

Examples

Optics (Light)  $\Rightarrow \underline{CI}$



SAFALTA CLASS<sup>TM</sup>

An Initiative by अमरउजाला



# RAY OPTICS

## किरण प्रकाशिकी

BY - SALIL BAJPAI SIR

# LIGHT (प्रकाश)

① Light is an electromagnetic radiation that can be detected by the human eye.

वैद्युत चुम्बकीय तरंग

• Light is a Transverse wave.



• Light shows wave-particle duality.

तरंग - कण

• Light not need any medium to travel.

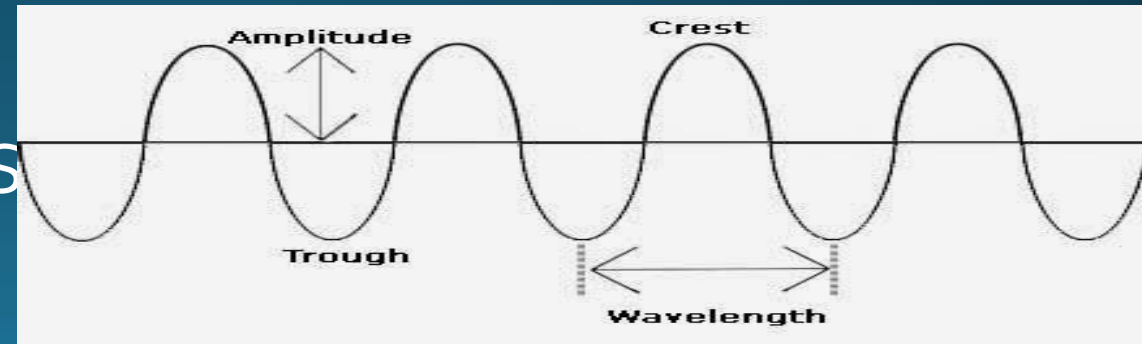
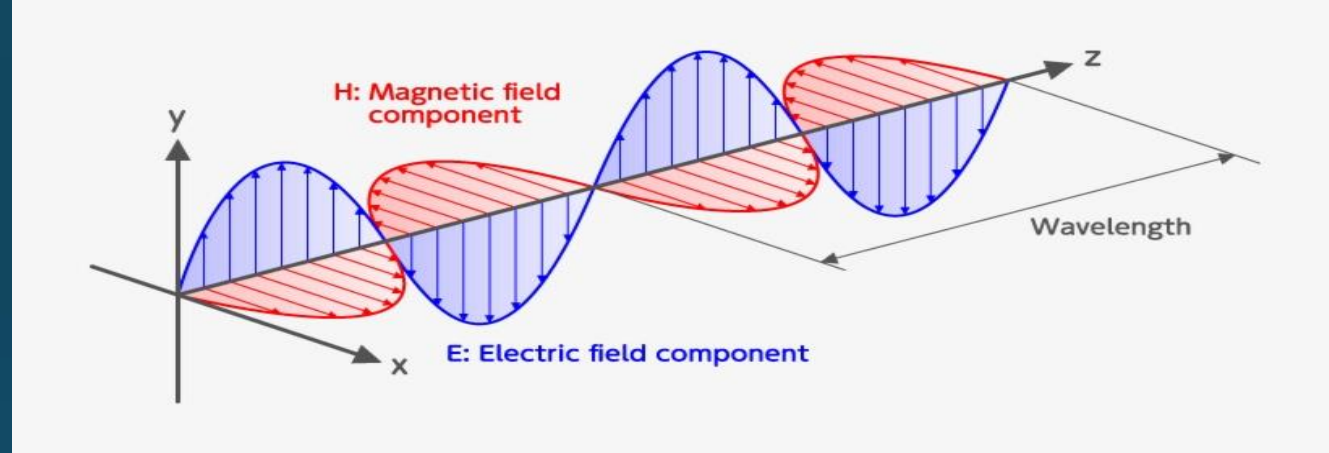
माध्यम

• Fundamental particle in light is – PHOTONS

फोटॉन

• Speed of light is  $3 \times 10^8 \text{ ms}^{-1}$

$3 \times 10^8 \text{ m/s}$



**BY - SALIL BAJPAI SIR**

- प्रकाश एक विद्युत चुम्बकीय विकिरण है जिसे मानव आँख द्वारा पता लगाया जा सकता है।
- प्रकाश एक अनुप्रस्थ तरंग है।
- प्रकाश तरंग-कण द्वंद्व को दर्शाता है।
- यात्रा के लिए प्रकाश को किसी माध्यम की आवश्यकता नहीं है।
- प्रकाश में मौलिक कण है - फोटोन्स।
- प्रकाश की गति  $3 \times 10^8 \text{ ms}^{-1}$  है

- Wave nature of light explains – DIFFRACTION & INTERFERENCE  
Phenomenon.  
व्यतिकरण और विवर्तन

- Light travels through vacuum.

- Transverse nature of light explained by – POLARIZATION.  
एक दिशा

- Visible Spectrum have range – 400nm to 750nm.  
400 750

- Shadow created due to rectilinear propagation of light.

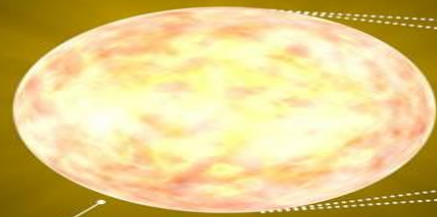
- Eclipse also occurred due to rectilinear propagation of light.  
अस्त

**BY - SALIL BAJPAI SIR**

- प्रकाश की तरंग प्रकृति बताती है – व्यतिकरण, विवर्तन घटना।
- प्रकाश एक निर्वात के माध्यम से यात्रा करता है।
- प्रकाश की अनुप्रस्थ प्रकृति समझाया गया है – ध्रुवीकरण द्वारा ।
- दर्शनीय स्पेक्ट्रम की एक सीमा होती है -  $400\text{nm}$  से  $750\text{nm}$ ।
- प्रकाश के सुव्यवस्थित प्रसार के कारण निर्मित छाया।
- प्रकाश के प्रत्यावर्ती प्रसार के कारण ग्रहण भी हुआ।

# SOLAR ECLIPSE

SUN, MOON, AND EARTH  
LINE UP, WITH THE MOON IN THE MIDDLE



Sun

FULL SHADOW  
(UMBRA)

PARTIAL SHADOW  
(PENUMBRA)

Moon

PARTIAL SHADOW  
(PENUMBRA)

Earth

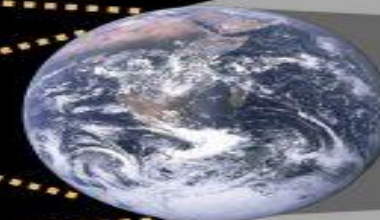
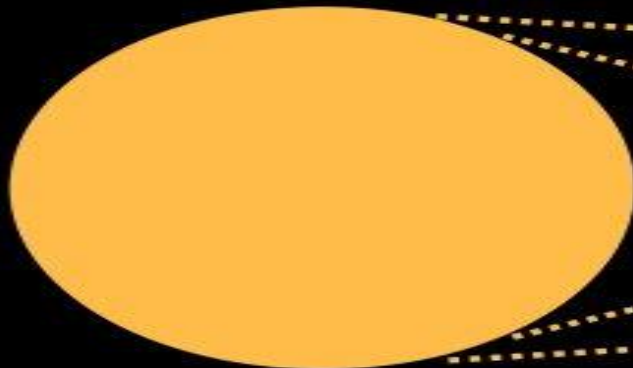
MOON'S ORBIT

[whenisthenexteclipse.com](http://whenisthenexteclipse.com)

SUN

EARTH

MOON



Umbra

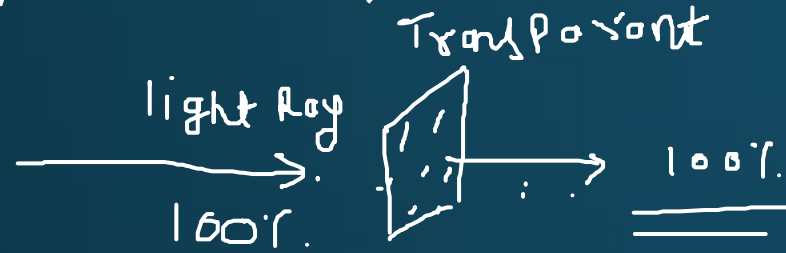
Penumbra



BY - SALILBAJPAI SIR



- **Transparent medium:-** It is a medium through which light can be propagated easily. (e.g., sun, candle, electric arc)



- **Translucent medium:-** It is a medium through which light is propagated partially. (e.g., paper, ground, glass)



- **Opaque:-** It is a medium through which light can be propagated. (e.g., wood, iron)



## ILLUSTRATION OF TRANSPARENT, TRANSLUCENT AND OPAQUE MATERIALS:

Transparent	Translucent	Opaque

**BY - SALIL BAJPAI SIR**



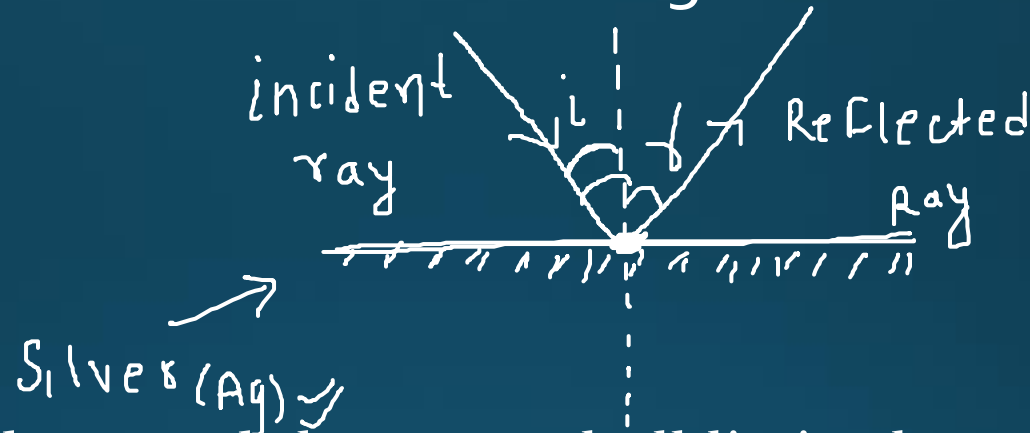
- पारदर्शी माध्यम: - यह एक ऐसा माध्यम है जिसके माध्यम से प्रकाश को आसानी से प्रचारित किया जा सकता है। (जैसे, सूरज, मोमबत्ती, बिजली के माध्यम)।
- पारभासी माध्यम: - यह एक ऐसा माध्यम है जिसके माध्यम से प्रकाश को आंशिक रूप से प्रचारित किया जाता है। (जैसे, पेपर, ग्राउंड, ग्लास)
- अपारदर्शी: - यह एक ऐसा माध्यम है जिसके माध्यम से प्रकाश का प्रचार किया जा सकता है। (जैसे, लकड़ी, लोहा)

# REFLECTION OF LIGHT BY - SALIL BAJPAI SIR (प्रकाश का परावर्तन)

- When a ray of light approaches a smooth polished surface and the light ray bounces back, it is called the **REFLECTION** of light.

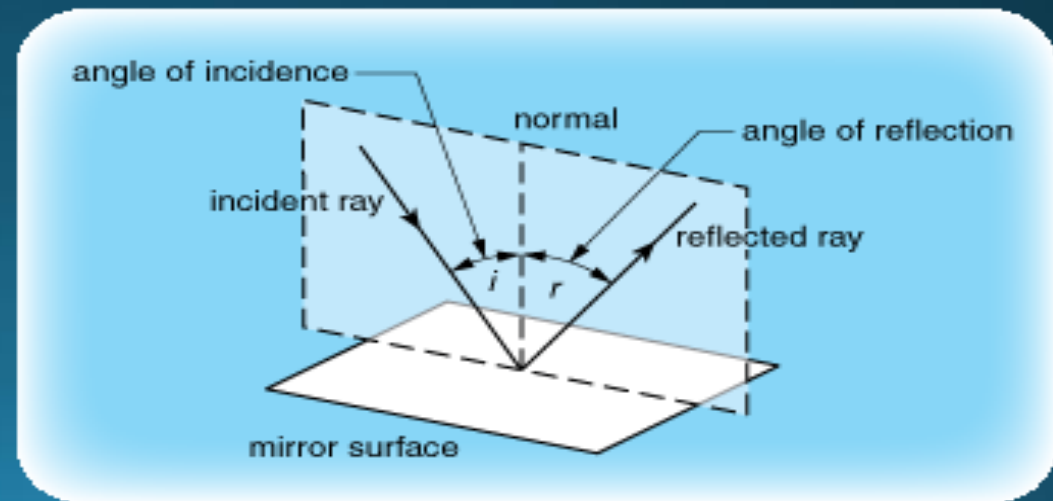
- Laws of Reflection:

- The incident ray, the reflected ray and the normal all lie in the same plane.



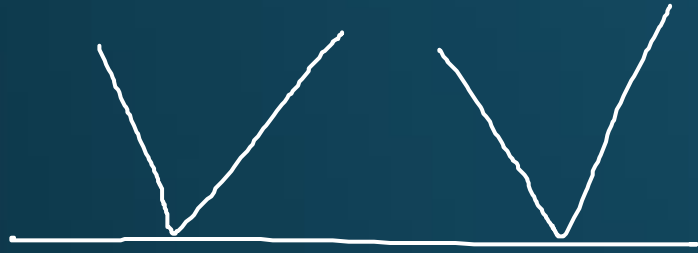
- The angle of incidence = Angle of reflection.

$$\angle i = \angle r \quad \checkmark \checkmark$$



# • प्रकाश का परावर्तन

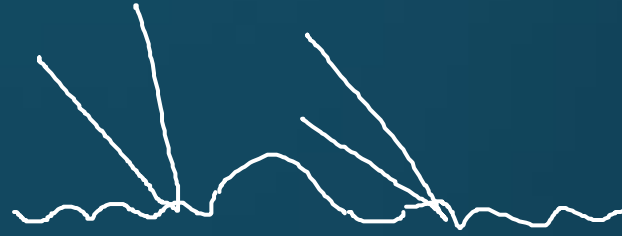
- जब कोई प्रकाश की किरण किसी Light source यानी प्रकाश के स्रोत से निकल कर किसी चमकदार सतह से टकराकर वापस लौट जाती है इसे प्रकाश का परावर्तन या Reflection of Light कहते हैं
- प्रतिबिंब के नियम:
  - 1. प्रकाश के परावर्तन में आपतन कोण और परावर्तन कोण का मान हमेशा समान होता है, आपतित किरण, परावर्तित किरण, अभिलंब और आपतन बिंदु सभी एक ही तल में होते हैं
  - 2. आपतन कोण = परावर्तन का कोण।



Plane Surface

ସମତଳ ଧୂଳି

Regular



Rough (ଅସମତଳ)



# Types of Reflection of Light: (प्रकार)

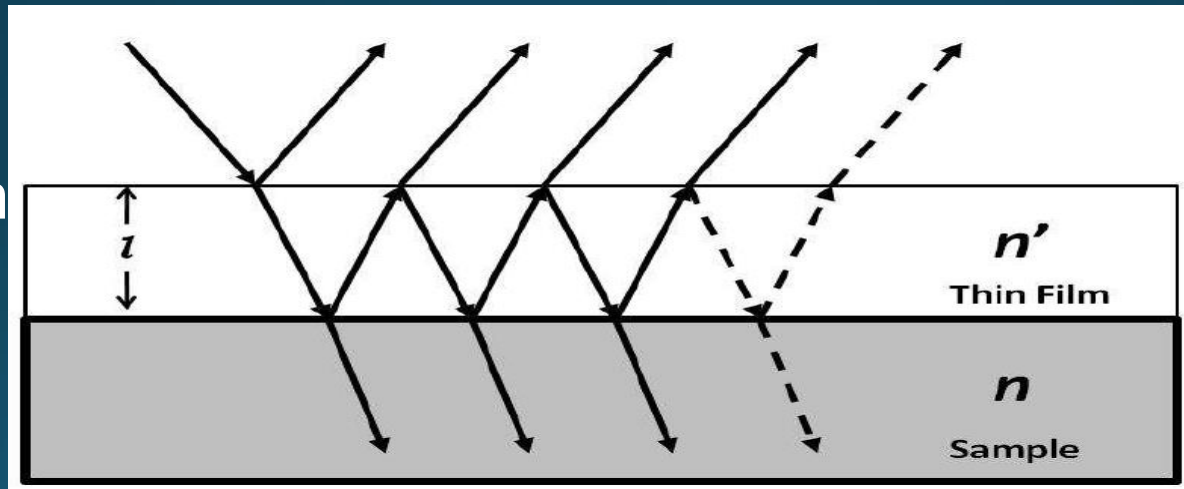
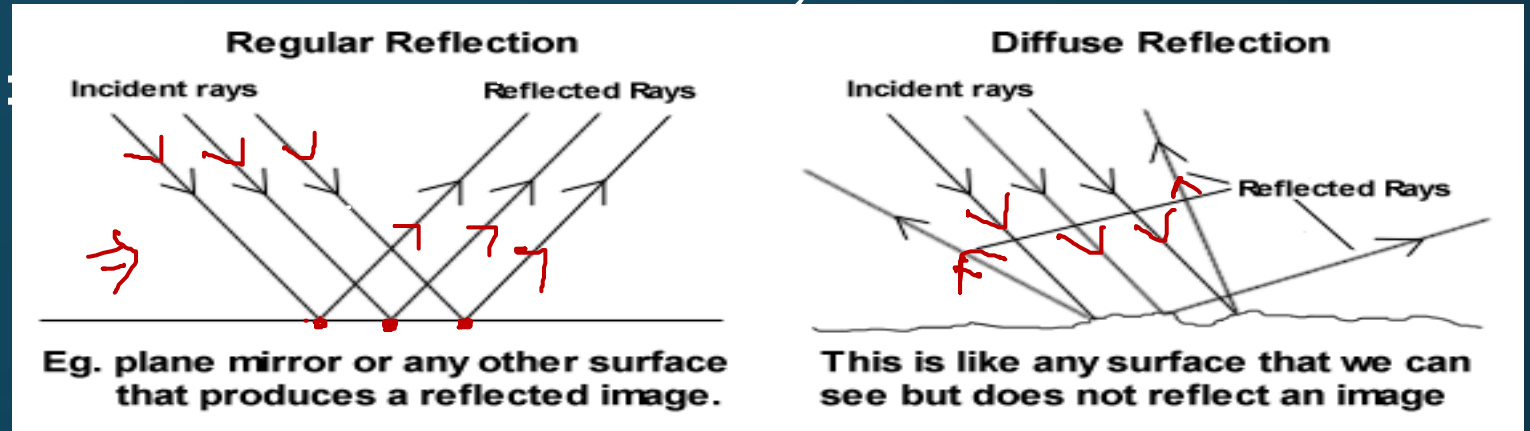
- Regular/ Specular Reflection:

$$\angle i = \angle r$$

- Diffused Reflection:

$$\Rightarrow \angle i = \angle r$$

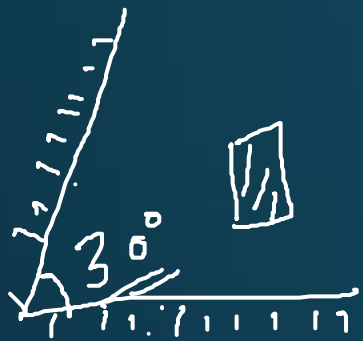
- Multiple Reflection



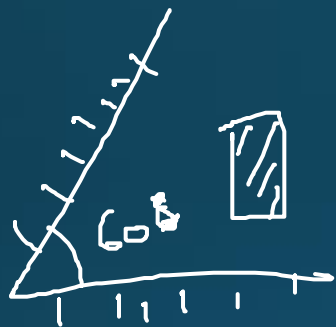
$$\text{Number of images} = \frac{360^\circ}{\text{angle between mirrors}} - 1$$

BY - SALIL BAJPAI SIR

①



$$\Rightarrow \text{no. of images} = \frac{360^\circ}{30} - 1 = 12 - 1 = \underline{\underline{11}}$$



⑤

\* Angle  $\rightarrow 90^\circ \rightarrow \text{images} = \underline{\underline{3}}$

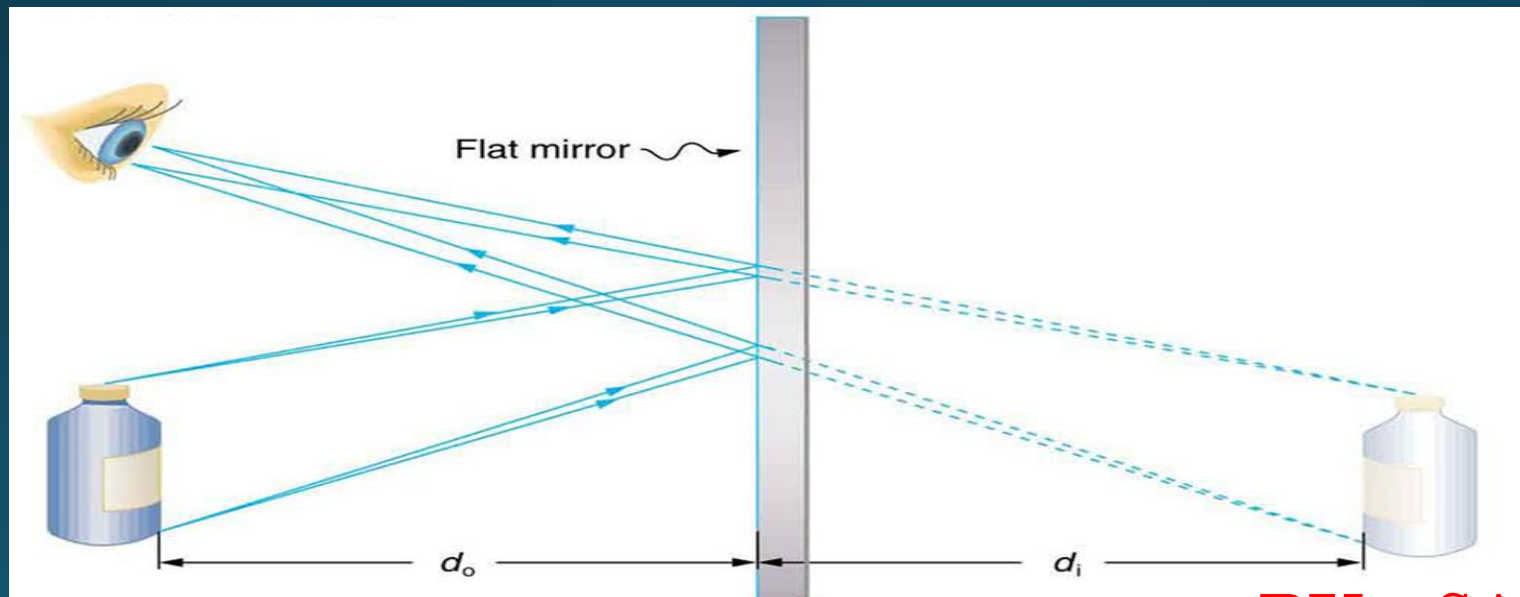
Angle  $\rightarrow 180^\circ \Rightarrow \underline{\underline{1}}$

Angle  $0^\circ \Rightarrow \underline{\underline{\infty}}$  ✓

# MIRROR

उत्तर मिरर

- A mirror is defined as reflecting surface and can be explained by the law of reflection, which states that when a ray of light is made to fall on the reflecting surface, the reflected ray has its angle of reflection, incident ray, and the reflected ray are normal to the surface at a point of incidence.



BY - SALIL BAJPAI SIR



# दर्पण

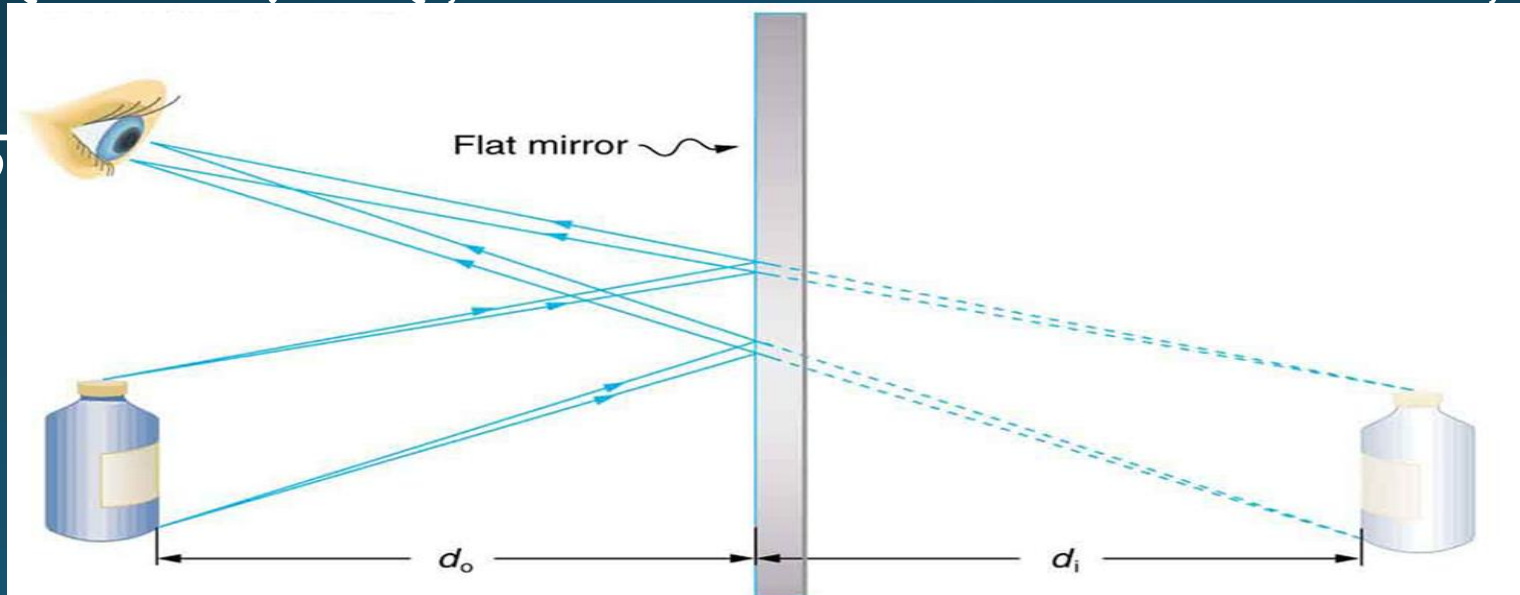
3

एक दर्पण को परावर्तक सतह के रूप में परिभाषित किया गया है और इसे प्रतिबिंब के

नियम द्वारा समझाया जा सकता है, जिसमें कहा गया है कि जब प्रकाश की किरण

परावर्तक सतह पर पड़ती है, तो परावर्तित किरण का परावर्तन, आपतित किरण, और

परावर्तित किरण सामान्य हैं।



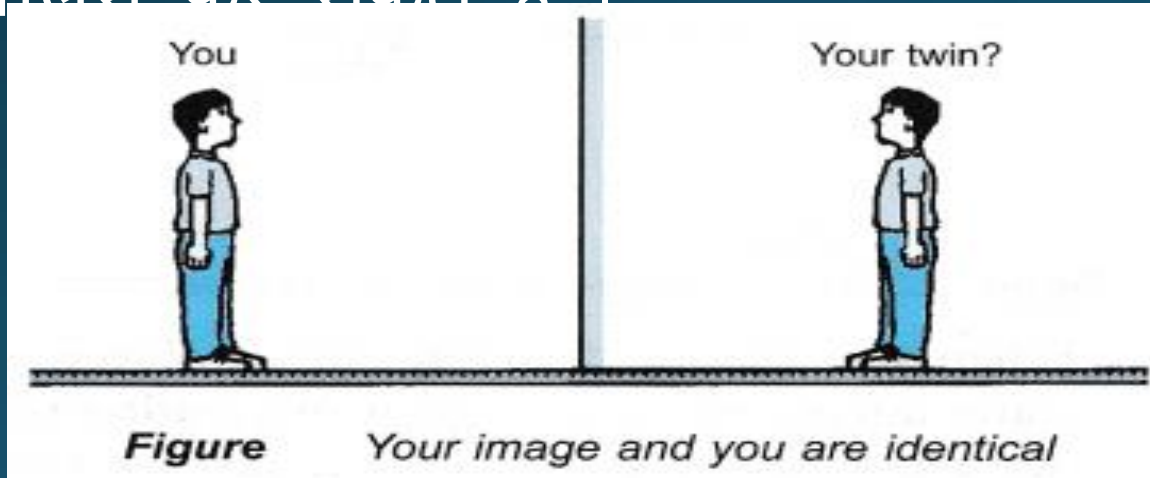
सतह के लिए

# • Types Of Mirror

समतल दर्पण (समतल)

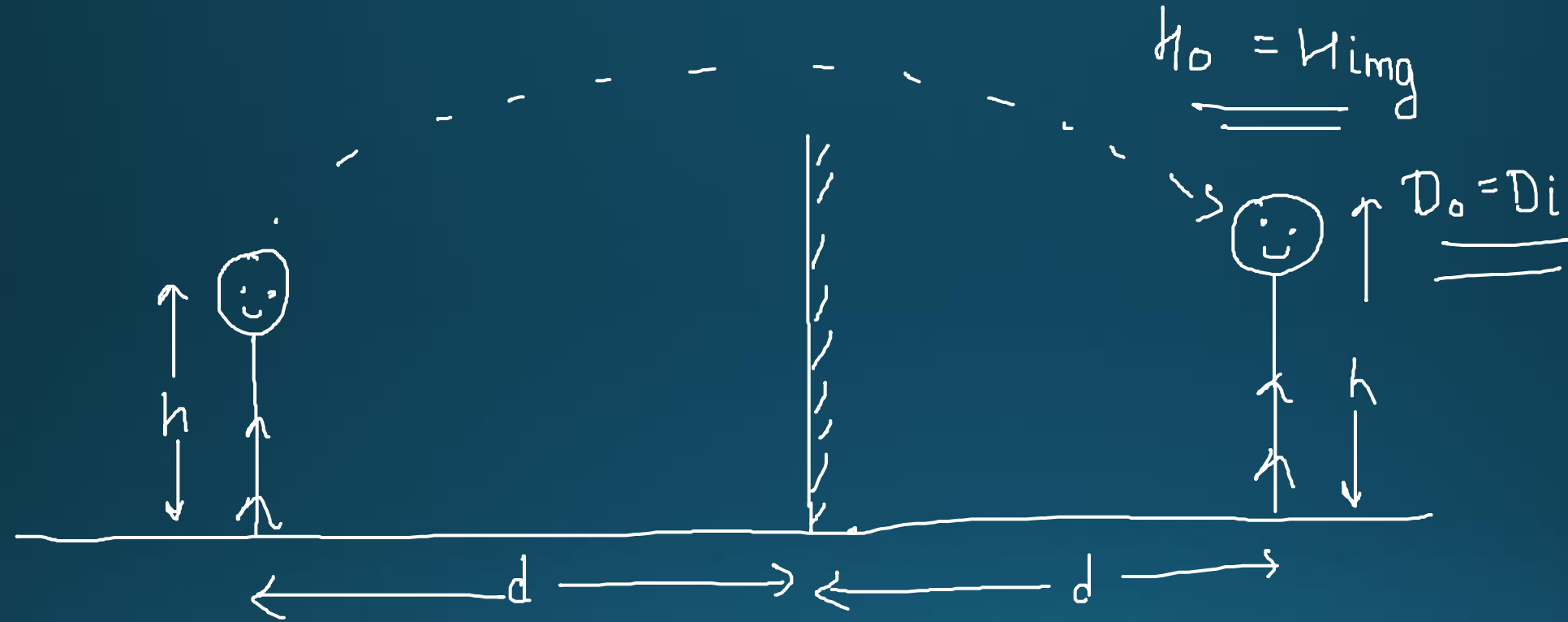
- **Plane mirror:** The images formed from a plane mirror are the reflected images in their normal proportions but reversed from left to right. These are the most widely used mirrors.

- यदि किसी काँच की पट्टिका की एक सतह को पॉलिश कर दी जाये तो वह पट्टिका दर्पण कहलाती है। चाँदी (Silver) सबसे अच्छा परावर्तक है अतः हम इसकी पॉलिश कर सकते हैं।



BY - SALIL BAJPAI SIR

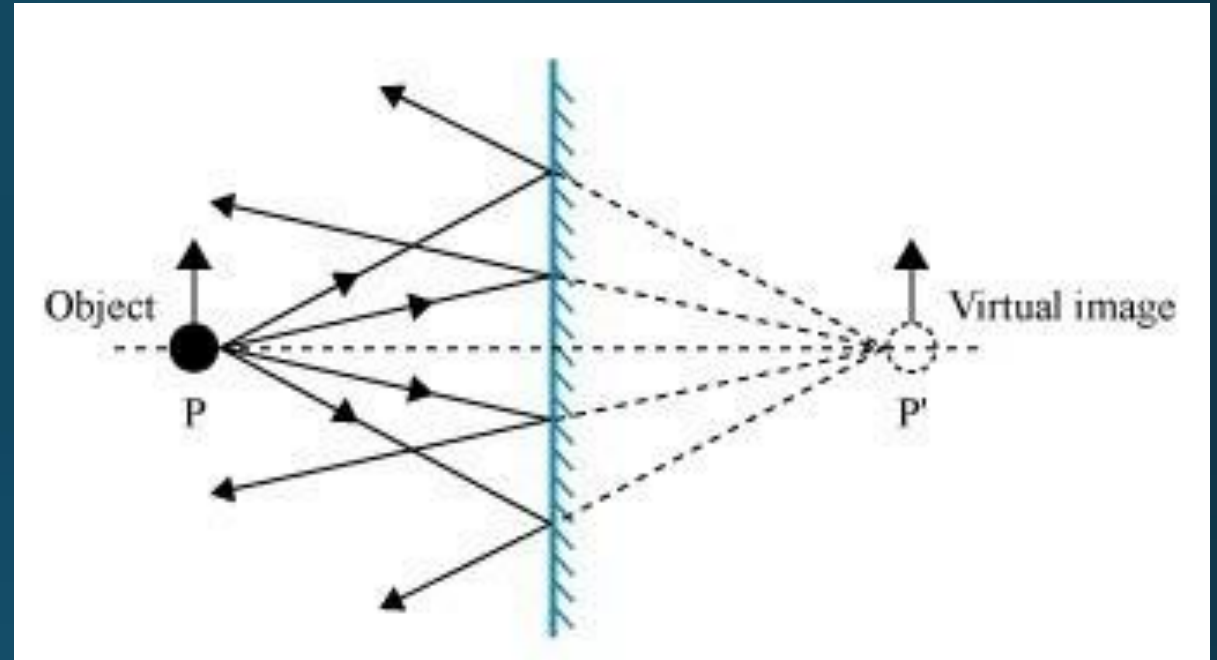
\*\* Image formation by Plane mirror:- virtual (आभासी)



\* Image Lat. inverted.  $\Rightarrow L \rightarrow R$   
 $R \rightarrow L$

# • Properties of an image formed by plane mirror

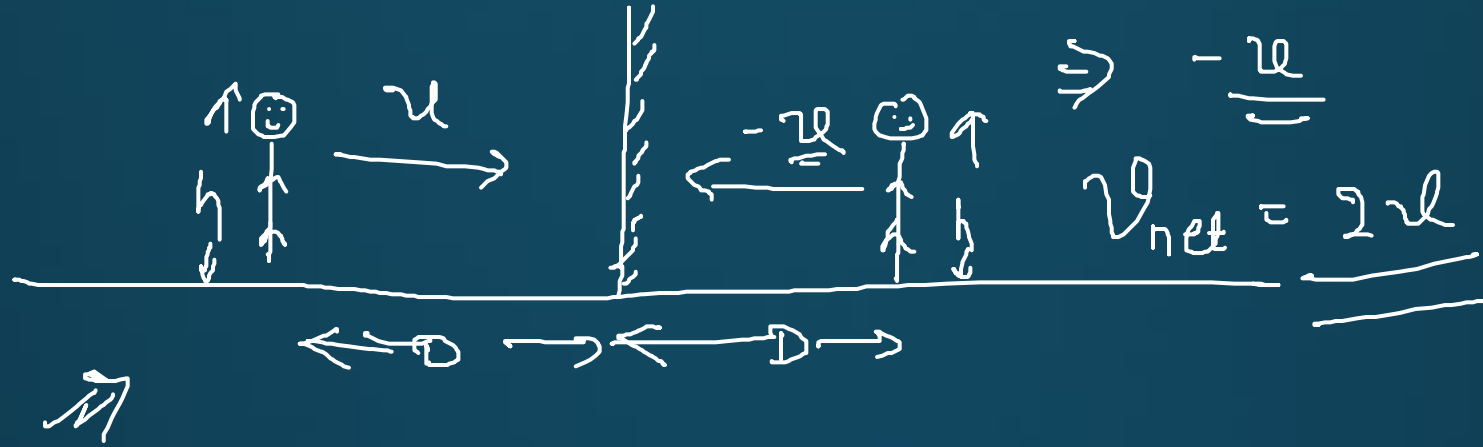
- The image obtained is virtual.
- The image is laterally inverted.
- The image is erect.
- The size of the image is the same as the size of the object.
- The distance between the image obtained is the same as the distance between the object from the mirror.



## समतल दर्पण द्वारा बने प्रतिबिम्ब के गुणधर्म ( Properties of Image Formed by Plane Mirror ) :

1. समतल दर्पण द्वारा प्रतिबिम्ब दर्पण से उतना ही दूर बनता है जितनी की वस्तु दर्पण से दूर होती है | अर्थात्  $u = v$
2. समतल दर्पण के द्वारा बने प्रतिबिम्ब की ऊँचाई , वस्तु की ऊँचाई के बराबर होती है | अर्थात्  $h = h'$
3. समतल दर्पण द्वारा प्रतिबिम्ब हमेशा आभासी और सीधा बनता है |
4. समतल दर्पण द्वारा बने प्रतिबिम्ब का आवर्धन (  $m$  ) इकाई यानि 1 होता है |

11

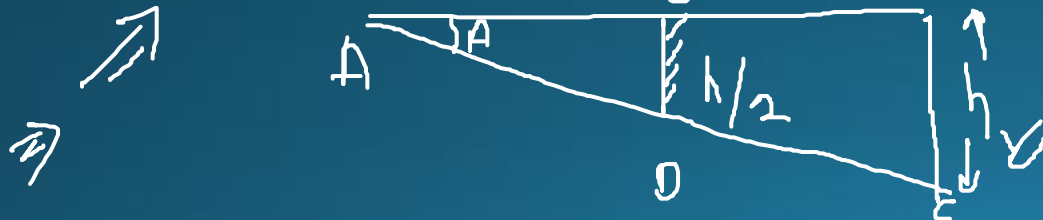


12



minimum height of  
plane mirror = ?

आपकी ऊँचाई का आधा

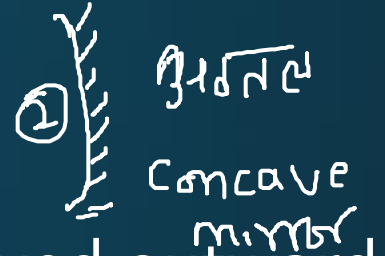
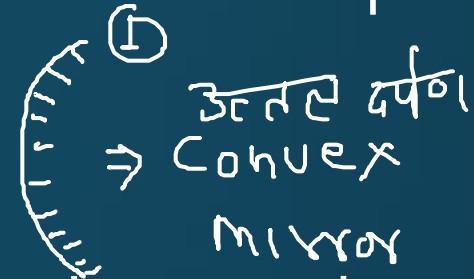


$$BC = 2DE$$

- **Concave mirrors:** These are the spherical mirror that is curved inward and the image obtained from these mirrors depend on the placement of the object. ଅବନତ ଦର୍ପଣ

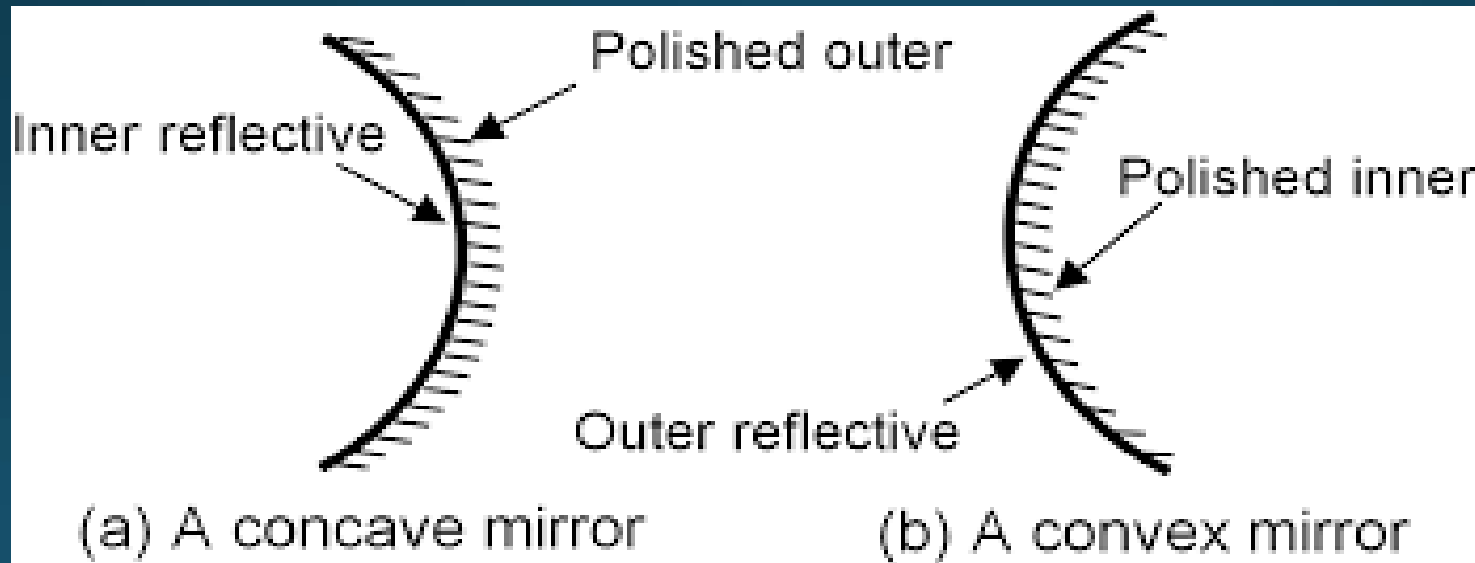


⇒



- **Convex mirror:** These are the spherical mirror that is curved outward and the image obtained is virtual, diminished and erect for a real object. ଅବନତ ଦର୍ପଣ

⇒





Light comes  
from this side

Hard surface

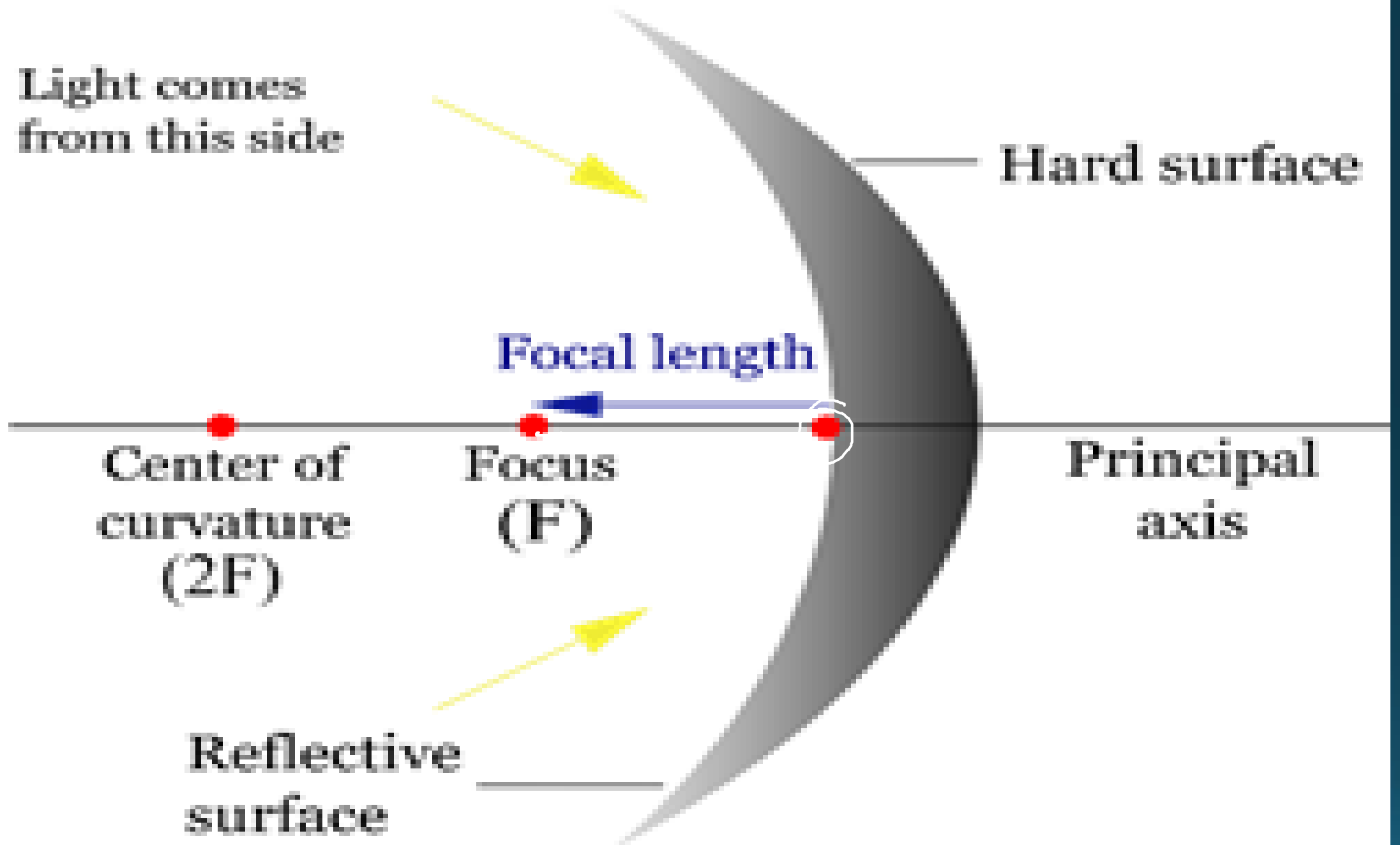
Focal length

Center of  
curvature  
( $2F$ )

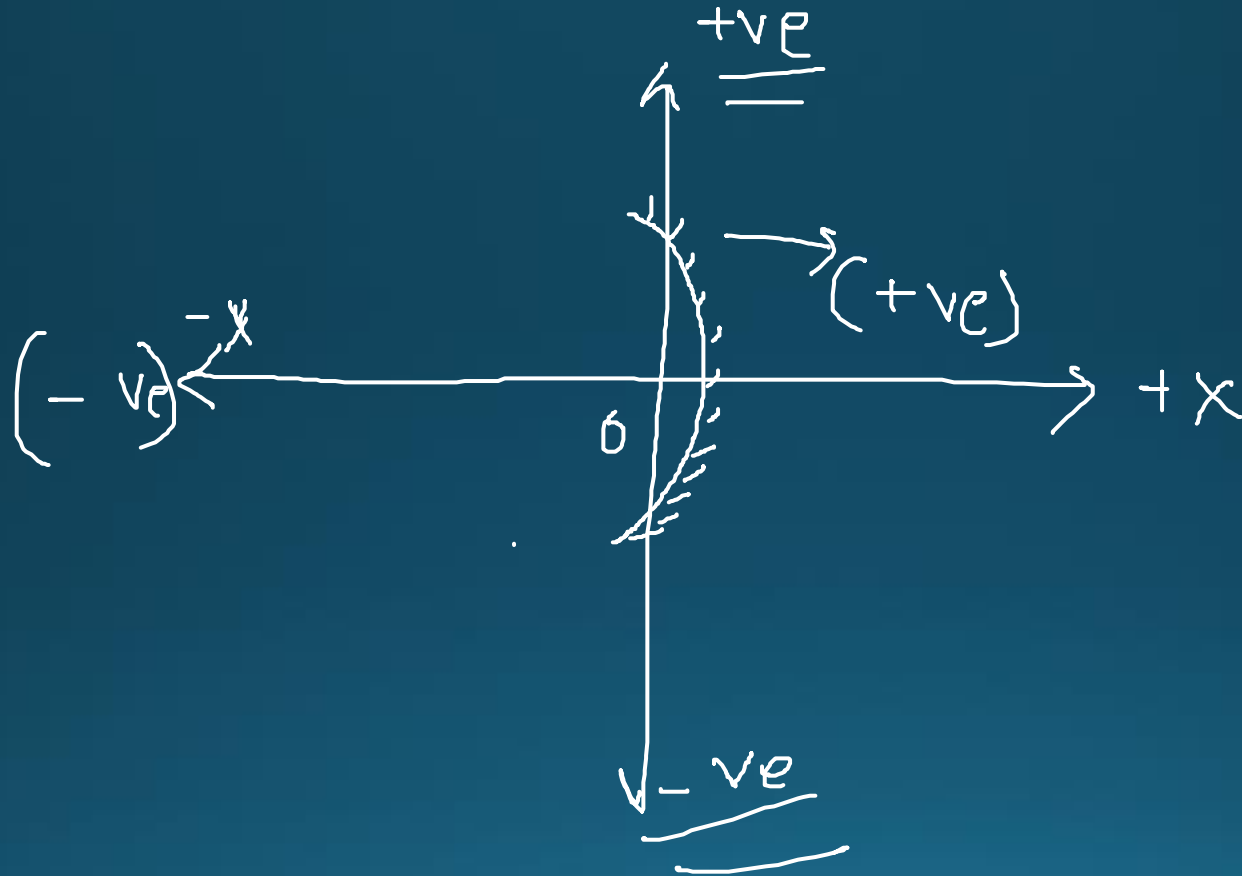
Focus  
( $F$ )

Principal  
axis

Reflective  
surface

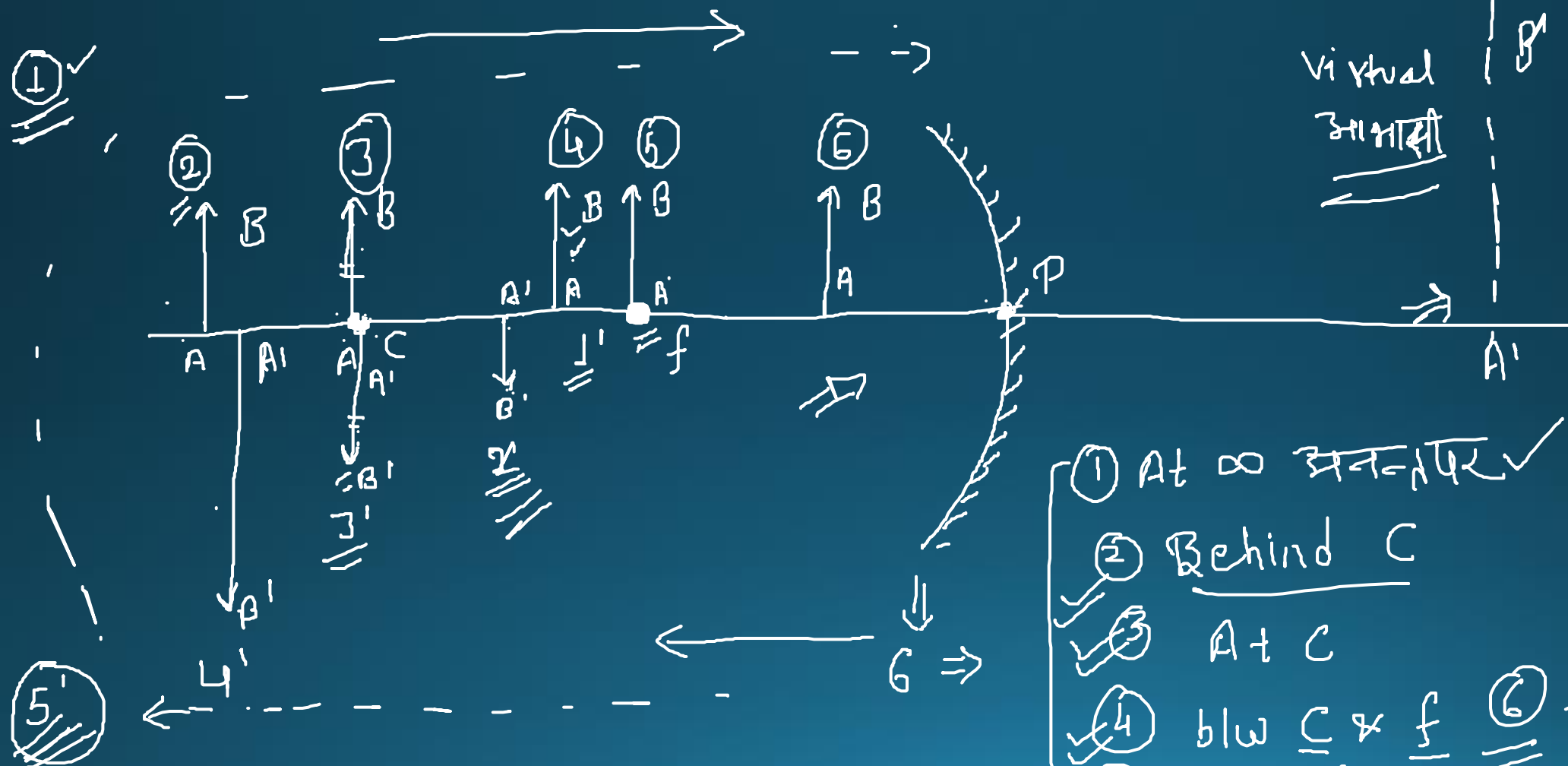


# Sign Conventions




# Image formation by mirror:-

## (i) Concave mirror:- ✓




- ① At  $\infty$  अनन्त पर ✓
- ② Behind C
- ③ At C
- ④ b/w C & f
- ⑤ At f
- ⑥ b/w f & P

# Image Formation



Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At focus, F	Highly diminished and pointed in size	Inverted and Real
Beyond C	Between F and C	Diminished	Inverted and Real
At C	At C	Same size	Inverted and Real
Between C and F	Beyond C	Enlarged	Inverted and Real
At F	At infinity	Highly enlarged	Inverted and Real
Between F and P	Behind the mirror	Enlarged	Erect and virtual



# • Uses of Concave Mirrors

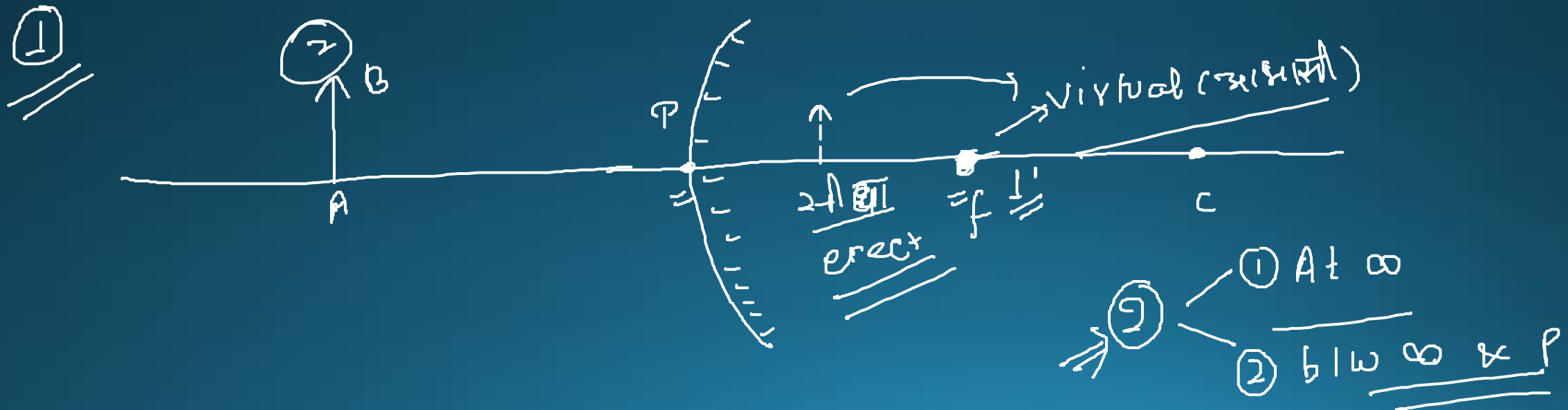


- Torches, search-lights and vehicles headlights use concave mirrors to get powerful parallel beams of light.
- Shaving mirrors used are usually concave mirrors to get a magnified image of the face.
- To see large images of the teeth of patient's, dentists use concave mirrors.
- Concave mirrors are also used in reflecting telescopes.
- Concave mirrors are used to form optical cavities, which are important in the construction of laser.
- For concentrating sunlight to produce heat in solar furnaces large concave mirrors are used.
- Concave mirrors are used as the mirror landing aid system of modern aircraft carriers.

# Image Formation By Convex Mirror

उत्तल  
दर्पण

- When an object is placed at infinity, a virtual image is formed at the focus. The size of the image is much smaller than compared to that of the object.
- When an object is placed at a finite distance from the mirror, a virtual image is formed between the pole and the focus of the convex mirror.






S. No	Position Of Object	Position of Image	Size of Image	Nature of Image
1	At Infinity	At the focus F, behind the mirror	Highly diminished	Virtual and Erect
2	Between Infinity and the Pole	Between P and F, behind the mirror	Diminished	Virtual and Erect



# Uses of Concave Mirrors

- Inside buildings
  - Vehicle mirrors
  - Magnifying glass
  - Security purposes
- 

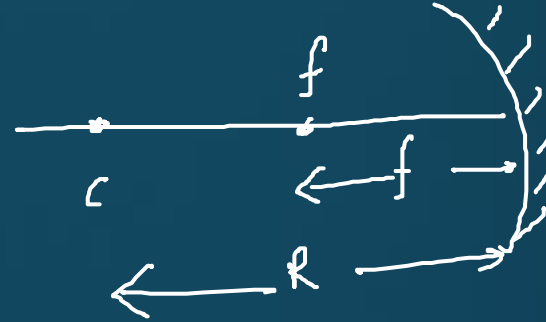
## उत्तल दर्पण का उपयोग :

- (i) उत्तल दर्पणों का उपयोग सामान्यतः वाहनों के पश्च.दृश्य (wing) दर्पणों के रूप में किया जाता है।
- (ii) ये दर्पण वाहन के पार्श्व (side) में लगे होते हैं तथा इनमें ड्राइवर अपने पीछे के वाहनों को देख सकते हैं जिससे वे सुरक्षित रूप से वाहन चला सके।
- (iii) इसका उपयोग टेलिस्कोप में भी होता है ।
- (iv) उत्तल दर्पण का उपयोग स्ट्रीट लाइट रिफ्लेक्टर के रूप में भी किया जाता है क्योंकि यह एक बड़े क्षेत्र पर प्रकाश प्रसार करने में सक्षम हैं ।



# • Relation Between Radius of Curvature and Focal Length

$$\underline{\underline{R = 2f}}$$



$$\Rightarrow \boxed{R = 2f}$$

# • Mirror Equation



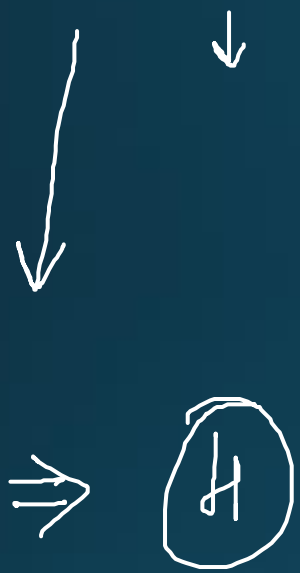
$$\Rightarrow \underline{\underline{\frac{1}{f} = \frac{1}{v} + \frac{1}{u}}}$$

दूरता में प्रतिबिम्ब की दूरी

वस्तु की दूरी

$u \rightarrow$  Distance of object from mirror

- **Linear Magnification (m)**: Linear magnification (m) is the ratio of the height of the image (h') to the height of the object (h).



$$\Rightarrow \underline{\underline{m}} = \frac{h'}{h} = -\frac{v}{u}$$

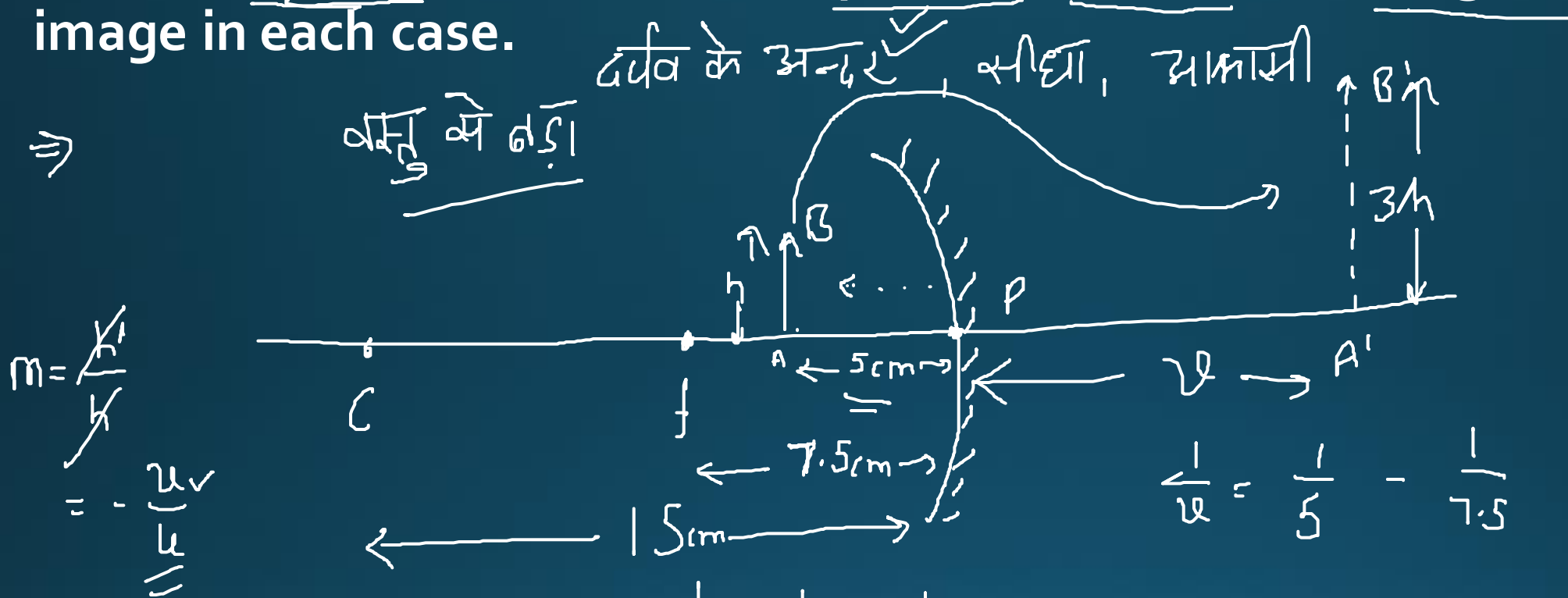
unitless  
अदिम र्माण

$$\underline{\underline{h'}}$$

$$\Rightarrow \underline{\underline{m}} = \frac{h'}{h} = \frac{\text{height of image}}{\text{height of object}} = \underline{\underline{-\frac{v}{u}}}$$

$\Rightarrow \underline{\underline{m}} \Rightarrow \underline{\underline{\text{Plane mirror}}} \Rightarrow \underline{\underline{m}} = \frac{h'}{h} = \frac{K}{K} = \underline{\underline{1}}$

- 1. An object is found to be 5cm in front of a concave mirror of radius of curvature 15 cm. Determine the position, nature, and magnification of the image in each case.



$$\frac{1}{v} = \frac{1}{5} - \frac{1}{7.5}$$

$$= \frac{1}{5} - \frac{2}{15}$$

$$= \frac{3-2}{15} = \frac{1}{15}$$

$$v = 15 \text{ cm} \Rightarrow m = +\frac{15}{5} = +3$$

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

$$\frac{1}{-7.5} = \frac{1}{u} + \frac{1}{(-15)}$$

$$\Rightarrow \begin{cases} f = 7.5 \text{ cm} \\ u = 5 \text{ cm} \\ v = ? \end{cases}$$

• What is the relation between focal length (f) and radius of curvature (r) of a curve mirror?

• A:  $f = 2r$

B:  $f = r/2$  ✓

C:  $f = r/3$  ✗

D:  $f = 3r/2$

$$R = 2f$$

$$f = \frac{R}{2}$$

• What is the focal length of a curve mirror is it has a radius of curvature is 40 cm.

- ✓ A: 20 cm
- ✓ B: 35 cm
- C: 25 cm
- D: 40 cm

$$R = 40 \text{ cm}$$

$$f = ?$$

$$f = \frac{R}{2}$$

$$= \frac{40}{2}$$

$$= 20$$

• Which type of mirror used in the headlight of a motorcycle?

- A: Concave mirror
- B: Convex mirror
- C: Flat mirror
- D: none of the above



- **Which type of mirror used in the dental clinic?**
- A: Concave mirror  
B: Convex mirror  
C: Flat mirror  
D: None of the above

- In case of refraction, if the angle of incidence and the angle of refraction are 45 degrees and 30 degrees respectively, then the angle of deviation is
- A:  $75^\circ$   
B:  $15^\circ$   
C:  $7.5^\circ$   
D:  $37.5^\circ$

- If a refractive index of a medium is  $\mu$ , and the velocity of a light in free space is  $c$ , then the velocity of light of that medium is
- A:  $\mu c$   
B:  $(c/\mu)^{1/2}$   
C:  $(\mu c)^{1/2}$   
D:  $c/\mu$

- **When the light is passing from rarer to a denser medium, which is the correct statement?**
- A: Incident angle is equal to refracted angle
- B: Incident angle is greater than refracted angle
- C: Incident angle is less than refracted angle
- D: Can not be determined

- **Which physical quantity is remain constant in case refraction?**
- A: Wavelength of light  
B: Frequency of light  
D: Amplitude  
E: All of the above

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