

Reaction Guidelines

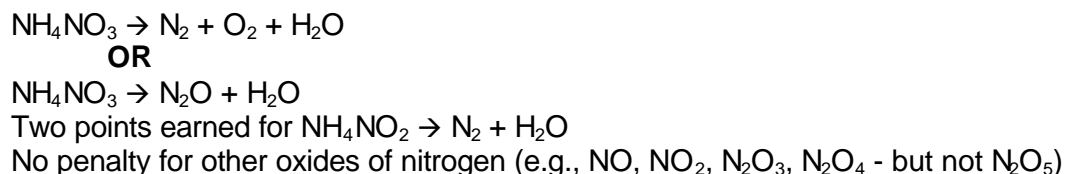
Students choose five of the eight reactions. Only the answers in the boxes are graded (unless clearly marked otherwise). Each correct answer earns 3 points, 1 point for reactants and 2 points for products. All products must be correct to earn both product points. Equations do not need to be balanced and phases need not be indicated. Any spectator ions on the reactant side nullify the 1 possible reactant point, but if they appear again on the product side, there is no product-point penalty. A fully molecular equation (when it should be ionic) earns a maximum of one point. Ion charges must be correct.

1999 AP Reaction Problem

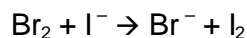
(a) Calcium oxide powder is added to distilled water.



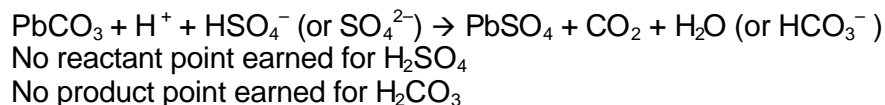
(b) Solid ammonium nitrate is heated to temperatures above 300°C.



(c) Liquid bromine is shaken with a 0.5 M sodium iodide solution.



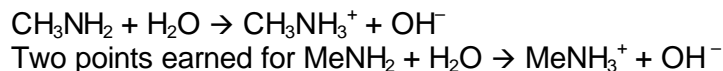
(d) Solid lead(II) carbonate is added to a 0.5 M sulfuric acid solution.



(e) A mixture of powdered iron(III) oxide and powdered aluminum metal is heated strongly.



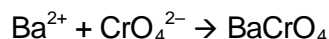
(f) Methylamine gas is bubbled into distilled water.



(g) Carbon dioxide gas is passed over hot, solid sodium oxide.

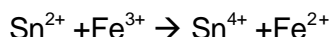


(h) A 0.2 M barium nitrate solution is added to an alkaline 0.2 M potassium chromate solution.



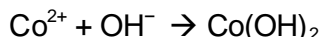
1998 AP Reaction Problems

(a) Solutions of tin(II) chloride and iron(III) chloride are mixed.



Two points earned if only error is wrong symbol for tin (e.g., Ti)

(b) Solutions of cobalt(II) nitrate and sodium hydroxide are mixed.

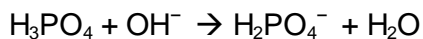


(c) Ethene gas is burned air.



No penalty for other oxidized forms of carbon as products (e.g., C, CO)

(d) Equal volumes of equimolar solutions of phosphoric acid and potassium hydroxide are mixed.



One point earned for $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$

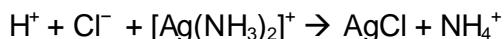
Two points earned for removal of H^+ from any $\text{H}_x\text{P}_y\text{O}_z$ species and H_2O as product

(e) Solid calcium sulfite is heated in a vacuum.



Two points earned for $\text{CaSO}_4 \rightarrow \text{CaO} + \text{SO}_3$

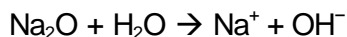
(f) Excess hydrochloric acid is added to a solution of diamminesilver(I) nitrate.



$\text{Cl}^- + [\text{Ag}(\text{NH}_3)_2]^+ \rightarrow \text{AgCl} + \text{NH}_3$ (or NH_4^+) earns two points

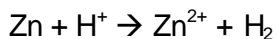
$\text{H}^+ + [\text{Ag}(\text{NH}_3)_2]^+ \rightarrow \text{Ag}^+ + \text{NH}_4^+$ earns two points

(g) Solid sodium oxide is added to distilled water.



Two points earned if reactants correct but only product is NaOH

(h) A strip of zinc is added to a solution of 6.0-molar hydrobromic acid.

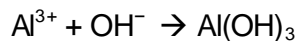


Two points earned for $\text{Zn} + \text{H}^+ + \text{Br}^- \rightarrow \text{ZnBr}_2 + \text{H}_2$

Two points earned for $\text{Zn} + \text{HBr} \rightarrow \text{Zn}^{2+} + \text{Br}^- + \text{H}_2$

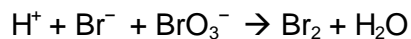
1997 AP Reaction Problems

(a) Excess potassium hydroxide solution is added to a solution of aluminum nitrate.



Other acceptable products: $\text{Al}(\text{OH})_4^{-}$; $\text{Al}(\text{OH})_4(\text{H}_2\text{O})_2^{-}$; Al_2O_3 ; $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$; AlO_2^{-}

(b) A solution of sodium bromide is added to an acidified solution of potassium bromate.

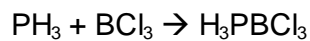


(c) Sulfur dioxide gas is bubbled into distilled water.



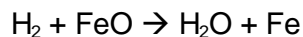
other acceptable products: $\text{H}^{+} + \text{HSO}_3^{-}$ or $\text{H}^{+} + \text{HSO}_3^{-} + \text{SO}_3^{2-}$

(d) Phosphine (phosphorus trihydride) gas is bubbled into liquid boron trichloride.



other acceptable products: PH_3BCl_3

(e) Hydrogen gas is passed over hot iron(II) oxide powder.

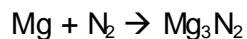


(f) Solid potassium amide is added to distilled water.

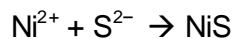


other acceptable products: $\text{NH}_4\text{OH} + \text{OH}^{-} + \text{K}^{+}$

(g) A strip of magnesium metal is heated strongly in pure nitrogen gas.



(h) A solution of nickel chloride is added to a solution of sodium sulfide.



or $\text{Ni}^{2+} + \text{H}_2\text{S} \rightarrow \text{NiS} + \text{H}^{+}$

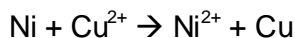
or $\text{Ni}^{2+} + \text{HS}^{-} \rightarrow \text{NiS} + \text{H}^{+}$

1996 AP Reaction Problems

- (a) Solid calcium carbonate is strongly heated.



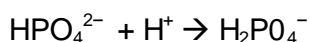
- (b) A piece of nickel metal is immersed in a solution of copper(II) sulfate.



hydrated ions acceptable with correct charge

1 point for $\text{Ni}(\text{OH})_2$ as product

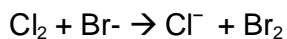
- (c) Equal volumes of equimolar solutions of disodium hydrogen phosphate and hydrochloric acid are mixed.



incorrect charge on H_2PO_4^- when only one product occurs, 1 point only

1 product point for transfer of H^+ from an ionic reactant to product when a phosphate species is incorrectly but consistently written.

- (d) Chlorine gas is bubbled into a solution of sodium bromide.



no credit for monatomic Cl as reactant or Br as product

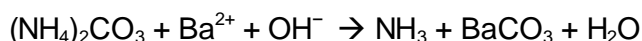
- (e) Ammonia gas is bubbled into a solution of ethanoic (acetic) acid.



1 product point for $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$

1 point for $\text{NH}_3 + \text{H}^+ \rightarrow \text{NH}_4$

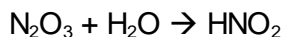
- (f) Solid ammonium carbonate is added to a saturated solution of barium hydroxide.



1 product point for either NH_3 or BaCO_3

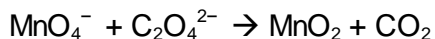
2 product points for all three species correct

- (g) Drops of liquid dinitrogen trioxide are added to distilled water.



1 product point for $\text{H}^+ + \text{NO}_2^-$

- (h) Solutions of potassium permanganate and sodium oxalate are mixed.

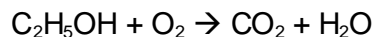


no penalty for OH^- or H_2O in equation

no point earned for Mn^{2+} as product

1995 AP Reaction Problems

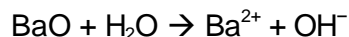
(a) Ethanol is burned in oxygen.



CO acceptable as oxidized form of carbon

C acceptable as product if accompanied by CO or CO₂

(b) Solid barium oxide is added to distilled water.



Only 1 product point awarded for Ba(OH)₂

(c) Chlorine gas is bubbled into a cold, dilute solution of potassium hydroxide.

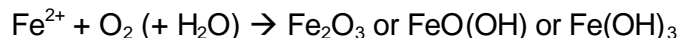


both an oxidized and a reduced form of Cl necessary for 2 product points

H₂O not necessary as product

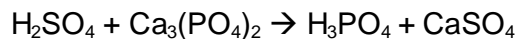
both ClO⁻ and ClO₂⁻ acceptable as oxidized forms of Cl 1 point deducted if acidic products shown (e.g., H⁺, HClO, HCl)

(d) A solution of iron(II) nitrate is exposed to air for an extended period of time.



Fe³⁺, Fe³⁺ + OH⁻, and FeO₂ or Fe₃O₄ awarded only 1 product point

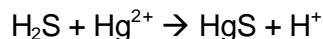
(e) Excess concentrated sulfuric acid is added to solid calcium phosphate.



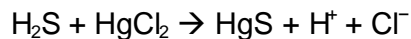
no ionized form of H₃PO₄ acceptable

CaSO₄ may appear as Ca²⁺ + SO₄²⁻, or Ca²⁺ + HSO₄⁻, or Ca(HSO₄)₂

(f) Hydrogen sulfide gas is bubbled into a solution of mercury(II) chloride.

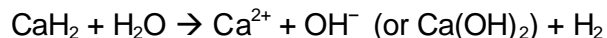


OR



If reactant is HgCl₂, products must include Cl⁻

(g) Solid calcium hydride is added to distilled water.



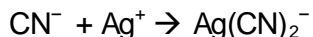
no ionized form of CaH₂ is acceptable; no H⁻ as a reactant

(h) A bar of zinc metal is immersed in a solution of copper(II) sulfate.



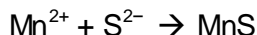
1994 AP Reaction Problems

(a) Excess sodium cyanide is added to a solution of silver nitrate.



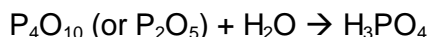
Note: any complex ion of Ag^+ with cyanide with consistent charge earns 3 points; AgCN given as product earns one product point.

(b) Solutions of manganese(II) sulfate and ammonium sulfide are mixed.



Note: If Mg is used instead of Mn , maximum possible score is two points.

(c) Phosphorous(V) oxide powder is sprinkled over distilled water.



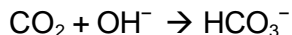
Note: Acidic species (H^+ or oxyacid of phosphorous) earns one product point; P in +5 oxidation state in oxyanion earns one product point; anions of oxyacids of phosphorous require H^+ for full credit for products.

(d) Solid ammonium carbonate is heated.



Note: any one product earns one point; all three earn two points. $\text{NH}_4\text{OH} + \text{CO}_2$ earns one product point. $\text{NH}_3 + \text{H}_2\text{CO}_3$ earns one product point.

(e) Carbon dioxide gas is bubbled through a concentrated solution of potassium hydroxide.



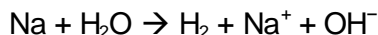
Note: $\text{CO}_3^{2-} + \text{H}_2\text{O}$ as products earns two product points. CO_3^{2-} alone as product earns one product point. $\text{HCO}_3^- + \text{H}_2\text{O}$ earns one product point.

(f) A concentrated solution of hydrochloric acid is added to solid potassium permanganate.



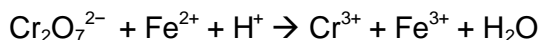
Note: HCl and MnO_4^- acceptable as reactants. Any valid redox product earns one point. All four products earn two points. K^+ and/or H_2O only as products earns no credit. If both H^+ and H_2O omitted, then maximum of two points possible.

(g) A small piece of sodium metal is added to distilled water.



Note: all three products earn two product points. Any valid redox product earns one product point.

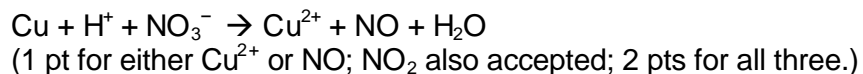
(h) A solution of potassium dichromate is added to an acidified solution of iron(II) chloride.



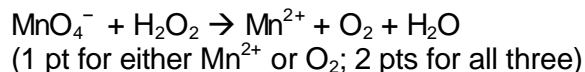
Note: All three products earn two product points. Any valid redox product earns one product point. H_2O only earns no credit. If $\text{Cl}^- \rightarrow \text{Cl}_2$ instead of $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$, then maximum of two points possible.

1993 AP Reaction Problems

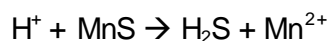
(a) A strip of copper is immersed in dilute nitric acid.



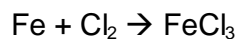
(b) Potassium permanganate solution is added to an acidic solution of hydrogen peroxide.



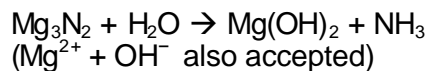
(c) Concentrated hydrochloric acid is added to solid manganese(II) sulfide.



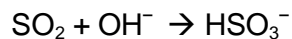
(d) Excess chlorine gas is passed over hot iron filings.



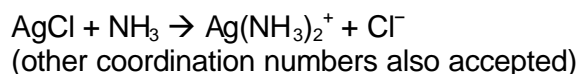
(e) Water is added to a sample of solid magnesium nitride.



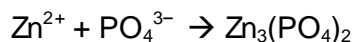
(f) Excess sulfur dioxide gas is bubbled through a dilute solution of potassium hydroxide.



(g) Excess concentrated ammonia solution is added to a suspension of silver chloride.

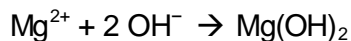


(h) Solutions of tri-potassium phosphate and zinc nitrate are mixed.

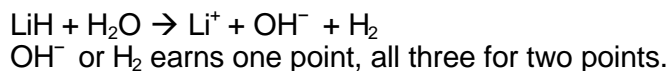


1992 AP Reaction Problems

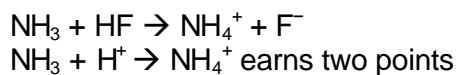
(a) An excess of sodium hydroxide solution is added to a solution of magnesium nitrate.



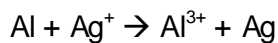
(b) Solid lithium hydride is added to water.



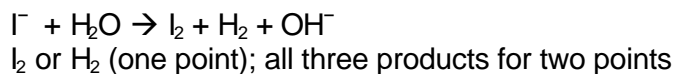
(c) Solutions of ammonia and hydrofluoric acid are mixed.



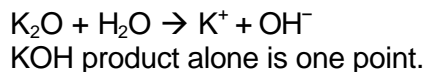
(d) A piece of aluminum metal is added to a solution of silver nitrate.



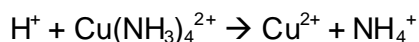
(e) A solution of potassium iodide is electrolyzed.



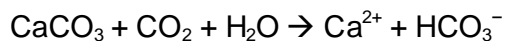
(f) Solid potassium oxide is added to water.



(g) An excess of nitric acid solution is added to a solution of tetraamminecopper(II) sulfate.

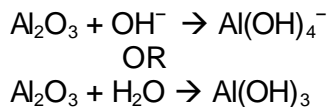


(h) Carbon dioxide gas is bubbled through water containing a suspension of calcium carbonate.

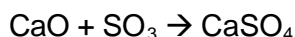


1991 AP Reaction Problems

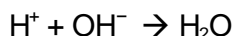
(a) Solid aluminum oxide is added to a solution of sodium hydroxide.



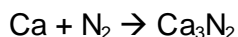
(b) Solid calcium oxide is heated in the presence of sulfur trioxide gas.



(c) Equal volumes of 0.1-molar sulfuric acid and 0.1-molar potassium hydroxide are mixed.



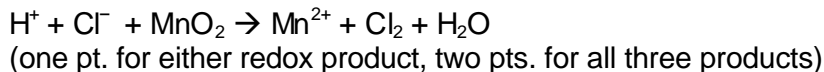
(d) Calcium metal is heated strongly in nitrogen gas.



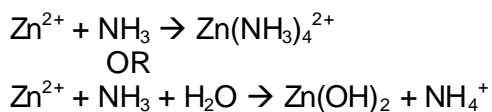
(e) Solid copper(II) sulfide is heated strongly in oxygen gas.



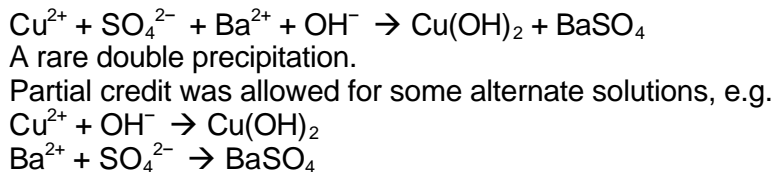
(f) A concentrated solution of hydrochloric acid is added to powdered manganese dioxide and gently heated.



(g) A concentrated solution of ammonia is added to a solution of zinc iodide.

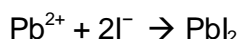


(h) A solution of copper(II) sulfate is added to a solution of barium hydroxide.

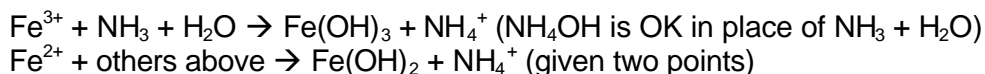


1990 AP Reaction Problems

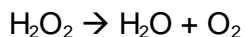
(a) Solutions of sodium iodide and lead nitrate are mixed.



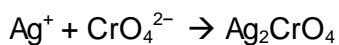
(b) A solution of ammonia is added to a solution of ferric chloride.



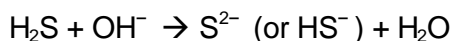
(c) A solution of hydrogen peroxide is heated.



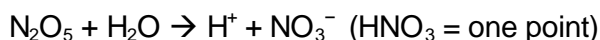
(d) Solutions of silver nitrate and sodium chromate are mixed.



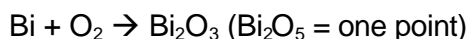
(e) Hydrogen sulfide gas is bubbled through a solution of potassium hydroxide.



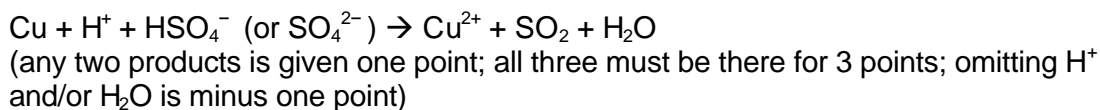
(f) Solid dinitrogen pentoxide is added to water.



(g) A piece of solid bismuth is heated

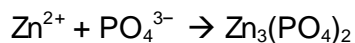


(h) A strip of copper metal is added to a concentrated solution of sulfuric acid.

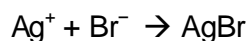


1989 AP Reaction Problems

(a) Solutions of zinc sulfate and sodium phosphate are mixed.



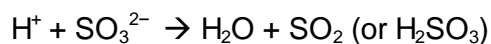
(b) Solutions of silver nitrate and lithium bromide are mixed.



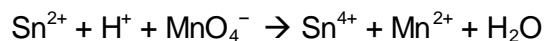
(c) A stream of chlorine gas is passed through a solution of cold, dilute sodium hydroxide.



(d) Excess hydrochloric acid solution is added to a solution of potassium sulfite.



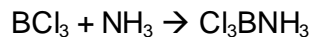
(e) A solution of tin(II) chloride is added to an acidified solution of potassium permanganate.



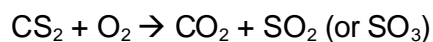
(f) A solution of ammonium thiocyanate is added to a solution of iron(III) chloride.



(g) Samples of boron trichloride gas and ammonia gas are mixed.

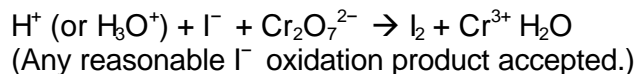


(h) Carbon disulfide vapor is burned in excess oxygen.

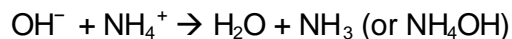


1988 AP Reaction Problems

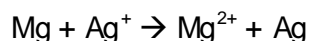
(a) A solution of potassium iodide is added to an acidified solution of potassium dichromate.



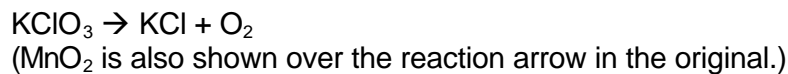
(b) A solution of sodium hydroxide is added to a solution of ammonium chloride.



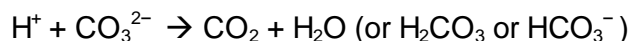
(c) A strip of magnesium is added to a solution of silver nitrate.



(d) Solid potassium chlorate is heated in the presence of manganese dioxide as a catalyst.



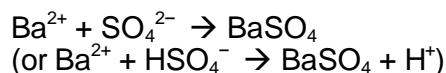
(e) Dilute hydrochloric acid is added to a solution of potassium carbonate.



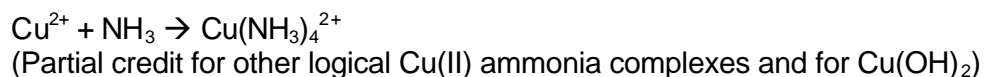
(f) Sulfur trioxide gas is added to excess water.



(g) Dilute sulfuric acid is added to a solution of barium chloride.

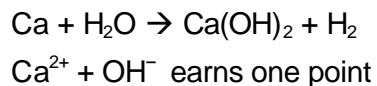


(h) A concentrated solution of ammonia is added to a solution of copper(II) chloride.

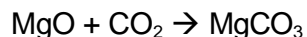


1987 AP Reaction Problems

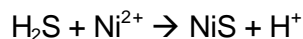
(a) Solid calcium is added to warm water.



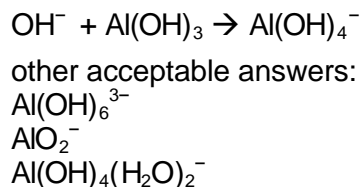
(b) Powdered magnesium oxide is added to a container of carbon dioxide gas.



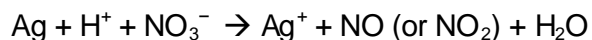
(c) Gaseous hydrogen sulfide is bubbled through a solution of nickel(II) nitrate.



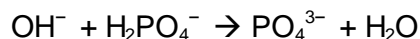
(d) Excess concentrated sodium hydroxide solution is added to solid aluminum hydroxide.



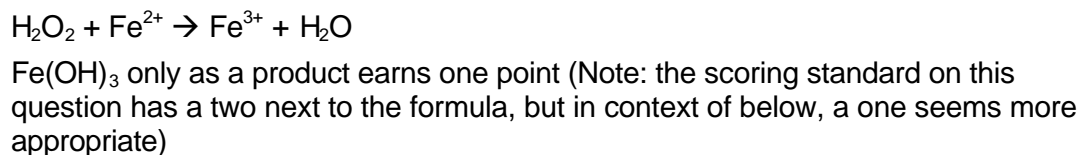
(e) Solid silver is added to a dilute nitric acid (6M) solution.



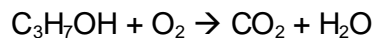
(f) Excess potassium hydroxide solution is added to a solution of potassium dihydrogen phosphate.



(g) Hydrogen peroxide solution is added to a solution of iron(II) sulfate.

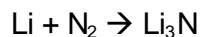


(h) Propanol is burned completely in air.

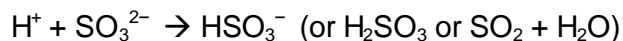


1986 AP Reaction Problems

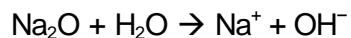
(a) A piece of lithium metal is dropped into a container of nitrogen gas.



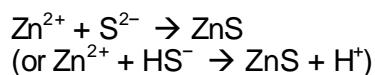
(b) Dilute hydrochloric acid is added to a solution of potassium sulfite.



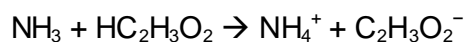
(c) Solid sodium oxide is added to water.



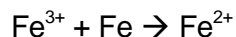
(d) A solution of sodium sulfide is added to a solution of zinc nitrate.



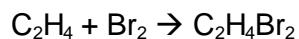
(e) A solution of ammonia is added to a dilute solution of acetic acid.



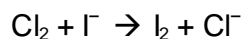
(f) A piece of iron is added to a solution of iron(III) sulfate.



(g) Ethene (ethylene) gas is bubbled through a solution of bromine.



(h) Chlorine gas is bubbled into a solution of potassium iodide.



1985 AP Reaction Problems

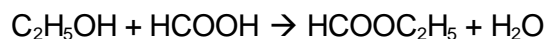
(a) Sodium metal is added to water.



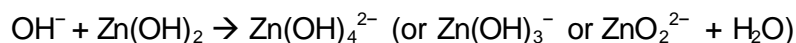
(b) Dilute sulfuric acid is added to a solution of lithium hydrogen carbonate.



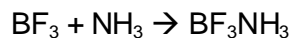
(c) Ethanol and formic acid (methanoic acid) are mixed and warmed.



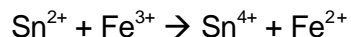
(d) Excess concentrated potassium hydroxide solution is added to a precipitate of zinc hydroxide.



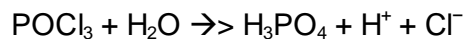
(e) The gases boron trifluoride and ammonia are mixed.



(f) A solution of tin(II) chloride is added to a solution of iron(III) sulfite.



(g) Phosphorus(V) oxytrichloride is added to water.



(h) An acidified solution of sodium permanganate is added to a solution of sodium sulfite.

