Blue Print (As per PU Board)

Topic	1 mark questions	2 marks questions	3 marks questions	5 marks questions	Total Marks
Ray optics and optical Instruments	1	1	–	1	8

One mark questions

1. **Define principal focus of a spherical mirror.**
   Answer: The principal focus of a spherical mirror is defined as that fixed point through which rays of light after reflection by the mirror converge (as in a concave mirror) or appear to diverge (as in the case of a convex mirror).
2. **What happens to the frequency of light when it travels from one medium to another?**
   Answer: The frequency of light does not change when it travels from one medium to another.
3. **Define power of a lens. Define one dioptre.**
   Answer: The power of a lens is the ability of the lens to converge or diverge rays of light falling on it as close to it as possible. The SI unit of power of a lens is 1dioptre . One dioptre (D) is the power of a lens which has focal length equal to 1metre .

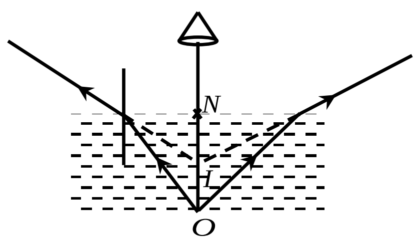
Two marks questions

4. **Draw the ray diagram of normal shift. Write the formula for normal shift**
   (i) When the object is in a denser medium and observer in the rarer medium.
   Answer:

$$n = \frac{\text{real depth}}{\text{apparent depth}}$$

$NO = \text{real depth}$

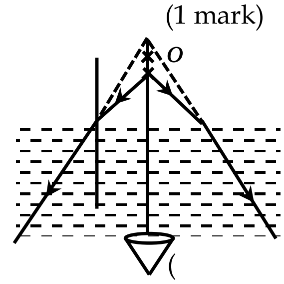
$NI = \text{apparent depth}$



(1 mark)

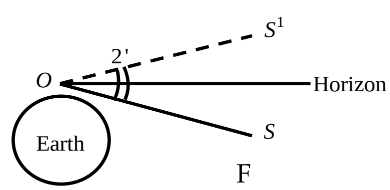
(ii) when the object in a rarer medium is viewed by an observer in a denser medium

$$n = \frac{\text{apparent depth}}{\text{real depth}}$$



(1 mark)

5. **Sun is seen a little before it rises and for a short while after it sets. Explain**
   Answer: Consider an observer O on earth. At a certain time, let S be the actual position of the sun. Light from the sun reaches O after refraction through the earth's atmosphere. The refractive index of air with respect to vacuum is 1.0029. The refracted light appears to come from S' . Thus S' is the apparent position of the sun.



F
fig. (1 mark)

This explains as to how the sun is visible before the actual sunrise and also after actual sunset.

(1 mark)

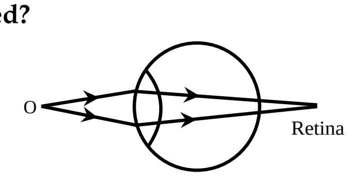
6. **Define magnifying power of microscope. Write an expression for the magnifying power of a microscope.**
Answer: The magnifying power of a microscope is defined as the ratio of the angle subtended by the image to the angle subtended by the object as seen at the least distance of distinct vision.
$m=\left(\frac{L}{f_0}\right)\left(\frac{D}{f_e}\right)$ (1 mark)
where $L=$ Length of the telescope. It is the distance between the second focal point of the objective and the first focal point of the eyepiece. D is the distance between the final image and the eyepiece.
$L=v_o+u_e$ (When the final image is formed at D)
$L=v_o+f_e$ (When the final image is formed at ∞) (1 mark)

Three marks questions

7. **An equilateral glass prism produces a minimum deviation of $40°$. Calculate (i) the refractive index of the material of the prism (ii) Angle of incidence at the first face** **(3 marks)**
Answer:
$$n=\frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$ (1 mark)
$$n=\frac{\sin\left(\frac{60°+40°}{2}\right)}{\sin\left(\frac{60°}{2}\right)}$$
$$=\frac{\sin 50°}{\sin 30°}=\frac{0.766}{\left(\frac{1}{2}\right)}=1.532$$ (1 mark)
$$i_1=\left(\frac{A+D}{2}\right)=50°$$ (1 mark)

8. **A convex lens has focal length $20\,\text{cm}$. What is its power? What will be the power of the combination when this lens is combined coaxially with a concave lens of focal length $25\,\text{cm}$. Also find the nature of the combination and its focal length.** (3 marks)
Answer: $f_1=20\,\text{cm}$
$$P_1=\frac{100}{f_1}=\frac{100}{20}=+5D$$ (1 mark)
When this is combined with a concave lens $f_2=-25\,\text{cm}$
$$P_2=\frac{100}{-f_2}=\frac{100}{-25}=-4D$$
Power of the combination $=P=P_1+P_2$ (1 mark)
$=5-4 \quad =+1D$
The combination is converging with a focal length of $1\,\text{m}$ or $100\,\text{cm}$. (1 mark)

9. **What is hyper metropia (Long sightedness). Explain how it is corrected?**
Answer: A long sighted person has an abnormally large least distance of distinct vision. He has his own near point N beyond which only he can see objects. Rays of light coming out from a point close to the eye lens are brought to focus behind the retina. (1 mark)



N is the near point of the defective eye. An object placed beyond N is not seen clearly. So a convex lens of a suitable focal length should be used to rectify this defect.

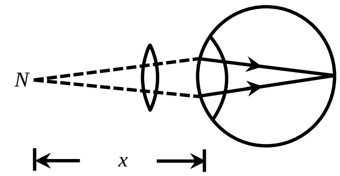


Fig. (1 mark)

The focal length of this convex lens should be such that an object placed at distance 'x' from the eye should have its image on the retina. $f=\frac{Dx}{D-x}$ (1 mark)

Five marks questions

10. Derive the mirror equation.

Answer: $AB=$ Object, $A'B'=$ Read image AB.

$P=$ pole of the mirror

$F=$ Principal focus of the mirror

$C=$ Centre of curvature of the mirror

$A'B'=$ Read image of the object AB.

ΔABC is similar to $A'B'C$

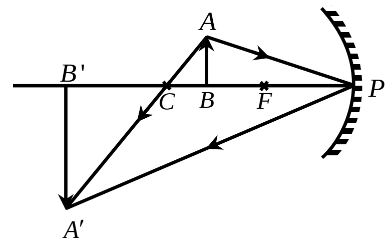


Fig. (1 mark)

$\therefore \frac{AB}{A'B'}=\frac{BC}{B'C}$ …(1)

ΔAPB is similar to $\Delta A'PB'$

$\therefore \frac{AB}{A'B'}=\frac{PB}{PB'}$ …(2)

From (1) and (2) $\frac{BC}{B'C}=\frac{PB}{PB'}$ …(3) (1 mark)

$BC=PC-PB$

$=-R-(-u)=(u-R)$

$B'C=PB'-PC$

$=-v-(-R)=(R-v)$ (1 mark)

$PB=$ Object distance $=-u$

$PB'=$ Image distance $=-v$ (1 mark)

Substituting all these in (3), we get

$\frac{u-R}{R-v}=\frac{-u}{-v}=\frac{u}{v}$

$v(u-R)=u(R-v)$

$uv-vR=uR-uv$

$2uv=uR+vR$

Divide throughout by uvR

$\frac{2}{R}=\frac{1}{v}+\frac{1}{u}$

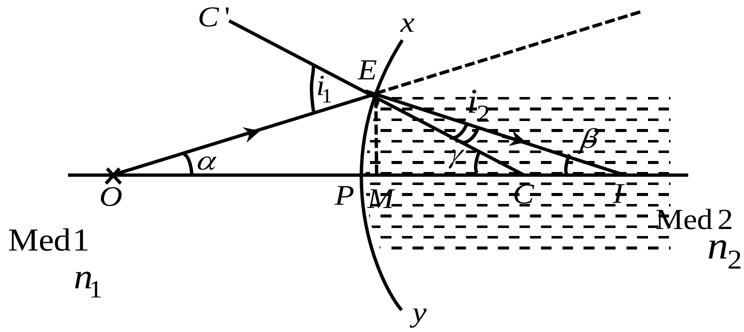
Put $R=2f$

$\therefore \frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ (1 mark)

11. Derive the refraction formula for a single refracting surface.

OR Prove that $\frac{n_2}{v}-\frac{n_1}{u}=\left(\frac{n_2\sim n_1}{R}\right)$ where the symbols have their usual meanings

Answer: $XY=$ Spherical refracting surface separating two media 1 and 2, having refractive indices n_1 and n_2 respectively



OE = Incident ray
C = Centre of curvature
R = Radius of curvature
i_1 = Angle of incidence
i_2 = Angle of refraction
u = Object distance = PO
v = Image distance = PI
R = Radius of curvature = CP
$n_1 \sin i_1 = n_2 \sin i_2$ fig. (1 mark)
(By Snell's law)

For angles $\sin\theta \approx \theta$
$\therefore n_1 i_1 = n_2 i_2$ (1 mark)
In $\Delta ECO,\ i_1 = (\alpha + \gamma)$
$\Delta ECI,\ \gamma = i_2 + \beta$ or $i_2 = (\gamma - \beta)$
$n_1(\alpha+\gamma) = n_2(\gamma-\beta)$
$n_1\alpha + n_1\gamma = n_2\gamma - n_2\beta$
$n_1\alpha + n_2\beta = (n_2 - n_1)\gamma$ …(1) (1 mark)
$\tan\alpha \approx \alpha, \quad \therefore \alpha = \frac{EM}{OM}$
$OM \approx OP = -u$
$\therefore \alpha = \frac{EM}{-u}$ …(2)
In ΔEMI, $\tan\beta = \frac{Em}{MI}$
$\tan\beta \approx \beta,\ MI = v$
$\therefore \beta = \frac{EM}{v}$ …(3)
In $\Delta EMC, \tan\gamma = \frac{EM}{MC}$
$\tan\gamma \approx \gamma,\ MC = R$
$\therefore \gamma = \frac{EM}{R}$ …(4) (1 mark)
Substituting these in (1)
$n_1\left[\frac{EM}{-u}\right] + n_2\left[\frac{EM}{v}\right] = (n_2 - n_1)\frac{EM}{R}$
Divide throughout by EM
$\therefore \frac{n_2}{v} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R}$ (1 mark)

12. Derive an expression for the magnifying power of a compound microscope.
Answer: The objective forms a real inverted enlarged image $A'B'$. The position of the object is

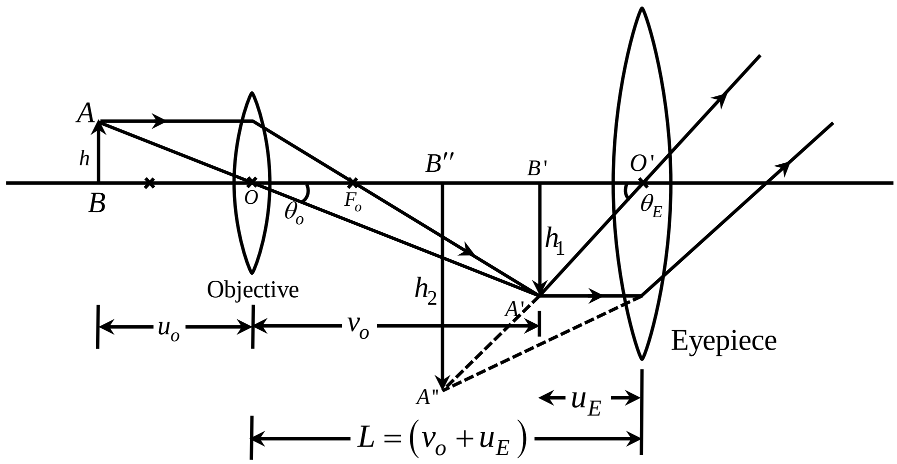
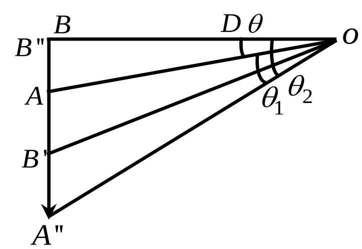


Fig. (1 mark)

adjusted so that the image $A'B'$ is formed within the principal focus of the eyepiece. The eyepiece forms a virtual, erect enlarged image $A''B''$

Let the final image be formed at the least distance of vision



$$m=\frac{\tan\theta_2}{\tan\theta}=\frac{\left(\frac{A''B''}{D}\right)}{\left(\frac{AB}{D}\right)}=\frac{A''B''}{AB}=\frac{n_2}{n}$$

$$m=\left(\frac{n_2}{n_1}\right)\times\left(\frac{n_1}{n}\right)$$

$m=m_E\times m_O$ …(1) (1 mark)

m_E is the magnifying power of the eyepiece

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f_E}$$

Multiply throughout by v

$$1-\frac{v}{u}=\frac{-v}{f_E}$$

But $\frac{v}{u=}$ magnifying power of the eyepiece

$=m_E$. Put $v=-D$

$$\therefore 1-m_E=-\frac{v}{f_E}$$

$$1-\frac{v}{f_E}=m_E$$

Put $v=-D$

$1+\frac{D}{f_E}=m_E$ …(2) (1 mark)

$m_o=\frac{v_o}{u_o}$ …(3) (1 mark)

Substituting these in (1)

$m=\frac{v_o}{u_o}\left[1+\frac{D}{f_E}\right]$ [For compound microscope] (1 mark)