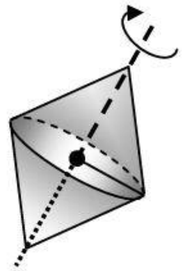
# Experimental Measurements & Theoretical Calculations: Diamond Core

**Calculation: Diamond Core – Central Axis**

$$I_{Diamond} = \frac{3}{5} MR^2$$

$$I_{Diamond} = \frac{3}{5}(2.580kg)(0.058m)^2$$

$$I_{Diamond} = 5.20 \times 10^{-3}\, kg \cdot m^2$$



| Data | |
|---|---|
| Core Mass | 2.580 (kg) |
| Core Radius | 0.058 (m) |

| Experimental Data | | |
|---|---|---|
| Hanging Mass: | m = | 0.051 (kg) |
| Rotational Axis Radius of Platform: | $r_p$ = | 0.0063 (m) |
| Local Gravitational Acceleration: | g = | 9.8002 (m/s²) |
| Drop Height: | h = | 0.85 (m) |

| Time Trials (sec) | |
|---|---|
| $t_1$ | 17.50 |
| $t_2$ | 17.47 |
| $t_3$ | 17.72 |
| $t_4$ | 17.91 |
| $t_5$ | 17.78 |
| $t_6$ | 17.53 |
| $t_7$ | 17.87 |
| $t_8$ | 18.22 |
| $t_9$ | 18.47 |
| $t_{10}$ | 18.16 |
| $t_{avg}$ | 17.87 |

$$I_{Diamond+Rod} = \frac{\left(\left(gt^2 - 2h\right) mr_p^2\right)}{2h}$$

$$I_{Diamond+Rod} = \frac{\left(\left(9.8002\frac{m}{s^2}(17.87s)^2 - 2(0.85m)\right)(0.051kg)(0.0063m)^2\right)}{2(0.85m)}$$

$$I_{Diamond+Rod} = 3.724 \times 10^{-3}\, kg \cdot m^2$$

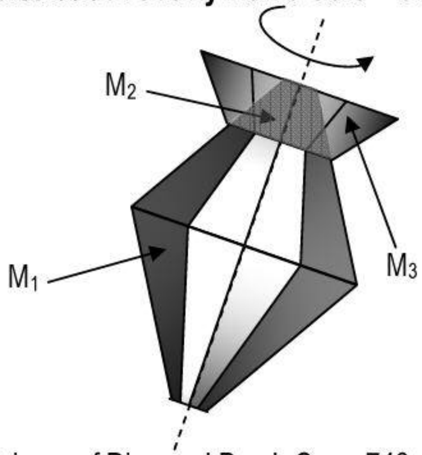
$$I_{Diamond} = I_{Diamond+Rod} - I_{Rod}$$

$$I_{Diamond} = \left(3.724 \times 10^{-3}\, kg \cdot m^2\right) - \left(4.58 \times 10^{-4}\, kg \cdot m^2\right)$$

$$I_{Diamond} = 3.144 \times 10^{-3}\, kg \cdot m^2$$

# EXPERIMENTAL MEASUREMENTS & THEORETICAL CALCULATIONS: CHERRY BOMB CORE

**Calculation: Cherry Bomb Core – Central Axis**

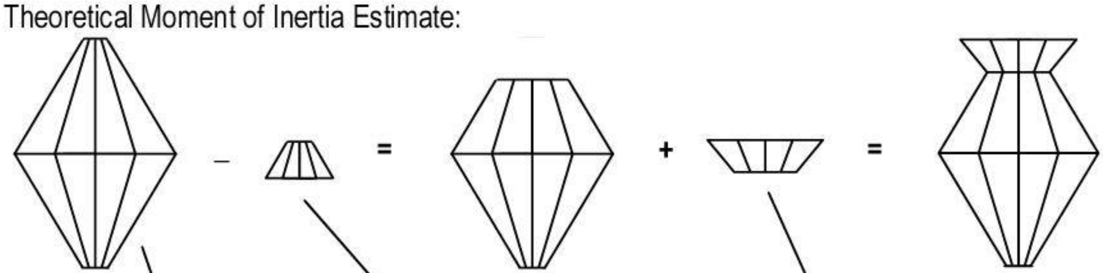



| | Data |
|---|---|
| **Core Mass** | 2 |
| $R_1$ | 0 |
| $R_2$ | 0 |
| $R_3$ | 0 |
| $V_1$ | 6 |
| $V_2$ | |
| $V_3$ | 1 |

Volume of Diamond Bomb Core: 740 mL
Average Density: 2290 g / 740 mL = 3.10 g/mL

Section 1: Mass Section 1 = $M_1$ = (3.10 g/mL)×($V_1$) = 1984 g
Section 2: Mass Section 2 = $M_2$ = (2.50 g/mL)×($V_2$) = 186 g
Section 3: Mass Section 3 = $M_3$ = (2.50 g/mL)×($V_3$) = 310 g

Theoretical Moment of Inertia Estimate:



$$I_{Bomb} = \left(\frac{3}{5}(M_1 + M_2)(R_1)^2\right) - \left(\frac{3}{10}M_2(R_2)^2\right) =$$  $$+\left(\frac{1}{2}M_3(R_3)^2\right) =$$ 

$$I_{Bomb} = \left(\frac{3}{5}(M_1 + M_2)(R_1)^2\right) - \left(\frac{3}{10}M_2(R_2)^2\right) + \left(\frac{1}{2}M_3(R_3)^2\right) =$$ 

$$I_{Bomb} = \left(\frac{3}{5}(1.984kg + 0.186kg)(0.055m)^2\right) - \left(\frac{3}{10}(0.186kg)(0.028m)^2\right) + \left(\frac{1}{2}(0.310kg)(0.031m)^2\right)$$

$$I_{Bomb} = \left(3.94\times10^{-3}kg\cdot m^2\right) - \left(4.37\times10^{-5}kg\cdot m^2\right) + \left(1.49\times10^{-4}kg\cdot m^2\right)$$

$$\boxed{I_{Bomb} = 4.05\times10^{-3}kg\cdot m^2} =$$ 

## Experimental Measurements & Theoretical Calculations: Cherry Bomb Core

| Experimental Data | | |
|---|---|---|
| **Hanging Mass:** | m = | 0.051 (kg) |
| **Rotational Axis Radius of Platform:** | $r_p$ = | 0.0063 (m) |
| **Local Gravitational Acceleration:** | g = | 9.8002 $(m/s^2)$ |
| **Drop Height:** | h = | 0.85 (m) |

| Time Trials (sec) | |
|---|---|
| $t_1$ | 15.29 |
| $t_2$ | 14.88 |
| $t_3$ | 17.47 |
| $t_4$ | 16.34 |
| $t_5$ | 17.85 |
| $t_6$ | 17.09 |
| $t_7$ | 17.97 |
| $t_8$ | 15.60 |
| $t_9$ | 15.00 |
| $t_{10}$ | 17.15 |
| $t_{avg}$ | 16.53 |

$$I_{Bomb+Rod} = \frac{\left(\left(gt^2 - 2h\right) m r_p^{\;2}\right)}{2h}$$

$$I_{Bomb+Rod} = \frac{\left(\left(9.8002\,\tfrac{m}{s^2}(16.53s)^2 - 2(0.85m)\right)(0.051kg)(0.0063m)^2\right)}{2(0.85m)}$$

$$I_{Bomb+Rod} = 3.186\times10^{-3}\;kg\cdot m^2$$

$$I_{Bomb} = I_{Bomb+Rod} - I_{Rod}$$

$$I_{Bomb} = \left(3.186\times10^{-3}\;kg\cdot m^2\right) - \left(4.58\times10^{-4}\;kg\cdot m^2\right)$$

$$I_{Bomb} = 2.73\times10^{-3}\;kg\cdot m^2$$

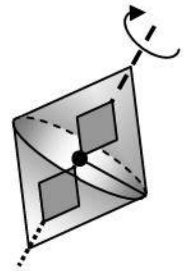
# Experimental Measurements & Theoretical Calculations: Diamond Cherry C² Core

**Calculation: Diamond Cherry C² Core – Central Axis**

$$I_{Diamond} = \frac{3}{5}MR^2$$

$$I_{Diamond} = \frac{3}{5}(1.950kg)(0.058m)^2$$

$$I_{Diamond} = 3.90\times10^{-3}\,kg\cdot m^2$$



| Data | |
|---|---|
| Core Mass | 1.950 (kg) |
| Core Radius | 0.058 (m) |

| Experimental Data | |
|---|---|
| Hanging Mass: | m = 0.051 (kg) |
| Rotational Axis Radius of Platform: | $r_p$ = 0.0063 (m) |
| Local Gravitational Acceleration: | g = 9.8002 (m/s²) |
| Drop Height: | h = 0.85 (m) |

| Time Trials (sec) | |
|---|---|
| $t_1$ | 15.29 |
| $t_2$ | 15.65 |
| $t_3$ | 15.31 |
| $t_4$ | 15.78 |
| $t_5$ | 15.81 |
| $t_6$ | 15.31 |
| $t_7$ | 15.91 |
| $t_8$ | 15.59 |
| $t_9$ | 15.85 |
| $t_{10}$ | 15.62 |
| $t_{avg}$ | 15.62 |

$$I_{C^2+Rod} = \frac{\left((gt^2-2h)\,mr_p^{\,2}\right)}{2h}$$

$$I_{C^2+Rod} = \frac{\left((9.8002\tfrac{m}{s^2}(15.62s)^2-2(0.85m))\,(0.051kg)(0.0063m)^2\right)}{2(0.85m)}$$

$$I_{C^2+Rod} = 2.85\times10^{-3}\,kg\cdot m^2$$

$$I_{C^2} = I_{C^2+Rod} - I_{Rod}$$

$$I_{C^2} = \left(2.85\times10^{-3}\,kg\cdot m^2\right)-\left(4.58\times10^{-4}\,kg\cdot m^2\right)$$

$$I_{C^2} = 2.39\times10^{-3}\,kg\cdot m^2$$

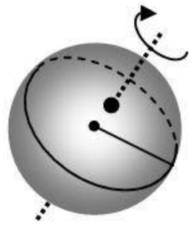
# Experimental Measurements & Theoretical Calculations: Solid Sphere

**Calculation: Sphere – Central Axis**

$$I_{Sphere} = \frac{2}{5} MR^2$$

$$I_{Sphere} = \frac{2}{5}(0.715kg)(0.05m)^2$$

$$I_{Sphere} = 7.15 \times 10^{-4} \, kg \cdot m^2$$



| Data | |
|---|---|
| Core Mass | 0.715 (kg) |
| Core Radius | 0.05 (m) |

| Experimental Data | |
|---|---|
| Hanging Mass: | m = 0.051 (kg) |
| Rotational Axis Radius of Platform: | $r_p$ = 0.0063 (m) |
| Local Gravitational Acceleration: | g = 9.8002 (m/s²) |
| Drop Height: | h = 0.85 (m) |

| Time Trials (sec) | |
|---|---|
| $t_1$ | 10.44 |
| $t_2$ | 10.44 |
| $t_3$ | 10.47 |
| $t_4$ | 10.47 |
| $t_5$ | 10.56 |
| $t_6$ | 10.33 |
| $t_7$ | 10.65 |
| $t_8$ | 10.58 |
| $t_9$ | 10.38 |
| $t_{10}$ | 10.60 |
| $t_{avg}$ | 10.49 |

$$I_{Sphere+Rod} = \frac{\left((gt^2 - 2h)\, mr_p^2\right)}{2h}$$

$$I_{Sphere+Rod} = \frac{\left((9.8002 \tfrac{m}{s^2} (10.49s)^2 - 2(0.85m))(0.051kg)(0.0063m)^2\right)}{2(0.85m)}$$

$$I_{Sphere+Rod} = 1.282 \times 10^{-3} \, kg \cdot m^2$$

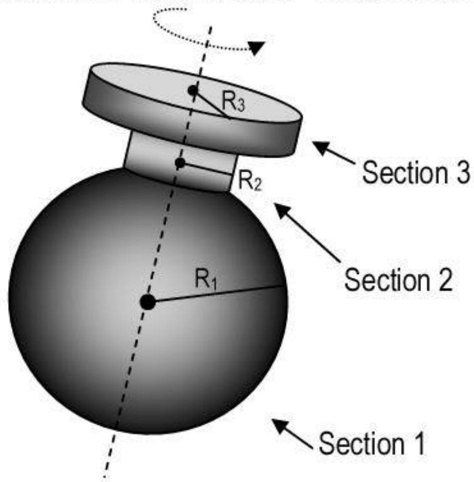
$$I_{Sphere} = I_{Sphere+Rod} - I_{Rod}$$

$$I_{Sphere} = \left(1.282 \times 10^{-3} \, kg \cdot m^2\right) - \left(4.58 \times 10^{-4} \, kg \cdot m^2\right)$$

$$I_{Sphere} = 8.240 \times 10^{-4} \, kg \cdot m^2$$

# Experimental Measurements & Theoretical Calculations: Voodoo Core

**Calculation: Voodoo Core – Central Axis**




| Data | |
|---|---|
| **Core Mass** | 1.760 (kg) |
| $R_1$ | 0.085 (m) |
| $R_2$ | 0.039 (m) |
| $R_3$ | 0.075 (m) |
| $V_1$ | 575 (mL) |
| $V_2$ | 10 (mL) |
| $V_3$ | 120 (mL) |

Volume of Voodoo Core: 705 mL
Average Density: 1760 g / 705 mL = 2.50 g/mL

Section 1: Mass Section 1 = $M_1 = (2.50\ \text{g/mL})\times(V_1) = 1435.5$ g
Section 2: Mass Section 2 = $M_2 = (2.50\ \text{g/mL})\times(V_2) = 25.0$ g
Section 3: Mass Section 3 = $M_3 = (2.50\ \text{g/mL})\times(V_3) = 300$ g

Theoretical Moment of Inertia Estimate:

$$I_{\text{Voodoo}} = \left(\frac{2}{5}M_1(R_1)^2\right) + \left(\frac{1}{2}M_2(R_2)^2\right) + \left(\frac{1}{2}M_3(R_3)^2\right)$$

$$I_{\text{Voodoo}} = \left(\frac{2}{5}(1.436\,kg)(0.085\,m)^2\right) + \left(\frac{1}{2}(0.025\,kg)(0.039\,m)^2\right) + \left(\frac{1}{2}(0.300\,kg)(0.075\,m)^2\right)$$

$$I_{\text{Voodoo}} = \left(4.15\times10^{-3}\,kg\cdot m^2\right) + \left(1.90\times10^{-5}\,kg\cdot m^2\right) + \left(8.44\times10^{-4}\,kg\cdot m^2\right)$$

$$I_{\text{Voodoo}} = 5.01\times10^{-3}\,kg\cdot m^2$$

# EXPERIMENTAL MEASUREMENTS & THEORETICAL CALCULATIONS: VOODOO CORE

| Experimental Data | |
|---|---|
| **Hanging Mass:** | m = 0.051 (kg) |
| **Rotational Axis Radius of Platform:** | $r_p$ = 0.0063 (m) |
| **Local Gravitational Acceleration:** | g = 9.8002 (m/s²) |
| **Drop Height:** | h = 0.85 (m) |

| Time Trials (sec) | |
|---|---|
| $t_1$ | 15.09 |
| $t_2$ | 14.75 |
| $t_3$ | 14.53 |
| $t_4$ | 14.68 |
| $t_5$ | 15.07 |
| $t_6$ | 15.06 |
| $t_7$ | 14.69 |
| $t_8$ | 15.08 |
| $t_9$ | 14.54 |
| $t_{10}$ | 14.82 |
| $t_{avg}$ | 14.83 |

$$I_{Voodoo+Rod} = \frac{\left(\left(gt^2 - 2h\right) m r_p^{\,2}\right)}{2h}$$

$$I_{Voodoo+Rod} = \frac{\left(\left(9.8002\,\tfrac{m}{s^2}(14.83s)^2 - 2(0.85m)\right)(0.051kg)(0.0063m)^2\right)}{2(0.85m)}$$

$$I_{Voodoo+Rod} = 2.564\times10^{-3}\,kg\cdot m^2$$

$$I_{Voodoo} = I_{Voodoo+Rod} - I_{Rod}$$

$$I_{Voodoo} = \left(2.564\times10^{-3}\,kg\cdot m^2\right) - \left(4.58\times10^{-4}\,kg\cdot m^2\right)$$

$$\boxed{I_{Voodoo} = 2.106\times10^{-3}\,kg\cdot m^2}$$

# Experimental Measurements & Calculations: Rotational Dynamics Platform

| Experimental Data | | |
|---|---|---|
| Hanging Mass: | m = | 0.051 (kg) |
| Rotational Axis Radius of Platform: | $r_p$ = | 0.0063 (m) |
| Local Gravitational Acceleration: | g = | 9.8002 (m/s²) |
| Drop Height: | h = | 0.85 (m) |

| Time Trials (sec) | |
|---|---|
| $t_1$ | 6.34 |
| $t_2$ | 6.19 |
| $t_3$ | 5.90 |
| $t_4$ | 6.34 |
| $t_5$ | 6.25 |
| $t_6$ | 6.29 |
| $t_7$ | 6.37 |
| $t_8$ | 6.29 |
| $t_9$ | 6.41 |
| $t_{10}$ | 6.31 |
| $t_{avg}$ | 6.27 |

$$I_{Rod} = \frac{\left(\left(gt^2 - 2h\right) m r_p{}^2\right)}{2h}$$

$$I_{Rod} = \frac{\left(\left(9.8002 \tfrac{m}{s^2}(6.27s)^2 - 2(0.85m)\right)(0.051kg)(0.0063m)^2\right)}{2(0.85m)}$$

$$I_{Rod} = 4.58 \times 10^{-4}\ kg \cdot m^2$$