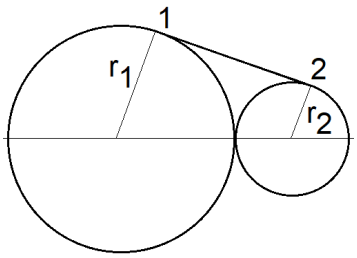
Two circles



$$x_1^2 + y_1^2 = r_1^2 \qquad (x_2 - r_1 - r_2)^2 + y_2^2 = r_2^2$$

$$r_1 := 1\ m \qquad r_2 := 0.7\ m$$

$$S2(x_1, y_1, x_2, y_2) := (x_1 - x_2)^2 + (y_1 - y_2)^2$$

Ограничения Начальные приближения

$$x_1 := \frac{r_1}{2} \qquad y_1 := \sqrt{r_1^2 - x_1^2}$$

$$x_2 := r_1 + 1.5\ r_2 \qquad y_2 := \sqrt{r_1^2 - (x_2 - r_1 - r_2)^2}$$

Решатель

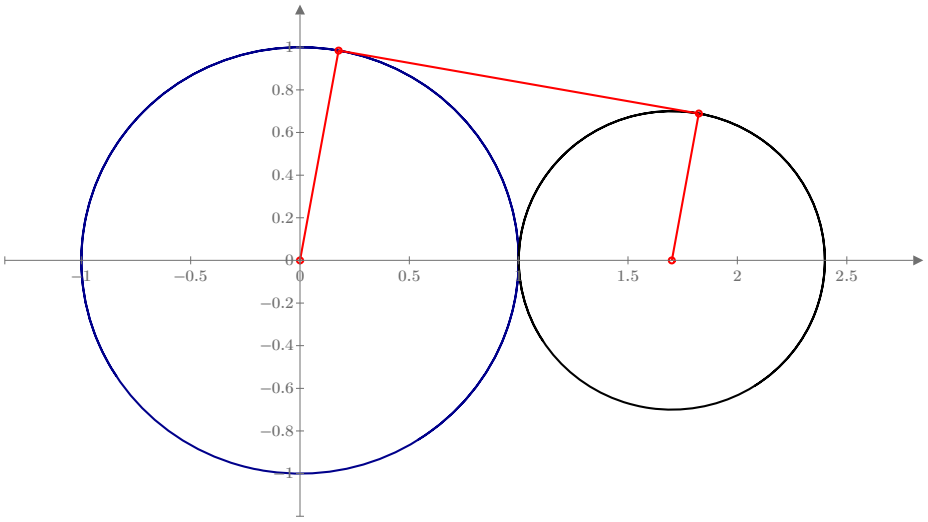
$$x_1^2 + y_1^2 = r_1^2 \qquad (x_2 - r_1 - r_2)^2 + y_2^2 = r_2^2$$

$$S2(x_1, y_1, x_2, y_2) + r_1^2 = S2(0\ m, 0\ m, x_2, y_2)$$

$$S2(x_1, y_1, x_2, y_2) + r_2^2 = S2(r_1 + r_2, 0\ m, x_1, y_1)$$

$$\begin{bmatrix} x_1 \\ y_1 \\ x_2 \\ y_2 \end{bmatrix} := \text{Find}(x_1, y_1, x_2, y_2) = \begin{bmatrix} 0.176 \\ 0.984 \\ 1.824 \\ 0.689 \end{bmatrix} m$$

$$\alpha := 0, \frac{\pi}{180} .. 2\ \pi \qquad X := [0\ m\ \ x_1\ \ x_2\ \ r_1 + r_2]^T \qquad Y := [0\ m\ \ y_1\ \ y_2\ \ 0\ m]^T$$



$r_1 \cdot \sin(a)\ \ (m)$

$r_2 \cdot \sin(a)\ \ (m)$

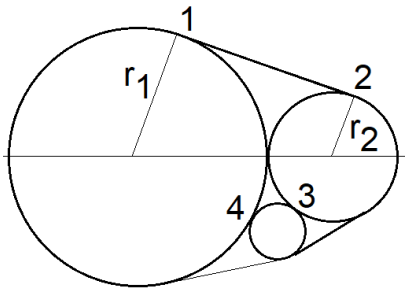
$Y\ \ (m)$

$r_1 \cdot \cos(a)\ \ (m)$ $\qquad r_2 \cdot \cos(a) + r_1 + r_2\ \ (m)$ $\qquad X\ \ (m)$

$$\beta := \operatorname{atan}\left(\frac{y_2 - 0\ m}{x_2 - r_1 - r_2}\right) = 79.836\ deg$$

$$L := 2 \cdot \left(\sqrt{S2\left(x_1, y_1, x_2, y_2\right)} + r_2 \cdot \beta + r_1 \cdot \left(\pi - \beta\right)\right) = 8.794\ m$$

Three circles



$$r_3 := 0.4\ m$$

Начальные приближения

$$x_{03} := -1\ m \quad y_{03} := 1.5\ m \quad x_4 := 2\ m \quad y_4 := -1.5\ m \quad x_3 := 2\ m \quad y_3 := -1.5\ m$$

Ограничения

$$x_4^{\,2} + y_4^{\,2} = r_1^{\,2}$$

$$\left(x_3 - r_1 - r_2\right)^2 + y_3^{\,2} = r_2^{\,2}$$

$$\sqrt{S2\left(0\ m, 0\ m, x_{03}, y_{03}\right)} = r_1 + r_3$$

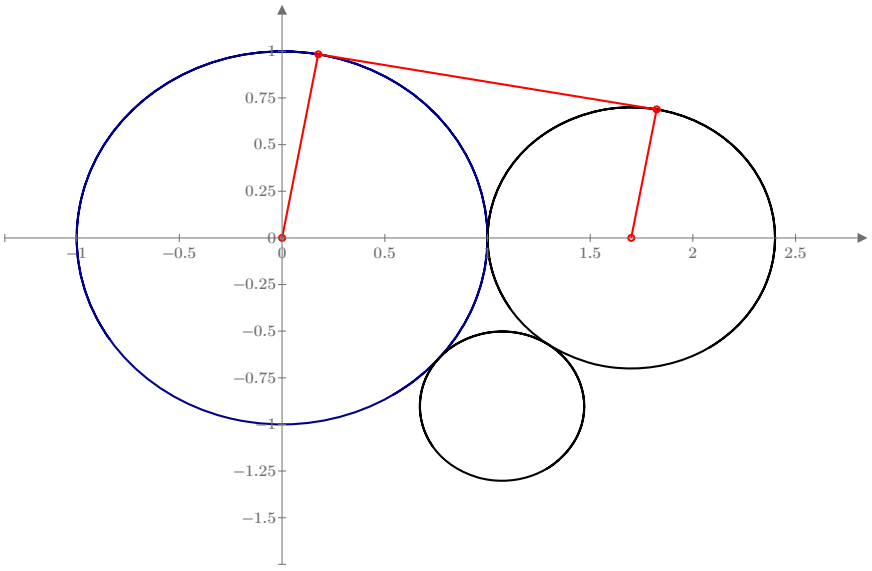
$$\sqrt{S2\left(r_1 + r_2, 0\ m, x_{03}, y_{03}\right)} = r_2 + r_3 \qquad y_{03} < 0\ m$$

$$\sqrt{S2\left(x_4, y_4, x_{03}, y_{03}\right)} = r_3$$

$$\sqrt{S2\left(x_3, y_3, x_{03}, y_{03}\right)} = r_3$$

Решатель

$$\begin{bmatrix} x_{03} \\ y_{03} \\ x_4 \\ y_4 \\ x_3 \\ y_3 \end{bmatrix} := \operatorname{Find}\left(x_{03}, y_{03}, x_4, y_4, x_3, y_3\right) = \begin{bmatrix} 1.071 \\ -0.902 \\ 0.765 \\ -0.644 \\ 1.299 \\ -0.574 \end{bmatrix} m$$



$r_1 \cdot \sin(a)$ (m)

$r_2 \cdot \sin(a)$ (m)

Y (m)

$r_3 \cdot \sin(a) + y_{03}$ (m)

$r_1 \cdot \cos(a)$ (m)

$r_2 \cdot \cos(a) + r_1 + r_2$ (m)

X (m)

$r_3 \cdot \cos(a) + x_{03}$ (m)

Next, we heed twice to solve the problem solved above - the problem of two circles.