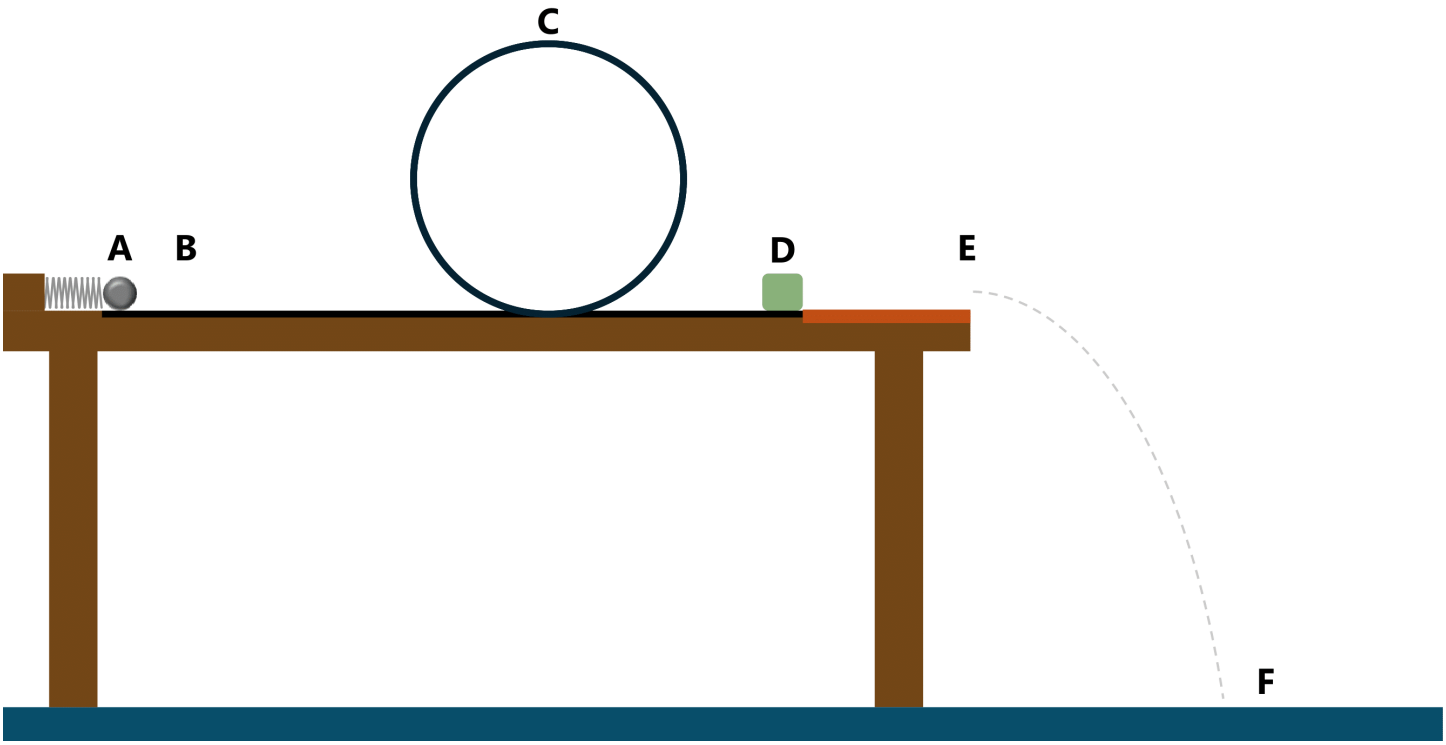
Mechanics Super Problem

The Scenario:

A 0.2-kg steel ball is launched by a 115 N/m spring compressed by 0.2 m. It rolls frictionlessly through a loop with a radius of 0.38 m and into a 0.15-kg box. The box catches the ball and immediately starts sliding on a portion of the table with a coefficient of friction of 0.527. After sliding for 0.5 meters, the ball and box launch horizontally off the 1.15-m tall table.



Locations of Interest

A	Ball before being launched by the fully compressed spring
B	Ball loses contact with the spring and begins to roll freely
C	Ball at the top of the circular loop
D	Ball is caught by the cup and starts sliding as a ball/cup system
E	Ball/Cup launch horizontally off the table
F	Ball/Cup hit the ground

Assumptions

- Friction and drag are negligible everywhere except between positions D and E
- Rotational kinetic energy is negligible

ALL THE CONTENT
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Name: _____

Position A

1. How much elastic potential energy is stored up in the spring fully compressed at position A?

Position B

2. What is the velocity that the ball exits the spring at position B?

Position C

3. What is the velocity of the ball at the top of the circular loop (position C)?

4. Draw a free body diagram for the ball at position C

5. What is the net force acting on the ball at position C?

6. What is the normal force acting on the ball at position C?

Position D

7. Assuming that the ball exits the loop with the same speed that it had leaving the spring, what is the velocity of the ball/cup system immediately after the ball is caught by cup at position D?

8. What is the kinetic energy of the ball/cup system after the ball is caught by the cup at position D?

9. Assuming that all of the kinetic energy lost in the inelastic collision becomes heat, how much heat energy is produced in the collision at position D?

Between Position D and Position E

10. What is the force of friction opposing the motion of the ball/cup system between D and E?

11. What is the work done by friction on the ball/cup system between D and E?

Position E

12. What is the velocity of the ball/cup system at position E after slowing down during the slide?

Between Position E and Position F

13. How much time is the ball/cup system airborne between E and F?

14. What is the horizontal distance traveled between the edge of the table (E) and landing location (F)?

15. What is the impact velocity of the ball/cup system when it hits the floor (position F) at an angle?