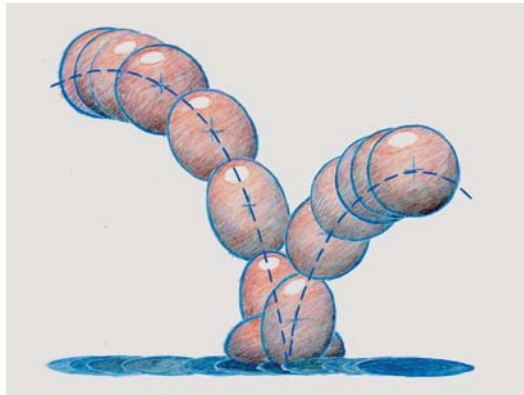


The Bouncing Ball

Class objective: To get a sense of spacing, timing, weight, and flexibility in motion.

Equipment required: Lightbox, pencil, and paper.

Now that we have established the principles of key, breakdown, and in-between positions in an action, it is now possible to go further and tackle something a little more advanced. The principle of the bouncing ball has been around since animation began, and it's very tempting to think it cliché to work with it here.

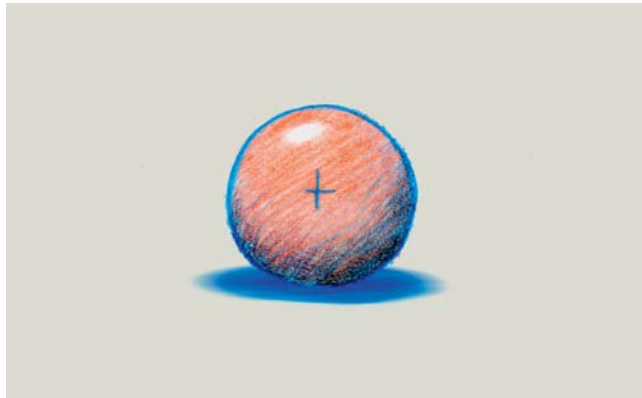


The core frames that comprise a bouncing ball action.

However, there is no better exercise for the beginner to attempt, as it covers all the major principles of animation—namely, the importance of key, breakdown, and in-between positions; as well as arcs, paths of action, slowing-in and slowing-out, weight, gravity, and timing. But, first things first.

Weight, Mass, and Flexibility

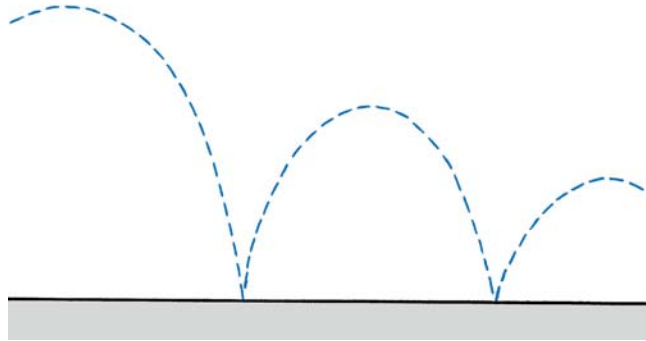
Before we can discuss the actual bouncing of the ball, we have to first ascertain the weight and density of the ball to be bounced. For example, a soft, rubber bouncy ball will move in a far different way than a heavy, solid rubber ball. A ping-pong ball will bounce in a far different way than a soccer ball. It is all about weight, mass, and flexibility, and this always has to be borne in mind with any animated object or character, quite aside from the rubber ball challenge. You will find in my other books adequate descriptions of the varying types of bouncing ball effects, so I won't go over them again here. Suffice it to say, let us assume that we are going to work with a standard bouncy, rubber ball, the kind that any kid will kick around in their house or yard.



A basic rubber ball.

Gravity and the Path of Action

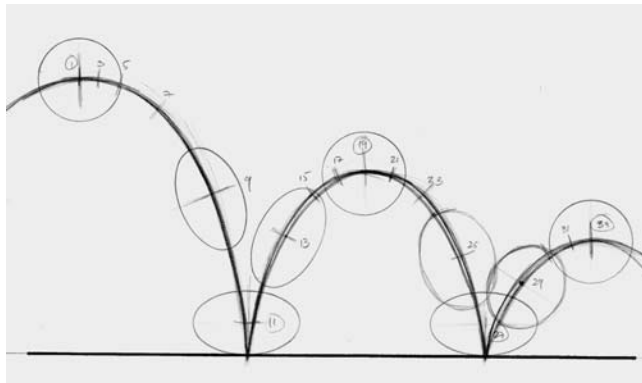
First let's consider the path of action the ball is to take. Gravity will always exert an effect with all things. With the bouncing ball, gravity will merely ensure that each bounce will get less and less, as the kinetic energy within the ball is unable to fight against the constant pull of gravity. Therefore, as the ball moves forward with a certain amount of velocity, the bounces of that ball will increasingly diminish and be less and less apart. This will give us a path of action for our bounce.



Note that a ball will require increasingly diminishing bounces that become lower and lower before it comes to a halt, possibly preceded by it rolling.

Key Positions

Next we need to establish our key positions along the designated path of action. In the illustration below they are numbers '1', '11', '19', '27' and '31'. With any bouncing action, the main key positions will be at the contact point with the ground and at the apex of the upward arc. However, if we leave our key ball positions in the air and on the ground perfectly round, there would be no life or rubbery feel to the ball—it would merely appear like a cut-out shape moving up and down across the screen, with no life at all. Consequently we need to apply the age-old principles of squash and stretch.



I always like to sketch my key positions first. I may modify them as I begin to animate, but this does at least give me a reliable ground plan to work with. Here I have added the linking positions too, just to indicate the nature of the transitions from one key position to the next.

Squash

Remember that the ball we are dealing with is rubber, and therefore it is subject to shape changes. Rubber is flexible. If the ball were a metal cannonball, it would not be subject to shape shifting and that gives the animator the means to define the nature of the ball's mass. When a flexible,

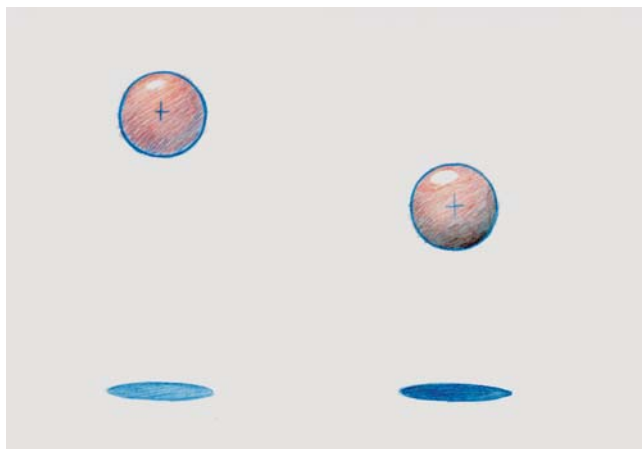
rubber ball hits the solid ground it will distort in shape. In other words, it will “squash.” The harder the ground and the faster the velocity the ball contains before it hits the ground will define the amount of squash exerted on it. Therefore, the higher the bounce and the further the ball travels from bounce to bounce, the more the squash distortion will appear. In considering the path of action we have already defined for ourselves, I would suggest the key squash position in the following figure would be reasonable.

This does have sufficient squash to suggest that it is a standard rubber ball. Other balls, such as a soccer ball or a cannonball, would behave differently, of course.



Note, however, that the apex positions of the ball in the figure do not squash, as they are not subject to any contact with a hard surface like the ground, or are even being distorted by velocity.

The beginning and end, up, (north) positions of our bounce.

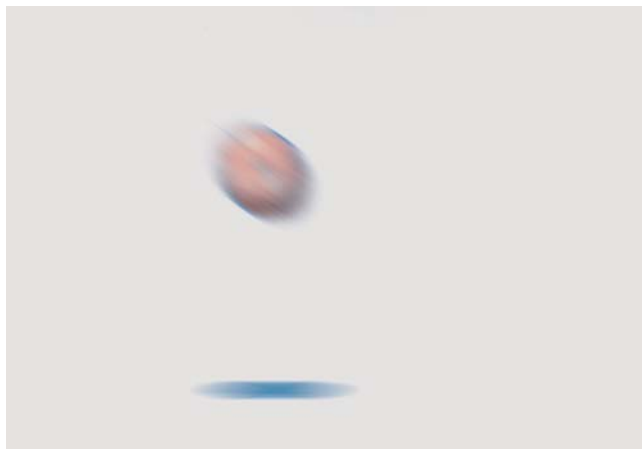


What is meant by this is that at the apex of a bouncing arc the ball is momentarily at a zero point of movement and impact. Here, the ball has slowly ground to a halt, as the kinetic energy from the previous bounce

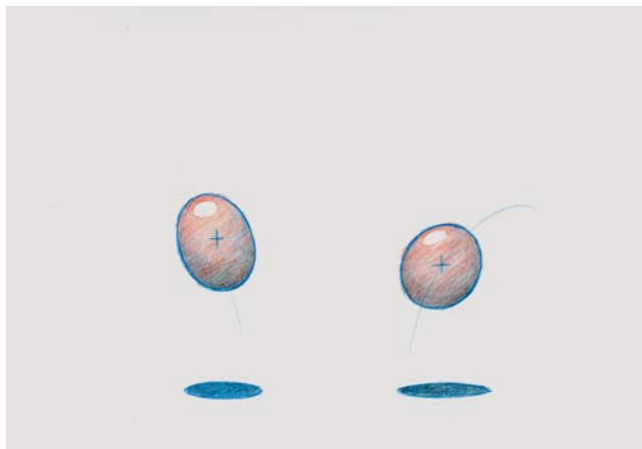
has run out, and yet the forces of gravity have not taken hold quite yet. Consequently, our rubber ball returns to its natural, circular shape. This is not true, however, of its shape on the way up or the way down.

Stretch

If you freeze a movie sequence of a moving shape you will notice that it will actually appear as a blur. This is because at the regular film speed of 24 fps the shutter is not fast enough to capture a sharp image of the moving object, thus the motion blur it presents. In animation, specifically drawn 2D animation, it is not easy to emulate the blur look. Consequently, the animator has to distort, or “stretch,” the object to give the illusion of this fast-action blur. This is especially so with the action of our ball when it is on the way up and on the way down.



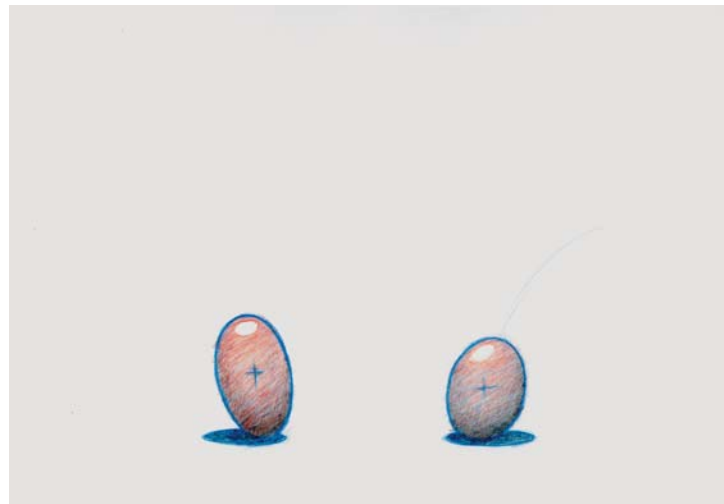
A simulated-motion blur effect to emulate the real-world appearance of a ball moving fast through space.



The dropping-down and rising-up stretch effects on the ball, which are separated by the moment when it actually hits the ground.

The amount of stretch is dependent on the degree of flexibility within the object being animated and the speed or velocity it is moving at. For example, our rubber ball will distort significantly as it moves at speed, whereas a metal cannon ball will not stretch very much. Also, the degree of stretch will vary in accordance to the amount of distance covered and the speed the ball is moving. In our reducing-bounce path of action, the distortion of the bounce will therefore look like the following figure as we block-in the breakdown positions.

The stretched ball on the left is longer because the gravity-assisted, downward velocity gives it greater speed. The stretched distortion of the ball on the right is not quite as extended, as it has just hit the ground and therefore has lost a great deal of its earlier velocity.



Note how the amount of distortion is increased with the higher bounces and diminished with the lower ones.

Timing

Another factor that gives our bouncing ball action credibility is its timing. Remember that as a ball reaches its uppermost apex position in an arced path of action it will slow down to an almost stopped position, then it will begin to accelerate as gravity begins to pull it earthward again. This will require that we apply slowing-in and slowing-out principles to the in-betweens and we chart them out. That means that more drawings need to be added to and from the uppermost key position, as we have already established that more drawings mean less speed.