Name _____

CE 326 Principles of Environmental Engineering
Water Supply and Treatment - 2nd Exam

Defendable True/False Questions. If the statement is true as stated, mark it OK. If the statement is false, correct it by changing the underlined word or words in the sentence so that it will be true.
Note atomic weights: H = 1.0, C = 12.0, O = 16, Fe = 55.8.

1. When a water is <u>over-saturated</u> with calcium carbonate the concentration of dissolved calcium can be calculated from the following: $K_{sp} = [Ca^{2+}][CO_3^{2-}]$.

2. Hardness, as measured by the sum of <u>polyvalent</u> cations, is a concern due to aesthetic reasons, mainly scale formation and difficulty in adequate suds formation during washing.

3. Abnormally high concentrations of <u>nitrate</u> in drinking water are a concern since they may lead dental fluorosis, a discoloration and mottling of teeth.

4. At a pH = 11 most of the alkalinity exists as <u>bicarbonate, HCO_3^-,</u> species.

5. The effective size of a particular filter media refers to the <u>d_{50}</u> size.

6. <u>Flocculation</u> refers to the addition of iron and ferric salts to destabilize particles in water. Once the particles (colloids) are destabilized they become sticky and can aggregate to form larger, settleable particles.

7. A mixer motor of <u>13.9 hp</u> is required to provide a G value of 1000 s^{-1} to a plant with a flow of 0.44 m^3/s and detention time of 30 s. $G = (P/\mu V)^{0.5}$ also 1 hp = 745.7 watt, $\mu = 1.053X10^{-3}$ Pa·s.

8. <u>Chlorine dioxide</u> is not a powerful oxidant, but it leaves a very long lasting residual, so it is often used in conjunction with other disinfectants.

9. One of the major provisions of the Safe Drinking Water Act was to provide for a treatment technique for a class of compounds for which it is not possible to monitor actual concentrations. An example of this is the filtration rule for the control of <u>giardia and cryptosporidium</u>.

10. A circular horizontal flow clarifier with a diameter of 50 m should remove substantially all of the particles with a terminal settling velocity greater than or equal to 0.23 mm/s if the flow rate is less than or equal to 0.55 m^3/s.

Short Answers - 10 points each

11. Sketch a typical water treatment plant treating a groundwater as the source water. Identify clearly each treatment unit, the chemicals that are added, and any residues produced.

12. Briefly explain the laboratory procedure for a jar test. What information is obtained and why is it important to the operation of a water treatment plant? Use sketches as needed.

13. Define and explain the meaning of the terms shown below.

SWTR: _____

_____

_____

GAC: _____

_____

_____

MCL: _____

_____

_____

Numerical Problems - 20 points each

14. Calculate the alkalinity (exactly in mg/L as $CaCO_3$) of a water that has the following composition:
(Note the $pK_{a1} = 6.35$ and $pK_{a2} = 10.33$ for carbonic acid at 25°C).

Temperature	25°C
CO_3^{2-}	10 mg/L
HCO_3^-	160 mg/L

EQUATIONS:

$$K_a = \frac{[H^+][W^-]}{[HW]} \qquad K_W = [OH^-][H^+]$$

$$alk = HCO_3^- + CO_3^{2-} + OH^- - H^+ \quad \textit{when expressed as mg/L as } CaCO_3$$

15. Calculate the clean bed headloss for a 50 m^2 filter loaded at a rate of 200 $m^3/m^2 \cdot d$ with uniformly sized media (U.C.=1.0) with the following characteristics:

D = 0.6 m
s.g. = 2.65
sphericity = 0.80
ϵ = 0.40
E.S. = 0.40 mm
U.C. = 1.0
$\nu = 1.307X10^{-6}$ m^2/s
ρ = 1000 kg/m^3
g = 9.8 m/s^2

$$h_L = \frac{1.067 \left(v_a\right)^2 D}{\phi g \left(\epsilon\right)^4} \sum \frac{c_D f}{d}$$

$$R = \frac{\phi d v_a}{\nu}$$

$$C_D = \frac{24}{R} + \frac{3}{R^{0.5}} + 0.34$$

Based on your results, what would you recommend?