$$F_1\cos\alpha_1 + F_2\cos\alpha_2 + F_3\cos\alpha_3 = R\cos\alpha;$$
$$F_1\cos\beta_1 - F_2\cos\beta_2 - F_3\cos\beta_3 = -R\cos\beta.$$

$$R = \sqrt{R_x^2 + R_y^2}$$

$$\cos\alpha = \frac{R_x}{R}; \quad \cos\beta = \frac{R_y}{R}.$$

$$\sum F_{ix} = 0; \quad \sum F_{iy} = 0.$$

$$\sum_{i=1}^{3} F_{ix} = 0; \ \ \sum_{i=1}^{3} F_{iy} = 0;$$

$$-T_2 \cos 60^\circ + T_1 \cos 30^\circ = 0;$$

$$T_2 \cos 30^\circ + T_1 \cos 60^\circ - mg = 0.$$

$$T_1 = 2{,}5 \text{ H}; \ \ T_2 = 4{,}34 \text{ H}.$$

$$F_2\cos\alpha - F_1\cos\alpha = 0.$$

$$\text{mom}(\overline{F}_1, \overline{F}_2) = +F_1h = +Fh.$$

$$\text{mom}(\overline{F}_1, \overline{F}_2) = -F_1h = -Fh.$$

$$\text{mom}_O(\overline{F}_1) = -F_1d = -Fd;$$
$$\text{mom}_O(\overline{F}_2) = +F_2l = +Fl;$$
$$\text{mom}_O(\overline{F}_1) + \text{mom}_O(\overline{F}_2) = -Fd + Fl = -(d - l)F = -Fh.$$

$\overline{F}_1, \overline{F}_2, \ldots, \overline{F}_n$

$$\overline{F}'_1 = \overline{F}_1,\ \ldots,\ \overline{F}'_n = \overline{F}_n,$$

$$\overline{F}''_1 = -\overline{F}_1,\ \ldots,\ \overline{F}''_n = -\overline{F}_n.$$

$$\overline{F}'_1, \overline{F}'_2, \ldots, \overline{F}'_n$$

$$m_1 = \mathrm{mom}(\overline{F}_1\overline{F}''_1),\quad m_2 = \mathrm{mom}(\overline{F}_2\overline{F}''_2),$$

$$m_n = \mathrm{mom}(\overline{F}_n\overline{F}''_n).$$

$$\overline{R} = \overline{F}'_1 + \overline{F}'_2 + \ldots + \overline{F}'_n,$$

$$\overline{F}_1 = \overline{F}'_1 \qquad \overline{R} = \overline{F}_1 + \overline{F}_2 + \ldots + \overline{F}_n.$$

$$M_O = m_1 + m_2 + \ldots + m_n.$$

$$R = \sqrt{R_x^2 + R_y^2}.$$

$$R_x = \sum_{i=1}^{n} F_{ix} \qquad R_y = \sum_{i=1}^{n} F_{iy},$$

$$\sum_{i=1}^{n} F_{ix} = 0; \ \sum_{i=1}^{n} F_{iy} = 0; \ \sum_{i=1}^{n} \mathrm{mom}_o(\overline{F}_i) = 0.$$

$$\sum_{i=1}^{n} F_{ix} = 0; \ \sum_{i=1}^{n} \mathrm{mom}_A(\overline{F}_i) = 0; \ \sum_{i=1}^{n} \mathrm{mom}_B(\overline{F}_i) = 0.$$

$$\sum_{i=1}^{n} \text{mom}_A(\overline{F}_i) = 0; \quad \sum_{i=1}^{n} \text{mom}_B(\overline{F}_i) = 0; \quad \sum_{i=1}^{n} \text{mom}_C(\overline{F}_i) = 0.$$

$$\sum_{i=1}^{5} F_{ix} = 0; \ N_B \cos 60^\circ + X_A - 20 = 0;$$

$$\sum_{i=1}^{5} F_{iy} = 0; \ N_B \cos 30^\circ + Y_A - 100 = 0;$$

$$\sum_{i=1}^{5} \text{mom}_B(F_i) = 0; \ -100 \cdot 10 + Y_A \cdot 20 + 20 \cdot 4 = 0.$$

$$Y_A = 46 \text{ кН}, \ N_B = 62{,}4 \text{ кН}; \ X_A = -11{,}2 \text{ кН}.$$

$$\overline{M}_O = \overline{r} \times \overline{F} = \overline{\mathrm{mom}_O}(\overline{F}).$$

$$M_O = hF = rF\sin(\overline{r}, \overline{F}) = 2 \text{ площади } \Delta OAB.$$

$$\bar{M}_O = M_x\bar{i} + M_y\bar{j} + M_z\bar{k};$$

$$\bar{r} = x\bar{i} + y\bar{j} + z\bar{k}; \quad \bar{F} = F_x\bar{i} + F_y\bar{j} + F_z\bar{k}.$$

$$\bar{M}_O = (yF_z - zF_y)\bar{i} + (zF_x - xF_z)\bar{j} + (xF_y - yF_z)\bar{k}.$$

$$M_x = yF_z - zF_y; \quad M_y = zF_x - xF_z; \quad M_z = xF_y - yF_x.$$

$$\cos(\bar{M}_O, \bar{i}) = \frac{M_x}{M_O}; \quad \cos(\bar{M}_O, \bar{j}) = \frac{M_y}{M_O}; \quad \cos(\bar{M}_O, \bar{k}) = \frac{M_x}{M_O}.$$

$$\text{mom}_x(\bar{F}) = M_x = yF_z - zF_y;$$

$$\text{mom}_y(\bar{F}) = M_y = zF_x - xF_z;$$

$$\text{mom}_z(\bar{F}) = M_z = xF_y - yF_x;$$

$$M_O = \sqrt{M_x^2 + M_y^2 + M_z^2}.$$

$\overline{F}_1' = -\overline{F}_1''$; $\overline{F}_2' = -\overline{F}_2''$

$\overline{F}_1' = \overline{F}_1, \ldots, \overline{F}_n' = \overline{F}_n.$

$\overline{F}_i'$

$\overline{R} = \overline{F}_1' + \overline{F}_2' + \ldots + \overline{F}_n'.$

$\overline{F}_1'', \overline{F}_2'', \ldots, \overline{F}_n''$

$$\overline{\mathrm{mom}}_O(\overline{F}_1) = \overline{m}_1;$$
$$\overline{\mathrm{mom}}_O(\overline{F}_2) = \overline{m}_2;$$
$$\ldots\ldots\ldots$$
$$\overline{\mathrm{mom}}_O(\overline{F}_n) = \overline{m}_n.$$

$$\bar{M}_O = \sum_{i=1}^{n} \overline{\text{mom}}_O(\bar{F}_i) = \sum_{i=1}^{n} \bar{m}_i.$$

$$R_x = \sum_{i=1}^{n} F_{ix}; \quad R_y = \sum_{i=1}^{n} F_{iy}; \quad R_z = \sum_{i=1}^{n} F_{iz};$$

$$M_x = \sum_{i=1}^{n} m_{ix}; \quad M_y = \sum_{i=1}^{n} m_{iy}; \quad M_z = \sum_{i=1}^{n} m_{ix}.$$

$$\overline{R} \perp \overline{M}_O.$$

$\overline{R} \neq 0; \overline{M}_O \neq 0$ и $\overline{R} \not\angle \overline{M}_O$

$$R = \sqrt{R_x^2 + R_y^2 + R_z^2} = 0,$$

$$\sum_{i=1}^{n} F_{ix} = 0; \quad \sum_{i=1}^{n} F_{iy} = 0; \quad \sum_{i=1}^{n} F_{iz} = 0;$$

$$\sum_{i=1}^{n} \mathrm{mom}_x(\overline{F}_i) = 0; \quad \sum_{i=1}^{n} \mathrm{mom}_y(\overline{F}_i) = 0; \quad \sum_{i=1}^{n} \mathrm{mom}_z(\overline{F}_i) = 0.$$

$$X_B = \frac{60\cos 30^\circ \cdot 0{,}5}{1{,}5} = 17 \text{ Н}.$$

$$Z_B = \frac{360 \cdot 1 - 60 \cdot 0{,}5 \cdot 0{,}5}{1{,}5} = 230 \text{ Н};$$

$$Z_O = 360 - 230 + 60 \cdot 0{,}5 = 160 \text{ Н};$$

$$X_O = -(17 + 60 \cdot 0{,}85) = -68 \text{ Н}.$$

$$\sum_{i=0}^{2} \mathrm{mom}_{B_1}\left(\overline{F}_i\right) = F_2 \cdot A_2B_1 - F_1 \cdot A_1B_1 = 0.$$

$$\sum_{i=1}^{n+1} \overline{\text{mom}}_O\left(\overline{F}_i\right) = \sum_{i=1}^{n} \overline{\text{mom}}_O\left(\overline{F}_i\right) + \overline{\text{mom}}_O\left(\overline{R}'\right) = 0.$$

$$\sum_{i=1}^{n} \overline{r}_i \times \overline{F}_i - \overline{r}_C \times \overline{R} = 0,$$

$$\sum_{i=1}^{n} \overline{r}_i \times \overline{F}_i - \overline{r}_C \times \overline{R}.$$

$$\overline{r}_C \times \overline{R} = \sum_{i=1}^{n} \overline{r}_i \times \overline{F}_i$$

$$\mathrm{mom}_x\left(\overline{R}\right) = \sum_{i=1}^{n} \mathrm{mom}_x\left(\overline{F}_i\right);$$

$$\mathrm{mom}_y\left(\overline{R}\right) = \sum_{i=1}^{n} \mathrm{mom}_y\left(\overline{F}_i\right);$$

$$\mathrm{mom}_z\left(\overline{R}\right) = \sum_{i=1}^{n} \mathrm{mom}_z\left(\overline{F}_i\right).$$

$$Rx_C = \sum_{i=1}^{n} F_i x_i, \text{ откуда } x_C = \frac{\sum_{i=1}^{n} F_i x_i}{R} = \frac{\sum_{i=1}^{n} F_i x_i}{\sum_{i=1}^{n} F_i}.$$

$$y_C = \frac{\sum_{i=1}^{n} F_i y_i}{R} = \frac{\sum_{i=1}^{n} F_i y_i}{\sum_{i=1}^{n} F_i}; \quad z_C = \frac{\sum_{i=1}^{n} F_i z_i}{R} = \frac{\sum_{i=1}^{n} F_i z_i}{\sum_{i=1}^{n} F_i}$$

$$x_C = \frac{\sum m_i g_x x_i}{mg} = \frac{\sum V_i x_i}{V}; \quad y_C = \frac{\sum m_i g_x y_i}{mg} = \frac{\sum V_i y_i}{V};$$

$$z_C = \frac{\sum m_i g_x z_i}{mg} = \frac{\sum V_i z_i}{V},$$

$$x_C = \frac{\sum S_i x_i}{S}; \quad y_C = \frac{\sum S_i y_i}{S}; \quad z_C = \frac{\sum S_i z_i}{S}.$$

$$x_C = \frac{\sum m_i x_i}{m}; \quad y_C = \frac{\sum m_i y_i}{m}; \quad z_C = \frac{\sum m_i z_i}{m}.$$

$$x_C = \frac{\sum S_i x_i}{S} = \frac{76}{36} = 2\frac{1}{9} \text{ см}; \quad y_C = \frac{\sum S_i y_i}{S} = \frac{112}{36} = 5\frac{8}{9} \text{ см}.$$

$$S_2 = -\pi r^2 = -\pi \cdot 1^2 = -\pi \text{ см}^2.$$

$$x_C = \frac{\sum S_i x_i}{S} = \frac{-3\pi}{35\pi} = -\frac{3}{35} \text{ см},$$

$$\sum_{i=1}^{3} \text{mom}_A\left(\overline{F}_i\right) = 0; \; mga - N_B l = 0.$$

$$a = \frac{N_B l}{mg}.$$

$$\overline{r} = \overline{r}(t).$$

$$x = 2 + 4t;\ y = -3 + 8t,$$

$$\frac{x-2}{4} = \frac{y+3}{8}, \text{ или } 2x - y = 7.$$

$$\bar{v} = \frac{d\bar{r}}{dt}.$$

$\bar{v} = d\bar{r}/dt$

$$\bar{v} = \frac{d\bar{r}}{dS}\frac{dS}{dt}.$$

$d\bar{r}/dS$

$$\bar{v} = \frac{dS}{dt}\bar{\tau}.$$

$$\bar{r} = \bar{i}x + \bar{j}y + \bar{k}z.$$

$$\bar{v} = \frac{d\bar{r}}{dt} = \frac{d}{dt}\left(x\bar{i} + y\bar{j} + z\bar{k}\right) = \bar{i}\frac{dx}{dt} + \bar{j}\frac{dy}{dt} + \bar{k}\frac{dz}{dt}.$$

$$\overline{v} = \overline{i}\,v_x + \overline{j}\,v_y + \overline{k}\,v_z.$$

$$v = \sqrt{v_x^2 + v_y^2 + v_z^2}.$$

$$a = \sqrt{a_x^2 + a_y^2 + a_z^2}.$$

$$\overline{a} = a_\tau \overline{\tau} + a_n \overline{n}.$$

$$S = S_0 + v_0 t \pm \frac{at^2}{2}$$

$$S = S_0 + v_0 t \pm a_\tau \frac{t^2}{2}.$$

$$S = v_0 t - \frac{a_\tau t^2}{2}$$

$$v = v_0 - a_\tau t.$$

$$a_{n0} = \frac{v_0^2}{R} = \frac{100}{1\,000} = 0{,}1 \text{ м/с}^2$$

$$a_0^2 = a_{n0}^2 + a_\tau^2;\ a_\tau = \sqrt{a_0^2 - a_{n0}^2} = \sqrt{0{,}125^2 - 0{,}1^2} = 0{,}075\ \text{м/с}^2.$$

$$560 = 10t - \frac{0{,}75t^2}{2}.$$

$$t = \frac{10 \pm \sqrt{100 - 1\,120 \cdot 0{,}075}}{0{,}075} = \frac{10 \pm 4}{0{,}075}\ \text{с}.$$

$$t_1 = \frac{14}{0{,}075}\ \text{с};\ \ t_2 = \frac{6}{0{,}075}\ \text{с}.$$

$$t_2 = \frac{6}{0{,}075}\ \text{с},$$

$$t_2 = \frac{6}{0{,}075}\ \text{с}.$$

$$a_{nк} = \frac{v_к^2}{R} = \frac{4^2}{1000} = 0{,}016\ \text{м/с}^2.$$

$$a_к = \sqrt{a_{nк}^2 + a_\tau^2} = \sqrt{0{,}016^2 + 0{,}075^2} = 0{,}0767\ \text{м/с}^2.$$

$$\varepsilon = \frac{d\omega}{dt} = \frac{d^2\varphi}{dt^2}.$$

$$\overline{a} = a_\tau \overline{\tau} + a_n \overline{n}.$$

$$a = \sqrt{a_\tau^2 + a_n^2}.$$

$$\int_{\varphi_0}^{\varphi} d\varphi = \omega \int_{t_0}^{t} dt,$$

$$\varphi = \varphi_0 + \omega_0 t + \frac{\varepsilon t^2}{2}.$$

$$b_1B_1 = v_{BM} = MB \cdot \omega; \;\; c_1C_1 = v_{CM} = MC \cdot \omega,$$

$$\frac{c_1C_1}{b_1B_1} = \frac{MC}{MB}.$$

$$\frac{c_1C_1}{b_1B_1} = \frac{M_1c_1}{M_1b_1}.$$

$$\frac{M_1C_1}{M_1B_1} = \frac{M_1c_1}{M_1b_1} \text{ или } \frac{M_1C_1}{M_1B_1} = \frac{MC}{MB} \text{ и } \frac{M_1C_1}{C_1B_1} = \frac{MC}{CB},$$

$$\bar{r}_M = \bar{r}_O + \bar{\rho},$$

$$\bar{v}_M = \frac{d}{dt}(\bar{r}_M) = \frac{d}{dt}(\bar{r}_O + \bar{\rho}), \quad \text{или} \quad \bar{v}_M = \frac{d}{dt}(\bar{r}_O) + \frac{d}{dt}(\bar{\rho}).$$

$$\frac{d}{dt}(\bar{\rho})$$

$$\frac{d}{dt}(\bar{\rho}) = \frac{d}{dt}\left(x\bar{i} + y\bar{j} + z\bar{k}\right) = \bar{i}\frac{dx}{dt} + \bar{j}\frac{dy}{dt} + \bar{k}\frac{dz}{dt} + x\frac{d\bar{i}}{dt} + y\frac{d\bar{j}}{dt} + z\frac{d\bar{k}}{dt}.$$

$$\bar{v}_r = \frac{dx}{dt}\bar{i} + \frac{dy}{dt}\bar{j} + \frac{dz}{dt}\bar{k} = v_x\bar{i} + v_y\bar{j} + v_z\bar{k}.$$

$$v_x = \frac{dx}{dt},\ v_y = \frac{dy}{dt}\ \text{и}\ v_z = \frac{dz}{dt}$$

$$\bar{v}_M = \bar{v}_O + x\frac{d\bar{i}}{dt} + y\frac{d\bar{j}}{dt} + z\frac{d\bar{k}}{dt} + \bar{v}_r.$$

$$\frac{d\bar{k}}{dt}$$

$$x\frac{d\bar{i}}{dt} + y\frac{d\bar{j}}{dt} + z\frac{d\bar{k}}{dt} = x\bar{v}_A + y\bar{v}_B + z\bar{v}_C.$$

$$x\frac{d\bar{i}}{dt} = x\bar{v}_A = x\bar{\omega}\times\bar{i} = \bar{\omega}\times x\bar{i};$$

$$y\frac{d\bar{j}}{dt} = \bar{\omega}\times y\bar{j};\ z\frac{d\bar{k}}{dt} = \bar{\omega}\times z\bar{k},$$

$$x\frac{d\bar{i}}{dt} + y\frac{d\bar{j}}{dt} + z\frac{d\bar{k}}{dt} = \bar{\omega}\times\left(x\bar{i} + y\bar{j} + z\bar{k}\right) = \bar{\omega}\times\bar{\rho}.$$

$$\bar{v}_M = (\bar{v}_O + \bar{\omega}\times\bar{\rho}) + \bar{v}_r.$$

$$\bar{v} = \bar{v}_r + \bar{v}_e.$$

$$v = \sqrt{v_r^2 + v_e^2 + 2v_r v_e\cos\left(\bar{v}_r, \bar{v}_e\right)}.$$

$$\overline{\omega} \times \overline{R} = \overline{\omega}_r \times \overline{R} + \overline{\omega}_e \times \overline{R},$$

$$\overline{\omega} \times \overline{R} = (\overline{\omega}_r + \overline{\omega}_e) \times \overline{R}.$$

$$\overline{\omega} = \overline{\omega}_r + \overline{\omega}_e.$$

$$v_K = \omega h_\Omega.$$

$$\omega = v_{Pr} / PP_r = v_{Pe} / PP_e.$$

$$\frac{PP_e}{PP_r} = \frac{\omega_r}{\omega_e}.$$

$$\overline{v}_{Pe} = \overline{v}_r + \overline{v}_e = \overline{v}_r + 0 = \overline{v}_r.$$

$$m\ddot{x} = F_x; \quad m\ddot{y} = F_y; \quad m\ddot{z} = F_z,$$

$$ma_n = F_n; \quad ma_\tau = F_\tau; \quad ma_b = F_b,$$

$$x = r\cos kt; \quad y = r\sin kt.$$

$$v_x = \dot{x} = -kr\sin kt; \quad v_y = \dot{y} = kr\cos kt.$$

$$a_x = \dot{v}_x = -k^2 r\cos kt; \quad a_y = \dot{v}_y = -k^2 r\sin kt.$$

$$F_x = -mk^2\cos kt; \quad F_y = -mk^2\sin kt.$$

$$F = \sqrt{F_x^2 + F_y^2} = mk^2 r\sqrt{\cos^2 kt + \sin^2 kt} = mk^2 r.$$

$$\cos\alpha = \frac{F_x}{F} = -\cos kt = -\frac{x}{r}; \quad \cos\beta = \frac{F_y}{F} = -\sin kt = -\frac{y}{r}.$$

$$\overline{F}_{ин} = -m\overline{a}.$$

$$m\overline{a} = \overline{F}_1 + \overline{F}_2 + \ldots + \overline{F}_n.$$

$$0 = \overline{F}_1 + \overline{F}_2 + \ldots + \overline{F}_n - m\overline{a}.$$

$$\overline{F}_1 + \overline{F}_2 + \ldots + \overline{F}_n + \overline{F}_{ин} = 0.$$

$$\overline{R}^J = \sum_{i=1}^{k} \overline{F}_i^J = 0.$$

$$\sum_{i=1}^{k} \overline{F}_{ix}^J = 0; \quad \sum_{i=1}^{k} \overline{F}_{iy}^J = 0; \quad \sum_{i=1}^{k} \overline{F}_{iz}^J = 0.$$

$$\overline{M}_O^J = \sum_{i=1}^{k} \overline{M}_{iO}^J = 0$$

$$\sum_{i=1}^{k} \mathrm{mom}_x(\overline{F}_i^J) = 0; \quad \sum_{i=1}^{k} \mathrm{mom}_y(\overline{F}_i^J) = 0; \quad \sum_{i=1}^{k} \mathrm{mom}_z(\overline{F}_i^J) = 0.$$

$$x_C = \frac{\sum_{i=1}^{k} m_i x_i}{m}; \quad y_C = \frac{\sum_{i=1}^{k} m_i y_i}{m}; \quad z_C = \frac{\sum_{i=1}^{k} m_i z_i}{m},$$

$$m x_C = \sum_{i=1}^{k} m_i x_i; \quad m y_C = \sum_{i=1}^{k} m_i y_i; \quad m z_C = \sum_{i=1}^{k} m_i z_i.$$

$$m \ddot{x}_C = \sum_{i=1}^{k} m_i \ddot{x}_i; \quad m \ddot{y}_C = \sum_{i=1}^{k} m_i \ddot{y}_i; \quad m \ddot{z}_C = \sum_{i=1}^{k} m_i \ddot{z}_i.$$

$$m\ddot{x}_C = \sum_{i=1}^{k} F_{ix}^{E} + \sum_{i=1}^{k} F_{ix}^{J}\,;\; m\ddot{y}_C = \sum_{i=1}^{k} F_{iy}^{E} + \sum_{i=1}^{k} F_{iy}^{J}\,;\;\; m\ddot{z}_C = \sum_{i=1}^{k} F_{iz}^{E} + \sum_{i=1}^{k} F_{iz}^{J}\,.$$

$$m\ddot{x}_C = \sum_{i=1}^{k} F_{ix}^{E};\;\; m\ddot{y}_C = \sum_{i=1}^{k} F_{iy}^{E};\;\; m\ddot{z}_C = \sum_{i=1}^{k} F_{ix}^{E}.$$

$$m\ddot{x}_C = \sum_{i=1}^{2} F_{ix}^E; \quad m\ddot{y}_C = \sum_{i=1}^{2} F_{iy}^E,$$

$$m\ddot{x}_C = 0; \quad m\ddot{y}_C = -m_1 g - m_2 g + N.$$

$$x_{C\,\text{нач}} = \frac{m_1 x_{1\,\text{нач}} + m_2 x_{2\,\text{нач}}}{m_1 + m_2};$$
$$x_{C\,\text{кон}} = \frac{m_1 x_{1\,\text{кон}} + m_2 x_{2\,\text{кон}}}{m_1 + m_2}.$$

$$x_{1\,\text{нач}} = b; \quad x_{2\,\text{нач}} = -AB\sin 30^\circ = -8 \cdot \frac{1}{2} = -4 \text{ м};$$
$$x_{1\,\text{кон}} = b - l; \quad x_{2\,\text{кон}} = -l.$$

$$m_1 x_{1\,\text{нач}} + m_2 x_{2\,\text{нач}} = m_1 x_{1\,\text{кон}} + m_2 x_{2\,\text{кон}},$$

$$m_1 b + m_2(-4) = m_1(b - l) + m_2(-l); \; m_1 b - m_2 \cdot 4 = m_1 b - m_1 l - m_2 l;$$

$$-2\,000 \cdot 4 = -20\,000 l - 2\,000 l; \quad l = (4 \cdot 2\,000)/(20\,000 + 2\,000) = 0{,}36 \text{ м}.$$

$$A = mgH = 1200 \cdot 9{,}8 \cdot 2800 = 32\,828\,000 \text{ Н} \cdot \text{м} = 32{,}82 \text{ МН} \cdot \text{м}.$$

$$\delta A = F_i \Delta S_i \cos \alpha_i,$$

$$A = \sum \delta A.$$

$$A_{1,2} = \lim_{\substack{n\to\infty \\ \Delta S\to 0}} \sum_{i=1}^{n} F_i \Delta S_i \cos\alpha_i.$$

$$A_{1,2} = \int_{M_1M_2} F\cos\alpha\, ds.$$

$$\delta A = \overline{F} \cdot d\overline{r},$$

$$A_{1,2} = \int_{M_1M_2} \left(F_x dx + F_y dy + F_z dz\right),$$

$$A_{1,2} = \int_{t_1}^{t_2} \left(F_x \dot{x} + F_y \dot{y} + F_z \dot{z}\right) dt.$$

$\overline{F}_1^E, \overline{F}_2^E, \ldots, \overline{F}_n^E,$

$$\delta A_i^E = F_{i\tau}^E dS_i = F_{i\tau}^E r_i d\varphi = M_{iz}^E d\varphi.$$

$$\delta A = \sum \delta A_i^E = \sum M_{iz}^E d\varphi = d\varphi \sum M_{iz}^E,$$

$$\sum M_{iz}^E = M_z^E$$

$$\delta A = \sum \delta A_i^E = M_z^E d\varphi,$$

$$\sum A_i = \int_{\varphi_1}^{\varphi_2} M_z^E d\varphi.$$

$$\sum A_i = M_z^E \int_{\varphi_1}^{\varphi_2} d\varphi = M_z^E (\varphi_2 - \varphi_1).$$

$$N = Fv\cos\alpha.$$

$$N = M_{кр}\omega = M_{кр}\frac{n}{30},$$

$$A = \int\limits_{M_1M} \left(F_x dx + F_y dy + F_z dz\right), \quad \text{или} \quad A = \int\limits_{t1}^{t} \left(F_x \dot{x} + F_y \dot{y} + F_z \dot{z}\right) dt.$$

$$N = \lim_{\Delta t \to 0} \frac{\Delta A}{\Delta t} = \frac{dA}{dt},$$

$$N = \frac{dA}{dt} = \overline{F} \cdot \frac{d\overline{r}}{dt} = \overline{F} \cdot \overline{v} = \overline{F}_x \dot{x} + \overline{F}_y \dot{y} + \overline{F}_z \dot{z},$$

$$\eta = \frac{A_{\text{полез}}}{A_{\text{полн}}} < 1.$$

$$J = \int r^2 dm = \sum r_i^2 m_i.$$

$$J_{yOz} = \sum m_i x_i^2;\ J_{xOy} = \sum m_i z_i^2;\ J_{zOx} = \sum m_i y_i^2;$$

$$J_x = \sum m_i (y_i^2 + z_i^2);\ \ J_y = \sum m_i (z_i^2 + x_i^2);\ \ J_z = \sum m_i (x_i^2 + y_i^2);$$

$$J_O = \sum m_i (x_i^2 + y_i^2 + z_i^2).$$

$$J_O = \sum m_i (x_i^2 + y_i^2 + z_i^2) = J_{xOy} + J_{yOz} + J_{zOx};$$

$$J_x + J_y + J_z = 2\sum m_i (x_i^2 + y_i^2 + z_i^2) = 2J_O.$$

$$J_{iz1} = m_i h_i^2 \text{ и } J_{izC} = m_i r_i^2.$$

$$r_i^2 = x_i^2 + y_i^2, \text{ а } h_i^2 = (y_i - d)^2 + x_i^2 = r_i^2 - 2y_i d + d^2.$$

$$J_{z1} = \sum m_i r_i^2 - 2\sum m_i y_i d + \sum m_i d^2,$$

$$J_{z1} = J_{zC} - 2d\sum m_i y_i + d^2\sum m_i.$$

$$J_{z1} = J_{zC} + md^2,$$

$$J_{zC} = \int_{0}^{2\pi R} \rho h dS\, R^2 = \rho h R^2 2\pi R = mR^2.$$

$$\overline{S} = \overline{F}(t_2 - t_1).$$

$$S = F(t_2 - t_1).$$

$$\overline{S} = \lim_{\Delta t_k \to 0} \sum \Delta \overline{S}_k = \lim_{\Delta t_k \to 0} \sum \overline{F} \Delta t_k \ \text{ или } \ \overline{S} = \int_{t_1}^{t_2} \overline{F} dt.$$

$$S_x = \int_{t_1}^{t_2} F_x dt; \ \ S_y = \int_{t_1}^{t_2} F_y dt; \ S_z = \int_{t_1}^{t_2} F_z dt.$$

$$S = \sqrt{S_x^2 + S_y^2 + S_z^2},$$

$$\cos(\overline{S},\ \overline{i}) = S_x / S; \ \ \cos(\overline{S},\ \overline{j}) = S_y / S; \ \ \cos(\overline{S},\ \overline{k}) = S_z / S.$$

$$m\overline{a} = \overline{F}.$$

$$\frac{d(m\overline{v})}{dt} = \overline{F}.$$

$$\int_{\bar{v}_1}^{\bar{v}_2} d(m\bar{v}) = \int_{t_1}^{t_2} \bar{F}dt.$$

$$m\bar{v}_2 - m\bar{v}_1 = \bar{S}, \text{ или } m\bar{v}_2 = \bar{S} + m\bar{v}_1,$$

$$m\bar{v}_2 - m\bar{v}_1 = \sum \bar{S}_i.$$

$$\bar{K} = \sum m_i \bar{v}_i.$$

$$\bar{K} = \sum m_i \bar{v}_i = \sum \left(m_i \, d\bar{r}_i / dt \right) = d\left(\sum m_i \bar{r}_i \right) / dt.$$

$$\bar{K} = m\bar{v}_C,$$

$$K_x = \sum m_i v_{ix} = mv_{Cx}; \; K_y = \sum m_i v_{iy} = mv_{Cy}; \; K_z = \sum m_i v_{iz} = mv_{Cz}.$$

$$dK_x / dt = m dv_{Cx} / dt = m\ddot{x}_C;$$
$$dK_y / dt = m dv_{Cy} / dt = m\ddot{y}_C;$$
$$dK_z / dt = m dv_{Cz} / dt = m\ddot{z}_C.$$

$$m\ddot{x}_C = \sum F_{ix}^E; \; m\ddot{y}_C = \sum F_{iy}^E; \; m\ddot{z}_C = \sum F_{iz}^E.$$

$$dK_x / dt = \sum F_{ix}^E; \; dK_y / dt = \sum F_{iy}^E; \; dK_z / dt = \sum F_{iz}^E.$$

$$\bar{R}^E = \sum \bar{F}_i^E,$$

$$\frac{d\overline{K}}{dt} = \overline{R}^E,$$

$$\overline{R}^E = 0,\ d\overline{K}/dt = 0,\ \overline{K} = \text{const.}$$

$\overline{F}_i^E,$ $\overline{F}_i^J$

$$\left(m_i\overline{v}_i\right)_2 - \left(m_i\overline{v}_i\right)_1 = \overline{S}_i^E + \overline{S}_i^J,$$

$\overline{S}_i^E$ $\overline{S}_i^J$

$$\sum\left(m_i\overline{v}_i\right)_2 - \sum\left(m_i\overline{v}_i\right)_1 = \sum\overline{S}_i^E + \sum\overline{S}_i^J.$$

$\overline{R}^J = 0,$ $\sum\overline{S}_i^J = 0.$

$$\overline{K}_2 - \overline{K}_1 = \sum\overline{S}_i^E.$$

$$\overline{K}_1 = m_1\overline{v}_{C1};\ K_1 = \left(4G/g\right)\omega\left(l/2\right) = 2\left(G/g\right)\omega l.$$

$$\overline{K}_2 = m_2\overline{v};\ K_2 = \left(G/g\right)v_2 = \left(G/g\right)\omega l.$$

$$r_C = \frac{\sum m_i r_i}{\sum m_i} = \frac{G_1\left(l/2\right) + G_2 l}{G_1 + G_2} = \frac{4G\left(l/2\right) + Gl}{4G + G} = 0{,}6l.$$

$$\overline{K} = m\overline{v}_C;\ K = \frac{G_1 + G_2}{g}\omega \cdot 0{,}6l = 3\left(G/g\right)\omega l.$$

$$\overline{M}_O = \overline{r} \times \overline{F}$$

$$\overline{L}_O = \overline{r} \times m\overline{v}.$$

$$\frac{d}{dt}\overline{L}_O = \frac{d}{dt}(\overline{r} \times m\overline{v}) = \frac{d\overline{r}}{dt} \times m\overline{v} + \overline{r} \times \frac{d}{dt}m\overline{v} =$$
$$= \overline{v} \times m\overline{v} + \overline{r} \times m\overline{a} = 0 + \overline{r} \times \overline{F} = \overline{M}_O.$$

$$d\overline{L}_O / dt = \sum \overline{M}_{iO},$$

$$dL_x / dt = \sum M_{ix};\ dL_y / dt = \sum M_{iy};\ dL_z / dt = \sum M_{iz}.$$

$$L_z = \sum L_{iz}.$$

$\overline{F}_i^E$ $\overline{F}_i^J$

$$\frac{d}{dt}\overline{L}_{iO} = \overline{M}_{iO}^E + \overline{M}_{iO}^J.$$

$$\sum \frac{d}{dt}\overline{L}_{iO} = \sum \overline{M}_{iO}^E + \sum \overline{M}_{iO}^J.$$

$\sum \overline{M}_{iO}^J = 0.$

$$\sum \frac{d}{dt}\overline{L}_{iO} = \sum \overline{M}_{iO}^E \text{ или } \frac{d}{dt}\sum \overline{L}_{iO} = \sum \overline{M}_{iO}^E.$$

$\sum \overline{L}_{iO}$

$$\frac{d}{dt}\overline{L}_O = \sum \overline{M}_{iO}^E = \overline{M}_O^E.$$

$$dL_x/dt = M_x^E;\ dL_y/dt = M_y^E;\ dL_z/dt = M_z^E,$$

M_x^E, M_y^E, M_x^E

$$a_\tau = \frac{dv}{dt} =$$

$$= \frac{dv}{dS}\frac{dS}{dt} = \frac{dv}{dS}v,$$

$$mvdv/dS = F_\tau \text{ или } mvdv = F_\tau dS,$$
$$\text{или } d\left(mv^2/2\right) = FdS\cos\left(\overline{F}, \overline{\tau}\right).$$

$$d\left(mv^2/2\right) = \delta A.$$

$F_\tau = \sum F_{i\tau},$

$$\delta A = \sum \delta A_i,$$

$$d\left(mv^2/2\right) = \sum \delta A_i,$$

$$m\int_{v_1}^{v_2} vdv = \sum \int_{M_1}^{M_2} F_i dS\cos\left(\overline{F}_i, \overline{\tau}\right),$$

$$mv_2^2/2 - mv_1^2/2 = \sum \delta A_i.$$

$$m\ddot{x}_C = \sum_{i=1}^{k} F_{ix}^E;\ m\ddot{y}_C = \sum_{i=1}^{k} F_{iy}^E;\ m\ddot{z}_C = \sum_{i=1}^{k} F_{iz}^E.$$

$\ddot{x}_C, \ddot{y}_C, \ddot{z}_C$

$F_{ix}^E,\ F_{iy}^E,\ F_{iz}^E$

$$L_z = \sum m_i v_i r_i = \sum m_i \omega v_i r_i = \sum m_i \omega r_i^2 =$$
$$= \omega \sum m_i r_i^2 = \omega J_z.$$

$$dL_z/dt = \sum M_{iz}^E \text{ или } d(J_z\omega)/dt = \sum M_{iz}^E,$$

$$J_z d\omega/dt = \sum M_{iz}^E \text{ или } J_z\varepsilon = \sum M_{iz}^E.$$

$$J_z\ddot{\varphi} = \sum M_{iz}^E.$$

$$\overline{F}_i^E,$$

$$J_z\ddot{\varphi} = M_z^E.$$