DO NOT TURN THIS PAGE UNTIL DIRECTED TO DO SO.

These tests are machine graded; therefore, be sure to use a No. 1 or 2 pencil for marking the answer sheets.

Completely blacken the answer circle. If you change an answer, erase completely the previous mark.

You may remove you answer sheet from this booklet. If you have a pink test, test form A should be darkened (B for Blue), if it is not, notify your instructor immediately.

Fill in your last name, first name, and initial. Blacken the corresponding letters below.

Fill in your ID number. CAREFULLY, blacken the corresponding numbers below this section.

Fill in the Dept. Course No. and Section. The Dept. = CHEM, the Course No. = 102, and your section refers to your lab section.

If you what your scores posted by a portion of your ID #, mark A under the option column.

READ THE TEST CAREFULLY. The time limit on this test is 50 minutes.

Use the test for scratch paper.

Mark your answers in this booklet as well as on the answer sheet so you can check your score with the key after the test.

There are XX questions. Each counts 6 points for a total of XX points. NO GRADES OVER 100 WILL BE RECORDED.

Your score will be calculated from the number of correct answers. There is no penalty for guessing.

Turn in your scan sheet, show your ID, and have your calculator checked. You will also turn in your test.

A key will be on the electronic class bulletin board. This is accessed through the class homepage

IMPORTANT INFORMATION:
S for liquid water is 4.184 J/g • degree C  
c = 3.00 x 10^8 m/s
R = 0.0821 L • atmos/ K • mol or  R = 8.314 J/k mol
F = 1.8 C + 32
S_{\text{liquid water}} = 4.184J/g \cdot ^{\circ}C

q = ms\Delta t  
K_p = K_c(RT)^{\Delta n}  
\Delta G = \Delta H - T \Delta S  
S_{\text{liquid water}} = 4.184J/g \cdot ^{\circ}C

\ln[A] = -akt + \ln [A]_0  
[A] = -akt + [A]_0  \quad \Delta G^\circ = -RT \ln K

\frac{[A]_0}{2ak} = \frac{t_{1/2}}{ak[A]_0} \quad \frac{1}{0.693} = \frac{t_{1/2}}{ak} \quad \frac{1}{[A]} = \frac{1}{akt + [A]_0}

\ln \left[ \frac{k_2}{k_1} \right] = \frac{E_a}{R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]  
pH = pK_a + \log [\text{conj}] \quad \frac{pK_a + \log [\text{conj}]}{[\text{acid}]}
1. Calculate the pH of a solution prepared from 20.0 mL of 0.015 M HF and 10.0 mL of 0.033 M KOH. (Ionization Constant for HF is $K_a = 7 \times 10^{-4}$)

A. 11.00  B. 3.00  C. 7.00  D. 10.85  E. 3.15

2. Which of the following indicators would be the best to use for the titration between 0.10 M HCN and 0.25 M KOH?

<table>
<thead>
<tr>
<th>Indicator</th>
<th>pH range of color change</th>
</tr>
</thead>
<tbody>
<tr>
<td>crystal violet</td>
<td>0.0 - 2.0</td>
</tr>
<tr>
<td>erythrosin B</td>
<td>2.2 - 3.8</td>
</tr>
<tr>
<td>methyl red</td>
<td>4.4 - 6.2</td>
</tr>
<tr>
<td>bromthymol blue</td>
<td>6.2 - 7.6</td>
</tr>
<tr>
<td>o-cresolphthalein</td>
<td>8.2 - 9.8</td>
</tr>
</tbody>
</table>

A. bromthymol blue  B. erythrosin B  C. methyl red  
D. crystal violet  E. o-cresolphthalein

3. A buffer was prepared by mixing 0.4 mol of acetic acid and 0.5 mol of sodium acetate to form an aqueous solution with 1.00 L volume. To this solution 0.4 mol of HCl was added. What is the resulting pH? (assume no change in volume.) $K_a$ for acetic acid $= 1.8 \times 10^{-5}$

A. 5.65  B. 4.74  C. 7.00  D. 3.74  E. 3.84

4. When two compounds react, the beaker becomes quite hot. Which of the following CORRECTLY describes the thermodynamic changes in the formation of the solution?

A. $\Delta G<0$, $\Delta H<0$, $\Delta S<0$, $K<1$  B. $\Delta G<0$, $\Delta H<0$, $\Delta S>0$, $K>1$  
C. $\Delta G<0$, $\Delta H>0$, $\Delta S>0$, $K>1$  D. $\Delta G>0$, $\Delta H>0$, $\Delta S>0$, $K>1$  
E. $\Delta G<0$, $\Delta H>0$, $\Delta S>0$, $K<1$

5. What is the consequence of heating the following equilibrium system at constant pressure?

$$2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \quad \Delta H^\circ = -99 \text{ kJ/mol}$$

A. the total volume of the system will decrease  
B. the concentration of SO$_3$ will decrease  
C. the partial pressure of SO$_2$ will decrease  
D. the equilibrium constant will increase  
E. favor the formation of the products
6. In the graph below, which is FALSE?

A. A buffer exists at point III  
B. At the 1/2 neutralization point, there is excess strong acid and a weakly acidic salt.  
C. The pH at point V is due to the equilibrium between the weak base and its salt.  
D. The titrant is a weak base.  
E. The equivalence point is characteristic of a weak acidic salt.

7. Acid       | $K_a$  
------------|--------
HCOOH       | $1.7 \times 10^{-4}$  
HF          | $6.8 \times 10^{-4}$  
HNO$_2$     | $4.5 \times 10^{-4}$  
HCN         | $4.9 \times 10^{-10}$  
HSO$_3^-$   | $6.3 \times 10^{-8}$  

Assume the ions below are all in solutions of the same molarity. Which one will have the highest pH?

A. NO$_2^-$  
B. F$^-$  
C. CN$^-$  
D. SO$_3^{2-}$  
E. COOH$^-$

8. Which one of the following is true for any triprotic acid, H$_3$X?

A. $K_a2 < K_a3$  
B. $K_a2 = K_a3$  
C. $K_a2 = K_a3 + pK_b$  
D. $K_a2 > K_a3$  
E. you can’t predict a relationship between $K_a2$ and $K_a3$

9. What is the conjugate base of NH$_3$?

A. NH$_3$  
B. NH$_4^+$  
C. NH$_3^+$  
D. N$_3^-$  
E. NH$_2^-$

10. Calculate the pH of a 0.15 M NaCN. (K$_a$ of HCN = $4.0 \times 10^{-10}$)

A. 11.29  
B. 7.00  
C. 4.40  
D. 9.29  
E. 2.71

11. The pH of 0.10 M weak base solution is 9.69. Calculate the Kb.

A. 4.9 e-4  
B. 4.9 e-5  
C. 4.3 e-3  
D. 2.4 e-8  
E. 1.0 e-9.69
12. Calculate the pH of 0.25 M NaOH.
A. 13.40  B. 3.20  C. 13.75  D. 0.60  E. 7.00

13. In which pair of acids is the first member stronger than the second?
A. HIO > HBrO  B. H₂Te > HNO₃  C. H₃P > H₃As  
D. HBr > HCl  E. H₂SO₂ > H₂SO₃

14. In the reaction shown below, the H₂O is is acting as a(n) _________ acid but not as a(n) _________ acid.

A. Lewis, Bronsted-Lowry  B. Arrhenius, Lewis  
C. Bronsted-Lowry, Lewis  D. Lewis, Arrhenius  
E. Arrhenius, Bronsted-Lowry

15. In a solution originally 0.10 M in KF and 0.20 M in HF, the respective equilibrium [F⁻] and [H⁺] are (0.10 + x) M and x M. What is the equilibrium [HF]?
A. (0.20 - x) M  B. (0.10 + x) M  C. x M  D. (0.20 + x) M  E. (0.10 - x) M

16. Consider a buffer solution prepared by mixing 0.43 moles of acetic acid with 0.28 moles of sodium acetate in 1.00 liter of solution. (Ka of acetic acid = 1.8 x 10⁻⁵)
The addition of 0.01 moles of HCl to this buffer solution will cause the pH to_____________ because the H⁺ from HCl reacts with the_____________ that is present.
A. remain unchanged, sodium ion  B. increase slightly, acetate ion  
C. decrease slightly, acetate ion  D. decrease slightly, acetic acid  
E. increase slightly, sodium ion

17. Calculate the pH of a buffer solution prepared by dissolving 0.10 mol of NH₄Cl and 0.50 mol of ammonia (NH₃) in enough water to make 1.00 L of solution. (Kb of NH₃ = 1.8 X 10⁻⁵)
A. 7.00  B. 12.05  C. 9.95  D. 10.15  E. 11.85
18. Mg(OH)$_2$ is titrated with HBr. At the equivalence point, the pH will be:

(A) higher than 7, due to the hydrolysis of Mg$^{2+}$
(B) higher than 7, due to the hydrolysis of Br$^-$
(C) lower than 7, due to the hydrolysis of Mg$^{2+}$
(D) lower than 7, due to the hydrolysis of Br$^-$
(E) exactly 7 due to the production of a neutral salt

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<tr>
<th>question</th>
<th>6 pts each (unless noted)</th>
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<tr>
<td>1</td>
<td>A (B = 3)</td>
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<td>E</td>
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<td>3</td>
<td>E (A = 3 pts)</td>
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<td>4</td>
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