction: $NO(g) + O(g) \rightarrow NO_2(g)$

A. +495 kJ B. +427 kJ C. –398 kJ D. –466 kJ (E) –233 kJ

24. The data below were collected for the following reaction: $2\ NO_2(g) + F_2(g) \rightarrow 2\ NO_2F(g)$

Trial	$[NO_2]$ (mol/L)	$[F_2]$ (mol/L)	Initial Rate (mol/L·s)
1	0.100	0.100	0.026
2	0.200	0.100	0.051
3	0.200	0.200	0.103
4	0.400	0.400	0.411

The value of the rate constant, k, for this reaction is closest to

A. 0.20 L/mol·s B. 2.6 L/mol·s C. 0.26 L/mol·s
D. 0.010 L/mol·s E. 0.40 L/mol·s

25. When 45.0 g of an alloy at 100.0 °C is dropped into 100.0 g of water at 25.0 °C, the final temperature is 37.0 °C. What is the specific heat of the alloy?

A. 5.02 J/g·°C B. 4.50 J/g·°C C. 4.18 J/g·°C D. 1.77 J/g·°C E. 3.70 J/g·°C

Chemistry I Answer Key PINK TEST
Date: Thursday April 11, 2013

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