PAGE 261

Q1.
Lens A has more power because of its shorter focal length.
Q2.
Convex lens of short focal length causes more bending of light rays passing through it.
Q3.
Power of a lens.
Q4.
1 diopter is the power of a lens whose focal length is 1 metre.
Q5.
a) Positive power - Convex lens.
b) Negative power - Concave lens.
Q6.
Lens of short focal length.
Q7.
Power of lens is reciprocal of its focal length in metres.
Q8.
Thick convex lens has more power because of its shorter focal length.
Q9.
f = 25 cm = 0.25 cm.
P = 1/f = 1/0.25 = +4 D.
Q10.
f = 0.5 m
P = 1/f = 1/0.5 = +2 D.
Q11.
f = 50 mm = 0.05 m
P = 1/f = 1/0.05 = +20 D.
Q12.
f = 80 cm = 0.8 m.
P = 1/f = 1/0.8 = +1.25 D.
Q13.
Here, f = -3 cm = -0.03 m (Diverging lens)
P = 1/f = 1/(-0.03) = -33.33 D.
Q14.
P = +0.2 D.
P = 1/f.
f = 1/P = 1/0.2 = +5 m.
Q15.
P = -2 D.
P = 1/f.
f = 1/P = 1/(-2) = -0.5 m = -50 cm.
Q16.
Convex lens.
Q17.
Concave lens.
Q18.
(a) Convex lens
(b) P = +0.5 D.
P = 1/f.
f = 1/P = 1/0.5 = 2 m.
Q19.
P = -1.5 D

P = 1/f.
f = 1/P = 1/(-0.5) = -0.66 m = -66.6 m.
Since focal length is negative, it is a diverging lens.

PAGE 262

Q20.
f = -10 cm = -0.1 m
P = 1/f = 1/(-0.1) = -10 D
It is a concave lens.
Q21.
f = +150 mm = +0.15 m
It is a convex lens since its focal length is positive.
P = 1/f = 1/0.15 = +6.66 D
Q22.
(a) power, dioptres.
(b) positive, negative.
Q23.

$$h = 4\text{cm}$$
$$u = -15\text{cm}$$
$$P = -10\text{D}$$
$$P = \frac{1}{f}$$
$$f = \frac{1}{P}$$
$$= \frac{1}{-10}$$
$$= -0.1\,\text{m}$$
$$= -10\,\text{cm}$$

Using Lens formula,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$
$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$
$$= \frac{1}{-10} + \frac{1}{-15}$$
$$= \frac{-5}{30}$$
$$v = -6\,\text{cm}$$

$$\text{Magnification, } m = \frac{h'}{h} = \frac{v}{u}$$
$$\frac{h'}{4} = \frac{-6}{-15}$$
$$h' = 1.6\,\text{cm}$$

Q24.

$h = 4.25\,mm = 42.5\,cm$

$u = -10\,cm$

$P = +5D$

(i) $P = \frac{1}{f}$

$f = \frac{1}{P} = \frac{1}{5} = 0.2\,m = 20\,cm$

(ii) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$= \frac{1}{20} + \frac{1}{-10}$

$= \frac{-1}{20}$

$v = -20\,cm$

$m = \frac{h'}{h} = \frac{v}{u}$

$\Rightarrow \frac{h'}{42.5} = \frac{-20}{-10}$

$h' = 85\,cm = 8.5\,mm$

Q25.

$P_1 = +5D,\ P_2 = -7.5D$

(a) Power of combination:

$P = P_1 + P_2 = +5D + (-7.5D) = -2.5D$

(b) Focal length of the combination:

$f = \frac{1}{P} = \frac{1}{-2.5} = -0.4\,m = -40\,cm$

Q26.

$f_1 = 25\,cm = 0.25\,m$

$P_1 = \frac{1}{f_1} = \frac{1}{0.25} = 4D$

$f_2 = -10\,cm = -0.1\,m$

$P_2 = \frac{1}{f_2} = \frac{1}{-0.1} = -10D$

(a) Power of the combination:

$P = P_1 + P_2$

$= 4D + (-10D)$

$= -6D$

(b) Focal length of the combination:

$f = \frac{1}{P} = \frac{1}{-6} = -0.1666\,m = -16.66\,cm$

(c) The combination has negative focal length, so it is diverging.

Q27.

(a) $P = P_X + P_Y$

$$P = \frac{1}{f_X} + \frac{1}{f_Y}$$

$$5 = \frac{100}{15} + \frac{1}{f_Y}$$

$$\frac{1}{f_Y} = 5 - \frac{100}{15}$$

$$= \frac{-25}{15}$$

$$f_Y = -0.6\,m = -60\,cm$$

(b) Lens Y is a concave lens since it has negative focal length.

Q28.

$f_A = +20\,cm = +0.2\,m$
$f_B = -10\,cm = -0.1\,m$

(a) Lens A is a convex lens (positive focal length) and lens B is a concave lens (negative focal length).

(b) $P_A = \frac{1}{f_A} = \frac{1}{+0.2} = +5D$

$P_B = \frac{1}{f_B} = \frac{1}{-0.1} = -10D$

(c) Power of combination
$P = P_A + P_B = +5D + (-10D) = -5D$

Q29.

(a) Power of a lens is a measure of the degree of convergence or divergence of light rays falling in it.

Power of a lens depends on its focal length.

(b) Unit of power of a lens is dioptre.

One dioptre is the power of a lens whose focal length is 1 metre.

(c) $f_1 = 20\,cm = 0.2\,m$

$$P_1 = \frac{1}{f_1} = \frac{1}{0.2} = +5D$$

$f_2 = 40\,cm = 0.4\,m$

$$P_2 = \frac{1}{f_2} = \frac{1}{0.4} = +2.5D$$

$f_3 = -50\,cm = -0.5\,m$

$$P_3 = \frac{1}{f_3} = \frac{1}{-0.5} = -2D$$

Power of the combination
$P = P_1 + P_2 + P_3$
$= +5D + 2.5D + (-2D)$
$= +5.5D$

Focal length of thr combination

$$f = \frac{1}{P} = \frac{1}{+5.5} = +0.1818\,m = +18.18\,cm$$

Q30.

(a) $P_A = +2D$

$f_A = \frac{1}{P_A} = \frac{1}{2} = +0.5\,m = +50\,cm$

Lens A is a convex lens.

$P_B = -4D$

$f_B = \frac{1}{P_B} = \frac{1}{-4} = -0.25\,m = -25\,cm$

Lens B is a concave lens.

(b) Case 1: For lens A

$f_A = +50\,cm$

$u_A = -100\,cm$

$\frac{1}{f_A} = \frac{1}{v_A} - \frac{1}{u_A}$

$\frac{1}{v_A} = \frac{1}{f_A} + \frac{1}{u_A}$

$= \frac{1}{50} + \frac{1}{-100}$

$= \frac{1}{100}$

Image distance, $v_A = 100\,cm$

Magnification, $m_A = \frac{v_A}{u_A} = \frac{100}{-100} = -1$

Case 1: For lens B

$f_B = -25\,cm$

$u_B = -100\,cm$

$\frac{1}{f_B} = \frac{1}{v_B} - \frac{1}{u_B}$

$\frac{1}{v_B} = \frac{1}{f_B} + \frac{1}{u_B}$

$= \frac{1}{-25} + \frac{1}{-100}$

$= \frac{-5}{100}$

Image distance, $v_B = -20\,cm$

Magnification, $m_B = \frac{v_B}{u_B} = \frac{-20}{-100} = +0.2$

PAGE 263

Q39.
(a) These lenses have negative powers and hence negative focal lengths, so they are concave lenses.
Concave lenses are thinner in the middle.
(b) Lens of lower power has greater focal length.
So, -3.50 D lens has greater focal length.
(c) Left eye is the weaker one because it needs a lens of greater power for its correction.
Q40.
(a) These lenses have positive powers and hence positive focal lengths, so they are convex lenses.
Convex lenses are thicker in the middle.
(b) Lens of greater power bends light rays more quickly.
So, +2.50 D lens bends light rays more quickly.
(c) These spectacle lenses will converge the light rays because these are convex lenses.

********** END **********