# CONVERSION FACTORS - CANADIAN ABC EXAMINATION

On the left hand column of the table is the SI (Systeme International d'Unites). To convert from metric units to imperial units, simply multiple by the conversion factor in the upper portion of each cell. To convert from the Imperial units to metric units, simply multiple by the conversion factor in the lower portion of each cell. The arrows next to each conversion factor show the direction of the conversions.

## Length

| | | |
|---|---|---|
| mm | x 0.039 37 ➔<br>🡐x 25.4 | inches |
| mm | x 3.28 x $10^{-3}$➔<br>🡐x 304.8 | feet |
| cm | x 0.393 7 ➔<br>🡐x 2.54 | inches |
| cm | x 0.032 8 ➔<br>🡐x 30.48 | feet |
| m | x 39.37 ➔<br>🡐x 0.025 4 | inches |
| m | x 3.281 ➔<br>🡐x 0.304 8 | feet |
| km | x 3 280.84 ➔<br>🡐0.3048 x $10^{-3}$ | feet |
| km | x 1 093.61 ➔<br>🡐 x 9.144 x $10^{-4}$ | yards |
| km | x 0.621 4 ➔<br>🡐x 1.609 | miles |

## Area & Volume

| | | |
|---|---|---|
| $m^2$ | x 10.763 9 ➔<br>🡐x 0.092 9 | square feet |
| $m^2$ | x 1.196 ➔<br>🡐x 0.836 1 | square yards |
| $m^2$ | x 2.471 x $10^{-4}$ ➔<br>🡐x 4046.9 | acres |
| ha | x 2.471➔<br>🡐x 0.404 69 | acres |
| $cm^3$ | x 0.061 024 ➔<br>🡐x 16.387 | cubic inches |
| $m^3$ | x 35.315 ➔<br>🡐x 0.028 32 | cubic feet |
| $m^3$ | x 219.9 ➔<br>🡐x 4.546 x $10^{-3}$ | Imperial gallons |
| L | x 0.2199 ➔<br>🡐x 4.546 | Imperial gallons |
| mL | x 0.000219 ➔<br>🡐x 4546.09188 | Imperial gallons |
| $m^3$ | x 0.2199 x $10^{-3}$➔<br>🡐x 4.546 x $10^3$ | Million Imp. gallons |
| US gallons | x 0.832 7 ➔<br>🡐x 1.2001 | Imperial gallons |

## Weight / Mass

| | | |
|---|---|---|
| g | x 2.205 x $10^{-3}$➔<br>🡐x 453.59 | pounds |
| g | x 15.432 3 ➔<br>🡐x 0.064 799 | grains |
| g | x 0.035 27 ➔<br>🡐x 28.349 5 | ounces |
| mg | x 2.205 x $10^{-6}$ ➔<br>🡐x 453 592.3 | pounds |
| mg | x 0.015 43 ➔<br>🡐x 64.799 | grains |
| kg | x 2.204 6 ➔<br>🡐x 0.4536 | pounds |

## Temperature

| | | |
|---|---|---|
| $^0C$ | (1.8 x $^0C$) + 32 = $^0F$ ➔<br>🡐$^0C$ = ($^0F$-32) x 0.5556 | $^0F$ |
| | | |
| | | |
| | | |

## Work / Energy & Power

| | | |
|---|---|---|
| J | x 0.737 6 ➔<br>🡐x 1.356 | foot pounds |
| kJ | x 0.947 8 ➔<br>🡐x 1.055 | BTU |
| kW | x 1.341➔<br>🡐x 0.745 7 | hp (electric) |

## Pressure

| | | |
|---|---|---|
| Pa | x 0.145 x $10^{-3}$ ➔<br>🡐x 6.895 x $10^3$ | pounds per square inch |
| kPa | x 0.145 ➔<br>🡐x 6.895 | pounds per square inch |
| kPa | x 4.014 5 ➔<br>🡐x 0.249 | inches of water column |
| kPa | x 0.295 ➔<br>🡐x 3.386 | inches of mercury col. |
| psi | x 2.31 ➔<br>🡐x 0.433 | Feet of water depth |

## Flow Rate (volume / time)

| | | |
|---|---|---|
| L/s | x 13.198 5 →<br>← x 0.075 84 | gallons (Imperial) per minute |
| L/s | x 0.035 3 →<br>← x 28.316 | cubic feet per second |
| L/s | x 2.118 9 →<br>← x 0.471 9 | cubic feet per minute |
| L/s | x 127.134 →<br>← x 7.865 x $10^{-3}$ | cubic feet per hour |
| L/s | x 0.019 →<br>← x 52.616 | million gallons (Imperial) per day |
| L/d | x 0.219 975 →<br>← x 4.545 9 | gallons (Imperial) per day |
| ML/d | x 0.219 975 →<br>← x 4.545 9 | million gallons (Imperial) per day |
| $m^3$/d | x 219.975 →<br>← x 4.545 9 x $10^{-3}$ | gallons (Imperial) per day |
| $m^3$/d | x 0.219 97 x $10^{-3}$ →<br>← x 4.545 9 x $10^{3}$ | million gallons (Imperial) per day |
| $m^3$/s | x 19.005 6 →<br>← x 0.052 616 | million gallons (Imperial) per day |
| $m^3$/s | x 2 119 →<br>← x 4.719 x $10^{-4}$ | cubic feet per minute |
| $m^3$/s | x 35.315 →<br>← x 0.0283 2 | cubic feet per second |
| $10^3$ X $m^3$/d | x 490.596 →<br>← x 4.545 9 | million gallons (Imperial) per day |
| $m^3$/min | x 35.315 →<br>← x 0.028 32 | cubic feet per minute |
| L/min | x 0.219 975 →<br>← x 4.550 4 | gallons (Imperial) per minute |

## Rates

| | | |
|---|---|---|
| kg/h | x 2.205 →<br>← x 0.453 6 | pounds per hour |
| kg/d | x 2.205 →<br>← x 0.453 6 | pounds per day |
| g/$m^2$ Xs | x 17.70 →<br>← x 0.056 51 | pounds per day per square foot |
| kg/$m^2$ Xh | x 4.883 →<br>← x 0.204 8 | pounds per hour per square foot |
| kg/$m^2$ Xd | x 0.204 8 →<br>← x 4.883 | pounds per square foot per day |
| kg/ha Xd | x 0.892 2 →<br>← x 1.121 | pounds per acre per day |
| kg/ha Xy | x 0.892 2 →<br>← x 1.121 | pounds per acre per year |
| kg/$m^3$ Xd | x 0.062 43 →<br>← x 10.02 | pounds per cubic foot per day |
| m/h | x 3.281 →<br>← x 0.304 8 | feet per hour |
| $m^3$/$m^2$ Xh | x 3.281 →<br>← x 2.0385 x $10^{-3}$ | gallons (Imperial) per day per square foot |
| $m^3$/$m^2$ Xh | x 20.441 5 →<br>← x 0.304 8 | cubic feet per hour per square foot |
| $m^3$/$m^2$ Xd | x 16.02 →<br>← x 0.048 92 | gallons (Imperial) per day per square foot |
| $m^3$/kg | x 35.315 →<br>← x 0.062 43 | cubic feet per pound |

## AREAS

| | |
|---|---|
| Triangle<br>Area = ½ BxH<br>B = length of base<br>H = height of triangle | Rectangle<br>Area = L x W<br>L = length of rectangle<br>W = width of rectangle |
| Circle Area $= \pi R^2$ or $\frac{\pi D^2}{4}$ | $\pi$ = 3.1416<br>R = radius<br>D = diameter |

## VOLUMES

| | |
|---|---|
| Rectangular tank<br>Volume = area of base x H<br>or V = L x W x H | L = length of rectangle<br>W = width of rectangle<br>H = height of rectangle |
| Cylindrical tank<br>Volume = area of base x H<br>or V = $\pi R^2 \times H$<br>or V = $\frac{\pi D^2}{4} \times H$ | R = radius of base<br>D = diameter of base<br>H = height of cylinder |
| Cone<br>Volume = 1/3 area of base x H<br>or V = $1/3\pi R^2 \times H$<br>or V = $1/3\pi \frac{D^2}{4} \times H = \frac{1}{12}\pi D^2 \times H$ | R = radius of base<br>D = diameter of base<br>H = height of cone from base to apex |
| Prism<br>Volume = ½ area of rectangular base x H<br>or V = ½ L x W x H | L = length of rectangular base<br>W = width of rectangular base<br>H = height from base to apex |
| Sphere (ball)<br>Volume = $\frac{4\pi R^3}{3}$<br>or V = $\frac{4}{3}\pi \frac{D^3}{8} = \frac{1}{6}\pi D^3$ | R = radius of sphere<br>D = diameter of sphere |

## RATE OF FLOW

| | |
|---|---|
| Rate of flow = W x D x V<br>($m^3/s$) | W = width of channel (m)<br>D = depth of liquid in channel (m)<br>V = velocity of the flow (m/s) |
| PIPE:<br>Rate of flow = A x V<br>($m^3/s$) | A = cross sectional area ($m^2$)   $A = \pi R^2$<br>V = velocity (m/s) |

## DETENTION TIME

| | |
|---|---|
| Detention Time (hours) = $\frac{VT}{Q \times 3600}$ | VT = volume of tank ($m^3$)<br>Q = rate of flow ($m^3/s$) |

## OVERFLOW RATE

| | |
|---|---|
| Weir Overflow rate (L/sXm) = $\frac{Q}{WL}$ | Q = rate of flow (L/s)<br>WL = weir length (m)<br>Circumference of a circle = $2\pi R$ |

## EFFICIENCY

| | |
|---|---|
| Overall Efficiency (%) = $\frac{\text{Output} \times 100}{\text{Input}}$<br><br>Treatment Efficiency (%) = $\frac{(Ci - Ce) \times 100}{Ci}$ | Ci = concentration in the influent<br>Ce = concentration in the effluent |

## CHLORINATION

Chlorine Dosage = Chlorine Demand + Chlorine Residual

## RATE OF CHLORINE DOSAGE

| | |
|---|---|
| CD(mg/L) = $\frac{C\ (kg) \times 1000}{V\ (m^3)}$ OR CD(mg/L) = $\frac{C\ (kg)}{V\ (ML)}$ | CD = rate of chlorine applied (mg/L)<br>C = weight of chlorine added (kg)<br>V = volume of water treated ($m^3$ or ML depending on formula used) |

## FILTER LOADING RATE

| | |
|---|---|
| Filter Loading Rate ($L/m^2Xs$) = $\frac{Q\ (m^3/d) \times 0.0116}{A}$<br><br>Note: If flow rate Q is in L/s then the equation is:<br><br>Filter Loading Rate = $\frac{Q\ (L/s)}{A}$ | Q = flow rate ($m^3/d$)<br>A = surface area of the filter ($m^2$) |

## FILTER BACKWASH RATE

| | |
|---|---|
| Method 1. Filter Backwash Rate ($L/m^2Xs$) = $\frac{Q}{A}$<br><br>Method 2. Filter Backwash Rate (m/h) = $\frac{R}{T}$ | Q = rate of upflow of backwash water (L/s)<br>A = surface area of filter ($m^2$)<br>R = water rise (m)<br>T = time (h) |

## CHEMICAL FEEDING

| | |
|---|---|
| Chemical Feed Rate (ml/min) = $\frac{D \times Q}{c \times d \times 1440}$ | D = chemical dosage (mg/L)<br>Q = flow rate ($m^3/d$)<br>c = % active chemical expressed as a decimal<br>d = relative density of chemical feed ($g/cm^3$) |

## ORGANIC LOADING

Organic loading of an aeration tank refers to the daily mass of BOD entering the aeration tank volume.

| | |
|---|---|
| Organic Loading (kg BOD/$m^3$Xd) = $\frac{Q \times C}{V \times 1000}$ | Q = flow of settled sewage to aeration tank ($m^3$/d)<br>C = concentration of BOD in settled sewage (mg/L)<br>V = volume of aeration tank ($m^3$)<br><br>Note: the same formula can be used for the organic loading to a trickling filter. |

## SLUDGE VOLUME INDEX

| | |
|---|---|
| SVI = $\frac{\text{volume of settled sludge (mL)} \times 1000}{\text{MLSS (mg/L)}}$<br><br>SVI = $\frac{\text{volume of settled sludge (\%)}}{\text{mixed liquor suspended solids (\%)}}$ | MLSS = mixed liquor suspended solids (mg/L) |

## SLUDGE DENSITY INDEX

| | |
|---|---|
| SDI = $\frac{100}{\text{SVI}}$ | SVI = sludge volume index |

## F/M RATIO

| | |
|---|---|
| $\frac{F}{M}$ ratio = $\frac{BOD_5\ kg}{MLVSS\ kg}$<br><br>= $\frac{Q \times B}{V \times VSS}$ | $BOD_5$ *kg/d* = $\frac{Q \times B}{1000}$<br><br>where Q = flow of settled wastewater ($m^3$/d)<br>B = $BOD_5$ concentration of settled sewage (mg/L)<br>MLVSS *kg* = mixed liquor volatile suspended solids<br>MLVSS is assumed to be equal to the mass of microorganisms in the aeration tank<br><br>= $\frac{V \times VSS}{1000}$<br><br>where V = volume of aeration tank ($m^3$)<br>VSS = mixed liquor volatile suspended solids (mg/L) |

## RECYCLE RATE

| | |
|---|---|
| $Q_R$ = $\frac{Q_E \times MLSS}{RSSS - MLSS}$ | $Q_R$ = return or recycle sludge flow rate ($m^3$/d)<br>$Q_E$ = effluent flow rate ($m^3$/d) (may be assumed to equal influent flow rate)<br><br>MLSS = mixed liquor suspended solids (mg/L)<br>RSSS = return or recycle sludge suspended solids (mg/L) |

## SOLIDS RETENTION TIME (or Mean Cell Residence Time)

Solids Retention Time (SRT) or Mean Cell Retention Time (MCRT) is the length of time that biological solids are held within a process. SRT and MCRT is stated in days.

$$MCRT = \frac{(V_A \times MLSS) + (V_C \times MLSS)}{(Q_W \times WSSS) + (Q_E \times FESS)}$$

or in simplified form by omitting sludge in clarifier

$$SRT = \frac{V_A \times MLSS}{(Q_W \times WSSS) + (Q_E \times FESS)}$$

SRT = solids retention time in days
$V_A$ = volume of aeration tank(s) ($m^3$)
$V_C$ = volume of final settling tank ($m^3$)
$Q_W$ = daily waste sludge flow ($m^3$/d)
$Q_E$ = effluent (or influent) flow ($m^3$/d)
MLSS = mixed liquor suspended solids (mg/L)
WSSS = waste sludge suspended solids (mg/L)
FESS = final effluent suspended solids (mg/L)

## SLUDGE WASTING

$$\text{Waste Sludge Rate Required} = \frac{(M_1 - M_2) \times V}{R}$$

$M_1$ = present MLSS (mg/L)
$M_2$ = desired MLSS (mg/L)
V = volume of aeration tank ($m^3$)
R = suspended solids in sludge recycle or return (mg/L)

## RESPIRATION RATES

Oxygen Uptake Rate or Specific Uptake Rate (SUR)

$$\text{Oxygen Uptake Rate } (mgO_2/LXh) = \frac{(DO_1 - DO_2) \times 60}{T}$$

$$\text{Specific Uptake Rate} = SUR\ (mgO_2/hXg\ MLVSS)$$

$$= \frac{\text{Oxygen Uptake Rate} \times 1000}{MLVSS\ (mg/L)}$$

$DO_1$ = dissolved oxygen in mixed liquor sample at start of test (mg/L)
$DO_2$ = dissolved oxygen in mixed liquor sample at end of test (mg/L0
T =duration of the test (min.)

Oxygen Uptake Rate = rate of oxygen utilization ($mgO_2$/L ! h)

MLVSS = mixed liquor volatile suspended solids (mg/L)

## DIGESTER LOADING (volatile solids)

$$\text{Loading } (kg/m3Xd) = \frac{C \times P \times Q}{V \times 10}$$

C = concentration of solids in sludge feed (%)
P = concentration of volatile solids in sludge feed (%)
Q = volume of sludge feed ($m^3$/d)
V = volume of digester ($m^3$)

## REDUCTION OF VOLATILE SOLIDS IN DIGESTER

$$\text{Reduction } (\%) = \frac{(P_I - P_D)}{P_I - (P_I \times P_D)} \times 100$$

$P_D$ = volatile matter in digested sludge (%)
$P_I$ = volatile matter in feed (raw) sludge (%)

## FILTER YIELD (VACUUM)

$$\text{Yield } (kg/m^2Xh) = \frac{(C/100) \times Q}{A}$$

C = concentration of solids in sludge feed (%)
Q = sludge feed rate to filter (L/h)
A = surface area of filter ($m^2$)
(This formula assumes there are no solids in the filtrate and the specific gravity of sludge is equal to water.)

## POWER CALCULATIONS

| | |
|---|---|
| Water Power (kW) $= \frac{Q \times H}{6125}$ <br><br> Water Horsepower (Hp) $= \frac{Q \times H}{4570}$ | Q = rate of flow (L/min)<br>H = head of water (m)<br><br>(This equation assumes 100% motor and pump efficiency)<br><br>1 Hp (electric) = 0.7457 kW |
| Motor Power (kW) $= \frac{Q \times H}{6125} = \frac{\text{Water Power}}{\text{Pump Effic.}} = \frac{\text{Brake Power}}{\text{Motor Effic.}}$ | This equation does not assume 100% motor or pump efficiency.<br>A pump efficiency of 100% = 1<br>A motor efficiency of 100% = 1 |

## HYPOCHLORITE SOLUTIONS

| | |
|---|---|
| Amount of Hypochlorite needed = $\frac{\text{Strength of solution (\%)} \times \text{Volume of solution}}{\text{Strength of Hypochlorite available (\%)}}$ | Strength of solution = Strength of solution you need (%)<br>Volume of solution = Volume of solution you are making up |