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Electric Train Physics Formulas

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List of 15 Electric Train Physics Formulas

Electric Train Physics

1) Accelerating Weight of Train

Open Calculator

fx $$W_e = W \cdot 1.10$$

ex $$33000\text{AT (US)} = 30000\text{AT (US)} \cdot 1.10$$

2) Aerodynamic Drag Force

Open Calculator

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

ex $$1091.374\text{N} = 1.39 \cdot \left(\frac{98\text{kg/m}^3 \cdot (6.4\text{km/h})^2}{2} \right) \cdot 5.07\text{m}^2$$

3) Coefficient of Adhesion

Open Calculator

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

ex $$0.622857 = \frac{545\text{N}}{30000\text{AT (US)}}$$

4) Crest Speed given Time for Acceleration

Open Calculator

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

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

5) Energy Consumption for Run

Open Calculator

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

ex $14.12396\text{W*h} = 0.5 \cdot 545\text{N} \cdot 98.35\text{km/h} \cdot 6.83\text{s}$

6) Maximum Power Output from Driving Axle

Open Calculator

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

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

7) Retardation of Train

Open Calculator

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

ex $10.36354\text{km/h*s} = \frac{98.35\text{km/h}}{9.49\text{s}}$

8) Rotating Speed of Driven Wheel

Open Calculator

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

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

9) Schedule Speed

Open Calculator

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

ex $$25.12987\text{km/h} = \frac{258\text{km}}{10\text{h} + 16\text{min}}$$

10) Schedule Time

Open Calculator

fx $$T_s = T_{run} + T_{stop}$$

ex $$10.26667\text{h} = 10\text{h} + 16\text{min}$$

11) Time for Acceleration

Open Calculator

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

ex $$6.829861\text{s} = \frac{98.35\text{km/h}}{14.40\text{km/h*s}}$$

12) Time for Retardation

Open Calculator

fx $$t_{\beta} = \frac{V_{m}}{\beta}$$

ex $$9.493243\text{s} = \frac{98.35\text{km/h}}{10.36\text{km/h*s}}$$

13) Torque Generated by Scherbius Drive

Open Calculator

fx $$\tau = 1.35 \cdot \left(\frac{E_{b} \cdot E_{L} \cdot I_{r} \cdot E_{r}}{E_{b} \cdot \omega_{f}} \right)$$

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

14) Torque of Squirrel Cage Induction Motor

Open Calculator

fx $$\tau = \frac{K \cdot E^{2} \cdot R_{r}}{(R_{s} + R_{r})^{2} + (X_{s} + X_{r})^{2}}$$

ex $$5.339779\text{N*m} = \frac{0.6 \cdot (200\text{V})^{2} \cdot 2.75\Omega}{(55\Omega + 2.75\Omega)^{2} + (50\Omega + 45\Omega)^{2}}$$

15) Wheel Force Function

Open Calculator

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

ex $$5.396825\text{N} = \frac{2.55 \cdot 2 \cdot 4\text{N*m}}{2 \cdot 1.89\text{m}}$$

Variables Used

- A_{ref} Reference Area *(Square Meter)*
- C_{drag} Drag Coefficient
- D Distance Travelled by Train *(Kilometer)*
- E Voltage *(Volt)*
- E_b Back Emf *(Volt)*
- E_L AC Line Voltage *(Volt)*
- E_r RMS Value of Rotor Side Line Voltage *(Volt)*
- E_{run} Energy Consumption for Run *(Watt-Hour)*
- F_{drag} Drag Force *(Newton)*
- F_t Tractive Effort *(Newton)*
- F_w Wheel Force Function *(Newton)*
- i Gear Ratio of Transmission
- i_o Gear Ratio of Final Drive
- I_r Rectified Rotor Current *(Ampere)*
- K Constant
- N_{pp} Speed of Motor Shaft in Powerplant *(Revolution per Minute)*
- N_w Rotating Speed of Driven Wheels *(Revolution per Minute)*
- P_{max} Maximum Output Power *(Watt)*
- R_r Rotor Resistance *(Ohm)*
- R_s Stator Resistance *(Ohm)*
- r_w Radius of Wheel *(Meter)*

- T_{run} Running Time of Train *(Hour)*
- T_s Schedule Time *(Hour)*
- T_{stop} Stop Time of Train *(Minute)*
- t_α Time for Acceleration *(Second)*
- t_β Time for Retardation *(Second)*
- V_f Flow Velocity *(Kilometer per Hour)*
- V_m Crest Speed *(Kilometer per Hour)*
- V_s Schedule Speed *(Kilometer per Hour)*
- W Weight of Train *(Ton (Assay) (US))*
- W_e Accelerating Weight of Train *(Ton (Assay) (US))*
- X_r Rotor Reactance *(Ohm)*
- X_s Stator Reactance *(Ohm)*
- α Acceleration of Train *(Kilometer per Hour Second)*
- β Retardation of Train *(Kilometer per Hour Second)*
- μ Coefficient of Adhesion
- ρ Mass Density *(Kilogram per Cubic Meter)*
- τ Torque *(Newton Meter)*
- τ_e 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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