METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH zima22 – Príklady 2

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Príklad 1

(a) Let v_0 denote the asymptotic common speed.

In a given time interval Δt, the cluster collides with $v_0\Delta t/d$ further beads, which increases its mass by $\Delta m = mv_0\Delta t/d$ and its momentum by $\Delta p = v_0\Delta m = mv_0^2\Delta t/d$. According to Newton's law of motion,

$$F = \frac{\Delta p}{\Delta t} = \frac{mv_0^2}{d},$$

which yields $v_0 = \sqrt{Fd/m}$ for the ultimate speed in the case of inelastic collisions.

(b) In an elastic collision between two equal mass bodies with one of them initially at rest, their velocities are exchanged. The body initially moving with velocity v stops, while the second one moves away with velocity v.

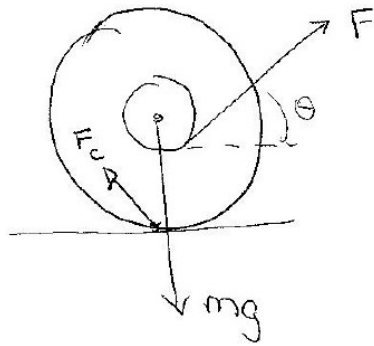The leftmost bead accelerates uniformly and reaches a speed of

$$v_1 = \sqrt{\frac{2Fd}{m}} = \sqrt{2}v_0$$

before the first (elastic) collision takes place. It then transfers its speed to the second bead and stops, after which it starts accelerating again as a result of the external force. The second bead moves at a constant speed v_1, collides with the third bead and stops. The third and subsequent beads behave similarly, and a 'shock wave' propagates forward at speed v_1.

Meanwhile, the leftmost bead is again accelerated to speed v_1, collides with the second bead, which is now at rest, and the process is repeated, thus starting a new 'shock wave'. The speed of the leftmost bead varies uniformly from zero to v_1, its average value is $v_1/2 = v_0/\sqrt{2} = \sqrt{Fd/(2m)}$.

Príklad 2

2.

$$y: \quad \Sigma F_y = F_{cy} + F\sin\theta - mg = 0$$

$$x: \quad \Sigma F_y = -F_{cx} + F\cos\theta = MR\frac{d\omega}{dt}$$

$$\uparrow \text{ about CM} \quad \Sigma\vec{\tau} = +F_{cx}R - Fr = I_0\frac{d\omega}{dt}$$

$$F_{cx} = F\cos\theta - MR\frac{d\omega}{dt}$$

$$\left(F\cos\theta - MR\frac{d\omega}{dt}\right)R - Fr = I_0\frac{d\omega}{dt}$$

$$\frac{d\omega}{dt} = \frac{FR\cos\theta - Fr}{I_0 + MR^2}$$

Forward motion occurs when $\frac{d\omega}{dt} > 0$ if

$$FR\cos\theta > Fr \qquad \cos\theta > \frac{r}{R}$$

Backward motion occurs when $\cos\theta < \frac{r}{R}$

So. $\cos\theta_c = \frac{r}{R}$