ACTIVITY

AIM

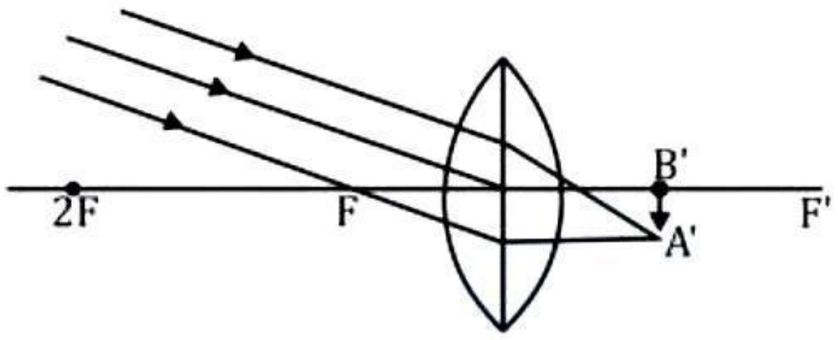
To study the nature and size of an image formed by a convex lens on a screen by using a candle and screen.

MATERIAL REQUIRED

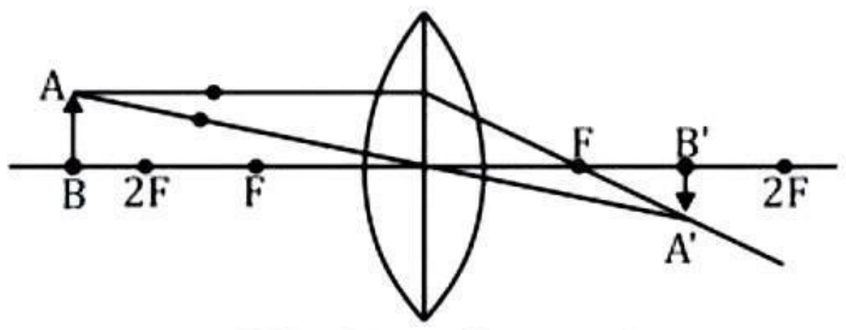
Optical bench with its three uprights, a convex lens, 3 uprights, lens holder, candles, matchbox, cardboard screen pasted with a centimeter graph paper.

THEORY

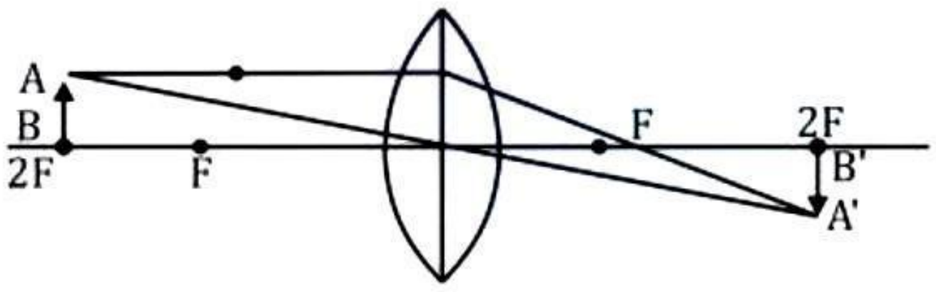
Ray diagrams for image formation for various positions of the object



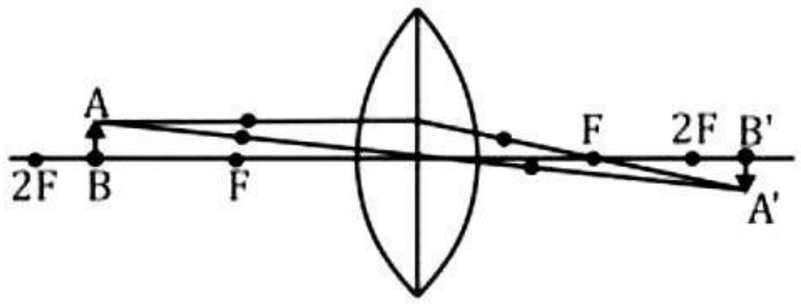
(a) object at infinity



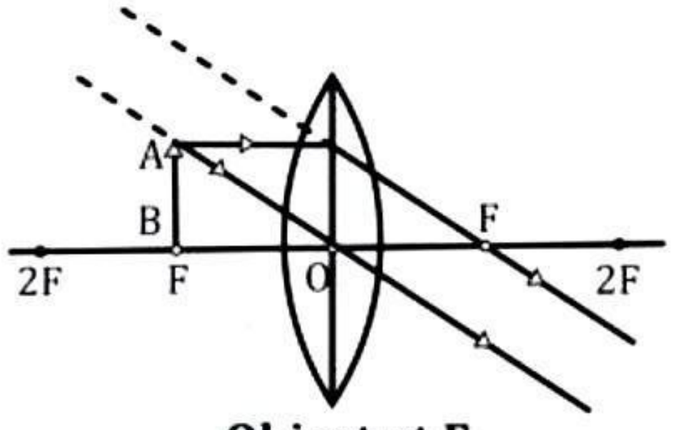
(b) object beyond 2F



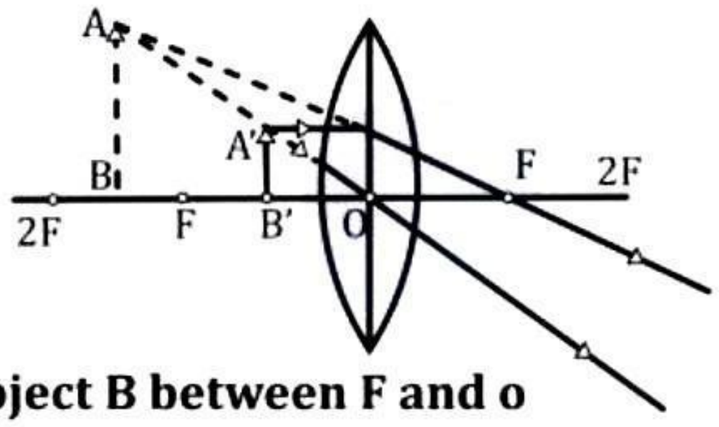
(c) object at 2F



(d) object between 2F and F



Object at F



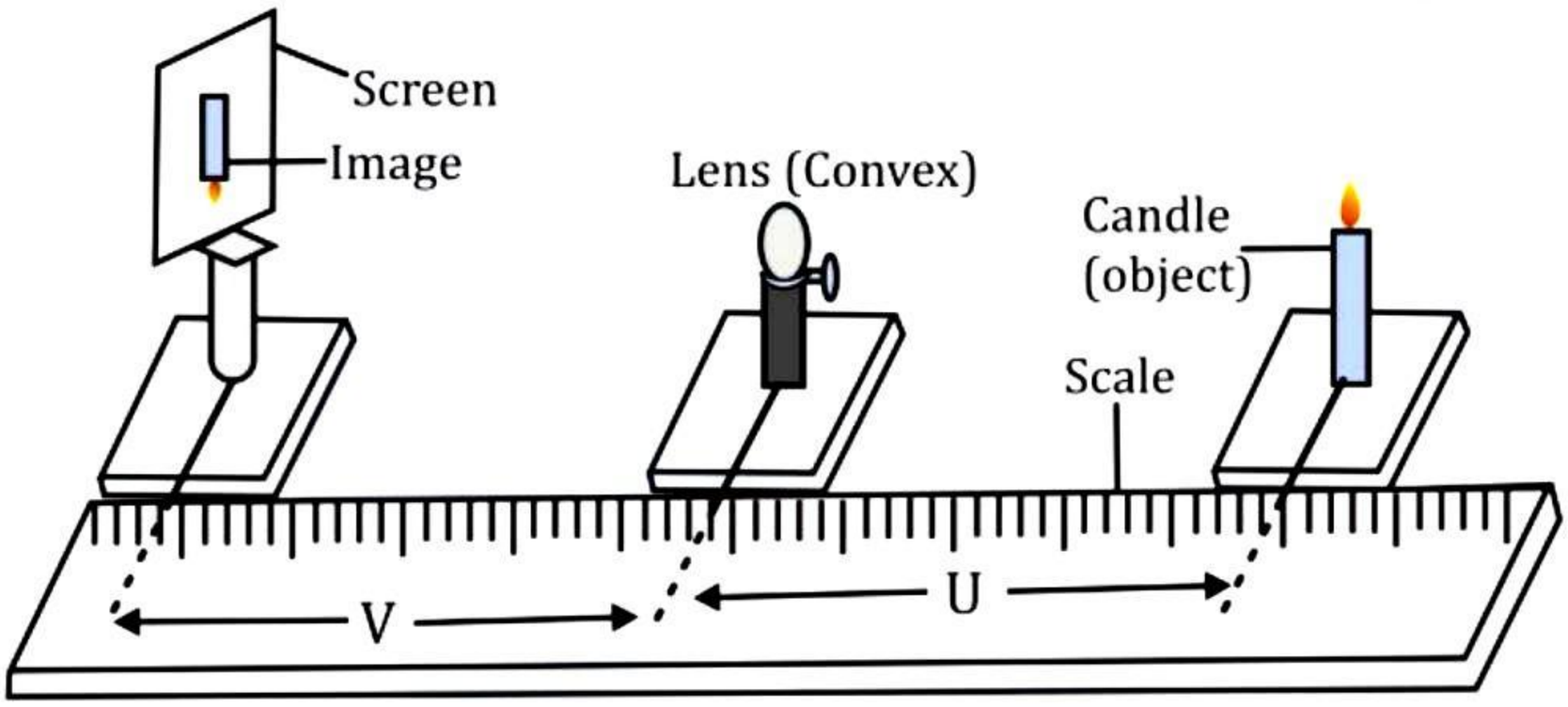
Object B between F and o

S. No.	Position of the object	Details about the image		
		Position	Nature	Size
1.	At infinity	At F_2 on the other side of the lens	Real and inverted (almost a point)	Extremely diminished
2.	Beyond $2F_1$	Between F_2 and $2F_2$ the other side of the lens	Real and inverted	Diminished in size
3.	At $2F_1$	At $2F_2$ the other side of the lens	Real and inverted	Same size as the object

4.	**Between F_1 and $2F_1$**	**Beyond $2F_2$ the other side of the lens**	**Real and inverted**	**Magnified in size**
5.	At F_1	At infinity on another side of the lens	Real and inverted	Very very large
6.	**Between F_1 and lens**	**Beyond the object on that very side of the lens**	**Virtual, erect**	**Magnified in size**

PROCEDURE

1. Find the rough focal length of the lens. Fix the lens in the lens holder and set it upright on an optical bench.
2. Place the candle on the second upright and a screen on the third upright. Make sure all three are at the same height on the upright.
3. Place the lens between the candle and the screen on the optical bench. Light up the candle.
4. For various distances on the optical bench between the candle and lens, obtain images of the candle on the screen by shifting its position on an optical bench.



OBSERVATION

Image formed by a convex lens at different positions

No. of observa-tions	Position of lens (cm)	Position of candle flame (cm)	Position of image (cm)	Size of the image (cm)
1.		Between F and 2 F		
2.		**At 2F**		
3.		Beyond 2F		
4.		**At infinity**		

RESULT

1. As the object is brought closer from infinity towards the optical center of the convex lens, the image size progressively enlarges.
2. If the object is situated beyond 2F, the image is smaller than the object.
3. When the object is positioned at 2F, the image size matches that of the object.
4. Moving the object between F and 2F results in an image size larger than that of the object.

PRECAUTION

1. Conduct this experiment in a shaded location devoid of direct light, preferably in a dark room, to ensure

clear visibility of images; otherwise, they may appear indistinct.

2. When approximating the focal length (f) of the lens by focusing on the Sun, avoid direct eye contact with the image to prevent potential eye injury.
3. Ensure that the supports for the optical elements are both sturdy and vertically positioned.
4. Keep the lens aperture small to ensure the formation of a clear image.
5. Maintain a distance of more than 25 cm between your eyes and the image formed on the screen.

SOURCE OF ERROR

1. The vertical alignment of the uprights might be lacking.
2. Achieving flawless parallax removal may not be guaranteed.
3. When using a knitting needle or index rod to determine index correction, an imprecise length measurement on the scale may result if the needle is not as sharp as required.

VIVA- VOCE

Q 1. Which lens is called diverging lens and why?

Ans. Concave lens is called diverging lens because it diverges all the ray's incident on it.

Q 2. What do you mean by optical centre of a lens?

Ans. A point in the centre of the lens lying on the principal axis is said to be optical centre. A ray of light passing through optical centre does not deviate.

Q 3. Define principal focus of convex lens.

Ans. A beam of light parallel to the principal axis of convex lens passes through the lens and converges at a point called principal focus.

Q 4. Give uses of convex lens.

Ans. Convex lens is used in spectacles, telescopes and microscopes (simple and compound).

Q 5. What is the nature of an image formed by convex lens when object is placed at 2F.

Ans. The image formed is inverted, real and of same size as that of object, obtained on the screen at 2F.

Q 6. What is the nature of an image formed by convex lens if the object is placed beyond 2F?

Ans. The image formed is real, inverted and diminished, between F and 2F.

Q 7. What is magnification of image?

Ans The ratio of height of image to height of object is said to be the magnification. It is given by

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

Q 8. What type of image is formed by convex lens?

Ans. Convex lens forms a real image. It can be magnified or diminished.

Q 9. How can you use convex lens as a magnifying glass?

Ans. When the object is placed between the focus of the lens and the aperture of the lens then the image formed will be magnified and lens can be used as magnifying lens.

Q 10. What type of image is formed by concave lens?

Ans. A concave lens always form virtual, erect and diminished images.

ACTIVITY - 6(B)

AIM

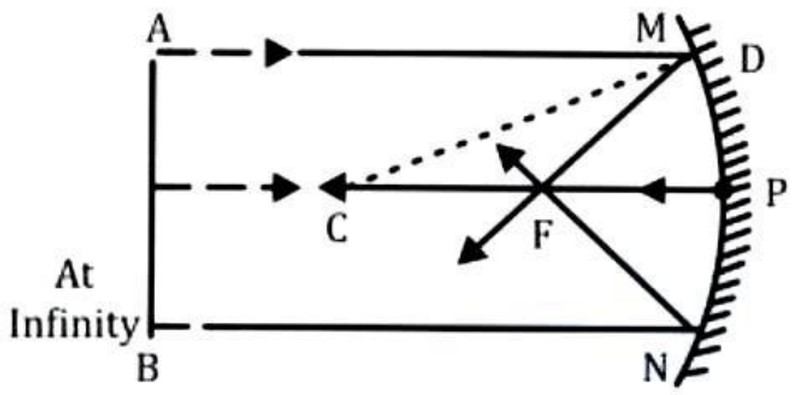
To study the nature and size of an image formed by a concave mirror using a candle and screen.

MATERIAL REQUIRED

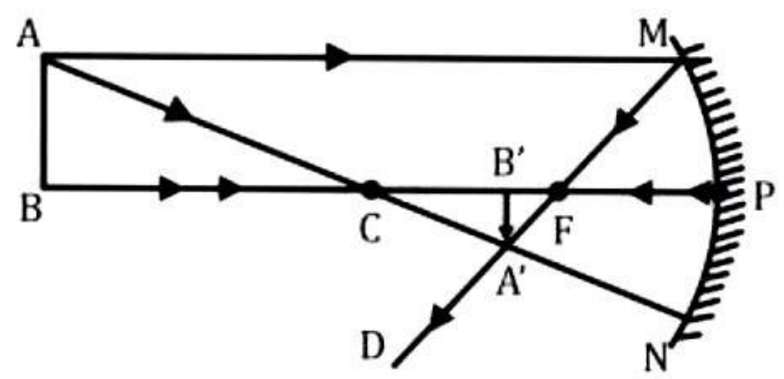
Optical bench with its three uprights, concave mirror, mirror holder in the uprights, candle, screen, match-box, metre scale, 3 uprights cardboard screen pasted with a centimeter graph paper.

THEORY

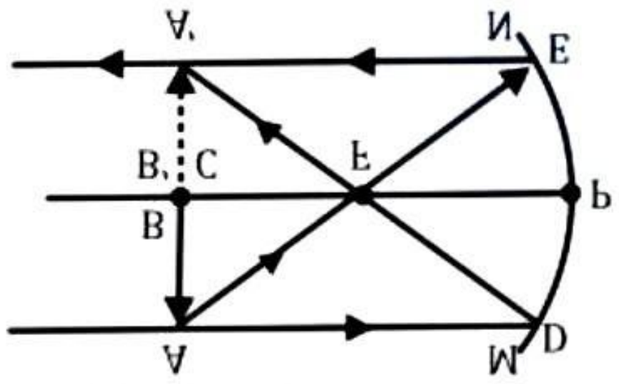
Ray diagrams for image formation for various positions of the object



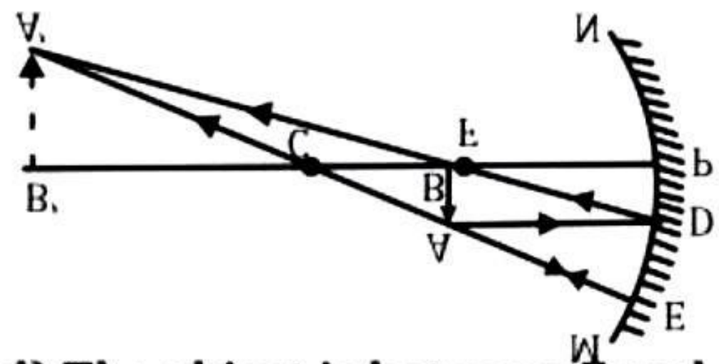
(a) The object is at infinity



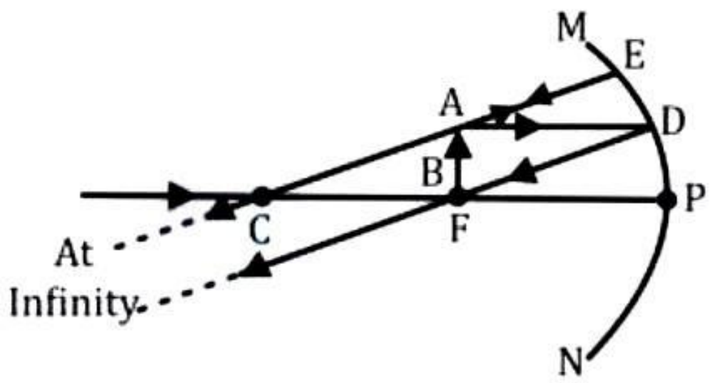
(b) The object is beyond C



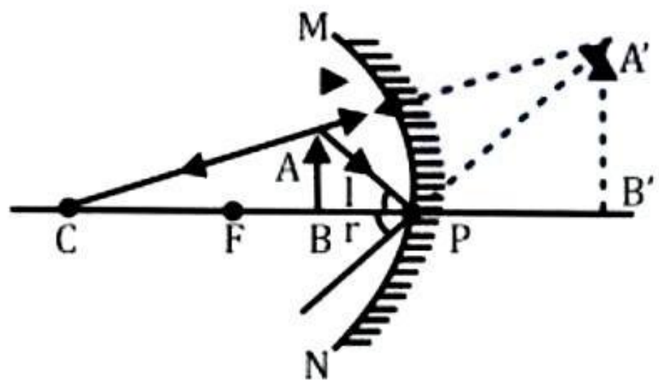
(c) The object is at C



(d) The object is between F and C



(e) The object is at F



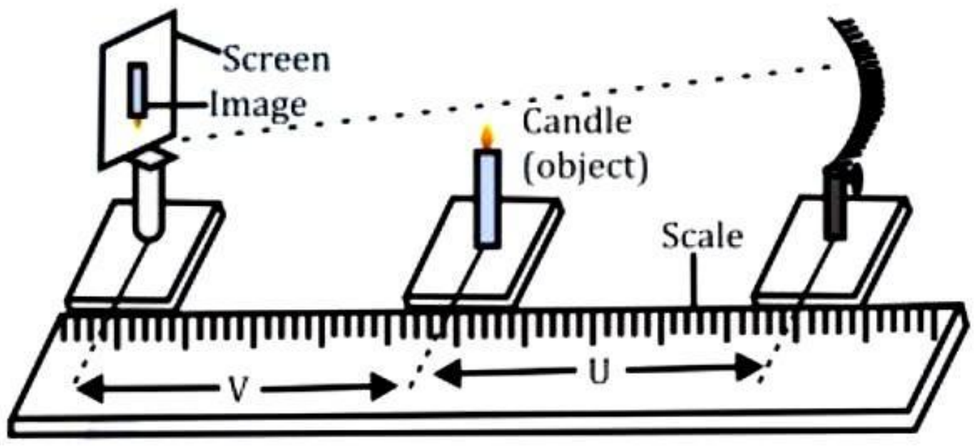
(f) The object is P and F

PROCEDURE

The procedure followed in the activity is the same as that for the lens. However, the mirror is not placed between the object and the screen. The screen is positioned between the object and mirror or behind the object depending upon the position of the object (candle).

1. Prior to engaging in this activity, prepare the screen by placing a white plastic or Perspex sheet on which the image will form. Create a slot ADEB in the screen, ensuring that the edge AB aligns with the center C of the screen and passes through it.

2. Determine the approximate focal length of the concave mirror provided by capturing a sharp, clear image of a distant object on a white paper.
3. Level the optical bench using a spirit level.
4. Secure the mirror in a clamp on one of the three uprights on the optical bench, placing it near one end. Look into the mirror with your eye at the height of the pole or vertex of the mirror. Rotate the mirror until you observe an image of your own eye at the mirror's center. Ensure the principal axis of the mirror is parallel to the optical bench's length.
5. Install the lighted candle and the screen on two additional uprights, adjusting their heights so that the tip of the candle flame, the center of the white screen (upper edge AB of the slot), and the mirror's pole are at the same height.
6. Laterally adjust the upright carrying the candle, i.e., perpendicular to the scale, so that the line connecting the mirror's pole and the tip of the candle flame is parallel to the bench's length.
7. Determine the approximate position of the center of curvature using the relation:
   $r = 2f$
   The focal length, f, was determined in step (2), and the center of curvature C is at a distance r from the mirror's pole.
8. Move the candle upright towards the mirror's pole, placing it between the principal focus F and the center of curvature C.
9. Identify the position of the candle flame's image on the principal axis of the mirror. Adjust the screen's position along the bench to obtain a sharper image of the candle flame. Since the candle (object) is between C and F, you will observe a real, inverted, and magnified image beyond C.
10. Repeat the activity for two more distinct positions of the candle flame, and observe the position, nature, and size of the image.



S. No.	Position of the object	Details about the image		
		Position	Nature	Size
1.	At infinity,	At the focus point, F	Real inverted	Much diminished (just a point size)
2.	Beyond C	Between F and C	Real inverted	Diminished in size
3.	At C	At C itself	Real inverted	Same size as the object
4.	Between F and C	Beyond C	Real inverted	Magnified in size
5.	At F	At infinity	Real inverted	Very very large
6.	Between the mirror and F	Behind the mirror	Virtual, erect	Magnified in size

RESULT

1. The image size progressively enlarges as the object approaches the concave mirror.

2. If the object is situated beyond C, the resulting image is diminished in size and located between F and C.
3. When the object is positioned at C, the image is also formed at C, and its size matches that of the object.
4. Upon moving the object between positions C and F, the image size increases, forming beyond C.
5. When the object is shifted to a position within F, the image undergoes significant magnification and is formed behind the mirror.

PRECAUTIONS

1. Find the rough focal length of the concave mirror before starting the activity.
2. The frame of the burning candle and the pole of the mirror should be kept at the same height.
3. The uprights and the mirror holder must be vertical.
4. A clear and distinct image should be obtained on the screen.

SOURCE OF ERROR

Same as in Activity - 6(A).

VIVA- VOCE

Q 1. Define refraction of light.

Ans. When a ray of light passes from a rarer to a denser medium or vice versa, it bends from its path. This phenomenon of the bending of light is known as the refraction of light.

Q 2. Define a lens.

Ans. A lens is defined as a piece of transparent material (glass) bounded by two surfaces, at least one of which is spherical.

Q 3. Which lens is converging in nature?

Ans. Convex lens.

Q 4. Write one difference between a convex lens and a concave lens.

Ans. Convex lens: It is thick at the centre, but thinner at the edges.
Concave lens: It is thin at the centre, but thicker at the edges.

Q 5. If the image formed by a convex lens is of the same size as that of the object, what is the position of the image concerning the lens?

Ans. At $2f$.

Q 6. What is the nature of the lens, if the image formed by a lens is always diminished and erect?

Ans. Concave lens.

Q 7. If a 2 cm long candle is placed at a distance of $2f$ from a convex lens, what will be the height of the image formed?

Ans. 2 cm.

Q 8. If an object is placed at the focus of a convex lens, where is the image formed?

Ans. At infinity.

Q 9. Where should an object be placed in front of a convex lens to obtain its magnified, erect image?

Ans. Between F and optical centre O of the lens.