**The effect of drop height and surface material  
on the rebound height of a tennis ball**

Rumen Mitov (S2ENA; ES Luxembourg I)

**Aim:**

The purpose of these experiments is to find out if different materials have an impact on how a high a tennis ball can bounce back up off a surface of a certain material.

**Blocks used in the experiment**

LEAD

WOOD

IRON

LEAD

WOOD

IRON

**Methods:**

1) I measured the mass of all the blocks.

**Part a)**

1. I dropped the tennis ball 100 cm above the surface of the first material;

2. While the tennis ball was falling, I recorder a short video of it;

3. I then put the video on slow motion and recorded the height the tennis ball reached after it had bounced back up;

Note: When I dropped the tennis ball and recorded its bounce, I always looked the ball’s highest point.

4. I repeated the actions in points 1, 2 and 3 with the other materials;

5. I re-checked everything by doing part a) again. Then I took the averages.



**Part b)**

1. I picked the material on which the tennis ball had bounced the median height;

2. I took another block, identical to the first one, and stacked one on top of the other;

3. I moved the ruler so that the “0 cm” line was at the level of the top surface;

4. Then I dropped the ball at a 100 cm distance from the top surface and recorded everything with my camera;

5. I repeated part b) again and took an average of my results.

****

**Part c)**

1. I repeated part b), but instead of using the same material, which has caused the tennis ball to bounce the medium height, I used the material which had caused the ball to bounce the highest. I put that material on top of the material which had caused the ball to bounce the lowest;

2. I repeated point 1 again but this time I reversed the order of the two materials;

3. I repeated part c) and took an average of my results.



**Part d)**

1. I repeated part b); this time I used only one block of the material I used in part b). Also I changed the point of dropping or the drop distance from 100 cm to 50 cm.

2. I repeated part d) and took an average of my results.



**Observations:**

*Part a): Average bouncing distance*

Wood

(6 g/cm3) 66.00 cm

Iron

(29.3 g/cm3(1dp)) 64.50 cm

Lead

(97 g/cm3(2gf)) 62.50 cm

*Part b): Average bouncing distance*

Iron

2 x Iron 64.50 cm

Iron

*Part c): Average bouncing distance*

Wood

Lead

Lead

Wood

*Part d): Average bouncing distance*

Iron

Iron 22.50 cm

**Analysis and Discussion**

My experiment demonstrates that the type of material influences the height of the tennis ball’s bounce.

Firstly, I thought that the materials density was the sole factor having impact on the ball’s bounce. It turns out that the material’s surface friction, the distance between the surface (material) and the point of drop of the ball, as well as the height of the surface on which the tennis ball bounces, are all factors which influenced the outcome of the experiment.

I did an extra experiment in order to check the friction of all materials which I used in my original experiment. The results of these two experiments matched the assumptions of my hypothesis.

My hypothesis is that for part a) the height of the ball’s bounce varies because of the different materials’ surface friction -- the more friction, the more the object is slowed down, making it lose inertia which leads to lower bounce.

In part c) the experiment demonstrated that the combination of wood on top of lead caused a higher bounce than lead on top of wood. The fact that I have observed is that even though the contact surface was wood, the bounce was lower than in part a) where it was only one wood block. Having in mind that the distance between the surface and the point of drop were the same, all of this shows that the friction is not the only factor having impact on the height of bounce of the tennis ball.

A possible explanation for this could be the two different heights of the surface materials in part a) and in part c) -- one block vs two blocks. Since in part c) the impact of the ball and the material was higher than in part a), this could mean that gravity has a lower effect on the ball which would not give the ball as much inertia as in part a). With less inertia the tennis ball would not bounce as high. There is an exception however. The results for part b) (iron) matched with those for part a) (iron). This is most likely due to a mistake occurred during the experiment.

In part d) the distance between the drop and the surface is much shorter which does not give the tennis ball a lot of time to pick up inertia, resulting in a much lower bounce.

**Precautions:**

\* I used a slow motion camera;

\* I used a ruler to know from where to drop the tennis ball from.

**Conclusion:**

This experiment demonstrates that there are three factors that could change the tennis ball bounce outcome. These are:

1. The friction of the material;

2. The height of the surface of the material;

3. The distance between the surface of the material and the point of drop of the tennis ball.

Next time I could do this experiment with a partner in order to achieve more precise answers.