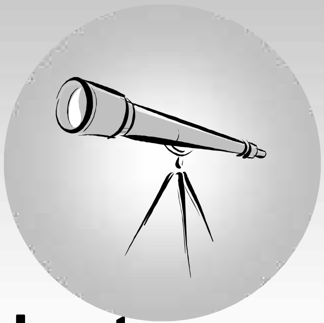
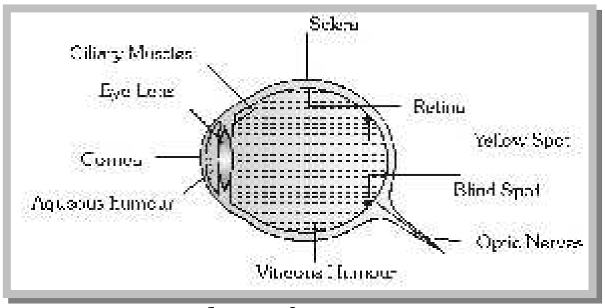


# Optical Instruments

## Human Eye




(1) **Eye lens :** Over all behaves as a convex lens of $\mu = 1.437$

(2) **Retina :** Real and inverted image of an object, obtained at retina, brain sense it erect.

(3) **Yellow spot :** It is the most sensitive part, the image formed at yellow spot is brightest.

(4) **Blind spot :** Optic nerves goes to brain through blind spot. It is not sensitive for light.

(5) **Ciliary muscles –** Eye lens is fixed between these muscles. It's both radius of curvature can be changed by applying pressure on it through ciliary muscles.

(6) **Power of accomodation :** The ability of eye to see near objects as well as far objects is called power of accomodation.

*Note* : ❑ When we look distant objects, the eye is relaxed and it's focal length is largest.

(7) **Range of vision :** For healthy eye it is 25 *cm* (near point) to ∞ (far point).

A normal eye can see the objects clearly, only if they are at a distance greater than 25 *cm*. This distance is called Least distance of distinct vision and is represented by *D*.

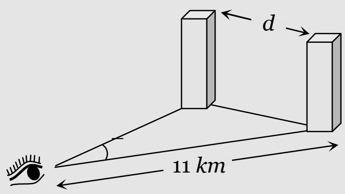
(8) **Persistence of vision :** Is 1/10 *sec. i.e.* if time interval between two consecutive light pulses is lesser than 0.1 *sec*., eye cannot distinguish them separately.

(9) **Binocular vision :** The seeing with two eyes is called binocular vision.

(10) **Resolving limit :** The minimum angular displacement between two objects, so that they are just resolved is called resolving limit. For eye it is $1' = \left(\frac{1}{60}\right)^o$.

***Specific Example***

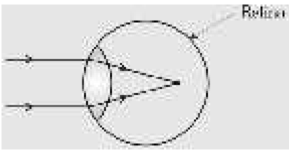
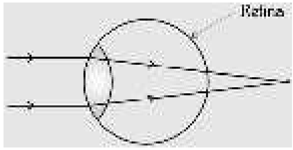
A person wishes to distinguish between two pillars located at a distances of 11 *Km*. What should be the minimum distance between the pillars.



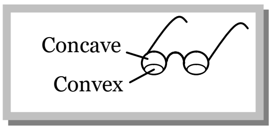

*Solution* : As the limit of resolution of eye is $\left(\frac{1}{60}\right)^o$

So $\theta > \left(\frac{1}{60}\right)^o \Rightarrow \frac{d}{11 \times 10^3} > \left(\frac{1}{60}\right) \times \frac{\pi}{180} \Rightarrow d > 3.2\, m$

(11) **Defects in eye**

| Myopia (short sightness) | Hypermetropia (long sightness) |
|---|---|
| (i) Distant objects are not seen clearly but nearer objects are clearly visible. | (i) Distant objects are seen clearly but nearer object are not clearly visible. |
| (ii) Image formed before the retina.<br><br> | (ii) Image formed behind the retina.<br><br> |
| (iii) Far point comes closer. | (iii) Near point moves away |
| (iv) Reasons :<br>(a) Focal length or radii of curvature of lens reduced or power of lens increases.<br>(b) Distance between eye lens and retina increases. | (iv) Reasons :<br>(a) Focal length or radii of curvature of lens increases or power of lens decreases.<br>(b) Distance between eye lens and retina decreases. |
| (v) Removal : By using a concave lens of suitable focal length. | (v) Removal : By using a convex lens. |
| (vi) Focal length :<br>(a) A person can see upto distance $\to x$<br>wants to see $\to \infty$, so<br>focal length of used lens $f = -x = -$ (defected far point)<br>(b) A person can see upto distance $\to x$<br>wants to see distance $\to y$ $(y > x)$<br>so $f = \frac{xy}{x - y}$ | (vi) Focal length :<br>(a) A person cannot see before distance $\to d$<br>wants to see the object place at distance $\to D$<br>so $f = \frac{dD}{d - D}$ |

**Presbyopia :** In this defect both near and far objects are not clearly visible. It is an old age disease and it is due to the loosing power of accommodation. It can be removed by using bifocal lens.




**Astigmatism :** In this defect eye cannot see horizontal and vertical lines clearly, simultaneously. It is due to imperfect spherical nature of eye lens. This defect can be removed by using cylindrical lens (Torric lenses).

## Microscope

It is an optical instrument used to see very small objects. It's magnifying power is given by

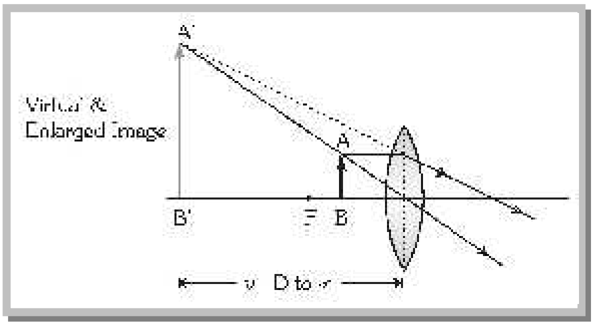
$$m = \frac{\text{Visual angle with instrument ( )}}{\text{Visual angle when object is placed at least distance of distinct vision (~)}}$$

(1) **Simple miscroscope**

(i) It is a single convex lens of lesser focal length.

(ii) Also called magnifying glass or reading lens.

(iii) Magnification's, when final image is formed at $D$ and $\infty$ (*i.e.* $m_D$ and $m_\infty$)



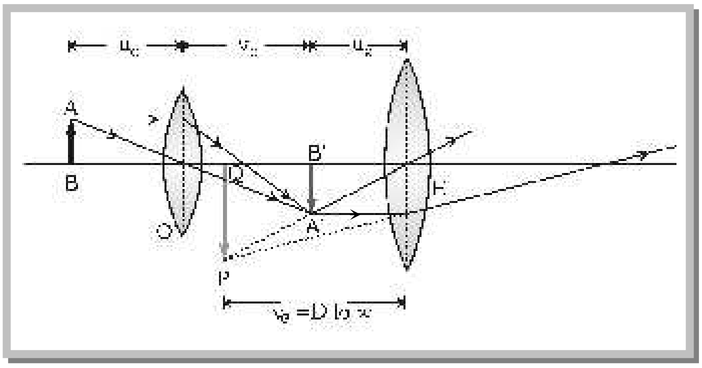

$$m_D = \left(1 + \frac{D}{f}\right)_{max} \text{ and } m_\infty = \left(\frac{D}{f}\right)_{min}$$

**Note** : ❑ $m_{max.} - m_{min.} = 1$

❑ If lens is kept at a distance $a$ from the eye then

$$m_D = 1 + \frac{D-a}{f} \text{ and } m_\infty = \frac{D-a}{f}$$

(2) **Compound microscope**




(i) Consist of two converging lenses called objective and eye lens.

(ii) $f_{\text{eye lens}} > f_{\text{objective}}$ and

(diameter) $_{\text{eye lens}}$ > (diameter )$_{\text{objective}}$

(iii) Final image is magnified, virtual and inverted.

(iv) $u_0$ = Distance of object from objective ($o$), $v_0$ = Distance of image ($A'B'$) formed by objective from objective, $u_e$ = Distance of $A'B'$ from eye lens, $v_e$ = Distance of final image from eye lens, $f_0$ = Focal length of objective, $f_e$ = Focal length of eye lens.

Magnification : $$m_D = -\frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right) = -\frac{f_0}{(u_0 - f_0)}\left(1 + \frac{D}{f_e}\right) = -\frac{(v_0 - f_0)}{f_0}\left(1 + \frac{D}{f_e}\right)$$

$$m_\infty = -\frac{v_0}{u_0}.\frac{D}{F_e} = \frac{-f_0}{(u_0 - f_0)}\left(\frac{D}{f_e}\right) = -\frac{(v_0 - f_0)}{f_0}.\frac{D}{F_e}$$

**Length of the tube** (*i.e.* distance between two lenses)

When final image is formed at $D$ ; $$L_D = v_0 + u_e = \frac{u_0 f_0}{u_0 - f_0} + \frac{f_e D}{f_e + D}$$

When final images is formed at $\infty$ ; $$L_\infty = v_0 + f_e = \frac{u_0 f_0}{u_0 - f_0} + f_e$$

(Do not use sign convention while solving the problems)

**Note** : ❑ $m_\infty = \dfrac{(L_\infty - f_0 - f_e)D}{f_0 f_e}$

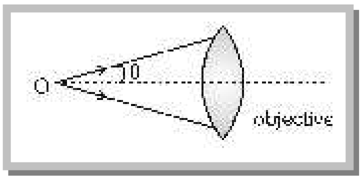
❑ For maximum magnification both $f_0$ and $f_e$ must be less.

❑ $m = m_{\text{objective}} \times m_{\text{eye lens}}$

❑ If objective and eye lens are interchanged, practically there is no change in magnification.

(3) **Resolving limit and resolving power :** In reference to a microscope, the minimum distance between two lines at which they are just distinct is called Resolving limit (*RL*) and it's reciprocal is called Resolving power (*RP*)

$$R.L. = \frac{a}{2« \sin ¯} \text{ and } R.P. = \frac{2« \sin ¯}{a} \Rightarrow R.P. \propto \frac{1}{a}$$




a = Wavelength of light used to illuminate the object,

« = Refractive index of the medium between object and objective,

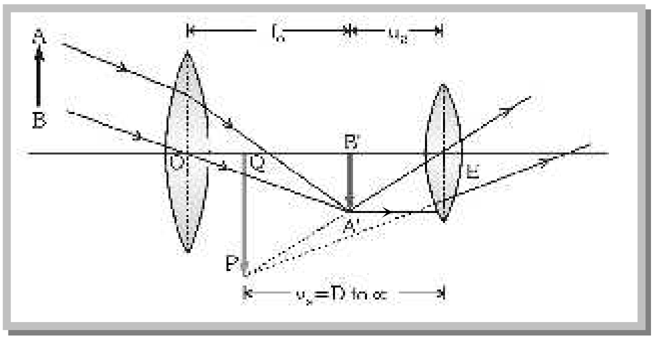
¯ = Half angle of the cone of light from the point object, « sin¯ = Numerical aperture.

**Note :** ❑ Electron microscope : electron beam ($a \approx 1 Å$) is used in it so it's *R.P.* is approx 5000 times more than that of ordinary microscope ($a \approx 5000 Å$)

## Telescope

By telescope distant objects are seen.

(1) **Astronomical telescope**




(i) Used to see heavenly bodies.

(ii) $f_{objective} > f_{eyelens}$ and $d_{objective} > d_{eye\ lens}$.

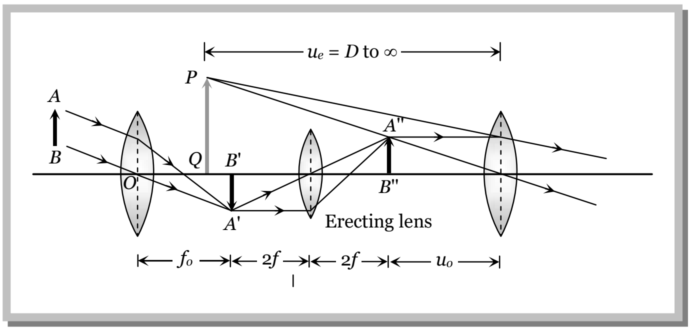
(iii) Intermediate image is real, inverted and small.

(iv) Final image is virtual, inverted and small.

(v) Magnification : $m_D = -\frac{f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$ and $m_\infty = -\frac{f_o}{f_e}$

(vi) Length : $L_D = f_0 + u_e = f_0 + \frac{f_e D}{f_e + D}$ and $L_\infty = f_0 + f_e$

(2) **Terrestrial telescope**




(i) Used to see far off object on the earth.

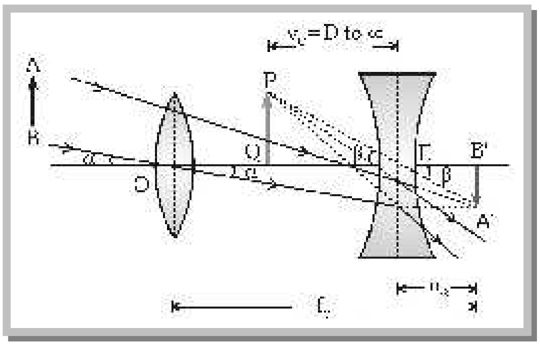
(ii) It consists of three converging lens : objective, eye lens and erecting lens.

(iii) It's final image is virtual erect and smaller.

(iv) Magnification : $m_D = \frac{f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$ and $m_\infty = \frac{f_0}{f_e}$

(v) Length : $L_D = f_0 + 4f + u_e = f_0 + 4f + \frac{f_e D}{f_e + D}$ and $L_\infty = f_0 + 4f + f_e$

(3) **Galilean telescope**




(i) It is also a terrestrial telescope but of much smaller field of view.

(ii) Objective is a converging lens while eye lens is diverging lens.

(iii) Magnification : $m_D = \frac{f_0}{f_e}\left(1 - \frac{f_e}{D}\right)$ and $m_\infty = \frac{f_0}{f_e}$

(iv) Length : $L_D = f_0 - u_e$ and $L_\infty = f_0 - f_e$

(4) **Resolving limit and resolving power**

Smallest angular separations ($d\theta$) between two distant objects, whose images are separated in the telescope is called resolving limit. So resolving limit $d\theta = \frac{1.22\,a}{a}$

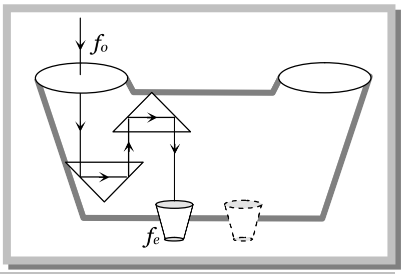
and resolving power $(RP) = \frac{1}{d\theta} = \frac{a}{1.22\,a} \Rightarrow R.P. \propto \frac{1}{a}$ where $a$ = aperture of objective.

**Note :** ❑ Minimum separation ($d$) between objects, so they can just resolved by a telescope is – $d = \frac{r}{R.P.}$

where $r$ = distance of objects from telescope.

(5) **Binocular**

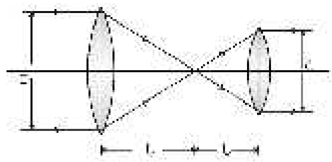
If two telescopes are mounted parallel to each other so that an object can be seen by both the eyes simultaneously, the arrangement is called 'binocular'. In a binocular, the length of each tube is reduced by using a set of totally reflecting prisms which provided intense, erect image free from lateral inversion. Through a binocular we get two images of the same object from different angles at same time. Their superposition gives the perception of depth also along with length and breadth, *i.e.*, binocular vision gives proper three-dimensional (3*D*) image.



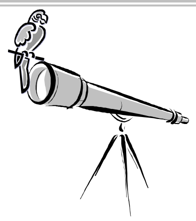

## *Concepts*

- *As magnifying power is negative, the image seen in astronomical telescope is truly inverted, i.e., left is turned right with upside down simultaneously. However, as most of the astronomical objects are symmetrical this inversion does not affect the observations.*
- *Objective and eye lens of a telescope are interchanged, it will not behave as a microscope but object appears very small.*
- *In a telescope, if field and eye lenses are interchanged magnification will change from ($f_o$ / $f_e$) to ($f_e$ / $f_o$), i.e., it will change from m to (1/m), i.e., will become (1/m$^2$) times of its initial value.*
- *As magnification for normal setting as ($f_o$ / $f_e$), so to have large magnification, $f_o$ must be as large as practically possible and $f_e$ small. This is why in a telescope, objective is of large focal length while eye piece of small.*
- *In a telescope, aperture of the field lens is made as large as practically possible to increase its resolving power as resolving power of a telescope ó (D/a)*. Large aperture of objective also helps in improving the brightness of image by gathering more light from distant object. However, it increases aberrations particularly spherical.*
- *For a telescope with increase in length of the tube, magnification decreases.*
- *In case of a telescope if object and final image are at infinity then :*

$$m = \frac{f_o}{f_e} = \frac{D}{d}$$



- *If we are given four convex lenses having focal lengths $f_1 > f_2 > f_3 > f_4$. For making a good telescope and microscope. We choose the following lenses respectively. Telescope $f_1(o), f_4(e)$ Microscope $f_4(o), f_3(e)$*
- *If a parrot is sitting on the objective of a large telescope and we look towards (or take a photograph)of distant astronomical object (say moon) through it, the parrot will not be seen but the intensity of the image will be slightly reduced as the parrot will act as obstruction to light and will reduce the aperture of the objective.*



## Example

***Example*: 1** A man can see the objects upto a distance of one metre from his eyes. For correcting his eye sight so that he can see an object at infinity, he requires a lens whose power is

or

A man can see upto 100 *cm* of the distant object. The power of the lens required to see far objects will be

(a) +0.5 *D* (b) +1.0 *D* (c) +2.0 *D* (d) –1.0 *D*

*Solution:* (d) $f$ = –(defected far point) = – 100 *cm*. So power of the lens $P=\frac{100}{f}=\frac{100}{-100}=-1D$

***Example*: 2** A man can see clearly up to 3 *metres*. Prescribe a lens for his spectacles so that he can see clearly up to 12 *metres*

(a) – 3/4 *D* (b) 3 *D* (c) – 1/4 *D* (d) – 4 *D*

*Solution:* (c) By using $f=\frac{xy}{x-y}\Rightarrow f=\frac{3\times 12}{3-12}=-4m$ . Hence power $P=\frac{1}{f}=-\frac{1}{4}D$

***Example*: 3** The diameter of the eye-ball of a normal eye is about 2.5 *cm*. The power of the eye lens varies from

(a) 2 *D* to 10 *D* (b) 40 *D* to 32 *D* (c) 9 *D* to 8 *D* (d) 44 *D* to 40 *D*

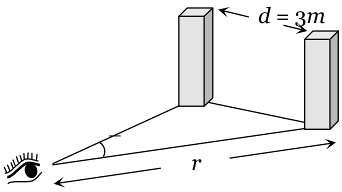
*Solution:* (d) An eye sees distant objects with full relaxation so $\frac{1}{2.5\times 10^{-2}}-\frac{1}{-\infty}=\frac{1}{f}$ or $P=\frac{1}{f}=\frac{1}{25\times 10^{-2}}=40D$

An eye sees an object at 25 *cm* with strain so $\frac{1}{2.5\times 10^{-2}}-\frac{1}{-25\times 10^{-2}}=\frac{1}{f}$ or $P=\frac{1}{f}=40+4=44D$

***Example*: 4** The resolution limit of eye is 1 *minute*. At a distance of *r* from the eye, two persons stand with a lateral separation of 3 *metre*. For the two persons to be just resolved by the naked eye, *r* should be

(a) 10 *km* (b) 15 *km* (c) 20 *km* (d) 30 *km*

*Solution:* (a) From figure $\theta=\frac{d}{r}$; where $\theta=1'=\left(\frac{1}{60}\right)^o=\left(\frac{1}{60}\right)\times\frac{\pi}{180}rad$




$\Rightarrow 1\times\frac{1}{60}\times\frac{\pi}{180}=\frac{3}{r}\Rightarrow r$ = 10 *km*

***Example*: 5** Two points separated by a distance of 0.1 *mm* can just be resolved in a microscope when a light of wavelength 6000 *Å* is used. If the light of wavelength 4800 *Å* is used this limit of resolution becomes

(a) 0.08 *mm* (b) 0.10 *mm* (c) 0.12 *mm* (d) 0.06 *mm*

*Solution:* (a) By using resolving limit $(R.L.)\propto\lambda\Rightarrow\frac{(R.L.)_1}{(R.L.)_2}=\frac{\lambda_1}{\lambda_2}\Rightarrow\frac{0.1}{(R.L.)_2}=\frac{6000}{4800}\Rightarrow(R.L.)_2=0.08\,mm$ .

***Example*: 6** In a compound microscope, the focal lengths of two lenses are 1.5 *cm* and 6.25 *cm* an object is placed at 2 *cm* form objective and the final image is formed at 25 *cm* from eye lens. The distance between the two lenses is

(a) 6.00 *cm* (b) 7.75 *cm* (c) 9.25 *cm* (d) 11.00 *cm*

*Solution:* (d) It is given that $f_o = 1.5\ cm, f_e = 6.25\ cm, u_o = 2\ cm$

When final image is formed at least distance of distinct vision, length of the tube $L_D = \frac{u_o f_o}{u_o - f_o} + \frac{f_e D}{f_e + D}$

$\Rightarrow L_D = \frac{2 \times 1.5}{(2 - 1.5)} + \frac{6.25 \times 25}{(6.25 + 25)} = 11\ cm$.

**Example: 7** The focal lengths of the objective and the eye-piece of a compound microscope are 2.0 *cm* and 3.0 *cm* respectively. The distance between the objective and the eye-piece is 15.0 *cm*. The final image formed by the eye-piece is at infinity. The two lenses are thin. The distances in *cm* of the object and the image produced by the objective measured from the objective lens are respectively

(a) 2.4 and 12.0 (b) 2.4 and 15.0 (c) 2.3 and 12.0 (d) 2.3 and 3.0

*Solution:* (a) Given that $f_o = 2\ cm$, $f_e = 3\ cm$, $L_\infty = 15\ cm$

By using $L_\infty = v_o + f_e \Rightarrow 15 = v_o + 3 \Rightarrow v_o = 12\ cm$. Also $\frac{v_o}{u_o} = \frac{v_o - f_o}{f_o} \Rightarrow \frac{12}{u_o} = \frac{12 - 2}{2} \Rightarrow u_o = 2.4\ cm$.

**Example: 8** The focal lengths of the objective and eye-lens of a microscope are 1 *cm* and 5 *cm* respectively. If the magnifying power for the relaxed eye is 45, then the length of the tube is

(a) 30 *cm* (b) 25 *cm* (c) 15 *cm* (d) 12 *cm*

*Solution:* (c) Given that $f_o = 1\ cm$, $f_e = 5\ cm$, $m_\infty = 45$

By using $m_\infty = \frac{(L_\infty - f_o - f_e)}{f_o f_e} \Rightarrow 45 = \frac{(L_\infty - 1 - 5) \times 25}{1 \times 5} \Rightarrow L_\infty = 15\ cm$

**Example: 9** If the focal lengths of objective and eye lens of a microscope are 1.2 *cm* and 3 *cm* respectively and the object is put 1.25 *cm* away from the objective lens and the final image is formed at infinity, then magnifying power of the microscope is

(a) 150 (b) 200 (c) 250 (d) 400

*Solution:* (b) Given that $f_o = 1.2\ cm$, $f_e = 3\ cm$, $u_o = 1.25\ cm$

By using $m_\infty = -\frac{f_o}{(u_o - f_o)} \cdot \frac{D}{f_e} \Rightarrow m_\infty = -\frac{1.2}{(1.25 - 1.2)} \times \frac{25}{3} = -200$.

**Example: 10** The magnifying power of an astronomical telescope is 8 and the distance between the two lenses is 54*cm*. The focal length of eye lens and objective lens will be respectively

(a) 6 *cm* and 48 *cm* (b) 48 *cm* and 6 *cm* (c) 8 *cm* and 64 *cm* (d) 64 *cm* and 8 *cm*

*Solution:* (a) Given that $m_\infty = 8$ and $L_\infty = 54$

By using $|m_\infty| = \frac{f_o}{f_e}$ and $L_\infty = f_o + f_e$ we get $f_o = 6\ cm$ and $f_e = 48\ cm$.

**Example: 11** If an object subtend angle of 2° at eye when seen through telescope having objective and eyepiece of focal length $f_o = 60\ cm$ and $f_e = 5\ cm$ respectively than angle subtend by image at eye piece will be

(a) 16° (b) 50° (c) 24° (d) 10°

*Solution:* (c) By using $\frac{\quad}{\sim} = \frac{f_o}{f_e} \Rightarrow \frac{\quad}{20} = \frac{60}{5} \Rightarrow \quad = 24°$

**Example: 12** The focal lengths of the lenses of an astronomical telescope are 50 *cm* and 5 *cm*. The length of the telescope when the image is formed at the least distance of distinct vision is

(a) 45 *cm* (b) 55 *cm* (c) $\frac{275}{6}$ *cm* (d) $\frac{325}{6}$ *cm*

*Solution:* (d) By using $L_D = f_o + u_e = f_o + \frac{f_e D}{f_e + D} = 50 + \frac{5 \times 25}{(5 + 25)} = \frac{325}{6}\ cm$

***Example*: 13** The diameter of moon is $3.5\times10^{3}\,km$ and its distance from the earth is $3.8\times10^{5}\,km$. If it is seen through a telescope whose focal length for objective and eye lens are 4 *m* and 10 *cm* respectively, then the angle subtended by the moon on the eye will be approximately

(a) 15° (b) 20° (c) 30° (d) 35°

*Solution:* (b) The angle subtended by the moon on the objective of telescope $\sim = \frac{3.5\times10^{3}}{3.8\times10^{5}} = \frac{3.5}{3.8}\times10^{-2}\,rad$

Also $m = \frac{f_o}{f_e} = \frac{—}{\sim} \Rightarrow \frac{400}{10} = \frac{—}{\sim} \Rightarrow \quad = 40\sim \Rightarrow \quad = 40\times\frac{3.5\times10^{3}}{3.8\times10^{5}}\times\frac{180}{®} = 20°$

***Example*: 14** A telescope has an objective lens of 10 *cm* diameter and is situated at a distance one *kilometre* from two objects. The minimum distance between these two objects, which can be resolved by the telescope, when the mean wavelength of light is 5000 *Å*, is of the order of

(a) 0.5 *m* (b) 5 *m* (c) 5 *mm* (d) 5*cm*

*Solution:* (b) Suppose minimum distance between objects is *x* and their distance from telescope is *r*

So Resolving limit $d\_ = \frac{1.22\,a}{a} = \frac{x}{r} \Rightarrow x = \frac{1.22\,a\times r}{a} = \frac{1.22\times(5000\times10^{-10})\times(1\times10^{3})}{(0-1)} = 6.1\times10^{-3}\,m = 6.1\,mm$

Hence, It's order is ≈ 5 *mm*.

***Example*: 15** A compound microscope has a magnifying power 30. The focal length of its eye-piece is 5 *cm*. Assuming the final image to be at the least distance of distinct vision. The magnification produced by the objective will be

(a) +5 (b) – 5 (c) +6 (d) – 6

*Solution* (b) Magnification produced by compound microscope $m = m_o\times m_e$

where $m_o$ = ? and $m_e = \left(1+\frac{D}{f_e}\right) = 1+\frac{25}{5} = 6 \Rightarrow 30 = -m_o\times6 \Rightarrow m_o = -5$.

**Tricky example: 1**

A man is looking at a small object placed at his least distance of distinct vision. Without changing his position and that of the object he puts a simple microscope of magnifying power 10 *X* and just sees the clear image again. The angular magnification obtained is

(a) 2.5 (b) 10.0 (c) 5.0 (d) 1.0

*Solution* : (d) Angular magnification $= \frac{—}{\sim} = \frac{\tan}{\tan\sim} = \frac{I/D}{O/D} = \frac{I}{O}$

Since image and object are at the same position, $\frac{I}{O} = \frac{v}{u} = 1 \Rightarrow$ Angular magnification = 1

**Tricky example: 2**

A compound microscope is used to enlarge an object kept at a distance 0.03*m* from it's objective which consists of several convex lenses in contact and has focal length 0.02*m*. If a lensof focal length

(a) 2.5 *cm* (b) 6 *cm* (c) 15 *cm* (d) 9 *cm*

*Solution* : (d) If initially the objective (focal length $F_o$) forms the image at distance $v_o$ then $v_o = \frac{u_o f_o}{u_o - f_o} = \frac{3\times2}{3-2} = 6\,cm$

Now as in case of lenses in contact $\frac{1}{F_o} = \frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}+\ldots.. = \frac{1}{f_1}+\frac{1}{F'_o}$ $\left\{\text{where } \frac{1}{F'_o} = \frac{1}{f_2}+\frac{1}{f_3}+\ldots..\right\}$

So if one of the lens is removed, the focal length of the remaining lens system

$$\frac{1}{F_o'} = \frac{1}{F_0} - \frac{1}{f_1} = \frac{1}{2} - \frac{1}{10} \Rightarrow F_o' = 2.5\ cm$$

This lens will form the image of same object at a distance $v_o'$ such that $v_o' = \frac{u_o F_o'}{u_o - F_o'} = \frac{3 \times 2.5}{(3 - 2.5)} = 15\ cm$

So to refocus the image, eye-piece must be moved by the same distance through which the image formed by the objective has shifted *i.e.* 15 – 6 = 9 *cm*.

# Assignment

## *Human eye*

**1.** Near and far points of human eye are

(a) 25 *cm* and infinite (b) 50 *cm* and 100 *cm* (c) 25 *cm* and 50 *cm* (d) 0 *cm* and 25 *cm*

**2.** A defective eye cannot see close objects clearly because their image is formed

(a) On the eye lens (b) Between eye lens and retina

(c) On the retina (d) Beyond retina

**3.** Retina of eye acts like ..... of camera

(a) Shutter (b) Film (c) Lens (d) None of these

**4.** A person who can see things most clearly at a distance of 10 *cm*. Requires spectacles to enable him to see clearly things at a distance of 30 *cm*. What should be the focal length of the spectacles

(a) 15 *cm* (concave) (b) 15 *cm* (convex) (c) 10 *cm* (d) 0

**5.** An astronaut is looking down on earth's surface from a space shuttle at an altitude of $400\,km$. Assuming that the astronaut's pupil diameter is $5\,mm$ and the wavelength of visible light is $500\,nm$. The astronaut will be able to resolve linear object of the size of about

(a) 0.5 *m* (b) $5\,m$ (c) 50 *m* (d) 500 *m*

**6.** A person uses a lens of power + 3*D* to normalise vision. Near point of hypermetropic eye is

(a) 1 *m* (b) 1.66 *m* (c) 2 *m* (d) 0.66 *m*

**7.** The separation between two microscopic particles is measured $P_A$ and $P_B$ by two different lights of wavelength 2000 Å and 3000 Å respectively, then

(a) $P_A > P_B$ (b) $P_A < P_B$ (c) $P_A < 3/2P_B$ (d) $P_A = P_B$

**8.** To remove myopia (short sightedness) a lens of power 0.66 *D* is required. The distant point of the eye is approximately

(a) 100 *cm* (b) 150 *cm* (c) 50 *cm* (d) 25 *cm*

**9.** A person suffering from 'presbyopia' should use

(a) A concave lens (b) A convex lens

(c) A bifocal lens whose lower portion is convex (d) A bifocal lens whose upper portion is convex

**10.** The resolving limit of healthy eye is about

(a) 1′ (b) 1″ (c) 1° (d) $\frac{1}{60}''$

**11.** A person uses spectacles of power + 2*D*. He is suffering from

(a) Short sightedness or myopia (b) Long sightedness or hypermetropia

(c) Presbyopia (d) Astigmatism

**12.** The hyper metropia is a

(a) Short-side defect (b) Long-side defect

(c) Bad vision due to old age (d) None of these

**13.** A man cannot see clearly the objects beyond a distance of 20 *cm* from his eyes. To see distant objects clearly he must use which kind of lenses and of what focal length

(a) 100 *cm* convex (b) 100 *cm* concave (c) 20 *cm* convex (d) 20 *cm* concave

**14.** An eye specialist prescribes spectacles having a combination of convex lens of focal length 40 *cm* in contact with a concave lens of focal length 25 *cm*. The power of this lens combination in diopters is

(a) + 1.5 (b) –1.5 (c) +6.67 (d) –6.67

**15.** Two parallel pillars are 11 *km* away from an observer. The minimum distance between the pillars so that they can be seen separately will be

(a) 3.2 *m* (b) 20.8 *m* (c) 91.5 *m* (d) 183 *m*

**16.** A person cannot see objects clearly beyond 2.0 *m*. The power of lens required to correct his vision will be

(a) + 2.0 *D* (b) – 1.0 *D* (c) + 1.0 *D* (d) – 0.5 *D*

**17.** When objects at different distances are seen by the eye, which of the following remains constant

(a) The focal length of the eye lens (b) The object distance from the eye lens

(c) The radii of curvature of the eye lens (d) The image distance from the eye lens

**18.** A person wears glasses of power –2.0 *D*. The defect of the eye and the far point of the person without the glasses will be

(a) Nearsighted, 50 *cm* (b) Farsighted, 50 *cm* (c) Nearsighted, 250 *cm* (d) Astigmatism, 50 *cm*

**19.** A person is suffering from the defect astigmatism. Its main reason is

(a) Distance of the eye lens from retina is increased (b) Distance of the eye lens from retina is decreased

(c) The cornea is not spherical (d) Power of accommodation of the eye is decreased

**20.** Myopia is due to

(a) Elongation of eye ball (b) Irregular change in focal length

(c) Shortening of eye ball (d) Older age

**21.** Human eye is most sensitive to visible light of the wavelength

(a) 6050 *Å* (b) 5500 *Å* (c) 4500 *Å* (d) 7500 *Å*

**22.** Match the List I with the List II from the combinations shown

| | |
|---|---|
| (I) Presbiopia | (A) Sphero-cylindrical lens |
| (II) Hypermetropia | (B) Convex lens of proper power may be used close to the eye |
| (III) Astigmatism | (C) Concave lens of suitable focal length |
| (IV) Myopia | (D) Convex spectacle lens of suitable focal length |

(a) I-A; II-C; III-B; IV-D (b) I-B; II-D; III-C; IV-A (c) I-D; II-B; III-A; IV-C (d) I-D; II-A; III-C; IV-B

**23.** The human eye has a lens which has a

(a) Soft portion at its centre (b) Hard surface

(c) Varying refractive index (d) Constant refractive index

**24.** A man with defective eyes cannot see distinctly object at the distance more than 60 *cm* from his eyes. The power of the lens to be used will be

(a) + 60*D* (b) – 60*D* (c) – 1.66*D* (d) $\frac{1}{1.66}D$

**25.** A person's near point is 50 *cm* and his far point is 3 *m*. Power of the lenses he requires for

(i) Reading and (ii) For seeing distant stars are

(a) – 2*D* and 0.33*D* (b) 2*D* and – 0.33*D* (c) – 2*D* and 3*D* (d) 2*D* and – 3*D*

**26.** The focal length of a simple convex lens used as a magnifier is 10 *cm*. For the image to be formed at a distance of distinct vision ($D$ = 25 *cm*), the object must be placed away from the lens at a distance of

(a) 5 *cm* (b) 7.14 *cm* (c) 7.20 *cm* (d) 16.16 *cm*

**27.** A person is suffering from myopic defect. He is able to see clear objects placed at 15 *cm*. What type and of what focal length of lens he should use to see clearly the object placed 60 *cm* away

(a) Concave lens of 20 *cm* focal length (b) Convex lens of 20 *cm* focal length

(c) Concave lens of 12 *cm* focal length (d) Convex lens of 12 *cm* focal length

**28.** A person can see a thing clearly when it is at a distance of 1 *metre* only. If he wishes to see a distance star, he needs a lens of focal length

(a) +100 *cm* (b) – 100 *cm* (c) +50 *cm* (d) –50 *cm*

**29.** A man suffering from myopia can read a book placed at 10 *cm* distance. For reading the book at a distance of 60 *cm* with relaxed vision, focal length of the lens required will be

(a) 45 *cm* (b) – 20 *cm* (c) –12 *cm* (d) 30 *cm*

**30.** A person can see clearly objects at 100 *cm* distance. If he wants to see objects at 40 *cm* distance, then the power of the lens he shall require is

(a) +1.5 *D* (b) – 1.5 *D* (c) +3.0 *D* (d) –3.0 *D*

**31.** If the distance of the far point for a myopia patient is doubled, the focal length of the lens required to cure it will become

(a) Half (b) Double

(c) The same but a convex lens (d) The same but a concave lens

**32.** Image is formed for the short sighted person at

(a) Retina (b) Before retina (c) Behind the retina (d) Image is not formed at all

**33.** A man who cannot see clearly beyond 5 *m* wants to see stars clearly. He should use a lens of focal length

(a) – 100 *metre* (b) + 5 *metre* (c) – 5 *metre* (d) Very large

**34.** Far point of myopic eye is 250 *cm*, then the focal length of the lens to be used will be

(a) + 250 *cm* (b) – 250 *cm* (c) + 250/9 *cm* (d) – 250/9 *cm*

**35.** One can take pictures of objects which are completely invisible to the eye using camera film which are invisible to

(a) Ultra-violet rays (b) Sodium light (c) Visible light (d) Infra-red rays

**36.** In human eye the focussing is done by

(a) To and fro movement of eye lens (b) To and fro movement of the retina

(c) Change in the convexity of the lens surface (d) Change in the refractive index of the eye fluids

**37.** The minimum light intensity that can be perceived by the eye is about $10^{-10}\ watt / metre^2$. The number of photons of wavelength $5.6 \times 10^{-7}$ *metre* that must enter per second the pupil of area $10^{-4}\ metre^2$ for vision, is approximately equal to $(h = 6.6 \times 10^{-34}\ joule - \text{sec})$

(a) $3 \times 10^2$ *photons* (b) $3 \times 10^6$ *photons* (c) $3 \times 10^4$ *photons* (d) $3 \times 10^5$ *photons*

**38.** A far sighted man who has lost his spectacles, reads a book by looking through a small hole (3-4 *mm*) in a sheet of paper. The reason will be

(a) Because the hole produces an image of the letters at a longer distance

(b) Because in doing so, the focal length of the eye lens is effectively increased

(c) Because in doing so, the focal length of the eye lens is effectively decreased

(d) None of these

**39.** The maximum focal length of the eye-lens of a person is greater than its distance from the retina. The eye is

(a) Always strained in looking at an object (b) Strained for objects at large distances only

(c) Strained for objects at short distances only (d) Unstrained for all distances

**40.** The focal length of a normal eye-lens is about

(a) 1 *mm* (b) 2 *cm* (c) 25 *cm* (d) 1

**41.** The distance of the eye-lens from the retina is *x*. For normal eye, the maximum focal length of the eye-lens is

(a) $= x$ (b) $< x$ (c) $> x$ (d) $= 2x$

**42.** A man wearing glasses of focal length +1*m* can clearly see beyond 1*m*

(a) If he is farsighted (b) If he is nearsighted (c) If his vision is normal (d) In each of these cases

**43.** The near point of a person is 50 *cm* and the far point is 1.5 *m*. The spectacles required for reading purpose and for seeing distance are respectively

(a) $+2D, -\left(\frac{2}{3}\right)D$ (b) $+\left(\frac{2}{3}\right)D - 2D$ (c) $-2D, +\left(\frac{2}{3}\right)D$ (d) $-\left(\frac{2}{3}\right)D + 2D$

**44.** A man, wearing glasses of power +2*D* can read clearly a book placed at a distance of 40 *cm* from the eye. The power of the lens required so that he can read at 25 *cm* from the eye is

(a) +4.5 *D* (b) +4.0 *D* (c) +3.5 *D* (d) +3.0 *D*

**45.** A person can see clearly between 1 *m* and 2*m*. His corrective lenses should be

(a) Bifocals with power −0.5*D* and additional +3.5*D* (b) Bifocals with power −1.0*D* and additional +3.0 *D*

(c) Concave with power 1.0 *D* (d) Convex with power 0.5 *D*

**46.** While reading the book a man keeps the page at a distance of 2.5 *cm* from his eye. He wants to read the book by holding the page at 25 *cm*. What is the nature of spectacles one should advice him to use to completely cure his eye sight

(a) Convex lens of focal length 25 *cm* (b) Concave lens of focal length 25 *cm*

(c) Convex lens of focal length 2.5 *cm* (d) Concave lens of focal length 2.5 *cm*

**47.** The blades of a rotating fan can not be distinguished from each other due to

(a) Parallex (b) Power of accommodation (c) Persistence of vision (d) Binocular vision

**48.** Aperture of the human eye is 2 *mm*. Assuming the mean wavelength of light to be 5000 *Å*, the angular resolution limit of the eye is nearly

(a) 2 *minutes* (b) 1 *minute* (c) 0.5 *minute* (d) 1.5 *minutes*

**49.** If there had been one eye of the man, then

(a) Image of the object would have been inverted (b) Visible region would have decreased

(c) Image would have not been seen three dimensional (d) (b) and (c) both

**50.** A man can see the object between 15*cm* and 30*cm*. He uses the lens to see the far objects. Then due to the lens used, the near point will be at

(a) $\frac{10}{3}$ *cm* (b) 30 *cm* (c) 15 *cm* (d) $\frac{100}{3}$ *cm*

**51.** A presbyopic patient has near point as 30 *cm* and far point as 40 *cm*. The dioptric power for the corrective lens for seeing distant objects is

(a) 40 *D* (b) 4 *D* (c) 2.5 *D* (d) 0.25 *D*

**52.** A man swimming under clear water is unable to see clearly because

(a) The size of the aperture decreases (b) The size of the aperture increases

(c) The focal length of eye lens increases (d) The focal length of eye lens decreases

**53.** The distance between retina and eye-lens in a normal eye is 2.0 *cm*. The accommodated power of eye lens range from

(a) 45 *D* to 50 *D* (b) 50 *D* to 54 *D* (c) 10 *D* to 16 *D* (d) 5 *D* to 8 *D*

**54.** If the eye is taken as a spherical ball of radius 1 *cm*, the range of accommodated focal length of eye-lens is

(a) 1.85 *cm* to 2.0 *cm* (b) 1.0 *cm* to 2.8 *cm* (c) 1.56 *cm* to 2.5 *cm* (d) 1.6 *cm* to 2.0 *cm*

**55.** A person cannot read printed matter within 100 *cm* from his eye. The power of the correcting lens required to read at 20 *cm* from his eye if the distance between the eye lens and the correcting lens is 2 *cm* is

(a) 4.8 *D* (b) 1.25 *D* (c) 4.25 *D* (d) 4.55 *D*

**56.** A student having –1.5 *D* spectacles uses a lens of focal length 5 *cm* as a simple microscope to read minute scale divisions in the laboratory. The least distance of distinct vision without glasses is 20 *cm* for the student. The maximum magnifying power he gets with spectacles on is

(a) 6 (b) 9 (c) 5 (d) 4

## *Microscope*

**57.** In a compound microscope the object of $f_o$ and eyepiece of $f_e$ are placed at distance *L* such that *L* equals

(a) $f_o + f_e$ (b) $f_o - f_e$

(c) Much greater than $f_o$ or $f_e$ (d) Need not depend either value of focal lengths

**58.** In a simple microscope, if the final image is located at infinity then its magnifying power is

(a) $\frac{25}{f}$ (b) $\frac{D}{25}$ (c) $\frac{f}{25}$ (d) $\frac{f}{D^{+1}}$

**59.** In a simple microscope, if the final image is located at 25 *cm* from the eye placed close to the lens, then the magnifying power is

(a) $\frac{25}{f}$ (b) $1+\frac{25}{f}$ (c) $\frac{f}{25}$ (d) $\frac{f}{25}+1$

**60.** The maximum magnification that can be obtained with a convex lens of focal length 2.5 *cm* is (the least distance of distinct vision is 25 *cm*)

(a) 10 (b) 0.1 (c) 62.5 (d) 11

**61.** In a compound microscope, the intermediate image is

(a) Virtual, erect and magnified (b)Real, erect and magnified

(c) Real, inverted and magnified (d)Virtual, erect and reduced

**62.** A compound microscope has two lenses. The magnifying power of one is 5 and the combined magnifying power is 100. The magnifying power of the other lens is

(a) 10 (b) 20 (c) 50 (d) 25

**63.** Wavelength of light used in an optical instrument are $\lambda_1 = 4000\ Å$ and $\lambda_2 = 5000\ Å$, then ratio of their respective resolving power (corresponding to $\lambda_1$ and $\lambda_2$) is

(a) 16 : 25 (b) 9 : 1 (c) 4 : 5 (d) 5 : 4

**64.** The angular magnification of a simple microscope can be increased by increasing

(a) Focal length of lens (b) Size of object (c) Aperture of lens (d) Power of lens

**65.** The magnification produced by the objective lens and the eye lens of a compound microscope are 25 and 6 respectively. The magnifying power of this microscope is

(a) 19 (b) 31 (c) 150 (d) $\sqrt{150}$

**66.** The length of the compound microscope is 14 *cm*. The magnifying power for relaxed eye is 25. If the focal length of eye lens is 5 *cm*, then the object distance for objective lens will be

(a) 1.8 *cm* (b) 1.5 *cm* (c) 2.1 *cm* (d) 2.4 *cm*

**67.** The magnifying power of a simple microscope is 6. The focal length of its lens in *metres* will be, if least distance of distinct vision is 25 *cm*

(a) 0.05 (b) 0.06 (c) 0.25 (d) 0.12

**68.** Relative difference of focal lengths of objective and eye lens in the microscope and telescope is given as

(a) It is equal in both (b) It is more in telescope (c) It is more in microscope (d) It may be more in any one

**69.** Three objective focal lengths ($f_o$) and two eye piece focal lengths ($f_e$) are available for a compound microscope. By combining these two, the magnification of microscope will be maximum when

(a) $f_o = f_e$ (b) $f_o >> f_e$ (c) $f_o$ and $f_e$ both are small (d) $f_o >> f_e$

**70.** If the red light is replaced by blue light illuminating the object in a microscope the resolving power of the microscope

(a) Decreases (b) Increases (c) Gets halved (d) Remains unchanged

**71.** In case of a simple microscope, the object is placed at

(a) Focus *f* of the convex lens (b) A position between *f* and 2*f* (c) Beyond 2*f* (d) Between the lens and *f*

**72.** In a compound microscope cross-wires are fixed at the point

(a) Where the image is formed by the objective (b) Where the image is formed by the eye-piece

(c) Where the focal point of the objective lies (d) Where the focal point of the eye-piece lies

**73.** The length of the tube of a microscope is 10 *cm*. The focal lengths of the objective and eye lenses are 0.5 *cm* and 1.0 *cm*. The magnifying power of the microscope is about

(a) 5 (b) 23 (c) 166 (d) 500

**74.** Least distance of distinct vision is 25 *cm*. Magnifying power of simple microscope of focal length 5 *cm* is

(a) 1/5 (b) 5 (c) 1/6 (d) 6

**75.** The objective of a compound microscope is essentially

(a) A concave lens of small focal length and small aperture (b) Convex lens of small focal length and large aperture

(c) Convex lens of large focal length and large aperture (d) Convex lens of small focal length and small aperture

**76.** For relaxed eye, the magnifying power of a microscope is

(a) $-\frac{v_o}{u_o} \times \frac{D}{f_e}$ (b) $-\frac{v_o}{u_o} \times \frac{f_e}{D}$ (c) $\frac{u_o}{v_o} \times \frac{D}{f_e}$ (d) $\frac{u_o}{v_o} \times \left(-\frac{D}{f_e}\right)$

**77.** A person using a lens as a simple microscope sees an

(a) Inverted virtual image (b) Inverted real magnified image

(c) Upright virtual image (d) Upright real magnified image

**78.** The focal length of the objective lens of a compound microscope is

(a) Equal to the focal length of its eye piece (b) Less than the focal length of eye piece

(c) Greater than the focal length of eye piece (d) Any of the above three

**79.** To produce magnified erect image of a far object, we will be required along with a convex lens, is

(a) Another convex lens (b) Concave lens (c) A plane mirror (d) A concave mirror

**80.** An object placed 10 *cm* in front of a lens has an image 20 *cm* behind the lens. What is the power of the lens (in *dioptres*)

(a) 1.5 (b) 3.0 (c) – 15.0 (d) +15.0

**81.** Resolving power of a microscope depends upon

(a) The focal length and aperture of the eye lens (b) The focal lengths of the objective and the eye lens

(c) The apertures of the objective and the eye lens (d) The wavelength of light illuminating the object

**82.** If the focal length of the objective lens is increased then

(a) Magnifying power of microscope will increase but that of telescope will decrease

(b) Magnifying power of microscope and telescope both will increase

(c) Magnifying power of microscope and telescope both will decrease

(d) Magnifying power of microscope will decrease but that of telescope will increase

**83.** If in compound microscope $m_1$ and $m_2$ be the linear magnification of the objective lens and eye lens respectively, then magnifying power of the compound microscope will be

(a) $m_1 - m_2$ (b) $\sqrt{m_1 + m_2}$ (c) $(m_1 + m_2)/2$ (d) $m_1 \times m_2$

**84.** The magnifying power of a microscope with an objective of 5 *mm* focal length is 400. The length of its tube is 20 *cm*. Then the focal length of the eye-piece is

(a) 200 *cm* (b) 160 *cm* (c) 2.5 *cm* (d) 0.1 *cm*

**85.** In a compound microscope, if the objective produces an image $I_o$ and the eye piece produces an image $I_e$, then

(a) $I_o$ is virtual but $I_e$ is real (b) $I_o$ is real but $I_e$ is virtual (c) $I_o$ and $I_e$ are both real (d) $I_o$ and $I_e$ are both virtual

**86.** In an electron microscope if the potential is increased from 20 *kV* to 80 *kV*, the resolving power of the microscope will change from *R* to

(a) $R/4$ (b) $4R$ (c) $2R$ (d) $R/2$

**87.** When the length of a microscope tube increases, its magnifying power

(a) Decreases (b) Increases (c) Does not change (d) May decrease or increase

**88.** An electron microscope is superior to an optical microscope in

(a) Having better resolving power (b) Being easy to handle

(c) Low cost (d) Quickness of observation

**89.** In a compound microscope magnification will be large, if the focal length of the eye piece is

(a) Large (b) Smaller (c) Equal to that of objective (d) Less than that of objective

**90.** An electron microscope gives better resolution than optical microscope because

(a) Electrons are abundant (b) Electrons can be focused nicely

(c) Effective wavelength of electron is small (d) None of these

**91.** A man is looking at a small object placed at his near point. Without altering the position of his eye or the object, he puts a simple microscope of magnifying power 5*X* before his eyes. The angular magnification achieved is

(a) 5 (b) 2.5 (c) 1 (d) 0.2

**92.** The focal length of the objective of a compound microscope is $f_0$ and its distance from the eyepiece is *L*. The object is placed at a distance *u* from the objective. For proper working of the instrument

(a) $L < u$ (b) $L > u$ (c) $f_0 < L < 2f_0$ (d) $L > 2f_0$

**93.** Find the maximum magnifying power of a compound microscope having a 25 *diopter* lens as the objective, a 5 *diopter* lens as the eyepiece and the separation 30 *cm* between the two lenses. The least distance for clear vision is 25 *cm*

(a) 8.4 (b) 7.4 (c) 9.4 (d) 10.4

**94.** The focal length of the objective and the eye-piece of a microscope are 2 *cm* and 5 *cm* respectively and the distance between them is 30 *cm*. If the image seen by the eye is 25 *cm* from the eye-piece, the distance of the object from the objective is

(a) 0.8 *cm* (b) 2.3 *cm* (c) 0.4 *cm* (d) 1.2 *cm*

**95.** The focal length of objective and eye-piece of a microscope are 1 *cm* and 5 *cm* respectively. If the magnifying power for relaxed eye is 45, then length of the tube is

(a) 6 *cm* (b) 9 *cm* (c) 12 *cm* (d) 15 *cm*

**96.** A microscope has an objective of focal length 1.5 *cm* and an eye-piece of focal length 2.5 *cm*. If the distance between objective and eye-piece is 25 *cm*. What is the approximate value of magnification produced for relaxed eye is

(a) 75 (b) 110 (c) 140 (d) 25

**97.** The magnifying power of a microscope is generally marked as 10*X*, 100 *X*, etc. These markings are for a normal relaxed eye. A microscope marked 10*X* is used by an old man having his near point at 40 *cm*. The magnifying power of the microscope for the old man with his eyes completely relaxed is

(a) 10 (b) 18 (c) 12 (d) 16

**98.** If the focal length of objective and eye lens are 1.2 *cm* and 3 *cm* respectively and the object is put 1.25 *cm* away from the objective lens and the final image is formed at infinity. The magnifying power of the microscope is

(a) 150 (b) 200 (c) 250 (d) 400

**99.** A compound microscope is adjusted for viewing the distant image of an object, the distance of the object from the object glass is now slightly increased, what re-adjustment of the instrument would be necessary for obtaining a distant image again

(a) Objective should be moved away from the eye-piece (b) Eye-piece should be moved towards the objective

(c) Both should be moved towards each other (d) Both should be moved away from each other

**100.** When the object is self-luminous, the resolving power of a microscope is given by the expression

(a) $\frac{2\text{«} \sin \text{¯}}{\text{a}}$ (b) $\frac{\text{«} \sin \text{¯}}{\text{a}}$ (c) $\frac{2\text{«} \cos \text{¯}}{\text{a}}$ (d) $\frac{2\text{«}}{\text{a}}$

**101.** In a compound microscope, maximum magnification is obtained when the final image

(a) Is formed at infinity (b) Is formed at the least of distinct vision

(c) Coincides with the object (d) Coincides with the objective lens

**102.** How should people wearing spectacles work with a microscope

(a) They should keep on wearing their spectacles

(b) They should take off their spectacles

(c) They may keep on wearing or take off their spectacles, It makes no difference

(d) They cannot use a microscope at all

## *Telescope*

**103.** The focal length of the objective and eyepiece of an astronomical telescope for normal adjustments are 50 *cm* and 5 *cm*. The length of the telescope should be

(a) 50 *cm* (b) 55 *cm* (c) 60 *cm* (d) 45 *cm*

**104.** The resolving power of an astronomical telescope is 0.2 *seconds*. If the central half portion of the objective lens is covered, the resolving power will be

(a) 0.1 *sec* (b) 0.2 *sec* (c) 1.0 *sec* (d) 0.6 *sec*

**105.** If $F_o$ and $F_e$ are the focal length of the objective and eye-piece respectively of a telescope, then its magnifying power will be

(a) $F_o + F_e$ (b) $F_o \times F_e$ (c) $F_o / F_e$ (d) $\frac{1}{2}(F_o + F_e)$

**106.** The length of an astronomical telescope for normal vision (relaxed eye) ($f_o$ = focal length of objective lens and $f_e$ = focal length of eye lens) is

(a) $f_o \times f_e$ (b) $\frac{f_o}{f_e}$ (c) $f_o + f_e$ (d) $f_o - f_e$

**107.** A telescope of diameter 2*m* uses light of wavelength 5000 *Å* for viewing stars. The minimum angular separation between two stars whose image is just resolved by this telescope is

(a) $4 \times 10^{-4}$ *rad* (b) $0.25 \times 10^{-6}$ *rad* (c) $0.31 \times 10^{-6}$ *rad* (d) $5.0 \times 10^{-3}$ *rad*

**108.** The aperture of the objective lens of a telescope is made large so as to

(a) Increase the magnifying power of the telescope
(b) Increase the resolving power of the telescope
(c) Make image aberration less
(d) Focus on distant objects

**109.** The distance of the moon from earth is $3.8 \times 10^5$ *km*. The eye is most sensitive to light of wavelength 5500 *Å*. The separation of two points on the moon that can be resolved by a 500 *cm* telescope will be

(a) 51 *m* (b) 60 *m* (c) 70 *m* (d) All of the above

**110.** To increase both the resolving power and magnifying power of a telescope

(a) Both the focal length and aperture of the objective has to be increased
(b) The focal length of the objective has to be increased
(c) The aperture of the objective has to be increased
(d) The wavelength of light has to be decreased

**111.** The focal lengths of the objective and eye lenses of a telescope are respectively 200*cm* and 5*cm*. The maximum magnifying power of the telescope will be

(a) – 40 (b) – 48 (c) – 60 (d) – 100

**112.** A telescope has an objective of focal length 50 *cm* and an eye piece of focal length 5 *cm*. The least distance of distinct vision is 25 *cm*. The telescope is focussed for distinct vision on a scale 200 *cm* away. The separation between the objective and the eye-piece is

(a) 75 *cm* (b) 60 *cm* (c) 71 *cm* (d) 74 *cm*

**113.** In a laboratory four convex lenses $L_1, L_2, L_3$ and $L_4$ of focal lengths 2, 4, 6 and 8*cm* respectively are available. Two of these lenses form a telescope of length 10*cm* and magnifying power 4. The objective and eye lenses are

(a) $L_2, L_3$ (b) $L_1, L_4$ (c) $L_3, L_2$ (d) $L_4, L_1$

**114.** Four lenses of focal length + 15 *cm*, + 20 *cm*, + 150 *cm* and + 250 *cm* are available for making an astronomical telescope. To produce the largest magnification, the focal length of the eye-piece should be

(a) + 15 *cm* (b) + 20 *cm* (c) + 150 *cm* (d) + 250 *cm*

**115.** In a terrestrial telescope, the focal length of objective is 90 *cm*, of inverting lens is 5 *cm* and of eye lens is 6 *cm*. If the final image is at 30 *cm*, then the magnification will be

(a) 21 (b) 12 (c) 18 (d) 15

**116.** The focal lengths of the objective and the eyepiece of an astronomical telescope are 20 *cm* and 5 *cm* respectively. If the final image is formed at a distance of 30 *cm* from the eye piece, find the separation between the lenses for distinct vision

(a) 32.4 *cm* (b) 42.3 *cm* (c) 24.3 *cm* (d) 30.24 *cm*

**117.** Resolving power of reflecting type telescope increases with

(a) Decrease in wavelength of incident light
(b) Increase in wavelength of incident light
(c) Increase in diameter of objective lens
(d) None of these

**118.** A planet is observed by an astronomical refracting telescope having an objective of focal length 16 *m* and an eye-piece of focal length 2*cm*

(a) The distance between the objective and the eye-piece is 16.02 *m*
(b) The angular magnification of the planet is 800
(c) The image of the planet is inverted
(d) All of the above

**119.** The astronomical telescope consists of objective and eye-piece. The focal length of the objective is

(a) Equal to that of the eye-piece
(b) Greater than that of the eye-piece
(c) Shorter than that of the eye-piece
(d) Five times shorter than that of the eye-piece

**120.** The diameter of the objective of a telescope is *a*, the magnifying power is *m* and wavelength of light is ª. The resolving power of the telescope is

(a) (1.22ª)/*a* (b) (1.22*a*)/ª (c) ª*m*/(1.22*a*) (d) *a*/(1.22ª*m*)

**121.** An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and the eyepiece is 36 *cm* and final image is formed at infinity. The focal lengths of the objective and eyepiece are respectively

(a) 20 *cm*, 16 *cm* (b) 50 *cm*, 10 *cm* (c) 30 *cm*, 6 *cm* (d) 45 *cm*, –9 *cm*

**122.** A photograph of the moon was taken with telescope. Later on, it was found that a housefly was sitting on the objective lens of the telescope. In photograph

(a) The image of housefly will be reduced
(b) There is a reduction in the intensity of the image
(c) There is an increase in the intensity of the image
(d) The image of the housefly will be enlarged

**123.** The magnifying power of a telescope is $M$. If the focal length of eye piece is doubled, then the magnifying power will become

(a) $2M$ (b) $M/2$ (c) $\sqrt{2M}$ (d) $3M$

**124.** The minimum magnifying power of a telescope is $M$. If the focal length of its eyelens is halved, the magnifying power will become

(a) $M/2$ (b) $2M$ (c) $3M$ (d) $4M$

**125.** The final image in an astronomical telescope is

(a) Real and errect (b) Virtual and inverted (c) Real and inverted (d) Virtual and errect

**126.** The astronomical telescope has two lenses of focal powers 0.5 $D$ and 20 $D$. Its magnifying power will be

(a) 40 (b) 10 (c) 100 (d) 35

**127.** An astronomical telescope of ten-fold angular magnification has a length of 44 *cm*. The focal length of the objective is

(a) 4 *cm* (b) 40 *cm* (c) 44 *cm* (d) 440 *cm*

**128.** A telescope consisting of an objective of focal length 100 *cm* and a single eyes lens of focal length 10 *cm* is focussed on a distant object in such a way that parallel rays emerge from the eye lens. If the object subtends an angle of 2° at the objective, the angular width of the image is

(a) 20° (b) 1/6° (c) 10° (d) 24°

**129.** When diameter of the aperture of the objective of an astronomical telescope is increased, its

(a) Magnifying power is increased and resolving power is decreased
(b) Magnifying power and resolving power both are increased
(c) Magnifying power remains the same but resolving power is increased
(d) Magnifying power and resolving power both are decreased

**130.** The focal length of objective and eye-piece of a telescope are 100 *cm* and 5 *cm* respectively. Final image is formed at least distance of distinct vision. The magnification of telescope is

(a) 20 (b) 24 (c) 30 (d) 36

**131.** A simple telescope, consisting of an objective of focal length 60 *cm* and single eye lens of focal length 5 *cm* is focussed on a distant object in such a way that parallel rays comes out from the eye lens. If the object subtends an angle 2° at the objective, the angular width of the image

(a) 10° (b) 24° (c) 50° (d) 1/6°

**132.** The diameter of the objective of the telescope is 0.1 *metre* and wavelength of light is 6000 *Å*. Its resolving power would be approximately

(a) $7.32 \times 10^{-6}$ *radian* (b) $1.36 \times 10^{6}$ *radian* (c) $7.32 \times 10^{-5}$ *radian* (d) $1.36 \times 10^{5}$ *radian*

**133.** A Gallilean telescope has objective and eye-piece of focal lengths 200 *cm* and 2 *cm* respectively. The magnifying power of the telescope for normal vision is

(a) 90 (b) 100 (c) 108 (d) 198

**134.** All of the following statements are correct except

(a) The total focal length of an astronomical telescope is the sum of the focal lengths of its two lenses

(b) The image formed by the astronomical telescope is always erect because the effect of the combination of the two lenses its divergent

(c) The magnification of an astronomical telescope can be increased by decreasing the focal length of the eye-piece

(d) The magnifying power of the refracting type of astronomical telescope is the ratio of the focal length of the objective to that of the eye-piece

**135.** The length of a telescope is 36 *cm*. The focal length of its lenses can be

(a) 30 *cm*, 6 *cm* (b) – 30 *cm*, – 6 *cm* (c) – 30 *cm*, – 6 *cm* (d) – 30 *cm*, 6 *cm*

**136.** The diameter of the objective lens of telescope is 5.0 *m* and wavelength of light is 6000 *Å*. The limit of resolution of this telescope will be

(a) 0.03 *sec* (b) 3.03 *sec* (c) 0.06 *sec* (d) 0.15 *sec*

**137.** If tube length of astronomical telescope is 105 *cm* and magnifying power is 20 for normal setting, calculate the focal length of objective

(a) 100 *cm* (b) 10 *cm* (c) 20 *cm* (d) 25 *cm*

**138.** Radio telescope is used to see

(a) Distant start and planets (b) Sun and to measure its temperature

(c) Stars and to measures diameters (d) None of these

**139.** Four lenses with focal lens ± 15 *cm* and ± 150 *cm* are being placed for used as a telescopic objective. The focal length of the lens which produces the largest magnification with a given eye-piece is

(a) –15 *cm* (b) +150 *cm* (c) –150 *cm* (d) +15 *cm*

**140.** The image of a star (effectively a point source) is made by convergent lens of focal length 50 *cm* and diameter of aperture 5.0 *cm*. If the lens is ideal, and the effective wavelength in image formation is taken as $5 \times 10^{-5}\ cm$, the diameter of the image formed will be nearest to

(a) Zero (b) $10^{-6}\ cm$ (c) $10^{-5}\ cm$ (d) $10^{-3}\ cm$

**141.** To increase the magnifying power of telescope ($f_o$ = focal length of the objective and $f_e$ = focal length of the eye lens)

(a) $f_o$ should be large and $f_e$ should be small (b) $f_o$ should be small and $f_e$ should be large

(c) $f_o$ and $f_e$ both should be large (d) $f_o$ and $f_e$ both should be small

**142.** The limit of resolution of a 100 *cm* telescope ($^{a} = 5.5 \times 10^{-7}\ m$) is

(a) 0.14" (b) 0.3" (c) 1′ (d) 1"

**143.** In a reflecting astronomical telescope, if the objective (a spherical mirror) is replaced by a parabolic mirror of the same focal length and aperture, then

(a) The final image will be erect (b) The larger image will be obtained

(c) The telescope will gather more light (d) Spherical aberration will be absent

**144.** A planet is observed by an astronomical refracting telescope having an objective of focal length 16 *m* and an eyepiece of focal length 2 *cm*

(a) The distance between the objective and the eyepiece is 16.02 *m*

(b) The angular magnification of the planet is 800

(c) The image of the planet is inverted

(d) The objective is larger than the eyepiece

**145.** The average distance between the earth and moon is $38.6 \times 10^{4}\ km$. The minimum separation between the two points on the surface of the moon that can be resolved by a telescope whose objective lens has a diameter of 5 *m* with $^{a}$ = 6000 *Å* is

(a) 5.65 *m* (b) 28.25 *m* (c) 11.30 *m* (d) 56.51 *m*

**146.** The focal length of the objective and eye piece of a telescope are respectively 60 *cm* and 10 *cm*. The magnitude of the magnifying power when the image is formed at infinity is

(a) 50 (b) 6 (c) 70 (d) 5

**147.** The focal length of an objective of a telescope is 3 *metre* and diameter 15 *cm*. Assuming for a normal eye, the diameter of the pupil is 3 *mm* for its complete use, the focal length of eye piece must be

(a) 6 *cm* (b) 6.3 *cm* (c) 20 *cm* (d) 60 *cm*

**148.** An opera glass (Gallilean telescope) measures 9 *cm* from the objective to the eyepiece. The focal length of the objective is 15 *cm*. Its magnifying power is

(a) 2.5 (b) 2/5 (c) 5/3 (d) 0.4

**149.** The focal length of objective and eye lens of a astronomical telescope are respectively 2 *m* and 5 *cm*. Final image is formed at (i) least distance of distinct vision (ii) infinity. The magnifying power in both cases will be

(a) – 48, – 40 (b) – 40, – 48 (c) – 40, 48 (d) – 48, 40

**150.** An optical device that enables an observer to see over or around opaque objects, is called

(a) Microscope (b) Telescope (c) Periscope (d) Hydrometer

**151.** The magnifying power of a telescope can be increased by

(a) Increasing focal length of the system (b) Fitting eye piece of high power
(c) Fitting eye piece of low power (d) Increasing the distance of objects

**152.** An achromatic telescope objective is to be made by combining the lenses of flint and crown glasses. This proper choice is

(a) Convergent of crown and divergent of flint (b) Divergent of crown and convergent of flint
(c) Both divergent (d) Both convergent

**153.** An observer looks at a tree of height 15 *m* with a telescope of magnifying power 10. To him, the tree appears

(a) 10 times taller (b) 15 times taller (c) 10 times nearer (d) 15 times nearer

**154.** The magnification produced by an astronomical telescope for normal adjustment is 10 and the length of the telescope is 1.1 *m*. The magnification when the image is formed at least distance of distinct vision ($D$ = 25 *cm*) is

(a) 14 (b) 6 (c) 16 (d) 18

**155.** The objective of a telescope has a focal length of 1.2 *m*. it is used to view a 10.0 *m* tall tower 2 *km* away. What is the height of the image of the tower formed by the objective

(a) 2 *mm* (b) 4 *mm* (c) 6 *mm* (d) 8 *mm*

**156.** A giant telescope in an observatory has an objective of focal length 19 *m* and an eye-piece of focal length 1.0 *cm*. In normal adjustment, the telescope is used to view the moon. What is the diameter of the image of the moon formed by the objective? The diameter of the moon is $3.5 \times 10^6$ *m* and the radius of the lunar orbit round the earth is $3.8 \times 10^8$ *m*

(a) 10 *cm* (b) 12.5 *cm* (c) 15 *cm* (d) 17.5 *cm*

**157.** The aperture of the largest telescope in the world is ≈ 5 *metre*. If the separation between the moon and the earth is $\approx 4 \times 10^5$ *km* and the wavelength of the visible light is $\cong 5000$ Å, then the minimum separation between the objects on the surface of the moon which can be just resolved is

(a) 1 *metre* approximately (b) 10 *metre* approximately (c) 50 *metre* approximately (d) 200 *metre* approximately

**158.** In Galileo's telescope, magnifying power for normal vision is 20 and power of eye-piece is –20 *D*. Distance between the objective and eye-piece should be

(a) 90 *cm* (b) 95 *cm* (c) 100 *cm* (d) 105 *cm*

**159.** The least resolve angle by a telescope using objective of aperture 5 *m* and light of wavelength = 4000 *A.U.* is nearly

(a) $\frac{1}{50}^\circ$ (b) $\frac{1}{50}$ *sec* (c) $\frac{1}{50}$ *minute* (d) $\frac{1}{500}$ *sec*

**160.** The limit of resolution of a 10 *cm* telescope for visible light of wavelength 6000 Å is approximately

(a) 0.1 *s* or arc (b) 30° (c) $\left(\frac{1}{6}\right)^o$ (d) None of these

**161.** An eye-piece of a telescope with a magnification of 100 has a power of 20 diopters. The object of this telescope has a power of

(a) 2 *diopters* (b) 0.2 *diopters* (c) 2000 *diopters* (d) 20 *diopters*

**162.** The Yerkes Observatory telescope has a large telescope with objective of diameter of about 1 *m*. Assuming wavelength of light to be $6 \times 10^{-7} m$, the angular distance ¯ between two stars which can just be resolved is

(a) $(7.3 \times 10^{-7})^\circ$ (b) $7.3 \times 10^{-7}$ *rad* (c) $\frac{1}{40}$ of a second (d) None of these

**163.** A Galilean telescope measures 9 *cm* from the objective to the eye-piece. The focal length of the objective is 15 *cm*. Its magnifying power is

(a) 2.5 (b) 2/5 (c) 5/3 (d) 0.4

**164.** For seeing a cricket match, we prefer binoculars to the terrestrial telescope, because

(a) Binoculars give three-dimensional view (b) Terrestrial telescope gives inverted image

(c) To avoid chromatic aberration (d) To have larger magnification

**165.** A simple two lens telescope has an objective of focal length 50 *cm* and an eye-piece of 2.5 *cm*. The telescope is pointed at an object at a very large distance which subtends at an angle of 1 *milliradian* on the naked eye. The eye piece is adjusted so that the final virtual image is formed at infinity. The size of the real image formed by the objective is

(a) 5 *mm* (b) 1 *mm* (c) 0.5 *mm* (d) 0.1 *mm*

**166.** The objective of a telescope, after focussing for infinity is taken out and a slit of length $L$ is placed in its position. A sharp image of the slit is formed by the eye-piece at a certain distance from it on the other side. The length of this image is $l$, then magnification of telescope is

(a) $\frac{l}{2L}$ (b) $\frac{2L}{l}$ (c) $\frac{l}{L}$ (d) $\frac{L}{l}$

**167.** An astronomical telescope in normal adjustment receives light from a distant source $S$. The tube length is now decreased slightly

(a) A virtual image of $S$ will be formed at a finite distance

(b) No image will be formed

(c) A small, real image of $S$ will be formed behind the eye-piece, close to it

(d) A large, real image of $S$ will be formed behind the eye-piece, far away from it

**168.** A telescope consisting of object glass of power + 2 $D$ and eye-glass of power + 20 $D$ is focussed on an object 1*m* from the object glass. The final image is seen with completely relaxed eye. The magnifying power of the telescope is

(a) 20 (b) 41 (c) 24 (d) 49.2

**169.** An astronomical telescope and a Galilean telescope use identical objective lenses. They have the same magnification, when both are in normal adjustment. The eye-piece of the astronomical telescope has a focal length $f$

(a) The tube lengths of the two telescopes differ by $f$ (b) The tube lengths of the two telescopes differ by $2f$

(c) The Galilean telescope has a shorter tube length (d) The Galilean telescope has a longer tube length

# Answer Sheet

## *Assignments*

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| a | d | b | a | c | a | b | b | c | a | b | b | d | b | a | d | d | a | c | a |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| b | c | c | c | b | b | c | b | c | a | b | b | c | b | d | c | c | a | a | b |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| a | d | a | c | a | d | c | b | d | b | c | c | b | a | d | a | c | a | b | d |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| c | b | d | d | c | a | a | b | c | b | d | a | d | d | d | a | c | b | b | d |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| d | d | d | c | b | c | a | a | b | c | c | b,d | a | b | d | c | d | b | b | a |
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| b | b | b | c | c | c | c | b | a | a | b | c | d | a | c | c | a, c | d | b | d |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| c | b | b | b | b | a | b | a | c | b | b | d | b | b | a | a | a | a | b | d |
| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| a | a | d | a | d | b | a | a | a | c | b | a | c | a | c | d | c | b | b | a |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | | | | | | | | | | | |
| b | b | a | a | c | d | a | b | b, c | | | | | | | | | | | |