A. Balance and complete each of the following reactions.

1. $Mg(HCO_3)_2\,(aq) \text{ -----> } MgCO_3(s) + H_2CO_3(aq)$ $H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$ (boil water)
2. $CaCl_2(aq) + Na_2CO_3(aq) \text{ ------> } CaCO_3(s) + 2NaCl(aq)$
3. $MgSO_4(aq) + Na_2CO_3(aq) \text{ -----> } MgCO_3(s) + Na_2SO_4(aq)$
4. $Ca(HCO_3)_2(aq) + Na_3PO_4(aq) \text{ ------> } Ca_3(PO_4)_2(s) + 6NaHCO_3(aq)$
5. $Ca(OH)_2(aq) + Al_2(SO_4)_3(aq) \text{ ------> } 2Al(OH)_3(s) + 3CaSO_4(aq)$

B. Fill in the blanks:

The bonds joining hydrogen and oxygen together in water molecules are called polar covalent bonds. Water molecules are bonded to other molecules by hydrogen bonding. "Permanent" hard water contains primarily Mg^{2+}, Ca^{2+} and Fe^{3+} ions, while "temporary" hardness is due primarily to the presence of these two ions with HCO_3^- ion. Temporary hardness may be removed by boiling.

C. Practice Multiple Choice Questions.

1. Water has many unusual or unique properties which are best explained by:
   a. the small size of its molecules
   (b.) the theory of hydrogen-bonding
   c. its common occurrence
   d. its polar covalent bonds
   e. none of these

2. Which of the following ions will precipitate soap in solution? $Ca^{2+}, Mg^{2+}, Fe^{3+}$ are hard water ions.
   a. Cl^{-1} (b.) Ca^{+2} c. Na^{+1} d. HCO_3^{-1} e. NH_4^{+1}

3. The temperature at which a solid becomes a liquid is called the
   (a.) melting point c. condensation point
   b. boiling point d. decomposition point

   knowing the differences between:
   - melting - vaporization
   - freezing - condensation

4. The process by which a liquid is converted to a gas is called
   a. condensation c. liquification
   b. ionization (d.) vaporization

5. Unlike most solids, solid water (ice) is
   (a.) less dense than liquid water
   b. the same density as liquid water
   c. more dense than liquid water
   d. solid water has a density of zero

6. Water
   a. dissolves many ionic substances Know this about H_2O
   b. has a high heat capacity
   c. has a high heat of vaporization
   (d.) all of these

7. Ice is less dense than liquid water because it

a. is ionic
b. has large hexagonal holes in its molecular arrangement
c. is less polar than liquid water
d. has some molecules destroyed as it freezes

8. A sewage plant with secondary treatment effectively removes
a. only suspended solids
b. most oxygen-consuming organic wastes
c. nitrates
d. phosphates

9. Alum and lime remove suspended solids and clarify water by
a. acidification
b. filtration
c. formation of a gelatinous precipitate
d. oxidation

10. Soap is
a. a glycerol ester
b. a sodium salt
c. sodium carbonate
d. trisodium phosphate

11. Washing soda is
a. NaOH b. Na_2CO_3 c. Na_3PO_4 d. NaCl

12. Detergents are better cleaners than soaps in
a. hard water
b. soft water
c. alkaline water
d. all of these

13. Substances added to surfactants to increase their detergency are
a. bleaches
b. builders
c. emulsifiers
d. enzymes

14. Soaps are
a. anionic surfactants
b. cationic surfactants
c. nonionic surfactants
d. neutral surfactants

15. Which mixture creates potentially toxic gases?
a. bleach and toilet bowl cleaner
b. ammonia and detergent
c. vinegar and baking soda
d. toilet bowl cleaner and baking soda

produces toxic $Cl_2(g)$

D. Additional Notes.

1. You should understand the differences between permanent and temporary water hardness.
2. You should have a basic understanding how detergents and other household cleaners work.