

Gravity Source: <https://www.ssbwiki.com/Gravity>

Gravity is a measure of how fast a falling character reaches their maximum falling speed. A character with high gravity does not necessarily have a fast falling speed; they simply reach their top falling speed faster.

In Brawl and SSB4, the vertical knockback suffered by characters is based on both their weight and their gravity, with higher-gravity characters taking more knockback; horizontal knockback is unaffected. This reduces the natural effect of gravity on launch distance, keeping characters with low weight but high gravity (most notably Fox) from having disproportionately high vertical endurance, and in fact results in their endurance being slightly worse than a fighter with lower gravity. Despite horizontal knockback being unaffected, fighters with higher gravity tend to have poorer horizontal endurance, due to the gravity compensation resulting in slightly higher hitstun. Since a character's air friction only takes effect after the hitstun ends, this results in it taking slightly longer for fighters with higher gravity to be slowed down by their air friction, thus resulting in them dying earlier. It also affects how difficult the character is to combo - by applying slightly more knockback to characters that more quickly fall into the next attack, it slightly normalizes the effect of setup and multi-hit moves on the cast.

Gravity also affects how high a character is able to jump; two characters with the same jump force will not jump the same height if they have different gravity.

In Smash 4, a character's gravity can be altered by using the equipment bonus effects, Thistle Jump or Anchor Jump, with Thistle Jump decreasing it, while Anchor Jump increases it. However, both bonus effects also alter a character's falling speed.

Falling speed Source: https://www.ssbwiki.com/Falling_speed

Falling speed is the rate at which a character can move downward in mid-air. A character's falling speed can greatly impact the fighting style - for instance, Fox, a fast-faller, uses his aerial speed to perform SHFFL'd attacks very quickly, whereas Jigglypuff, a floaty character, uses its low falling speed to attack multiple times in mid-air.

While falling speed's main effect is determining how quickly a character can drop downwards, it also affects the physics of knockback. After a character is launched, their gravity still applies, slowing their vertical ascent until the reduction equals their falling speed; as a result, characters with higher falling speed have their vertical knockback reduced for longer, improving their vertical endurance while also hampering their ability to recover from horizontal blows. However, weight is still the main factor in how much knockback is sustained in the first place, and the two factors are independent - a fast-falling character is not necessarily heavy, and vice versa. Samus and Fox are notable examples of this.

The items Bunny Hood and Metal Box increase the user's falling speed. Some stages can also affect a character's falling speed, such as the flying-type portion of Pokémon Stadium 2 and the falling portion of Summit.

In Super Smash Bros. 4, the equipment bonus effects, Thistle Jump and Anchor Jump, can be used to alter a character's falling speed, with Thistle Jump decreasing it, while Anchor Jump increases it. However, both bonus effects also alter a character's gravity.

All characters can also fast fall at any time to increase falling speed.

Fast fall Source: https://www.ssbwiki.com/Fast_fall

A Fast fall is the act of falling more quickly than usual in mid-air. It is performed by tapping down on the control stick while falling. The character will continue to fast fall until landing on the platform or taking a hit. Gravity is ignored once a fast fall is begun; the character's downward velocity is simply set to their fast falling speed without accelerating. Fast falling is a technique commonly used to speed up a character's game, especially after a short hop. It is a part of SHFFL'ing, an advanced technique.

Stall-then-fall aerials have an effect similar to fastfalling, though the move is an attack, and most of the time cannot be stopped or slowed.

If players press down while hanging from a ledge, their character will begin to fast fall, whereas if pressed in the opposite direction of the ledge, the character will merely let go of the ledge. This also works with down + B attacks, except for ones that slow down falling or gain height. (An example is Fox's Reflector or Luigi's Luigi Cyclone.)

In Super Smash Bros. and Super Smash Bros. 4[1], the character will flash and a white star will appear at his or her torso when fast-falling (in Smash 4, the stars can appear in several places, but all are still located near the fast-falling character's midsection). In Super Smash Bros. Melee, a "whoosh" sound will be heard when fast falling, but there is no visual indicator, making it harder to pick up on, especially with other surrounding sound effects. There is no indicator in Super Smash Bros. Brawl whatsoever.

In Super Smash Bros. 4, characters can cancel a fastfall by using an aerial attack. This will set their falling speed to the normal maximum.

1. In what ways would the motion of an falling object in the Super Smash Bros. universe be similar or different to the motion of a falling object in our universe (e.g. on the Earth)? Assume they do not fastfall. Consider the following in your comparison: gravitational acceleration, air friction, terminal velocity.
2. Consider a character who has been launched upwards from ground level ($x_0 = 0$) and with an initial velocity v_0 greater than their falling speed. The character does not fastfall.
 - a) Describe the motion of the character until the return to the ground.
 - b) Sketch the following graphs of the character from when they are launched until the return to the ground.
 - i. position vs. time. On the axes, label x_{\max} and t_c , the time when the object reaches its maximum downwards velocity.
 - ii. velocity vs. time. On the axes, label v_0 , v_{\max} and t_c .
 - iii. acceleration vs. time. On the axes, label t_c .