How Pressing a Piano Key Produces an Audible Note

What is included in this guide?
The process of converting a key press into a note which can be heard is completed by a mechanical system known as the piano’s action. This guide is intended to teach pianists of any skill level about the mechanism that makes their instrument work. While the structure of many instruments makes the nature of their function clear, most musicians will find the piano action to be less intuitive. This complex device is best understood by first gaining a general idea of how the system works, and then examining the specific functions of its components.

Overview of Piano Mechanics:
The Basics
To understand the purpose of the piano’s action, we must first have a working knowledge of how this instrument creates sounds that we interpret as musical notes.

What part of the piano produces sound?
A piano produces sound waves by initiating the controlled vibration of one or more strings made of high carbon steel. The vibrating strings resonate with a frequency which depends on the properties of the wire. Long, thick wires have a lower natural frequency, which human beings hear as low pitched noise. Short, thin wires have a higher natural frequency, heard as a high pitched noise. A piano has many strings of different length and diameter which allow it to produce a variety of pitches. Each key on the piano might play two or three strings to produce a note. These strings are kept at high tension, which is enabled by a cast iron plate which reinforces the wooden piano frame.

How is string vibration controlled?
When strings are at rest, they are in contact with a damper. Depressing the piano key corresponding to a given string releases the damper, and triggers a hammer to strike the string. The hammer only contacts the string once, and the damper remains separated from the string until the key is released. The damper behaves like the brakes...
on a car. When the damper is turned on (in contact with the string), string vibration quickly stops and cannot be easily initiated. When the damper is turned off (separated from the string), a hammer strike results in string vibration. Sound produced by the strings is amplified by the piano soundboard, which is a large wooden piece adjacent to the strings. The shape of the soundboard and type of wood used gives each piano a distinctive sound.

*How do the pedals work?*

There are three pedals on a piano: the soft pedal, the sostenuto pedal, and the sustaining pedal. Each has an important and unique function for the pianist.

**Soft Pedal:** Each time a key is pressed on the piano, it causes a hammer to strike two or three strings, producing a note. The soft pedal causes all hammers to shift to one side (usually the left side) such that they strike fewer strings. This result is a reduction in volume of all notes on the keyboard.

**Sostenuto Pedal:** The function of this pedal is to withhold the dampeners from all of the keys which are depressed at the moment. The effect is that notes that were being played when the pedaling begun will be sustained even when the fingers are withdrawn from the keys. Notes played after the pedaling began may still be played staccato (short). On less expensive pianos, this pedal may function differently, acting simply to sustain all notes on the left side of the keyboard.

**Sustaining Pedal:** This pedal withholds the dampeners from all keys, allowing strings to continue vibrating uncontrolled until the pedal is released. What differentiates this pedal from the sostenuto pedal is that the latter only un-dampens *some* of the keys, while the sustaining pedal un-dampens *all* keys.
Piece by Piece Explanation of Piano Action
The piano action is a device which uses the mechanical energy of a key press to perform the functions necessary to produce a clear, sustained, and repeatable vibration of one or more piano strings. It is important to understand that while the explanation that follows is approximately chronological, certain events (such as the jack moving upwards and the damper moving to the right) occur simultaneously.

- **Key Lever** - When a key is depressed, the key lever exerts an upward force on the rocker (also called the wippen). The lever also amplifies the force of the key press, since the lever arm is longer on the side of the key than on the string side. This reduces how much force the pianist must exert on the key before a sound is produced.
- **Rocker/Wippen** - This horizontal rod rotates counterclockwise when the key lever presses its right side upwards. The purpose of the rocker is to remove the damper from the string, and to set the hammer in motion by exerting an upward force on the jack. When the rocker rotates, the damper is moved down and to the right, and it loses contact with the string.
• **Jack** - A small but critical piece, the jack is forced upwards into the base of the hammer when the rocker rotates. It slides to the right and upwards along the perimeter of the hammer, causing the hammer to strike the string. Eventually, the jack breaks contact with the hammer and comes to rest to the right of the hammer base until the key is released. This is important, since the hammer must be allowed to break contact with the string, or the sound will be dampened.

• **Hammer** - The felt of the hammer strikes the string after motion is initiated by a push from the jack. After impact, the hammer is pulled to the back check by the repetition mechanism. If the same key is pressed in rapid succession, the hammer may never relax all the way back to the hammer rail. There is a momentary delay upon releasing the key before the hammer relaxes completely, and the jack returns to its original position contacting the bottom of the hammer.

• **Repetition Mechanism** - In an upright piano, a small ribbon connects the hammer base to the back check. This helps the hammer move to the back check quickly after striking the string, which means that the key can be used more often by the pianist. Another component of the repetition mechanism is the jack spring, which is a small spring connecting the jack to the rocker. This spring repositions the jack after it slides off to the right of the hammer base. These two components make up the repetition mechanism in an upright piano, and determine how quickly a certain key may be used repeatedly.

• **Damper** - This is the piece that keeps the string quiet until it is played, and stops the sound when the key is released. The damper moves away from the string when the key is depressed or when the sustaining pedal is depressed. When the damper returns to contact with the string, the sound will quickly be cut off.

**Conclusion**

The modern piano is a complex instrument. Its function relies on intricate mechanical processes which are not intuitive. Studying the details of piano action can improve any pianist’s understanding of how their instrument works and will provide insight into the mechanisms underlying the limits of this well-purposed machine.