## AP<sup>®</sup> CHEMISTRY 2012 SCORING GUIDELINES

## Question 4 (15 points)

(a) A piece of solid strontium carbonate is dropped into a 0.1 M solution of hydrochloric acid.

(i) Balanced equation:	1 point is earned for the correct reactants.
$2 \operatorname{H}^{+} + \operatorname{SrCO}_{3} \rightarrow \operatorname{Sr}^{2+} + \operatorname{CO}_{2} + \operatorname{H}_{2}\operatorname{O}$	2 points are earned for the correct products.
OR, H <sup>+</sup> + SrCO <sub>3</sub> $\rightarrow$ Sr <sup>2+</sup> + HCO <sub>3</sub> <sup>-</sup>	1 point is earned for correctly balancing the equation for mass and charge.

(ii) Indicate one thing that would be observed as the reaction occurs.

The solid dissolves OR a gas is given off.	1 point is earned for either observation.
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(b) Magnesium metal is strongly heated in oxygen gas.

(i) Balanced equation:	2 points are earned for the correct reactants.			
$2 \text{ Mg} + \text{O}_2 \rightarrow 2 \text{ MgO}$	<ol> <li>point is earned for the correct product.</li> <li>point is earned for correctly balancing the equation for mass and charge.</li> </ol>			

(ii) What is the oxidation number of magnesium before the reaction occurs, and what is the oxidation number of magnesium after the reaction is complete?

Oxidation number before = 0. Oxidation number after = $+2$ .	1 point is earned for two correct responses.

## AP<sup>®</sup> CHEMISTRY 2012 SCORING GUIDELINES

## **Question 4 (continued)**

(c) A solution of nickel(II) chloride is added to a solution of sodium hydroxide, forming a precipitate.

(i) Balanced equation:	2 points are earned for the correct reactants.			
$Ni^{2+} + 2 OH^{-} \rightarrow Ni(OH)_{2}$	1 point is earned for the correct product.			
	1 point is earned for correctly balancing the equation for mass and charge.			

(ii) If equal volumes of 1.0 M nickel (II) chloride and 1.0 M sodium hydroxide are used, what ion is present in the solution in the highest concentration after the precipitate forms?

The chloride ion	1 point is earned for the correct ion.
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## CHEMISTRY

Part B

Time—40 minutes NO CALCULATORS MAY BE USED FOR PART B.

Answer Question 4 below. The Section II score weighting for this question is 10 percent.

4. For each of the following three reactions, write a balanced equation for the reaction in part (i) and answer the question about the reaction in part (ii). In part (i), coefficients should be in terms of lowest whole numbers. Assume that solutions are aqueous unless otherwise indicated. Represent substances in solutions as ions if the substances are extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction. You may use the empty space at the bottom of the next page for scratch work, but only equations that are written in the answer boxes provided will be scored.

EXAMPLE: A strip of magnesium metal is added to a solution of silver(I) nitrate. (i) Balanced equation:  $Mg + 2Ag^{+} \longrightarrow Mg^{2+} + 2Ag^{-}$ (ii) Which substance is oxidized in the reaction? is opidized. Ma Sr -> H120 + CO2 + Sr

(a) A piece of solid strontium carbonate is dropped into a 0.1 M solution of hydrochloric acid.

(i) Balanced equation: -> H20 + CO2 + Sr2+ Jr(Oa +7

(ii) Indicate one thing that would be observed as the reaction occurs.

bubbles

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# BBBBBBBBBBBBBBBBB

(b) Magnesium metal is strongly heated in oxygen gas.

(i) Balanced equation: > 2 m(ii) What is the oxidation number of magnesium before the reaction occurs, and what is the oxidation number of magnesium after the reaction is complete? >+2()Ni 2+ (c) A solution of nickel(II) chloride is added to a solution of sodium hydroxide, forming a precipitate. (i) Balanced equation: 27 +20H (ii) If equal volumes of 1.0 M nickel(II) chloride and 1.0 M sodium hydroxide are used, what ion is present in the solution in the highest concentration after the precipitate forms? YOU MAY USE THE SPACE BELOW FOR SCRATCH WORK, BUT ONLY EQUATIONS THAT ARE WRITTEN IN THE ANSWER BOXES PROVIDED WILL BE SCORED.

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### CHEMISTRY

Part B

## Time—40 minutes NO CALCULATORS MAY BE USED FOR PART B.

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EXAMPLE: A strip of magnesium metal is added to a solution of silver(I) nitrate. (i) Balanced equation: Mg + 2 Agt -> Mg2+ + 2 Ag (ii) Which substance is oxidized in the reaction? is opidized

(a) A piece of solid strontium carbonate is dropped into a 0.1 M solution of hydrochloric acid.

(i) Balanced equation: >SF# + Ha (03

(ii) Indicate one thing that would be observed as the reaction occurs. The DH of the Solution would decrease.

Sr CO3 + 2HCI -> Sr Cl2 + H2 CO3 Sr CO3 + 2H<sup>f</sup> + 2CI -> Sr Cl2 + H2 CO3

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## BBBBBBBBBBBBBBBB

(b) Magnesium metal is strongly heated in oxygen gas.

(i) Balanced equation: -> MgO  $0_2$ 

(ii) What is the oxidation number of magnesium before the reaction occurs, and what is the oxidation number of magnesium after the reaction is complete?

oxidation number of magnesium would anc +2 reaction Zen the rpa

(c) A solution of nickel(II) chloride is added to a solution of sodium hydroxide, forming a precipitate.

(i) Balanced equation:  $f^2 + 20 H^- \longrightarrow Ni(OH)_2$ 

(ii) If equal volumes of 1.0 *M* nickel(II) chloride and 1.0 *M* sodium hydroxide are used, what ion is present in the solution in the highest concentration after the precipitate forms?

ions would Tho be present in acter une

## YOU MAY USE THE SPACE BELOW FOR SCRATCH WORK, BUT ONLY EQUATIONS THAT ARE WRITTEN IN THE ANSWER BOXES PROVIDED WILL BE SCORED.

NICL, +2NaOH - NIOH, +2NaCI Ni+2+2015 +2Not +20H- > Ni(0H)2+2Not+201-Ni+2+20H->Ni(0H) 1.0M 1.0M

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### CHEMISTRY

Part B

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Ī	EXAMPLE:
	A strip of magnesium metal is added to a solution of silver(I) nitrate.
	(i) Balanced equation: $Ma^{2+} + 2Aa^{+} \longrightarrow Ma^{2+} + 2Aa$
	My T ZNY T T T
	(ii) Which substance is oxidized in the reaction?
	- Nig populizio
1	

(a) A piece of solid strontium carbonate is dropped into a 0.1 M solution of hydrochloric acid.

(i) Balanced equ	lation:		
Sc 2+	+201-	->	Srcla

(ii) Indicate one thing that would be observed as the reaction occurs.

The	Pieca	of	solid s	stronkin	in cul	banate we	6st
bubble	in	the	liqui d	and	there	cours d	
possibly	br.	cla-	chunge	in col	01.		

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## BBBBBBBBBBBBBBBB

(b) Magnesium metal is strongly heated in oxygen gas.

(i) Balanced equation:

$$M_{g} + O_{2} \rightarrow ZO^{2-} + M_{g}^{2+}$$

(ii) What is the oxidation number of magnesium before the reaction occurs, and what is the oxidation number of magnesium after the reaction is complete?

The	cridate	on num	011	of Mg	befor	the	reaction	:50	
and	2+	ofter	14	occurs	5.				

(c) A solution of nickel(II) chloride is added to a solution of sodium hydroxide, forming a precipitate.

(i) Balanced equation: -> N:(OH)2 N1:2+ + 2'0+1"

(ii) If equal volumes of 1.0 *M* nickel(II) chloride and 1.0 *M* sodium hydroxide are used, what ion is present in the solution in the highest concentration after the precipitate forms?

Na	ion	:5	the	highest	CON	centruk	ion	after	
 the	precip	sitada	Forms	because	5 2.	it is	er	spectuto.	
-ion	and	2005	hol tal	ke place	10	the	1 Real,	tion.	

## YOU MAY USE THE SPACE BELOW FOR SCRATCH WORK, BUT ONLY EQUATIONS THAT ARE WRITTEN IN THE ANSWER BOXES PROVIDED WILL BE SCORED.

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## AP<sup>®</sup> CHEMISTRY 2012 SCORING COMMENTARY

## **Question 4**

## Overview

This question assessed students' ability to communicate their knowledge of chemical processes. Important skills tested included writing chemical formulas for substances and balancing equations. Additional aspects of the question evaluated general understanding of chemical concepts presented to students in both the classroom and the laboratory.

## Sample: 4A Score: 15

The response earned all 15 available points.

## Sample: 4B Score: 12

In part (a)(i) the response did not earn 1 of the product points because it includes a carbonic acid molecule instead of its decomposition products of  $CO_2$  and  $H_2O$ . In part (a)(ii) the point was not earned because the pH change is interpreted as a measurement and not an appropriate observation. The response did not earn the balancing point in part (b)(i).

## Sample: 4C Score: 9

The response did not earn any reactant or product points in part (a)(i) but did earn 1 point for writing a mass and charge balanced equation that is connected to the given information. In part (a)(ii) the point was earned for providing an appropriate observation, namely, that the solid strontium carbonate will bubble. In part (b)(i) the product point was not earned as a consequence of dissociating the MgO into ions. The response did not earn the balancing point in part (b)(i) because the equation is not balanced for charge. The response did not earn the point in part (c)(ii) because it identifies Na<sup>+</sup> as the ion with the highest concentration after the precipitate forms.