Question 4

4. Write the formulas to show the reactants and the products for any FIVE of the laboratory situations described below. Answers to more than five choices will not be graded. In all cases, a reaction occurs. Assume that solutions are aqueous unless otherwise indicated. Represent substances in solution as ions if the substances are extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction. You need not balance the equations.

General Scoring: Three points are earned for each reaction: 1 point for correct reactant(s) and 2 points for correct product(s). Designation of physical states is not required.

(a) Solid potassium chlorate is strongly heated.

$$KClO_3 \rightarrow KCl + O_2$$

(b) Solid silver chloride is added to a solution of concentrated hydrochloric acid.

$$AgCl + Cl^- \rightarrow [AgCl_2]^-$$

(c) A solution of ethanoic (acetic) acid is added to a solution of barium hydroxide.

$$HC_2H_3O_2 + OH^- \rightarrow H_2O + C_2H_3O_2^-$$

(d) Ammonia gas is bubbled into a solution of hydrofluoric acid.

$$NH_3 + HF \rightarrow NH_4^+ + F^-$$

(e) Zinc metal is placed in a solution of copper(II) sulfate.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

(f) Hydrogen phosphide (phosphine) gas is added to boron trichloride gas.

$$PH_3 + BCl_3 \rightarrow H_3PBCl_3$$

Note: PH_3BCl_3 also acceptable as a product.

(g) A solution of nickel(II) bromide is added to a solution of potassium hydroxide.

$$Ni^{2+} + OH^- \rightarrow Ni(OH)_2$$

(h) Hexane is combusted in air.

$$C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$$

USE THIS PAGE FOR ANSWERING QUESTION 4.
PLEASE WRITE THE LETTER FOR THE REACTION IN THE SQUARE AT THE LEFT END OF EACH BOX. ONLY THE ANSWERS IN THE BOXES WILL BE SCORED.

A	$KClO_{3(s)} \xrightarrow{\Delta} KCl_{(s)} + O_{2(g)}$

C	$HC_2H_3O_{2(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + C_2H_3O_{2(aq)}^-$

D	$NH_{3(g)} + HF_{(aq)} \rightarrow NH_4^+_{(aq)} + F^-_{(aq)}$

E	$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+} + Cu_{(s)}$

G	$Ni^{2+}_{(aq)} + OH^-_{(aq)} \rightarrow Ni(OH)_{2(s)}$

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h	$C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$

b	$AgCl + Cl^- \rightarrow AgCl_2^-$

g	$Ni^{2+} + OH^- \rightarrow Ni(OH)_2$

a	$KClO_4 \rightarrow K^+ + ClO_4^-$

d	$NH_3 + H^+ \rightarrow NH_4^+$

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e	$Zn(s) + SO_4^{-2} \rightarrow ZnSO_4$

d	$NH_3 + HF \rightarrow NH_4^+ + F_2$

h	$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

g	$NiBr + OH^- \rightarrow NiOH + Br_2$

C	$H^+ + C_2H_3O_2^- + BaOH_2 \rightarrow H_2O + Ba(C_2H_3O_2)_2$

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AP® CHEMISTRY
2006 SCORING COMMENTARY

Question 4

Overview

The intent of this question was to determine whether students could apply general principles of chemical reactions in order to predict the products of a variety of reactions. The students were given names of reactants for eight different reactions, including decomposition, complex ion formation, weak acid/strong base, weak acid/weak base, redox, Lewis acid/base, precipitation, and combustion reactions. In this and former versions of the AP Chemistry Exam, the students were only required to write reactants and products as net ionic equations when applicable; balancing and states of matter were not scored.

Sample: 4A
Score: 15

This response earned all 15 points. In each part, 1 point was earned for the correct reactant(s), and 2 points were earned for the correct product(s).

Sample: 4B
Score: 11

This response earned 3 points each for reactions (h), (b), and (g): the brackets were not necessary for earning credit for the product for reaction (b). The reactant point was not earned for reaction (a) because the formula is that of potassium perchlorate, not potassium chlorate, a common error. The product points were not earned because they are written as though the reactant is dissolving, not decomposing. For reaction (d) the reactant point was not earned because the hydrofluoric acid is written as a strong acid; however, the 2 product points were earned because the product written is consistent with the reactants.

Sample: 4C
Score: 4

No points were earned for reaction (e). Only 1 product point was earned for reaction (d) because F_2 is given as one of the products instead of F^-, a fairly common error. The reactant point was not earned for reaction (h) because the formula for hexane is incorrect. No points were earned for reaction (g). Reaction (c) earned 1 point for the product H_2O: acetic acid should be depicted as a weak acid, and barium acetate should be depicted as soluble. Note that the formula for barium hydroxide is also incorrect.