Practice Worksheet for Chemistry 1B, Exam II **Name:** Key

1. Determine the pH of a 0.032 *M* solution of H_2SO_4. The dissociation occurs in two steps. K_{a1} is extremely large; K_{a2} is 1.2×10^{-2}.

H_2SO_4 is a strong acid, so $[H_2SO_4]_i = [H_3O^+] = [HSO_4^-] = 0.032\ M$ (after dissociation)

$HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$ (HSO_4^- is a weak acid)

	HSO_4^-		SO_4^{2-}	H_3O^+
I	0.032	—	0	0.032
C	$-x$	—	$+x$	$+x$
E	$0.032-x$	—	x	$0.032+x$

$K_{a2} = 1.2\times10^{-2} = \dfrac{x(0.032+x)}{(0.032-x)}$ can't neglect x, use quadratic

pH = 1.40 [See work page 2]

2. The pain killer morphine is a weak base when added to water. The reaction produces one mole of hydroxide ions for every one mole of morphine that reacts with water. The K_b is 1.60×10^{-6}. What is the pH of a 5.00×10^{-3} M solution of morphine?

$Morphine + H_2O \rightleftharpoons HMorphine + OH^-$

	Morphine		HMorphine	OH^-
	5.0×10^{-3} M		0	0
	$-x$		$+x$	$+x$
	5.0×10^{-3} M $-x$		x	x

$K_b = \dfrac{x^2}{(5.0\times10^{-3} - x)} = 1.60\times10^{-6}$ neglect x

$x = 8.94\times10^{-5}\ M = [OH^-]$

pOH = 4.05

pH = 9.95

3. A 50.0-mL sample of 0.10 *M* HNO_2 ($K_a = 4.0 \times 10^{-4}$) is titrated with 0.12 M NaOH. What is the pH after 25.0 mL of NaOH have been added?

$50.0\ mL\ HNO_2 \left(\frac{1\ L}{1000\ mL}\right)\left(\frac{0.10\ mol\ HNO_2}{1\ L}\right) = 5.00\times10^{-3}\ mol$

$25.0\ mL\ NaOH \left(\frac{1\ L}{1000\ mL}\right)\left(\frac{0.12\ mol\ OH^-}{1\ L}\right) = 3.00\times10^{-3}\ mol$

Buffer! Use HH

$pK_a = -\log K_a = 3.4$

$pH = pK_a + \log\dfrac{[A^-]}{[HA]}$

$= 3.4 + \log\dfrac{(0.003)}{0.002}$

pH = 3.6

Reacts completely

	HNO_2	+ OH^-	→ NO_2^-	+ H_2O
	0.005	0.003	0	
	−0.003	−0.003	+0.003	
	0.002 HNO_2	0	0.003 NO_2^-	

4. The solubility of silver phosphate, Ag_3PO_4, at 25°C is 1.61×10^{-5} mol/L. Determine the concentration of the Ag^+ ion in a saturated solution.

$Ag_3PO_4(s) \rightleftharpoons 3Ag^+ + PO_4^{3-}$

		$3Ag^+$	PO_4^{3-}
I	—	0	0
C	—	$+3s$	$+s$
E	—	$3s$	s

$K_{sp} = (3s)^3 s = 27 s^4 = 1.61\times10^{-5}$

$s^4 = 5.96\times10^{-7}$

$s = 0.0278\ M$

$[Ag^+] = 3s = 0.0834\ M$

Using quadratic (see also section 14.17 in text)

$$1.2\times10^{-2} = \frac{x(0.032+x)}{(0.032-x)}$$

$$(1.2\times10^{-2})(0.032-x) = x(0.032+x)$$

$$0.000384 - 0.012x = 0.032x + x^2$$

$$0 = x^2 + 0.044x + 0.000384$$

use quadratic:

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$x = \frac{-0.044 \pm \sqrt{(0.044)^2 + 4(0.000384)(1)}}{2(1)}$$

$$= \frac{-0.044 \pm 0.0589}{2}$$ (only positive solution is possible)

$$x = 0.00746$$

$[H_3O^+] = 0.032 + x = 0.032 + 0.00746 = 0.0395\,M$

(from ICE table)

$$pH = -\log[H_3O^+] = -\log(0.0395) = 1.40$$