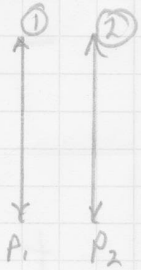
Dr. Bob

1. The optical power of a diamond lens is higher than the optical powe of a glass lens of the same shape, because the index of refraction of diamond is greater than that of glass.

2.



$P_1 = 2.5\,\text{f}$

$P_2 = 4.0\,\text{f}$

$P_{tot} = P_1 + P_2 = 2.5\,\text{f} + 4.0\,\text{f}$

$P_{tot} = 6.5\,\text{f}$

$f_{eff} = \frac{1}{P_{tot}} = \frac{1}{6.5\,m^{-1}} = 0.15\,m$

$\boxed{f_{eff} = 0.15\,m}$

3.

$f_1 = 10\,cm = 0.10\,m$

$f_2 = -15\,cm = -0.15\,m$

$P_1 = \frac{1}{f_1} = \frac{1}{0.10\,m} = 10\,\text{f}$

$P_2 = \frac{1}{f_2} = \frac{-1}{0.15\,m} = -6.67\,\text{f}$

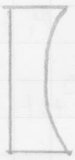
$P_{tot} = P_1 + P_2 = 10\,\text{f} - 6.67\,\text{f}$

$P_{tot} = 3.3\overline{3}\,\text{f}$

$f_{eff} = \frac{1}{P_{tot}} = \frac{1}{0.3\overline{3}\,m^{-1}} = 0.3\,m$

$\boxed{f_{eff} = 0.3\,m}$

4. (optional)

Type of Lens	Shape	R_1	R_2
Biconvex		+	−
Plano concave		∞	+
Biconcave		−	+

5. 

$f = 35\text{cm} = 0.35\text{m}$

$P = ?$

$P = \frac{1}{f} = \frac{1}{0.35\text{m}} = 2.9\text{f}$

$\boxed{P = 2.9\text{f}}$

6. 

$P = 3.25\text{f}$

$f = ?$

$f = \frac{1}{P} = 0.308\text{m}$

$\boxed{f = 0.308\text{m}}$

7. 

$P = -5.5\,\delta$

a) $f = ?$ $\quad f = \frac{1}{P} = \frac{1}{-5.5\,m^{-1}}$

$\boxed{f = -0.18\,m}$

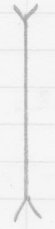
b) Diverging

8. 

$f = -20.0\,cm = -0.200\,m$

$P = \frac{1}{f} = \frac{1}{-0.200\,m}$

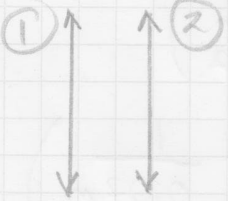
$\boxed{P = -5.00\,m}$

9. 

$f = ?$ $\quad P = -2.5\,m$

$f = \frac{1}{P} = \frac{-1}{2.5\,m}$

$f = -0.40\,\delta$

10. 

$f_1 = 10\,cm = 0.10\,m$

$f_2 = 25\,cm = 0.25\,m$

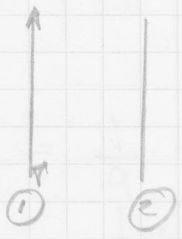
$P = P_1 + P_2 \qquad P = \frac{1}{f}$

$P = \frac{1}{0.10\,m} + \frac{1}{0.25\,m} = 14\,\delta$

$f = \frac{1}{P} = \frac{1}{14\,m^{-1}} = 0.0714$

$\boxed{f = 0.071\,m}$

11.



$P_1 = 2.5\,\delta$

$P_{tot} = 4.0\,\delta$

$P_2 = ?$

$f_2 = ?$

$P = \frac{1}{f}$

$f = \frac{1}{P}$

$P_{tot} = P_1 + P_2$

$P_2 = P_{tot} - P_1$

$= 4.0\,\delta - 2.5\,\delta$

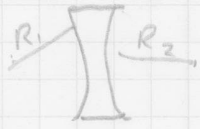
$P_2 = 1.5\,\delta$

$f_2 = \frac{1}{1.5\,m^{-1}} = 1.7\,m$

$\boxed{f_2 = 1.7\,m}$

Converging, positive Lens.

12. $n = 1.52$



$R_1 = -12\,cm = -0.12\,m$

$R_2 = 7\,cm = 0.07\,m$

$P = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (1.52-1)\left(\frac{1}{-0.12\,m} - \frac{1}{0.07\,m}\right)$

$\boxed{P = -11.8\,\delta}$

$f = -0.085\,m$

P. 112 (continued)

13,

Sign convention

$R_1 = -2R_2$ $\quad f = 20\text{cm} = 0.20\text{m}$

$n = 1.50$ $\quad f = 0.20\text{m}$

$R_1 = ?$

$R_2 = ?$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$= (n-1)\left(\frac{1}{-2R_2} - \frac{1}{R_2}\right)$$

$$= (n-1)\left(\frac{-1}{2R_2} - \frac{2}{2R_2}\right)$$

$$\frac{1}{f} = (n-1)\left(\frac{-3}{2R_2}\right)$$

$$f = \frac{-2R_2}{3(n-1)}$$

$$R_2 = \frac{-3f(n-1)}{2} = \frac{-3(0.20\text{m})(1.50-1)}{2}$$

$$\boxed{R_2 = -0.150\text{m}}$$

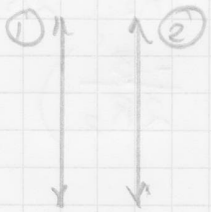
$$R_1 = -2R_2 = -2(-0.150\text{m})$$

$$\boxed{R_1 = 0.30\text{m}}$$

14. Diamond $n = 2.42$

Crown glass $n = 1.52$

The higher index of refraction of diamond means the lens will refract more giving a shorter focal length. Therefore, the crown glass lens will have a longer focal length. Crown glass refracts light less than than diamond.

15. 

$f_1 = 12\text{cm} = 0.12\text{m}$

$f_2 = 20\text{cm} = 0.20\text{m}$

$P = \frac{1}{f} \qquad P_{tot} = P_1 + P_2$

$$P_{tot} = P_1 + P_2 = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{0.12\text{m}} + \frac{1}{0.20\text{m}}$$

$$P_{tot} = 13.3\ \delta$$

$$f_{eff} = \frac{1}{P_{tot}} = \frac{1}{13.3\ \text{m}^{-1}} = 0.075\text{m}$$

$$\boxed{f_{eff} = 0.075\text{m}}$$

P. 112 (continued)

16.

$P_1 = 4\,\delta$

$f_2 = -7\,cm = -0.07\,m$

$P = \frac{1}{f}$ $\qquad$ $P = P_1 + P_2$

a) $P = P_1 + P_2 = P_1 + \frac{1}{f_2} = 4\,\delta + \frac{1}{-0.07\,m}$

$$\boxed{P = -10.3\,\delta}$$

b) Since $P < 0$ the lens is diverging