Optics of the Eye

4.4. What is the power of accommodation if the near point is 50 cm and the far point is 10 m away from the eye?

4.5. What is the power of the lens of a pair of eyeglasses which
a) corrects the near point of a hyperopic eye from 1 m to the normal value (25 cm),
b) corrects the far point of a myopic eye from 1 m to the normal value (infinity)?

4.6. How far is the near point (measured without glasses) of a hyperopic patient who wears a pair of 2 dpt eyeglasses? (The healthy near point is 25 cm.)

4.7. In the Mária Street Department of Ophthalmology the near and far point of a patient was determined: the former turned out to be 120 cm while the latter practically infinite.
a) What type of refractive error can be diagnosed?
b) What is the power of accommodation of the patient?
c) What type and power (in dpt) of glasses does the patient need to be able to read the newspaper from 30 cm distance?

4.8. a) What visual angle do two points 2 cm away from each other subtend at 3 m? Express the result in radians, degrees, and minutes of arc.
b) What is the distance between the images of the points formed on the retina? The image distance of the reduced eye is 17 mm.
c) Are the two points seen separated considering an average healthy eye?

4.9. The normal limiting visual angle is 1'. What should be the least distance between two points to be just separately visible
a) at 25 cm, and
b) at 5 m distance?

4.10. A car approaches us on a long and straight road. From how many meters will we see the headlights separately supposing normal limiting visual angle (1') if they are 1.2 m away from each other?

4.27. A patient can see the Landolt broken ring with a 0.4 mm gap with his left eye from 1.5 meters away. The distance of the *K* nodal point from the *macula lutea* is 17 mm.
a) Find the limiting visual angle in minutes of arc.
b) Find the visual acuity.
c) Find the approximate size of a receptor.
d) Find the approximate receptor density with respect to 1 mm^2 surface area.

4.28. There are two dots on a paper sheet 6 cm apart from each other. We would like to use them to examine the blind spot of our right eye. We move the paper toward our eye while looking at one of the dots: the paper is 23 cm away from the eye when the other dot disappears and at 19 cm when it reappears. The distance of the *K* nodal point from the *macula lutea* is 17 mm.
a) Should we look at the dot to the right or at the dot to the left so that the other disappears?
b) Find the average distance of the blind spot from the *macula lutea*.
c) Find the size of the blind spot.

Formulae

$i_{\text{eye}} = 17$ mm

$$D = \frac{1}{f} = \frac{1}{o} + \frac{1}{i}$$

$$\Delta D = D_p - D_r = \frac{1}{f_p} - \frac{1}{f_r} = \left(\frac{1}{o_p} + \frac{1}{i}\right) - \left(\frac{1}{o_r} + \frac{1}{i}\right) = \frac{1}{o_p} - \frac{1}{o_r}$$

$$D_t = \sum_i D_i$$

$$2\pi\left[rad\right] = 360°$$

$$1° = 60'$$

$$1' = 60''$$

for small angles: $\alpha\left[rad\right] \approx \tan\alpha \approx \sin\alpha$

$$\tan\alpha = \frac{a}{x} = \frac{a'}{i}$$

$\alpha_{\text{limit,healthy}} = 1'$

$$VA = \frac{1'}{\alpha_{\text{limit}}}$$

$$d_{rec} \approx \frac{1}{(a')^2}$$

$$\frac{d}{x} = \frac{d'}{i}$$

Solutions

4.4. **1.9 dpt**

4.5 a) **3 dpt**
b) **–1 dpt**

4.6. **50 cm**

4.7. a) **hyperopia or presbyopia**
b) **0.833 dpt**
c) **a convergent lens of 2.5 dpt**

4.8. a) **0.00667 rad = 0.382° = 22.9’**
b) **113 µm**
c) **yes because the normal limiting visual angle is 1’, which is ways less than the calculated 22.9’ angle**

4.9. a) **0.073 mm**
b) **1.45 mm**

4.10. **4.13 km**

4.27. a) **0.9167’**
b) **109.08%**
c) **4.53 µm**
d) **48 660 / mm^2**

4.28. a) **the left one**
b) **4.90 mm**
c) **0.93 mm**