CHEM 103 TEST 1 KEY
Average ± std deviation = 86 (58%) ±27 (18%) Highest score = 144/150 (96%)
Rough corresponding grade: A = 120 and above; B = 105 +, C = 70 +
Part I

1 A	6 E	11 A
2 E	7 B	12 (skipped)
3 D	8 D	13 C
4 B	9 B	14 B
5 D	10 E	15 C

Part II
16 The enthalpy of dissolution of a gas is usually negative: It is the sum of the endothermic process of "separation of the solvent molecules as a step. Then there is the process of interaction between the gas molecules and the solvent molecules, an exothermic process. This second process is usually quite dominant energetically and overall the net enthalpy is negative, exothermic. According to Le Chatelier's principle, raising the temperature for an exothermic process favors the reverse (reactant) reaction.

17 According to Henry's Law, gas solubility is proportional to gas partial pressure: $S_{gas} = K_H P_{gas}$. When a diver descends into the deep, the pressure on the body increases tremendously, thus raising the partial pressure of the gases and as a consequence gases like nitrogen dissolve more in the blood stream of the diver. If the diver ascends too quickly, the pressure will decrease, solubility will decrease and excess dissolved gas will bubble out as the blood becomes supersaturated - like a soda can that is supersaturated with CO2 gases. This bubble formation causes the diver to "bend" in pain...

18 Let the unknown concentration = x. Then $[H_3O^+]$ for the HCl(aq) solution = x, and hence $[H_3O^+]$ for the acetic acid solution is x/100. But for the acetic acid solution, we also have $[H_3O^+] = \sqrt{(x.K_a)}$ Therefore
   $(x/100) = \sqrt{(x.K_a)}$ => $x^2/10^4 = x.K_a$ => $x = 10^4.K_a = 0.18$ M
Check: For HCl(aq), $[H_3O^+] = 0.18$ M => pH = 0.74.
For acetic acid, $[H_3O^+] = \sqrt{(0.18 \times 1.8 \times 10^{-5})} = 1.8 \times 10^{-3}$ => pH = 2.74.

19 answer is 401 g/mol : $\pi = iCRT = \{(m/MW) / V \} RT$ =>
MW = $\{(m/\pi) (RT/V) = (5.80g)(.0821$ atmL mol-1K-1)(300K)/(1.78atm(.200L))
MW = 401 g/mol

Part II
20 a)MW of H_2XCl = grams H_2XCl/Mol H_2XCl = grams H_2XCl/moles NaOH at equivalence point
          = 1.30g/{(0.500M)(.0150L)} = **173**. g/mole H_2XCl
b)Solution: K_{a1} equilibrium : H_2X^+ <==> H^+ +   HX   (see note below)
                0.300-.00263   .00263   .00263

$K_{a1} = [H^+][HX]/[H_2X^+] = (.00263)(.00263)/(.297) = 2.33x10^{-5}$. so $pK_{a1} = -logK_{a1} = $ **4.632**

Note: $[H_2X^+]_o$ = total mol NaOH @ e.p./V_{H2X+} = $M_{OH}V_{OH}/V_{H2X+}$ =
(.500M)(15.0mL)/(25.0mL)= 0.300M
Also: $[H^+] = [HX] = 10^{-pH} = 10^{-2.58}$ = .00263 M
c)Solution: let's look at the whole scheme:　　　　　　　4.632　　　　pK_2
　　　　　　　　　　　　　　　　　H_2X^+ <==> HX <==> X^-
At e.p. #1: pH = $(pK_1 + pK_2)/2$: 7.69 = $(4.63+pK_2)/2$ => pK_2 = 2(7.69) –4.63 = **10.75**
d)Solution: The total number of mLs must be double the amount needed to reach the 1st
equivalence point. That is: 2(15.0mL) = **30.0 mLs**
e) Solution: when a total of 19.0 mLs is added we are in the buffer region in which the
major species are: HX and X^-. We use buffer equation: pH =pK_{a2} + log$[X^-]$/[HX] . pH =
10.75 + log{(19-15)/(30-19)}
pH = 10.75 + log (4/11) = **10.31**
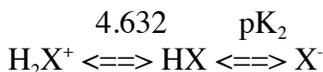
21) a) Consider 1 liter of solution: there are 12.1 moles of HCl (36.45 g/mol) and so we
have:

%(w/w) = (12.1mol HCl / 1000mL)(35.45g/mol)(1 mL/1.10g) (100%) = **40.1%**

b) Consider 1 Liter of solution: there are 12.1 moles HCl, the total mass of the solution
is: 1000mL x (1.10g/mL) = 1100 g; of that, how many grams are solvent??

mass of solution - mass of solute = mass of solvent
1100 g - (12.1mol HCl)(36.45g/mol) = 1100 - 441.0 = 659.0 g x (1kg/1000g)
= 0.659 kg solvent
so molality = 12.1 mol HCl/ 0.659 kg H2O = **18.4 m**

c) the Tf = 0.00°C - ΔTf = -ikfm = -(2)(1.86 °C/m)(18.4 m) = **-68.4 °C**

d) $P_{H2O} = X_{H2O}P°_{H2O}$
 $X_{H2O} = n_{H2O}/(n_{H2O}+n_{HCl})$;
Consider 1 liter of solution:
n_{H2O} = 659.0g H2O (1 mol /18.0 g) = 36.6 mol H2O

n_{HCl} = 12.1 moles HCl (2) = 24.2 moles of H+ and Cl - particles so : X =
(36.6)/(36.6+24.2)=0.602
thus: $P_{H2O} = X_{H2O}P°_{H2O}$ = (0.602)(200mmHg) = **120. mm Hg**