



# **Electric Train Physics Formulas**

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# **List of 15 Electric Train Physics Formulas**

# Electric Train Physics 🗗

1) Accelerating Weight of Train

fx  $W_e = W \cdot 1.10$ 

Open Calculator

= 33000AT (US) = 30000AT (US) · 1.10

#### 2) Aerodynamic Drag Force

 $\left| \mathbf{F}_{\mathrm{drag}} = C_{\mathrm{drag}} \cdot \left( rac{
ho \cdot V_{\mathrm{f}}^2}{2} 
ight) \cdot A_{\mathrm{ref}} \, .$ 

Open Calculator 🗗

 $oxed{ex} 1091.374 \mathrm{N} = 1.39 \cdot \left(rac{98 \mathrm{kg/m^3} \cdot \left(6.4 \mathrm{km/h}
ight)^2}{2}
ight) \cdot 5.07 \mathrm{m^2}$ 

3) Coefficient of Adhesion

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

Open Calculator

 $ext{ex} 0.622857 = rac{545 ext{N}}{30000 ext{AT (US)}}$ 



#### 4) Crest Speed given Time for Acceleration G

fx  $V_{\mathrm{m}}=t_{lpha}\cdotlpha$ 

Open Calculator

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

## 5) Energy Consumption for Run

Open Calculator

fx  $ext{E}_{ ext{run}} = 0.5 \cdot ext{F}_{ ext{t}} \cdot ext{V}_{ ext{m}} \cdot ext{t}_{lpha}$  $(2.5 \pm 14.12396W) + (1.5 \pm 14.1239W) + (1.5 \pm 14.1239W)$ 

# 6) Maximum Power Output from Driving Axle

 $m P_{max} = rac{F_t \cdot V_m}{3600}$ 

Open Calculator

= 14.8891W =  $\frac{545\text{N} \cdot 98.35\text{km/h}}{2.335}$ 3600

## 7) Retardation of Train

= 10.36354km/h\*s =  $\frac{98.35 \text{km/h}}{0.40}$ 



## 8) Rotating Speed of Driven Wheel



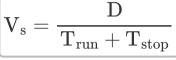
Open Calculator

Open Calculator 2

$$N_{
m w} = rac{N_{
m pp}}{{
m i}\cdot{
m i}_{
m o}}$$

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

# 9) Schedule Speed 🛂



 $oxed{ex} 25.12987 {
m km/h} = rac{258 {
m km}}{10 {
m h} + 16 {
m min}}$ 

# 10) Schedule Time

fx  $T_{
m s} = T_{
m run} + T_{
m stop}$ 10.26667h = 10h + 16min

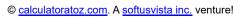
# 11) Time for Acceleration 😉

$$=$$
  $6.829861 \mathrm{s} = rac{98.35 \mathrm{km/h}}{14.40 \mathrm{km/h*s}}$ 

Open Calculator 2

Open Calculator







#### 12) Time for Retardation

$$\mathbf{f}\mathbf{x}igg|\mathbf{t}_{eta}=rac{\mathrm{V}_{\mathrm{m}}}{\mathrm{g}}igg|$$

Open Calculator

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

## 13) Torque Generated by Scherbius Drive

$$au = 1.35 \cdot \left(rac{\mathrm{E_b} \cdot \mathrm{E_L} \cdot \mathrm{I_r} \cdot \mathrm{E_r}}{\mathrm{E_b} \cdot \omega_\mathrm{f}}
ight)$$

Open Calculator 🗗

 $= 1.35 \cdot \left( \frac{145 \text{V} \cdot 120 \text{V} \cdot 0.11 \text{A} \cdot 156 \text{V}}{145 \text{V} \cdot 520 \text{rad/s}} \right)$ 

$$au = rac{ ext{K} \cdot ext{E}^2 \cdot ext{R}_{ ext{r}}}{\left( ext{R}_{ ext{s}} + ext{R}_{ ext{r}}
ight)^2 + \left( ext{X}_{ ext{s}} + ext{X}_{ ext{r}}
ight)^2}$$

Open Calculator

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



## 15) Wheel Force Function



$$= \frac{2.55 \cdot 2 \cdot 4N^*m}{2 \cdot 1.89m}$$



#### Variables Used

- 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>I</sub> AC Line Voltage (Volt)
- Er RMS Value of Rotor Side Line Voltage (Volt)
- Erun 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>0</sub> Gear Ratio of Final Drive
- Ir 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>n</sub> Time for Acceleration (Second)
- t<sub>B</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))
- We Accelerating Weight of Train (Ton (Assay) (US))
- X<sub>r</sub> Rotor Reactance (Ohm)
- X<sub>s</sub> Stator Reactance (Ohm)
- α Acceleration of Train (Kilometer per Hour Second)
- β Retardation of Train (Kilometer per Hour Second)
- µ Coefficient of Adhesion
- p Mass Density (Kilogram per Cubic Meter)
- T Torque (Newton Meter)
- Te Engine Torque (Newton Meter)
- **ω**f Angular Frequency (Radian per Second)





## Constants, Functions, Measurements used

- 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 (m²)
   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/m³)
   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
- Measurement: Angular Frequency in Radian per Second (rad/s)

  Angular Frequency Unit Conversion





#### **Check other formula lists**

- Electric Traction Drives Formulas
- Electric Train Physics Formulas

- Mechanics of Train Movement Formulas
- Power & Energy Formulas
- Traction Physics Formulas
- Tractive Effort Formulas

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