1. a) $Ba(NO_3)_{2(s)} \rightarrow Ba^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$

↳ cation of Group 2 metal does not cause a hydrolysis Rxn

↳ anion of strong acid does not cause a hydrolysis rxn

$Ba(NO_3)_2 \rightarrow$ neutral

b) $HNO_{3\,(aq)} \rightarrow$ strong acid / ionizes completely

c) $NH_4NO_{3\,(s)} \longrightarrow NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}$

↳ cation of weak base acts as conjugate acid producing $H_3O^+{}_{(aq)}$

↳ anion of strong acid does not cause a hydrolysis rxn

$NH_4^+{}_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+{}_{(aq)} + NH_{3\,(aq)}$

$K_A = \frac{K_W}{K_B \text{ for } NH_3} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}}$

$K_A = 5.5 \times 10^{-10}$

d) $Al(NO_3)_{3\,(s)} \rightarrow Al^{3+}{}_{(aq)} + 3NO_3^-{}_{(aq)}$

↳ forms $H_3O^+{}_{(aq)}$ bcz large +ve core density

↳ anion of strong acid does not affect pH

$Al^{3+}{}_{(aq)} + 6H_2O_{(l)} \rightleftharpoons [Al(H_2O)_6]^{3+}{}_{(aq)}$

$[Al(H_2O)_6]^{3+}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons [Al(H_2O)_5(OH)]^{2+}{}_{(aq)} + H_3O^+{}_{(aq)}$

$K_A = 9.8 \times 10^{-6}$

e) $NaF_{(s)} \longrightarrow Na^+{}_{(aq)} + F^-{}_{(aq)}$

↳ cation of Group 1 metal, no hydrolysis rxn

↳ anion of weak acid acts as conjugate base causing a hydrolysis rxn

$K_B = \frac{K_W}{K_A \text{ for } HF}$

$F^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons HF_{(aq)} + OH^-{}_{(aq)}$

$= \frac{1 \times 10^{-14}}{6.6 \times 10^{-4}}$

$K_B = 1.5 \times 10^{-9}$

HNO_3	$Al(NO_3)_3$	NH_4NO_3	$Ba(NO_3)_2$	NaF
strong acid	$Ka = 9.8 \times 10^{-6}$	5.5×10^{-10}	neutral	produces base high pH

2. a) $NH_4Cl_{(s)} \rightarrow NH_4^+{}_{(aq)} + Cl^-{}_{(aq)}$

NH_4^+: cation of weak base acts as conjugate acid

Cl^-: anion of a strong acid no affect on pH bcz does not cause hydrolysis rxn

$$[NH_4^+]_I = [NH_4Cl] \times \text{mol ratio}$$

$$= \frac{0.100 \text{ mol } NH_4Cl}{L} \times \frac{1 \text{ mol } NH_4^+}{1 \text{ mol } NH_4Cl}$$

$$= 0.100 \frac{\text{mol } NH_4^+}{L}$$

	$NH_4^+{}_{(aq)}$	$+ H_2O_{(l)}$	$\rightleftharpoons NH_{3(aq)}$	$+ H_3O^+{}_{(aq)}$
I	0.1	/	0	(1×10^{-7})
C	$-x$		$+x$	$+x$
E	$0.1-x$		x	x

$$K_A = \frac{K_W}{K_B} = \frac{1\times10^{-14}}{1.8\times10^{-5}} = 5.56\times10^{-10}$$

$$K_A = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$$

$$5.5\times10^{-10} = \frac{(x)(x)}{0.1}$$

$$x = 7.42\times10^{-6}$$

$$[H_3O^+] = 7.42\times10^{-6}$$

$$pH = -\log[H_3O^+]$$

$$= -\log(7.42\times10^{-6})$$

$$\boxed{pH = 5.130}$$

check

$$\frac{[\,]}{K_A} = \frac{0.1}{5.5\times10^{-10}} >> 100$$

proof

$$\frac{x}{[\,]_I} \times 100\%$$

$$\frac{7.42\times10^{-6}}{0.100} \times 100\% = 0.00742\% < 5\%$$

2b) $NaCN_{(s)} \rightarrow Na^+_{(aq)} + CN^-_{(aq)}$

cation of Group I Metal does not cause a hydrolysis rxn

↳ anion of weak acid acts as conjugate base

$[CN^-] = [NaCN] \times \text{mol ratio}$

$= \frac{0.1 \text{ mol NaCN}}{L} \times \frac{1 \text{ mol } CN^-}{1 \text{ mol NaCN}}$

$= 0.100 \frac{\text{mol } CN^-}{L}$

	$CN^-_{(aq)}$	$+ H_2O_{(l)}$	$\rightleftharpoons HCN_{(aq)}$	$+ OH^-_{(aq)}$
I	0.1	/	0	(1×10^{-7})
C	$-x$		$+x$	$+x$
E	$0.1-x$		x	x

$K_B = \frac{K_W}{K_{A_{CN}}} = \frac{1\times10^{-14}}{6.2\times10^{-10}} = 1.61\times10^{-5}$

$K_B = \frac{[HCN][OH^-]}{[CN^-]}$

$\frac{[\ ]_I}{K_B} = \frac{0.1}{1.6\times10^{-5}} >> 100$

$1.61\times10^{-5} = \frac{(x)(x)}{0.1}$

$x = 1.27\times10^{-3}$.

$\frac{x}{[\ ]_I} \times 100\% = \frac{1.27\times10^{-3}}{0.1} \times 100\%$

$= 1.27\%$

$[OH^-] = 1.27\times10^{-3} \text{ mol/L}$

$pOH = -\log[OH^-]$

$= -\log(1.27\times10^{-3})$

$= +2.897$

$pH = 14 - pOH$

$= 14 - 2.897$

$pH = 11.103$

20) $Li_2CO_{3\,(s)} \rightarrow 2Li^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

cation of Group I metals does not cause a hydrolysis rxn

↳ anion of a weak acid causes a hydrolysis rxn

$CO_3^{2-}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons HCO_3^{2-}{}_{(aq)} + OH^-_{(aq)}$

$HCO_3^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)} + OH^-_{(aq)}$

$[CO_3^{2-}] = [Li_2CO_3] \times \text{mol ratio}$

$= 0.100 \frac{\text{mol } Li_2CO_3}{L} \times \frac{1 \text{ mol } CO_3^{2-}}{1 \text{ mol } Li_2CO_3}$

$= 0.100 \frac{\text{mol } CO_3^{2-}}{L}$

$K_B = \frac{K_w}{K_A \text{ for } HCO_3^{2-}}$

$= \frac{1\times10^{-14}}{4.7\times10^{-11}}$

$= 2.13\times10^{-4}$

	$CO_3^{2-}{}_{(aq)}$ +	$H_2O_{(l)}$ ⇌	$HCO_3^-{}_{(aq)}$ +	$OH^-_{(aq)}$
I	0.1	/	0	(1×10^{-7})
C	−x		+x	+x
E	0.1−x		x	x

$K_B = \frac{[HCO_3^-][OH^-]}{[CO_3^{2-}]}$

$2.13\times10^{-4} = \frac{(x)(x)}{0.1}$

$x = 4.61\times10^{-3}$

Check

$\frac{[\,]_I}{K_B} = \frac{0.1}{2.3\times10^{-4}} >> 100$

proof

$\frac{x}{[\,]_I} \times 100\%$

$\frac{4.61\times10^{-3}}{0.1} \times 100\% = 4.61\%$

	$HCO_3^-{}_{(aq)}$ +	$H_2O_{(l)}$ ⇌	$H_2CO_{3(aq)}$ +	$OH^-_{(aq)}$
I	4.61×10^{-3}	/	0	4.61×10^{-3}
C	−x		+x	+x
E	$4.61\times10^{-3} - x$		x	$4.61\times10^{-3} + x$
	$\approx 4.61\times10^{-3}$			$\approx 4.61\times10^{-3}$

$K_B = \frac{K_w}{K_A \text{ for } H_2CO_3}$

$= \frac{1\times10^{-14}}{4.4\times10^{-7}}$

$= 2.27\times10^{-8}$

$K_B = \frac{[H_2CO_3][OH^-]}{[HCO_3^-]}$

$2.27\times10^{-8} = \frac{(4.61\times10^{-3})\,x}{(4.61\times10^{-3})}$

$x = 2.27\times10^{-8}$

∴ no significant OH^- produced in 2nd rxn

check

$\frac{[\,]_I}{K_B} = \frac{4.61\times10^{-3}}{2.27\times10^{-8}} >> 100$

proof

$\frac{x}{[\,]_I} \times 100\%$

$\frac{2.27\times10^{-8}}{4.61\times10^{-3}} \times 100\%$

$= 4.92\times10^{-4}\ \%$

$pOH = -\log[OH^-]$

$= -\log(2.27\times10^{-8})$

$= 7.643$

$pH = 14 - pOH$

$= 14 - 7.643 = 6.357$