Short Reports

BODY SLIDING ON AN INCLINED PLANE

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By consideration of processes of falling of a body or sliding of a body without a friction downwards on an inclined plane the law of preservation of mechanical energy in a kind is used: $mgh = mV_k^2/2$, where h - initial height of a body over a surface of the Earth, V_k - final speed. We will designate length of inclined plane S, and a corner of its inclination to horizon - α, then $h = S \cdot \sin\alpha$. According to the law of conservation of energy, final speed will be same: and in case of vertical falling, and in case of sliding on an inclined plane: $V_k = \sqrt{2gh}$ etc. It is said that the gravity in all cases has made same work mgh. We Will imagine, that corner α very is small. Then the body will appear on considerable removal from a place of vertical falling. Thus it will possess precisely same kinetic energy, as well as at vertical falling. At sliding on an inclined plane the body not only goes down to the Earth, but also moving work on considerable distance is made. Work at sliding should be more works at vertical falling.

At movement of a body without a friction on an inclined plane gravity $P = mg$ can be spread out on two components: rolling force $F_\alpha = mg\sin\alpha$ and normal reaction of support $N = mg\cos\alpha$. The square of time of sliding on an inclined plane is equal $t_k^2 = 2S/a = 2h/g\sin^2\alpha$.

Work of roll down forces

$$A_a = F_a S = mgS\sin\alpha = mgh \quad (1)$$

It is possible to express through an impulse rolling forces $I_a = F_a t_k$

$$A_a = F_a \cdot \frac{at_k^2}{2} = \frac{F_a^2 t_k^2}{2m} = \frac{I_a^2}{2m} \quad (1a)$$

Work of normal force we will write down through an impulse of force $I_N = Nt_k$

$$A_{N} = \frac{I_N^2}{2m} = \frac{N^2 t_K^2}{2m} = mgh \cdot \mathrm{ctg}^2\alpha \quad (2)$$

Since forces F_a and N orthogonal works of these forces are additive. Then total work of these forces can be found arithmetic addition

$$A_\Sigma = A_a + A_N = mgh(1 + \mathrm{ctg}^2\alpha) = \frac{mgh}{\sin^2\alpha} \quad (3)$$

From (3) as the special case turns out gravity work at vertical falling ($\alpha = 90^o$): $A_\Sigma = mgh$. At coal $\alpha = 10^o$ work of gravity $A_\Sigma \cong 33mgh$.

If the inclined plane is rough, movement occurs to some factor of friction μ. We will consider a case of spontaneous sliding of a body ($\mu < \mathrm{tg}\alpha$). In this case uniformly accelerated sliding will occur downwards under the influence of force $F_\alpha = mg(\sin\alpha - \mu\cos\alpha)$. Sliding time.

$$t_k^2 = \frac{2S}{a} = \frac{2h}{a\sin\alpha} = \frac{2h}{g\sin^2\alpha(1 - \mu/tg\alpha)} \quad (4)$$

Speed in the end of an inclined plane

$$V_k^2 = 2gh(1 - \mu/\mathrm{tg}\alpha) \quad (5)$$

The work made by a gravity, at sliding with a friction on an inclined surface.

$$A_{\Sigma}^{T} = \frac{m^2 g^2 t_k^2}{2m} = \frac{mgh}{\sin^2\alpha(1-\mu/tg\alpha)} \quad (6)$$

At factor of friction $\mu = 0$ we receive a parity (3). The relation of work with friction A_{Σ}^{T} to work of gravity A_{Σ} in the absence of a friction depending on relation $\mu/\mathrm{tg}\alpha$ are resulted in table 1.

Table 1

$\mu/\mathrm{tg}\alpha$	0	0,2	0,4	0,5	0,6	0,7	0,8	0,9	0,95
$A_{\Sigma}^{T}/A_{\Sigma}$	1	1,25	1,667	2	2,5	3,33	5	10	20

At factor of friction $\mu = 0{,}9\mathrm{tg}\alpha$ and coal $\alpha = 10^{o}$ work of gravity $A_{\Sigma}^{T} \cong 330mgh$.

More detailed conclusion of formulas for calculation of work of various forces is resulted in [1,2].

References

1. Ivanov E.M. Work and energy in the classical mechanics and the first law of thermodynamics. Dimitrovgrad: DITUD UlGTU, 2004.

2. Ivanov E.M. Work of centripetal and gyroscopic Forces.//European Journal Natural History, 2006, #1, p.80.

WORK OF TURN AND WORK OF CENTRIPETAL FORCES

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Turn work is a work, which needs to be spent to change a direction of movement of a body (to turn a vector of speed V_0 on some corner α):

$$A_{\alpha} = \frac{I_2^2}{2m} = \frac{I_0^2}{m}(1-\cos\alpha)$$

where $I_0 = mV_0$ - a body impulse. Under the same formula work of centripetal force pays off.

From the law of inertia Galilee (Newton's I law) follows, that any body shows resistance at attempts to set it in motion or to change the module or the DIRECTION of its speed. This property of bodies is called as inertness. To overcome resistance, it is necessary to make effort, i.e. to make work. The formula for calculation of work of change of speed of a body is resulted in all textbooks of physics. It is received on the basis of Newton's II law for a resultant of force $F_a = \sum F_i = ma$ in a kind

$$A = F_a \cdot S \quad (1)$$

As way $S = at^2/2 = Ft^2/2m$ it is possible to express work through an impulse of force $I_a = F_a t$

$$A = F_a^2 t^2/2m = I_a^2/2m \quad (2)$$

Let's define work, which needs to be spent to change the DIRECTION of movement of a body, i.e. to turn a vector of speed V_0 on some corner α. The author [1-3] named its WORK of TURN. At change of a direction of movement at $V_0 = \mathrm{const}$ kinetic energy of a body does not change, but work should be spent, as the body shows resistance to attempt to change a direction of its speed. Change of a direction of movement we will make at the expense of action of