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Vehicle Collision Formulas

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List of 21 Vehicle Collision Formulas

Vehicle Collision

1) Acceleration of Airbag

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

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 13500m/s^2 = \frac{(90m/s)^2 - (0.03m/s)^2}{2 \cdot 0.30m}$$

2) Constant Deceleration of Vehicle during Collision

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

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 200.9967m/s^2 = 0.5 \cdot \frac{(11m/s)^2}{0.301m}$$

3) Direction of Final Velocity of Vehicles after Collision

$$fx \quad \theta = a \tan \left(\frac{V_{fy}}{V_{fx}} \right)$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 56.3496^\circ = a \tan \left(\frac{6.67m/s}{4.44m/s} \right)$$



4) Force Exerted on Airbag after Collision

$$fx \quad F = m \cdot a$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 33750N = 2.50kg \cdot 13500m/s^2$$

5) Impact Force on Vehicle after Crash

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 5.9E^7N = \frac{0.5 \cdot 14230N \cdot (50m/s)^2}{0.301m}$$

6) Kinetic Energy after Collision of Vehicles

$$fx \quad K_f = \left(\frac{m1}{m1 + m2} \right) \cdot K_i$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 8.012646m/s = \sqrt{(4.44m/s)^2 + (6.67m/s)^2}$$



8) Stopping Distance of Vehicle after Collision

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

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 0.30085m = 0.5 \cdot 11m/s \cdot 0.0547s$$

9) Stopping Time of Vehicle after Collision

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 0.054726s = \frac{11m/s}{201m/s^2}$$

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

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 0.046253s = \sqrt{\frac{2 \cdot 0.215m}{201m/s^2}}$$

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

$$fx \quad P_{tot_{ix}} = P_{1_{ix}} + P_{2_{ix}}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 10000.02kg \cdot m/s = 10000kg \cdot m/s + 0.02$$



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

$$fx \quad P_{tot_{iy}} = P_{1_{iy}} + P_{2_{iy}}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 18000.01kg \cdot m/s = 0.01kg \cdot m/s + 18000kg \cdot m/s$$

13) Velocity of Occupant with Respect to Vehicle after Collision

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 9.296697m/s = 11m/s \cdot \sqrt{\frac{0.215m}{0.301m}}$$

Final Velocity

14) Final Velocity after Collision in x-Direction

$$fx \quad V_{fx} = \frac{P_{tot_{fx}}}{M_{total}}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$ex \quad 2.962963m/s = \frac{8000kg \cdot m/s}{2700kg}$$

15) Final Velocity after Collision in y-Direction

$$fx \quad V_{fy} = \frac{P_{tot_{fy}}}{M_{total}}$$

[Open Calculator !\[\]\(e50091943b385fe16d3277389202856f_img.jpg\)](#)

$$ex \quad 6.851852m/s = \frac{18500kg \cdot m/s}{2700kg}$$



16) Final Velocity of Vehicle after Collision

$$fx \quad V_f = \frac{P_{tot_f}}{M_{tot}}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

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

Momentum

17) Momentum of First Vehicle before Collision

$$fx \quad P1_i = m1 \cdot V1_i$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719_img.jpg\)](#)

$$ex \quad 3kg \cdot m/s = 1.5kg \cdot 2m/s$$

18) Momentum of First Vehicle before Collision in x-Direction

$$fx \quad P1_{ix} = m1 \cdot V1_{ix}$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7_img.jpg\)](#)

$$ex \quad 10000.05kg \cdot m/s = 1.5kg \cdot 6666.7m/s$$

19) Momentum of Second Vehicle before Collision

$$fx \quad P2_i = m2 \cdot V2_i$$

[Open Calculator !\[\]\(21226b58c700e5231ab98d27101bac58_img.jpg\)](#)

$$ex \quad -7.5kg \cdot m/s = 2.5kg \cdot -3m/s$$



20) Momentum of Second Vehicle before Collision in y-Direction

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

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

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

21) Momentum of Two Vehicles before Collision

$$fx \quad P_{tot_i} = P_{1_i} + P_{2_i}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

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



Variables Used

- **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_j** 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_j** Momentum of Second Vehicle before Collision (Kilogram Meter per Second)
- **P2_{ix}** Total Momentum Second Vehicle in X-Direction












- **P_{2iy}** Momentum of Second Car before Collision in Y-Dir (*Kilogram Meter per Second*)
- **P_{tot_f}** Momentum of Two Vehicles after Collision (*Kilogram Meter per Second*)
- **$P_{tot_{fx}}$** 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*)



- V_{1ix} X-Direction Velocity of First Car before Collision (Meter per Second)
- V_{2i} Velocity of Second Vehicle before Collision (Meter per Second)
- V_{2iy} 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)



Constants, Functions, Measurements used

- **Function:** **atan**, atan(Number)
Inverse trigonometric tangent function
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Function:** **tan**, tan(Angle)
Trigonometric tangent function
- **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 



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