

TEAM NAME:

The Caribbeans

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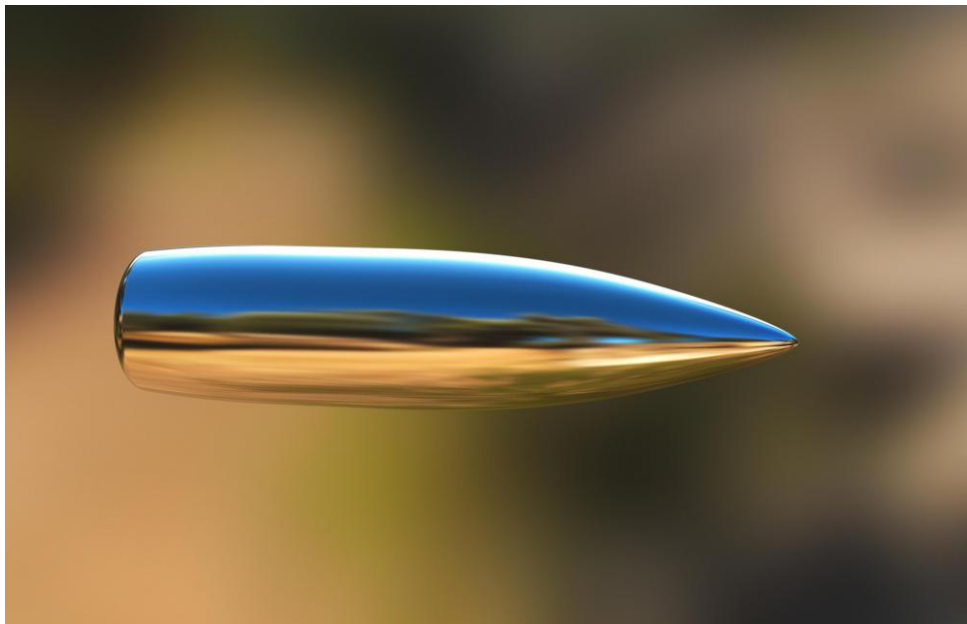
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## Impact Force Behind a Bullet

In mechanics, impact force is defined as the force with which two bodies collide over a short period. As you may already know, bullets tend to have a massive force of impact. The problem was figuring out exactly how much force each bullet produced at the moment of impact with an 1¼" piece of bulletproof glass. Bulletproof glass refers to any type of glass that is manufactured to withstand the impact of a bullet and prevent penetration.

(2)



(1)

$$\text{Weight of car} = 3200 \text{ lb} = 14,230 \text{ N}$$

$$\text{Mass} = \frac{W}{g} = \frac{3200 \text{ lb}}{32 \text{ ft/s}^2} = 100 \text{ slugs}$$

$$\text{KE}_{\text{initial}} = \frac{1}{2}mv^2$$

$$\text{Velocity} = 30 \text{ mi/hr} = 44 \text{ ft/s}$$

$$\text{KE} = \frac{1}{2}(100 \text{ slugs})(44 \text{ ft/s})^2$$

$$\text{KE} = 96,800 \text{ ft lb}$$

$$d = 1 \text{ foot after impact}$$



What effect would it have on the impact force if the car were more rigid, collapsing only 6 inches?

$$F_{\text{avg}} d = -\frac{1}{2}mv^2$$

Work required to stop the car

$$F_{\text{avg}} = \frac{-\frac{1}{2}mv^2}{d}$$

$$F_{\text{avg}} = \frac{96,800 \text{ ft lb}}{1 \text{ ft}} = 96,800 \text{ lb}$$

$$= 48.4 \text{ tons!}$$

## Equations

1. Constants: This constant represents the thickness, in feet, of the bulletproof glass that the projectiles will be fired at (3). The value below is equivalent to 1¼".

$$d = .1040'$$

2. First, we find the mass of the desired bullet, in slugs, using their weight in lbs. by using this equation (1). Where g is Earth's gravitational constant =  $g = 32.17 \frac{ft.}{s^2}$

$$w = \frac{m}{g}$$

3. Then, with this equation we find the kinetic energy of the chosen bullet, in ft./lbs., using their weight calculated previously and the velocity of the chosen bullet.(1)

$$KE = \frac{1}{2} * m * v^2$$

4. The following equations are displayed to clarify how we derived our final equation. Where F is the total impact force of the projectile. (1)

$$work = KE = F * d = \frac{1}{2} * m * v^2 = F = \frac{\frac{1}{2} * m * v^2}{d}$$

5. Finally, we use the equation derived previously to calculate the total impact force of the chosen projectile using the mass calculated at the beginning of the program, the given velocity of the chosen bullet, and d = the distance upon which the force of the bullet will act upon. (1)

$$F = \frac{\frac{1}{2} * m * v^2}{d}$$

## Parameters:

### Inputs

- a) Weight of the bullets, b) Earth's gravitational constant, c) the bullets velocity, d) the thickness of the bulletproof glass, which is the distance the force of the bullet will act upon impact.

### Outputs

- a) The mass in slugs, b) The Kinetic Energy of the bullet in ft./lbs., c) The impact force in ft./lbs.

## Output

### -Test Run #1:

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =

1.2467e+03

V40 =

1.1155e+03

V45 =

836.6100

V7\_62 =

2.4213e+03

V50 =

2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.

Input 2 to calculate mass of .40 bullet.

Input 3 to calculate the mass of .45 bullet.

Input 4 to calculate the mass of 7.62x39 bullet.

Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = 1

The mass of the 9mm bullet is 0.001 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the 9mm bullet is 507.313 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the 9mm bullet is approximately 4878.011 ft.lbs.  
Enlarge figure to see proper display of data.

## **-Test Run #2:**

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =  
1.2467e+03  
V40 =  
1.1155e+03  
V45 =  
836.6100  
V7\_62 =  
2.4213e+03  
V50 =  
2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.  
Input 2 to calculate mass of .40 bullet.  
Input 3 to calculate the mass of .45 bullet.  
Input 4 to calculate the mass of 7.62x39 bullet.  
Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = 2

The mass of the .40 bullet is 0.001 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the .40 bullet is 464.153 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the .40 bullet is approximately 4463.014 ft.lbs.  
Enlarge figure to see proper display of data.



### **-Test Run #3:**

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =

1.2467e+03

V40 =

1.1155e+03

V45 =

836.6100

V7\_62 =

2.4213e+03

V50 =

2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.

Input 2 to calculate mass of .40 bullet.

Input 3 to calculate the mass of .45 bullet.

Input 4 to calculate the mass of 7.62x39 bullet.

Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = 3

The mass of the .45 bullet is 0.001 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the .45 bullet is 358.987 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the .45 bullet is approximately 3451.800 ft.lbs.  
Enlarge figure to see proper display of data.

#### **-Test Run #4:**

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =  
1.2467e+03  
V40 =  
1.1155e+03  
V45 =  
836.6100  
V7\_62 =  
2.4213e+03  
V50 =  
2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.  
Input 2 to calculate mass of .40 bullet.  
Input 3 to calculate the mass of .45 bullet.  
Input 4 to calculate the mass of 7.62x39 bullet.  
Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = 4

The mass of the 7.62x39 bullet is 0.001 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the 7.62x39 bullet is 1640.115 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the 7.62x39 bullet is approximately 15770.337 ft.lbs.  
Enlarge figure to see proper display of data.

### **-Test Run #5:**

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =

1.2467e+03

V40 =

1.1155e+03

V45 =

836.6100

V7\_62 =

2.4213e+03

V50 =

2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.

Input 2 to calculate mass of .40 bullet.

Input 3 to calculate the mass of .45 bullet.

Input 4 to calculate the mass of 7.62x39 bullet.

Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = 5

The mass of the .50BMG bullet is 0.004 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the .50BMG bullet is 14836.478 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the .50BMG bullet is approximately 142658.438 ft.lbs.  
Enlarge figure to see proper display of data.

#### **-Test Run #6:**

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =  
1.2467e+03  
V40 =  
1.1155e+03  
V45 =  
836.6100  
V7\_62 =  
2.4213e+03  
V50 =  
2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.  
Input 2 to calculate mass of .40 bullet.  
Input 3 to calculate the mass of .45 bullet.  
Input 4 to calculate the mass of 7.62x39 bullet.  
Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = 6

Please input value from 1-5.  
Invalid entry. Please try again.  
Selection variable is = 6  
Please input value from 1-5.  
Invalid entry. Please try again.  
Selection variable is = 6  
Please input value from 1-5.  
Invalid entry. Please try again.  
Selection variable is = 4  
The mass of the 7.62x39 bullet is 0.001 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the 7.62x39 bullet is 1640.115 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the 7.62x39 bullet is approximately 15770.337 ft.lbs.  
Enlarge figure to see proper display of data.

### **-Test Run #7:**

The following variables represent constants to be used by the program:

d =

0.1040

The value above is in feet, but it is equivalent to 1.25 inches.

g =

32.1700

The following variables represent the weights of every caliber in pounds(lbs.):

W9 =

0.0210

W40 =

0.0240

W45 =

0.0330

W7\_62 =

0.0180

W50 =

0.1140

The following variables represent the velocity of each bullet in feet per second (ft./s):

V9 =

1.2467e+03

V40 =

1.1155e+03

V45 =

836.6100

V7\_62 =

2.4213e+03

V50 =

2.8937e+03

Choose an input from the selection below for the program to calculate the mass of the chosen bullet, in slugs, using their weight in lbs.

Input 1 to calculate mass of 9mm bullet.

Input 2 to calculate mass of .40 bullet.

Input 3 to calculate the mass of .45 bullet.

Input 4 to calculate the mass of 7.62x39 bullet.

Input 5 to calculate the mass of .50BMG bullet.

Selection variable is = a

Error using input

Undefined function or variable 'a'.

Error in force\_of\_impact\_final\_project (line 42)

W = input('Selection variable is = ');

Selection variable is = k

Error using input

Undefined function or variable 'k'.

Error in force\_of\_impact\_final\_project (line 42)

W = input('Selection variable is = ');

Selection variable is = 5

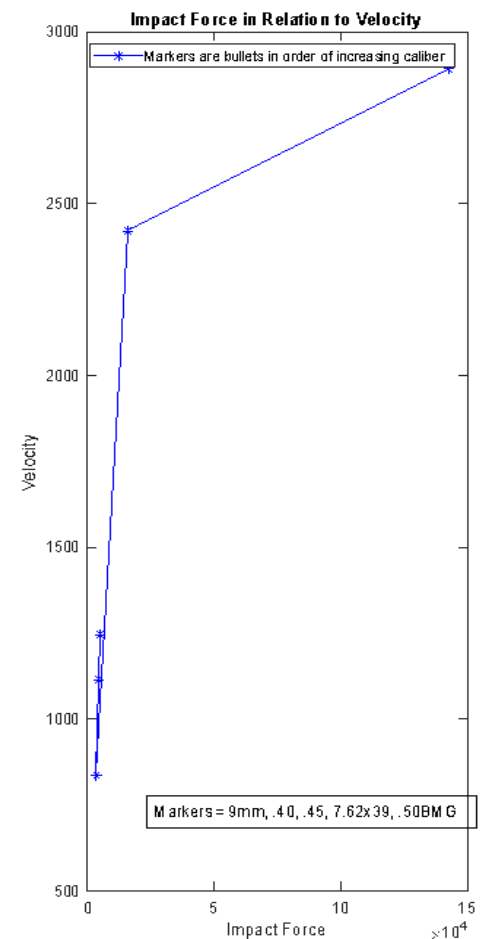
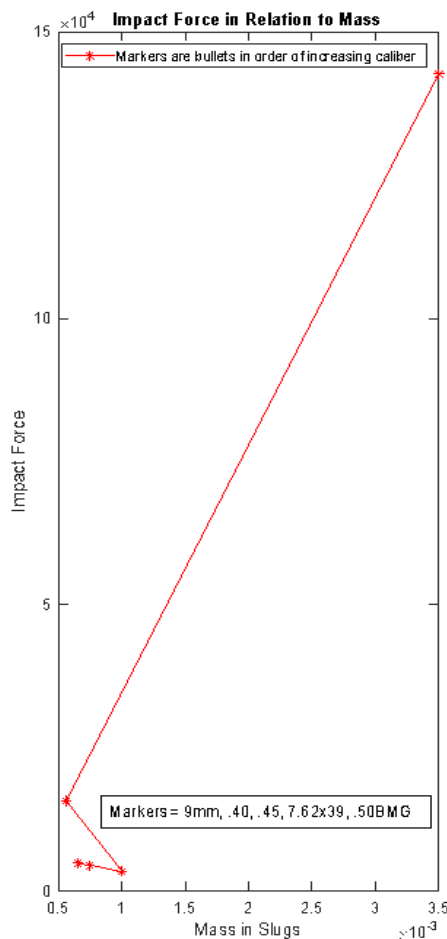
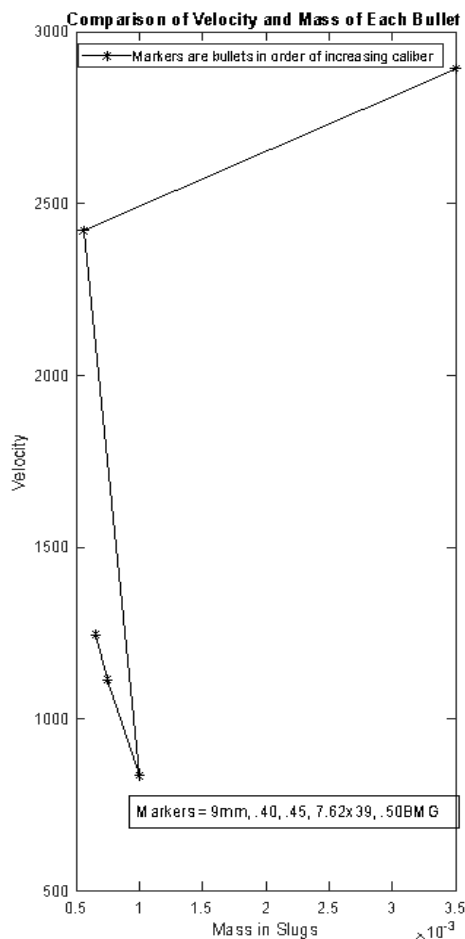
The mass of the .50BMG bullet is 0.004 slugs.

The program is now calculating the Kinetic Energy of each projectile using the mass previously acquired and the velocities of the bullets.  
please wait a few seconds

The Kinetic Energy of the .50BMG bullet is 14836.478 ft.lbs.

The program is now calculating the total impact force of the chosen bullet.  
please wait a few seconds

The impact force of the .50BMG bullet is approximately 142658.438 ft.lbs.  
Enlarge figure to see proper display of data.





## Bibliography

- (1) <http://hydrogen.physik.uniwuppertal.de/hyperphysics/hyperphysics/hbase/carc2.html>
- (2) <https://www.wisegeek.com/what-is-bullet-proof-glass.htm>
- (3) [http://cdn2.hubspot.net/hub/211952/file-213902473-pdf/docs/tss\\_the\\_8\\_levels\\_of\\_resistance.pdf?hsCtaTracking=d64e25a0-a93d-4163-9dd5-8b05f78cfcff%7Ceb640bd0-b869-45f4-9b13-f901a22d9601](http://cdn2.hubspot.net/hub/211952/file-213902473-pdf/docs/tss_the_8_levels_of_resistance.pdf?hsCtaTracking=d64e25a0-a93d-4163-9dd5-8b05f78cfcff%7Ceb640bd0-b869-45f4-9b13-f901a22d9601)