

Light $\begin{cases} \text{Ray optics (✓)} \\ \text{Wave optics (x)} \end{cases}$



RAY OPTICS

किरण प्रकाशिकी

BY - SALIL BAJPAI SIR

LIGHT (प्रकाश)

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

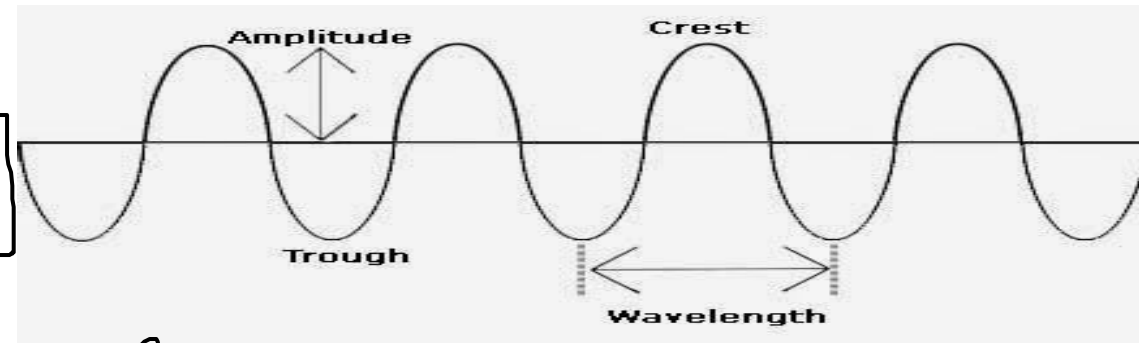
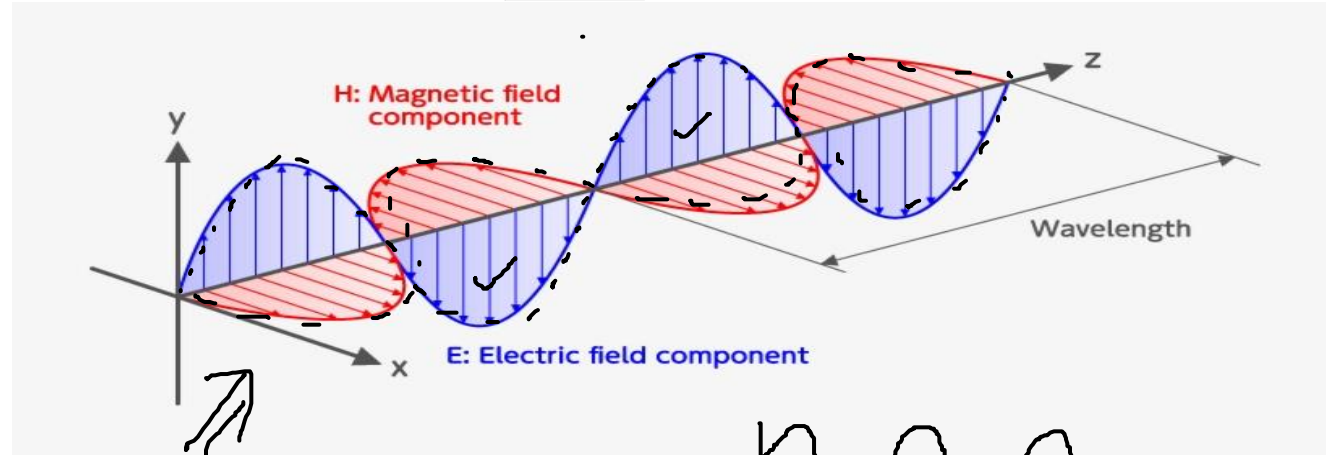
- Light is a Transverse wave. ✓

- Light shows wave-particle duality.

- Light not need any medium to travel. (vacuum) ✓

- Fundamental particle in light is – [PHOTONS.]
फोटॉन

- Speed of light is $3 \times 10^8 \text{ ms}^{-1}$ (vacuum $\rightarrow S = 3 \times 10^8 \text{ m/s}$)

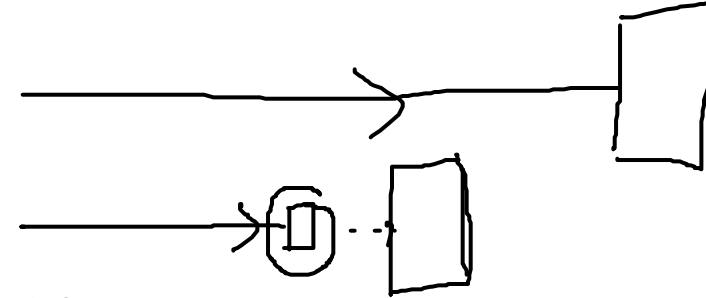


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- प्रकाश एक विद्युत चुम्बकीय विकिरण है जिसे मानव आँख द्वारा पता लगाया जा सकता है।
- प्रकाश एक अनुप्रस्थ तरंग है।
- प्रकाश तरंग-कण द्वंद्व को दर्शाता है।
- यात्रा के लिए प्रकाश को किसी माध्यम की आवश्यकता नहीं है।
- प्रकाश में मौलिक कण है - फोटोन्स।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

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

- Light travels through vacuum.



- Transverse nature of light explained by – POLARIZATION. (ध्रुवता)

- Visible Spectrum have range – 400nm to 750nm. ($1\text{nm} = 10^{-9}\text{m}$)

- Shadow created due to rectilinear propagation of light.

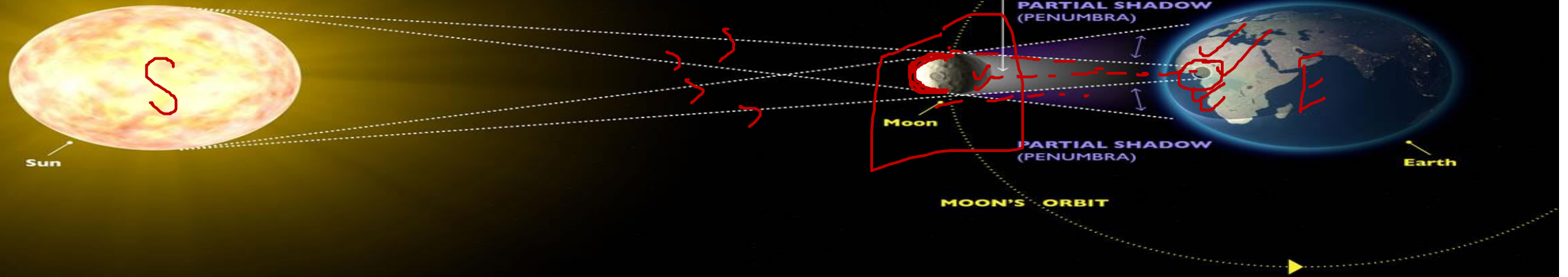
- Eclipse also occurred due to rectilinear propagation of light. ✓

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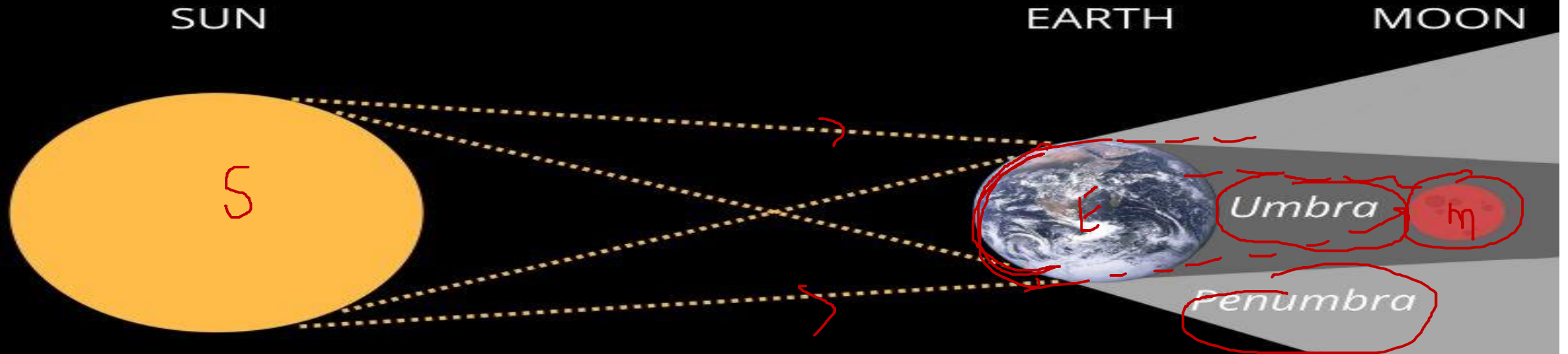
- प्रकाश की तरंग प्रकृति बताती है – व्यतिकरण , विवर्तन घटना।
- प्रकाश एक निर्वात के माध्यम से यात्रा करता है।
- प्रकाश की अनुप्रस्थ प्रकृति समझाया गया है – ध्रुवीकरण द्वारा ।
- दर्शनीय स्पेक्ट्रम की एक सीमा होती है - 400nm से 750nm।
- प्रकाश के सुव्यवस्थित प्रसार के कारण निर्मित छाया।
- प्रकाश के प्रत्यावर्ती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

SOLAR ECLIPSE

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

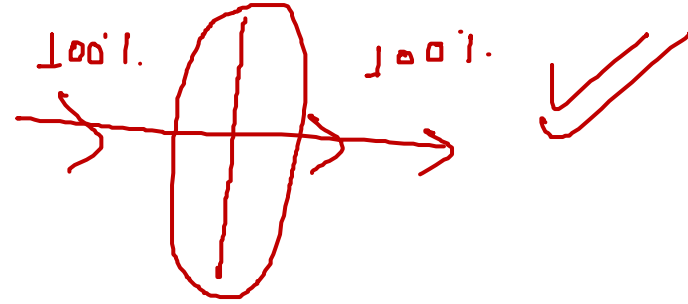


whenisthenexteclipse.com

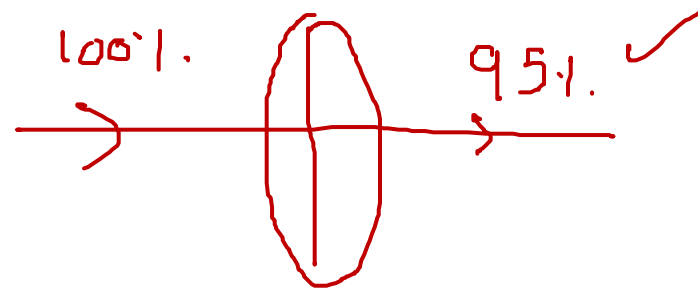


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- **Transparent medium:-** It is a medium through which light can be propagated easily.(e.g., sun, candle, electric arc)



- **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

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- 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 (प्रतिबिम्ब)

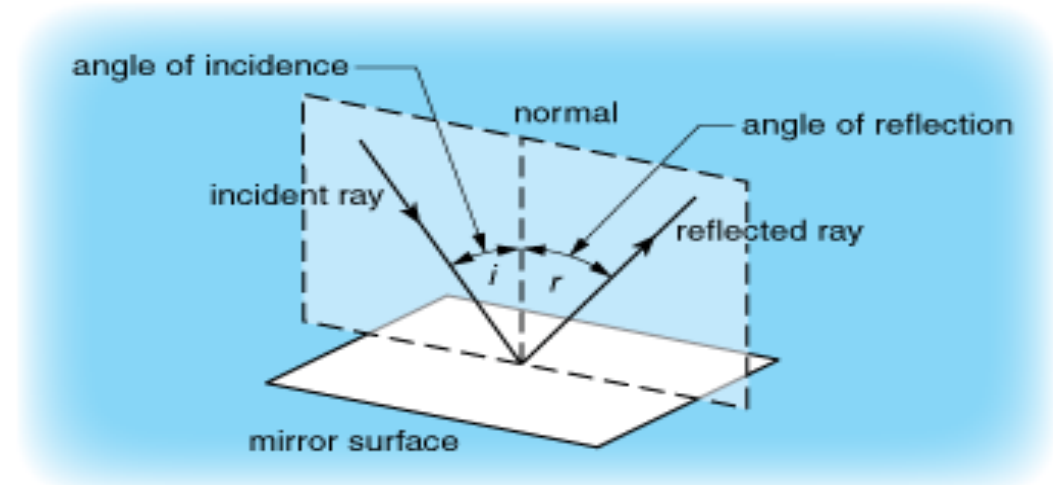
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- When a ray of light approaches a smooth polished surface and the light ray bounces back, it is called the **REFLECTION** of light. ✓

- Laws of Reflection:

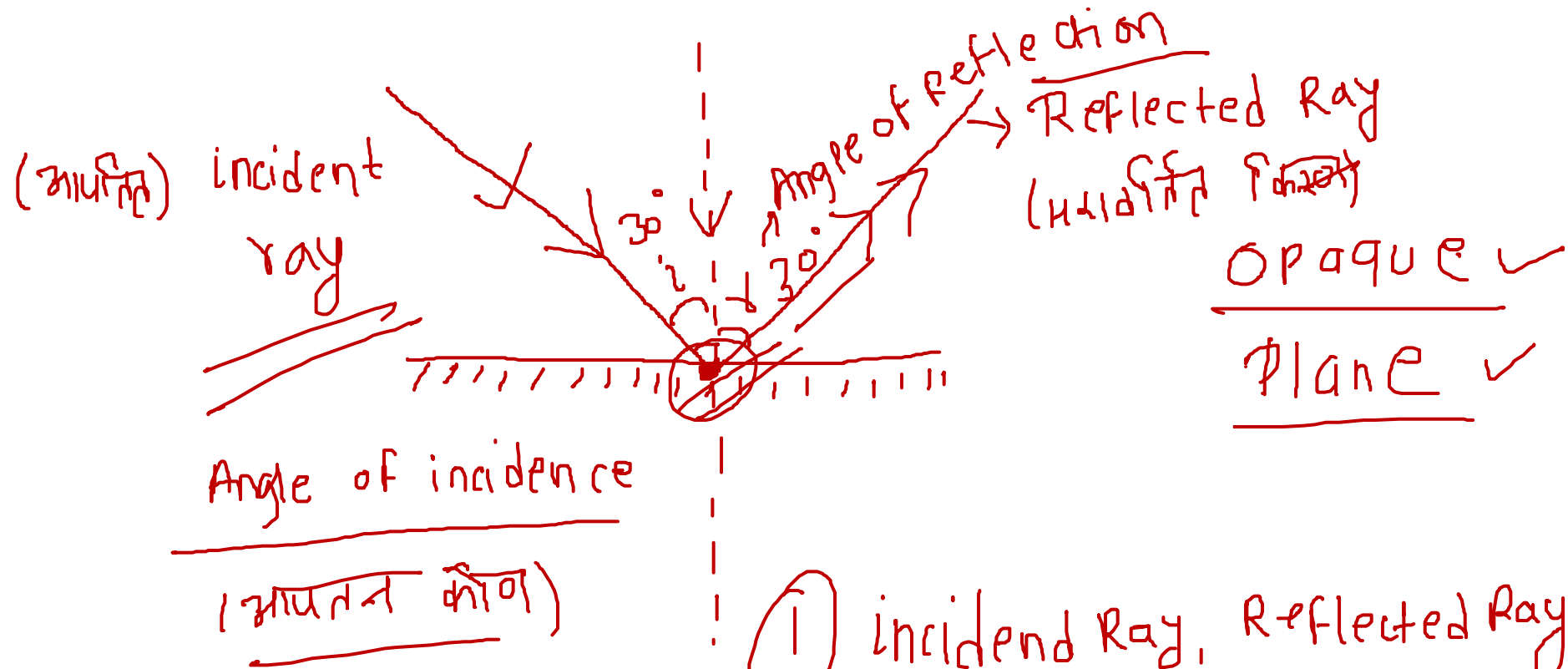
- The incident ray, the reflected ray and the normal all lie in the same plane. ✓

- The angle of incidence = Angle of reflection. ✓



• 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।

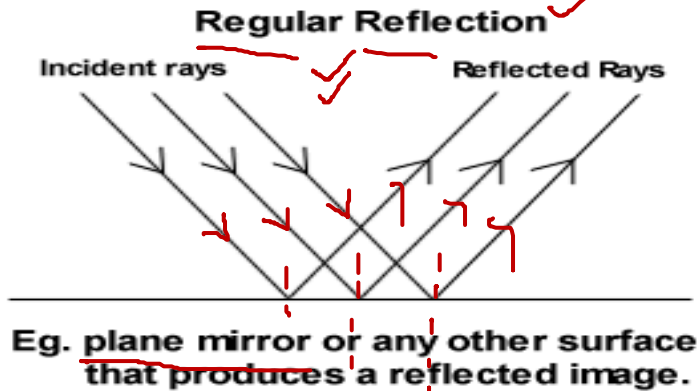


① Incident Ray, Reflected Ray & Normal lies on same plane.

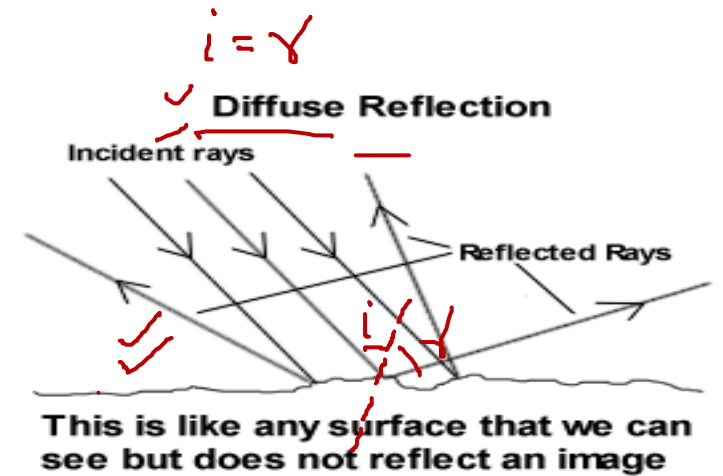
② $\angle i = \angle r$

Types of Reflection of Light:

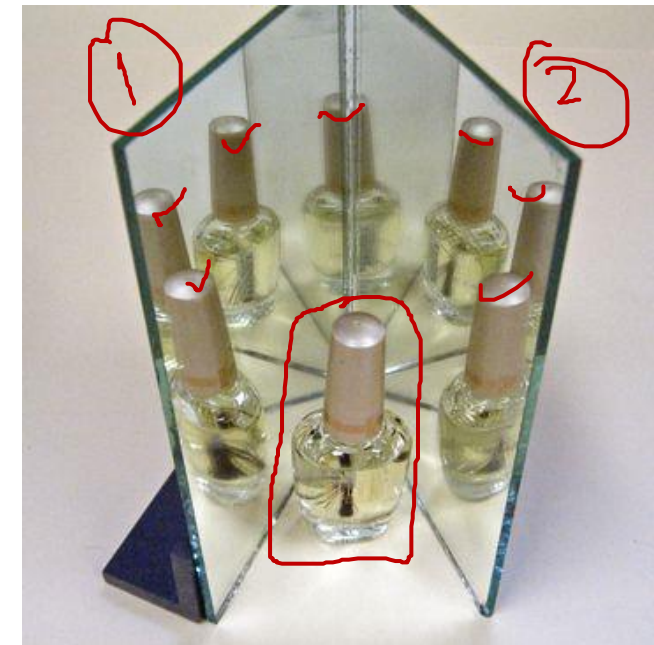
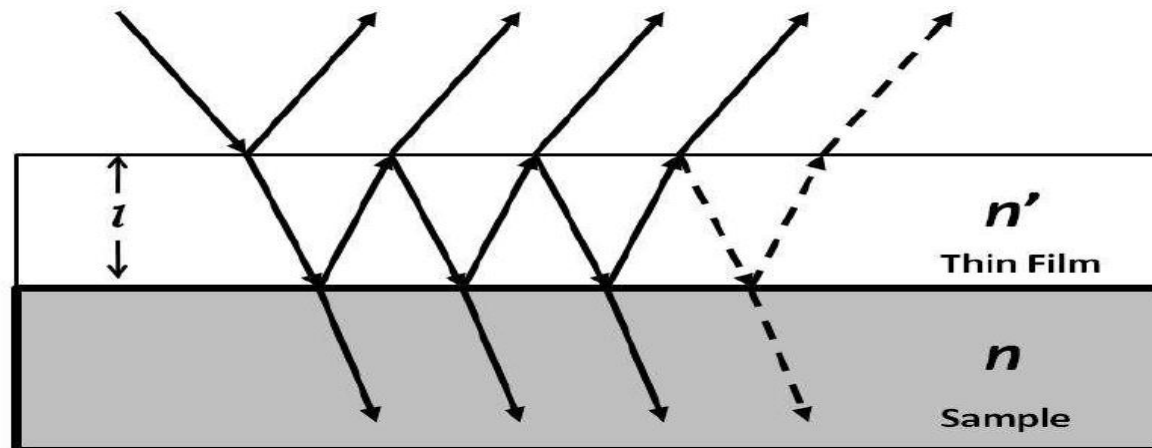
- Regular/ Specular Reflection:



- Diffused Reflection:



- Multiple Reflection



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

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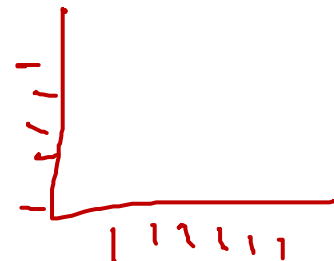
$$n = \frac{360}{\text{angle b/w mirrors}} - 1$$

c.g.:

60°



$$n = \frac{360}{60} - 1 = 5$$

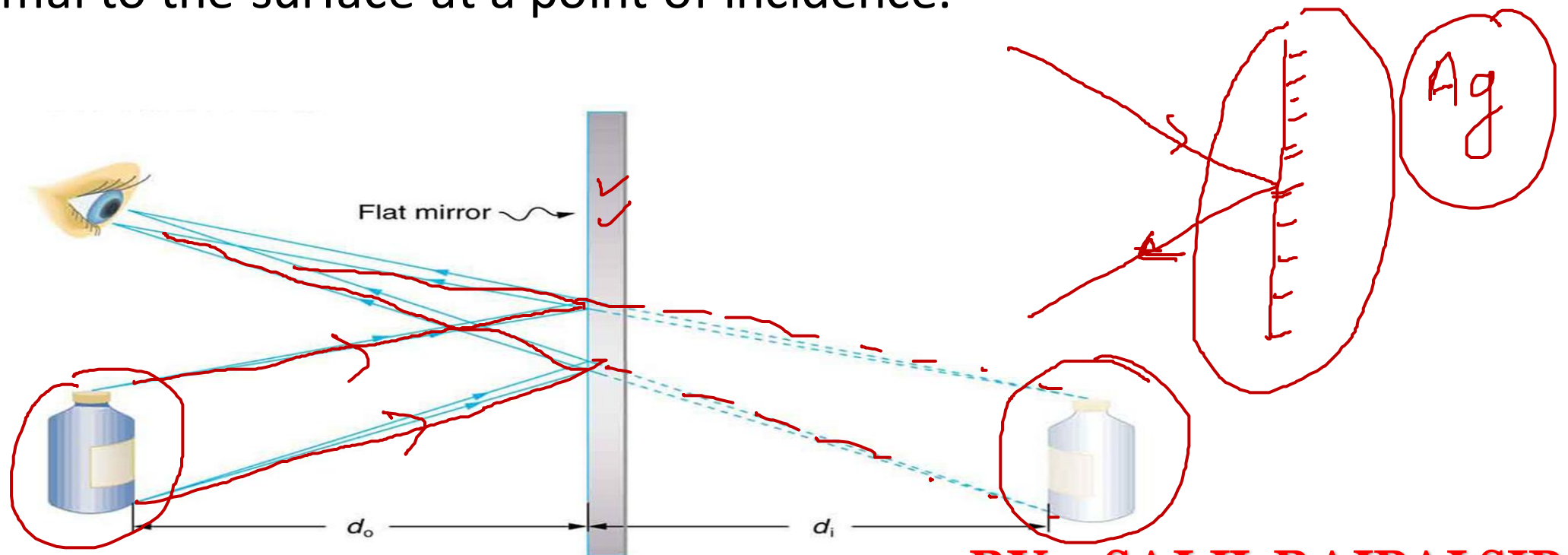


$$\frac{360}{120} - 1 = 2$$

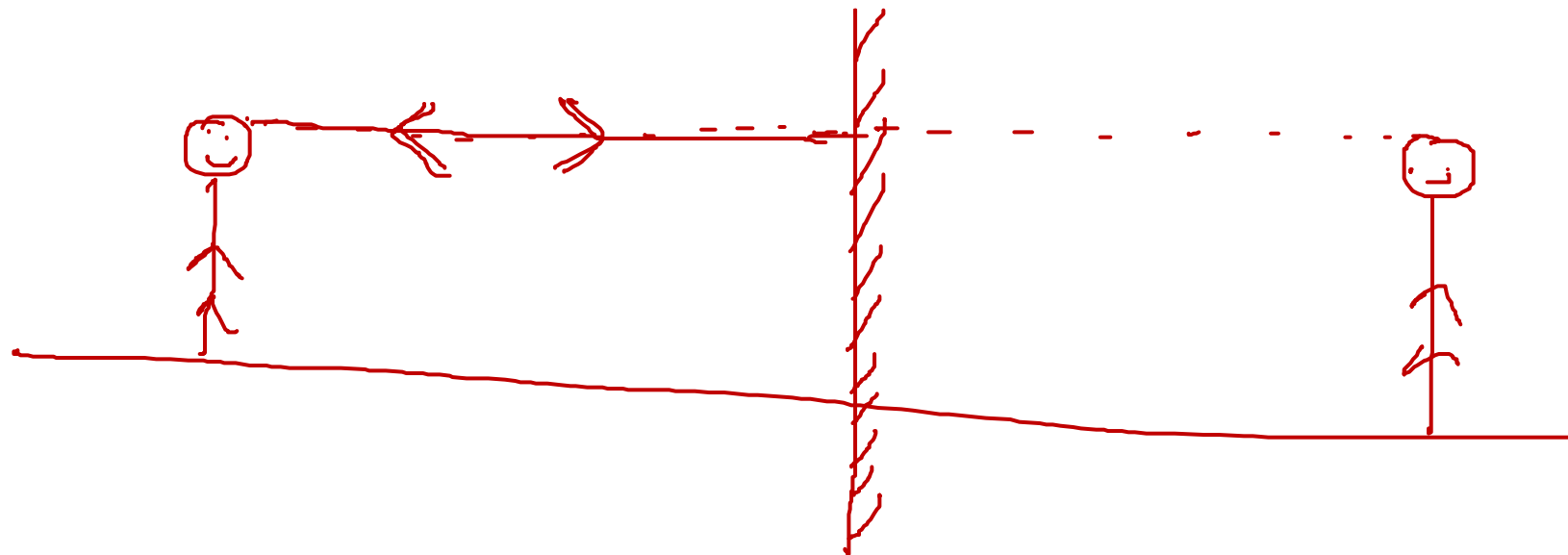
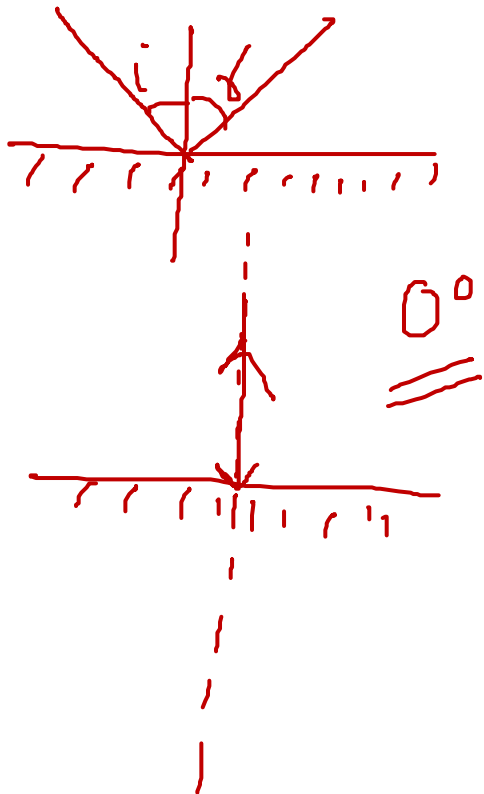
0°

MIRROR

- 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.



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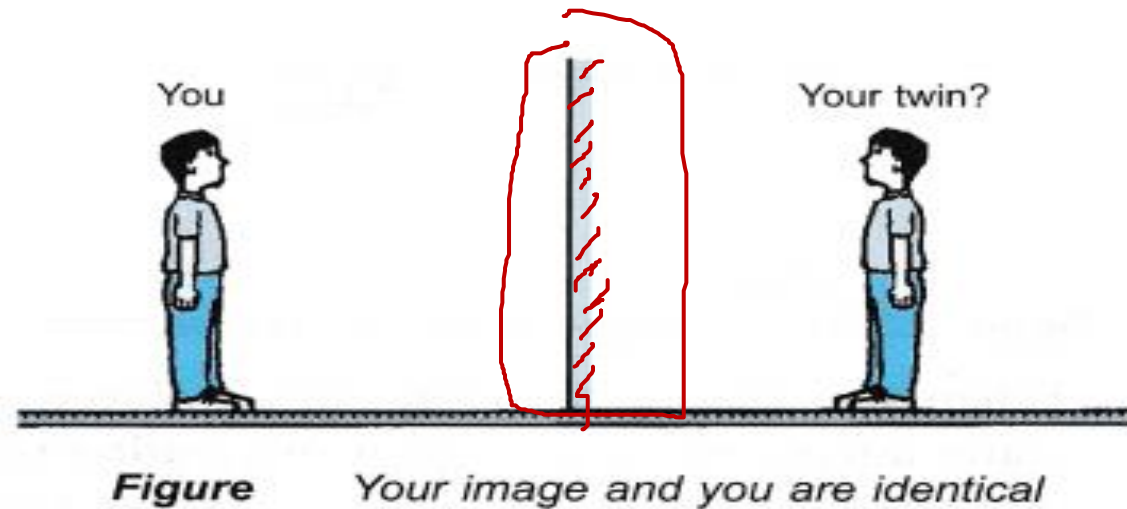


• Types Of Mirror (समतल दर्पण)

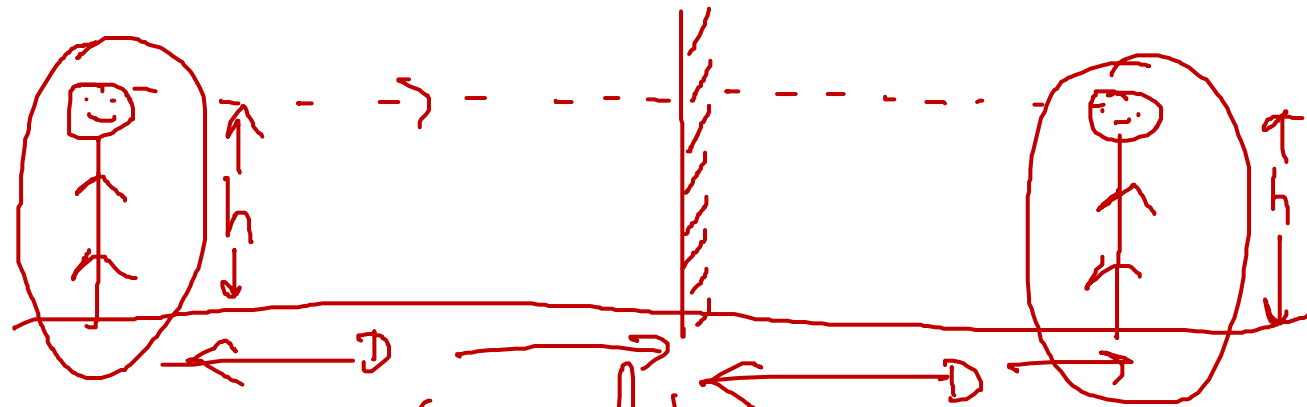
- Plane mirror: The images formed from a plane mirror are the reflected images in their normal proportions but reversed from left to right. These are the most widely used mirrors.

• Characteristics of the image formed by a plane mirror :

- It is virtual ✓
- It is erect and of the same size as the object.
- The distance of the object from the plane mirror is the same as the distance of the image from the plane mirror.
- the image is that it is laterally inverted.



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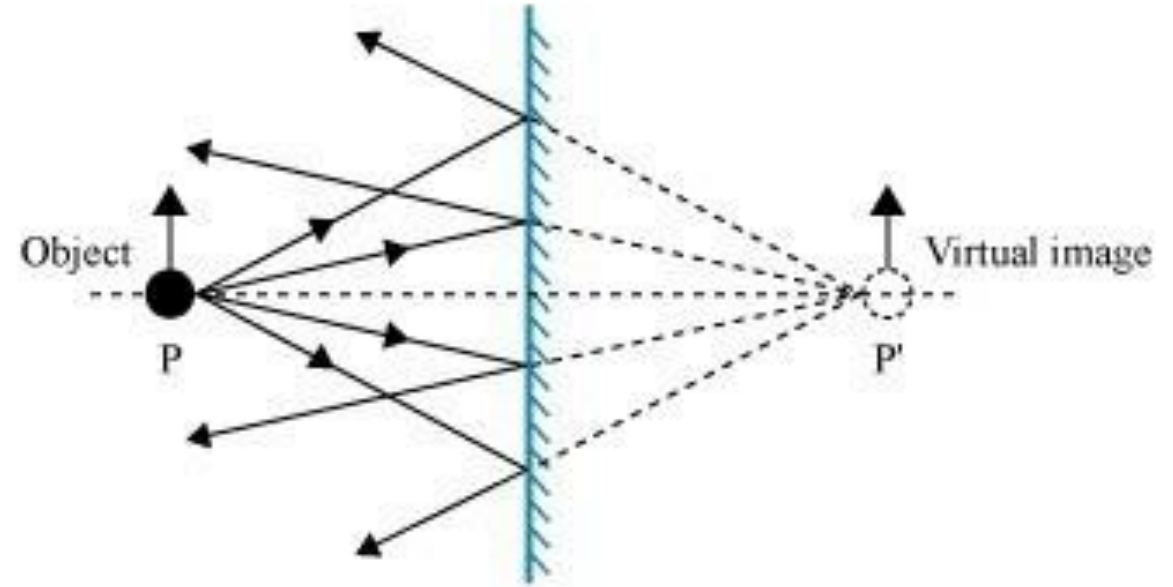


- ① Virtual Image (आभासी)
- ② Effect \rightarrow Same Size (समान आकार)
- ③ Same Distance of obj from mirror.
- ④ Lat. inverted:- $RHS \rightarrow LHS \times$
 $LHS \rightarrow RHS$

Plane
mirror

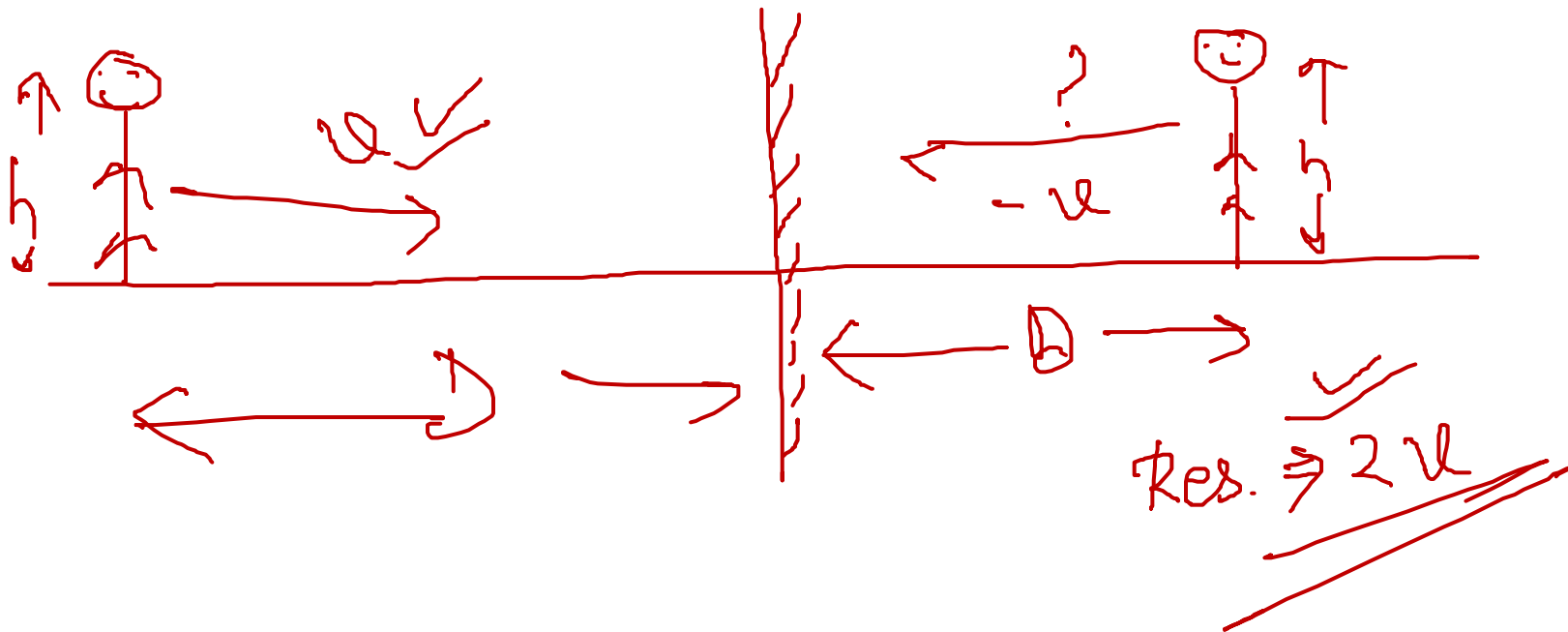
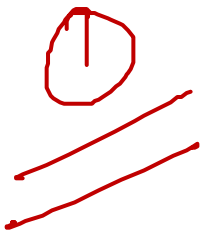
• Properties of an image formed by plane mirror

- The image obtained is virtual.
- The image is laterally inverted.
- The image is erect.

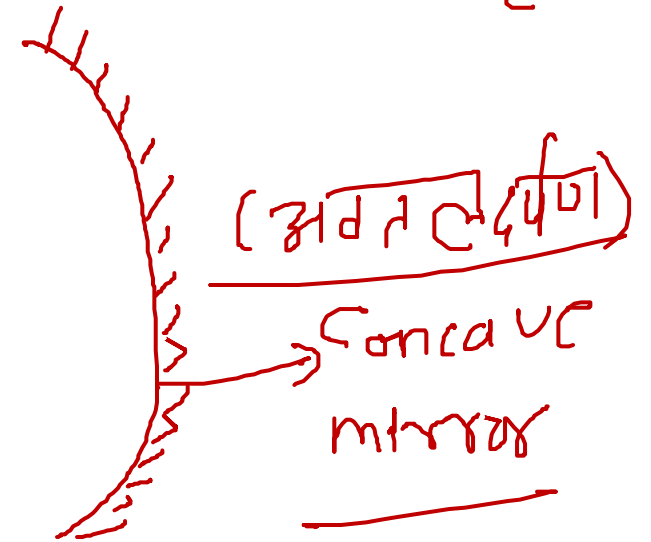
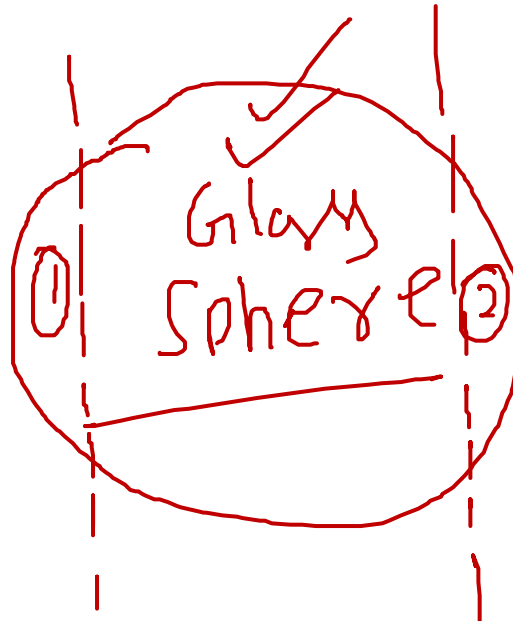
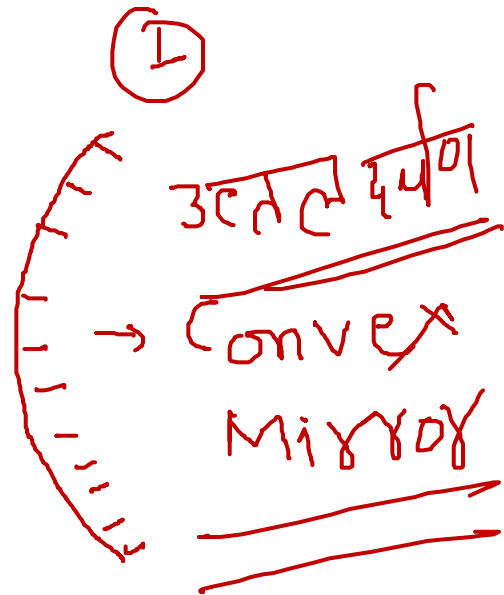
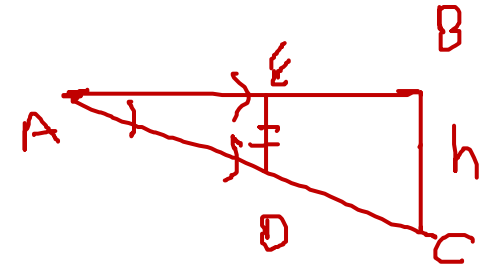
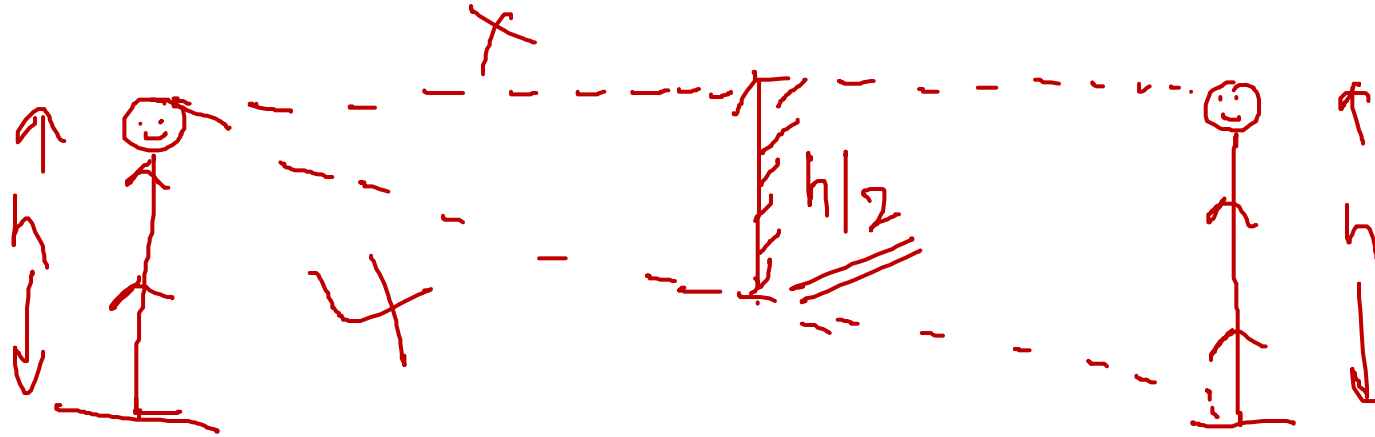


- The size of the image is the same as the size of the object.
- The distance between the image obtained ~~is~~ the same as the distance between the object from the mirror.

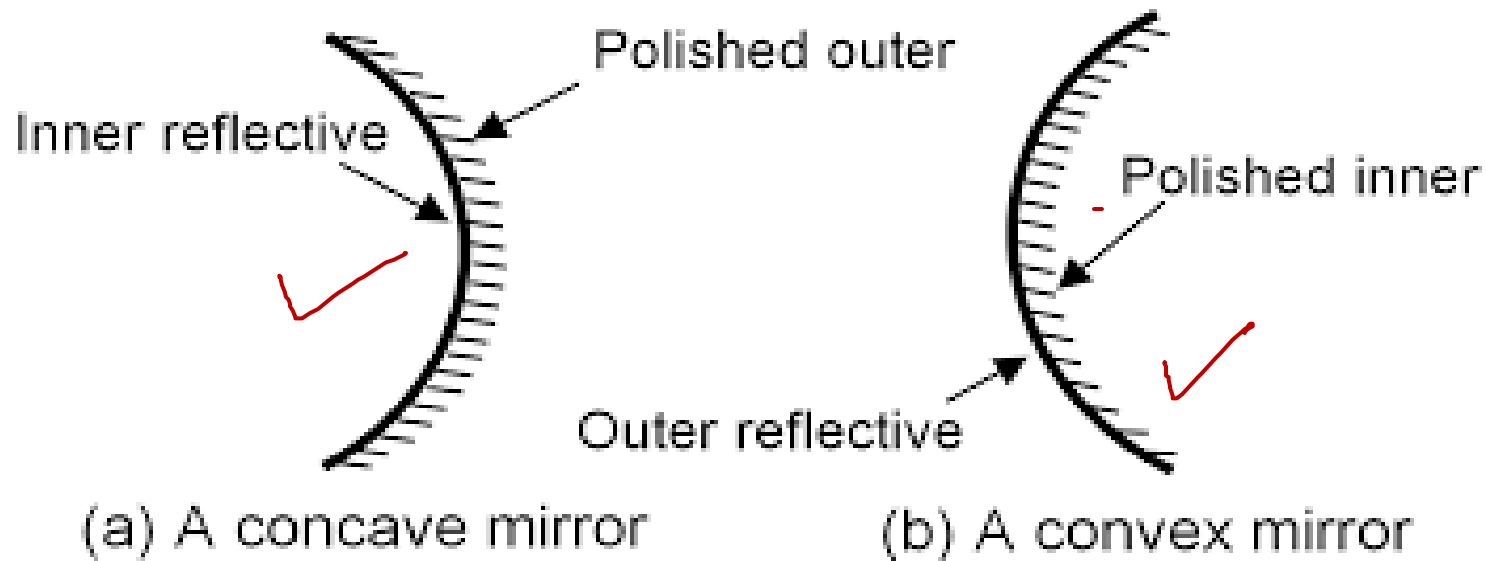
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2

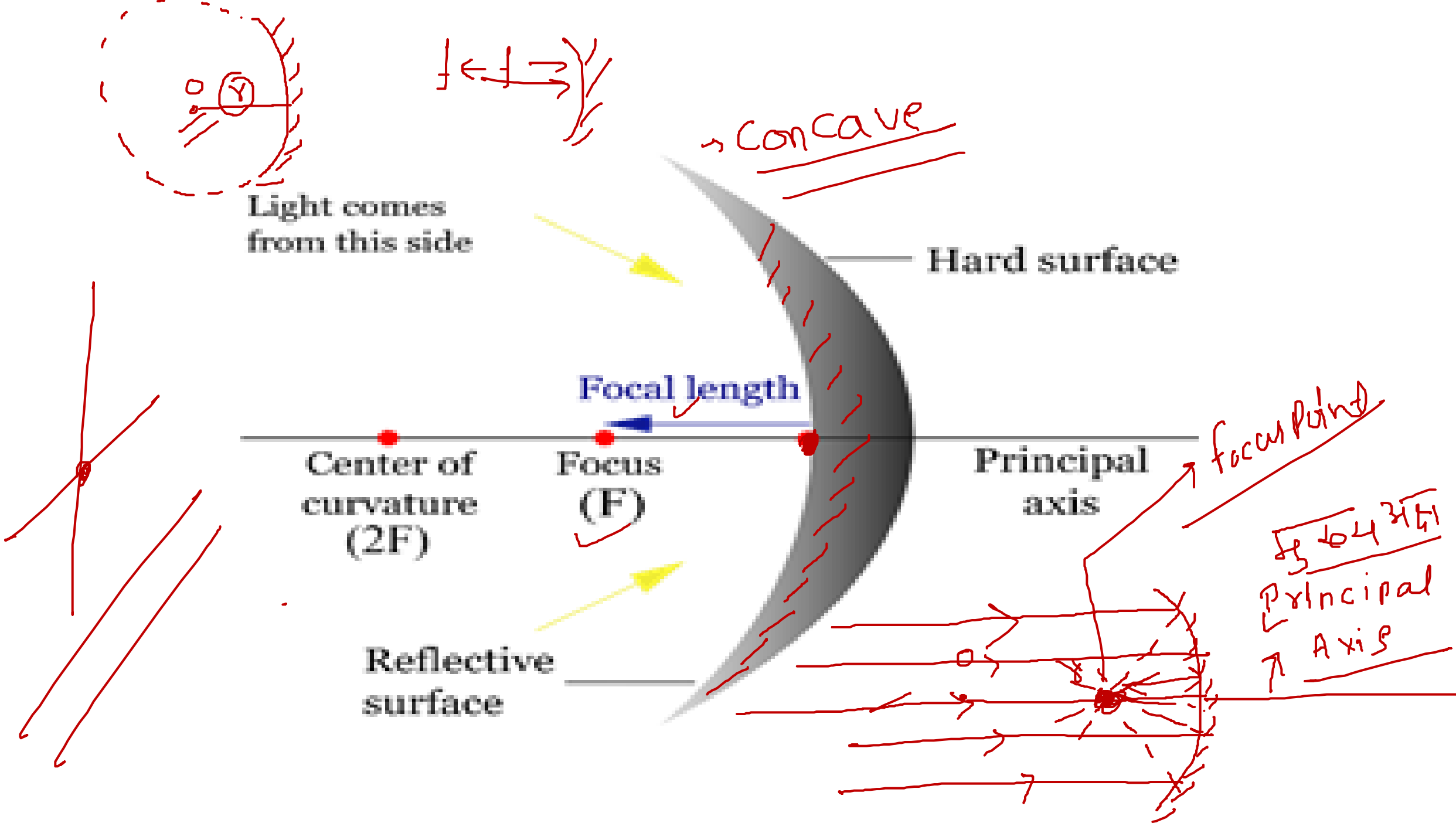


- **Concave mirrors:** ✓ These are the spherical mirror that is curved inward and the image obtained from these mirrors depend on the placement of the object.
- **Convex mirror:** These are the spherical mirror that is curved outward and the image obtained is virtual, diminished and erect for a real object.

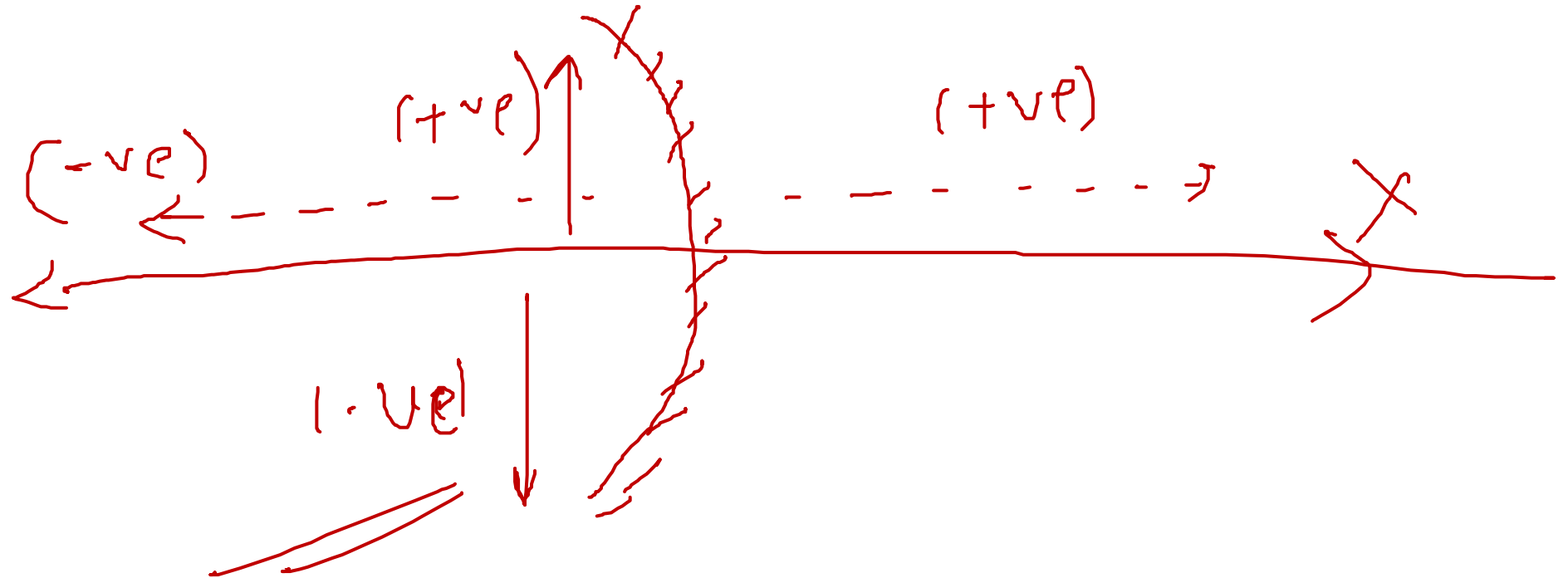
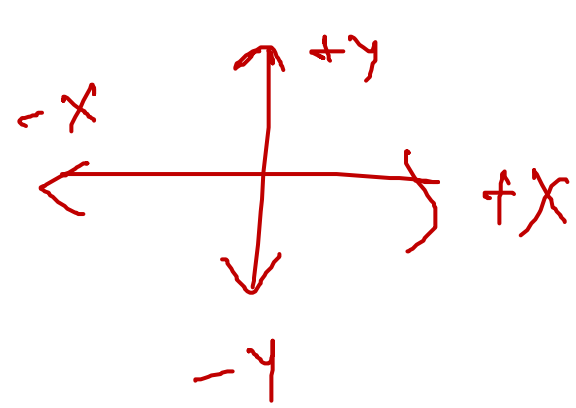


• Important Terms

- **Pole:** it is the centre of the reflecting surface of a spherical mirror. It lies on the surface of the mirror and it is usually denoted by P.
- **Centre of curvature:** the centre of the sphere formed by the reflecting part of a spherical mirror is called centre of curvature. It is generally denoted by C. **The**
- **radius of curvature:** it is the radius of the sphere formed by the reflecting part of the sphere. It is represented by R.
- **Principal axis:** it is the straight line passing through the pole and centre of curvature of the spherical mirror. This is normal to the mirror at its pole.
- **Principal focus:** the incident rays coming parallel to the principal axis after reflection appear to converge to a common point on the principal axis, this point is called the principal focus of a concave mirror. It is usually denoted by F.
- **Focal length:** it is the distance between the pole and principal focus of the concave mirror. It is denoted by f.

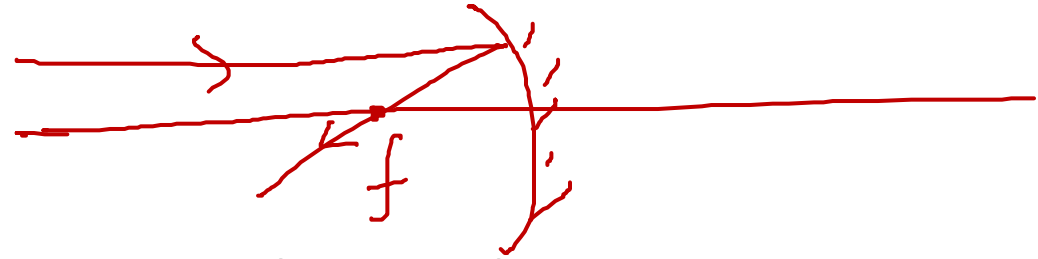


Sign Conventions

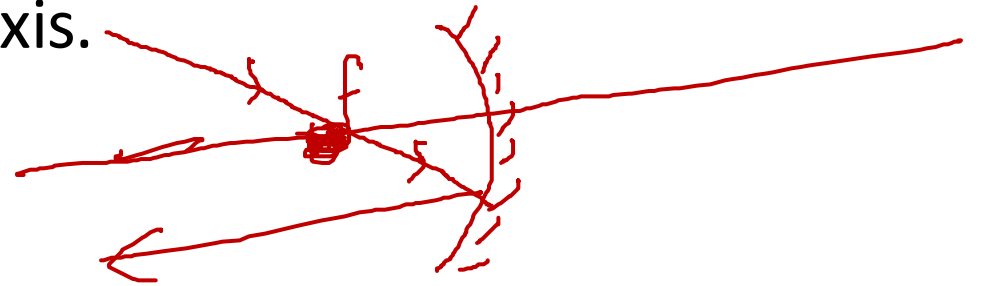


Concave Mirror Ray Diagrams

- a) A ray parallel to the principal axis, after reflection, will pass through the principal focus of a concave mirror.

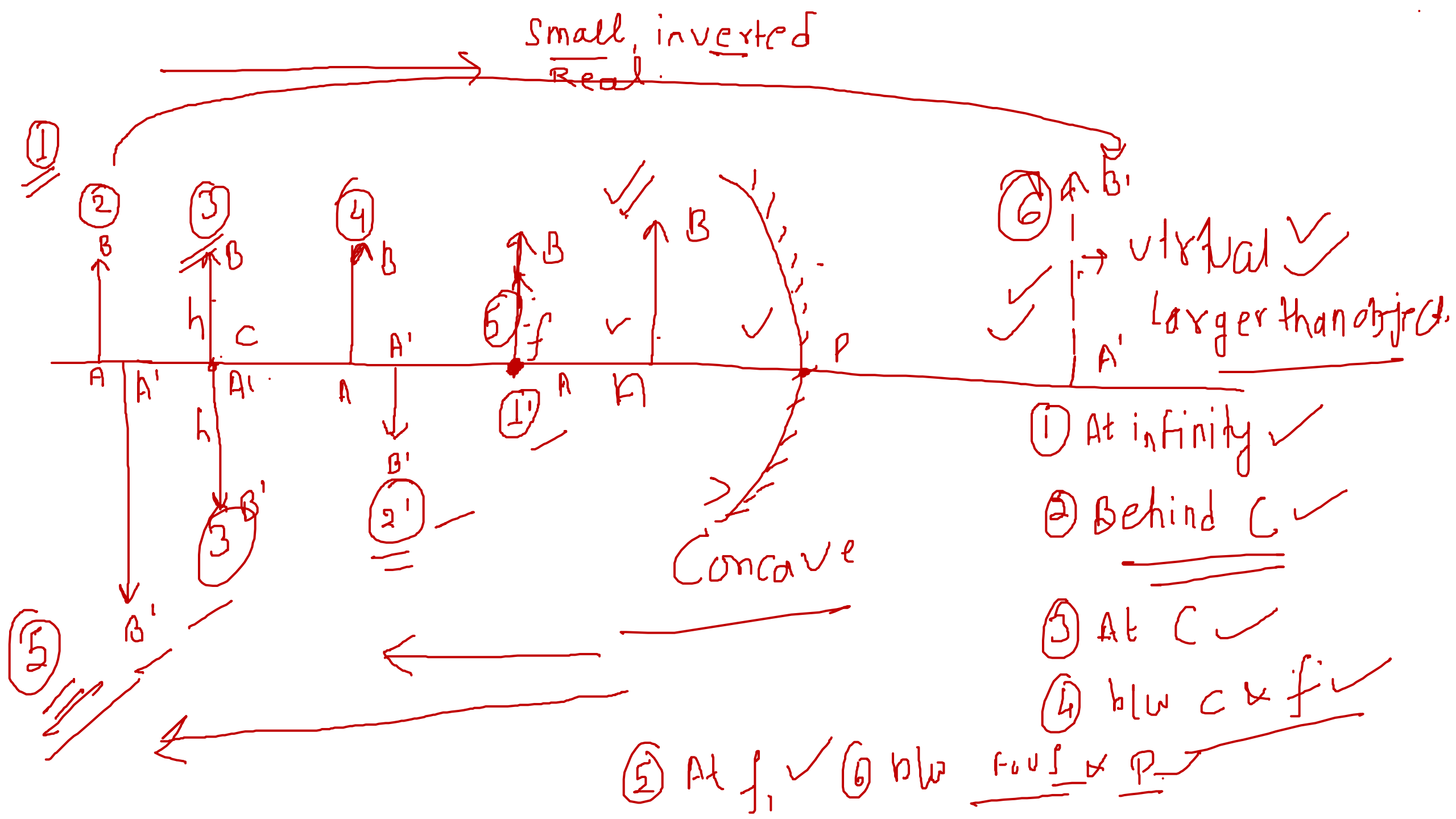


- b) A ray which is passing through the principal focus of a concave mirror, after reflection, will emerge parallel to the principal axis.



- c) A ray passing through the center of curvature of a concave mirror, after reflection, is reflected along the same path. The light rays come back along the same path because the incident rays fall on the mirror along the normal to the reflecting surface.





Small, inverted
Real

virtual
larger than object

Concave

① At infinity ✓

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

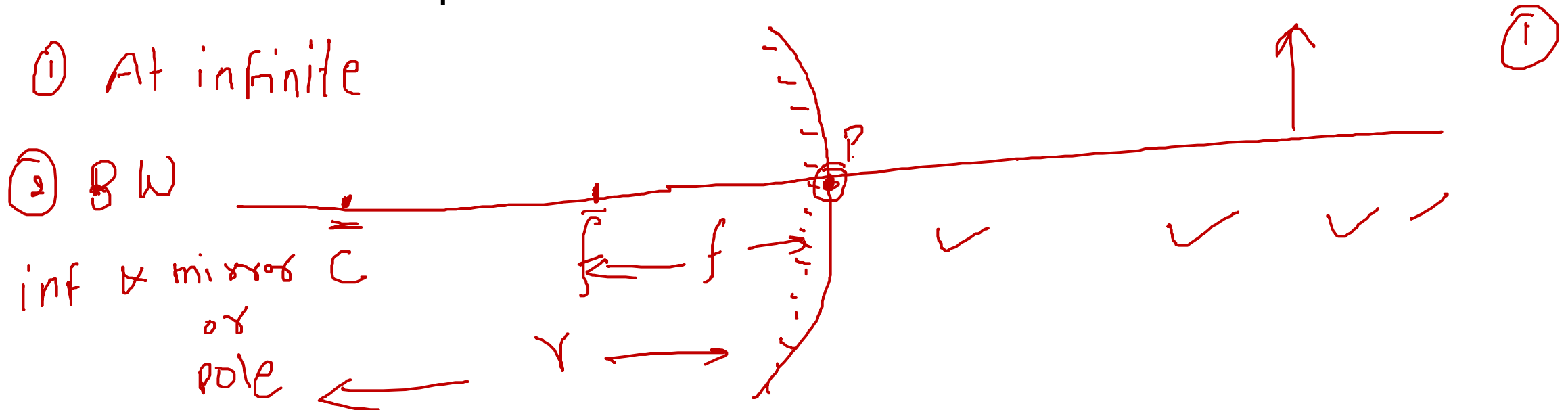
- Torches, search-lights and vehicles headlights use concave mirrors to get powerful parallel beams of light.
- ✓• Shaving mirrors used are usually concave mirrors to get a magnified image of the face.
- ✓• To see large images of the teeth of patient's, dentists use concave mirrors.
- Concave mirrors 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.

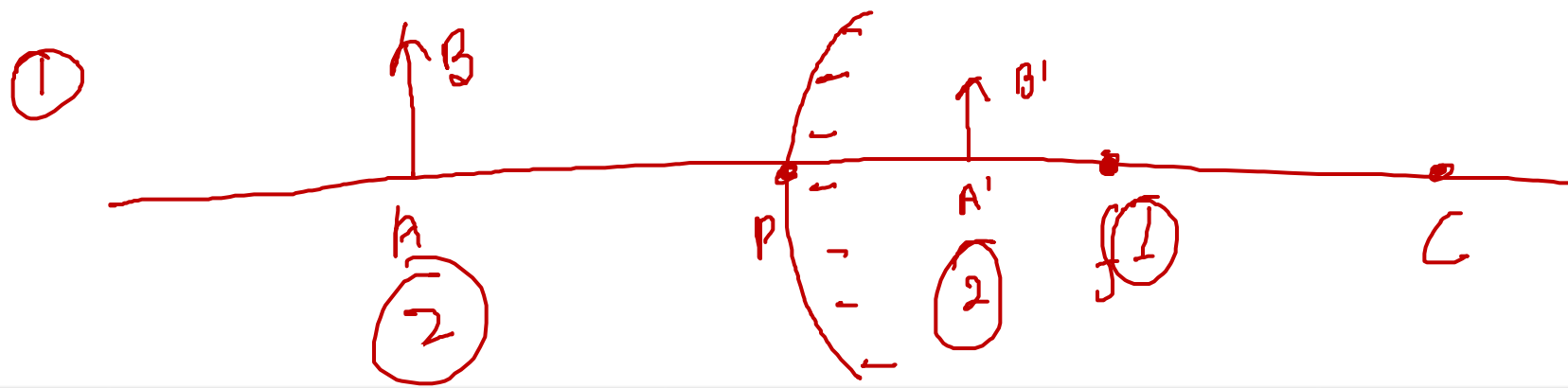
Image Formation By Convex Mirror

- 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

① Virtual (आभासी)

Uses of Concave Mirrors

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



• Relation Between Radius of Curvature and Focal Length

$$R = 50\text{cm}$$

$$f = 25\text{cm}$$

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

• Mirror Equation

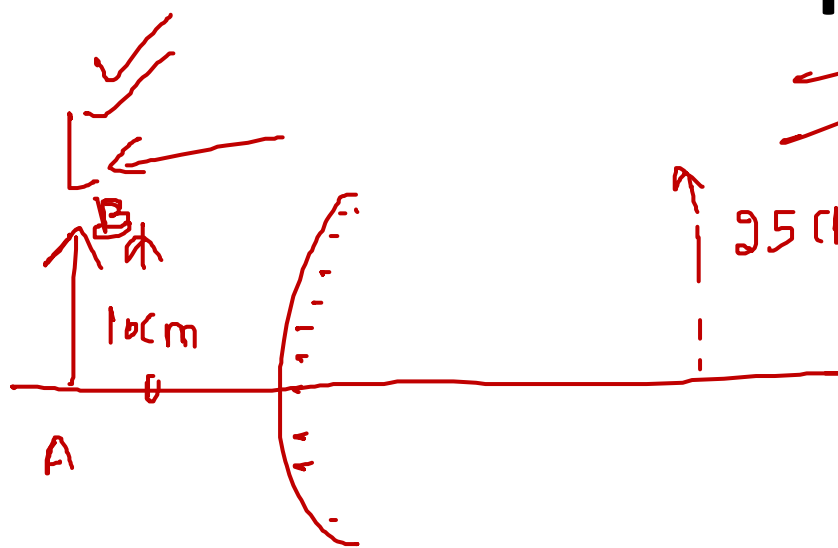
$$\boxed{\frac{1}{f} = \frac{1}{v} + \frac{1}{u}}$$

distance of Object from mirror.

Focal Length

Dist of image from mirror.

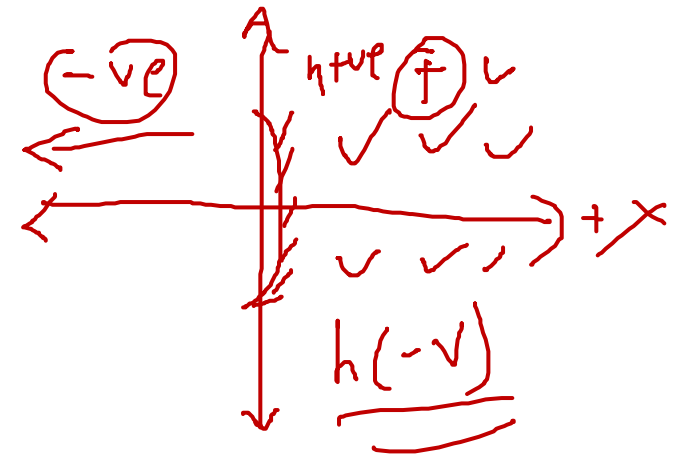
- **Linear Magnification (m)**: Linear magnification (m) is the ratio of the height of the image (h') to the height of the object (h).



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

h' → height of image
 h ↓ height of object

$\Rightarrow m = 2.5$



- 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.

$$\frac{1}{1.5} + \frac{1}{5} = \frac{1}{u} \quad \frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{f} - \frac{1}{u} = \frac{1}{v}$$

