AP Chemistry Flashcards

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1. Polyatomic Ions to Memorize

31 cards

TERM	DEFINITION
Ammonium	NH_4^+ The most common polyatomic cation.
Hydronium	H_3O^+ A water molecule that has gained H^+; present in every acidic solution.
Mercury(I) ion	Hg_2^{2+} Two bonded Hg atoms: mercury(I) chloride is Hg_2Cl_2, not HgCl.
Hydroxide	OH^- The ion that makes a solution basic.
Cyanide	CN^- Carbon and nitrogen only, no oxygen.
Thiocyanate	SCN^- Cyanate OCN^- with its O replaced by S.
Acetate	CH_3COO^-, also written $C_2H_3O_2^-$ Follows no -ate/-ite pattern: learn it on its own.
Nitrate	NO_3^- Nitrite has one O fewer, with the same 1− charge.
Nitrite	NO_2^- The -ite form: one O fewer than nitrate.
Hypochlorite	ClO^- The active ion in household bleach; one O fewer than chlorite.
Chlorite	ClO_2^- One O more than hypochlorite, one fewer than chlorate.

TERM	DEFINITION
Chlorate	ClO_3^- The reference -ate of the chlorine family.
Perchlorate	ClO_4^- per-: one O more than chlorate, same charge.
Bromate	BrO_3^- Same pattern as chlorate, with bromine.
Iodate	IO_3^- Same pattern as chlorate, with iodine.
Permanganate	MnO_4^- Deep purple oxidizing agent of redox titrations; same O count as manganate MnO_4^{2-}, so per- here does not add an O.
Hydrogen carbonate (bicarbonate)	HCO_3^- Carbonate plus H^+: the charge goes from 2− to 1−.
Hydrogen sulfate (bisulfate)	HSO_4^- Sulfate plus H^+: charge 1−.
Hydrogen sulfite (bisulfite)	HSO_3^- Sulfite plus H^+: charge 1−.
Dihydrogen phosphate	$H_2PO_4^-$ Phosphate plus two H^+: the charge goes from 3− to 1−.
Carbonate	CO_3^{2-} Releases CO_2 gas when it reacts with an acid.
Sulfate	SO_4^{2-} Sulfite has one O fewer, with the same 2− charge.
Sulfite	SO_3^{2-} The -ite form: one O fewer than sulfate.

TERM	DEFINITION
Thiosulfate	$S_2O_3^{2-}$ Sulfate with one O replaced by S.
Chromate	CrO_4^{2-} Yellow in solution; same shape of formula as sulfate.
Dichromate	$Cr_2O_7^{2-}$ Orange; two Cr atoms but still a 2− charge.
Oxalate	$C_2O_4^{2-}$ Two carbons; comes from oxalic acid, $H_2C_2O_4$.
Peroxide	O_2^{2-} Two bonded O atoms: hydrogen peroxide is H_2O_2.
Hydrogen phosphate	HPO_4^{2-} Phosphate plus one H^+: charge 2−.
Phosphate	PO_4^{3-} The main 3− ion; phosphite has one O fewer.
Phosphite	PO_3^{3-} Formula used in course lists; in solution, the real phosphite ion is HPO_3^{2-}.

2. How to Remember the Solubility Rules

28 cards

Rules

Which salts must you know as soluble for the AP Chemistry exam?

All sodium, potassium, ammonium and nitrate salts are soluble in water. The AP exam does not assess other solubility rules by rote.

Many classes still teach the full list below.

Which cations always form soluble salts?

Group 1 ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and ammonium, NH_4^+.

LiOH and $(NH_4)_2SO_4$ are both soluble.

Which anions always form soluble salts?

Nitrate NO_3^-, and also acetate, chlorate and perchlorate.

$Mg(NO_3)_2$ and $Ca(CH_3COO)_2$ are soluble.

Which chlorides, bromides and iodides are not soluble?

Those of Ag^+, Pb^{2+} and Hg_2^{2+}. All other halides (Cl^-, Br^-, I^-) are soluble.

$CaCl_2$ dissolves, PbI_2 does not.

Which sulfates are not soluble?

Those of Ba^{2+}, Pb^{2+} and Ca^{2+}; many lists add Sr^{2+}, Ag^+ and Hg_2^{2+}. Most other sulfates are soluble.

$CuSO_4$ dissolves, $BaSO_4$ does not.

Are carbonates and phosphates soluble?

Mostly insoluble, except with Group 1 ions and NH_4^+.

$CaCO_3$ is insoluble, $(NH_4)_3PO_4$ is soluble.

Are hydroxides soluble?

Mostly insoluble, except Group 1 and NH_4^+ hydroxides, plus $Ba(OH)_2$ and $Sr(OH)_2$. $Ca(OH)_2$ is only slightly soluble.

$Fe(OH)_3$ is insoluble, $Ba(OH)_2$ is soluble.

Are sulfides soluble?

Mostly insoluble, except with Group 1 ions and NH_4^+. Group 2 sulfides are listed as soluble or slightly soluble depending on the source.

CuS is insoluble, Na_2S is soluble.

What if a salt matches two rules that disagree?

The Group 1, ammonium and nitrate rules win: they have no exceptions.

K_3PO_4 is soluble even though phosphates are mostly insoluble.

Exercises

Write your answer on the line. The answers are at the end.

1. Soluble or insoluble in water?
$NaCH_3COO$

2. Soluble or insoluble in water?
$Pb(NO_3)_2$

3. Soluble or insoluble in water?
NH_4Cl

4. Soluble or insoluble in water?
$AgNO_3$

5. Soluble or insoluble in water?
$AgCl$

6. Soluble or insoluble in water?
$FeCl_2$

7. Soluble or insoluble in water?
Hg_2Cl_2

8. Soluble or insoluble in water?
$ZnSO_4$

9. Soluble or insoluble in water?
$PbSO_4$

10. Soluble or insoluble in water?
Na_2CO_3

11. Soluble or insoluble in water?
$MgCO_3$

12. Soluble or insoluble in water?
$Ca_3(PO_4)_2$

13. Soluble or insoluble in water?
$Mg(OH)_2$

14. Soluble or insoluble in water?
KOH

15. Soluble or insoluble in water?
ZnS

16. Which solid forms when $AgNO_3(aq)$ and NaCl(aq) are mixed?

17. Which solid forms when $K_2CO_3(aq)$ and $Ba(NO_3)_2(aq)$ are mixed?

18. Which solid forms when KOH(aq) and $MgCl_2(aq)$ are mixed?

19. Does a precipitate form when $KNO_3(aq)$ and NaCl(aq) are mixed?

3. List of Strong Acids and Bases

26 cards

QUESTION	ANSWER
Which six acids does AP Chemistry list as strong?	HCl, HBr, HI, $HClO_4$, H_2SO_4 and HNO_3. Each ionizes completely in water, so $[H_3O^+]$ equals the starting concentration of the acid.
What makes an acid “strong”?	It ionizes completely in water: essentially no intact acid molecules remain. Strength is about ionization, not concentration: a dilute strong acid is still strong.
What is the name of HCl(aq)?	Hydrochloric acid. A binary acid, like HBr and HI.
What is the name of HBr(aq)?	Hydrobromic acid. Fully ionized in water, like HCl and HI.
What is the name of HI(aq)?	Hydroiodic acid. In water it is fully ionized, like HCl and HBr; it is the strongest of the three only in a less basic solvent such as ethanol.
What is the name of HNO_3?	Nitric acid. Its conjugate base is nitrate, NO_3^-.
What is the name of H_2SO_4?	Sulfuric acid. Only its first ionization is complete; see the card on HSO_4^-.
What is the formula of perchloric acid?	$HClO_4$. The only chlorine oxyacid on the AP list of strong acids.
Which hydrogen halide is a weak acid?	HF, with $K_a = 6.8 \times 10^{-4}$. Acidity increases HF < HCl < HBr < HI, so fluorine is the odd one out.
Is HSO_4^- a strong or a weak acid?	Weak, with $K_a = 1.2 \times 10^{-2}$. That is why H_2SO_4 ionizes completely only in its first step.

QUESTION	ANSWER
Which hydroxides of Group 1 are strong bases?	LiOH, NaOH, KOH, RbOH and CsOH. They dissociate completely into M^+ and OH^-, so $[OH^-]$ equals the starting concentration.
Which hydroxides of Group 2 are usually listed as strong bases?	$Ca(OH)_2$, $Sr(OH)_2$ and $Ba(OH)_2$. Each releases two OH^- per formula unit, so $[OH^-]$ is twice the starting concentration.
What is the pH of 0.010 M HCl?	2.00. HCl is strong, so $[H_3O^+] = 0.010$ M and pH = −log(0.010).
What is the pH of 0.0050 M HNO_3?	2.30. $[H_3O^+] = 0.0050$ M because nitric acid is strong; $-\log(5.0 \times 10^{-3}) \approx 2.30$.
What is the pH of 1.0×10^{-3} M HBr?	3.00. HBr is strong; with a coefficient of 1.0, the exponent gives the pH directly.
What is the pH of 0.0010 M KOH?	11.00. $[OH^-] = 0.0010$ M, so pOH = 3.00 and pH = 14.00 − 3.00.
What is $[OH^-]$ in 0.010 M NaOH?	0.010 M. One OH^- per NaOH, so pOH = 2.00 and pH = 12.00.
What is $[OH^-]$ in 0.010 M $Ba(OH)_2$?	0.020 M. $Ba(OH)_2$ gives two OH^- per formula unit, so pOH ≈ 1.70 and pH ≈ 12.30.
What is the relation between pH and pOH at 25 °C?	pH + pOH = 14.00. It comes from $K_w = [H_3O^+][OH^-] = 1.0 \times 10^{-14}$.
Is acetic acid, CH_3COOH, a strong or a weak acid?	Weak, with $K_a = 1.8 \times 10^{-5}$. Only a small fraction of molecules ionize, so you need an equilibrium (ICE) calculation, not $[H_3O^+] = c$.

QUESTION	ANSWER
How do nitrous acid and nitric acid differ in strength?	HNO_2 is weak (Ka = 4.6×10^{-4}); HNO_3 is strong. One extra oxygen changes the name ending, from -ous to -ic, and the strength.
Is ammonia, NH_3, a strong or a weak base?	Weak, with Kb = 1.8×10^{-5}. It has no OH^- in its formula: it makes OH^- by taking H^+ from water, and only slightly.
How strong a base is Cl^-, the conjugate base of HCl?	Negligibly weak: it does not change the pH. The stronger the acid, the weaker its conjugate base.
What relates Ka and Kb of a conjugate acid-base pair?	Ka × Kb = Kw. In logs: pKa + pKb = pKw = 14.00 at 25 °C.
Does a 5.0 M solution of acetic acid count as a strong acid?	No, it is still a weak acid. A high concentration does not make it ionize completely; strong and weak describe ionization, not concentration.
How do you find $[H_3O^+]$ for a strong acid versus a weak acid?	Strong: $[H_3O^+]$ = initial concentration. Weak: solve with Ka. This split decides which pH method to use on an exam problem.

Answer key

How to Remember the Solubility Rules

1. Soluble.

It has a sodium cation and an acetate anion, and either one is enough.

2. Soluble.

Nitrates have no exceptions, even with Pb^{2+}.

3. Soluble.

Ammonium salts are soluble whatever the anion.

4. Soluble.

It is a nitrate, so the Ag^{+} cation does not matter here.

5. Insoluble.

Chloride is an exception with Ag^{+}: AgCl is a white precipitate.

6. Soluble.

Chlorides are soluble, and Fe^{2+} is not among the halide exceptions.

7. Insoluble.

Hg_2^{2+} is the third halide exception, after Ag^{+} and Pb^{2+}.

8. Soluble.

Zn^{2+} is not one of the sulfate exceptions (Ba^{2+}, Pb^{2+}, Ca^{2+} and, on longer lists, Sr^{2+}, Ag^{+}, Hg_2^{2+}).

9. Insoluble.

Pb^{2+} makes both its halides and its sulfate insoluble.

10. Soluble.

The sodium rule overrides the mostly insoluble carbonates.

11. Insoluble.

Carbonate with a Group 2 cation is not covered by the soluble exceptions.

12. Insoluble.

Phosphates dissolve only with Group 1 ions or NH_4^{+}, and Ca^{2+} is neither.

13. Insoluble.

Only $Ba(OH)_2$ and $Sr(OH)_2$ are soluble among the Group 2 hydroxides, besides slightly soluble $Ca(OH)_2$.

14. Soluble.

Hydroxides of Group 1 are soluble: this is why KOH is a common strong base solution.

15. Insoluble.

Sulfides dissolve only with Group 1 ions or NH_4^+ (and Group 2, depending on the list).

16. AgCl(s).

The two possible products are AgCl and $NaNO_3$; the sodium nitrate stays dissolved and the silver chloride precipitates.

17. $BaCO_3$(s).

KNO_3 is soluble, but carbonates dissolve only with Group 1 ions or NH_4^+, so barium carbonate precipitates.

18. $Mg(OH)_2$(s).

KCl is soluble, and magnesium hydroxide is not.

19. No.

The possible products, KCl and $NaNO_3$, are both soluble, so every ion stays in solution.