HANG TIME vs MAXIMUM JUMP HEIGHT-THEORY

HANG TIME *is the total time that an object or person stays in the air when the object is thrown or when the person jumps.* The **HANG TIME** is measured from the instant the player's feet leave the ground until the time the player's feet return to the ground. The higher a person jumps, the greater the time he or she will appear to be "hanging" at the highest point of the jump.

To derive an equation that relates the **HANG TIME** to the **JUMP HEIGHT** we start with the physics concept that in a gravitational situation, what goes up must come down. We also can state as true that the time an object takes to go from the ground up a certain distance, is the same time it takes that object to return to ground.

We know from simple physics that to calculate how long it takes an object to fall a distance d above the ground is given by the formula $d = -\frac{1}{2} \times g \times t^2$, where g is the gravitational acceleration on the planet Earth. (g is approximately equal to -9.8 meters/(seconds)^2 and in US units, -32 feet/(second)^2). t is the time it takes to fall the distance d and g is the acceleration, or the change of velocity (caused by gravity) with respect to time. In words, on planet Earth, the velocity (which is given in say feet/second) changes by -32 feet/second every second it is in the air. If the velocity was say -4 feet/second at the start time, then 1 second later the velocity would be -36 feet/second. The velocity changes by -32 feet per second. Thus in that 1 second of falling due to gravity, the object speeds up from -4 feet/second downward at the start to a total velocity of – 36 feet/second (-4 feet/second + (-32 feet/second)).

The formula for distance d is: $d = -\frac{1}{2} \times g \times t^2$ can be rewritten as $t = \sqrt{-\frac{2d}{g}}$ **Equation (1)**

The time to go up to a height d and then back down is the **HANG TIME** and just 2 times **Equation (1)** or

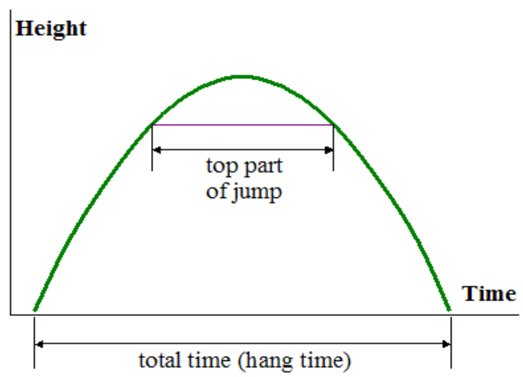
HANG TIME $= 2 \times t = 2 \times \sqrt{-\frac{2d}{g}} = \sqrt{-\frac{8 \times d}{g}}$ **Equation (2)**

If g on the planet Earth is equal to: -32 feet/(second)^2, then converting feet to inches we get -32 x 12 inches/second)^2 and substituting this in Equation (2) we get

HANG TIME $= \sqrt{-\frac{8d}{g}} = \sqrt{\frac{8 \times d}{32 \times 12}} = \sqrt{\frac{d}{48}}$ where d is now JUMP HEIGHT in inches **Equation (3)**

(Side 1)

When LeBron James jumps to slam dunk the basketball, how long do you think he is usually in the air? In other words, what is his hang time? Most people are surprised to learn that James' maximum **HANG TIME** for slam-dunks is about 1 second! Many people think that when someone like LeBron James or Michael Jordan leaps into the air, they return to the ground when they want to, rather than obeying the physical law of gravity! This may be partly because we see so many instant replays in super slow motion creating the illusion of the basketball player floating. Muggsy Bogues, now retired, at 5'-3" was the shortest NBA player in history, but he reportedly had **a 44-inch** measured vertical leap.



The stronger the surface gravity, on the Sun and Jupiter, the more difficult it is to jump high with shorter **HANG TIME**. For weaker surface gravity, such as on Mars and the moon, the higher one can jump and the longer the **HANG TIME**.

Member of Solar System and Their Surface Gravity g-factor	How High Can **Michael Jordan Jump** From Each Surface? Jump Height/(g-factor)	How Long Will **Michael Jordan** Hang in the Air? Hang time/(g-factor)	How High Could **You** Jump From Each Solar Surface? Your Jump Height/(g-factor)	How Long Will **You** Hang from Each Solar Surface? Your Hang time/(g-factor)
Earth 1.00	Say 48 inches	1.00 seconds		
Sun 27.90	1.72 inches	0.036 sec		
Mercury 0.38	126.3 (Over 10 feet)	2.63 sec		
Venus 0.91	53.75 inches	1.10 sec		
Mars 0.38	126.3 (Over 10 feet)	2.63 sec		
Jupiter 2.36	20.34 inches	0.42 sec		
Saturn 0.92	52.17 inches	1.09 sec		
Uranus 0.89	53.93 inches	1.12 sec		
Neptune 1.12	42.68 inches	0.89 sec		
Pluto 0.06	800 (Over 66 feet)	16.67 sec		
Moon 0.16	300 (25 feet)	6.25 sec		