

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

**Soft Conversion Factors**

<b>Metric</b>	<b>English</b>	<b>English</b>	<b>Metric</b>
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**

<b>Lane Width</b>		<b>Shoulder Width/Clearance</b>	
<b>Metric (m)</b>	<b>English (ft)</b>	<b>Metric (m)</b>	<b>English (ft)</b>
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)

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

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

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

English	Metric
$R_{sec} = A \times 10^8 / (365TVL)$ <p>Where:  <math>R_{sec}</math> = 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)</p>	$R_{sec} = A \times 10^8 / (365TVL)$ <p>Where:  <math>R_{sec}</math> = 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)</p>
$R_{spot} = A \times 10^6 / (365 TV)$ <p>Where:  <math>R_{spot}</math> = 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)</p>	
$d = \frac{v_i^2 - v_f^2}{2a}$ <p>Where:  d = distance  <math>v_i</math> = initial velocity (fps)  <math>v_f</math> = final velocity (fps)  a = acceleration rate (ft/sec<sup>2</sup>)</p>	$d = \frac{v_i^2 - v_f^2}{2a}$ <p>Where:  d = distance  <math>v_i</math> = initial velocity (mps)  <math>v_f</math> = final velocity (mps)  a = acceleration rate (m/sec<sup>2</sup>)</p>