

New Jersey Science League

Chemistry II Exam January 2013

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

1. Which has the most oxygen atoms?

- A. 4.0×10^{-3} g of aluminum oxide
- B. 18 mg of water
- C. 6.0 mg of sucrose, $C_{12}H_{22}O_{11}$
- D. 0.032 g of oxygen
- E. All have the same number of oxygen atoms

2. 100.0 mL of 0.10 M silver nitrate solution, $AgNO_3$, solution is added to 150.0 mL 0.10 M ammonium phosphate, $(NH_4)_3PO_4$, solution. After the reaction is completed, which of these ions has the highest concentration in the final solution?

- A. Ag^+ B. NO_3^- C. NH_4^+ D. PO_4^{3-} E. OH^-

3. An individual accidentally ingests one drop of 0.010 M $Hg(NO_3)_2$ solution. What is the mercury ion concentration, in ppb (parts per billions) by mass in the individual's blood? 20 drops \cong 1.0 mL and an adult human body has about 5.0 L of blood. Also assume that the density of blood is 1.0 g/mL. Hg = 200; N = 14 and O = 16.

- A. 12 B. 20 C. 81 D. 200 E. 324

4. In which of the following species is the oxidation number of phosphorus the lowest?

- A. PH_3 B. P_4O_{10} C. H_3PO_4 D. $P_2O_7^{4-}$ E. PO_3^-

5. Which of the following compounds has the highest nitrogen content by mass?

- A. ammonium nitrate, NH_4NO_3
- B. aluminum nitrite, $Al(NO_2)_3$
- C. sodium azide, NaN_3
- D. potassium nitrate, KNO_3
- E. lithium nitride, Li_3N

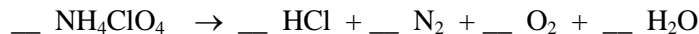
6. Cadmium metal is used in electroplating industry. It is an extremely toxic element. An engineer would like to replace it with a less toxic metal with similar chemical properties. Which of the following elements could replace cadmium?

- A. Hg B. Au C. Zn D. In E. Ag

7. A sample of brass (an alloy of copper and zinc) weighing 3.00 g was treated with a solution of dilute hydrochloric acid. The mass of the gas produced is 0.060 g. What is the mass percent composition of Cu in the brass sample? Cu = 63.5; Zn = 65.0 and H = 1.00 (Note: An activity series of the metals is provided in Question 24).

- A. 20.0 B. 35.0 C. 50.0 D. 65.0 E. 72.0

8. Ammonium perchlorate's thermal decomposition reaction is represented by the equation below. When the equation is balanced using the smallest-whole-number coefficients, the sum of the coefficients of the **products** is equal to

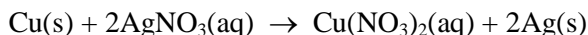


- A. 14 B. 15 C. 16 D. 17 E. 18

9. An imaginary element (atomic weight 73.500 amu) has three naturally-occurring isotopes with isotopic weights of 71.900, 73.900 and 74.900. The abundance of the heaviest isotope is 20.0%. What is the percent abundance of the lightest isotope?

- A. 10.0 B. 20.0 C. 30.0 D. 40.0 E. 50.0

10. A sample containing 7.45 grams of KCl is dissolved in sufficient distilled water and reacted with 1000.0 mL 0.300 M AgNO₃ solution. Excess silver nitrate solution reacted with the metallic copper according to the following reaction:



The precipitate is filtered off and a strip of copper weighing 10.00 grams is dropped into the filtrate. After the reaction is terminated, the mass of unreacted copper remaining is

- A. 9.35 g B. 8.65 g C. 7.35 g D. 6.35 g E. 3.65 g

11. Based on the tabulated temperature data, which of the following mathematical formulas can be used to convert any given temperature from Réaumur scale to Newton scale?

Celsius °C	Fahrenheit °F	Kelvin K	Newton °N	Réaumur °Ré
300.00	572.00	573.15	99.00	240.00
200.00	392.00	473.15	66.00	160.00
100.00	212.00	373.15	33.00	80.00
0.00	32.00	273.15	0.00	0.00

- A. °N = °Ré × (5/4)
 B. °Ré = °N × (5/4)
 C. °N = °Ré × (33/80)
 D. °N = °Ré × (80/33)
 E. °Ré = °N + 47

12. A mixture of hydrogen and chlorine gases in a closed container at a constant temperature was irradiated by a strong light. The resulting mixture had a molar composition as follows: 60% chlorine, 10% hydrogen and 30% hydrogen chloride. What was the composition of H_2 in the initial mixture?

- A. 10% B. 20% C. 25% D. 30% E. 35%

13. Which of the following reactions will NOT give a precipitate?

- A. $Fe(NO_3)_3(aq) + NaOH(aq) \rightarrow$
B. $H_2SO_4(aq) + BaCl_2(aq) \rightarrow$
C. $CaCl_2(aq) + Na_3PO_4(aq) \rightarrow$
D. $Pb(NO_3)_2(aq) + K_2SO_4(aq) \rightarrow$
E. $HCl(aq) + Zn(NO_3)_2(aq) \rightarrow$

14. How many **moles of sulfate ions** are in 400.0 mL of a solution of 0.0030 M $Al_2(SO_4)_3$?

- A. 012 B. 1.2 C. 1.2×10^{-3} D. 3.6×10^{-3} E. 3.6×10^{-4}

15. Which of the following acids has the least hydrogen in its formula?

- A. phosphorus acid
B. phosphoric acid
C. sulfuric acid
D. sulfurous acid
E. hypobromous acid

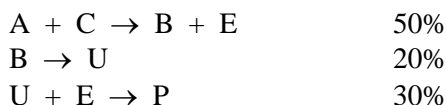
16. Most electronic transitions are not visible to us. Which of the following transitions is visible to the human eye?

- A. $5 \rightarrow 1$ B. $4 \rightarrow 3$ C. $6 \rightarrow 2$ D. $4 \rightarrow 1$ E. $2 \rightarrow 1$

17. The quantum numbers $n = 5$; $l = 1$; $m_l = 0$ could represent a valence electron in which atom in its ground state?

- A. Tl B. Ga C. Cd D. Te E. Rb

18. Product P is produced from its reactants A and C in three-step reactions.



The percent yields of the individual reactions are given next to the equations. What is the yield of the overall reaction?

- A. 3 B. 20 C. 30 D. 70 E. 100

19. Which sublevel is being filled in the actinides series?

- A. 4f B. 5f C. 5d D. 4d E. 3p

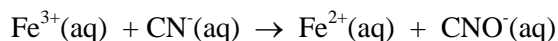
20. Which of the following elements has the largest atomic radius?

- A. Ge B. As C. Se D. P E. Sb

21. Which of the following electron configurations represents an excited state of the magnesium atom?

- A. $1s^2 2s^2 2p^6$
 B. $1s^2 2s^2 2p^6 3s^1 5p^1$
 C. $1s^2 2s^2 2p^5$
 D. $1s^2 2s^2 2p^6 3s^2$
 E. $1s^2 2s^2 2p^6 3s^1$

22. When the following redox equation is balanced in basic medium using the lowest possible whole number coefficients, the coefficient of CN^- is



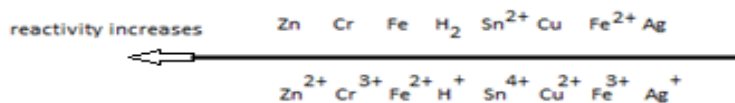
- A. 2 B. 3 C. 1 D. 4 E. 5

23. In the following balanced equation, which element is reduced?



- A. H B. S C. K D. Cr E. Ni

24. Based on the activity series provided below, which of the following reactions will occur spontaneously as written? (The equations are not balanced)



- A. $\text{Sn}^{4+}(\text{aq}) + \text{Fe}^{3+}(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + \text{Fe}^{2+}(\text{aq})$
 B. $\text{Fe}^{2+}(\text{aq}) + \text{H}_2(\text{g}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{H}^+(\text{aq})$
 C. $\text{Zn}^{2+}(\text{aq}) + \text{Cr}(\text{s}) \rightarrow \text{Zn}(\text{s}) + \text{Cr}^{3+}(\text{aq})$
 D. $\text{Fe}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Fe}(\text{s}) + \text{Zn}^{2+}(\text{aq})$
 E. $\text{Zn}^{2+} + \text{Ag}(\text{s}) \rightarrow \text{Ag}^+ + \text{Zn}(\text{s})$

25. Element X reacts with oxygen to produce X_2O_3 . In an experiment, it is found that 2.0000 g of X produces 2.8594 g of X_2O_3 . What is the atomic weight of X in amu?

- A. 55.847 B. 26.982 C. 204.78 D. 208.98 E. 51.996

Chemistry II January 2013 Answer Key

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

New Jersey Science League
Chemistry II Exam February 2013

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

1. A compound contains only carbon and hydrogen atoms. A 0.7155 g sample is burned in pure oxygen to give 1.433 L of CO_2 collected by water displacement method at 20°C . The barometric pressure in the room temperature is 86.93 kPa. The vapor pressure of water vapor is 23 mmHg at this temperature. What is the empirical formula of the compound? Assume that the solubility of CO_2 in water is negligible. $1 \text{ atm} = 760 \text{ mmHg} = 101.3 \text{ kPa}$

- | | |
|---------------------------|------------------------------|
| A. CH_2 | D. C_3H_8 |
| B. C_2H_5 | E. C_4H_{10} |
| C. C_3H_7 | |

2. Which of the following substances is *least soluble* in water?

- | | |
|---------------------------------------|-------------------------------|
| A. $(\text{NH}_4)_3\text{PO}_4$ | D. $\text{Pb}(\text{NO}_3)_2$ |
| B. $\text{AgC}_2\text{H}_3\text{O}_2$ | E. CoS |
| C. CuCl_2 | |

3. What is the hybridization of Te atom in TeF_2 as predicted by the VSEPR model and valence bond theory?

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

4. What is the shape of the XeO_3 molecules as predicted by VSEPR model?

- | | |
|------------------|-----------|
| A. tetrahedral | D. linear |
| B. square planar | E. bent |
| C. pyramidal | |

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

- A. TeF_4 B. H_2O C. SO_2 D. NF_3 E. SF_6

6. Which of the pairs of species have the same molecular shapes according to VSEPR theory?

I. NO_3^- and CO_3^{2-} II. N_3^- and I_3^- III. NH_3 and BH_3

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

7. Which two orbitals are degenerate (of equal energies) in atoms having two or more electrons?

- A. $4p_x$ and $4p_z$
B. $3s$ and $3p$
C. $4p_x$ and $5p_x$

- D. $4p_z$ and $4d_z^2$
E. $2p_x$ and $3p_z$

8. Calculate the de Broglie wavelength, in meters, of a proton moving at 90.0% of the speed of light. The mass of a proton is 1.6726×10^{-27} kg. The speed of light is 3.00×10^8 m/s.

- A. 1.3×10^{-15}
B. 1.63×10^{-15}
C. 1.46×10^{-11}

- D. 1.46×10^{-15}
E. 1.46

9. Which of the following orbitals can hold two electrons?

- I. $2p_x$ II. $3s$ III. $3d_{xy}$

- A. Only II
B. I and II
C. Only III

- D. I, II and III
E. Only I

10. Which of the following gases can NOT be collected by water displacement?

- A. CH_4 B. NH_3 C. N_2 D. O_2 E. Ar

11. Which of the following compounds has the highest boiling point?

- A. $\text{CH}_3\text{CH}_2\text{NH}_2$
B. $\text{C}_2\text{H}_5\text{OH}$
C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

- D. CH_3NH_2
E. CH_3OH

12. 3.20 g of an iron oxide reacts with excess carbon monoxide at high temperature. 2.24 g of metallic iron is produced in this reaction. What is the formula of the iron oxide?

- A. Fe_2O B. FeO_2 C. FeO D. Fe_3O_4 E. Fe_2O_3

13. A sample of 0.276 g of K_2CO_3 contains some impurities. This sample is treated with excess hydrochloric acid. The CO_2 produced in this experiment is bubbled into a saturated solution of

Ba(OH)₂. After the reaction is terminated, the dried precipitate weighed 0.384 g. What is the purity of the sample?

- A. 82.3% B. 90.5% C. 92.4% D. 95.4% E. 97.5%

14. 1.00 g of solid Na₂CO₃ is dissolved in a small amount of distilled water and added to 50.0 mL of 0.500 M of CaCl₂ solution. The precipitate is filtered, washed and dried. The mass of the dry precipitate is 0.903 g. What is the percent yield of the reaction?

- A. 91.2% B. 94.3% C. 95.6% D. 97.8% E. 98.9%

15. A rigid vessel of volume 0.50 L containing Ar at 27°C and pressure of 10.0 atm is connected to a second rigid vessel of volume of 0.70 L containing Ne at 37°C at pressure of 5.0 atm. A valve separating the two vessels is opened and both cooled to a temperature of 17°C. What is the final pressure in the vessel?

- A. 6.8 atm B. 8.2 atm C. 9.1 atm D. 9.6 atm E. 15.0 atm

16. Which of the following pairs of anions does NOT have the same charge?

- A. phosphate and perchlorate
B. nitrate and nitrite
C. carbonate and sulfate
D. acetate and bromate
E. cyanide and hypochlorite

17. A hydrate containing copper, sulfur, oxygen, and water lost 0.632 g upon heating. Originally the hydrate had weighed 2.50 g. Analysis of the anhydrous substance revealed that the 0.744 g of Cu, 0.375 g of S, and 0.750 g of O were present. Find the formula of the hydrate?
Cu = 63.5; S = 32; O = 16.

- A. CuSO₄•2H₂O D. CuSO₄•3H₂O
B. Cu₂SO₃•3H₂O E. Cu₂SO₄•7H₂O
C. CuSO₄•5H₂O

18. In which of the compounds is the carbon-carbon bond the shortest?

- A. C₂H₂ B. C₂H₄ C. C₂H₆ D. C₂H₅OH E. C₂H₅Br

19. Which is the correct order when the elements Na, Mg and Al, are arranged in order of increasing first ionization energy?

- A. Na, Mg, Al
- B. Na, Al, Mg
- C. Al, Mg, Na

- D. Al, Na, Mg
- E. Mg, Al, Na

20. Which compound has the highest vapor pressure at 25°C?

- A. CH₃OH
- B. CH₃CH₂OH
- C. H₂O

- D. CCl₄
- E. C₂H₅OC₂H₅

21. For the same mass, which would produce the largest change in the water level when added to water in a 50-mL graduated cylinder?

- A. Glass $d = 2.60 \text{ g/cm}^3$
- B. Graphite $d = 2.27 \text{ g/cm}^3$
- C. Aluminum $d = 2.73 \text{ g/cm}^3$
- D. Copper $d = 8.94 \text{ g/cm}^3$
- E. Lead $d = 11.34 \text{ g/cm}^3$

22. During the complete combustion of C₂H₄, what change in hybridization do the carbon atoms undergo?

- A. sp to sp^3
- B. sp^2 to sp^3
- C. sp^2 to sp
- D. sp^3 to sp
- E. sp^2 to dsp^3

23. The electron configuration [Ar] 3d⁸ belongs to

- A. Fe
- B. Fe²⁺
- C. Cu²⁺
- D. Ni²⁺
- E. Cr³⁺

24. Which of the following molecules does NOT have a sp^3 hybridized central atom?

- A. ClO₃⁻
- B. BF₄⁻
- C. BH₃
- D. XeO₃
- E. NH₃

25. Which of the following molecules can NOT present hydrogen bonding within a sample of the pure substance?

- A. CH₃NH₂
- B. HF
- C. HC₂H₃O₂
- D. CH₃OH
- E. CH₃F

Chemistry II February 2013 Answer Key

The return envelope containing the student filled in scan-trons and filled in area records must be postmarked within one week of the official date the exam was to be given or the scores will not count.

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

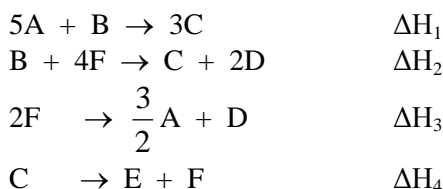
New Jersey Science League
Chemistry II Exam March 2013

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

1. The vapor pressure of a solvent (MW = 74.0 g/mol) is 442 mmHg at 27°C. If 3.00 g of a nonvolatile unknown molecular compound are dissolved in 50.0 g of solvent at this temperature, the vapor pressure falls to 426 mmHg. Calculate the molar mass of the unknown compound. Assume that the solution is very dilute.

- A. 61g B. 92.5g C. 74g D. 118g E. 123g

2. Use the reactions below:



What is the change in enthalpy for the reaction $2A \rightarrow 2E + 2F$?

- A. $\Delta H_1 - \Delta H_2 + 2(\Delta H_3 + \Delta H_4)$ D. $\Delta H_1 + \Delta H_2 - \Delta H_3 + 2\Delta H_4$
B. $\Delta H_1 - \Delta H_2 + 2(\Delta H_3 - \Delta H_4)$ E. $\Delta H_1 - \Delta H_2 - 2\Delta H_3 + 2\Delta H_4$
C. $2(\Delta H_1 - \Delta H_2) + \Delta H_3 + \Delta H_4$

3. Given the following bond energies, calculate the heat of combustion of ethene, C_2H_4 ?

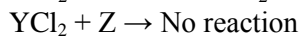
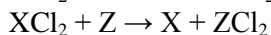
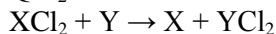
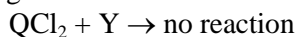
Bond Dissociation Enthalpies (kJ/mol)	
C – H	413
C = O	745
C = C	610
O = O	498
H – O	463
C – C	346

- A. -1297 kJ B. -1076 kJ C. -1297 kJ D. 1076 kJ E. -638 kJ

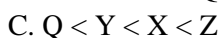
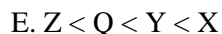
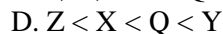
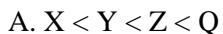
4. Which of the following equations does NOT represent an oxidation-reduction reaction?

- A. $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$
B. $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
C. $Cr_2O_7^{2-}(aq) + 2OH^-(aq) \rightarrow 2CrO_4^{2-}(aq) + H_2O(l)$
D. $2CuCl(aq) \rightarrow CuCl_2(aq) + Cu(s)$
E. $SiCl_4(s) + 2Mg(s) \rightarrow 2MgCl_2(s) + Si(s)$

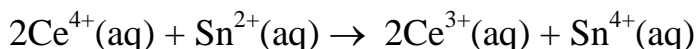
5. Consider the following reactions:



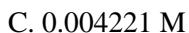
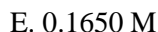
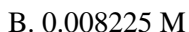
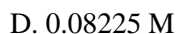
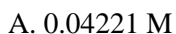
What is the correct order of increasing activity (least to most) for the metals X, Y, Z and Q?



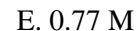
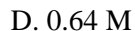
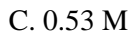
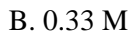
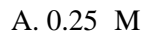
6. Cerium(IV) ion is a strong oxidizing agent that accepts one electron to produce cerium(III) ion. A solution containing an unknown concentration of Sn^{2+} ions was titrated with a solution containing Ce^{4+} ions, which oxidize the Sn^{2+} ions to Sn^{4+} oxidation state.



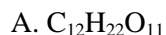
In one titration 10.50 mL of the unknown solution required 16.45 mL of a 0.1050 M Ce^{4+} solution to reach the stoichiometric point. Calculate the concentration of Sn^{2+} ions in the unknown solution.



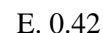
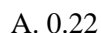
7. What is the Na^+ ion concentration in the solution formed by mixing 30.0 mL 0.25 M NaCl, 20.0 mL of 0.10 M Na_2SO_4 solution with 50.0 mL of 0.35 M Na_3PO_4 solution?



8. Which of the following 0.30 *m* solutions has the lowest freezing point?



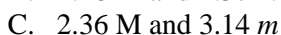
9. A piece of metal with a mass of 25.14 g is heated in boiling water to 97.5°C and then dropped into a coffee-cup calorimeter containing 75.0 g of water at 22.7°C. When the thermal equilibrium is reached, the final temperature is 24.9°C. Calculate the specific heat capacity of the metal in units of J/g°C.



10. In which of the following compounds does manganese have the highest oxidation number?



11. Concentrated hydrochloric acid solution is 36.5% HCl by mass. Its density is 1.18 g/mL. What are the molarity and the molality of the concentrated HCl solution?

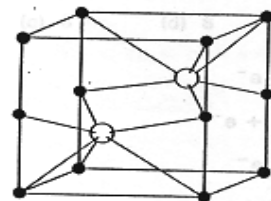


12. What is the name of $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$?

- A. Diammonium iron(II) sulfate hydrate
- B. Ammonium iron(II) sulfate hydrate
- C. Ammonium iron(II) disulfate hexahydrate
- D. Ammonium iron(III) sulfate hexahydrate
- E. Ammonium iron(II) sulfate hexahydrate

13. The figure depicts the unit cell for a compound containing atoms X (filled circles) and Z (open circles). The empirical formula is:

- A. XZ
- B. XZ_2
- C. X_2Z_3
- D. X_2Z
- E. XZ_3



14. How many sigma and pi bonds are there in an acetonitrile, CH_3CN , molecule?

- A. five sigma, and one pi bonds.
- B. four sigma, and two pi bonds.
- C. five sigma, and 2 pi bonds.
- D. four sigma, and 3 pi bonds.
- E. six sigma, and one pi bonds.

15. Which of the following compounds contains only ionic bonds?

- A. KNO_3
- B. NH_4Cl
- C. NH_4NO_3
- D. CS_2
- E. MgO

16. Which of the following gases is odorless?

- A. H_2S
- B. CH_4
- C. SO_2
- D. NH_3
- E. Cl_2

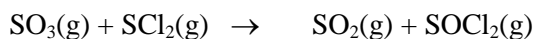
17. Which of the following silver compounds is soluble in water?

- A. $\text{AgC}_2\text{H}_3\text{O}_2$
- B. AgI
- C. Ag_3PO_4
- D. Ag_2S
- E. Ag_3AsO_4

18. Which of the following transition elements used mostly in medical imaging is not found naturally on earth and must be synthesized in the laboratory?

- A. Zr
- B. Tc
- C. Ru
- D. Re
- E. Ta

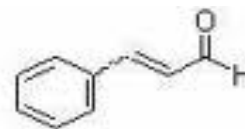
19. Thionyl chloride, SOCl_2 , is prepared according to the following equation represented below:



If 12.0 g of SO_3 and 12.0 g of SCl_2 are used and 8.0 g of SOCl_2 is produced, what would be the percent yield of the reaction?

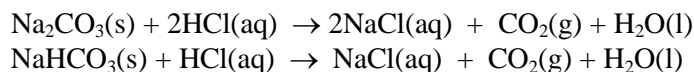
- A. 57.7
- B. 65.3
- C. 71.8
- D. 77.2
- E. 80.1

20. The structure of cinnamic aldehyde is given on the right. Its derivatives are used in *sunscreens* formulas because they contain highly conjugated π -bonds, e.g. alternating double bonds. This compound and its derivatives absorb _____ radiations.



A. Infrared B. visible C. radio wave D. microwave E. UV

21. A 1.00 g mixture of Na_2CO_3 and NaHCO_3 has been treated with an HCl solution. When the reaction was complete, 240 mL of CO_2 was liberated at 760 mmHg and 20.0 °C. What is the mass of Na_2CO_3 in the original mixture?



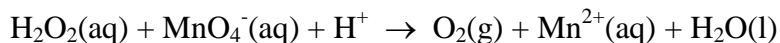
A. 0.27 B. 0.33 C. 0.50 D. 0.78 E. 0.83

22. Which of the following statements is(are) correct about the solubility of an ionic compound?

- I. Solubility increases with increasing lattice energy
- II. Ionic compounds are more soluble in a polar solvent
- III. Solubility increases with enthalpy of hydration of the cation and anion.

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

23. A commercial hydrogen peroxide solution is titrated in strong acidic medium using freshly prepared KMnO_4 solution. The concentration of the permanganate solution is standardized using dried sodium oxalate. The titration of 5.00 mL aliquot of peroxide solution requires 24.07 mL of 0.01905 M permanganate solution. What is the percent concentration by mass of the peroxide solution if the density is 1.03 g/mL? *The reaction is not balanced.*



A. 1.52 B. 0.756 C. 0.505 D. 2.30 E. 3.01

24. At what temperature will water boil under a pressure of 787 torr? The latent heat of vaporization is

40.66 kJ/mol. *The Clausius-Clapeyron equation is given as* $\ln \frac{p_2}{p_1} = \frac{\Delta H_{\text{vap}}}{R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$

A. 299 K B. 312 K C. 334 K D. 358 K E. 374 K

25. In which choice are the alkali halides listed in order of increasing lattice energy?

- A. NaF, NaBr, NaCl D. NaBr, NaCl, NaF
- B. KF, NaF, KI E. LiF, KBr, LiI
- C. KF, NaF, NaI

Chemistry II March 2013 Answer Key

Yellow Test

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

New Jersey Science League

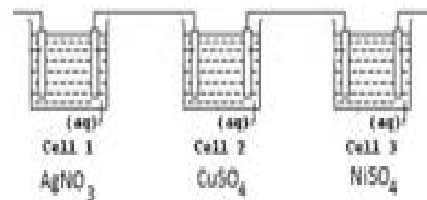
Chemistry II Exam April 2013

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

1. A 25.0 mL, pH = 2.0 HCl solution is added into 75.0 mL of a pH = 6.0 HCl solution. What is the pH of the final solution?

- A. 2.0 B. 2.6 C. 4.0 D. 6.3 E. 8.0

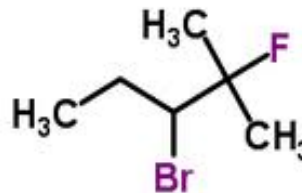
2. Three electrolytic cells are connected in series as shown in the figure on the right. The first cell contains a solution of silver nitrate. The second and third cells contain solutions of copper(II) sulfate and nickel(II) sulfate, respectively. If 1.08 g of silver is deposited at the cathode in the first cell, which of the following choices is correct assuming that the same current and equivalent amount of time traverse all three cells?



- A. 1.08 g of copper in the second cell.
B. 1.08 g of nickel in the third cell.
C. 6.35 g of copper in the second cell.
D. 0.294 g of nickel in the third cell.
E. 5.87 g of nickel in the third cell.

3. What is the IUPAC name of the compound shown here?

- A. 3-bromo-2-fluoro-2-methylpentane
B. 2-bromo-3-fluoro-2-methylpentane
C. 3-bromo-2-fluoro-2-methylhexane
D. 2-bromo-2-fluoro-3-methylpentane
E. 3-bromo-3-fluoro-2-methylpentane



4. What is the systematic name of $K[Au(CN)_4]$?

- A. potassium gold cyanide
B. potassium tetracyanogold(III)
C. potassium tetracyanoaurate(III)
D. potassium tetracyanoaurate
E. potassium gold(III) tetracyanide

5. Which of the following 0.10 M aqueous solution has a pH higher than 7.0?

- A. $NaNO_3$ B. K_3PO_4 C. $FeCl_3$ D. $NaBr$ E. NH_4I

6. It could take up to 60 hours for a radioactive isotope to be delivered to the research laboratory from the isotope enrichment center. If the research laboratory needs 10 mg of sodium-24, which has a half-life of 15 hours, what is the minimum mass of the radioisotope that must be shipped from the center?

- A. 160 mg B. 80 mg C. 40 mg D. 20 mg E. 10 mg

7. A reaction's overall order is 4. What is the unit of its rate constant?

A. $\text{mol}^{-1} \times \text{L} \times \text{s}$
 D. $\text{mol}^3 \times \text{L}^{-3} \times \text{s}^{-1}$

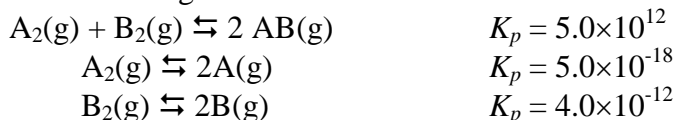
B. $\text{mol}^4 \times \text{L}^{-4} \times \text{s}^{-1}$
 E. $\text{mol}^{-3} \times \text{L}^3 \times \text{s}^{-1}$

C. $\text{mol}^{-4} \times \text{L}^4 \times \text{s}$

8. A first order reaction is observed to have a rate constant of $5.0 \times 10^{-4} \text{ s}^{-1}$. If the initial concentration of the reactant is 0.020 M, how much time (in seconds) must elapse for its concentration to drop to 0.0040 M?

- A. 4100 s B. 3200 s C. 590 s D. 1200 s E. 930 s

9. The following equilibrium constants are given at 700 K.



Calculate K_p for the reaction $\text{A} + \text{B} \rightarrow \text{AB}$.

- A. 1.0×10^{10} B. 2.0×10^{10} C. 2.0×10^{-10} D. 5.0×10^4 E. 5.0×10^{20}

10. Which one of the following polymer is **NOT** a product of an addition polymerization reaction?

- A. Polyester B. Polyvinylchloride C. Polyethylene
 D. Polystyrene E. Polyvinyl alcohol

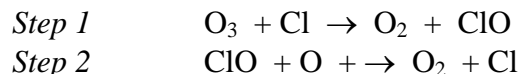
11. What volume of 0.0100 M H_3PO_4 is required to neutralize completely 150 mL 0.0200 M $\text{Ba}(\text{OH})_2$ solution?

- A. 150 mL B. 2.0×10^2 mL C. 3.0×10^2
 D. 4.0×10^2 mL E. 250 mL

12. Which of the following combinations of reagents will produce a buffer solution?

- A. 10.0 mL of 0.10 M of NaOH + 10.0 mL 0.20 M HCl
 B. 10.0 mL of 0.30 M of NaOH + 10.0 mL 0.20 M HCl
 C. 10.0 mL of 0.10 M of NaOH + 10.0 mL 0.10 M $\text{HC}_2\text{H}_3\text{O}_2$
 D. 20.0 mL of 0.10 M of NaOH + 10.0 mL 0.20 M $\text{HC}_2\text{H}_3\text{O}_2$
 E. 0.050 mol of $\text{NaC}_2\text{H}_3\text{O}_2$ dissolved in 100.0 mL 1.0 M $\text{HC}_2\text{H}_3\text{O}_2$

13. In the following mechanism



- I. Cl is catalyst. II. ClO is catalyst. III. Cl is intermedaite IV. ClO is intermediate.

Which of the following statements given above is(are) correct?

- A. Only I B. Only II C. Only I and II D. Only I and IV E. Only III

14. Based on the standard reduction potentials given below which of the following reactions has a negative *Gibbs Free Energy* change? Assume that the concentrations are 1M and are at a temperature of 25°C.

$$E^{\circ}_{\text{Al}^{3+}/\text{Al}} = -1.66 \text{ V};$$

$$E^{\circ}_{\text{Cu}^{2+}/\text{Cu}} = +0.34 \text{ V}$$

$$E^{\circ}_{\text{Fe}^{2+}/\text{Fe}} = -0.44 \text{ V}$$

$$E^{\circ}_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V};$$

- A. $\text{Fe}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Fe}(\text{s})$
- B. $\text{Al}^{3+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + \text{Al}(\text{s})$
- C. $\text{Al}^{3+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Al}(\text{s})$
- D. $\text{Fe}^{2+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + \text{Fe}(\text{s})$
- E. $\text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq})(\text{s})$

15. The van der Waals equation of state for the real gases is $(P + \frac{an^2}{V^2})(V - nb) = nRT$. This equation is reduced to the ideal gas equation when

- A. the pressure is high.
- B. the molar volume is low.
- C. the temperature is 25°C.
- D. the number of moles is low.
- E. all of these.

16. Which of the following lists the acids in order of increasing strength?

- I. $\text{H}_2\text{S} < \text{H}_2\text{SO}_3 < \text{HClO}_4$
- II. $\text{HF} < \text{HCl} < \text{HI}$
- III. $\text{CF}_3\text{COOH} < \text{CHF}_2\text{COOH} < \text{CH}_2\text{FCOOH} < \text{CH}_3\text{COOH}$
- IV. $\text{HClO} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$

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

17. What volume of gas at STP is produced when 1.00 kg of trinitrotoluene, $\text{C}_7\text{H}_5(\text{NO}_2)_3$ reacts? Use the equation below after balancing.



- A. 98.8 B. 987 C. 441 D. 882 E. 227

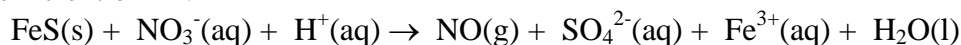
18. Consider the reaction $A + B \rightarrow C$. The following kinetic data was obtained:

Trial	[A] ₀	[B] ₀	Rate (mol/L.s)
1	0.20	0.40	9.1×10^{-6}
2	0.60	0.40	8.2×10^{-5}
3	0.20	0.60	9.1×10^{-6}

Which is the value of the rate constant?

- A. $2.3 \times 10^{-4} \text{ M}^{-1}\text{s}^{-1}$ B. $2.3 \times 10^{-4} \text{ M}^{-2}\text{s}^{-1}$ C. $2.3 \times 10^{-4} \text{ M}^{-3}\text{s}^{-1}$
D. $3.2 \times 10^{-4} \text{ M}^{-2}\text{s}^{-1}$ E. $3.2 \times 10^{-4} \text{ M}^{-3}\text{s}^{-1}$

19. When the equation given below is balanced using smallest whole number coefficients, what is the coefficient of H^+ ?



- A. 2 B. 3 C. 4 D. 8 E. 9

20. Two gases, nitrogen and oxygen, are simultaneously introduced into the opposite ends of a 80.0 cm glass tube. Predict using assumptions made with the kinetic molecular theory how far the nitrogen will have travelled when the two gases initially meet.

- A. 28.0 cm B. 32.0 cm C. 38.7 cm D. 41.3 cm E. 50 cm

21. What is the pH of a solution of 0.025 M NH_4Cl solution? $K_b = 1.8 \times 10^{-5}$ for NH_3 .

- A. 2.50 B. 3.71 C. 5.43 D. 8.57 E. 10.29

22. What is the concentration of the oxalate ions, $\text{C}_2\text{O}_4^{2-}$, in 0.010 M oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$, solution? $K_{a1} = 5.9 \times 10^{-2}$ and $K_{a2} = 6.4 \times 10^{-5}$.

- A. 0.0050 B. 0.059 C. 9.2×10^{-2} D. 6.4×10^{-5} E. 3.8×10^{-6}

23. Which of the following solids is amorphous?

- A. NaCl B. glass C. graphite D. gold E. CaO

24. Which one of the following choices will **cause the reaction below**

to increase the amount of AB_3 to be produced? $2\text{AB}_2(\text{g}) + \text{B}_2(\text{g}) \rightleftharpoons 2\text{AB}_3(\text{g}) \quad \Delta H^\circ < 0$

- A. Adding some AB_3 D. Using a catalyst
B. Removing some AB_2 E. Decreasing the temperature
C. Decreasing the pressure

25. What is the molar solubility of Ag_2CrO_4 at 25°C in a 0.0225 M K_2CrO_4 solution?

$K_{sp} = 9.0 \times 10^{-12}$

- A. 0.023 B. 3.0×10^{-6} C. 1.0×10^{-5} D. 2.0×10^{-5} E. 0.045

Chemistry II April 2013 Answer Key
Yellow Test

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