THE ROYAL SOCIETY

Be A Crash Test Investigator

Lockerbie Academy

&

Police Scotland

in association with

The Royal Society

Present

Be A Crash Test Investigator

Name _____ _____

Class _____

Group _____

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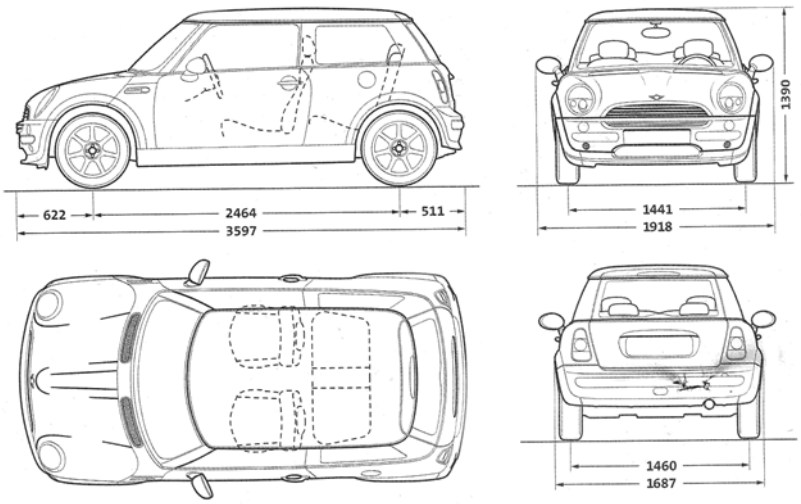
SCALING –with help!



Dimension	Real Mini (mm)	Model Mini (mm)	Scale Factor (real/model)
Front Bumper to middle of wheel	622	260	2.39
Back bumper to rear wheel	511	225	2.27
Mid wheel to mid wheel	2464	610	4.04
Total length	3597	1100	3.27
Wheel to wheel widths (front)	1441	530	2.72
Total width	1918	685	2.8
Total height	1390	545	2.19
Wheel to wheel widths (back)	1460	535	2.72
	1683	545	3.09

For our scene use a scale factor of 3:1 that is the real items would all be 3x bigger than the model

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SCALE FACTORS

Converting between metres per second and miles per hour

Speed	Speed	Scale factor
(mph)	(m/s)	
20	9.0	2.2
30	13.5	2.2
40	18.0	2.2
50	22.5	2.2
60	27.0	2.2
70	31.5	2.2

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Calculations for the crash scene involving a car and a pedestrian

The 'Skidman' provides a deceleration figure in metres per second per second or ms^{-2}.

The results for this scenario are as follows:

(1) $-6.80\ ms^{-2}$ (2) $-7.01\ ms^{-2}$

we use the formula **$v^2 = u^2 + 2as$**.

Where

v = Final velocity = 0
u = Initial velocity = ?
a = acceleration =
s = displacement =

Question 1 - What speed was the car traveling at when it started to skid?

Question 2 - What speed was the car doing when it collided with the pedestrian?

Question 3 - If the car had been travelling at the speed limit of 30mph would the car have still collided with the pedestrian?

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Car v Pedestrian answers and workings

Question 1 **-** *What speed was the car travelling at when it started to skid?*

To first calculate the velocity or speed of the car when it started to skid, we use the formula **$v^2 = u^2 + 2as$**.

Where

v = Final velocity = 0 ms^{-1}

u = Initial velocity = ?

a = acceleration = -6.80 ms^{-2}

(- figure due to it being a deceleration obtained from skid test results)

s = displacement = 24.45m (total length of the tyre skid mark)

Using **$v^2 = u^2 + 2as$**

$0 = u^2 + (2 \times -6.8 \times 24.45)$

$u^2 = 332.52$

so u = 18.23 m/s or 41mph.

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RESULTS

Question 2 - What speed was the car doing when it collided with the pedestrian?

To calculate the velocity or speed of the car when it collided with the pedestrian we use the same formula **$v^2 = u^2 + 2as$**.

To find the point of collision with the pedestrian we have to measure from the centre of the front wheels back to where the skid mark deviates slightly indicating where the contact took place. This is **7.17metres**.

Where v = final velocity = 0 ms^{-1}

u = initial velocity = ?

a = acceleration = **$-6.80\ ms^{-2}$**

(- figure due to it being a deceleration obtained from skid test results)

s = displacement = **7.17m**

(Length of skid mark after collision with pedestrian)

Using **$v^2 = u^2 + 2as$**

$0 = u^2 + (2 \times -6.8 \times 7.17)$

$u^2 = 97.512$

so u = 9.87 m/s. or 22mph.

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Question 3 ***- If the car had been travelling at the speed limit of 30mph would the car have still collided with the pedestrian?***

Again using the same formula **$v^2 = u^2 + 2as$**

Where v = Final velocity = 0 ms^{-1}

u = Initial velocity = 13.4 ms^{-1} (30mph)

a = acceleration = -6.80 ms^{-2} (- due to it being a deceleration)

s =displacement = ?

$$v^2 = u^2 + 2as$$

$$0 = 13.4^2 + (2 \times -6.8 \times s)$$

$$13.4^2 = 13.6s$$

$$s = \frac{179.86}{13.6}$$

$$s = \mathbf{13.22m}$$

Therefore had the car been traveling at 30mph then it would have stopped approximately 4 metres short of the pedestrian's position, and therefore would not have hit the pedestrian.

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Results of Crash Between a Car and a Pedestrian

The driver was banned from driving and spent 8 months in jail for this crash and failing to stop at the scene of a crash.

Don’t let something like this happen to YOU!

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Calculations for the crash scene involving cars A and B

The 'Skidman' provides a deceleration figure in metres per second per second or ms^{-2}.

The results for this scenario are as follows:-

(1) $-6.87ms^{-2}$ **(2) $-6.99ms^{-2}$**

The other values that are required that are not on the plan drawing are as follows

Mass of Car A = 1200 kg

Mass of Car B = 1400 kg

The formula for the tyre skid marks is **$v^2 = u^2 + 2as$**

Where v = final velocity (ms^{-1})

u= initial or starting velocity (ms^{-1})

a= acceleration (ms^{-2})

s =displacement

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RESULTS– collision between Car A & B

The final resting positions of the vehicles are the starting point for calculations, as it has some known values. The length of the skid mark post impact is calculated first and therefore its values are as follows:-

u = ?

v = 0m/s

a = acceleration = **-6.87ms^{-2}** (it's a minus due to it being a deceleration)

s = **10.6m** (find this from the plot)

Using **$v^2 = u^2 + 2as$**

$0 = u^2 + (2 \times -6.87 \times 10.6)$

$u^2 = 145.64$

so $u = 12.07 ms^{-1}$

This is the velocity of both the vehicles **just after** they collided and skidded along the roadway.

Conservation of Linear Momentum

When two or more bodies act upon one another, their total momentum remains constant, providing no external forces are acting upon them.

Total momentum before the collision = Total momentum after the collision.

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

For the puposes of the following calculations we are considering the momentum in the direction as travelled by car A, hence the reason the momentum for Car B below is zero.

Velocity of Both vehicles post collision = 12.07ms^{-1}

Mass of Car A = 1200 kg, Mass of Car B = 1400 kg

$1200 \times u_A + 0 = (1200 + 1400) \times 12.07$

$1200 u_A = 31382$

$u_A = \frac{31382}{1200}$

u_A = 26.15m/s = 57.5 mph

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It is now known that the velocity of car A was 26.15ms^{-1} when it collided with Car B.

Therefore again using the formula for the tyre skid mark **$v^2 = u^2 + 2as$** for the Initial skid marks made by car A its initial velocity can be calculated.

$$\mathbf{v^2 = u^2 + 2as}$$

$$26.15^2 = u^2 + (2 \times -6.87 \times 17.69)$$

$$u^2 = 683.82 + 243.06$$

$$u = \sqrt{926.88}$$

$$u = \mathbf{30.44ms^{-1}} \quad \mathbf{or\ 68mph.}$$

This speed calculated is a **MINIMUM** speed due to the 4 stages of braking which have been previously mentioned.

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