$\qquad$ Date:
F21 - first year for this practice, probably lots of typos and mistakes, EC for the first person to find them!
Instructions: Answer the following questions. Show ALL work for problems to receive full credit. Make sure to include proper units and significant figures for all answers.
[5 pt] 1. Sketch a picture showing how $\mathrm{BaCl}_{2}$ will dissolve in water. Label all IMF's present.
Should include both cation and anion each surrounded by water (in proper orientation).
Also include $p m$ and $\delta^{+} \delta^{-}$symbols.
Label DD, ID forces
[6 pt] 2. Sketch a picture showing how $\mathrm{AlCl}_{3}$ will dissolve in water. What is the attractive force between the ions and water molecules?
Should include both cation and anion each surrounded by water (in proper orientation).
Also include $\pm$ on cations/anions and $\delta^{+} \delta^{-}$symbols on water
Opposites attract
ID, HB should be shown


ALL ions


The second picture above could include the salt at the bottom as a solid showing an IB. Will redraw picture if I have time.
[6 pt] 3. Sketch a picture showing how $\mathrm{HC}_{2} \mathrm{H}_{3} \mathrm{O}_{2}$ will dissolve in water. What is the attractive force between the ions and water molecules?
Should include entire molecule ( $90 \%$ because wa) with waters forming a HB to it. Also include both cation and anion ( $<10 \%$ each surrounded by water (in proper orientation).
Also include $\pm$ and $\delta^{+} \delta^{-}$symbols
Opposites attract
HB and ID should be labeled
[4 pt] 4. Sketch a picture showing how $\mathrm{CH}_{2} \mathrm{O}$ will dissolve in water. What is the attractive force between the ions and water molecules?
This is a molecular compound, NO ions are formed, instead it dissolves because it can form HB with water.


Picture should look similar to the middle example. The example on the right shows how a similar molecule would dissolve in water.

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[15 pt] 5. Complete and balance the following reactions. Include the state of the products, and any energy/heat terms where appropriate. If no reaction occurs, write NR for the products.
(a) $\underline{2} \mathrm{HNO}_{3}(\mathrm{aq})+\underline{2} \mathrm{Na}(\mathrm{s}) \longrightarrow$
$\ldots \mathrm{H}_{2}(\mathrm{~g})+\underline{2} \mathrm{NaNO}_{3}(\mathrm{aq})$
(b) $1 \mathrm{Cu}(\mathrm{s})+2 \mathrm{HC}_{2} \mathrm{H}_{3} \mathrm{O}_{2}(\mathrm{aq}) \longrightarrow \mathrm{NR}$
(c) $\quad 3 \mathrm{KOH}(\mathrm{aq})+$ $\qquad$ $\mathrm{H}_{3} \mathrm{PO}_{4}(\mathrm{aq}) \longrightarrow$ $\_\mathrm{K}_{3} \mathrm{PO}_{4}(\mathrm{aq})+\underline{3} \mathrm{H}_{2} \mathrm{O}(\mathrm{l})+$ Heat
5(c)
5(b) NR
$(\mathrm{d}) \ldots \mathrm{H}_{2} \mathrm{SO}_{4}(\mathrm{aq})+\underline{2} \mathrm{NH}_{4} \mathrm{OH}(\mathrm{aq}) \longrightarrow \ldots\left(\mathrm{NH}_{4}\right)_{2} \mathrm{SO}_{4}(\mathrm{aq})+\underline{2} \mathrm{H}_{2} \mathrm{O}(\mathrm{l})+$ Heat $5(\mathrm{~d})$ $\qquad$
$(\mathrm{e}) \_\mathrm{K}_{2} \mathrm{CO}_{3}(\mathrm{aq})+\underline{2} \mathrm{HCl}(\mathrm{aq}) \longrightarrow \quad \underline{2} \mathrm{KCl}(\mathrm{aq})+\ldots \mathrm{CO}_{2}(\mathrm{~g})+\ldots \mathrm{H}_{2} \mathrm{O}(\mathrm{l}) \quad 5(\mathrm{e})$ $\qquad$
[8 pt] 6. Answer the following questions about acids, bases, and pH . (Recall that $\mathrm{pH}=-\log \left[\mathrm{H}^{+}\right],\left[\mathrm{H}^{+}\right]=10^{-p H}$, and $\mathrm{pH}+\mathrm{pOH}=14$ ). Additionally state whether the solution is $(\mathrm{A})$ cidic, ( B )asic, or (N)eutral
(a) What is the pH of solution with $\left[\mathrm{H}^{+}\right]=3.8 \times 10^{-10} \mathrm{M}$ ?

6(a) 9.42 - Basic
(b) What is the $\left[\mathrm{H}^{+}\right]$for a solution with $\mathrm{pH}=2.36$ ?

6 (b) $4.4 \times 10^{-} 3 \mathrm{M}-$ Acidic
(c) What is the pH for a solution with $\mathrm{p} 0 \mathrm{H}=5$ ?

6(c) $\mathbf{9 - B a s i c}$
(d) What is the pOH for a solution with $\left[\mathrm{H}^{+}\right]=3.80 \times 10^{-11} \mathrm{M}$ ?

6(d) 3.580 - Basic
$[8 \mathrm{pt}]$ 7. Answer the following questions about acids, bases, and pH . (Recall that $\mathrm{pH}=-\log \left[\mathrm{H}^{+}\right],\left[\mathrm{H}^{+}\right]=10^{-p H}$, and $\mathrm{pH}+\mathrm{pOH}=14$ ). Additionally state whether the solution is $(\mathrm{A})$ cidic, $(\mathrm{B})$ asic, or ( N )eutral
(a) What is the pH of solution with $\left[\mathrm{H}^{+}\right]=2.45 \times 10^{-4} \mathrm{M}$ ?

7(a) 3.61-Acidic
(b) What is the $\left[\mathrm{H}^{+}\right]$for a solution with $\mathrm{pH}=8.5$ ?

7(b) $\underline{3.2 \times 10^{-9} \mathrm{M}}$ - Basic
(c) What is the pH for a solution with $\mathrm{p} 0 \mathrm{H}=12$ ?

7(c) 2-Acidic
(d) What is the $\left[\mathrm{OH}^{-}\right]$for a solution with $\left[\mathrm{H}^{+}\right]=3.80 \times 10^{-11} \mathrm{M}$ ?

7(d) $2.63 \times 10^{-4} \mathbf{M}$ - Basic

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$[8 \mathrm{pt}]$ 8. Answer the following questions about acids, bases, and pH . (Recall that $\mathrm{pH}=-\log \left[\mathrm{H}^{+}\right],\left[\mathrm{H}^{+}\right]=10^{-p H}$, and $\mathrm{pH}+\mathrm{pOH}=14$ ). Additionally state whether the solution is (A)cidic, (B)asic, or (N)eutral
(a) What is the pH of solution with $\left[\mathrm{H}^{+}\right]=3.5 \times 10^{-4} \mathrm{M}$ ?

8(a) 3.46 - Acidic
(b) What is the $\left[\mathrm{H}^{+}\right]$for a solution with $\mathrm{pH}=9.50$ ?

8(b) $3.2 \times 10^{-10} \mathrm{M}$ - Basic
(c) What is the $\left[\mathrm{OH}^{-}\right]$for a solution with $\left[\mathrm{H}^{+}\right]=2.4 \times 10^{-11} \mathrm{M}$ ?

8(c) $4.2 \times 10^{-4} \mathrm{M}$ - Basic
(d) What is the pOH of a solution with a $\mathrm{pH}=3.25$ ?

8(d) 10.75 - Acidic
(e) What is the $\left[\mathrm{H}^{+}\right]$in a solution with pOH of 5.5 ?

8(e) $3.0 \times 10^{-} 9 \mathrm{M}$ - Basic
$\mathrm{pH}+5.5=14$
$\left[\mathrm{H}^{+}\right]=10^{-8.5}=3.0 \times 10^{-} 9$
[5 pt] 9. Fill in the missing values on the pH scale below.


Top Row $=0,7$
Middle Row $=1 \times 10^{-7} \mathrm{M}$, and $1 \times 10^{-14} \mathrm{M}$
Bottom Row $=$ Acidic, Basic
[4 pt] 10. Fill in the missing values below.

|  | Acid | Neutral | Base |
| :--- | :--- | :--- | :--- |
| pH Scale | $\mathrm{pH} \leq 7$ | $\mathrm{pH}=7$ | $\mathrm{pH} \geq 7$ |
| Concentration <br> Scale | $\left[\mathrm{H}^{+}\right] \geq 1 \times 10^{-7} \mathrm{M}$ | $\left[\mathrm{H}^{+}\right]=1 \times 10^{-7} \mathrm{M}$ | $\left[\mathrm{H}^{+}\right] \leq 1 \times 10^{-7} \mathrm{M}$ |

[ 5 pt ] 11. Calculate the volume (in mL ) of 1.25 M HCl required to neutralize 75.0 mL of $4.6011 . \underline{\mathbf{5 5 2} \mathbf{~ m L ~ H C l}}$ $\mathrm{M} \mathrm{Ca}(\mathrm{OH})_{2}$. Write a balanced equation for the reaction and show work to receive full credit.
Balanced Equation: $2 \mathrm{HCl}(\mathrm{aq})+1 \mathrm{Ca}(\mathrm{OH})_{2}(\mathrm{aq}) \longrightarrow \underline{1} \mathrm{CaCl}_{2}(\mathrm{aq})+\underline{2} \mathrm{H}_{2} \mathrm{O}(\mathrm{l})+$ heat $\frac{75.0 \mathrm{~mL} \mathrm{Ca}(\mathrm{OH})_{2}}{} \times \frac{0.001 \mathrm{~L}}{1 \mathrm{~mL}} \times \frac{4.60 \mathrm{~mol} \mathrm{Ca}(\mathrm{OH})_{2}}{1 \mathrm{~L}} \times \frac{2 \mathrm{~mol} \mathrm{HCl}}{1 \mathrm{~mol} \mathrm{Ca}(\mathrm{OH})_{2}} \times \frac{1 \mathrm{~L}}{1.25 \mathrm{~mol} \mathrm{HCl}} \frac{0.001 \mathrm{~L}}{1 \mathrm{~mL}}=552 \mathrm{~mL}$

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[4 pt] 12. How many grams of NaOH must you dissolve in $250 . \mathrm{mL}$ of water to prepare a 7.50 M NaOH solution. Show work to support your answer.
12. 75.0 g NaOH

Solve $\mathrm{mLA} \longrightarrow \mathrm{molA} \longrightarrow \mathrm{gA}$
$\frac{250 \mathrm{~mL}}{} \times \frac{0.001 \mathrm{~L}}{1 \mathrm{~mL}} \times \frac{7.50 \mathrm{~mol} \mathrm{NaOH}}{1 \mathrm{~L}} \times \frac{40.00 \mathrm{~g} \mathrm{NaOH}}{1 \mathrm{~mol} \mathrm{NaOH}}=75.0 \mathrm{~g} \mathrm{NaOH}$
[5 pt] 13. Calculate the volume (in mL ) of 3.75 M HCl required to neutralize 175.0 mL of $2.60 \mathrm{M} \mathrm{Ca}(\mathrm{OH})_{2}$. Write a balanced equation for the reaction and show work to receive full credit.
13. 242.7 mL HCl

Balanced Equation: $2 \mathrm{HCl}(\mathrm{aq})+\underline{1} \mathrm{Ca}(\mathrm{OH})_{2}(\mathrm{aq}) \longrightarrow \underline{1} \mathrm{CaCl}_{2}(\mathrm{aq})+\underline{2} \mathrm{H}_{2} \mathrm{O}(\mathrm{l})+$ heat $\frac{175.0 \mathrm{~mL} \mathrm{Ca}(\mathrm{OH})_{2}}{} \times \frac{0.001 \mathrm{~L}}{1 \mathrm{~mL}} \times \frac{2.60 \mathrm{~mol} \mathrm{Ca}(\mathrm{OH})_{2}}{1 \mathrm{~L}} \times \frac{2 \mathrm{~mol} \mathrm{HCl}}{1 \mathrm{~mol} \mathrm{Ca}(\mathrm{OH})_{2}} \times \frac{1 \mathrm{~L}}{3.75 \mathrm{~mol} \mathrm{HCl}} \frac{0.001 \mathrm{~L}}{1 \mathrm{~mL}}=242.666 \mathrm{~mL}$
[5 pt] 14. Calculate the Molarity of an $\mathrm{H}_{2} \mathrm{SO}_{4}$ solution that requires 175.0 mL to neutralize 83.0 mL of 2.60 M NaOH soution. Write a balanced equation for the reaction and show work to receive full credit.
14. $\underline{0.617 \mathrm{M} \mathrm{H}_{2} \mathrm{SO}_{4}}$
15. 105.0 mL of a KOH solution with unknown molarity neutralized 78.0 mL of a $2.25 \mathrm{M} \mathrm{H}_{3} \mathrm{PO}_{4}$ solution. What is the molarity of the KOH solution? Write a balanced equation for the reaction and show work to receive full credit.
15. 5.01 M KOH
16. Calculate the volume (in mL) of 8.55 M HCl required to neutralize 75.0 mL of $4.60 \mathrm{M} \mathrm{Ca}(\mathrm{OH})_{2}$. Write a balanced equation for the reaction and show work to receive full credit.
16. 80.7 mL HCl

Balanced Equation: $\underline{2} \mathrm{HCl}(\mathrm{aq})+\underline{1} \mathrm{Ca}(\mathrm{OH})_{2}(\mathrm{aq}) \longrightarrow \underline{1} \mathrm{CaCl}_{2}(\mathrm{aq})+\underline{2} \mathrm{H}_{2} \mathrm{O}(\mathrm{l})+$ heat $\frac{75.0 \mathrm{~mL} \mathrm{Ca}(\mathrm{OH})_{2}}{} \times \frac{0.001 \mathrm{~L}}{1 \mathrm{~mL}} \times \frac{4.60 \mathrm{~mol} \mathrm{Ca}(\mathrm{OH})_{2}}{1 \mathrm{~L}} \times \frac{2 \mathrm{~mol} \mathrm{HCl}}{1 \mathrm{~mol} \mathrm{Ca}(\mathrm{OH})_{2}} \times \frac{1 \mathrm{~L}}{8.55 \mathrm{~mol} \mathrm{HCl}} \frac{1 \mathrm{~mL}}{0.001 \mathrm{~L}}=80.7 \mathrm{~mL}$

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[10 pt] 17. Complete the following table by calculating the missing value and determining if the solution is (A)cidic, (B)asic, or (N)eutral.

| Given | Calculate the | Acid/Base/Neutral |
| :--- | :--- | :--- |
| $\left[\mathrm{H}^{+}\right]=6.25 \times 10^{-9} \mathrm{M}$ | $\mathrm{pH}=8.204$ | B |
| $\mathrm{pH}=2.50$ | $\left[\mathrm{H}^{+}\right]=3.2 \times 10^{-3} \mathrm{M}$ | A |
| $\left[\mathrm{OH}^{-}\right]=1.0 \times 10^{-7} \mathrm{M}$ | $\mathrm{pH}=7.00$ | N |
| $\mathrm{pOH}=6.25$ | $\mathrm{pH}=7.75$ | B |

Typo in F18 version $\mathrm{pH}=7.85$ and its Basic
[4 pt] 18. Define Acid and Base according to Bronsted-Lowry.
(a) Acid

Proton donor
(b) Base

Proton Acceptor
[10 pt] 19. Calculate the requested values below. Is the resulting solution (A)cidic, $\mathrm{B}(\mathrm{asic})$ or (N)eutral?
(a) What is the pH of solution with $\left[\mathrm{H}^{+}\right]=3.5 \times 10^{-4} \mathrm{M}$ ?
(b) What is the $\left[\mathrm{H}^{+}\right]$for a solution with $\mathrm{pH}=3.5$ ?
(c) What is the $\left[\mathrm{OH}^{-}\right]$for a solution with $\left[\mathrm{H}^{+}\right] 2.4 \times 10^{-11} \mathrm{M}$ ?
(d) What is the pOH of a solution with a $\mathrm{pH}=3.25$ ?
(e) What is the $\left[\mathrm{H}^{+}\right]$in a solution with pOH of 5.5 ?

19(a) 3.5-Acidic 19(b) $\underline{3.2 \times 10^{-4} \mathrm{M}-A c i d i c ~}$ 19(c) $4.2 \times 10^{-4} \mathbf{M}$ - Basic

19(d) 10.75 - Acidic

19(e) $3.2 \times 10^{-9} \mathbf{M}$ - Basic

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[ 9 pt$]$ 20. Define each of the following terms, list what type of molecules have these properties and give an example compound for each.

|  | Definition | Class of Molecules | Example |
| :--- | :--- | :--- | :--- |
| Strong Electrolyte | Dissociates 100\% into ions | Strong Acids <br> Strong Bases <br> Ionic (aq) | $\mathrm{H}_{2} \mathrm{SO}_{4}$ etc. <br> NaOH etc. |
| Weak Electrolyte | Dissociate $<10 \%$ into ions | NaCl(aq) etc. |  |
| Weak Acids |  |  |  |
| Non-Electrolyte | Do not dissociate <br> when dissolved in water | Molecular Compounds <br> Ionic (s) | $\mathrm{CHO}_{2}$ |

21. Identify the following substances as a (S)trong, (W)eak, or (N)on electrolyte.
(a) HF
(b) $\mathrm{SF}_{6}$
(c) $\mathrm{NaNO}_{3}$
(d) $\mathrm{HClO}_{4}$
(e) $\mathrm{BaSO}_{4}$
(f) $\mathrm{H}_{3} \mathrm{PO}_{4}(\mathrm{aq})$
(g) $\mathrm{SiCl}_{4}(\mathrm{aq})$
(h) $\mathrm{C}_{6} \mathrm{H}_{12}(\mathrm{aq})$

21(a) WE
21(b) NE
21(c) $\quad \mathbf{S E}$
21(d) $\quad \mathbf{S E}$
21(e) NE
21(f) NE
21(g) NE
21(h) NE
21(i) SE

21(j) NE
21(k) SE
21(1) SE
$21(\mathrm{~m}) \quad \mathbf{S E}$
21(n) WE
21(o) SE

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[4 pt] 22. Write the total ionic equation AND the net ionic equation for the following reaction: $\mathrm{Ca}\left(\mathrm{NO}_{3}\right)_{2}(\mathrm{aq})+$
$\mathrm{Na}_{2} \mathrm{CO}_{3}(\mathrm{aq}) \longrightarrow \mathrm{CaCO}_{3}(\mathrm{~s})+2 \mathrm{NaNO}_{3}(\mathrm{aq})$
Total Ionic: $\mathrm{Ca}^{+2}(\mathrm{aq})+2 \mathrm{NO}_{3}{ }^{-}(\mathrm{aq})+2 \mathrm{Na}^{+}(\mathrm{aq})+\mathrm{CO}_{3}{ }^{-2}(\mathrm{aq}) \longrightarrow \mathrm{CaCO}_{3}(\mathrm{~s})+2 \mathrm{Na}^{+}(\mathrm{aq})+2 \mathrm{NO}_{3}{ }^{-}(\mathrm{aq})$
Net Ionic: $\mathrm{Ca}^{+2}(\mathrm{aq})+\mathrm{CO}_{3}^{-2}(\mathrm{aq}) \longrightarrow \mathrm{CaCO}_{3}(\mathrm{~s})$
[4 pt] 23. Write the total ionic equation AND the net ionic equation for the following reaction:
$\mathrm{NaCl}(\mathrm{aq})+\mathrm{AgNO}_{3}(\mathrm{aq}) \longrightarrow \mathrm{NaNO}_{3}(\mathrm{aq})+\mathrm{AgCl}(\mathrm{s})$
Total Ionic: $\mathrm{Na}^{+}(\mathrm{aq})+\mathrm{Cl}^{-}(\mathrm{aq})+\mathrm{Ag}^{+}(\mathrm{aq}) \mathrm{NO}_{3}{ }^{-}(\mathrm{aq}) \longrightarrow \mathrm{Na}^{+}(\mathrm{aq})+\mathrm{NO}_{3}{ }^{-}(\mathrm{aq})+\mathrm{AgCl}(\mathrm{s})$
Net Ionic: $\mathrm{Ag}^{+}(\mathrm{aq})+\mathrm{Cl}^{-}(\mathrm{aq}) \longrightarrow \mathrm{AgCl}(\mathrm{s})$
[5 pt] 24. Write the total ionic AND net ionic equations for the following reaction:

$$
\mathrm{HF}(\mathrm{aq})+\mathrm{NaOH} \longrightarrow \mathrm{NaF}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})
$$

Total Ionic: $\mathrm{HF}(\mathrm{aq})+\mathrm{Na}^{+}(\mathrm{aq})+\mathrm{OH}^{-}(\mathrm{aq}) \longrightarrow \mathrm{Na}^{+}(\mathrm{aq})+\mathrm{F}^{-}(\mathrm{aq})+\mathrm{H}_{20}(\mathrm{l})$
Net Ionic: $\mathrm{HF}(\mathrm{aq})+\mathrm{OH}^{-}(\mathrm{aq}) \longrightarrow \mathrm{F}^{-}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
[5 pt] 25. Write the total ionic AND net ionic equations for the following reactions:
$\mathrm{NH}_{4} \mathrm{OH}(\mathrm{aq})+\mathrm{HCl}(\mathrm{aq}) \longrightarrow \mathrm{NH}_{4} \mathrm{Cl}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
Total Ionic: $\mathrm{NH}_{4} \mathrm{OH}(\mathrm{aq})+\mathrm{H}^{+}(\mathrm{aq})+\mathrm{Cl}^{-}(\mathrm{aq}) \longrightarrow \mathrm{NH}_{4}^{+}(\mathrm{aq})+\mathrm{Cl}^{-}(\mathrm{aq})+\mathrm{H}_{20}(\mathrm{l})$
Net Ionic: $\mathrm{NH}_{4} \mathrm{OH}(\mathrm{aq})+\mathrm{H}^{+}(\mathrm{aq}) \longrightarrow \mathrm{NH}_{4}{ }^{+}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
[5 pt] 26. Write the total ionic AND net ionic equations for the following reaction:
$\mathrm{H}_{2} \mathrm{SO}_{4}(\mathrm{aq})+2 \mathrm{NaOH} \longrightarrow \mathrm{Na}_{2} \mathrm{SO}_{4}(\mathrm{aq})+2 \mathrm{H}_{2} \mathrm{O}(\mathrm{l})$

Total Ionic : $2 \mathrm{H}^{+}(\mathrm{aq})+\mathrm{SO}_{4}^{-2}(\mathrm{aq})+2 \mathrm{Na}^{+}(\mathrm{aq})+2 \mathrm{OH}^{-}(\mathrm{aq}) \longrightarrow 2 \mathrm{Na}^{+}(\mathrm{aq})+\mathrm{SO}_{4}^{-2}(\mathrm{aq})+2 \mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
Net Ionic : $\mathrm{H}^{+}(\mathrm{aq})+\mathrm{OH}^{-}(\mathrm{aq}) \longrightarrow \mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
Coeffecients should be lowest ratio $(1,1$,$) but (2,2,2)$ is acceptable.
[5 pt] 27. Write the total ionic AND net ionic equations for the following reaction:
$2 \mathrm{Al}(\mathrm{s})+6 \mathrm{HBr}(\mathrm{aq}) \longrightarrow 2 \mathrm{AlBr}_{3}(\mathrm{aq})+3 \mathrm{H}_{2}(\mathrm{~g})$
Total Ionic : $2 \mathrm{Al}(\mathrm{s})+6 \mathrm{H}^{+}(\mathrm{aq})+6 \mathrm{Br}^{-}(\mathrm{aq}) \longrightarrow 2 \mathrm{Al}^{+3} \mathrm{aq}+6 \mathrm{Br}^{-}(\mathrm{aq})+3 \mathrm{H}_{2}(\mathrm{~g})$
Net Ionic : $2 \mathrm{Al}(\mathrm{s})+6 \mathrm{H}^{+}(\mathrm{aq}) \longrightarrow 2 \mathrm{Al}^{+3}(\mathrm{aq})+3 \mathrm{H}_{2}(\mathrm{~g})$

