

Bouncing ball animation: Study of factors which affects the bounciness of ball

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Abstract: The physics of a bouncing ball worries the bodily conduct of bouncing balls, particularly its movement earlier than, at some stage in, and after impact in opposition to the floor of any other body. Several elements of a bouncing ball's conduct serve as an creation to mechanics in high college or undergraduate level physics guides. However, the exact modeling of the conduct is complex and of hobby in sports engineering. The movement of a ball is generally defined by way of projectile movement (which can be laid low with gravity, drag, the magnus impact, and buoyancy), while its effect is generally characterized thru the coefficient of restitution (which can be tormented by the nature of the ball, the nature of the impacting surface, the impact speed, rotation, and neighborhood conditions together with temperature and stress). To make sure honest play, many sports activities governing our bodies set limits on the bounciness in their ball and forbid tampering with the ball's aerodynamic houses.

Key Words: Ball bouncing, bounciness, ball materials, animation principles, temperature, physics, bouncing height, bouncing effects.

1. INTRODUCTION OF BOUNCE:

Bounce means to hit against surface or ground or plane like spring come back. In different place the meaning will change. When you push or pull a spring then after striking the surface, it will suddenly regain its original position. In case of ball bounce, ball hit against surface or ground again and again due to their elasticity or rigidity property of material. If you discuss another form of bounce, you may be heard many times like my cheque is bounce, it mean, when your cheque returns to you by bank due to insufficient fund in payer account, it mean your cheque has been bounce from bank. If you trying to bounce a ball, it immediately moves up and down, because of you are continuously hit it from ground surface. Bouncing level are depends on many factor, first is by how much energy applied on each and every bounce when you hit that ball. Second is the roughness of ground or surface, ball material, elasticity, rigidity. When we discuss in IT sector, sometimes when you send an email to someone then suddenly or after some time your email returns to you, this is a bouncing of an Email. Then how and why it come back/return back, its due to technical problem, either it may be possible that the user to whom, you send mail is closed his mail account or it may be possible that at that particular time server of that domain was not work properly or any other technical problem.

2. BOUNCING BALL PHYSICS:

What is happen when a ball is bounce?

In real, when a ball is bounce from ground or surface by striking it, till ball is stop. This type of happens due to conversation of kinetic energy into potential energy. And whatever energy conversation going here, it totally depends upon mass and velocity of ball. That will be-

$$KE=1/2 mV^2 = PE + \text{Thermal Energy}$$

Where

KE is kinetic energy which is in joules (J),

m is mass of object (in Kg) and

V is velocity of object (m/s²).

PE is potential energy

Gravitational (force due o gravity which is generally $g=9.8m/s^2$) potential energy for rubber ball could be decided by

$$GPE= mg.h$$

Where mg is the weight (Mass. gravity),

And h is the height from where the ball is lifted. If you talking about energy then, the Law of conservation of Energy says that the energy neither loss nor gained in nature, it's only transferred from one type to another type. It means the kinetic energy of a moving object is totally converted into potential energy when object is stop. Is it possible, if there is no loss in energy than how our moving object can stop? Obviously, ball will stop. When object strike the ground, and

ground push that object in reverse direction then a little bit kinetic energy change into heat energy and into sound energy. That's why after some time bouncing ball will get their static position. (See in pic. 1)

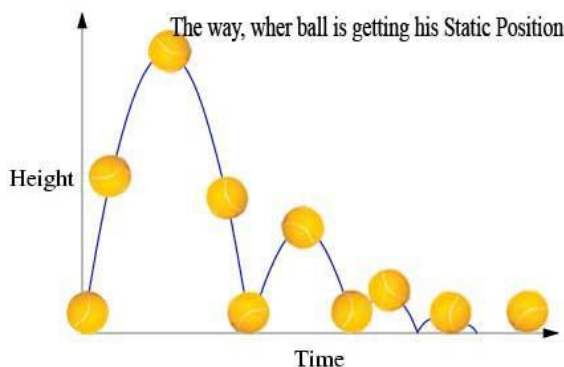


Figure 1: Bouncing Ball getting his static position

Next, you are again in doubt, why your bouncing ball is not getting its original height when it bounces next step? I already explain it in the above paragraph. Because when the ball pushes on the ground, then the ground again pushes it, in this reaction the ball's shape is deformed and kinetic energy changes into heat and sound energy. This is the reason the ball does not get its original height after striking the ground. (See in fig. 1).

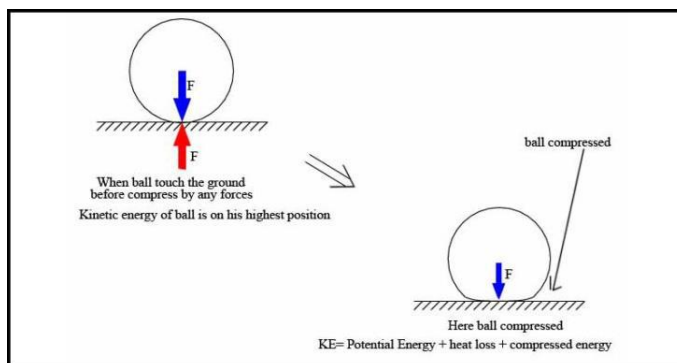


Figure 2: How Ball lost his kinetic energy after striking the Ground

You saw here one thing that is characteristic of the material of the ball is responsible for the ball bouncing. So the bounciness of the ball depends on its constructed material and the elastic property of the material allows it to retain its shape after collision of the ball from a surface without breaking shape.

3. TYPE OF BALL MATERIALS:

- Tennis ball
- Basket ball
- Golf ball
- Steel ball
- Rubber ball
- Base ball

4. TEMPERATURE EFFECT ON BOUNCING BALL:

Temperature will affect the bounciness and other factors of a bouncing ball. You have to learn how and why it affects will happen? When environment temperature increases, the particles or molecules of the surrounding environment will be more active and then the speed/velocity of particles/molecules will increase, and collision between these particles will increase. So when a bouncing ball moves up and down, it gets more energy due to the high speed of surrounding air particles. As same, if you will heat the ball, then the air particles of the inside material of the ball will be moving with high speed and their internal collision will also increase. Resulting the ball will get more internal energy on their surface.

But no. of bounce of a ball and height of bounce will depend on various things. Both factors affect are different for different balls which are made by different materials. It can be-

- Mass of ball,
- Ball material,
- Gradient of surface,
- Size of ball,

Kind of ball,
Ball density,

Air resistance (this may occur when the ball is dropped from greater heights). Temperature affects the no. of bounciness of ball and the height of bounce. Either both are increase due to increasing temperature or decreases due to decreasing temperature or it may be possible vice-versa. In general, if ball is dropped from a big height, then automatically the height of bounce and no of bounce will more.

5. COMPARES THE NO OF BOUNCE AND HEIGHT OF BOUNCE: RUBBER BALL AND METAL BALL:

Here we study on rubber ball and a metal ball bounce, that what kind of affect shown in their bounce height and no of bouncing step when we increase and decrease the environment temperature. First we discuss rubber ball: when we increase the environment temperature, rubber ball will be sticky due to loose of internal molecules of the materials. Resulting that ball not bounce much more height and they bounce a little bit less step. And vice-versa, if we keep rubber ball in freeze, the outer surface of ball will be harder, and their internal molecules are strongly connected to each other. So now this ball will bounce more heights, and will get more no. of steps. But in case of metallic ball the above process will be vice-versa. Now we will discuss about rebound of ball heights, if it bounce with different surfaces. Surface may be hard surface, soft surface, plane surface, rough surface, carpet, wood, sand, clay, grass, laminate, foam and

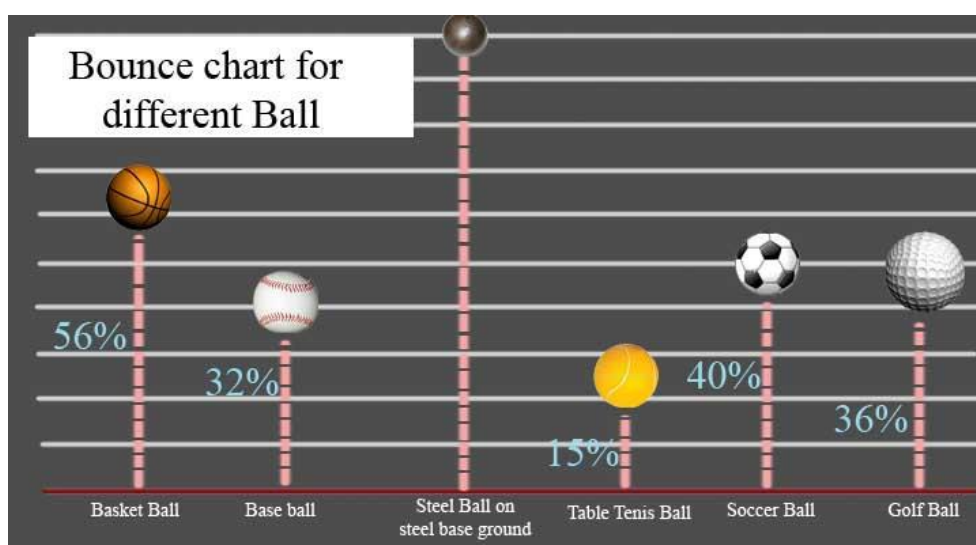


Figure 3: Bounce chart different ball

If you will try to play with Tennis ball on a hard surface, definitely it will get a height bounce and it will bounce many times. If the same ball bounce on grass surface it will bounce less height in respect to hard surface, it's happen due to rigidity, density and elasticity of striking surface. Again it will differ on different surfaces.

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