

Solubility Rules & Net Ionic Equations

Solubility rules

Usually soluble (aq)	Exceptions (form a precipitate)
Group 1 (Li^+ , Na^+ , K^+) and NH_4^+ compounds	none
Nitrates (NO_3^-) and acetates	none
Chlorides, bromides, iodides (Cl^- , Br^- , I^-)	Ag^+ , Pb^{2+} , Hg_2^{2+}
Sulfates (SO_4^{2-})	Ba^{2+} , Pb^{2+} , Ca^{2+} , Sr^{2+}
Usually insoluble (s)	Exceptions (soluble)
Carbonates, phosphates, sulfides (CO_3^{2-} , PO_4^{3-} , S^{2-})	Group 1 and NH_4^+
Hydroxides (OH^-)	Group 1, NH_4^+ , Ba^{2+}

Net ionic steps: (1) balanced molecular equation with states → (2) split every (aq) ionic compound into ions → (3) cancel ions that appear unchanged on both sides (spectators) → (4) check atoms and charge.

A Soluble or insoluble?

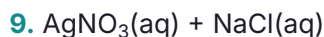
8 marks

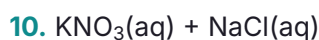
- | | | | |
|----------------------|-------|--|-------|
| 1. NaCl | _____ | 2. AgCl | _____ |
| 3. KNO ₃ | _____ | 4. BaSO ₄ | _____ |
| 5. CaCO ₃ | _____ | 6. (NH ₄) ₃ PO ₄ | _____ |
| 7. PbI ₂ | _____ | 8. Mg(OH) ₂ | _____ |

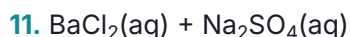
B Will a precipitate form?

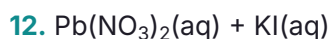
4 marks

If yes, name the precipitate. If no, explain.









C Molecular, total ionic and net ionic equations

9 marks

Include state symbols: (s), (l), (g), (aq). 3 marks each.

13. Aqueous silver nitrate and sodium chloride are mixed. Write the (a) balanced molecular, (b) total ionic and (c) net ionic equations.

(a)

(b)

(c)

14. Aqueous barium chloride and sodium sulfate are mixed. Write the (a) balanced molecular, (b) total ionic and (c) net ionic equations.

(a)

(b)

(c)

15. Aqueous lead(II) nitrate and potassium iodide are mixed. Write the (a) balanced molecular, (b) total ionic and (c) net ionic equations.

(a)

(b)

(c)

D Spectator ions

2 marks

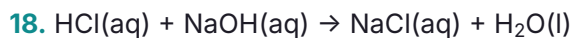
16. In question 14, which ions are spectator ions?

17. $\text{CaCl}_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{CaCO}_3(\text{s}) + 2\text{NaCl}(\text{aq})$

Write the net ionic equation and name the spectator ions.

E Neutralization

2 marks



Write the net ionic equation.



Write the net ionic equation. Why is it the same as question 18?

F Spot the mistake

2 marks

20. For $\text{AgNO}_3 + \text{NaCl}$, a student's "net ionic equation" is $\text{Ag}^+\text{(aq)} + \text{NO}_3^-\text{(aq)} + \text{Na}^+\text{(aq)} + \text{Cl}^-\text{(aq)} \rightarrow \text{AgCl(s)} + \text{Na}^+\text{(aq)} + \text{NO}_3^-\text{(aq)}$. Explain the error and correct it.

21. A student writes the precipitate AgCl(s) as $\text{Ag}^+\text{(aq)} + \text{Cl}^-\text{(aq)}$ on the product side. Explain the error and correct it.

G Challenge

2 marks

22. An unknown solution forms a white precipitate with $\text{Na}_2\text{SO}_4\text{(aq)}$ but not with NaCl(aq) . Which cation is most likely present: Ag^+ , Pb^{2+} or Ba^{2+} ? Explain.

23. A solution contains both Ag^+ and Ba^{2+} . Describe how to separate them using precipitation.

Solubility Rules & Net Ionic Equations

Name: _____

Date: _____ Score: ____ / 29

ANSWER KEY

Solubility rules

Usually soluble (aq)	Exceptions (form a precipitate)
Group 1 (Li^+ , Na^+ , K^+) and NH_4^+ compounds	none
Nitrates (NO_3^-) and acetates	none
Chlorides, bromides, iodides (Cl^- , Br^- , I^-)	Ag^+ , Pb^{2+} , Hg_2^{2+}
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Usually insoluble (s)	Exceptions (soluble)
Carbonates, phosphates, sulfides (CO_3^{2-} , PO_4^{3-} , S^{2-})	Group 1 and NH_4^+
Hydroxides (OH^-)	Group 1, NH_4^+ , Ba^{2+}

Net ionic steps: (1) balanced molecular equation with states → (2) split every (aq) ionic compound into ions → (3) cancel ions that appear unchanged on both sides (spectators) → (4) check atoms and charge.

A Soluble or insoluble?

8 marks

- | | | | |
|--------------------|-----------|---------------------------------|-----------|
| 1. NaCl | Soluble | 2. AgCl | Insoluble |
| 3. KNO_3 | Soluble | 4. BaSO_4 | Insoluble |
| 5. CaCO_3 | Insoluble | 6. $(\text{NH}_4)_3\text{PO}_4$ | Soluble |
| 7. PbI_2 | Insoluble | 8. $\text{Mg}(\text{OH})_2$ | Insoluble |

B Will a precipitate form?

4 marks

If yes, name the precipitate. If no, explain.

- $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq})$
Yes: $\text{AgCl}(\text{s})$
- $\text{KNO}_3(\text{aq}) + \text{NaCl}(\text{aq})$
No: every possible product (KCl , NaNO_3) is soluble
- $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq})$
Yes: $\text{BaSO}_4(\text{s})$
- $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{KI}(\text{aq})$
Yes: $\text{PbI}_2(\text{s})$

C Molecular, total ionic and net ionic equations

9 marks

Include state symbols: (s), (l), (g), (aq). 3 marks each.

13. Aqueous silver nitrate and sodium chloride are mixed. Write the (a) balanced molecular, (b) total ionic and (c) net ionic equations.



14. Aqueous barium chloride and sodium sulfate are mixed. Write the (a) balanced molecular, (b) total ionic and (c) net ionic equations.



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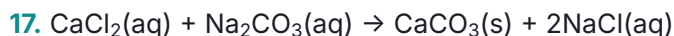


D Spectator ions

2 marks

16. In question 14, which ions are spectator ions?

Na^+ and Cl^-



Write the net ionic equation and name the spectator ions.

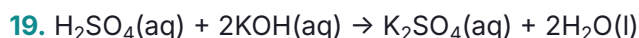
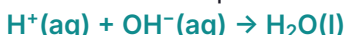


E Neutralization

2 marks



Write the net ionic equation.



Write the net ionic equation. Why is it the same as question 18?

$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$ (after dividing by 2). Every strong acid–strong base neutralization reduces to $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$; the other ions are spectators.

F Spot the mistake

2 marks

20. For $\text{AgNO}_3 + \text{NaCl}$, a student's "net ionic equation" is $\text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$. Explain the error and correct it.

That is the total ionic equation. Cancel the spectator ions (Na^+ , NO_3^-): $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$

21. A student writes the precipitate $\text{AgCl}(\text{s})$ as $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq})$ on the product side. Explain the error and correct it.

Solids, liquids and gases are never split into ions. Only soluble (aq) ionic compounds are written as ions.

G Challenge

2 marks

22. An unknown solution forms a white precipitate with $\text{Na}_2\text{SO}_4(\text{aq})$ but not with $\text{NaCl}(\text{aq})$. Which cation is most likely present: Ag^+ , Pb^{2+} or Ba^{2+} ? Explain.

Ba^{2+} : BaSO_4 is insoluble but BaCl_2 is soluble. Ag^+ and Pb^{2+} would also have precipitated with Cl^- .

23. A solution contains both Ag^+ and Ba^{2+} . Describe how to separate them using precipitation.

Add Cl^- first: only $\text{AgCl}(\text{s})$ forms, so filter it off. Then add SO_4^{2-} to the filtrate to precipitate $\text{BaSO}_4(\text{s})$.