pH Review! *1. Find the pH of each solution. (You will need a Ka/Kb chart for some of these)*

a. 0.30 M HNO_3 strong acid! $[H^+] = 0.30\,M$. $pH = -\log(.30) = \boxed{0.52}$

b. 0.30 M $NaNO_3$ neutral! $pH = \boxed{7.00}$

c. 0.30 M LiOH strong base! $[OH^-] = 0.30\,M$ $pOH = -\log(.30) = 0.52$

$pH = 14 - pOH = \boxed{13.48}$

d. 0.30 M K_2O strong base, di basic. $[OH^-] = 2(.30) = 0.60\,M$ $pOH = 0.22$

$O^{-2} + H_2O \rightarrow 2OH^{-1}$ $pH = \boxed{13.78}$

e. 0.30 M $Ca(OH)_2$

strong base $[OH^-] = 2(.30) = 0.60\,M$, $pH = \boxed{13.78}$ as above

f. 0.30 M NaH $[OH^-] = 0.30\,M$ $pOH = 0.52$

strong base! $H^{-1} + H_2O \rightarrow H_{2(g)} + OH^{-1}$ $pH = \boxed{13.48}$

g. 0.30 M $HC_4H_7O_2$ (butanoic acid)

weak acid! must use a Ka. look up: $K_a = 1.5\times10^{-5}$

$HC_4H_7O_2 \rightleftarrows H^{+1} + C_4H_7O_2^{-1}$ $K_a = \frac{x^2}{.30 - x} = 1.5\times10^{-5}$

$.30 - x$ x x

assume $x \ll .30$, get $x = 0.0021(2)\,M = [H^+]$

$pH = -\log(.0021(2)) = \boxed{2.67}$

h. A solution containing butanoic acid dissolved at 0.30 M, and sodium butanoate dissolved at 0.20 M

$HC_4H_7O_2 \rightleftarrows H^{+1} + C_4H_7O_2^{-1}$ So $[Na^+] = .20\,M$,

$.30 - x$ x $.20 + x$ $[C_4H_7O_2^-] = 0.20\,M$

$K_a = \frac{x(.20 + x)}{.30 - x} = 1.5\times10^{-5}$ $\frac{x(.20)}{.30} = 1.5\times10^{-5}$ $x = [H^+] = 2.2(5)\times10^{-5}\,M$

assume $x \ll .30, .20$ $\boxed{pH = 4.65}$

i. 0.30 M sodium butanoate, $NaC_4H_7O_2$

Since butanoic acid is a weak acid, its conjugate base, butanoate, will be significantly basic.

$K_b = \frac{x^2}{.30 - x} = \frac{K_w}{K_a(HC_4H_7O_2)}$

$C_4H_7O_2^{-1} + H_2O \rightleftarrows HC_4H_7O_2 + OH^{-1}$

$.30 - x$ x x

$= 6.67\times10^{-10}$

assume $x \ll .30$, $\frac{x^2}{.30} = 6.67\times10^{-10}$

$x = [OH^-] = 0.000014(14)\,M$. $pOH = 4.85$

$\boxed{pH = 9.15}$

j. 0.30 M HNO_2 weak acid $K_a = 4.5\times10^{-4}$

$HNO_2 \rightleftarrows H^{+1} + NO_2^{-1}$

$.30 - x$ x x

$\frac{x^2}{.30 - x} = 4.5\times10^{-4}$ $\frac{x^2}{.30} = 4.5\times10^{-4}$ $\frac{x^2}{.30 - .01162} = 4.5\times10^{-4}$ $[H^+] = .01140$

assume $x \ll .30$ $x = .01162\ldots$ $x = .01139, .01140,$ $\boxed{pH = 1.94}$

k. 0.30 Molar $LiNO_2$

Since HNO_2 is a weak acid, NO_2^{-1} ion is basic.

$K_b(NO_2^{-1}) = \frac{K_w}{K_a(HNO_2)} = \frac{1.00\times10^{-14}}{4.5\times10^{-4}} = 2.2(2)\times10^{-11}$

$NO_2^{-1} + H_2O \rightleftharpoons HNO_2 + OH^{-1}$
.30−x x x

$K_b = \frac{x^2}{.30-x} = 2.2(2)\times10^{-11}$

assume x << .30, get $x = 2.5(8)\times10^{-6}$ M
$x = [OH^{-1}]$
pOH = 5.59
$\boxed{pH = 8.41}$

l. 0.30 Molar pyridine, C_5H_5N

this is a base! $K_b = 1.7\times10^{-9}$ (looked up)

$K_b = \frac{x^2}{.30-x} = 1.7\times10^{-9}$

$C_5H_5N + H_2O \rightleftharpoons C_5H_5NH^{+1} + OH^{-1}$
.30 − x x x

ass. x << .30

$x = .000022(6)$ M $= [OH^-]$

pOH = 4.65, $\boxed{pH = 9.35}$

m. 0.30 M Pyridinium bromide, C_5H_5NHBr

this is the conjugate acid of pyridine; it is acidic.

$[C_5H_5NH^{+1}] = .30$ M, and $[Br^-] = .30$ M

$C_5H_5NH^{+1} \rightleftharpoons H^{+1} + C_5H_5N$
.30 −x x x

$K_a(C_5H_5NH^{+1}) = \frac{K_w}{K_b(C_5H_5N)} = 5.8(82)\times10^{-6}$

$\frac{x^2}{.30-x} = 5.882\times10^{-6}$ $x = [H^+] = .0013(3)$ M

yada yada → $\boxed{pH = 2.88}$

n. A solution containing pyridine dissolved at 0.30 M, and pyridium bromide dissolved at 0.20 M.

pyridinium..

$H_2O + C_5H_5N \rightleftharpoons C_5H_5NH^{+1} + OH^{-1}$
.30 −x .20 + x x

$[C_5H_5NH^{+1}] = .20$ M, $[Br^-] = .20$ M

$K_b = \frac{(.20+x)(x)}{.30-x} = 1.7\times10^{-9}$

assume x << .3, .2, $x = 2.5(5)\times10^{-9}$ M $= [OH^-]$
pOH = 8.59, $\boxed{pH = 5.41}$

(or you could do this whole problem using K_a, w/ $C_5H_5NH^{+1} \rightleftharpoons H^{+1} + C_5H_5N$!)

o. A solution of 0.30 M $KHCO_3$.

K_a of HCO_3^{-1} = K_{a2} of $H_2CO_3 = 5.6\times10^{-11}$

K_b of HCO_3^{-1} = K_w / K_a of H_2CO_3 = $\frac{K_w}{K_{a1}} = \frac{1.00\times10^{-14}}{4.3\times10^{-7}} = 2.3(26)\times10^{-8}$.

$K_b > K_a$ so HCO_3^{-1} is a base.

$HCO_3^{-1} + H_2O \rightleftharpoons H_2CO_3 + OH^{-1}$
.30 −x x x

$K_b = 2.3(26)\times10^{-8} = \frac{x^2}{.30-x}$ yoda yoda

$x = 8.3(5)\times10^{-5}$ M $= [OH^-]$

pOH = 4.08, $\boxed{pH = 9.92}$

p. A solution of 0.30 M NaH_2AsO_4.

K_a of $H_2AsO_4^{-1}$ = K_{a2} of $H_3AsO_4 = 1.0\times10^{-7}$

K_b of $H_2AsO_4^{-1}$ = K_w / K_{a1} of $H_3AsO_4 = \frac{1.00\times10^{-14}}{5.6\times10^{-3}} = 1.79\times10^{-12}$

$K_a > K_b$ so it's acidic

$H_2AsO_4^- \rightleftharpoons H^{+1} + AsO_4^{-2}$
.30 −x x x

$\frac{x^2}{.30-x} = 1.0\times10^{-7}$ x << .30 ...

$x = .00017(32)$ M $= [H^+]$

pH = $\boxed{3.76}$!!!!!