

2007 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS

CHEMISTRY

Part B

Time—40 minutes

NO CALCULATORS MAY BE USED FOR PART B.

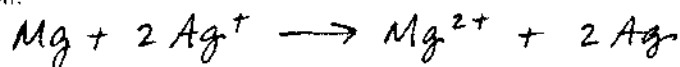
Answer Question 4 below. The Section II score weighting for this question is 10 percent.

4. For each of the following three reactions, in part (i) write a balanced equation for the reaction and in part (ii) answer the question about the reaction. 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 graded.

EXAMPLE:

A strip of magnesium metal is added to a solution of silver(I) nitrate.

(i) Balanced equation:



(ii) Which substance is oxidized in the reaction?

Mg is oxidized.

- (a) A solution of sodium hydroxide is added to a solution of lead(II) nitrate.

(i) Balanced equation:

- (ii) If 1.0 L volumes of 1.0 M solutions of sodium hydroxide and lead(II) nitrate are mixed together, how many moles of product(s) will be produced? Assume the reaction goes to completion.

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(b) Excess nitric acid is added to solid calcium carbonate.

(i) Balanced equation:

(ii) Briefly explain why statues made of marble (calcium carbonate) displayed outdoors in urban areas are deteriorating.

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(c) A solution containing silver(I) ion (an oxidizing agent) is mixed with a solution containing iron(II) ion (a reducing agent).

(i) Balanced equation:

(ii) If the contents of the reaction mixture described above are filtered, what substance(s), if any, would remain on the filter paper?

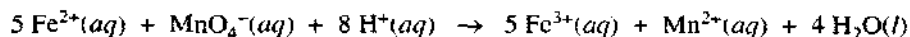
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Answer Question 5 and Question 6. The Section II score weighting for these questions is 15 percent each.

Your responses to these questions will be graded on the basis of the accuracy and relevance of the information cited. Explanations should be clear and well organized. Examples and equations may be included in your responses where appropriate. Specific answers are preferable to broad, diffuse responses.



5. The mass percent of iron in a soluble iron(II) compound is measured using a titration based on the balanced equation above.

- (a) What is the oxidation number of manganese in the permanganate ion,  $\text{MnO}_4^{-}(aq)$  ?
- (b) Identify the reducing agent in the reaction represented above.

The mass of a sample of the iron(II) compound is carefully measured before the sample is dissolved in distilled water. The resulting solution is acidified with  $\text{H}_2\text{SO}_4(aq)$ . The solution is then titrated with  $\text{MnO}_4^{-}(aq)$  until the end point is reached.

- (c) Describe the color change that occurs in the flask when the end point of the titration has been reached. Explain why the color of the solution changes at the end point.
- (d) Let the variables  $g$ ,  $M$ , and  $V$  be defined as follows:

$g$  = the mass, in grams, of the sample of the iron(II) compound

$M$  = the molarity of the  $\text{MnO}_4^{-}(aq)$  used as the titrant

$V$  = the volume, in liters, of  $\text{MnO}_4^{-}(aq)$  added to reach the end point

In terms of these variables, the number of moles of  $\text{MnO}_4^{-}(aq)$  added to reach the end point of the titration is expressed as  $M \times V$ . Using the variables defined above, the molar mass of iron ( $55.85 \text{ g mol}^{-1}$ ), and the coefficients in the balanced chemical equation, write the expression for each of the following quantities.

- (i) The number of moles of iron in the sample
- (ii) The mass of iron in the sample, in grams
- (iii) The mass percent of iron in the compound
- (e) What effect will adding too much titrant have on the experimentally determined value of the mass percent of iron in the compound? Justify your answer.