

1. 画图易知

2.

$$f' = 75\text{mm}$$

$$x = -\infty, x' = 0\text{mm}$$

$$x = -10000\text{mm}, x' = 0.5625\text{mm}$$

$$x = -8000\text{mm}, x' = 0.703125\text{mm}$$

$$x = -6000\text{mm}, x' = 0.9375\text{mm}$$

$$x = -4000\text{mm}, x' = 1.40625\text{mm}$$

$$x = -2000\text{mm}, x' = 2.8125\text{mm}$$

3.

$$\beta = -10 = -\frac{fl'}{f'l} = \frac{l'}{l}$$

$$-l + l' + d = 7200\text{mm}, -f + f' + d = 1140\text{mm}$$

$$\frac{1}{l'} - \frac{1}{l} = \frac{1}{f'}, -f = f'$$

解得 $l = -660\text{mm}, l' = 6600\text{mm}, f = -600\text{mm}, f' = 600\text{mm}, d = -60\text{mm}$

4.

$$\beta_1 = -3 = \frac{l'_1}{l_1}$$

$$\beta_2 = -4 = \frac{l'_2}{l_2}$$

$$\frac{1}{l'_1} - \frac{1}{l_1} = \frac{1}{f'}$$

$$\frac{1}{l'_2} - \frac{1}{l_2} = \frac{1}{f'}$$

$$l_2 = l_1 + 18\text{mm}$$

解得 $l_1 = -288\text{mm}, l_2 = -270\text{mm}, l'_1 = -864\text{mm}, l'_2 = -1080\text{mm}, f' = 216\text{mm}$

5.

$$\beta_1 = -1 = \frac{l'_1}{l}, \frac{1}{l'_1} - \frac{1}{l} = \frac{1}{f'_1}$$

$$\beta_2 = -\frac{3}{4} = \frac{l'}{l}, \frac{1}{l'} - \frac{1}{l} = \frac{1}{f'}$$

$$l' = l'_1 - 20\text{mm}, \frac{1}{f'} = \frac{1}{f'_1} + \frac{1}{f'_2}$$

6.

$$\beta_1 = -\frac{1}{2} = \frac{l'_1}{l_1}$$

$$\frac{1}{l'_1} - \frac{1}{l_1} = \frac{1}{f'}$$

$$\beta_2 = -1 = \frac{l'_2}{l_2}$$

$$\frac{1}{l'_2} - \frac{1}{l_2} = \frac{1}{f'}$$

$$l_2 = l_1 + 100\text{mm}$$

解得 $f' = 100\text{mm}$

7.

$$\frac{1}{f'} = \frac{1}{f'_1} + \frac{1}{f'_2} - \frac{d}{f'_1 f'_2} = 1200\text{mm}$$

$$d + l'_2 = 700\text{mm}$$

$$l'_2 = 400\text{mm}$$

$$d = 300\text{mm}, l_1 = -\infty$$

$$l'_1 = f'_1, l_2 = f'_1 - d$$

$$\frac{1}{l'_2} - \frac{1}{l_2} = \frac{1}{f'_2}$$

解得 $f'_1 = 450\text{mm}, f'_2 = -240\text{mm}$

8. 仅考虑双光组结构

$$\frac{1}{f'} = \frac{1}{f'_1} + \frac{1}{f'_2} - \frac{d}{f'_1 f'_2} = \frac{1}{35\text{mm}}, d = L - l'_k$$

$$h_1 = 100\text{mm}, h_2 = h_1 - d \tan U'_1, \tan U'_1 = \frac{h_1}{f'_1}$$

$$\tan U'_2 = \frac{h_2}{l'_k} = \frac{h_1}{f'}$$

解得 $f'_1 = -35\text{mm}, f'_2 = 25\text{mm}$

9.

$$\frac{n}{f'_1} = \frac{n-1}{r_1}, f'_1 = -600\text{mm}$$

$$\frac{1}{f'_2} = \frac{1-n}{r_2}, f'_2 = 600\text{mm}$$

$$\Delta = d - f'_1 + f_2$$

$$\frac{1}{f_2} = \frac{n-1}{nr_2}, f_2 = -900\text{mm}, \Delta = -250\text{mm}$$

$$f' = -\frac{f'_1 f'_2}{\Delta} = -1440\text{mm}, \Phi = \frac{1}{f'}$$

$$l_2 = f'_1 - d = -650\text{mm}$$

$$\frac{1}{l'_2} - \frac{n}{l_2} = \frac{1-n}{r_2},$$

10.

$$\Delta = d - f'_1 - f_2, f'_1 = 100\text{mm}, f'_2 = 50\text{mm}$$

$$f' = -\frac{f'_1 f'_2}{\Delta} = 100\text{mm}, f_2 = -50\text{mm}$$

$$d = 100\text{mm}$$

11.

$$r_1 = 10\text{mm}, r_2 = -10\text{mm}, n = 1.5, d = 60\text{mm}$$

$$f'_1 = \frac{nr_1}{n-1} = 30\text{mm}, f'_2 = \frac{r_2}{1-n} = 20\text{mm}, f_2 = \frac{nr_2}{n-1} = -30\text{mm}$$

$$\Delta = d - f'_1 + f_2 = 0\text{mm}$$

$$f' = -\frac{f'_1 f'_2}{\Delta} = \infty$$

$$l_2 = f'_1 - d = -30\text{mm}$$

$$\frac{1}{l'_2} - \frac{n}{l_2} = \frac{1-n}{r_2}, l'_2 = \infty$$

无焦系统出射光线平行于光轴，焦点和主点在无穷远处。

12.

$$\begin{aligned} l'_1 &= \frac{nr}{n-1} = 480\text{mm} \\ \frac{2}{r} &= \frac{1}{80\text{mm}} \\ r &= 160\text{mm}, n = 1.5 \end{aligned}$$

13. 条件一：间隔不变，物距任意，放大率不变

$$\begin{aligned} x_1 x'_1 &= -f'_1^2 \\ -x_2 &= d - x'_1 - f'_1 - f'_2 \\ x_2 x'_2 &= -f'_2^2 \\ \beta = \beta_1 \beta_2 &= \frac{f'_1 f'_2}{x_1 x_2} = \frac{f'_1 f'_2}{(f'_1 + f'_2 - d)x_1 - f'_1^2} = \text{constant} \\ \frac{1}{\beta} &= \frac{(f'_1 + f'_2 - d)x_1 - f'_1^2}{f'_1 f'_2} \\ \frac{d(\frac{1}{\beta})}{dx_1} &= 0 = \frac{f'_1 + f'_2 - d}{f'_1 f'_2} \end{aligned}$$

条件二：间隔变化，物距不变，放大率不变

$$\frac{d(\frac{1}{\beta})}{dd} = 0 = -\frac{x_1}{f'_1 f'_2}$$

14.

$$\begin{aligned} l_1 &= f_1, l'_1 = \infty \\ l_2 &= \infty, l'_2 = f'_2 \\ \Delta &= d - f'_1 - f'_2 \\ \beta = \beta_1 \beta_2 &= \frac{f_1 l'_1}{f'_1 l_1} \frac{f_2 l'_2}{f'_2 l_2} = \frac{l'_1 l'_2}{l_1 l_2} = \frac{f'_2}{-f'_1} \\ f' &= -\frac{f'_1 f'_2}{\Delta} = \frac{f'_1 f'_2}{f'_1 + f'_2 - d} \\ x'_F &= \frac{f'_2^2}{d - f'_1 - f'_2} \end{aligned}$$

15.