

# Important Electric Train Physics Formulas PDF



## Formulas Examples with Units

### List of 15 Important Electric Train Physics Formulas

#### 1) Accelerating Weight of Train Formula ↻

Formula

$$W_e = W \cdot 1.10$$

Example with Units

$$30000 \text{ AT (US)} = 30000 \text{ AT (US)} \cdot 1.10$$

Evaluate Formula ↻

#### 2) Aerodynamic Drag Force Formula ↻

Formula

$$F_{\text{drag}} = C_{\text{drag}} \cdot \left( \frac{\rho \cdot V_f^2}{2} \right) \cdot A_{\text{ref}}$$

Example with Units

$$1091.3745 \text{ N} = 1.39 \cdot \left( \frac{98 \text{ kg/m}^3 \cdot 6.4 \text{ km/h}^2}{2} \right) \cdot 5.07 \text{ m}^2$$

Evaluate Formula ↻

#### 3) Coefficient of Adhesion Formula ↻

Formula

$$\mu = \frac{F_t}{W}$$

Example with Units

$$0.6229 = \frac{545 \text{ N}}{30000 \text{ AT (US)}}$$

Evaluate Formula ↻

#### 4) Crest Speed given Time for Acceleration Formula ↻

Formula

$$V_m = t_\alpha \cdot \alpha$$

Example with Units

$$98.352 \text{ km/h} = 6.83 \text{ s} \cdot 14.40 \text{ km/h*s}$$

Evaluate Formula ↻

#### 5) Energy Consumption for Run Formula ↻

Formula

$$E_{\text{run}} = 0.5 \cdot F_t \cdot V_m \cdot t_\alpha$$

Example with Units

$$14.124 \text{ w*h} = 0.5 \cdot 545 \text{ N} \cdot 98.35 \text{ km/h} \cdot 6.83 \text{ s}$$

Evaluate Formula ↻

#### 6) Maximum Power Output from Driving Axle Formula ↻

Formula

$$P_{\text{max}} = \frac{F_t \cdot V_m}{3600}$$

Example with Units

$$14.8891 \text{ w} = \frac{545 \text{ N} \cdot 98.35 \text{ km/h}}{3600}$$

Evaluate Formula ↻



## 7) Retardation of Train Formula ↻

Formula

$$\beta = \frac{V_m}{t_\beta}$$

Example with Units

$$10.3635 \text{ km/h}^*s = \frac{98.35 \text{ km/h}}{9.49_s}$$

Evaluate Formula ↻

## 8) Rotating Speed of Driven Wheel Formula ↻

Formula

$$N_w = \frac{N_{pp}}{i \cdot i_o}$$

Example with Units

$$956.6667 \text{ rev/min} = \frac{4879 \text{ rev/min}}{2.55 \cdot 2}$$

Evaluate Formula ↻

## 9) Schedule Speed Formula ↻

Formula

$$V_s = \frac{D}{T_{\text{run}} + T_{\text{stop}}}$$

Example with Units

$$25.1299 \text{ km/h} = \frac{258 \text{ km}}{10_h + 16_{\text{min}}}$$

Evaluate Formula ↻

## 10) Schedule Time Formula ↻

Formula

$$T_s = T_{\text{run}} + T_{\text{stop}}$$

Example with Units

$$10.2667_h = 10_h + 16_{\text{min}}$$

Evaluate Formula ↻

## 11) Time for Acceleration Formula ↻

Formula

$$t_\alpha = \frac{V_m}{\alpha}$$

Example with Units

$$6.8299_s = \frac{98.35 \text{ km/h}}{14.40 \text{ km/h}^*s}$$

Evaluate Formula ↻

## 12) Time for Retardation Formula ↻

Formula

$$t_\beta = \frac{V_m}{\beta}$$

Example with Units

$$9.4932_s = \frac{98.35 \text{ km/h}}{10.36 \text{ km/h}^*s}$$

Evaluate Formula ↻

## 13) Torque Generated by Scherbius Drive Formula ↻

Formula

$$\tau = 1.35 \cdot \left( \frac{E_b \cdot E_L \cdot I_r \cdot E_r}{E_b \cdot \omega_f} \right)$$

Example with Units

$$5.346 \text{ N}^*m = 1.35 \cdot \left( \frac{145 \text{ v} \cdot 120 \text{ v} \cdot 0.11_A \cdot 156 \text{ v}}{145 \text{ v} \cdot 520 \text{ rad/s}} \right)$$

Evaluate Formula ↻



## 14) Torque of Squirrel Cage Induction Motor Formula

Formula

$$\tau = \frac{K \cdot E^2 \cdot R_r}{\left(R_s + R_r\right)^2 + \left(X_s + X_r\right)^2}$$

Evaluate Formula 

Example with Units

$$5.3398 \text{ N}\cdot\text{m} = \frac{0.6 \cdot 200 \text{ V}^2 \cdot 2.75 \Omega}{\left(55 \Omega + 2.75 \Omega\right)^2 + \left(50 \Omega + 45 \Omega\right)^2}$$

## 15) Wheel Force Function Formula

Formula

$$F_w = \frac{i \cdot i_o \cdot \tau_e}{2 \cdot r_w}$$

Example with Units

$$5.3968 \text{ N} = \frac{2.55 \cdot 2 \cdot 4 \text{ N}\cdot\text{m}}{2 \cdot 1.89 \text{ m}}$$

Evaluate Formula 



## Variables used in list of Electric Train Physics Formulas above

- **A<sub>ref</sub>** Reference Area (Square Meter)
- **C<sub>drag</sub>** Drag Coefficient
- **D** Distance Travelled by Train (Kilometer)
- **E** Voltage (Volt)
- **E<sub>b</sub>** Back Emf (Volt)
- **E<sub>L</sub>** AC Line Voltage (Volt)
- **E<sub>r</sub>** RMS Value of Rotor Side Line Voltage (Volt)
- **E<sub>run</sub>** Energy Consumption for Run (Watt-Hour)
- **F<sub>drag</sub>** Drag Force (Newton)
- **F<sub>t</sub>** Tractive Effort (Newton)
- **F<sub>w</sub>** Wheel Force Function (Newton)
- **i** Gear Ratio of Transmission
- **i<sub>o</sub>** Gear Ratio of Final Drive
- **I<sub>r</sub>** Rectified Rotor Current (Ampere)
- **K** Constant
- **N<sub>pp</sub>** Speed of Motor Shaft in Powerplant (Revolution per Minute)
- **N<sub>w</sub>** Rotating Speed of Driven Wheels (Revolution per Minute)
- **P<sub>max</sub>** Maximum Output Power (Watt)
- **R<sub>r</sub>** Rotor Resistance (Ohm)
- **R<sub>s</sub>** Stator Resistance (Ohm)
- **r<sub>w</sub>** Radius of Wheel (Meter)
- **T<sub>run</sub>** Running Time of Train (Hour)
- **T<sub>s</sub>** Schedule Time (Hour)
- **T<sub>stop</sub>** Stop Time of Train (Minute)
- **t<sub>α</sub>** Time for Acceleration (Second)
- **t<sub>β</sub>** Time for Retardation (Second)
- **V<sub>f</sub>** Flow Velocity (Kilometer per Hour)
- **V<sub>m</sub>** Crest Speed (Kilometer per Hour)
- **V<sub>s</sub>** Schedule Speed (Kilometer per Hour)
- **W** Weight of Train (Ton (Assay) (US))

## Constants, Functions, Measurements used in list of Electric Train Physics Formulas above

- **Measurement: Length** in Kilometer (km), Meter (m)  
[Length Unit Conversion](#)
- **Measurement: Weight** in Ton (Assay) (US) (AT (US))  
[Weight Unit Conversion](#)
- **Measurement: Time** in Second (s), Hour (h), Minute (min)  
[Time Unit Conversion](#)
- **Measurement: Electric Current** in Ampere (A)  
[Electric Current Unit Conversion](#)
- **Measurement: Area** in Square Meter (m<sup>2</sup>)  
[Area Unit Conversion](#)
- **Measurement: Speed** in Kilometer per Hour (km/h)  
[Speed Unit Conversion](#)
- **Measurement: Acceleration** in Kilometer per Hour Second (km/h\*s)  
[Acceleration Unit Conversion](#)
- **Measurement: Energy** in Watt-Hour (W\*h)  
[Energy Unit Conversion](#)
- **Measurement: Power** in Watt (W)  
[Power Unit Conversion](#)
- **Measurement: Force** in Newton (N)  
[Force Unit Conversion](#)
- **Measurement: Electric Resistance** in Ohm (Ω)  
[Electric Resistance Unit Conversion](#)
- **Measurement: Electric Potential** in Volt (V)  
[Electric Potential Unit Conversion](#)
- **Measurement: Mass Concentration** in Kilogram per Cubic Meter (kg/m<sup>3</sup>)  
[Mass Concentration Unit Conversion](#)
- **Measurement: Angular Velocity** in Revolution per Minute (rev/min)  
[Angular Velocity Unit Conversion](#)
- **Measurement: Torque** in Newton Meter (N\*m)  
[Torque Unit Conversion](#)



- **$W_e$**  Accelerating Weight of Train (*Ton (Assay) (US)*)
- **$X_r$**  Rotor Reactance (*Ohm*)
- **$X_s$**  Stator Reactance (*Ohm*)
- **$\alpha$**  Acceleration of Train (*Kilometer per Hour Second*)
- **$\beta$**  Retardation of Train (*Kilometer per Hour Second*)
- **$\mu$**  Coefficient of Adhesion
- **$\rho$**  Mass Density (*Kilogram per Cubic Meter*)
- **$T$**  Torque (*Newton Meter*)
- **$T_e$**  Engine Torque (*Newton Meter*)
- **$\omega_f$**  Angular Frequency (*Radian per Second*)

- **Measurement: Angular Frequency** in Radian per Second (rad/s)  
Angular Frequency Unit Conversion 



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