WATER OPERATOR EXAM FORMULA SHEET

9/1/15

1 minute (min) = 60 seconds (sec)
1 hour (hr) = 60 min
1 day = 24 hr = 1,440 min = 86,400 sec
1 inch (in) = 2.54 centimeters (cm)
1 ft = 12 in
1 ft = 0.433 pounds per square inch (psi)
1 psi = 2.31 ft
1 cubic foot (ft^3) = 7.48 gallons (gal) = 62.38 pounds (lbs)
1 ft^3 = 62.38 lbs
1 cubic yard = 27 ft^3
1 gal = 8 pints
1 gal = 8.34 lbs
1 gal = 3.785 liters (L)
1 lb = 454 grams (g)
1 L = 1,000 milliliters (mL)
1 milligrams per liter (mg/L) = 1 part per million (ppm)
1 % = 10,000 ppm
1 cubic foot per second (cfs or ft^3/sec) = 448 gallons per minute (gpm)
1 gpm = 1,440 gallons per day (gpd)
1 gpd = 2.63 mL/min
1 million gallons per day (MGD) = 694.4 gpm
1 grain per gallon (gpg) = 17.12 mg/L
1 ac-ft = 43,560 ft^3
π (pi) = 3.14
specific gravity (Sp Gr) of water = 1.00

ABBREVIATIONS

V = volume	A = area
v = velocity	D = diameter
Q = flow	r = radius
ft^2 = square feet	C = circumference
W/W = weight/weight	W/V = weight/volume
DT = detention time	HP = horsepower

TEMPERATURE

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

CIRCUMFERENCE, AREA & VOLUME

Circumference (C, ft) = π x D (ft)

Area of a rectangle (A, ft^2) = length (ft) x width (ft)
Area of a circle (A, ft^2) = 0.785 x D $(ft)^2$
Area of a circle (A, ft^2) = π x r $(ft)^2$

Volume of a rectangle (V, ft^3) = 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/ft^3)

Volume of a cylinder (V, ft^3) = 0.785 x D $(ft)^2$ x height (ft)
Volume of a cylinder (V, gal) = 0.785 x D $(ft)^2$ x height (ft) x 7.48 (gal/ft^3)

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

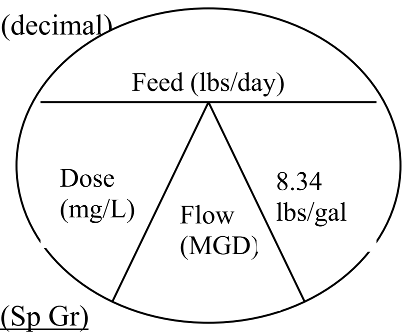
CHLORINATION
Chlorine dose (mg/L) = chlorine demand (mg/L) + chlorine residual (mg/L)

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)

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

Flow (Q, gps) = velocity (v, fps) x area (A, ft^2) x 7.48 (gal/ft^3)

Flow (Q, cfs) = velocity (v, fps) x area (A, ft^2)

COAGULATION AND FLOCCULATION

$$\text{Polymer (lbs)} = \frac{\text{polymer solution (gal) x 8.34 (lbs/gal) x polymer (\%) x (Sp Gr)}}{100\%}$$

FILTRATION

$$\text{Filtration or backwash rate (gpm/ft}^2\text{)} = \frac{\text{flow (Q, gpm)}}{\text{surface area (ft}^2\text{)}}$$

Unit Filter Rate Volume (UFRV) (g/ft^2) = filtration rate (gpm/ft^2) x filter run (hr) x 60 (min/hr)

Backwash water (gal) = backwash flow (gpm) x backwash time (min)

$$\text{Backwash (\%)} = \frac{\text{backwash water (gal) x (100\%)}}{\text{water filtered (gal)}}$$

FLUORIDATION

$$\text{Fluoride feed rate (lbs/day)} = \frac{\text{dose (mg/L) x flow (MGD) x 8.34 (lbs/gal)}}{\text{Available Fluoride Ion (AFI) x chemical purity (decimal)}}$$

$$\text{Fluoride feed rate (gpd)} = \frac{\text{dose (mg/L) x flow (gpd)}}{\text{18,000 mg/L}}$$

$$\text{Dose (mg/L)} = \frac{\text{fluoride feed rate (lbs/day) x AFI x chemical purity (decimal)}}{\text{flow (MGD) x 8.34 (lbs/gal)}}$$

$$\text{Dose (mg/L)} = \frac{\text{solution fed (gal) x 18,000 mg/L}}{\text{flow (gpd)}}$$

Chemical	Formula	Available Fluoride Ion (AFI) Concentration	Chemical Purity
Sodium fluoride	NaF	0.453	98%
Sodium fluorosilicate	Na_2SiF_6	0.607	98%
Fluorosilicic acid	H_2SiF_6	0.792	23%

CHEMICAL DOSES

$$\text{Chemical feed setting (mL/min)} = \frac{\text{flow (MGD) x alum dose (mg/L) x 3.785 (L/gal) x 1,000,000 (gal/MG)}}{\text{liquid alum (mg/mL) x 24 (hr/day) x 60 (min/hr)}}$$

$$\text{Dry chemical feeder (lbs/day)} = \frac{\text{chemical applied (lbs)}}{\text{length of application (day)}}$$

$$\text{Solution chemical feeder (lbs/day)} = \frac{\text{chem conc. (mg/L) x V pumped (mL) x 1,440 (min/day)}}{\text{time pumped (min) x 1,000 (mL/L) x 1,000 (mg/g) x 454 (g/lb)}}$$

$$\text{Average feed rate (lbs/day)} = \frac{\text{average feed rate (g/min) x 1,440 (min/day)}}{\text{454 (g/lb)}}$$

DISINFECTION

$$\text{Hypochlorite flow (gpd)} = \frac{\text{container area (ft}^2\text{) x drop (ft) x 7.48 (gal/ft}^3\text{) x 24 (hr/day)}}{\text{time (hr)}}$$

$$\text{Feed rate (gpd)} = \frac{\text{feed rate (lbs /day) x feed dose (mg/L)}}{\text{feed solution (mg/L)}}$$

$$\text{Feed rate (lbs/day)} = \frac{\text{feeder setting (lbs/day)}}{\text{24 (hr/day)}}$$

$$\text{CT (mg/L-min)} = \frac{\text{V (gal) x (}T_{10}\text{) x free chlorine residual (mg/L)}}{\text{flow (gpm)}}$$

$$\text{Free chlorine residual (mg/L)} = \frac{\text{CT (mg/L-min)}}{T_{10}\text{ (min)}}$$

HORSEPOWER

$$\text{Q (gpm)} = \frac{\text{3,956 (HP)}}{\text{head (ft) x Sp Gr}}$$

$$\text{HP} = \frac{\text{voltage x current x efficiency}}{746}$$

$$\text{Water (HP)} = \frac{\text{flow (gpm) x lift (ft) x 8.34 (lbs/gal)}}{\text{33,000 ft-lb/min-HP}}$$

Power (kW-hr/day) = motor (HP) x 24 (hr/day) x 0.746 (kW/HP)

MISC

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

$$\text{Average} = \frac{\text{sum of measurements}}{\text{number of measurements}}$$

General ratio $\frac{A1}{A2} = \frac{B1}{B2}$

Turnover or drawdown (ft) = pumping (ft) – static (ft)

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

$$\text{Alkalinity} = \frac{\text{mL of } H_2SO_4 \text{ x 1,000}}{\text{mL of sample}}$$

$$\text{Hardness} = \frac{\text{mL of EDTA x 1,000}}{\text{mL of sample}}$$

Reservoir Volume (V, gal) = V (ac-ft) x 43,560 (ft^3/ac-ft) x 7.48 (gal/ft^3)

$$\text{Feeder setting, \%} = \frac{\text{desired rate x 100\%}}{\text{maximum rate}}$$

Weight of substance (lbs/gal) = Sp Gr x 8.34 (lbs/gal)

$$\text{Volume needed, } \mu\text{L} = \frac{\text{dose (mg/L) x jar test beaker volume (L)}}{\text{Sp Gr x Conc., \% (expressed as a decimal)}}$$

$$(\text{Volume, mL})_1 = \frac{(\text{concentration, mg/L})_2(\text{volume, mL})_2}{(\text{concentration, mg/L})_1}$$