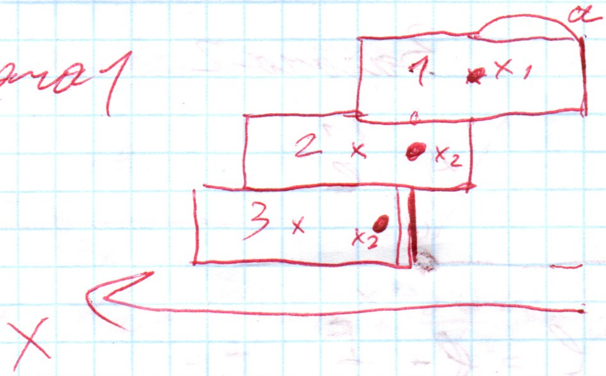
Задача 1



$$x_1 = a, \quad x_2 = \frac{1}{2}x_1 + \frac{1}{2}(x_1 + a) = x_1 + \frac{a}{2},$$

$$x_3 = \frac{2}{3}x_2 + \frac{1}{3}(x_2 + a) = x_2 + \frac{1}{3}a,$$

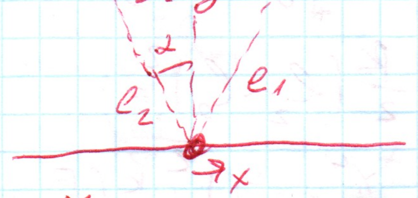
$$x_n = x_{n-1} + \frac{1}{n}a,$$

$$x_n = \sum_{k=1}^{n} \frac{a}{k} = 10a$$

$$\ln n + 0{,}58 = 10,$$

$$n = e^{10-0{,}58} \approx 12300$$

Задача 2



I) $(1+a)^{\gamma} = 1+\gamma a + \frac{\gamma(\gamma-1)}{2!}a^2 + \frac{\gamma(\gamma-1)(\gamma-2)}{3!}a^3 + \dots$

$\dots + \frac{\gamma(\gamma-1)(\gamma-2)(\gamma-3)}{4!}a^4 + \dots$

$$(1+a)^{\frac{1}{2}} = 1+\frac{1}{2}a - \frac{1}{8}a^2$$

$$l_0 = l - \frac{F}{k}$$

$$l_1 = \sqrt{l^2 - 2lx\sin\alpha + x^2} = l\sqrt{1-2\frac{x}{l}\sin\alpha + \left(\frac{x}{l}\right)^2}$$

Раскладываем с точностью до x^2

$$l_1(x) \approx l\left(1+\frac{1}{2}\left(2\frac{x}{l}\sin\alpha + \left(\frac{x}{l}\right)^2\right) - \frac{1}{8}\left(2\frac{x}{l}\sin\alpha + \cancel{\left(\frac{x}{l}\right)^2}\right)^2\right) \approx$$

$$\approx l\left(1+\frac{x}{l}\sin\alpha + \frac{x^2}{2l^2} - \frac{1}{2}\frac{x^2}{l^2}\sin^2\alpha\right) =$$

$$= l + x\sin\alpha + \frac{1}{2}(1-\sin^2\alpha)\frac{x^2}{l} = l + x\sin\alpha + \frac{1}{2}\cos^2\alpha\frac{x^2}{l}$$

$$\cancel{l_2(x) = l_1(x) - l - x\sin\alpha + \left(1-\frac{1}{2}\sin^2\alpha\right)\frac{x^2}{l}}$$

$$l_2(x) = l - x\sin\alpha + \frac{1}{2}\cos^2\alpha\frac{x^2}{l}$$

Пот. энергия: (до квадратов расш

$$V = \frac{k}{2}(l_1 - l_0)^2 + \frac{k}{2}(l_2 - l_0)^2 =$$

$$= \frac{k}{2}\left(\frac{F}{k} + x\sin\alpha + \frac{x^2}{2l}\cos^2\alpha\right)^2 + \frac{k}{2}\left(\frac{F}{k} - x\sin\alpha + \frac{x^2}{2l}\right.$$

$$= \frac{F^2}{k} + kx^2\sin^2\alpha + F\frac{x^2}{l}\cos^2\alpha$$

Кин. энергия: $T = \frac{m\dot{x}^2}{2}$

$$T + V = E = const$$

$$\frac{m}{2}\dot{x}^2 + \left(k\sin^2\alpha + \frac{F}{l}\cos^2\alpha\right)x^2 = const$$

$$\omega^2 = \frac{2k}{m}\sin^2\alpha + \frac{2F}{ml}\cos^2\alpha$$ (при $l - \frac{F}{k} = l_0$

$\omega = const$