WATER OPERATOR EXAM FORMULA SHEET

CONVERSION FACTORS

<table>
<thead>
<tr>
<th>Unit Conversion</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foot = 12 inches</td>
<td>1 minute = 60 seconds</td>
</tr>
<tr>
<td>1 inch = 2.54 centimeters</td>
<td>cfs = cubic feet per second</td>
</tr>
<tr>
<td>1 gallon = 8 pints</td>
<td>gpm = gallons per minute</td>
</tr>
<tr>
<td>1 gallon = 8.34 pounds</td>
<td>1 day = 86,400 seconds</td>
</tr>
<tr>
<td>1 gallon = 3.785 liters</td>
<td>gpd = gallon per day</td>
</tr>
<tr>
<td>1 liter = 1,000 milliliters</td>
<td>1 day = 24 hours</td>
</tr>
<tr>
<td>1 cubic foot = 7.48 gallons</td>
<td>mg/L = milligrams per liter</td>
</tr>
<tr>
<td>1 cfs = 448 gpm</td>
<td>ppm = parts per million</td>
</tr>
<tr>
<td>1 gpm = 1,440 gpd</td>
<td>1 cubic yard = 27 cubic feet</td>
</tr>
<tr>
<td>1 MGD = 1.55 cfs</td>
<td>cu ft = ft³ = cubic feet</td>
</tr>
<tr>
<td>1 psi = 2.31 feet</td>
<td>sq ft = ft² = square feet</td>
</tr>
<tr>
<td>1 foot = 0.433 psi</td>
<td>1 grain per gallon = 17.12 mg/L</td>
</tr>
<tr>
<td>π (pi) = 3.14</td>
<td></td>
</tr>
</tbody>
</table>

TEMPERATURE

Fahrenheit (°F) = (1.8 x °C) + 32
Celsius (°C) = 0.56 x (°F - 32)

CIRCUMFERENCE, AREA & VOLUME

Circumference (C, ft) = π x diameter (D, ft)
Area of a rectangle (A, sq ft) = (length, ft) x (width, ft)
Area of a circle (A, sq ft) = 0.785 x (diameter, ft)²
Area of a circle (A, sq ft) = π x (radius, ft)²
Volume of a rectangle (V, cu ft) = (length, ft) x (width, ft) x (height, ft)
Volume of a rectangle (V, gal) = (length, ft) x (width, ft) x (height, ft) x 7.48 gal/cu ft
Volume of a cylinder (V, cu ft) = 0.785 x (diameter, ft)² x (height, ft)
Volume of a cylinder (V, gal) = 0.785 x (diameter, ft)² x (height, ft) x 7.48 gal/cu ft

CHLORINATION

Chlorine dose (mg/L) = chlorine demand (mg/L) + chlorine residual (mg/L)
Total chlorine residual (mg/L) = free chlorine residual (mg/L) + combined chlorine residual (mg/L)

POUNDS, DOSAGE & FLOW

Dose (mg/L) = Feed (lbs/day) ÷ flow (MGD) ÷ (8.34 lbs/gal)
Flow (MGD) = Feed (lbs/day) ÷ dose (mg/L) ÷ (8.34 lbs/gal)
Feed (lbs/day) = dose (mg/L) x flow (MGD) x (8.34 lbs/gal)
Feed (lbs/day) = dose (mg/L) x flow (MGD) x (8.34 lbs/gal) ÷ % purity (decimal)
FLOW

Flow (Q, gpm) = volume (V, gal) ÷ time (t, min.)
Flow (Q, gps) = velocity (v, fps) x area (A, sq ft) x (7.48 gal/cu ft)
Flow (Q, cfs) = velocity (v, fps) x area (A, sq ft)

DETENTION TIME

Detention time (DT, min) = volume (V, gal) ÷ flow (Q, gpm)

PERCENT

Percent (%) = part ÷ whole x 100
Part = whole x percent ÷ 100

FLUORIDATION

Fluoride Feed Rate (lbs/day) = \[
\frac{\text{Dose (mg/L)} \times \text{Capacity (MGD)} \times (8.34 \text{ lbs/gal})}{\text{Available Fluoride Ion (AFI)} \times \text{chemical purity (decimal)}}
\]

Fluoride Feed Rate (gpd) = \[
\frac{\text{Dose (mg/L)} \times \text{Capacity (gpd)}}{18,000 \text{ mg/L}}
\]

Dose (mg/L) = Fluoride Feed rate (lbs/day) ÷ Available Fluoride Ion (AFI) ÷ chemical purity (decimal) ÷ Capacity (MGD) ÷ (8.34 lbs/gal)

Dose (mg/L) = Solution fed (gal) x 18,000 mg/L ÷ Capacity (gpd)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Formula</th>
<th>Available Fluoride Ion (AFI) Concentration</th>
<th>Chemical Purity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Fluoride</td>
<td>NaF</td>
<td>0.453</td>
<td>98%</td>
</tr>
<tr>
<td>Sodium Fluorosilicate</td>
<td>Na₂SiF₆</td>
<td>0.607</td>
<td>98%</td>
</tr>
<tr>
<td>Fluorosilicic Acid</td>
<td>H₂SiF₆</td>
<td>0.792</td>
<td>23%</td>
</tr>
</tbody>
</table>

Potassium Permanganate dose (mg/L) = 1(Iron concentration mg/L) + 2(Manganese concentration mg/L)

Alkalinity = \[
\frac{\text{mL of } H_2SO_4 \times 1,000}{\text{mL of sample}}
\]

Hardness = \[
\frac{\text{mL of EDTA} \times 1,000}{\text{mL of sample}}
\]
Chemical Feed Setting (mL/min) = \( \frac{(\text{Flow}, \text{MDG})(\text{Alum Dose}, \text{mg/L})(3.785\text{L/gal})(1,000,000 \text{ gal/MG})}{(\text{Liquid Alum}, \text{mg/mL})(24 \text{ hr/day})(60 \text{ min/hr})} \)

Calibration of a Dry Chemical Feeder (lbs/day) = Chemical Applied, lbs
Length of Application, day

Calibration of Solution
Chemical Feeder (lbs/day) = \( \frac{\text{Chem Conc, mg/L}(\text{Vol pumped, mL})(1,440 \text{ min/day})}{\text{(Time pumped, min)}(1,000 \text{ mL/L})(1,000 \text{ mg/g})(454 \text{ g/lb})} \)

Filtration Rate (gpm/sq ft) = \( \frac{\text{Flow, gpm}}{\text{Surface area, sq ft}} \)

Unit Filter Rate Volume (UFRV) = \( \frac{\text{Filtration Rate, gpm/sq ft}(\text{Filter Run, hr})(60 \text{ min/hr})}{\text{Chemical Applied, lbs}} \)

Backwash Water, gal = (Backwash Flow, gpm)(Backwash Time, min)

Backwash, % = \( \frac{\text{Backwash Water, gal}(100\%)}{\text{Water Filtered, gal}} \)

\[ \text{pHs} = A + B + \log(Ca^{2+}) + \log(Alk) \]

Langlier Index = \( \text{pH} - \text{pHs} \)

Polymer, lbs = \( \frac{\text{Polymer Solution, gal}(8.34 \text{ lbs/gal})(\text{Polymer, \%})(\text{Sp Gr})}{100\%} \)

Hypochlorite Flow, gpd = \( \frac{\text{Container area, sq ft}(\text{Drop, ft})(7.48 \text{ gal/cu ft})(24 \text{ hr/day})}{\text{(Time, hr)}} \)

Feed Rate, gal/day = \( \frac{(\text{Feed Rate, lbs/day})(\text{Feed Dose}, \text{mg/L})}{\text{Feed Solution, mg/L}} \)

Feed Rate, lbs/day = \( \frac{\text{Feeder Setting, lbs/day}}{24 \text{ hr/day}} \)

CT, mg/L-min = \( \frac{\text{Vol, gal}(T_{10})}{\text{Flow, gpm}} \)(\text{Free Chlorine Residual, mg/L})

Free Chlorine Residual, mg/L = \( \frac{(\text{CT, mg/L-min})}{T_{10}, \text{ min}} \)