Moment of Inertia Lab

Diagram of the components:

```
┌───────┐
│ C-B-D │
│     | │
│     A │
└───────┘
```

Part	Mass (g)	Length (cm)	OD (cm)	ID (cm)
A	133.08	55.5	2.15	1.5
B	72.79	30.5	2.15	1.5
C	12.77	2.5	2.81	2.15
D	33.37	7.2	2.81	2.15

1. Calculate the moment of inertia of the apparatus using measurements of the length and mass of each component. Show and label each step of the calculation.

```
1/12 * (2(0.1277 kg + 0.7279 kg) + 0.3337 kg) * (2(0.025 m + 0.305 m) + 0.072 m)^2
0.09129 kg m^2
```

2. Perform two experiments using different hanging masses, record Θ, t, m, Δy, and r in a data table format.

mass (g)	time (s)
200.	8.92
500.	5.20

3. Draw a free body diagram showing and labeling all forces and torques.

```
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|   ╠═════╦═════╣        |
|         ║              |
|         ║              |
|         ╟─────┐        |
|         ╨     |   |    |
|               |   | mg |
|               |   V    |
|               ▓        |
|                        |
└────────────────────────┘
```

```
┌────────────────────────┐
|T                       |
|     .-x^x-.   θ = 90°  |
|    x       x           |
|   |         |          |
|   X    O────X─┐        |
|   |         |θ|        |
|    x       x  |  |     |
|     ~-x_x-~   |  | τ   |
|               |  V     |
|               |        |
|                        |
└────────────────────────┘
```

4. Write the two Newton’s second law equations derived from the free body diagram.

```
F = mg
```

```
F = 0.200 kg * 9.8 m/s^2
F = 1.96 N

τ = r⊥F
τ = 0.0215 m * 1.96 N
τ = 0.04124 m*N
```

```
F = 0.500 kg * 9.8 m/s^2
F = 4.9 N

τ = r⊥F
τ = 0.0215 m * 4.9 N
τ = 0.10535 m*N
```

5. Use the experimental data to calculate I for the apparatus. Show each mathematical step. Provide a caption describing the purpose of each step.

The angular acceleration was first found by multiplying the tangential acceleration by the radius

```
α = a_tan / r
α = 8.92 rad/s^2 * 0.0215 m
α = 0.192 rad/s^2
```

And the inertia was found by solving the following equation

```
Στ = Iα
```

```
0.04124 m*N = I * 0.192 rad/s^2
I = 0.04124 m*N / 0.192 rad/s^2
I = 0.215
```

6. Compare the calculated I with the experimentally determined I. Analyze sources of error associated with each method used to determine I.

The calculated I was far smaller than the experimentally found I, which was almost certainly due to errors in the experimental calculations.