0.2 The period of a pendulum

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Abstract

Geometric demonstration located in *v, t* diagram explains the nature of the period of a pendulum, i.e. the universal connection of time with velocity (radius) and acceleration. Conceptual nature of the principles proof points to its universal validity. In other words, if it is valid for a circle, it is valid. Through the geometry of free fall we describe physical nature of irrational numbers π and $\sqrt{2}$. We demonstrate physical matrix of scale $\sqrt{2n\pi}$. Through the relationship between the variables of space, time and velocity, using the principle of the pendulum, we illustrate the foundation of the law of conservation of energy. Analyzing its motion we point to nature of distortion of Euclidean geometry.

The principle of the period of a pendulum

For the period of the object, which plunges along the curve in a constant gravitational environment, to be independent of its initial position, the object has to move along cycloid. Cycloid is a curve, which could be described as a trace of a point on a wheel that rolls (Figure 0.2a).

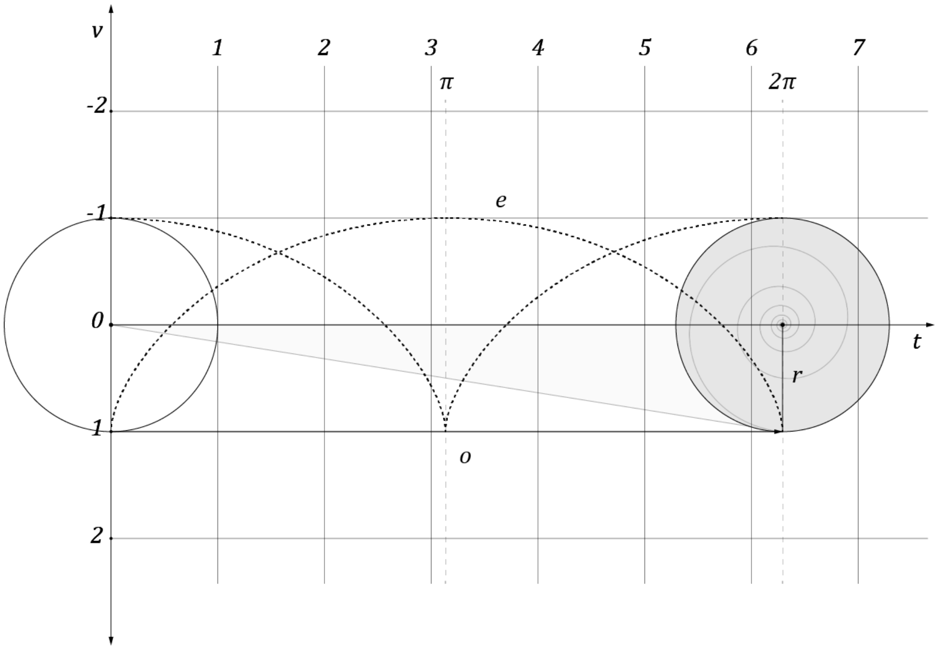

Figure 0.2a

Therefore, the arc of the circle, i.e. the curve at which the object moves, swinging at a fixed arm, differs from the cycloid, so the independence of its period on the amplitude is valid only for minor displacements, which is also a small approximation.

In the presented case of an ideal pendulum (Figure 0.2.a) applies, that the rotation period of the circle, which in a free fall rolls at *v, t* diagrams time coordinate *t*, and which radius equals the speed reached by acceleration of a system in one time unit, is *2π* units of time.

Accordingly, when the pendulums period is *2π*, the length of its arm (radius) is equal to the acceleration measured in a unit of time. In other words, **a natural constant *π* can be described as the half-period of an ideal pendulum whose length *l* i.e. radius *r*, equals to the acceleration *a* of measured environment.**

For any ideal pendulum applies that its orbital velocity equals to the geometric mean of its radius (speed) and the acceleration of surrounding;

$$v_o = \sqrt{ra} \qquad 0.2.1$$

Thereby, the orbital velocity of a pendulum whose radius is equal to the acceleration measured in one unit of time, is 1*r*. Stated indicates the necessity of equalizing the reference unit for length with the reference acceleration of surrounding, whereby the reference unit of time, is time in which light traveled reference radius of the reference system of acceleration (in our case, the radius of the Earth).

If we change the pendulums amplitude, we have changed the position on the *v* coordinate, i.e. the amount of speed reached by the pendulum in free fall (Figure 0.2.b).

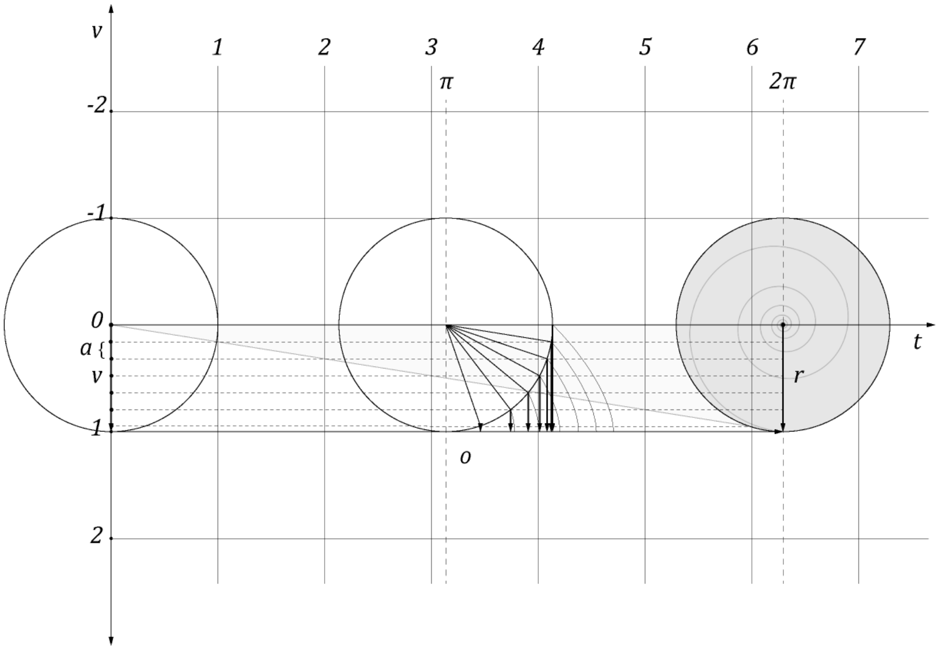

Figure 0.2b

The implication of change of speed *v* for an amount *n* is proportional to the change in distance traveled *s*;

$$nv = ns \qquad 0.2.2$$

In other words, as it is known, the period of the ideal pendulum depends only on its radius and acceleration of surrounding.

In the period of an ideal pendulum, whose orbital velocity is (0.2.1), the maximum trajectory of a point on the radius *r* is equal to its scope. Thus, the ideal pendulums period *T*, is equal to the ratio of the circumference and the speed of its orbit at radius *r*;

$$T = \frac{o}{v_o} = \frac{2r\pi}{\sqrt{ra}} \qquad 0.2.3$$

From the above equality derived is the conventional equation for the period of a pendulum, where radius *r* is denoted as length *l*, and where for the non-ideal pendulum, the sign for equality is replaced by a sign of approximation;

$$T = 2\pi\sqrt{\frac{r}{a}} \qquad 0.2.4$$

The above ratio applies for a circle, hence it is universally valid. When in the above relation we include the radius of any celestial body and the acceleration of its surface, the radius of any orbit... with its orbital acceleration..., obtained periods are revolution periods of corresponding orbital velocities of the calculated entities.

In the above formula (0.2.4), canceling units of conventionally understood radius (m) with the acceleration (m/s^2), results with the expected time unit *t*, expressed in seconds *s*;

$$T = 2\pi t \qquad 0.2.5$$

When the radius is interpreted as the speed, it is evident that the formulation r/a, i.e. v/a, from relation (0.2.4), represents time in which the acceleration reaches a speed equivalent to radius. As mentioned, when the radius (velocity) is equal to the amount of acceleration measured in the unit of time, the period of the ideal pendulum is 2π time units. By changing the radius changes the time at which acceleration reaches the equivalent speed, whereby the period of a pendulum is proportional to the root of that time (Figure 0.2.c);

$$T = 2\pi\sqrt{t} \qquad 0.2.6$$

Implicitly, by establishing a valid system, enigmatic matrix of patterns of the world are untying by themselves. Mechanism of the ideal pendulum demonstrates physical appearances of irrational scale $\sqrt{2n\pi}$.

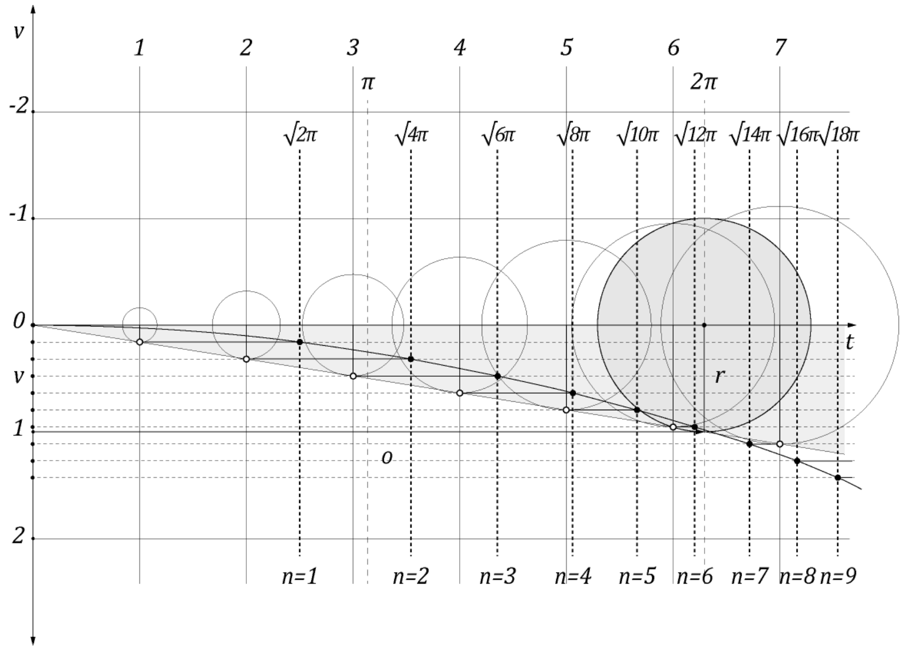

Figure 0.2c

Let us say that *n* is the product of an arbitrary radius r_n and the reference time *2π* (which means that the unit radius is equal to acceleration of environment);

$$n = r_n 2\pi \qquad 0.2.7$$

Since constant *2π* in displayed equality is a relationship with the unit of a reference time (reference velocity and acceleration), the variable scalar, radius r_n (velocity v_n) alternates the spatial product *n*. From the above relationship, we read that at the time coordinate *t*, *n* is equal to the circle scope of radius r_n. At the coordinate of velocity, *n* is the amount of a reduced acceleration a_π (1/2π) of a reference circle system whose radius is equal to the amount of acceleration of measured environment and whose period is *2π* units of reference time.

It is valid that the distance traveled s_n, i.e. the surface of a triangle at time position t_n, for each observed radius r_n is equal to half of the product *n*;

$$s_n = \frac{n}{2} \qquad 0.2.8$$

Accordingly, the area of all segments of the triangle representing distance traveled, measured between all neighboring unit products *n*, amounts one half. Towards an infinite radius, the spatial presence of mentioned areas points, at velocity coordinate tend to zero, while at the coordinate of time it tend to infinity. Since ratio of values of product n remains constant, we read fundamental law of conservation of energy expressed through the relationship of variables of space, time and speed.

For any arbitrary radii of the system described, applies that the ratio of corresponding circle area p_n and the distance traveled s_n is equal to the ratio of product n over period 2π;

$$\frac{p_n}{s_n} = \frac{n}{2\pi} \qquad 0.2.9$$

Accordingly, for the reference circle of reference time 2π applies that the distance traveled equals to its surface;

$$s = p \qquad 0.2.10$$

Implicitly, the period of the described ideal pendulum we can write;

$$T = 2\sqrt{s_n \pi} \qquad 0.2.11$$

$$T = 2\pi\sqrt{r_n} \qquad 0.2.12$$

Which is equal to;

$$T = \sqrt{2n\pi} \qquad 0.2.13$$

Through the principle of period of an ideal pendulum, we have demonstrated the physical matrix of appearance of the scale of irrational numbers $\sqrt{2n\pi}$.

In time $\sqrt{t}$ from the equation (0.2.6), acceleration of a system reaches orbital velocity whereby acceleration exceeds the half, and orbital velocity entire radius. In time $\sqrt{2t}$ acceleration of a system reaches escape velocity wherein acceleration exceeds full and escape velocity two radii.

Therefore, at the time of the collision with the surface, for velocity of the body in a free fall of a constant gravitational environment and without resistance of the media through which it falls, to be equal to the orbital velocity of the system, height of its trajectory is equal to half the value of the radius of the gravitational entity at which it falls. Consequently, to reach escape velocity, falling trajectory height is equal to the radius. It follows that **$\sqrt{2}$ is the universal factor of speed difference of a body in a free fall, in a constant gravitational environment, measured in arbitrary point of falling trajectory and its half** (Figure 0.2d).

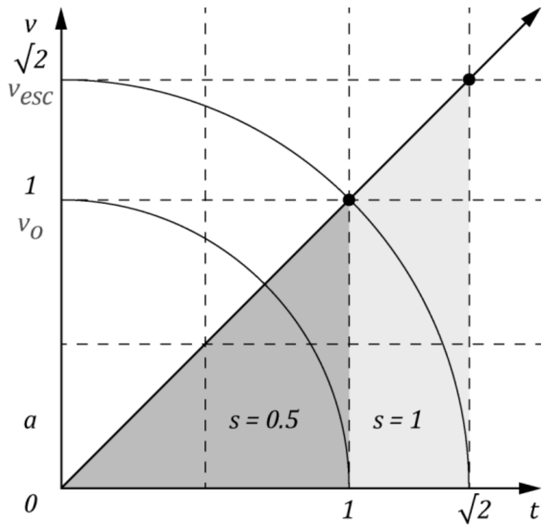

Figure 0.2d

Due to the fact that each immeasurably small difference in radius is implicit change of system of speed, in relation to the idea of approximation of constant acceleration, we record dilatation of space-time continuum. As we have shown, 2π reference units of time, is the cycle time of an ideal pendulum whose reference radius equals to the reference acceleration of measured environment. In other words, our π and our $\sqrt{2}$, is the relationship with our reference radius (velocity). The result 2π is a scope of a unit radius and the ratio of all scopes with their radiuses. The result $\sqrt{2}$ is a half of the diagonal of a square described in the same circle and the radius of the circle in which that square is inscribed. In other words, $\sqrt{2}$ is at the same time the diagonal ratio of all described and inscribed squares of observed circles, and the radius ratio of all described and inscribed circles of observed squares.

Accordingly, the geometry of Euclid space applies to any system of speed, i.e. radius. It is a world of frozen now in frozen here. Its abstract environment is a reference unit raster of all infinite radiuses (velocities). Its distortion, recorded from the reference radius, is a consequence of the dynamic relationship of the same geometry of Euclid space-times of infinite systems of velocities (radiuses).

For each radius applies that the ratio with its circumference is *2π*. Accordingly, for each radius applies the law of the same geometry. Implicitly, for each system of speed applies the same law of physics[1]. Manifestation of tension due to the differences among infinite systems of velocities (radiuses) creates an infinite scale of space-time distortions, i.e. the infinite variety and self-similarity of the appearance of the world[2].

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1 http://www.principiauniversi.com/blogs/13-0-dot-2-the-period-of-a-pendulum
2 http://www.principiauniversi.com/blogs/7-acceleration