ro&chi golf™ TP n.3

# Tecnhical Pamphlets

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## KINETIC ENERGY AND CONSERVATION OF MOMENTUM

The kinetic energy - conservation of momentum and kinetic energy

The total kinetic energy, in the case of a system of two or more bodies, is given by the sum of all the individual kinetic energies, and in the case of an elastic collision, ie collision in which the total kinetic energy of the system is preserved:

Ktot = K1 + k2 + …+ Kn e si misura in $kgm^2/sec^2$= J (joule)

Imagining the elastic collision between the putter and golf ball (actually elastic collision) we can calculate, giving:

mA = mass of the putter and arms = 5 kg

mB = mass if the ball= 0,04593 kg

vA = speed of the head of putter = 1 m/sec (before the impact)

vB = speed of the ball = 0 m/sec (before the impact)

First we calculate the kinetic energy of the system of two equations in two unknowns, for 2 conservation laws, it will resolve obtaining ::

**wA = 0,98 m/sec** speed of the putter head just after the impact with the ball, and

**wB = 1,98 m/sec**, speed of the ball just after the impact

**You can see that the speed of the putter, 1 m/sec before impact, after hitting the ball, it decreases really cheap (0.98 m/sec).**

**But watch what happens if we were to consider only the weight of the putter without the component of the arms, thus placing mA = 0.350 kg:**

**wA = 0,76 m/sec** speed of the putter head just after the impact with the ball, and

**wB = 1,76 m/sec**, speed of the ball just after the impact

It follows that the speed of the ball impact is reduced by 14% compared to the first case, while the effect on the speed of the putter head after collision by 21% compared to the first case (5 kg).

It is often said that with a heavier putter head provides greater length of roll the ball, but this is inaccurate, in fact:

**"The speed of the ball is modestly influenced by the mass of the putter, in other words, you want to mean that a shot run without a good connection with the arms, is less efficient"**

Seen in terms of speed, we now see the system in terms of momentum.

The law of conservation of momentum, the latter defined by the size p with the direction and sense of speed and modulus equal to the product mv, in relation to a body of mass m and velocity v of the magnitude p, which defines the amount of motion of the individual bodies can vary, but the total momentum remains the same.

Imagine the case of the first in which:

mA = mass of the putter and arms = 5 kg

mB = mass of the ball = 0,04593 kg

vA = speed of the head of putter = 1 m/sec (before the impact)

vB = speed of the ball = 0 m/sec (before the impact)

Nota : come vedremo oltre, la palla in uscita dalla rampa dello Stimpmeter ha una velocità di 1,83 m/sec, molto prossima ai due sistemi decsritti.

before impact the expression would be:

pA = mA x vA = 5 Ns (newton second)

pB = mB x vB = 0 Ns, on the other hand the ball is stationary before the collision.

Now, impact of the putter on the ball, we will

pA = 4,91 Ns

pB = 0,09 Ns

If then, again, we calculate the momentum as we did for the kinetic energy in which we place the weight of the putter to only 0,350 kg, we will find:

pA = 0,27 Ns (vs 4,91 with mA= 5kg)

pB = 0,08 Ns (vs 0,09 with mA= 5kg)

**All this processing to get to say what?**

***"The momentum transferred to the ball by the system undergoes small changes with the increase of mass of the putter, while it varies significantly to vary the speed of the putter impact".***

Summing up in terms of application golf, we can say that the momentum and kinetic energy transferred to the ball is not substantially dependent on the amplitude of the swing or the weight of the putter, but the speed of the putter at impact with the ball .

### Rolling Energy

Before introducing the topic, perhaps worth dwelling on the movement of the ball while rolling.

It is intuitively to imagine the trajectory that goes through the center of the ball that rotates perfectly, ie with a roto-translational pure, is straight and the length traveled during each revolution is equal to 2 x π xr that corresponds 13,4 cm.

It is often said that the ball was missing a lap to go in the hole , well, a spin of the ball corresponds to 13.4 cm, and since the diameter of the hole is 10.8 cm , a complete revolution of the ball exceeds the pit 2 , 6 cm ( just over half ball). From this we understand that very often just less than one revolution of the ball in the hole so that it goes into .

The data on the distance traveled by a revolution of the ball will come in handy when you talk of blows downhill. We will approach it in due time.

The ball moves with a roto - translational pure , that is, where the act exclusively rolling friction without sliding friction , in the case where the distance traveled by the ball is equal to the distance traveled by any point on the surface of the ball.

The ball that rotala undergoes a movement of rotation and translation with linear velocity ve angular velocity ω and K has kinetic energy equal to the sum of the translational and energy rolling , then :

$K = ½ mB \times vB^2 + 2/5 I \times \omega^2$,

will therefore, with the putter mass of 0.35 kg and initial velocity of the ball, with a mass of 0.04593 kg, equal to 1.76 m / sec

K = 0,072 J (joule)

If we introduce the mass of 5 kg (system putter arms), we have seen that the initial velocity of the ball is 1.98 m / sec, **we can write K = 0.091 J, which is a mass of the putter 14 times more energy to produce a rolling equal to 1.25 times higher.**

**This again confirms that to get more energy is required rolling greater swing speed and the mass of the putter is modestly influential**.

*Figure 8 : the trajectory of the ball from the red dot is called a "cycloid"*