

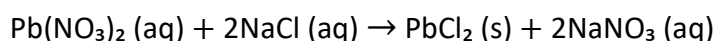
Ionic Equations

Mark Scheme



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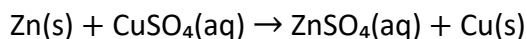
1. Many reactions in solution involve ions that do not change; an ionic equation is written to show only the particles that are actually involved in the reaction.
- a) A precipitation reaction occurs when aqueous solutions of lead(II) nitrate and sodium chloride are mixed.



Which ions are the spectator ions in this reaction?

B – is the only correct answer.	1 mark
	Total: 1 mark

- b) A student adds a piece of zinc metal to copper(II) sulfate solution. The equation for the reaction is:



What is the correct ionic equation for this reaction?

C – is the only correct answer.	1 mark
	Total: 1 mark

- c) Which equation correctly represents the neutralisation of a dilute strong acid by a strong alkali?

B – is the only correct answer.	1 mark
	Total: 1 mark

- d) The reaction between solid calcium carbonate and hydrochloric acid produces calcium chloride solution, water and carbon dioxide gas.



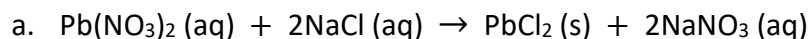
Which is the correct ionic equation for this reaction?

A – is the only correct answer.	1 mark
	Total: 1 mark

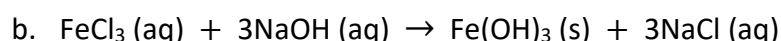
(Total for Question 1 is 4 marks)

For each of the equations below, rewrite the equation to show the separate aqueous ions (where appropriate) and then deduce the ionic equation.

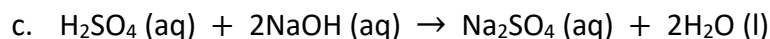
2. Write ionic equations for the following precipitation reactions:



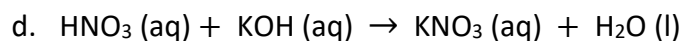
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow \text{PbCl}_2(\text{s}) + 2\text{Na}^{+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq})$	1 mark
$\text{Pb}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow \text{PbCl}_2(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{Fe}^{3+}(\text{aq}) + 3\text{Cl}^{-}(\text{aq}) + 3\text{Na}^{+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + 3\text{Na}^{+}(\text{aq}) + 3\text{Cl}^{-}(\text{aq})$	1 mark
$\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



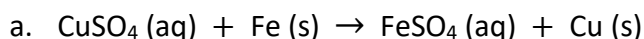
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$2\text{H}^{+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^{+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow 2\text{Na}^{+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$	1 mark
$2\text{H}^{+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l})$ or $\text{H}^{+}(\text{aq}) + \text{OH}^{-}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



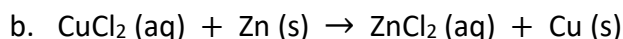
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{H}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq}) + \text{K}^{+}(\text{aq}) + \text{OH}^{-}(\text{aq}) \rightarrow \text{K}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	1 mark
$\text{H}^{+}(\text{aq}) + \text{OH}^{-}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks

(Total for Question 2 is 8 marks)

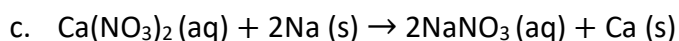
3. Write ionic equations for the following displacement reactions:



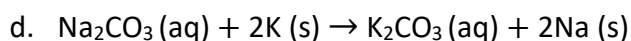
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{Cu}^{2+}(\text{aq}) + \cancel{\text{SO}_4^{2-}(\text{aq})} + \text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \cancel{\text{SO}_4^{2-}(\text{aq})} + \text{Cu}(\text{s})$	1 mark
$\text{Cu}^{2+}(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{Cu}(\text{s})$	1 mark
	Total: 2 marks



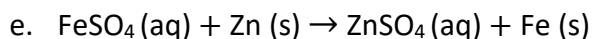
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{Cu}^{2+}(\text{aq}) + \cancel{2\text{Cl}^{-}(\text{aq})} + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \cancel{2\text{Cl}^{-}(\text{aq})} + \text{Cu}(\text{s})$	1 mark
$\text{Cu}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{Ca}^{2+}(\text{aq}) + \cancel{2\text{NO}_3^{-}(\text{aq})} + 2\text{Na}(\text{s}) \rightarrow 2\text{Na}^{+}(\text{aq}) + \cancel{2\text{NO}_3^{-}(\text{aq})} + \text{Ca}(\text{s})$	1 mark
$\text{Ca}^{2+}(\text{aq}) + 2\text{Na}(\text{s}) \rightarrow 2\text{Na}^{+}(\text{aq}) + \text{Ca}(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



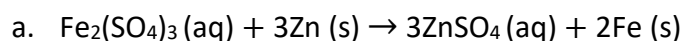
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$2\text{Na}^{+}(\text{aq}) + \cancel{\text{CO}_3^{2-}(\text{aq})} + 2\text{K}(\text{s}) \rightarrow 2\text{K}^{+}(\text{aq}) + \cancel{\text{CO}_3^{2-}(\text{aq})} + 2\text{Na}(\text{s})$	1 mark
$2\text{Na}^{+}(\text{aq}) + 2\text{K}(\text{s}) \rightarrow 2\text{K}^{+}(\text{aq}) + 2\text{Na}(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



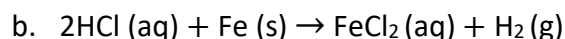
Ionic equation showing the <u>aqueous</u> ions written out separately.	
$\text{Fe}^{2+}(\text{aq}) + \cancel{\text{SO}_4^{2-}(\text{aq})} + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \cancel{\text{SO}_4^{2-}(\text{aq})} + \text{Fe}(\text{s})$	1 mark
$\text{Fe}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Fe}(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks

(Total for Question 3 is 10 marks)

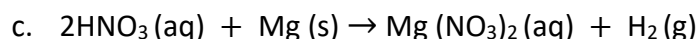
4. Write ionic equations for the following equations:



Ionic equation showing the <u>aqueous</u> ions written out separately.	
$2\text{Fe}^{3+}(\text{aq}) + 3\cancel{\text{SO}_4^{2-}}(\text{aq}) + 3\text{Zn}(\text{s}) \rightarrow 3\text{Zn}^{2+}(\text{aq}) + 3\cancel{\text{SO}_4^{2-}}(\text{aq}) + 2\text{Fe}(\text{s})$	1 mark
$2\text{Fe}^{3+}(\text{aq}) + 3\text{Zn}(\text{s}) \rightarrow 3\text{Zn}^{2+}(\text{aq}) + 2\text{Fe}(\text{s})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks

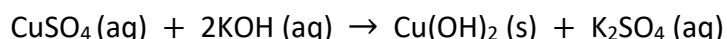


Ionic equation showing the <u>aqueous</u> ions written out separately.	
$2\text{H}^+(\text{aq}) + 2\cancel{\text{Cl}^-}(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + 2\cancel{\text{Cl}^-}(\text{aq}) + \text{H}_2(\text{g})$	1 mark
$2\text{H}^+(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{H}_2(\text{g})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks



Ionic equation showing the <u>aqueous</u> ions written out separately.	
$2\text{H}^+(\text{aq}) + 2\cancel{\text{NO}_3^-}(\text{aq}) + \text{Mg}(\text{s}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2\cancel{\text{NO}_3^-}(\text{aq}) + \text{H}_2(\text{g})$	1 mark
$2\text{H}^+(\text{aq}) + \text{Mg}(\text{s}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{H}_2(\text{g})$	1 mark
Correct ionic equation scores full marks with or without working.	
	Total: 2 marks

d. In the following reaction:



The mass of the precipitate was found to be 19.5g, deduce the mass of potassium sulphate left dissolved in solution. Explain your answer.

Reactants: $31.9\text{g} + 22.4\text{g} = 54.3\text{g}$	
Then subtract the mass of the precipitate: $54.3\text{g} - 19.5\text{g} = 34.8\text{g}$	1 mark
Correct answer with or without working scores 1 mark.	
Award 1 mark for a correct explanation:	
The law of conservation of mass states that the total mass of the reactants is equal to the total mass of the products.	1 mark
Accept equivalent phrasing: for example Mass is conserved in a reaction. Mass cannot be created or destroyed.	
	Total: 1 mark

(Total for Question 4 is 8 marks)

5. Write full **balanced** symbol equations with state symbols for the reactions below.
Then convert these into ionic equations as before.

a. Zinc (s) + copper (II) sulphate (aq) → zinc sulphate (aq) + copper (s)

$\text{Zn (s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu (s)}$	
$\text{Zn (s)} + \text{Cu}^{2+}\text{(aq)} + \text{SO}_4^{2-}\text{(aq)} \rightarrow \text{Zn}^{2+}\text{(aq)} + \text{SO}_4^{2-}\text{(aq)} + \text{Cu (s)}$	
$\text{Zn (s)} + \text{Cu}^{2+}\text{(aq)} + \cancel{\text{SO}_4^{2-}\text{(aq)}} \rightarrow \text{Zn}^{2+}\text{(aq)} + \cancel{\text{SO}_4^{2-}\text{(aq)}} + \text{Cu (s)}$	1 mark
$\text{Zn (s)} + \text{Cu}^{2+}\text{(aq)} \rightarrow \text{Zn}^{2+}\text{(aq)} + \text{Cu (s)}$	1 mark
	Total: 2 marks

b. Calcium nitrate (aq) + potassium (s) → potassium nitrate (aq) + calcium (s)

$\text{Ca(NO}_3)_2\text{(aq)} + 2\text{K (s)} \rightarrow 2\text{KNO}_3\text{(aq)} + \text{Ca (s)}$	
$\text{Ca}^{2+}\text{(aq)} + 2\text{NO}_3^-\text{(aq)} + 2\text{K (s)} \rightarrow 2\text{K}^+\text{(aq)} + 2\text{NO}_3^-\text{(aq)} + \text{Ca (s)}$	
$\text{Ca}^{2+}\text{(aq)} + \cancel{2\text{NO}_3^-\text{(aq)}} + 2\text{K (s)} \rightarrow 2\text{K}^+\text{(aq)} + \cancel{2\text{NO}_3^-\text{(aq)}} + \text{Ca (s)}$	1 mark
$\text{Ca}^{2+}\text{(aq)} + 2\text{K (s)} \rightarrow 2\text{K}^+\text{(aq)} + \text{Ca (s)}$	1 mark
	Total: 2 marks

c. lithium sulphate (aq) + sodium (s) →

$\text{Li}_2\text{SO}_4\text{(aq)} + 2\text{Na (s)} \rightarrow \text{Na}_2\text{SO}_4\text{(aq)} + 2\text{Li (s)}$	
$2\text{Li}^+\text{(aq)} + \text{SO}_4^{2-}\text{(aq)} + 2\text{Na (s)} \rightarrow 2\text{Na}^+\text{(aq)} + \text{SO}_4^{2-}\text{(aq)} + 2\text{Li (s)}$	
$2\text{Li}^+\text{(aq)} + \cancel{\text{SO}_4^{2-}\text{(aq)}} + 2\text{Na (s)} \rightarrow 2\text{Na}^+\text{(aq)} + \cancel{\text{SO}_4^{2-}\text{(aq)}} + 2\text{Li (s)}$	1 mark
$2\text{Li}^+\text{(aq)} + 2\text{Na (s)} \rightarrow 2\text{Na}^+\text{(aq)} + 2\text{Li (s)}$	1 mark
	Total: 2 marks

d. magnesium + hydrochloric acid →

$\text{Mg (s)} + 2\text{HCl (aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$	
$\text{Mg (s)} + 2\text{H}^+\text{(aq)} + \cancel{2\text{Cl}^-\text{(aq)}} \rightarrow \text{Mg}^{2+}\text{(aq)} + \cancel{2\text{Cl}^-\text{(aq)}} + \text{H}_2\text{(g)}$	1 mark
$\text{Mg (s)} + 2\text{H}^+\text{(aq)} \rightarrow \text{Mg}^{2+}\text{(aq)} + \text{H}_2\text{(g)}$	1 mark
	Total: 2 marks

e. iron + sulphuric acid →

$\text{Fe (s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{FeSO}_4\text{(aq)} + \text{H}_2\text{(g)}$	
$\text{Fe (s)} + 2\text{H}^+\text{(aq)} + \cancel{\text{SO}_4^{2-}\text{(aq)}} \rightarrow \text{Fe}^{2+}\text{(aq)} + \cancel{\text{SO}_4^{2-}\text{(aq)}} + \text{H}_2\text{(g)}$	1 mark
$\text{Fe (s)} + 2\text{H}^+\text{(aq)} \rightarrow \text{Fe}^{2+}\text{(aq)} + \text{H}_2\text{(g)}$	1 mark
	Total: 2 marks

f. potassium carbonate solution + nitric acid →

$K_2CO_3(aq) + 2HNO_3(aq) \rightarrow 2KNO_3(aq) + H_2O(l) + CO_2(g)$	
$2K^+(aq) + CO_3^{2-}(aq) + 2H^+(aq) + 2NO_3^-(aq) \rightarrow 2K^+(aq) + 2NO_3^-(aq) + CO_2(g) + H_2O$	
~~$2K^+(aq) + CO_3^{2-}(aq) + 2H^+(aq) + 2NO_3^-(aq) \rightarrow 2K^+(aq) + 2NO_3^-(aq) + CO_2(g) + H_2O$~~	1 mark
$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$	1 mark
	Total: 2 marks

g. For each of the following, classify the reaction as **precipitation**, **neutralisation** or **displacement**:

i. calcium hydroxide solution + ethanoic acid → calcium ethanoate + water

Neutralisation	1 mark
	Total: 1 mark

ii. magnesium + iron sulphate solution → magnesium sulphate solution + iron

Displacement	1 mark
	Total: 1 mark

iii. barium chloride solution + sodium sulphate solution → barium sulphate solid + sodium chloride solution

Precipitation	1 mark
	Total: 1 mark

(Total for Question 5 is 15 marks)