

Important Vehicle Collision Formulas PDF



Formulas Examples with Units

List of 21 Important Vehicle Collision Formulas

1) Acceleration of Airbag Formula ↻

Formula

$$a = \frac{V_f^2 - V_i^2}{2 \cdot d_t}$$

Example with Units

$$13499.9985 \text{ m/s}^2 = \frac{90 \text{ m/s}^2 - 0.03 \text{ m/s}^2}{2 \cdot 0.30 \text{ m}}$$

Evaluate Formula ↻

2) Constant Deceleration of Vehicle during Collision Formula ↻

Formula

$$A_v = 0.5 \cdot \frac{V_o^2}{d}$$

Example with Units

$$200.9967 \text{ m/s}^2 = 0.5 \cdot \frac{11 \text{ m/s}^2}{0.301 \text{ m}}$$

Evaluate Formula ↻

3) Direction of Final Velocity of Vehicles after Collision Formula ↻

Formula

$$\theta = \text{atan}\left(\frac{V_{fy}}{V_{fx}}\right)$$

Example with Units

$$56.3496^\circ = \text{atan}\left(\frac{6.67 \text{ m/s}}{4.44 \text{ m/s}}\right)$$

Evaluate Formula ↻

4) Force Exerted on Airbag after Collision Formula ↻

Formula

$$F = m \cdot a$$

Example with Units

$$33750 \text{ N} = 2.50 \text{ kg} \cdot 13500 \text{ m/s}^2$$

Evaluate Formula ↻

5) Impact Force on Vehicle after Crash Formula ↻

Formula

$$F_{\text{avg}} = \frac{0.5 \cdot M \cdot v^2}{d}$$

Example with Units

$$5.9\text{E}+7 \text{ N} = \frac{0.5 \cdot 14230 \text{ N} \cdot 50 \text{ m/s}^2}{0.301 \text{ m}}$$

Evaluate Formula ↻

6) Kinetic Energy after Collision of Vehicles Formula ↻

Formula

$$K_f = \left(\frac{m_1}{m_1 + m_2}\right) \cdot K_i$$

Example with Units

$$22500 \text{ J} = \left(\frac{1.5 \text{ kg}}{1.5 \text{ kg} + 2.5 \text{ kg}}\right) \cdot 60000 \text{ J}$$

Evaluate Formula ↻



7) Magnitude of Resultant Final Velocity after Collision of Two Vehicles Formula

Formula

$$V_{\text{final}} = \sqrt{V_{\text{fx}}^2 + V_{\text{fy}}^2}$$

Example with Units

$$8.0126 \text{ m/s} = \sqrt{4.44 \text{ m/s}^2 + 6.67 \text{ m/s}^2}$$

Evaluate Formula 

8) Stopping Distance of Vehicle after Collision Formula

Formula

$$d = 0.5 \cdot V_o \cdot T_v$$

Example with Units

$$0.3008 \text{ m} = 0.5 \cdot 11 \text{ m/s} \cdot 0.0547 \text{ s}$$

Evaluate Formula 

9) Stopping Time of Vehicle after Collision Formula

Formula

$$T_v = \frac{V_o}{A_v}$$

Example with Units

$$0.0547 \text{ s} = \frac{11 \text{ m/s}}{201 \text{ m/s}^2}$$

Evaluate Formula 

10) Time of Occupant to Stop after Contacting Interiors during Collision Formula

Formula

$$T_c = \sqrt{\frac{2 \cdot \delta_{\text{occ}}}{A_v}}$$

Example with Units

$$0.0463 \text{ s} = \sqrt{\frac{2 \cdot 0.215 \text{ m}}{201 \text{ m/s}^2}}$$

Evaluate Formula 

11) Total Momentum in x-Direction before Collision of Two Vehicles Formula

Formula

$$P_{\text{tot}_{ix}} = P1_{ix} + P2_{ix}$$

Example with Units

$$10000.02 \text{ kg*m/s} = 10000 \text{ kg*m/s} + 0.02$$

Evaluate Formula 

12) Total Momentum in y-Direction before Collision of Two Vehicles Formula

Formula

$$P_{\text{tot}_{iy}} = P1_{iy} + P2_{iy}$$

Example with Units

$$18000.01 \text{ kg*m/s} = 0.01 \text{ kg*m/s} + 18000 \text{ kg*m/s}$$

Evaluate Formula 

13) Velocity of Occupant with Respect to Vehicle after Collision Formula

Formula

$$V_r = V_o \cdot \sqrt{\frac{\delta_{\text{occ}}}{d}}$$

Example with Units

$$9.2967 \text{ m/s} = 11 \text{ m/s} \cdot \sqrt{\frac{0.215 \text{ m}}{0.301 \text{ m}}}$$

Evaluate Formula 



14) Final Velocity Formulas ↻

14.1) Final Velocity after Collision in x-Direction Formula ↻

Formula

$$V_{fx} = \frac{P_{totfx}}{M_{total}}$$

Example with Units

$$2.963 \text{ m/s} = \frac{8000 \text{ kg} \cdot \text{m/s}}{2700 \text{ kg}}$$

Evaluate Formula ↻

14.2) Final Velocity after Collision in y-Direction Formula ↻

Formula

$$V_{fy} = \frac{P_{totfy}}{M_{total}}$$

Example with Units

$$6.8519 \text{ m/s} = \frac{18500 \text{ kg} \cdot \text{m/s}}{2700 \text{ kg}}$$

Evaluate Formula ↻

14.3) Final Velocity of Vehicle after Collision Formula ↻

Formula

$$V_f = \frac{P_{totf}}{M_{tot}}$$

Example with Units

$$-1.0625 \text{ m/s} = \frac{-4.25 \text{ kg} \cdot \text{m/s}}{4 \text{ kg}}$$

Evaluate Formula ↻

15) Momentum Formulas ↻

15.1) Momentum of First Vehicle before Collision Formula ↻

Formula

$$P_{1i} = m_1 \cdot V_{1i}$$

Example with Units

$$3 \text{ kg} \cdot \text{m/s} = 1.5 \text{ kg} \cdot 2 \text{ m/s}$$

Evaluate Formula ↻

15.2) Momentum of First Vehicle before Collision in x-Direction Formula ↻

Formula

$$P_{1ix} = m_1 \cdot V_{1ix}$$

Example with Units

$$10000.05 \text{ kg} \cdot \text{m/s} = 1.5 \text{ kg} \cdot 6666.7 \text{ m/s}$$

Evaluate Formula ↻

15.3) Momentum of Second Vehicle before Collision Formula ↻

Formula

$$P_{2i} = m_2 \cdot V_{2i}$$

Example with Units

$$-7.5 \text{ kg} \cdot \text{m/s} = 2.5 \text{ kg} \cdot -3 \text{ m/s}$$

Evaluate Formula ↻

15.4) Momentum of Second Vehicle before Collision in y-Direction Formula ↻

Formula

$$P_{2iy} = m_2 \cdot V_{2iy}$$

Example with Units

$$18000 \text{ kg} \cdot \text{m/s} = 2.5 \text{ kg} \cdot 7200 \text{ m/s}$$

Evaluate Formula ↻

15.5) Momentum of Two Vehicles before Collision Formula ↻

Formula

$$P_{toti} = P_{1i} + P_{2i}$$

Example with Units

$$-4.5 \text{ kg} \cdot \text{m/s} = 3 \text{ kg} \cdot \text{m/s} + -7.5 \text{ kg} \cdot \text{m/s}$$

Evaluate Formula ↻



Variables used in list of Vehicle Collision Formulas above

- **a** Acceleration of Airbag (Meter per Square Second)
- **A_v** Constant Deceleration of Vehicle (Meter per Square Second)
- **d** Stopping Distance of Vehicle (Meter)
- **d_t** Distance Traveled by Airbag (Meter)
- **F** Force Exerted on Airbag (Newton)
- **F_{avg}** Impact Force on Vehicle after Crash (Newton)
- **K_f** Kinetic Energy after Collision of Vehicles (Joule)
- **K_i** Kinetic Energy before Collision of Vehicles (Joule)
- **m** Mass of Airbag (Kilogram)
- **M** Vehicle Mass (Newton)
- **M_{tot}** Total Mass of Two Vehicles (Kilogram)
- **M_{total}** Total Mass of Colliding Vehicles (Kilogram)
- **m1** Mass of First Vehicle before Collision (Kilogram)
- **m2** Mass of Second Vehicle before Collision (Kilogram)
- **P1_i** Momentum of First Vehicle before Collision (Kilogram Meter per Second)
- **P1_{ix}** Total Momentum of First Vehicle in X-Direction (Kilogram Meter per Second)
- **P1_{iy}** Momentum of First Car before Collision in Y-Dir (Kilogram Meter per Second)
- **P2_i** Momentum of Second Vehicle before Collision (Kilogram Meter per Second)
- **P2_{ix}** Total Momentum Second Vehicle in X-Direction
- **P2_{iy}** Momentum of Second Car before Collision in Y-Dir (Kilogram Meter per Second)
- **Ptot_f** Momentum of Two Vehicles after Collision (Kilogram Meter per Second)

Constants, Functions, Measurements used in list of Vehicle Collision Formulas above

- **Functions: atan**, atan(Number)
Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- **Functions: sqrt**, sqrt(Number)
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Functions: tan**, tan(Angle)
The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- **Measurement: Length** in Meter (m)
Length Unit Conversion 
- **Measurement: Weight** in Kilogram (kg)
Weight Unit Conversion 
- **Measurement: Time** in Second (s)
Time Unit Conversion 
- **Measurement: Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Acceleration** in Meter per Square Second (m/s²)
Acceleration Unit Conversion 
- **Measurement: Energy** in Joule (J)
Energy Unit Conversion 
- **Measurement: Force** in Newton (N)
Force Unit Conversion 
- **Measurement: Angle** in Degree (°)
Angle Unit Conversion 
- **Measurement: Momentum** in Kilogram Meter per Second (kg*m/s)
Momentum Unit Conversion 



- **$P_{tot_{fx}}$** Total Momentum X-Direction after Collision (Kilogram Meter per Second)
- **$P_{tot_{fy}}$** Total Momentum in Y-Direction after Collision (Kilogram Meter per Second)
- **P_{tot_i}** Momentum of Two Vehicles before Collision (Kilogram Meter per Second)
- **$P_{tot_{ix}}$** Total Momentum in X-Direction before Collision (Kilogram Meter per Second)
- **$P_{tot_{iy}}$** Total Momentum in Y-Direction before Collision (Kilogram Meter per Second)
- **T_c** Time of Occupant to Stop (Second)
- **T_v** Stopping Time of Vehicle (Second)
- **v** Forward Velocity of Vehicle (Meter per Second)
- **V_f** Final Velocity of Airbag (Meter per Second)
- **V_{final}** Magnitude of Resultant Final Velocity (Meter per Second)
- **V_{fx}** Final Velocity after Collision in X-Direction (Meter per Second)
- **V_{fy}** Final Velocity after Collision in Y-Direction (Meter per Second)
- **V_i** Initial Velocity of Airbag (Meter per Second)
- **V_o** Initial Velocity before Collision (Meter per Second)
- **V_r** Relative Velocity of Occupant after Collision (Meter per Second)
- **$V1_i$** Velocity of First Vehicle before Collision (Meter per Second)
- **$V1_{ix}$** X-Direction Velocity of First Car before Collision (Meter per Second)
- **$V2_i$** Velocity of Second Vehicle before Collision (Meter per Second)
- **$V2_{iy}$** Y-Direction Velocity of Sec Car before Collision (Meter per Second)
- **V_f** Final Velocity of Vehicle after Collision (Meter per Second)
- **δ_{occ}** Stopping Distance of Occupant (Meter)
- **θ** Direction of Final Velocity (Degree)



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