Chemistry
Pretest 4.1 2010 (mostly last year's test)

1. Write 2 chemical equations to show how HSO_3^- acts as an acid. One will do it the Arrhenius way and the other will act as a Bronsted-Lowry acid. **(2 m)**

Arrhenius way $HSO_3^- = H^+ + SO_3^{-2}$

Bronsted-Lowry $HSO_3^- + H_2O = H_3O^+ + SO_3^{-2}$

2. Identify two Bronsted-Lowry bases in the following equation. **(2 m)**

$$C_2H_4O_{2\,(aq)} + AsH_{3(aq)} \rightleftharpoons AsH_4^+{}_{(aq)} + C_2H_3O_2^-{}_{(aq)}$$

Proton acceptors are $AsH_{3(aq)}$ and $C_2H_3O_2^-{}_{(aq)}$

3. If the pH of a solution is 8.57, what is its $[OH^-]$? **(3 m)**

pOH = 14 – pH
= 14 – 8.57 = 5.43

$[OH^-] = 10^{-5.43} = 3.71 \times 10^{-6}$ moles/L

Don't forget the units!

4. If the concentration of H^+ is 0.00440 moles/L, what is its pOH? **(3 m)**

$[OH^-] = 10^{-14}/0.00440 = 2.27 \times 10^{-12}$ moles/L

pOH = -log(2.27 X10^{-12} = 11.6

or **pH = -**log(0.00440) = 2.4

pOH = 14 – pH = 14 – 2.4 = 11.6

5. If the acid HX has an equilibrium concentration of 0.600 M and a pH of 2.00, what is its K_A value? $HX_{(aq)} \rightleftharpoons H^+_{(aq)} + X^-_{(aq)}$

$$K_A = \frac{[X^-][H^+]}{[HX]} = \frac{[10^{-2}][10^{-2}]}{[0.600]} = 1.67\ X\ 10^{-4}$$

(3 m)

6. The K_A for HNO_2 is 4.5×10^{-4}.

Calculate the equilibrium concentration of NO_2^{-1} in a solution of HNO_2 initially prepared as 0.00010 M. **Show ICE chart.**

	$HNO_{2(aq)}$	$H^+_{(aq)}$	$NO_2^{-1}{}_{(aq)}$
I	**0.00010 M**	**0**	**0**
C	**x**	**x**	**x**
E	**0.00010 - x**	**x**	**x**

$$\mathbf{K_A = \frac{[NO_2^-][H^+]}{[HNO_2]} = \frac{[x][x]}{[0.00010 - x]} = 4.5 \times 10^{-4}}$$

$x^2 = 4.5 \times 10^{-4}(0.00010 - x)$
$x^2 + 4.5 \times 10^{-4}\ x - 4.5 \times 10^{-8} = 0$
$x = 0.000084$ moles/L = $[NO_2^{-1}{}_{(aq)}]$

(4 m)

7. Dimethylamine, $(CH_3)_2NH$, is a weak base. The dissociation of dimethylamine and its ionization constant, K_b, are shown below.

$(CH_3)_2NH_{(aq)} + H_2O_{(l)} \rightleftharpoons OH^-_{(aq)} + (CH_3)_2NH_2{}^+_{(aq)}$ $\quad K_b = 5.1 \times 10^{-4}$

A chemistry student places 3.1×10^{-2} grams of dimethylamine into 5.0×10^2 mL of distilled water. Find its pH.

	$(CH_3)_2NH_{(aq)} + H_2O_{(l)}$	$OH^-_{(aq)}$	$(CH_3)_2NH_2{}^+_{(aq)}$
I	**3.1×10^{-2} g/ (45 g/mole)/0.50 L= 0.001377 moles/L**	**0**	**0**
C	**x**	**x**	**x**
E	**0.001377 - x**	**x**	**x**

$$K_b = 5.1 \times 10^{-4} = \frac{[(CH3)2NH_2^+][OH^-]}{[(CH3)2NH]} = \frac{x^2}{0.001377 - x}$$

x = 0.0006209 moles/L = [OH$^-$]

pOH = -log(0.0006209) = 3.20

pH = 14 – 3.20= 10.8 **(4 m)**

8. Start with $K_AK_B = K_w$.
and use logs and log laws to relate the sum of pK_A and pK_B to the sum of pH and pOH.
(4 m)

$K_AK_B = K_w$.

Log both sides:

$\log(K_AK_B) = \log K_w$.

$\log K_A + \log K_B = \log K_w$

Multiply all by -1:

$-\log K_A - \log K_B = -\log K_w$

$-\log K_A - \log K_B = -\log (10^{-14})$

$pK_A + pK_b = 14$

But pH + pOH = 14, so

$pK_A + pK_b = pH + pOH$

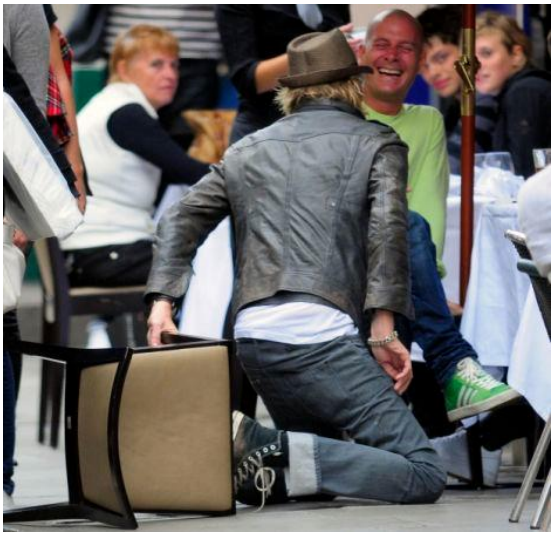
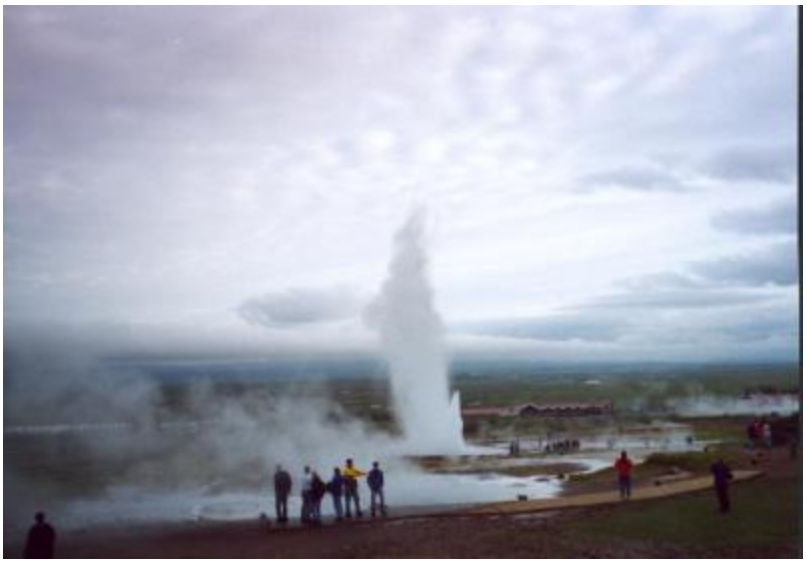


Figure 1 Man fell off his chair after seeing the solution to #8.

9. $H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

In Iceland geysers emit water at a temperature of 140 ^oC. This is an unusually high temperature for water, which boils at about 100^oC. What could account for the unusually high temperature? Hint: see above equation.

(2 m)



Strokkur Geyser, Iceland

If the pressure is very high below the surface, it will shift equilibrium towards the left hand side. This will keep water in the liquid state. Under normal conditions(101.3 kPa), water will boil at 100 ^oC and the temperature of liquid water does not get any higher because it just turns into gas. But if it's being forced to remain in the liquid state, it will keep absorbing heat from magma and exceed its normal boiling point.

10. TRUE? Or FALSE? SKIP a,e,f

b) The oxidation number of Zr in $Zr(NO_3)_2$ is 2.
TRUE (because it is attached to two NO_3^{-1} groups)

c) The oxidation number of N in $(NH_4)_2Cr_2O_7$ is 3.
FALSE, it is -3 because of NH_4^+

d) The oxidation number for nitrogen in a molecule is always +5.
FALSE

More Flashbacks

- $H_{2(g)}$ + $I_{2(g)}$ + energy = 2HI(g)
  (colourless) (purple) (colourless)

  A) **Will lowering pressure at constant temperature have an effect on the colour of the equilibrium mixture**? Why?
  B) What effect on colour will lowering temperature at constant pressure have?

a) No equal number of molecules on each side of equation.
b) Darker purple