2010 Ashdown Examination

**DIRECTIONS**

- Put your name, school, and test number on the bubble sheet, as follows;
  
  **NAME** __Your Name____
  
  **SUBJECT** __School____
  
  **PERIOD_____ DATE_____ Test Number____
  
- If you are using a graphing calculator, clear its memory now.

- Cell phones are not permitted. Make sure they are put away.

- Once you start the exam, you cannot leave the examination room.

- There are 85 questions, and the exam will last 100 minutes.

- When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a soft, #2 pencil. Make a heavy, full mark, but no stray marks. If you decide to change an answer, erase the unwanted mark very carefully.

- There is only one correct answer to each question. Any questions for which more than one response has been blackened will not be counted.

- Your score is based solely on the number of questions you answer correctly. It is to your advantage to answer every question.

- When you are told to start the exam, you may tear off this sheet and the periodic table sheet below this one.

- After the test is over and the proctors have collected the bubble sheets, you may take this exam home with you.

- Answers will be posted in the registration area after the examination.

- Prize winners and qualifiers will be notified within 3 days or sooner.

- Good luck!
1. The name of the carbon allotrope shown to the right is:
   A. graphite  B. diamond  C. buckminsterfullerene  D. nanotube

2. An example of a pure substance is:
   A. brass  B. gasoline  C. air  D. ice

3. The correct name for the anion, $\text{OH}^-$, is:
   A. hydrogen oxide  B. hydroxide  C. hypoxate  D. hydroxate

4. The element whose name comes from the object to the right is:
   A. sulfur  B. sodium  C. molybdenum  D. helium

5. Cryolite, $\text{Na}_3\text{AlF}_6$, is an important mineral in the production of aluminum and may be prepared by the unbalanced reaction below. Balance this equation with the smallest whole number coefficients and select the answer that is the sum of the coefficients.

   $$\text{____ NH}_4\text{F} + \text{____ NaOH} + \text{____Al(OH)}_3 \rightarrow \text{____ Na}_3\text{AlF}_6 + \text{____ H}_2\text{O} + \text{____ NH}_3$$

   A. 17  B. 20  C. 23  D. 40

6. You can get MSDS's from
   A. the Internet.
   B. chemicals that are ordered.
   C. commercial services.
   D. All of the above

7. Teachers just love it when students request the proper equipment when doing a laboratory. To impress your teacher, you ask for the item to the right as a:
   A. rubber policeman.
   B. spatula.
   C. stirrer.
   D. thingamajig.

8. An element X forms a compound with the formula $\text{XCl}_2$ that is 52.0% Cl (35.5 g/mole) by mass. X is:
   A. S  B. Fe  C. Zn  D. Ti

9. Which of the following combinations of aqueous solutions will produce a precipitate?
   A. $\text{Ca(NO}_3)_2$ and $\text{Na}_3\text{PO}_4$
   B. $\text{HC}_2\text{H}_3\text{O}_3$ and $\text{NaOH}$
   C. $\text{Cu(NO}_3)_2$ and $\text{Na}_2\text{SO}_4$
   D. $\text{NH}_4\text{NO}_3$ and $\text{Na}_2\text{S}$

10. The American Dental Association recommends that an adult should consume 3.0 mg of F per day to prevent tooth decay. If the fluoride is sodium fluoride, NaF, in Crest toothpaste that contains 0.243 % NaF by weight, how many grams of Crest toothpaste should be swallowed per day? (Na = 23.0, F = 19.0)
    A. 0.56 g  B. 2.7 g  C. 5.6 g  D. 27 g
11. Pennies made after 1982 pennies consist of zinc clad with copper. The zinc will dissolve in HCl if the copper coating is filed down. The reaction is:

\[ 2 \text{HCl}(aq) + \text{Zn}(s) \rightarrow \text{H}_2(g) + \text{ZnCl}_2(aq) \]

A penny weighs 2.518 g. When filed and placed in HCl, it produces 900 mL of hydrogen collected over water at 25°C with a total pressure of 794 torr. Assuming all the Zn dissolves, what is the %Zn in the penny? Vapor pressure H₂O = 24 torr, R = 0.0821 atm L/mole K, H = 1.008, Cu = 63.55, Zn = 65.41

A. 94.1%  B. 96.8%  C. 97.0%  D. 99.8%

12. Where are electrons found in atoms?
   A. In the nucleus   B. In orbits around the nucleus   C. Inside neutrons.   D. In clouds around the nucleus.

13. The pH of a 0.010 M solution of nitrous acid, HNO₂ (K_a = 4.0 x 10⁻⁴) is:
   A. 2.00  B. 2.70  C. 2.74  D. 2.75

14. The pH of a 0.010 M solution of NaNO₂ (K_a = 4.0 x 10⁻⁴) is:
   A. 6.30  B. 7.70  C. 10.60  D. 12.60

15. Tartaric acid, a white crystalline organic acid containing only C, H, and O, is found naturally in many plants, such as grapes, bananas, and tamarinds, and is one of the main acids in wine. Its sour taste gives foods, such as Sour Patch Kids, its zing. Combustion analysis of a 1.201 g sample produced 1.408 g of CO₂ and 0.432 g of H₂O. The empirical formula of tartaric acid is:

   A. CH₂O₂  B. C₂H₅O₃  C. C₄H₃O₆  D. C₄H₆O₁₁

16. The first ionization energies of the second row of the periodic table (right), show a general increasing trend, but irregularities occur. The reason for the irregularities is because
   A. they would violate the Pauli exclusion principle.  
   B. they would violate Hund’s rule.  
   C. the effective nuclear charge is decreasing.  
   D. orbitals are filled or half-filled.

17. Find the Xe—F bond energy, given that the heat of formation of XeF₆, ΔH° is -405 kJ:

   \[ \text{Xe} + 3 \text{F}_2 \rightarrow \text{XeF}_6 \]

   A. 12 kJ  B. 67.5 kJ  C. 121 kJ  D. 147 kJ

18. The image to the right is a:

   A. picture of the infant universe  
   B. 2s atomic orbital  
   C. black hole swallowing matter  
   D. supernova making elements
19. Because of the damage to the ozone layer, chlorofluorocarbon (CFC) production has been banned since 1996. However, car air conditioners are recharged from stockpiles of CFC-12 (CF₂Cl₂ = 120.9 g/mole). If each of 100 million cars contains 1.1 kg of CFC-12 that leaks 25% of it back into the atmosphere every year, the amount of **chlorine in metric tons** that is added to the atmosphere each year by car air conditioners is:

\[ \text{Cl} = 35.45 \]

A. 260  B. 8100  C. 16000  D. 65000

20. Assign the appropriate labels to the phase diagram shown to the right:

<table>
<thead>
<tr>
<th>Area A</th>
<th>Area B</th>
<th>Area C</th>
<th>Point D</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. liquid</td>
<td>solid</td>
<td>gas</td>
<td>critical point</td>
</tr>
<tr>
<td>B. gas</td>
<td>solid</td>
<td>liquid</td>
<td>triple point</td>
</tr>
<tr>
<td>C. gas</td>
<td>liquid</td>
<td>solid</td>
<td>critical point</td>
</tr>
<tr>
<td>D. liquid</td>
<td>gas</td>
<td>solid</td>
<td>triple point</td>
</tr>
</tbody>
</table>

21. Which of the following signs should be prominently displayed in a chemistry laboratory?

A. I only       B. II only      C. I, II, and III only  D. All should be prominently displayed

22. An example of the law of multiple proportions is:

A. A sample of chlorine is found to contain three times as much Cl-35 as Cl-37.
B. Two different compounds formed from carbon and oxygen have the following mass ratios:
   1.33 g O: 1 g C and 2.67 g O: 1 g C.
C. Two different samples of table salt are found to have the same ratio of sodium to chlorine.
D. The atomic mass of bromine is found to be 79.90 amu.

23. The length of the glass rod with the correct number of significant figures is:

A. 15 cm   b. 15.1 cm   C 15.10 cm   D. 15.100 cm
24. The rate law and the value of k for the following reaction using the data provided is:

\[ \text{NO}_2(g) + \text{O}_3(g) \rightarrow \text{NO}_3(g) + \text{O}_2(g) \]

<table>
<thead>
<tr>
<th>Initial [NO(_2)] (M)</th>
<th>Initial [O(_3)] (M)</th>
<th>Initial Rate (M s(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.33</td>
<td>1.42</td>
</tr>
<tr>
<td>0.10</td>
<td>0.66</td>
<td>2.84</td>
</tr>
<tr>
<td>0.25</td>
<td>0.66</td>
<td>7.10</td>
</tr>
</tbody>
</table>

A. Rate = 1360 M\(^{2.5}\) s\(^{-1}\) [NO\(_2\)]\(^{2.5}\) [O\(_3\)]
B. Rate = 227 M\(^{2.5}\) s\(^{-1}\) [NO\(_2\)][O\(_3\)]\(^{2.5}\)
C. Rate = 43 M\(^{-1}\) s\(^{-1}\) [NO\(_2\)][O\(_3\)]
D. Rate = 430 M\(^2\) s\(^{-1}\) [NO\(_2\)]\(^2\) [O\(_3\)]

25. Using Lewis structures and formal charges, which of the following ions is most stable?

<table>
<thead>
<tr>
<th></th>
<th>OCN</th>
<th>ONC</th>
<th>NOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>OCN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>ONC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>NOC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>All are equally stable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

26. The half-life of a nuclide that loses 38.0% of its mass in 387 hours is:

A. 277 hours  B. 455 hours  C. 561 hours  D. 639 hours

27. The answer for the following calculation of numbers obtained from scientific measurement is:

\((433.621-333.9) \times 11.900\)

A. 1.19 x 10\(^3\)  B. 1.187 x 10\(^3\)  C. 1.1868 x 10\(^3\)  D. 1.186799 x 10\(^3\)

28. How many chiral carbons are in the structure to the right?

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

29. Determine the electron geometry, molecular geometry, and polarity of XeF\(_2\).

<table>
<thead>
<tr>
<th>Electron Geometry</th>
<th>Molecular Geometry</th>
<th>Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. trigonal bipyramidal</td>
<td>bent</td>
<td>polar</td>
</tr>
<tr>
<td>B. linear</td>
<td>linear</td>
<td>nonpolar</td>
</tr>
<tr>
<td>C. tetrahedral</td>
<td>bent</td>
<td>polar</td>
</tr>
<tr>
<td>D. trigonal bipyramidal</td>
<td>linear</td>
<td>nonpolar</td>
</tr>
</tbody>
</table>

30. Which of the following statements is TRUE?

A. A strong acid is composed of a proton and an anion that have a very strong attraction for one another.
B. A weak base is composed of a cation and an anion with a very weak attraction between them.
C. A strong acid has a strong conjugate base.
D. The conjugate base of a very weak acid is stronger than the conjugate base of a strong acid.

31. Ammonium carbamate decomposes according to the equilibrium below. When the ammonia concentration at equilibrium is 2.9 x 10\(^{-3}\) M, the equilibrium concentration of CO\(_2\)(g) is:

\[ \text{NH}_2\text{COONH}_4(s) \rightleftharpoons 2 \text{NH}_3(g) + \text{CO}_2(g) \quad K_c = 1.58 \times 10^{-8} \]

A. 0.053 M  B. 4.6 x 10\(^{-11}\) M  C. 1.9 x 10\(^{-3}\) M  D. 5.4 x 10\(^{-6}\) M
32. One reaction involved in the conversion of iron ore to the metal is:

\[
\text{FeO(s)} + \text{CO(g)} \rightarrow \text{Fe(s)} + \text{CO}_2(g)
\]

\[\Delta H^\circ \text{ for this reaction is:}\]

A. -3.0 kJ  B. -11.0 kJ  C. -26.7 kJ  D. 14.0 kJ

33. As the energy of a photon increases which of the following occurs?

A. The frequency decreases.
B. The speed increases.
C. The deBroglie wavelength increases
D. None of the above occurs as the energy of a photon increases.

34. You really want to impress a certain person in your lab. You should:

A. Be sure to wear contacts, not glasses, and just be really careful about chemical fumes. Got long hair? Don't tie it back, flaunt it. Nice legs? Wear something short, with sandals to show off those toes. Also, impress him or her by doing something daring in the lab. Choose something involving fire.
B. Ditch the lab coat and goggles. Dress to impress. There's no way the person can tell your fashion sense when you cover it with safety gear.
C. Hey, lab coats are cool! Only ditch the goggles.
D. Impress him or her with how incredibly competent you are in the lab. That includes your ability to follow safe lab procedures.

35. Calculate \( \Delta G_{\text{rxn}} \) at 298 K under the conditions shown below for the following reaction.

\[3 \text{O}_2(g) \rightarrow 2 \text{O}_3(g)\]

where \( \Delta G^0 = 326 \text{ kJ} \) and the partial pressures of oxygen \( P(\text{O}_2) = 0.41 \text{ atm} \) and of ozone \( P(\text{O}_3) = 5.2 \text{ atm} \).

A. +341 kJ  B. +17.8 kJ  C. +332 kJ  D. -47.4 kJ  E. -109 kJ

36. A solution has an exothermic heat of solution when

A. the lattice energy is greater than the heat of hydration
B. the lattice energy is close to the heat of hydration
C. the lattice energy is less than heat of hydration
D. breaking solvent-solvent attractions is much greater than breaking solute-solute attractions

37. Water is added to 4.267 grams of \( \text{UF}_6 \) (352.0 grams/mole). The only products are 3.730 grams of solid containing only uranium, oxygen, and fluorine and 0.970 gram of HF gas. The formula of the solid product is: \((U = 238.0, O = 16.00, F = 19.00, H = 1.01)\)

A. \( \text{UO}_2\text{F}_2 \)  B. \( \text{UOF}_2 \)  C. \( \text{UOF}_4 \)  D. \( \text{U}_2\text{OF} \)
38. The order of molecular orbital (MO) energies in B$_2$, C$_2$, and N$_2$ ($\sigma_{2p} > \pi_{2p}$), is different from the order in O$_2$, F$_2$, and Ne$_2$ ($\sigma_{2p} < \pi_{2p}$), because of:

A. less effective overlap of p orbitals in O$_2$, F$_2$, and Ne$_2$.
B. less effective overlap of p orbitals in B$_2$, C$_2$, and N$_2$.
C. greater 2s-2p interaction in O$_2$, F$_2$, and Ne$_2$.
D. greater 2s-2p interaction in B$_2$, C$_2$, and N$_2$.

39. You want to find the percentage by weight of nitric acid, HNO$_3$, in a sample of concentrated nitric acid, whose density is 1.42 g/mL. The molar mass of nitric acid is 63.01 g/mole.

A NaOH solution was standardized with 1.518 grams of pure potassium hydrogen phthalate, KHC$_8$H$_4$O$_4$ (KHP), a monoprotic primary standard. The KHP was dissolved in water and titrated with 29.73 mL of the NaOH solution to reach the equivalence point. (Molecular mass: KHP = 204.23)

Next, 10.00-mL of the concentrated nitric acid was diluted with water to a total volume of 500.0 mL. Then 25.00 mL of the diluted acid solution was titrated with the standardized NaOH prepared above. It took 31.50 mL to reach the equivalence point. The percentage by weight of HNO$_3$ in the original sample of concentrated nitric acid is:

A. 15.7%     B. 63.0%     C. 69.9%     D. 99.3%

40. The wavelength of a photon with just enough energy to break a CN bond is:
(CN bond energy = 891 kJ/mole, $h = 6.62 \times 10^{-34}$ J·s, $c = 3.00 \times 10^8$ m/s)

A. 134 nm     B. 186 nm     C. 242 nm     D. 304 nm

41. The number of structural isomers of heptane are:

A. 4     B. 6     C. 8     D. 9

42. Industrially, elemental chlorine is produced by the chloralkali process, the electrolysis of brine. Along with chlorine, hydrogen gas and sodium hydroxide are also produced according to the following chemical equation:

$$2 \text{NaCl}(aq) + 2 \text{H}_2\text{O}(l) \rightarrow \text{Cl}_2(g) + \text{H}_2(g) + 2 \text{NaOH}(aq)$$

If 213 grams of chlorine gas are produced, the liters of hydrogen produced at 25°C at 1 atm are:

A. 6.15     B. 73.4     C. 146     D. 213

43. The famous chemist to the right is:

A. Ernest Rutherford
B. Amadeo Avogadro
C. G. N. Lewis
D. Dmitri Mendeleev
Use the following figures to answer questions 44-47.

44. It has an "explosive" personality.
45. It's a "standard."
46. Its chemistry grade is always just a “C.”
47. It's an "indicator" for acid-base titrations.

48. Which of the following compounds will be the most soluble in pure water?

- A. Cu(OH)₂ \( K_{sp} = 2 \times 10^{-20} \)
- B. Al(OH)₃ \( K_{sp} = 3 \times 10^{-34} \)
- C. Hg₂CO₃ \( K_{sp} = 2 \times 10^{-17} \)
- D. AgI \( K_{sp} = 8 \times 10^{-17} \)

49. A metal crystallizes in a face centered cubic structure and has a density of 11.9 g/cm³. If the radius of the metal atom is 138 pm, what is the identity of the metal? 1 pm = 10⁻¹² m

- A. Pb
- B. Pd
- C. Mn
- D. Ag

50. The pH of rain in Southern California is 5.3 whereas in Massachusetts it is 4.4. How many times more concentrated is the \( [H^+] \) of rain in Massachusetts compared to Southern California?

- A. 0.8
- B. 0.9
- C. 6
- D. 8

51. Ethylene glycol, used in automobile radiators as antifreeze, has a vapor pressure of 20.0 torr at 100°C and 50.0 torr at 227°C. The \( \Delta H_{vap} \) of ethylene glycol is: \( (R = 8.314 \text{ J} \text{ K}^{-1} \text{ mole}^{-1}) \)

- A. 1.3 kJ
- B. 4.9 kJ
- C. 11.2 kJ
- D. 30.5 kJ

52. Consider these two reactions and their respective equilibrium constants (\( K_p \)) at 300°C.

\[
\begin{align*}
\text{NO(g)} + \text{Br}_2(g) & \rightleftharpoons \text{NOBr(g)} & K_p &= 7.5 \\
2 \text{NO(g)} & \rightleftharpoons \text{N}_2(g) + \text{O}_2(g) & K_p &= 5.0 \times 10^{18}
\end{align*}
\]

The pressure-based equilibrium constant, \( K_p \), for the following reaction at 300° is:

\[
\text{N}_2(g) + \text{O}_2(g) + \text{Br}_2(g) \rightleftharpoons 2 \text{NOBr(g)}
\]

- A. 5.3 x 10⁻¹⁶
- B. 1.1 x 10⁻¹⁷
- C. 56.3
- D. 5.0 x 10¹⁸
53. The $K_{sp}$ of calcium hydroxide can be found by titrating a saturated solution of Ca(OH)$_2$ with a standard HCl. At 25°C, 3.00 grams of solid Ca(OH)$_2$ (74.08 g/mole) is shaken with 500. mL of deionized water and then filtered. Titrating a 50.0 mL of the filtrate took 10.25 mL of 0.100 M HCl. The $K_{sp}$ of Ca(OH)$_2$ is:

A. $4.30 \times 10^{-6}$  
B. $8.61 \times 10^{-6}$  
C. $3.44 \times 10^{-5}$  
D. $2.76 \times 10^{-4}$

54. What is the correct procedure for students to follow if a chemical is spilled:

A. Stand back and advise the teacher of the spill.  
B. Run madly about the room.  
C. Splash large amounts of water onto the spill.  
D. Immediately ask to go to the restroom.

55. The two curves, labeled 1 and 2, were obtained by titrating equal volumes of two different acids with the same sodium hydroxide solution. What do these curves show about the relative concentrations and strengths of acid 1 and acid 2?

A. The concentrations are the same but acid 1 is weaker than acid 2.  
B. The concentrations are the same but acid 1 is stronger than acid 2.  
C. Acid 1 is the same strength as acid 2, but it is less concentrated.  
D. Acid 1 is the same strength as acid 2, but it is more concentrated.

56. The concentration of a colored substance is determined by measuring the absorbance of its aqueous solution and interpolating from a graph of absorbance versus concentration. Which procedural error will result in a concentration that is too high?

I. Rinsing the cuvette with water just before filling it with the unknown solution  
II. Measuring the absorbance of the unknown solution at a wavelength other than its maximum.  
III. Using a cuvette for the unknown solution that has air bubbles in the solution.

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

57. An HCl solution is titrated to a pink phenolphthalein endpoint with a NaOH solution while stirring. If the solution becomes pink throughout but loses its color upon standing for a short time, what should be done to restore the color?

A. Add more phenolphthalein indicator.  
B. Add an additional drop of HCl solution.  
C. Add an additional drop of NaOH solution.  
D. Stir more vigorously.

58. A buffer solution of formic acid and sodium formate has a pH = 3.70. After the addition of 0.015 moles of [H$^+$], the pH decreases by 0.12. The initial molarity of the formic acid is: (pK$_a$ of formic acid = 3.74)

A. 0.084 M  
B. 0.105 M  
C. 0.115 M  
D. 0.210 M
59. From the following reduction potentials, find the solubility in g/L of I$_2$(s) in water. (I$_2$ = 253.8 g/mole)

<table>
<thead>
<tr>
<th>Reaction</th>
<th>$E^\circ$</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>I$_2$(s) + 2e $\rightarrow$ 2I</td>
<td>$E^\circ = 0.535$ V</td>
<td></td>
</tr>
<tr>
<td>I$_2$(aq) + 2e $\rightarrow$ 2I</td>
<td>$E^\circ = 0.620$ V</td>
<td></td>
</tr>
</tbody>
</table>

A. $1.3 \times 10^{-3}$  B. 0.34  C. 9.3  D. 14

Use the following reaction mechanism to answer questions 60 and 62.

<table>
<thead>
<tr>
<th>Step</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 PO $\rightarrow$ P$_2$O$_2$ fast</td>
</tr>
<tr>
<td>2</td>
<td>P$_2$O$_2$ + H$_2$ $\rightarrow$ P$_2$O + H$_2$O slow</td>
</tr>
<tr>
<td>3</td>
<td>P$_2$O + H$_2$ $\rightarrow$ P$_2$ + H$_2$O fast</td>
</tr>
</tbody>
</table>

60. Which of the following are products in the overall reaction?

A. P$_2$ and P$_2$O$_2$  B. P$_2$ and H$_2$O  C. P$_2$O$_2$ and PO$_2$  D. PO$_2$ and H$_2$O

61. The intermediates are:

A. NO and H$_2$  B. H$_2$O and P$_2$  C. P$_2$O$_2$ and PO  D. P$_2$O$_2$ and P$_2$O

62. Increasing the concentration of which of the following substances would cause the greatest increase in the reaction rate?

A. H$_2$  B. PO  C. P$_2$O  D. H$_2$O

63. A 25.0 mL sample of seawater was diluted to 250 mL in a volumetric flask. A 25.0 mL aliquot of the diluted seawater was pipetted into a flask. It required 15.0 mL of 0.10 M silver nitrate solution to precipitate all the Cl$^-$. Assuming all the Cl$^-$ is due to NaCl (58.45 g/mole), the percent (w/w) of NaCl in seawater, which has a density of 1.025 g/mL, is:

A. 0.034%  B. 3.4%  C. 3.5%  D. 20%

Problems 64 and 65 involve the following equilibrium:

$4$ CuO(s) $\rightarrow$ 2 Cu$_2$O(s) + O$_2$(g)

When 0.35 moles of CuO is placed in a 2.0-L flask at 1045°C, it decomposes to form Cu$_2$O and oxygen gas.

64. At equilibrium, the pressure of oxygen gas is 0.58 atm. The percent of CuO that decomposed is:

A. 1.0%  B. 3.1%  C. 12%  D. 15%

65. The equilibrium constant, $K_e$ at 1045°C for this reaction is:

A. $9.9 \times 10^{-5}$  B. $5.4 \times 10^{-3}$  C. $1.1 \times 10^{-2}$  D. 0.58
Use the following figures to answer questions 66-69.

66. Spiders spin it.

67. SpiderMAN spins it.

68. Wake up and smell the coffee.

69. Take it after the Ashdown for a splitting headache.

70. From the values of standard reduction potentials, the E° for this reaction is:

\[ \text{H}_2\text{O}_2(aq) + 2\text{H}^+(aq) + 2 \text{Ag}(s) \rightarrow 2\text{H}_2\text{O}(l) + 2 \text{Ag}^+(aq) \]

<table>
<thead>
<tr>
<th>Standard Reduction Potentials, E°</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{H}_2\text{O}_2(aq) + 2\text{H}^+(aq) + 2e^- \leftrightarrow 2\text{H}_2\text{O}(l) )</td>
</tr>
<tr>
<td>( \text{Ag}^+(aq) + e^- \leftrightarrow \text{Ag}(s) )</td>
</tr>
</tbody>
</table>

A. 0.163V  B. 0.963V  C. 2.563V  D. 3.363V

71. The Nernst equation is: \( E = E^o - \frac{0.0592}{n} \log Q_c \). What is the pH of the above cell that has a potential of +0.600V when \([\text{H}_2\text{O}_2] = 0.300 \text{ M}\) and \([\text{Ag}^+] = 0.100 \text{ M}\)?

A. 5.40  B. 6.87  C. 7.61  D. 10.80

72. The spectrometric data to the right shows the percent transmittance (%T) of individual samples of X and Y at a specific wavelength. The %T of a solution containing both X and Y at the concentrations given in the table is:

<table>
<thead>
<tr>
<th>Concentration</th>
<th>% T</th>
</tr>
</thead>
<tbody>
<tr>
<td>X 1.00 x 10(^{-3}) M</td>
<td>50.0%</td>
</tr>
<tr>
<td>Y 2.00 x 10(^{-2}) M</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

A. 2.0%  B. 2.0%  C. 12.5%  D. 75.0%

Use the following for problems 73 and 74.

Despite being a simple molecule, NO is a fundamental player in the fields of neuroscience, physiology, and immunology, and was proclaimed “Molecule of the Year” in 1992. It is also an air pollutant produced by automobile engines and power plants at high temperatures by the following equilibrium:

\[ \text{N}_2(g) + \text{O}_2(g) \leftrightarrow 2 \text{NO}(g) \]

73. \( \Delta H^o \) for the reaction is:

A. 9.9 kJ  B. 23 kJ  C. 83 kJ  D. 190 kJ

74. \( \Delta S^o \) for the reaction is:

A. 4.0 J/K  B. 14 J/K  C. 31 J/K  D. 94 J/K
Use the following for problems 75 and 76.

A solution containing pentane and hexane produces a vapor that is 36.3% by weight of pentane.

75. The mole fraction of pentane, $X_{\text{pentane}}$, in the vapor is:

   A. 0.27 B. 0.35 C. 0.40 D. 0.46

76. The percent pentane by weight in the original solution is:

   A. 16.4% B. 19.0% C. 23.5% D. 40.0%

77. At 25°C, the solubility of Ni(OH)$_2$ (92.71 g/mol) in pure water is only 3.2 x 10$^{-4}$ g/L. The solubility in g/L of a solution with final $[\text{NH}_3]$ = 6.0 M is: ($K_{sp}$ for Ni(OH)$_2$ = 1.6 x 10$^{-16}$ and $K_f$ for Ni(NH$_3$)$_6^{2+}$ = 5.5 x 10$^8$)

   A. 0.10 g/L B. 0.85 g/L C. 9.4 g/L D. 15 g/L

78. How many of the following molecules have at least one bond angle of approximately 180°?

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IF$_5$</td>
<td>CO$_2$</td>
<td>XeF$_4$</td>
<td>BF$_3$</td>
<td>H$_2$O</td>
</tr>
</tbody>
</table>

   A. 2 B. 3 C. 4 D. 5

79. Your lab report is due tomorrow. If you notice that your data isn't fitting the theory it is supposed to fit, it is best to...

   A. Come up with your own theory.
   B. Recall the procedure and try to correlate possible sources of error.
   C. Make up "better" data points.
   D. Go back and reacquire bad data points.

80. Ammonia can be found spectrophotometrically by its reaction with reagents, phenol and, ClO$^-$. A 30.14 mg protein sample was digested, converting all the nitrogen to NH$_3$ and then diluted to 100. mL. A 10.0 mL portion of this was treated with excess phenol and ClO$^-$ and diluted to 50.0 mL. The solution’s absorbance was 0.598.

   A 10.0 mL standard NH$_4$Cl containing 0.200 mg NH$_4$Cl per mL was treated with the reagents and diluted to 50.0 mL. Its absorbance was 0.514.

   A blank was prepared by adding the reagents and diluting to 50.0 mL. Its absorbance was 0.114.

   The percent nitrogen by weight in the protein sample is: ($N = 14.0$, NH$_4$Cl = 53.5, NH$_3$ = 17.0)

   A. 6.61% B. 21.0% C. 25.9% D. 30.2%
81. The best buy for nitrogen (N = 14.0) in price in $ / pound is:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Molar Mass</th>
<th>Weight</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>(NH₄)₂SO₄</td>
<td>132.1</td>
<td>325 lb</td>
<td>$2020</td>
</tr>
<tr>
<td>NH₄NO₃</td>
<td>80.0</td>
<td>100 lb</td>
<td>$1646</td>
</tr>
<tr>
<td>(NH₂)₂CO</td>
<td>60.1</td>
<td>100 lb</td>
<td>$573</td>
</tr>
<tr>
<td>(NH₄)₂CO₃</td>
<td>96.1</td>
<td>300 lb</td>
<td>$3500</td>
</tr>
</tbody>
</table>

A. (NH₄)₂SO₄   B. NH₄NO₃   C. (NH₂)₂CO   D. (NH₄)₂CO₃

82. The number of acidic, basic, or neutral aqueous solutions resulting when each following compounds is dissolved in water is:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Acidic</th>
<th>Basic</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₃COOH</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>NH₄Br</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>HOCH₂CH₂OH</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Fe(NO₃)₃</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>KClO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

83. Chemical syntheses of simple small organic molecules are considered essential in order for life to begin. Select all the correct answers below. Potentially important sources of organic compounds can be found in:

I. Deep oceanic thermal vents (black smokers)
II. Tidal pools
III. Earth’s solid crust
IV. Deep space

A. I and II   B. I, II, and III   C. II only   D. All of the above.

84. Bleach (active ingredient, sodium hypochlorite, NaOCl, (74.44 g/mole) may be analyzed in the laboratory by the following two steps:

First, the hypochlorite ion from bleach reacts with excess iodide ion, I⁻, in acid solution to form iodine. The net ionic equation is:

\[ \text{ClO}^{-}(aq) + 2 \text{H}^+(aq) + 2 \text{I}^-(aq) \rightarrow \text{I}_2(aq) + \text{Cl}^-(aq) + \text{H}_2\text{O}(l) \]  

(Eq. 1)

Followed by the redox titration of I₂ with a standardized solution of sodium thiosulfate, Na₂S₂O₃.

\[ 2 \text{S}_2\text{O}_3^{2-}(aq) + \text{I}_2(aq) \rightarrow 2 \text{I}^-(aq) + \text{S}_4\text{O}_6^{2-}(aq) \]  

(Eq. 2)

A 25.00 mL portion of Strong Bleach™ whose density is 1.057 g/mL, was pipetted into a 250.0 mL volumetric and diluted to the mark with distilled water. A 25.00 mL sample of the diluted bleach was added to an acidified solution so that I⁻ was converted into I₂. Iodine was then titrated to the starch endpoint with 40.00 mL of 0.100 M Na₂S₂O₃. The percent by weight of NaOCl in the bleach is:

A. 5.63%   B. 5.96%   C. 10.6%   D. 22.5%

85. Green chemistry is:

A. Any reaction performed by Kermit the Frog or his relatives.
B. A reaction that utilizes a green solids, liquids, and/or gases.
C. Anything, including treatment and recycling, that reduces pollution.
D. Design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.