On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS02007
1997 Nissan Altima four-door
Arizona
April, 2002

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract

This crash occurred in Arizona in April, 2002 at 0903 hours. The crash occurred on a two-lane undivided residential roadway. The asphalt roadway was dry and free of defects. The posted speed limit for streets in this area is 40 km/h (25 mph). The case vehicle, a 1997 Nissan Altima four-door driven by a restrained 14-year-old female, was traveling northbound on a two-lane residential street. The driver was seated in a fabric covered bucket seat. The seat track was adjusted to the middle track position. The driver was wearing the available lap and shoulder belt (ELR). The shoulder belt upper anchorage was in the full down position. The front right seat was occupied by a 19-month-old male. The front right occupant was originally seated in a fabric covered bucket seat. The seat track was adjusted to the middle track position. This occupant was wearing the available lap and shoulder belt (switchable in ELR position). According to the driver of the case vehicle, the front right occupant began getting out of the lap and shoulder belt and may have stood up. At this point, the driver leaned over to control the child. The case vehicle veered to the left and struck the left front of a parked 1988 Ford F250 pickup at a police-calculated impact speed of 37 km/h (23 mph). There was no pre-impact braking. The front of the case vehicle (12FDEW1) struck the front of the parked vehicle (11FYEW1). Both front air bags in the case vehicle deployed at impact. The parked truck was pushed into a second parked vehicle–a 1989 Buick Regal. The front right occupant of the case vehicle was taken by ambulance to a local hospital where he was declared brain dead and was taken off life support shortly after the crash.

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS02007

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BACKGROUND:

Description:	This child passenger air bag fatality case was located by NHTSA in a series of news articles. DSI was assigned the case on April 10, 2002. The case vehicle and scene were inspected on April 11, 2002. The investigating officer from the local jurisdiction was present during the vehicle inspection.
Investigation Type:	On-scene
Crash Location:	Arizona
Crash Date:	April 10, 2002
Notification Date:	April 10, 2002
Field Work Completed:	April 11, 2002

SUMMARY:

This crash occurred in Arizona in April, 2002 at 0903 hours. The crash occurred on a two-lane undivided residential roadway. The asphalt roadway was dry and free of defects. The posted speed limit for streets in this area is 40 km/h (25 mph).

Figure 1. Struck parked vehicle

The case vehicle, a 1997 Nissan Altima four-door driven by a restrained 14-year-old[1] female, was traveling northbound on a two-lane residential street. The driver was seated in a fabric covered bucket seat. The seat track was adjusted to the middle track position. The driver was wearing the available lap and shoulder belt (ELR). The shoulder belt upper anchorage was in the full down position. The front right seat was occupied by a 19-month-old male (87.3 cm/34.5 in, 11.8 kg/26 lbs). The front right occupant was originally seated in a fabric covered bucket seat. The seat track was adjusted to the middle track position. This occupant was wearing the lap portion of the available lap and shoulder belt (switchable in ELR position). The shoulder belt upper anchorage was in the full up position. He was wearing a T-shirt and tan shorts.

[1]For Arizona, if you are at least 15 years and 7 months of age you may be issued a graduated and/or a motorcycle instruction permit. You must be at least 18 for an operator permit.

The driver of the case vehicle was the front right occupant's aunt. The driver was coming back from a store after picking up milk. According to the driver of the case vehicle, the front right occupant began getting out of the lap and shoulder belt and may have stood up. At this point, the driver leaned over to control the child. The case vehicle veered to the left and struck the left front of a parked 1988 Ford F250 pickup at a police-calculated impact speed of 37 km/h (23 mph). DSI calculated the impact speed to be 38.6 km/h (24 mph)[2]. There was no pre-impact braking.

Figure 2. Front left, case vehicle

The front of the case vehicle (12FDEW1) struck the front of the parked vehicle (11FYEW1). The case vehicle had 118 cm (46.4 in) of direct contact beginning at the front right bumper corner and had a maximum crush[3] of 11 cm (4.3 in) at C1. The case vehicle sustained a total delta v of 24 km/h (14.9 mph), a longitudinal delta v of -24 km/h (–14.9 mph), a lateral delta v of 0 km/h (0 mph), and a barrier equivalent speed of 24.3 km/h (15 mph)[4]. Both front air bags in the case vehicle deployed at impact.

The other vehicle sustained a total delta v of 16.0 km/h (9.9 mph), a longitudinal delta v of -15.0 km/h (-9.3 mph), a lateral delta v of 5.5 km/h (3.4 mph), and a barrier equivalent speed of 15.8 km/h (9.8 mph).

The parked truck was pushed into a second parked vehicle–a 1989 Buick Regal.

[2]Calculated using in-line linear momentum formula (see attachment 1)

[3]Bumper crush averaged with above bumper crush

[4]Calculated using WinSmash version 2.1.2 using stiffness coefficients from NCAP test 2297, borderline reconstruction.

The driver of the case vehicle saw that the front right occupant was badly injured. She removed the child and took her to a local resident's house. CPR was initiated by a civilian on scene and then taken over by police and fire personnel as they arrived. The child was taken by air ambulance to a local hospital where he was declared brain dead and was taken off life support later that evening.

A timetable of events is shown below:

Time	Event
0903	Crash
0903	Police/fire dispatched
0905	Police on scene (CPR begun)
0909	Fire department on scene (CPR continued)
0920	Air ambulance on scene
0936	Air ambulance departs
1130	Pronounced brain dead
2330	Removed from life support, expired

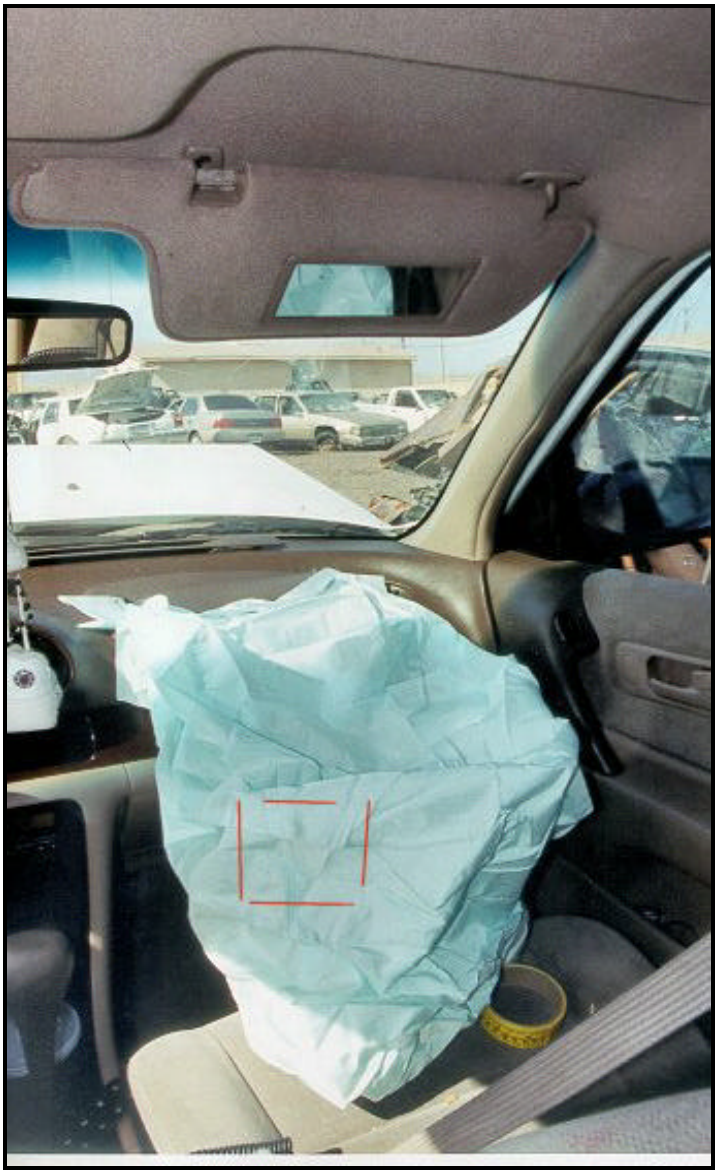

Figure 3. Passenger air bag–possible skin transfer

According to the autopsy report, the child sustained the following injuries: atlanto-occipital fracture dislocation, bilateral subdural hematomas, focal subarachnoid hemorrhage, marked cerebral edema, partial pontomedullary junction tear, bilateral hilar contusions of both lungs, linear abrasions across the anterior of the neck, and a square shaped focal contusion to the back of the head.

There was a possible skin transfer/contact to the left seam of the passenger air bag. There were no indications of any contact to the module cover. There was a light smear contact to the right side glass, but this may have been there for some time. There were no other specific indications of contact in the immediate seating area.

Scene Diagram

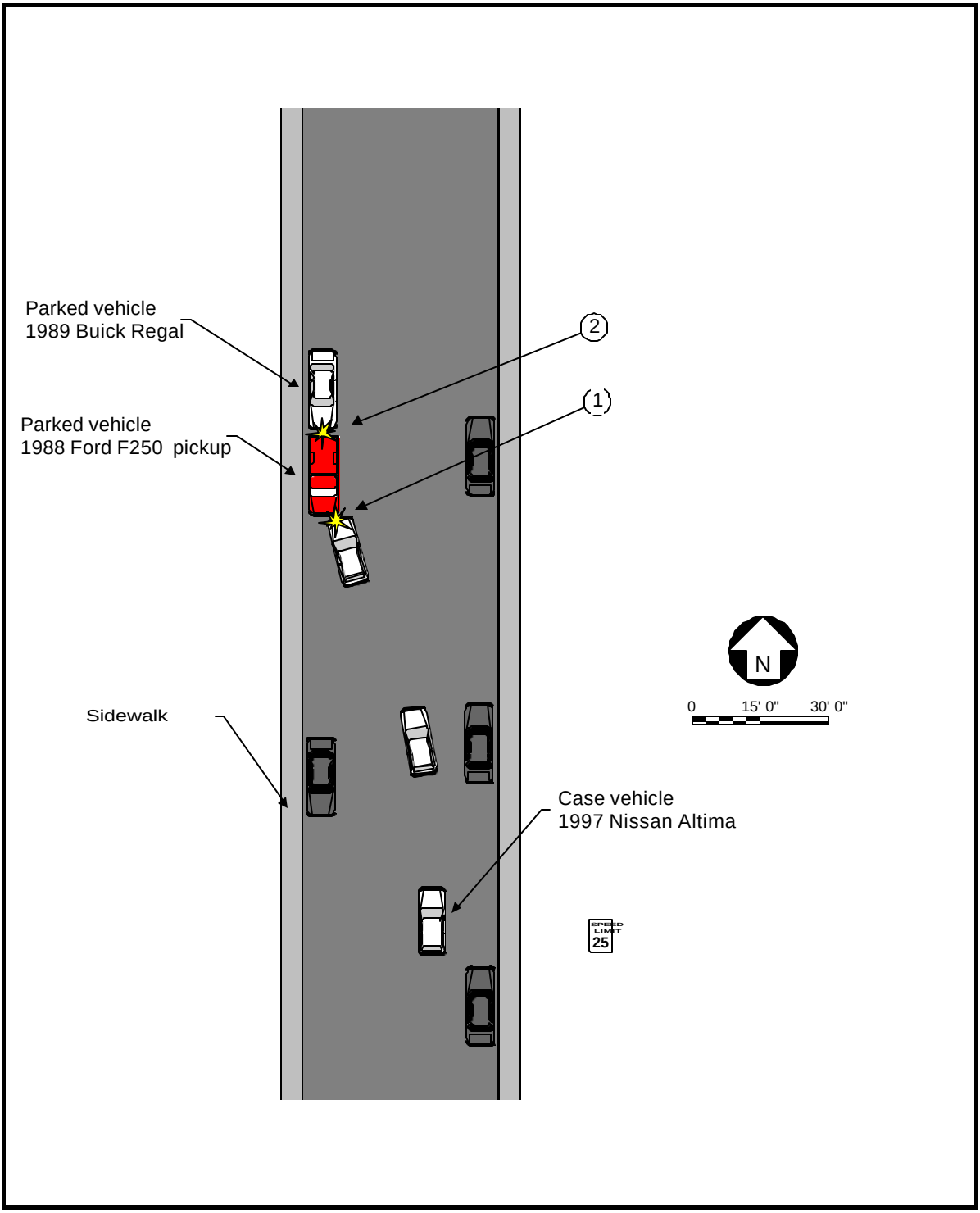

Figure 4. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	1997 Nissan Altima four-door	
VIN:	1N4BU31D9VCxxxxxx	
Odometer:	Unknown	
Engine:	146 CID, 4 cylinder	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate bumper and above bumper crush. Radiator damaged.	
CDC:	12FDEW1	
Impact Speed:	37 km/h (23 mph) - police estimate	
Delta V:	Total	24 km/h (14.9 mph)
	Longitudinal	-24.0 km/h (-14.9 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	30,151 joules (22,238 ft-lbs)

The driver's air bag is 70 cm (27.5 in) wide. There was one tether. There were two vent holes (11 and 1 o'clock positions). There was no damage to the air bag or the module cover.

The front right passenger air bag is 40 cm (15.7 in) wide, 60 cm (23.6 in) tall, and had a maximum post-crash excursion of 72 cm (28.3 in). There were no tether straps. There were two vent holes (3 and 9 o'clock positions). There was no damage to the air bag or the module cover.

Figure 5. Front of case vehicle

Other vehicle (parked)

Description:	1988 Ford F250 4 x 2 pickup	
VIN:	1FTHX25G0JKxxxxxx	
Odometer:	Unknown	
Engine:	460 CID, 8	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Minor frontal damage to bumper.	
CDC:	11FYEW1	
Delta V:	Total	16.0 km/h (9.9 mph)
	Longitudinal	-15.0 km/h (-9.3 mph)
	Latitudinal	5.5 km/h (3.4 mph)
	Energy	20,971 joules (15,467 ft-lbs)

Figure 6. Close up of damage to parked Ford pickup

Second other vehicle (parked)

Description:	1989 Buick Regal	
VIN:	2G4WB14T1K1xxxxxx	
Odometer:	Unknown	
Engine:	191 CID, 6 cylinder	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Minor frontal damage to bumper.	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Occupants

Case vehicle	Occupant 1	Occupant 2
Age/Sex:	14/Female	19 months/Male
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket seat. Seat adjusted to middle track position.	Fabric covered bucket seat. Seat adjusted to middle track position.
Height:	150 cm (59 in)	87.3 cm (34.5 in)
Weight:	43 kg (95 lbs)	11.8 kg (26 lbs)
Occupation:	Student	None
Pre-existing Medical Condition:	None noted	None
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Less that 1 year	NA
Body Posture:	Leaning to right	Upright, possibly trying to stand up. Facing forward.
Hand Position:	Right hand reaching over to Occupant 2	Unknown
Foot Position:	Right foot presumed to still be on accelerator, left on floor board	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used in some incorrect fashion
Air bag:	Driver's air bag available, deployed	Front right passenger air bag available, deployed

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	No reported injuries			
RF Occupant:	Partial pontomedullary junction tear[5]	140212.6,8	851.6	Air bag
	Bilateral subdural hematoma	140654.5,3	852.29	Air bag
	Bilateral hilar contusions to lungs	441410.4,3	861.21	Air bag
	Focal subarachnoid hemorrhage–most prominent at the base of the brain	140684.3,9	852.09	Air bag
	Marked cerebral edema	140660.3,9	348.5	Air bag
	Atlanto-occipital fracture subluxation (C2)	650204.2,6	805.02	Air bag
	Brush type abrasion to anterior neck (10 x 10 cm/ 4x4 in), with two prominent linear abrasions measuring (4.4 cm/1.75 in) each.	390202.1,5	910.0	Air bag
	Linear abrasion, left upper chest (5 cm/2 in)	490202.1,2	911.0	Air bag
	Focal abrasion to undersurface of chin, measuring (5x2.5 cm /2x1 in) in greatest dimension	290202.1,8	910.0	Air bag
	Squared shaped focal contusion, back of the head to the right	190402.1,6	920.0	Seat back

[5]Coded as brain stem laceration.

Laceration, right forearm	790600.1,1	881.00	Unknown
Thymus[6] contusion-left lateral aspect	442299.7,2	862.29	Air bag

[6]The thymus gland lies in the upper part of the medastinum behind the sternum and extends upward into the root of the neck.

Occupant Kinematics

The front right seat was occupied by a 19-month-old male (87.3 cm/34.5 in, 11.8 kg/26 lbs). The front right occupant was originally seated in a forward facing fashion in the fabric covered bucket seat. The seat track was adjusted to the middle track position. Based on the driver's statement it would appear that this occupant was initially wearing the available lap and shoulder belt. The shoulder belt upper anchorage was in the full up position. Based on his estimated erect sitting height (54.5 cm/21.4 in[7]), the top of the child's head would have been just below the top of the seat back. His arms would have been above the diagonal of the torso belt. It is this investigator's opinion that the child had put the torso portion behind him and was attempting to get up. He still had the lap portion on. At this point, the driver leaned over to control the child. The case vehicle veered to the left and struck the left front of the parked pickup at a police-calculated impact speed of 37 km/h (23 mph). There was no pre-impact braking. At impact, both frontal air bags deployed. The front right passenger air bag is 40 cm (15.7 in) wide, 60 cm (23.6 in) tall, and had a maximum post-crash excursion of 72 cm (28.3 in). This put the leading edge of the air bag 20 cm (7.9 in) from the face of the seat back.

Figure 7. Front right occupant seated area

The front right occupant pitched forward and engaged the still deploying airbag with the anterior portion of his neck causing the neck and facial abrasions. This occupant's head was forced rearward causing the atlanto-occipital fracture and the partial pontomedullary junction tear. This occupant was forced rearward into the front of the seat back–causing the contusion to the back of his head. The occupant also possibly contacted the right side glass leaving a skin oil transfer with his right hand or arm.

Figure 8. Possible hand/arm contact to side glass

[7]Anthropometry of Infants, Children and Youths to Age 18 for Product Safety Design, SAE SP450

The driver stated that she saw that the child was hurt so she removed his safety belt and took him to a nearby house.

Figure 9. Close up of skin oil transfer to side glass

Figure 10. Front right seat (red markings are paint or nail polish)

Attachment 1. Speed calculations

CASE NUMBER: DS02007

Comments: impact with first parked vehicle

*** * LINEAR MOMENTUM * ***

W1 × V1 - W2 × V2 = W1 × V3 + W2 × V4
2889.00 × V1 - 4310.00 × 0.00 = 2889.00 × 0.98 + 4310.00 × 8.26
2889.00 × V1 - 0.00 = 2831.22 + 35600.60
2889.00 × V1 - 0.00 = 38431.82
2889.00 × V1 = 38431.82 + 0.00
2889.00 × V1 = 38431.82

$$V1 = \frac{38431.82}{2889.00}$$

V1 = 13.30

W1 = The Wt of Veh 1 in Pounds.
W2 = The Wt of Veh 2 in Pounds.
V1 = The Speed of Veh 1 in MPH.
V2 = The Speed of Veh 2 in MPH.
V3 = The Spd After Impact, Veh 1.
V4 = The Spd After Impact, Veh 2.

INPUTS:	
The Wt of Veh 1 in Pounds is:	2889.00
The Min. Spd After Impact, Veh 1 is:	0.98
The Wt of Veh 2 in Pounds is:	4310.00
The Impact Spd of Veh 2 is:	0.00
The Min. Spd After Impact, Veh 2 is:	8.26

RESULTS:	
The Spd of Veh 1 in MPH is:	13.30
The Vel of Veh 1 in FPS is:	19.49

CASE NUMBER: DS02007

Comments: impact with first parked vehicle combined with second parked vehicle

*** * LINEAR MOMENTUM * ***

W1 × V1 - W2 × V2 = W1 × V3 + W2 × V4
2889.00 × V1 - 7333.00 × 0.00 = 2889.00 × 0.90 + 7333.00 × 7.59
2889.00 × V1 - 0.00 = 2600.10 + 55657.47
2889.00 × V1 - 0.00 = 58257.57
2889.00 × V1 = 58257.57 + 0.00
2889.00 × V1 = 58257.57

$$V1 = \frac{58257.57}{2889.00}$$

V1 = 20.16

W1 = The Wt of Veh 1 in Pounds.
W2 = The Wt of Veh 2 in Pounds.
V1 = The Speed of Veh 1 in MPH.
V2 = The Speed of Veh 2 in MPH.
V3 = The Spd After Impact, Veh 1.
V4 = The Spd After Impact, Veh 2.

INPUTS:	
The Wt of Veh 1 in Pounds is:	2889.00
The Min. Spd After Impact, Veh 1 is:	0.90
The Wt of Veh 2 in Pounds is:	7333.00
The Impact Spd of Veh 2 is:	0.00
The Min. Spd After Impact, Veh 2 is:	7.59

RESULTS:	
The Spd of Veh 1 in MPH is:	20.16
The Vel of Veh 1 in FPS is:	29.55

CASE NUMBER: DS02007

Comments: combined speeds

*** * COMBINED MINIMUM SPEEDS W/ KNOWN SPEEDS * ***

$S = \sqrt{S^2(1) + S^2(2) + \ldots S^2(n)}$

$S = \sqrt{(13.30)^2 + (20.16)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2}$

$S = \sqrt{176.89 + 406.42 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00}$

$S = \sqrt{583.31}$

$S = 24.15$

S = The Speed in MPH.
S^2 = The Individual Min. Speed.
(1), (2), (n) = The # of the individual speed.

INPUTS:	
Speed #1 in MPH is:	13.30
Speed #2 in MPH is:	20.16

RESULTS:	
The Speed in MPH is:	24.15
The Velocity in FPS is:	35.40