Exercices sur les lentilles

Convention
• lentille convergente: paramètre focal *f* positif
• lentille divergente: paramètre focal *f* négatif
• objet orienté vers le haut: paramètre *g* positif
• objet orienté vers le bas: paramètre *g* négatif
• image orienté vers le haut: paramètre *g'* positif
• objet orienté vers le bas: paramètre *g'* négatif
• objet réel, paramètre *p* positif
• objet virtuel, paramètre *p* négatif
• image réelle, paramètre *p'* positif
• image virtuelle, paramètre *p'* négatif

Notation
p' est noté pp
g' est noté gp (car ' est utilisé pour désigner une dérivée dans *Mathematica*).

Les deux équations utilisées sont $\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$ et $\frac{g'}{g} = -\frac{p'}{p}$

Il s'agit, connaissant 3 des 5 paramètres, de trouver les deux aurtes.

■ **Exercice 1**

```
data = {p → 4, g → 2, f → 3};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {gp, pp}];
sol /. data
```

```
{{gp → -6, pp → 12}}
```

■ **Exercice 2**

```
data = {p → 3, g → 2, f → 4};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {gp, pp}];
sol /. data
```

```
{{gp → 8, pp → -12}}
```

■ **Exercice 3**

```
data = {g → 15, p → 60, f → 40};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {gp, pp}];
sol /. data
```

```
{{gp → -30, pp → 120}}
```

■ **Exercice 4**

```
data = {f → 6, g → 4, p → {3, 6, 12, 18}};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {gp, pp}];
sol /. data
```

```
{{gp → {8, ComplexInfinity, -4, -2}, pp → {-6, ComplexInfinity, 12, 9}}}
```

■ **Exercice 5**

```
data = {p → {300, 800}, f → 5.};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {pp, gp}];
sol /. data
```

$$\{\{gp \to \{-0.0169492\ g,\ -0.00628931\ g\},\ pp \to \{5.08475,\ 5.03145\}\}\}$$

■ **Exercice 6**

On cherche d'abord la distance focale, puis on résout par rapport à p' pour une distance $p = 400$ cm:

```
data = {p → 500, pp → 11};
sol = Solve[1 / p + 1 / pp == 1 / f, f];
sol /. data
data = {p → 400, %[[1, 1]]};
sol = Solve[1 / p + 1 / pp == 1 / f, pp];
sol /. data
% // N
```

$$\left\{\left\{f \to \frac{5500}{511}\right\}\right\}$$

$$\left\{\left\{pp \to \frac{22\,000}{1989}\right\}\right\}$$

$$\{\{pp \to 11.0608\}\}$$

■ **Exercice 7**

```
data = {g → {24, 36}, f → 75, pp → 5000};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, p], gp];
sol /. data
```

$$\{\{gp \to \{-1576,\ -2364\}\}\}$$

■ **Exercice 8**

```
data = {g → 36, gp → 2000, pp → 12 000};
sol = Solve[{1 / p + 1 / pp == 1 / f, pp / p == 2000 / 36}, f];
sol /. data
% // N
```

$$\left\{\left\{f \to \frac{108\,000}{509}\right\}\right\}$$

$$\{\{f \to 212.181\}\}$$

■ **Exercice 9**

```
data = {f → 50, g → 24, gp → -2000};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, p], pp];
sol /. data
% // N
```

$$\left\{\left\{pp \to \frac{12\,650}{3}\right\}\right\}$$

$$\{\{pp \to 4216.67\}\}$$

- **Exercice 10**

```
data = {g → 4, p -> 4, f → -12};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {gp, pp}];
sol /. data
```

$$\{\{gp \to 3, \ pp \to -3\}\}$$

- **Exercice 11**

```
data = {f → -6, g → 4, p → {2, 3, 6, 12}};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {gp, pp}];
sol /. data
```

$$\left\{\left\{gp \to \left\{3, \ \frac{8}{3}, \ 2, \ \frac{4}{3}\right\}, \ pp \to \left\{-\frac{3}{2}, \ -2, \ -3, \ -4\right\}\right\}\right\}$$

- **Exercice 12**

```
data = {f → -150, pp → -60, gp → 18};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {p, g}];
sol /. data
```

$$\{\{g \to 30, \ p \to 100\}\}$$

- **Exercice 13**

```
data = {pp → -30, g → 1, gp → -5};
sol = Solve[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, {p, f}];
sol /. data
```

$$\{\{f \to -5, \ p \to -6\}\}$$

- **Exercice 14**

```
data = {p → 75, pp → 225};
sol = Solve[{1 / p + 1 / pp == 1 / f}, f];
sol /. data
% // N
```

$$\left\{\left\{f \to \frac{225}{4}\right\}\right\}$$

$$\{\{f \to 56.25\}\}$$

- **Exercice 15**

```
data = {d → 400, g → 1, gp → -3};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p, p + pp == d}, {pp}], {f, p}];
sol /. data
```

$$\{\{f \to 75, \ p \to 100\}\}$$

- **Exercice 16**

```
data = {f → 20, g → 1, gp → -1};
sol = Solve[{1 / p + 1 / p == 1 / f}, p];
sol /. data
```

$$\{\{p \to 40\}\}$$

■ **Exercice 17**

```
data = {d → 200, f → 32, g → 3};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p, p + pp == d}, {g, gp}], {p, pp}];
sol /. data
g * pp / p /. data /. %
```

$\{\{p \rightarrow 40, pp \rightarrow 160\}, \{p \rightarrow 160, pp \rightarrow 40\}\}$

$\left\{12, \dfrac{3}{4}\right\}$

■ **Exercice 18**

```
data = {f → 16, g → 1, gp → -4};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, pp], p];
sol /. data
```

$\{\{p \rightarrow 20\}\}$

■ **Exercice 19**

```
data = {f → -20, g → 1, gp → 1 / 2};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, pp], p];
sol /. data
```

$\{\{p \rightarrow 20\}\}$

■ **Exercice 20**

On cherche d'abord le paramètre focal *f*. On élimine *p'* puis on résout par rapport à *p* :

```
data = {d → 1000, g → 1, gp → -20};
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p, p + pp == d}, {p, pp}], f];
sol /. data
% // N
sol = Solve[Eliminate[{1 / p + 1 / pp == 1 / f, gp / g == -pp / p}, pp], p];
sol /. data /. %%
% // N
```

$\left\{\left\{f \rightarrow \dfrac{20\,000}{441}\right\}\right\}$

$\{\{f \rightarrow 45.3515\}\}$

$\{\{\{p \rightarrow 47.619\}\}\}$

$\{\{\{p \rightarrow 47.619\}\}\}$