

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, Ca = 40, Al = 27, S = 32.

1. Sedimentation of alum floc typically follows Type II, or flocculant, settling, which can be accurately modeled using the Stokes equation for laminar flow.
2. Noncarbonate hardness is defined as the difference between the total hardness and the turbidity.
3. The gentle mixing of colloidal particles to form larger settleable particles in a slow mix basin is termed flocculation.
4. Ultraviolet light is highly effective for drinking water disinfection, but it does not leave a residual. Consequently, chlorination or chloramination is also required to provide a disinfecting residual.
5. The effective size of a particular filter media refers to the d_{90}/d_{60} size.
6. The optimum coagulant dose in a jar test is the dose where the hardness is at a minimum.
7. For a given filter area and backwash flow rate an increase in depth of the sand will result in an increase in the resulting percent bed expansion.
8. Hardness is the sum of polyvalent anions in drinking water and has been associated with a significant decrease (about 50%) in heart disease in areas that use groundwater.
9. Chlorination and bromination of surface waters with a high content of iron may result in the formation of cancer causing compounds such as THMs and DBPs.
10. GAC is used in place of anthracite in filter adsorbers to obtain removal of VOCs, SOCs, DBPs, THMs, and other adsorbable contaminants.
11. An example of a specified treatment technique in Safer Drinking Water Act, is the use of filtration for the removal of *Polyammonia chloride* which causes gastrointestinal illness.
12. The principle treatment objective for surface water is the removal of hardness and iron.

Short Answers - 8 points each

11. Give a brief explanation for the following:

a. What is the advantage of dual media filtration over single media filtration?

b. How do slow sand filters work?

c. What is the difference between Type I, II, and III sedimentation?

12. For a given filter cycle indicate the appropriate item by filling in the corresponding letter:

1. ____

2. ____

3. ____

4. ____

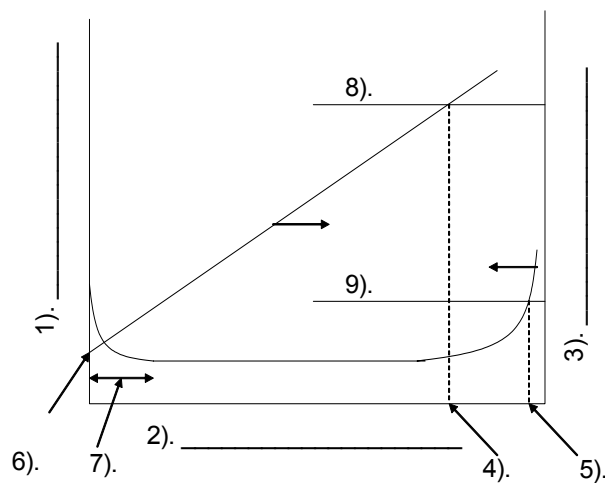
5. ____

6. ____

7. ____

8. ____

9. ____



a. clean bed headloss

b. maximum available headloss

c. time to backwash based on headloss

d. headloss, m

e. turbidity, NTU

f. time to backwash based on turbidity

g. turbidity standard, NTU

h. filter ripening

i. time, h

13. List five inorganic compounds that are regulated in drinking water and why they are a concern.

Numerical Problems :

14. (10 pts) Calculate the mixer horsepower for a rapid mix basin in a 10 mgd (million gallons per day) water treatment plant to achieve a G value of 750 s^{-1} and Gt value of 45,000.

Given: $G = (P/\mu V)^{0.5}$ $1 \text{ hp} = 745.7 \text{ watt}$ $\mu = 1.053 \times 10^{-3} \text{ Pa}\cdot\text{s}$
 $10^6 \text{ gallons} = 3785 \text{ m}^3$ $1 \text{ m}^3 = 264.2 \text{ gallons}$

15. (15 pts) Calculate the bicarbonate (HCO_3^{-2}) concentration in mg/L as CaCO_3 of a water sample that has the following composition:

Temperature	25 deg C
H_2CO_3	1.5 mg/L
pH	8.4

EQUATIONS:

Note the $\text{pK}_{a1} = 6.35$ for carbonic acid and bicarbonate and $\text{pK}_{a2} = 10.33$ for bicarbonate and carbonate at 25°C . $K_w = [\text{OH}^-][\text{H}^+]$ $\text{H}_2\text{CO}_3 = \text{CO}_2 + \text{H}_2\text{O}$

$$K_a = \frac{[\text{H}^+][\text{W}^-]}{[\text{HW}]}$$

2. (15 pts) Calculate the surface area and diameter for circular clarifiers (sedimentation basin) for a 12 million gallon per day ($1 \text{ m}^3 = 264.2 \text{ gal}$) water treatment plant? Assume a surface overflow rate of $60 \text{ m}^3/\text{m}^2\text{d}$ and a weir loading rate of $300 \text{ m}^3/\text{m}\text{d}$. Assume that two clarifiers are used. Indicate whether inboard weirs are necessary.

$$10^6 \text{ gallons} = 3785 \text{ m}^3$$

$$\text{Temp} = 20^\circ\text{C}$$

$$\mu = 1.002 \times 10^{-3} \text{ Pa}\cdot\text{s}$$

$$\nu = 1.004 \times 10^{-6} \text{ m}^2/\text{s}$$

$$\rho = 998.207 \text{ kg}/\text{m}^3$$

$$g = 9.8 \text{ m}/\text{s}^2$$

$$P = 100(\nu_s/\nu_o)$$

$$\nu_o = Q/A_s$$

$$\text{area of circle} = \pi r^2$$

$$\text{Circum.} = 2 \pi r$$

Miscellaneous equations:

$$\nu_s = \frac{g(\rho_s - \rho) d^2}{18\mu}$$

Stokes Law

$$R = \frac{d \nu_a}{\nu}$$

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