Lunar Basketball

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When civilization on the moon arises, the people of our lunar colonies will need ways to entertain themselves. These people may want to participate in “lunar sports”. These sports should be adapted, however, from their Earth counterparts, to account for the gravity on the moon.

These are my predictions for an adjustment from Earth Basketball to **Lunar Basketball**:

Question 1: How high should the hoops be?

On the moon, people will be able to jump higher. Now, if we kept the basketball rims on “Earth standard 10 feet (3.048 meters), everyone would be able to dunk the basketball. We must find the ideal rim height so that the game is more realistic: only the tallest players with the best jumping abilities should be able to dunk the basketball.

First, we must define the ideal height. I will make the ideal height be defined as this:

- On earth, the average person can jump a certain height. The distance between the bottom of their feet at the top of their jump and the rim should be the same on the Moon as it is on Earth.

Now that we defined an ideal height, let’s calculate what height that should be:

We start with making 4 assumptions:

1. The average person on Earth can jump 0.40 meters. (source: topendsports.com)
2. The average person has a mass of 62 kilograms (source: livescience.com)
3. A person can exert as much force on the ground on the moon as they can on Earth.
4. An average person bends down 0.32 meters before jumping. (Tested by a real test using myself and my dad)

We will use these “average” assumptions for our calculations. Let’s begin:

We start by asking ourselves how fast one must leave the ground to achieve a jump height of 0.40 meters.

$$\frac{\left(v_y{}^2 - v_{0_y}{}^2\right)}{2 \cdot \frac{9.8m}{s^2}} = 0.40\,m$$

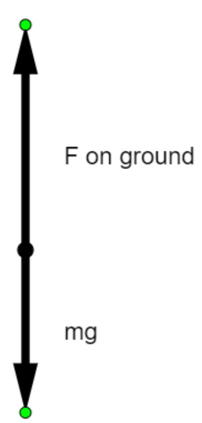
$$v_y = \frac{2.8\,m}{s}$$

The person accelerated from 0 m/s to 2.80 m/s in 0.32 meters.

$$\frac{\left(\frac{2.80\,m}{s}^2 - 0\right)}{2 \cdot 0.32\,m} = a_y$$

$$a_y = \frac{12.25\,m}{s^2}$$

Let’s draw a free-body diagram to determine the force exerted on the ground:



Newton's Third Law states that the force one exerts on the ground is equal to the force the ground exerts on the person.

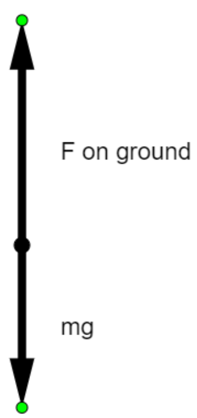
$$F\ on\ ground - mg = ma = F\ on\ ground - (62kg)\left(\frac{9.8\ m}{s^2}\right) = (62kg)\left(\frac{12.25\ m}{s^2}\right)$$

$$F\ on\ ground = 1367\ N$$

The average person exerts 1367 N of force on the ground.

Now, we made the assumption that a person can exert this same force on the surface of the moon.

We have the same free-body diagram, but this time the constant for g will be ⅙ of 9.8.



$$F\ on\ ground - mg = 1367\ N - (62kg)\left(\frac{1.62\ m}{s^2}\right) = (62kg)\left(a_y\right)$$

$$a_y = \frac{20.4\ m}{s^2}$$

We now calculate the velocity at which a lunar citizen can leave the ground, using the acceleration we just calculated and the fact that the average person will bend down about 0.32 meters before jumping.

$$\frac{\left(v_y^{\,2} - 0\right)}{2 \cdot\ 0.32\,m} = \frac{20.4\,m}{s^2}$$

$$v_y = \frac{3.62\,m}{s}$$

We’re nearly there. We must now use this initial velocity to find how high someone on the moon can jump. We’ll use 1.62 m/s^2 as our acceleration due to gravity:

$$\frac{\left(0 - \frac{3.62\,m}{s^2}^{\,2}\right)}{2 \cdot\ -\frac{1.62\,m}{s^2}} = y$$

$$y = 4.04\,m$$

So, using our average conditions and assumptions, we have established that the average person can reach a height of 4.04 meters off the ground when jumping on the moon.

Now, let’s finish the question. I established before that the ideal hoop height is when the distance between the bottom of one’s feet at the top of the jump and the rim is the same on the Earth as on the moon.

That distance should be:

$$3.048\,m - 0.40\,m = 2.648\,m$$

So, the rim should be 2.648 meters above the feet of a jumping player when he has reached his maximum height. To calculate the height of a lunar rim, we simply add.

$$h_{rim} = 4.04\,m + 2.648\,m = 6.688\,m \ or \sim 22\,feet$$

Earth Hoop

Moon Hoop