

CONVERSION FACTORS - CANADIAN ABC EXAMINATION

On the left hand column of the table are the SI units (Système International d'Unités). When multiplied by the conversion factors given in the lower portion of each cell the Imperial Measure units will be found. To convert from the Imperial units to metric simply multiply by the conversion factor in the upper portion of each cell. The arrows next to each conversion factor show the direction of the conversions.

Length		
mm	$\times 0.039\ 37 \rightarrow$	inches
	$\leftarrow \times 25.4$	
mm	$\times 3.28 \times 10^{-3} \rightarrow$	feet
	$\leftarrow \times 304.8$	
cm	$\times 0.393\ 7 \rightarrow$	inches
	$\leftarrow \times 2.54$	
cm	$\times 0.032\ 8 \rightarrow$	feet
	$\leftarrow \times 30.48$	
m	$\times 39.37 \rightarrow$	inches
	$\leftarrow \times 0.025\ 4$	
m	$\times 3.281 \rightarrow$	feet
	$\leftarrow \times 0.304\ 8$	
km	$\times 3\ 280.84 \rightarrow$	feet
	$\leftarrow \times 0.304\ 8 \times 10^{-3}$	
km	$\times 1\ 093.61 \rightarrow$	yards
	$\leftarrow \times 9.144 \times 10^{-4}$	
km	$\times 0.621\ 4 \rightarrow$	miles
	$\leftarrow \times 1.609$	
Weight/Mass		
g	$\times 2.205 \times 10^{-3} \rightarrow$	pounds
	$\leftarrow \times 453.59$	
g	$\times 15.432\ 3 \rightarrow$	grains
	$\leftarrow \times 0.064\ 799$	
g	$\times 0.035\ 27 \rightarrow$	ounces
	$\leftarrow \times 28.349\ 5$	
mg	$\times 2.205 \times 10^{-6} \rightarrow$	pounds
	$\leftarrow \times 453\ 592.3$	
mg	$\times 0.015\ 43 \rightarrow$	grains
	$\leftarrow \times 64.799$	
kg	$\times 2.204\ 6 \rightarrow$	pounds
	$\leftarrow \times 0.453\ 6$	
Temperature		
°C	$(1.8 \times ^\circ\text{C}) + 32 = ^\circ\text{F} \rightarrow$	°F
	$\leftarrow ^\circ\text{C} = (^\circ\text{F} - 32) \times 0.5556$	

Area & Volume		
m ²	$\times 10.763\ 9 \rightarrow$	square feet
	$\leftarrow \times 0.092\ 9$	
m ²	$\times 1.196 \rightarrow$	square yards
	$\leftarrow \times 0.836\ 1$	
m ²	$\times 2.471 \times 10^{-4} \rightarrow$	acres
	$\leftarrow \times 4046.9$	
ha	$\times 2.471 \rightarrow$	acres
	$\leftarrow \times 0.404\ 69$	
cm ³	$\times 0.061\ 024 \rightarrow$	cubic inches
	$\leftarrow \times 16.387$	
m ³	$\times 35.315 \rightarrow$	cubic feet
	$\leftarrow \times 0.028\ 32$	
m ³	$\times 219.9 \rightarrow$	Imperial gallons
	$\leftarrow \times 4.546 \times 10^{-3}$	
L	$\times 0.2199 \rightarrow$	Imperial gallons
	$\leftarrow \times 4.546$	
mL	$\times 219,969.4 \rightarrow$	Imperial gallons
	$\leftarrow \times 0.434\ 6 \times 10^{-5}$	
m ³	$\times 0.2199 \times 10^{-3} \rightarrow$	Million Imp. gallons
	$\leftarrow \times 4.546 \times 10^3$	
US gallons	$\times 0.832\ 7 \rightarrow$	Imperial gallons
	$\leftarrow \times 1.2001$	
Work/Energy & Power		
J	$\times 0.737\ 6 \rightarrow$	foot pounds
	$\leftarrow \times 1.356$	
kJ	$\times 0.947\ 8 \rightarrow$	BTU
	$\leftarrow \times 1.055$	
kW	$\times 1.341 \rightarrow$	hp (electric)
	$\leftarrow \times 0.745\ 7$	
Pressure		
Pa	$\times 0.145 \times 10^{-3} \rightarrow$	pounds per square inch
	$\leftarrow \times 6.895 \times 10^3$	
kPa	$\times 0.145 \rightarrow$	pounds per square inch
	$\leftarrow \times 6.895$	
kPa	$\times 4.014\ 5 \rightarrow$	inches of water column
	$\leftarrow \times 0.249$	
kPa	$\times 0.295 \rightarrow$	inches of mercury col.
	$\leftarrow \times 3.386$	

Flow Rate (volume / time)			Rates		
L/s	x 13.198 5 → ← x 0.075 84	gallons (Imperial) per minute	kg/h	x 2.205 → ← x 0.453 6	pounds per hour
L/s	x 0.035 3 → ← x 28.316	cubic feet per second	kg/d	x 2.205 → ← x 0.453 6	pounds per day
L/s	x 2.118 9 → ← x 0.471 9	cubic feet per minute	g/m ² • s	x 17.70 → ← x 0.056 51	pounds per day per square foot
L/s	x 127.134 → ← x 7.865 x 10 ⁻³	cubic feet per hour	kg/m ² • h	x 4.883 → ← x 0.204 8	pounds per hour per square foot
L/s	x 0.019 → ← x 52.616	million gallons (Imperial) per day	kg/m ² • d	x 0.204 8 → ← x 4.883	pounds per square foot per day
L/d	x 0.219 975 → ← x 4.545 9	gallons (Imperial) per day	kg/ha • d	x 0.892 2 → ← x 1.121	pounds per acre per day
ML/d	x 0.219 975 → ← x 4.545 9	million gallons (Imperial) per day	kg/ha • y	x 0.892 2 → ← x 1.121	pounds per acre per year
m ³ /d	x 219.975 → ← x 4.545 9 x 10 ⁻³	gallons (Imperial) per day	kg/m ³ • d	x 0.062 43 → ← x 10.02	pounds per cubic foot per day
m ³ /d	x 0.219 97 x 10 ⁻³ → ← x 4.545 9 x 10 ³	million gallons (Imperial) per day	m/h	x 3.281 → ← x 0.304 8	feet per hour
m ³ /s	x 19.005 6 → ← x 0.052 616	million gallons (Imperial) per day	m ³ /m ² • h	x 3.281 → ← x 2.0385 x 10 ⁻³	gallons (Imperial) per day per square foot
m ³ /s	x 2 119 → ← x 4.719 x 10 ⁻⁴	cubic feet per minute	m ³ /m ² • h	x 20.441 5 → ← x 0.304 8	cubic feet per hour per square foot
m ³ /s	x 35.315 → ← x 0.283 2	cubic feet per second	m ³ /m ² • d	x 16.02 → ← x 0.048 92	gallons (Imperial) per day per square foot
10 ³ • m ³ /d	x 490.596 → ← x 4.545 9	million gallons (Imperial) per day	m ³ /kg	x 35.315 → ← x 0.062 43	cubic feet per pound
m ³ /min	x 17.70 → ← x 0.028 32	cubic feet per minute			
L/min	x 0.219 975 → ← x 4.550 4	gallons (Imperial) per minute			

AREAS

<p>Triangle Area = $\frac{1}{2} B \times H$ B = length of base H = height of triangle</p> <p>Circle = πR^2 or $\frac{\pi D^2}{4}$ Area</p>	<p>Rectangle Area = $L \times W$ L = length of rectangle W = width of rectangle</p> <p>π = 3.1416 R = radius D = diameter</p>
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VOLUMES

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

Lagoon

Approx. Volume = $\frac{W \times L + (W-2SD) \times (L-2SD) \times D}{2}$

- W = width of lagoon
 L = length of lagoon
 S = slope (ratio of horizontal to vertical distances on the interior sides of lagoon example 3:1, slope is taken as 3)
 D = depth of lagoon or depth of liquid in lagoon

RATE OF FLOW

<p>Rate of flow (m³/s) = $W \times D \times V$</p>	<p>W = width of channel (m) D = depth of liquid in channel (m) V = velocity of the flow (m/s)</p>
<p>PIPE: Rate of flow (m³/s) = $A \times V$</p>	<p>A = cross sectional area (m²) $A = \pi R^2$ V = velocity (m/s)</p>

DETENTION TIME

$$\text{Detention Time} = \frac{VT}{Q \times 3600}$$

VT = volume of tank (m³)
Q = rate of flow (m³/s)

OVERFLOW RATE

$$\text{Weir Overflow rate} = \frac{Q}{WL}$$

(L/s•m²)

Q = rate of flow (L/s)
WL = weir length (m)
Q = rate of flow (L/s)

EFFICIENCY

$$\text{Overall Efficiency (\%)} = \frac{\text{Output} \times 100}{\text{Input}}$$

C_i = concentration in the influent
C_e = concentration in the effluent

$$\text{Treatment Efficiency (\%)} = \frac{(C_i - C_e) \times 100}{C_i}$$

CHLORINATION

Total Chlorine Dosage = Chlorine Demand + Chlorine Residual

RATE OF CHLORINE DOSAGE

$$CD = \frac{C \times 1000}{W}$$

CD = rate of chlorine applied (mg/L)
C = weight of chlorine added (kg)
W = volume of water treated (m³)

FILTER LOADING RATE

$$\text{Filter Loading Rate} = \frac{Q \text{ (m}^3\text{/d)} \times 0.0116}{A}$$

(L/m²•s)

Q = flow rate (m³/d)
A = surface area of the filter (m²)

Note: If flow rate Q is in L/s then the equation is:

$$\text{Filter Loading Rate} = \frac{Q \text{ (L/s)}}{A}$$

FILTER BACKWASH RATE

$$\text{Method 1. Filter Backwash Rate} = \frac{Q}{A}$$

(L/m²•s)

Q = rate of upflow of backwash water (L/s)
A = surface area of filter (m²)
R = water rise (m)
T = time (h)

$$\text{Method 2. Filter Backwash Rate} = \frac{R}{T}$$

(m/h)

CHEMICAL FEEDING

$$\text{Chemical Feed Rate} = \frac{D \times Q}{c \times d \times 1440}$$

(ml/min)

D = chemical dosage (mg/L)
Q = flow rate (m³/d)
c = % active chemical expressed as a decimal
d = relative density of chemical feed (g/cm³)

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.

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

or in simplified form by omitting sludge in clarifier

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

- 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)
 Oxygen Uptake Rate ($\text{mgO}_2/\text{L}\cdot\text{h}$) = $\frac{(\text{DO}_1 - \text{DO}_2) \times 60}{T}$

Specific Uptake Rate = SUR ($\text{mgO}_2/\text{h}\cdot\text{g MLVSS}$)
 = $\frac{\text{Oxygen Uptake Rate} \times 1000}{\text{MLVSS} (\text{mg}/\text{L})}$

- 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/L)
- T = duration of the test (min.)
- Oxygen Uptake Rate = rate of oxygen utilization ($\text{mgO}_2/\text{L}\cdot\text{h}$)
- MLVSS = mixed liquor volatile suspended solids (mg/L)

DIGESTER LOADING (volatile solids)

$$\text{Loading} (\text{kg}/\text{m}^3\cdot\text{d}) = \frac{C \times P \times Q}{V \times 10}$$

- 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

$$\text{Reduction} (\%) = \frac{(P_f - P_d)}{P_f - (P_f \times P_d)} \times 100$$

- P_d = volatile matter in digested sludge (%)
- P_f = volatile matter in feed (raw) sludge (%)

FILTER YIELD (VACUUM)

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

- 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.)

ORGANIC LOADING

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

$$\text{Organic Loading (kg BOD/m}^3\cdot\text{d)} = \frac{Q \times C}{V \times 1000}$$

Q = flow of settled sewage to aeration tank (m³/d)
 C = concentration of BOD in settled sewage (mg/L)
 V = volume of aeration tank (m³)

Note: the same formula can be used for the organic loading to a trickling filter.

SLUDGE VOLUME INDEX

$$\text{SVI} = \frac{\text{volume of settled sludge (mL)} \times 1000}{\text{MLSS (mg/L)}}$$

MLSS = mixed liquor suspended solids (mg/L)

$$\text{SVI} = \frac{\text{volume of settled sludge (\%)}}{\text{mixed liquor suspended solids (\%)}}$$

SLUDGE DENSITY INDEX

$$\text{SDI} = \frac{100}{\text{SVI}}$$

SVI = sludge volume index

F/M RATIO

$$\frac{\text{F ratio}}{\text{M}} = \frac{\text{BOD}_5 \text{ kg}}{\text{MLVSS kg}}$$

$$\text{BOD}_5 \text{ kg/d} = \frac{Q \times B}{1000}$$

where Q = flow of settled wastewater (m³/d)
 B = BOD₅ concentration of settled sewage (mg/L)

MLVSS kg = mixed liquor volatile suspended solids
 MLVSS is assumed to be equal to the mass of microorganisms in the aeration tank

$$= \frac{V \times \text{VSS}}{1000}$$

where V = volume of aeration tank (m³)
 VSS = mixed liquor volatile suspended solids (mg/L)

$$= \frac{Q \times B}{V \times \text{VSS}}$$

RECYCLE RATE

$$Q_R = \frac{Q_E \times \text{MLSS}}{\text{RSSS} - \text{MLSS}}$$

Q_R = return or recycle sludge flow rate (m³/d)
 Q_E = effluent flow rate (m³/d) (may be assumed to equal influent flow rate)

MLSS = mixed liquor suspended solids (mg/L)
 RSSS = return or recycle sludge suspended solids (mg/L)

POWER CALCULATIONS

$$\text{Water Power (kW)} = \frac{Q \times H}{6125}$$

Q = rate of flow (L/min)
H = head of water (m)

(This equation assumes 100% motor and pump efficiency)

$$\text{Water Horsepower (Hp)} = \frac{Q \times H}{4570}$$

1 Hp (electric) = 0.7457 kW

$$\text{Motor Power (kW)} = \frac{Q \times H}{6125} = \frac{\text{Water Power}}{\text{Pump Effic.}} = \frac{\text{Brake Power}}{\text{Motor Effic.}}$$

This equation does not assume 100% motor or pump efficiency.
A pump efficiency of 100% = 1
A motor efficiency of 100% = 1