Conversion Factors and Unique Formulae Associated With the Transportation Professional Certification Board's Certification Examinations

Soft Conversion Factors

Metric	**English**	**English**	**Metric**
1 meter (m)	3.28 feet (ft)	1 foot (ft)	0.305 meters (m)
1 kilometer (km)	0.62 miles	1 mile (5,280 ft)	1.609 kilometers (km)
1 km/hour	0.62 mph	1 mph	1.609 km/hour
1 kilogram (kg)	2.20 pounds (lb)	1 pound (lb)	0.454 kilograms (kg)

Hard Conversion Factors

Lane Width		**Shoulder Width/Clearance**	
Metric (m)	**English (ft)**	**Metric (m)**	**English (ft)**
3.6 meters (m)	12 feet (ft)	3.0 meters (m)	10 feet (ft)
3.3 meters (m)	11 feet (ft)	2.4 meters (m)	8 feet (ft)
3.0 meters (m)	10 feet (ft)	1.8 meters (m)	6 feet (ft)
2.7 meters (m)	9 feet (ft)	1.2 meters (m)	4 feet (ft)

English	**Metric**
$E_m = \lambda^2/\mu(\mu - \lambda)$ Where: E_m = average queue length (veh) λ = arrival rate (v/min) μ = service rate (v/min)	
If $S < L$, then $L = AS^2/2158$ If $S > L$, then $L = 2S - (2158/A)$ Where: L = length of vertical curve (ft) A = algebraic difference in grades (%) $\lvert G_1 - G_2 \rvert$ (absolute of $G_1 - G_2$ in %) S = sight distance (ft)	If $S < L$, then $L = AS^2/658$ If $S > L$, then $L = 2S - (658/A)$ Where: L = length of vertical curve (m) A = algebraic difference in grades (%) $\lvert G_1 - G_2 \rvert$ (absolute of $G_1 - G_2$ in %) S = sight distance (m)
$d = 1.47\ Vt + 1.075\ V^2/a$ Where: d = stopping distance (ft) V = initial speed (mph) t = brake reaction time, 2.5 s (s) a = deceleration rate (ft/s^2)	$d = 0.278\ Vt + 0.039\ V^2/a$ Where: d = stopping distance (m) V = initial speed (km/h) t = brake reaction time, 2.5 s (s) a = deceleration rate (m/s^2)

English	Metric
$P = F\,[1/(1 + i)^n]$ Where: P = present worth of a future amount F = future amount i = interest rate n = service life	
$P = A\,[(1 + i)^n - 1] / [i(1 + i)^n]$ Where: P = present worth of a series of future amounts A = annual amount i = interest rate n = service life	
Incremental benefit/cost ratio of project *j* over project *k* = $\frac{(Benefits_j - Benefits_k)}{(Costs_j - Costs_k)}$	
$CP = t + (v/(2a \pm 2Gg)) + (W + L)/v$ Where: CP = change period (change + clearance intervals) (s) t = driver perception/reaction time (s) v = approach velocity (ft/s) a = deceleration rate (ft/s^2) g = 32/2 ft/s^2 G = percent of grade/100 W = width of intersection (ft) L = length of vehicle (ft)	$CP = t + (v/(2a \pm 2Gg)) + (W + L)/v$ Where: CP = change period (change + clearance intervals) (s) t = driver perception/reaction time (s) v = approach velocity (m/s) a = deceleration rate (m/s^2) g = 9.8 m/s^2 G = percent of grade/100 W = width of intersection (m) L = length of vehicle (m)
$PF = f_p(1 - P)/(1 - (g/C))$ Where: PF = progression factor f_p = supplemental adjustment factor P = proportion of vehicles arriving on green g = green time of phase(s) C = cycle length	

English	Metric
$f = (V^2/15R) - e/100$ Where: f = side friction factor V = speed (mph) R = curve radius (ft) e = rate of superelevation (%)	$f = (V^2/127R) - e/100$ Where: f = side friction factor V = speed (km/h) R = curve radius (m) e = rate of superelevation (%)
$d = 1.47V(J + t_a)$ Where: d = sight distance required (ft) V = approaching train velocity (mph) J = driver perception/reaction time (s) t_a = time to accelerate and clear (s)	$d = 0.28V(J + t_a)$ Where: d = sight distance required (m) V = approaching train velocity (km/h) J = driver perception/reaction time (s) t_a = time to accelerate and clear (s)
$C_o = (1.5L + 5)/(1 - Y_1 - Y_2 - Y_3 - \ldots Y_n)$ Where: C_o = optimum cycle length(s) L = lost time/cycle(s) Y_n = critical volume/saturation flow rate by phase	
K = L/A Where: K = a factor L = length of curve (ft) A = algebraic difference in grades (%) $\|G_1 - G_2\|$ (absolute of $G_1 - G_2$ in %)	K = L/A Where: K = a factor L = length of curve (m) A = algebraic difference in grades (%) $\|G_1 - G_2\|$ (absolute of $G_1 - G_2$ in %)
$U_s = dn/\Sigma t$ $U_t = \Sigma u/n$ $U_t = U_s + \sigma_s^2/ U_s$ Where: U_s = average space-mean speed U_t = average time-mean speed σ_s^2 = variance of space-mean speeds d = distance traversed n = number of travel times observed t_i = travel time for the *i*th vehicle u_i = speed of the *i*th vehicle	

English	**Metric**
$R_{sec} = A \times 10^8/(365TVL)$ Where: R_{sec} = crash rate for the road section per hundred million vehicle miles A = number of reported crashes T = time period of the crashes (years) V = annual average daily traffic volume (vehicles per day) L = length of the segment (miles)	$R_{sec} = A \times 10^8/(365TVL)$ Where: R_{sec} = crash rate for the road section per hundred million vehicle kilometers A = number of reported crashes T = time period of the crashes (years) V = annual average daily traffic volume (vehicles per day) L = length of the segment (kilometers)
$R_{spot} = A \times 10^6/(365TV)$ Where: R_{spot} = crash rate for the spot per million vehicles A = number of reported crashes T = time period of the analysis (years) V = annual average daily traffic volume entering the spot (vehicles per day)	
$d = \frac{v_i^2 - v_f^2}{2a}$ Where: d = distance v_i = initial velocity (fps) v_f = final velocity (fps) a = acceleration rate (ft/sec^2)	$d = \frac{v_i^2 - v_f^2}{2a}$ Where: d = distance v_i = initial velocity (mps) v_f = final velocity (mps) a = acceleration rate (m/sec^2)
$t = \frac{v_f - v_i}{a}$ t = total time v_f = final speed (fps) v_i = initial speed (fps) a = acceleration (ft/sec^2)	$t = \frac{v_f - v_i}{a}$ t = total time v_f = final speed (mps) v_i = initial speed (mps) a = acceleration (m/sec^2)
$\text{Density (veh/mi)} = \frac{\text{flow rate (veh/h)}}{\text{average travel speed (mi/h)}}$	$\text{Density (veh/km)} = \frac{\text{flow rate (veh/h)}}{\text{average travel speed (km/h)}}$

Revised 12/2022