Drag Coefficients of Different Dimple Patterns

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Introduction

During ball flight, drag opposes the motion of the ball. To reduce drag, golf ball manufacturers have added dimples. Many designs exist with varying dimple shapes, sizes, and distribution patterns. The drag coefficient of several brands were found and compared to one another.

- Early golf balls were wooden spheres
- Golfers noticed that nicked up balls flew further and straighter
- Dimples then introduced to Guttie ball
- All modern golf balls contain dimples

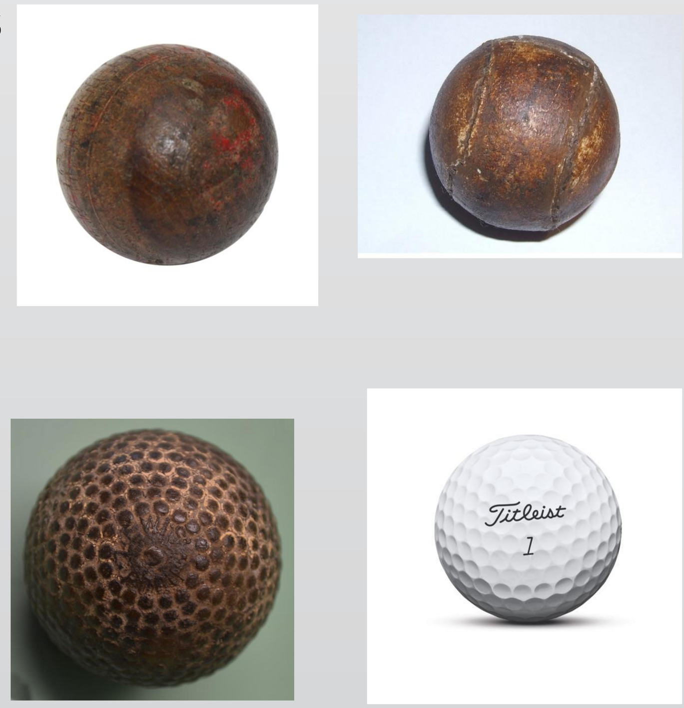

Figure 1. Evolution of golf balls
Top Left: Wooden Ball
Top Right: Featherie
Bottom Left: Guttie
Bottom Right: Titleist ProV1

Drag Reduction By Dimples

- Two types of flow in fluid dynamics
  - Laminar
  - Turbulent
- Drag
  - Dimples decrease the separation point of fluid from the ball
  - Smaller separation point results in a smaller drag wake.
- Lift
  - Spin introduces an imbalance in pressure
  - Forces higher pressure to the bottom of the golf ball causing lift

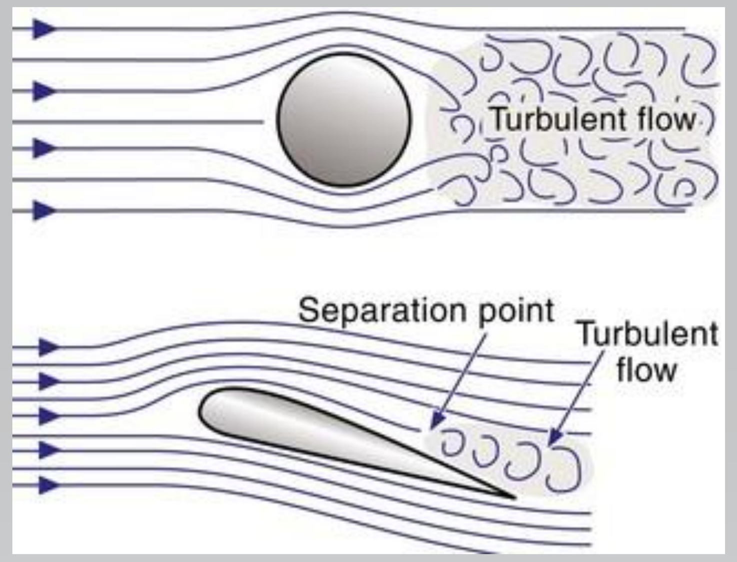

Figure 2. Schematic of laminar flow versus turbulent flow.

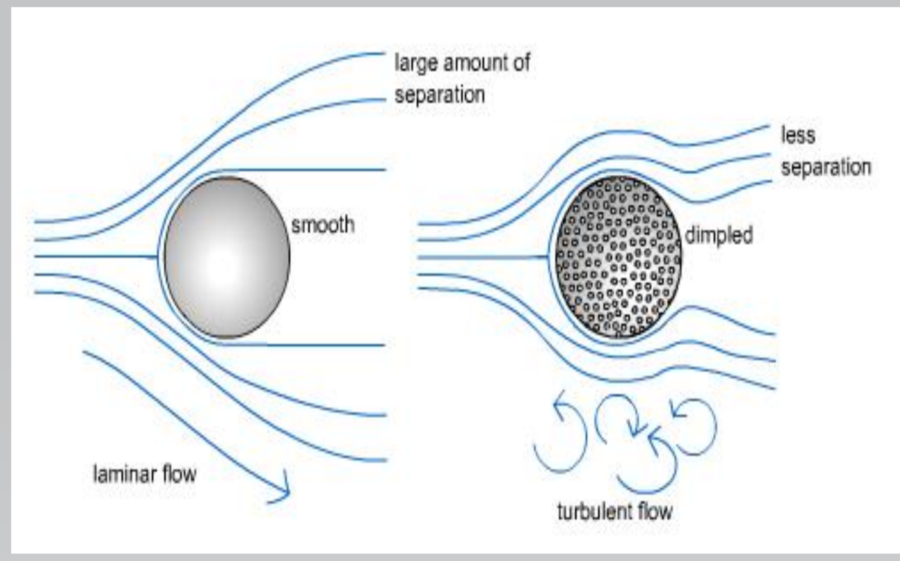

Figure 3. Flow of fluid around a smooth sphere compared to dimpled sphere.

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Experiment

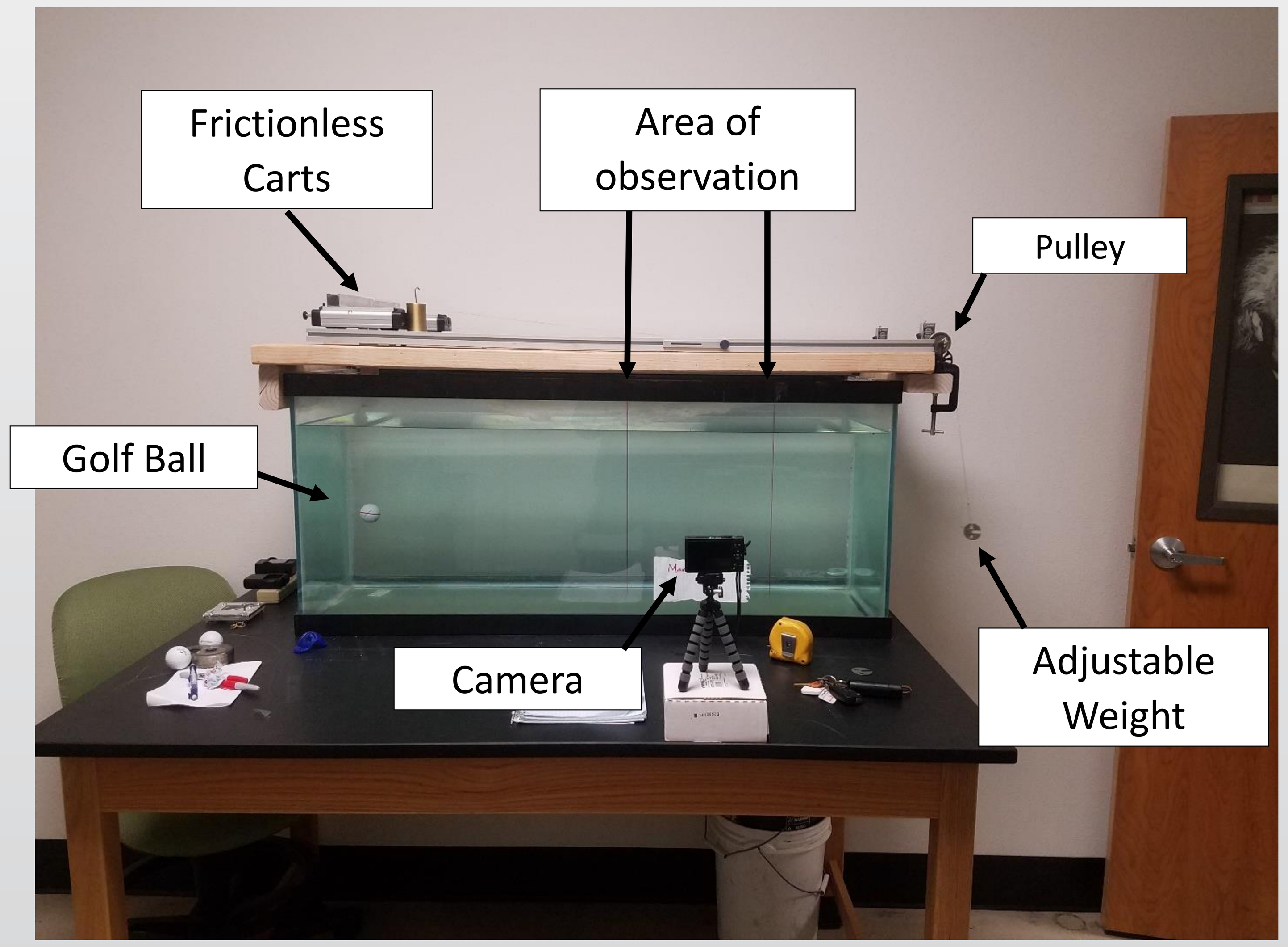

Figure 3. Photo of Experimental set up

- Water tank allowed low velocity measurements
- Simple Pendulum allowed forces to be calculated
- Motion of golf ball analyzed using *Tracker*
- Varying masses were used to adjust terminal velocity

Conclusions

The samples shown in the analysis portion clearly illustrate a strong agreement between data and trendline. It was expected that the Taylormade golf ball would have the highest drag coefficient as it has a traditional pattern; while other designs are presumably improvements on that one. However, the data show it has the lowest drag coefficient. Future work should be to study the role lift plays in total distance the ball travels. Numerical models would be useful in future endeavors towards determining the effect lift has, as well as including spin in experimental procedure.

Acknowledgements

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References

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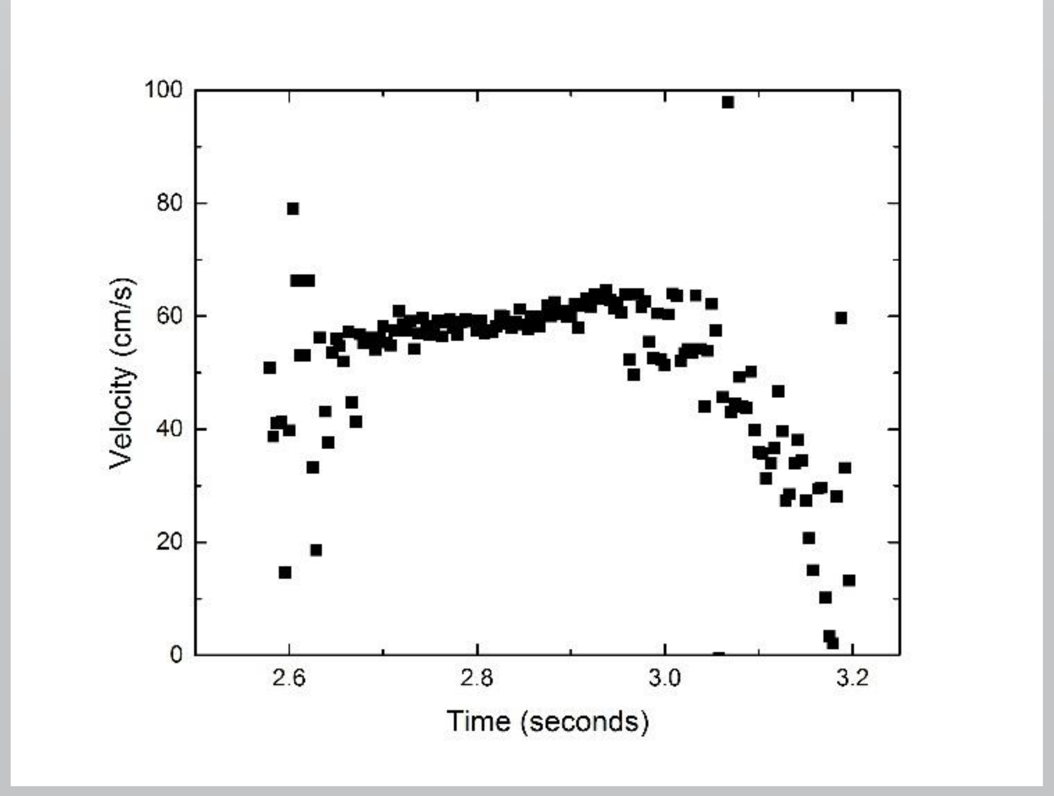
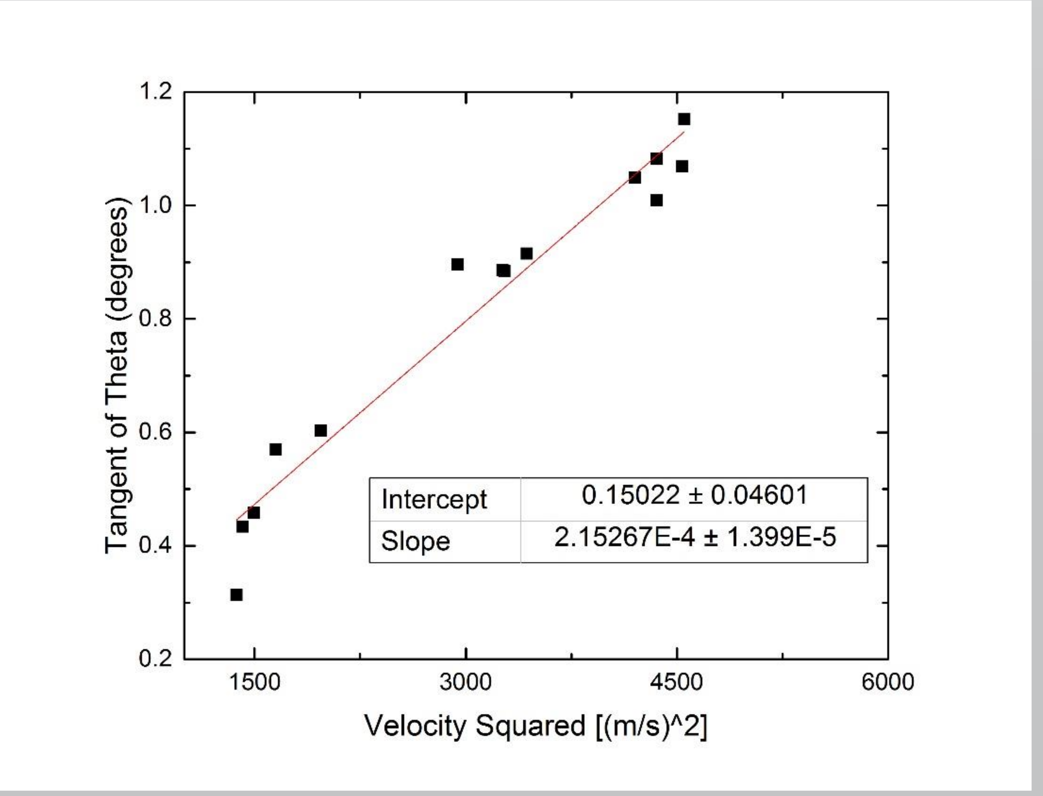
Analysis

a.



b.



Calculation of Drag Coefficients

$$F_d = \frac{C_d \rho A v^2}{2} \qquad F_d = tan\theta(mg - F_B)$$

$$C_d = \frac{2(mg - F_b)}{\rho A} \cdot \frac{tan\theta}{v^2}$$

- ρ = density of the water
- *A* = cross sectional area of ball

c.

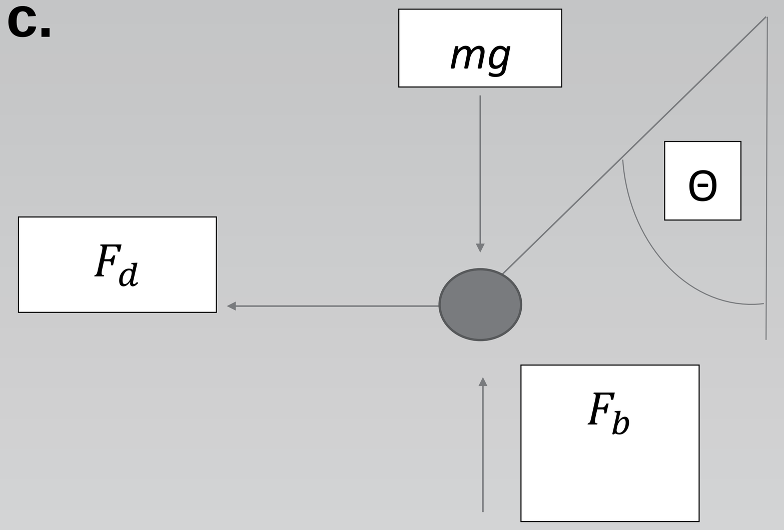


Table 1. Results of experiment

Golf Ball	Drag Coefficient
Bridgestone B330-RX	0.152
Callaway TourHex	0.143
Maxfli Tour Distance	0.149
Nike PD Long	0.173
Taylormade Penta	0.125

Figure 5. Example of results
a. Plot of v vs. time. Data for analysis was taken between 2.7 seconds and 2.9 seconds
b. Plot of v^2 vs. $tan\theta$ for Bridgestone golf ball
c. Free-Body diagram of simple pendulum