Internal Assessment: The Impact of the Sphere's Radius on the Sphere's Angular Velocity

IB Physics II Period 6, Dr. Petach

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1 Design

1.1 Research

The aim of the experiment is to investigate the relationship between radius and angular velocity for the linear motion of a sphere unraveling from a string at a fixed height. This will be done by changing the radius of the sphere that is being dropped through the use of various sizes balls that are unraveled from the string and then measuring the linear velocity of the falling ball using a photogate. The purpose of the string is to cause the ball to rotate while falling, due to the nature of its unraveling motion.

Prior to the experiment, I derived a relationship between the radius and the angular velocity of the rotational motion of the falling ball by the force analysis of the airplane, the definition of a period, and the radius of the flight path. Section 2.2.1 will more specifically detail the derivation. The derived relationship predicted that period and height will follow an inverse relationship. The experiment itself was to test if Newtonian physics upheld this inverse relationship with tangible experimentation.

1.2 Variables

The independent variable is the radius of the sphere. The dependent variable is the angular velocity of the ball as it passes through the photogate. The controlled variables include the height of the initial position of the ball that is attached to the clamp, material of the string, the photogate, and the properties of the surrounding environment.

1.3 Apparatus

- Photogate
- Four different sizes balls that are relatively uniform spheres
- String
- DataWorks software that reads data from the photogate
- Ring stand with clamp
- Meter stick

1.4 Procedure

1. Attach a clamp to a ringstand
2. Place a photogate toward the bottom of the ringstand so that the ball will drop through it.
3. Connect the photogate to the DataWorks software, such that it reads the linear velocity of the falling ball
4. Measure the height difference between the placement of the clamp and the photogate along the ring stand using a meter stick
5. Pick a ball, measure it radius using a meter stick
6. Tie one end of the string to a clamp attached to a ring stand, and the other end around the ball
7. Carefully wrap the string around the ball until the ball is level with the clamp
8. Drop the ball so that it falls through the photogate
9. Record the linear velocity that is measured by the photogate
10. Repeat steps 6 to 9 for six trials
11. Repeat steps 5 through 10 for the four different balls

1.5 Diagram

Figure 1: Picture of the experiment setup

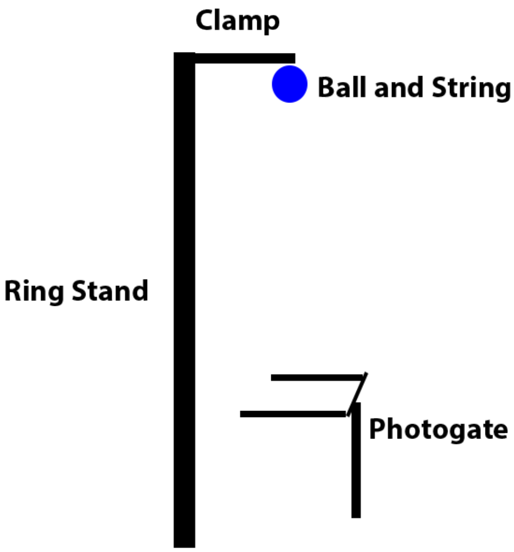

Figure 2: Diagram of the experiment setup

2 Data

2.1 Data Collection

Trial	Radius (cm)	Linear Velocity (m/s)	Height (cm)	Angular Velocity (rad/s)
1	2.34	1.86	50	79.49
2	2.34	1.81	50	77.35
3	2.34	3.10	50	132.48
4	2.34	2.50	50	106.84
5	2.34	2.87	50	122.65
6	2.34	2.20	50	94.02

Table 1: Data for six trials with ball radius of 2.34 cm.

Trial	Radius (cm)	Linear Velocity (m/s)	Height (cm)	Angular Velocity (rad/s)
1	1.90	2.12	50	111.87
2	1.90	2.38	50	125.59
3	1.90	2.98	50	157.26
4	1.90	2.23	50	117.68
5	1.90	2.35	50	124.01
6	1.90	2.23	50	117.68

Table 2: Data for six trials with ball radius of 1.90 cm.

Trial	Radius (cm)	Linear Velocity (m/s)	Height (cm)	Angular Velocity (rad/s)
1	1.69	3.32	50	196.45
2	1.69	3.18	50	188.17
3	1.69	2.22	50	131.36
4	1.69	3.91	50	227.22
5	1.69	2.85	50	168.64
6	1.69	3.63	50	214.79

Table 3: Data for six trials with ball radius of 1.69 cm.

Trial	Radius (cm)	Linear Velocity (m/s)	Height (cm)	Angular Velocity (rad/s)
1	1.40	2.91	50	208.60
2	1.40	3.62	50	259.50
3	1.40	3.62	50	259.50
4	1.40	2.31	50	165.59
5	1.40	3.67	50	263.08
6	1.40	3.41	50	244.44

Table 4: Data for six trials with ball radius of 1.40 cm.

2.2 Data Processing

2.2.1 Deriving the relationship between radius and angular velocity

3 Conclusion

3.1 Evaluation

3.2 Improvements