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1. Which of the following actions would lead to a reaction that could be classified as a precipitation?
- I. $\text{AgNO}_{3(\text{aq})}$ is added to $\text{NaBr}_{(\text{aq})}$
 - II. $\text{Pb}(\text{NO}_3)_{2(\text{aq})}$ is added to $\text{NaI}_{(\text{aq})}$
 - III. $\text{Zn}_{(\text{s})}$ is added to $\text{HCl}_{(\text{aq})}$
- (A) I only
(B) II only
(C) I and II only
(D) II and III only
(E) I, II, and III
2. Which of the following statements about the reaction between a solution of nitric acid and zinc metal is true?
- I. A gas is produced.
 - II. A precipitate is produced.
 - III. In the net ionic equation, one of the products would be $\text{Zn}^{2+}_{(\text{aq})}$.
- (A) I only
(B) II only
(C) I and II only
(D) I and III only
(E) I, II, and III
3. Which of the following is ALWAYS true of a balanced, net ionic, redox reaction?
- I. The species that loses electrons is the reducing agent.
 - II. There is always a loss of electrons by one species, but not always a gain of electrons by another.
 - III. The atoms and charges must balance.
 - IV. Species that lose electrons are oxidized.
- (A) I only
(B) I and II only
(C) I, III, and IV only
(D) II, III, and IV only
(E) I, II, III, and IV

4. In acid solution, the MnO_4^- (aq) ion can act as an oxidizing agent. Which choice describes the change that the permanganate ion undergoes?
- (A) It gains electrons and Mn^{2+} (aq) is a product
 - (B) It gains electrons and $\text{Mn}_{(s)}$ is a product
 - (C) It loses electrons and Mn^{8+} (aq) is a product
 - (D) It loses electrons and Mn^{2+} (aq) is a product
 - (E) None of the above
5. On heating a typical group 2 carbonate, which of the following would be an expected set of products?
- (A) the corresponding oxide and CO_3^{2-}
 - (B) the corresponding oxide and CO
 - (C) the corresponding oxide and CO_2
 - (D) the metal and CO_2
 - (E) the metal and CO
6. The reaction resulting from the direct heating of solid sulfur in a stream of oxygen gas could be classified as
- (A) decomposition
 - (B) single replacement
 - (C) synthesis
 - (D) double replacement
 - (E) No reaction occurs.
7. When a solution of copper(II) sulfate is added to a solution of sodium hydroxide, the products include
- (A) copper metal and sulfur
 - (B) solid copper(II) hydroxide and a solution that contains sodium and sulfate ions
 - (C) solid sodium sulfate and a solution that contains copper(II) and hydroxide ions
 - (D) sodium metal and water
 - (E) No reaction occurs.

1. For each of the following three statements write the balanced net ionic equation (show significantly ionized species as separate ions and cancel out spectators) and answer the question that follows. There is no need to include phase labels. In every case, a reaction does occur. One point may be awarded for reactants (no partial credit given) up to two points may be awarded for products (partial credit given), one point for balancing and one point for the follow-up question.

(a) (i) A sample of 1-butanol is burned in an excess of oxygen gas.



(ii) Name an isomer of 1-butanol.

(b) (i) Solutions of potassium chromate and lead(II) nitrate are mixed in a test tube



(ii) What color will sodium ions impart to a flame test?

(c) (i) Liquid bromine is added drop wise to a solution that contains lithium iodide.



(ii) How can this reaction be classified?
