2020

THIN LENSES

TEACHERS OF PHYSICS

www.teachersofphysics.com

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1. Define the following terms as used in curved lens.

i) Principal focus (F). (**1 mark**).

✓ *A straight line joining the two centers of curvature.*

ii) Focal length (f) (**1 mark**)

✓ *It is the distance between the optical center and the principal focus. (It is real for a converging lens and virtual (negative) for a diverging lens.)*

2. Distinguish between a real and a virtual image.

✓ *A real image is one that can be focused on a screen while a virtual image is one that cannot be focused on a screen*

3. A boy scout wanted to light up his match stick using a lens. State the type of lens he should use and explain how? (**3 marks**)

✓ *Converging/convex lens- this is because the lens has the ability to concentrate the solar energy to a point hence lighting the match stick*

4. State one similarity and one difference between a concave lens and a convex mirror (**2 marks**)

Similarity:

✓ *Both uses the same lens formula*

✓ *Both diverge parallel rays away from a focal point,*

✓ *Both have negative focal lengths,*

✓ *Both form only virtual*

✓ *They both form diminished/smaller images.*

Difference:

✓ *Convex mirrors reflect light rays while the concave lens refracts the light rays.*

✓ *Convex mirror has a single focal point in front of the mirror while the concave lens have two focal points on either side of the lens.*

5. State **one** similarity and **one** difference between a diverging lens and convex mirror (**2 marks**)

Similarity:

✓ *Both uses the same lens formula*

✓ *Both diverge parallel rays away from a focal point,*

✓ *Both have negative focal lengths,*

✓ *Both form only virtual*

✓ *They both form diminished/smaller images.*

Difference:

✓ *Convex mirrors reflect light rays while the concave lens refracts the light rays.*

✓ *Convex mirror has a single focal point in front of the mirror while the concave lens have two focal points on either side of the lens.*

6. Under what conditions does a converging lens form

(i) Real images (**1 mark**)

When the object is placed;

i. *between F and C*

ii. *at C*

iii. *beyond C*

iv. *at infinity*

(ii) Virtual images **(1 mark)**

✓ *When the object is placed between F and the lens*

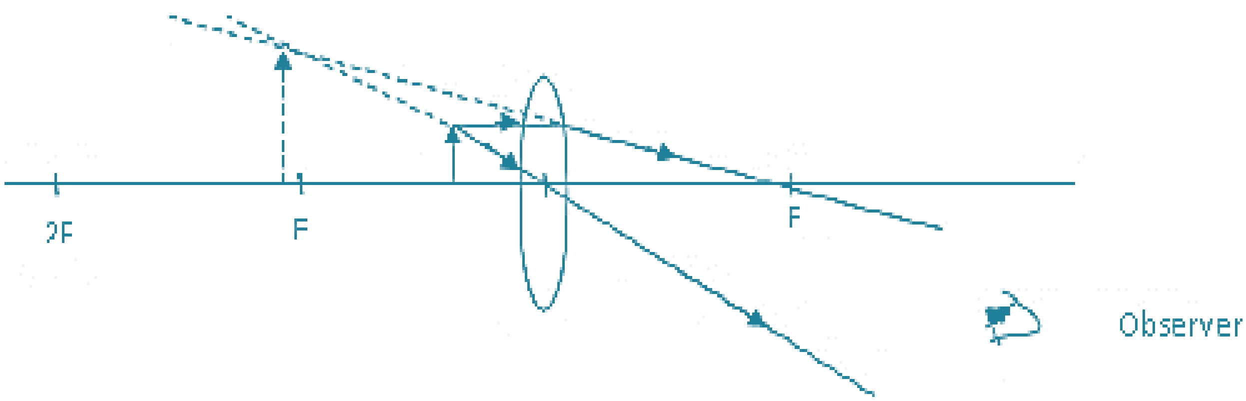
7. State one application of a convex lens where the object is positioned between principal focus and the center of curvature **(1 mark)**

i. *Simple microscope*

ii. *Compound microscope*

iii. *In the camera*

8. Sketch on a diagram to illustrate how a convex lens is used as a magnifying glass. **(3 marks)**



9. An object is placed at 2F in front of a converging lens and its image is observed. State how the image changes as the object is moved from 2F towards F.

✓ *At 2F the image formed is same size as the object as the object is moved towards F the image increases in size as it moves away from 2F to a max image formed at infinity when the object is at F*

10. Show that the linear magnification M of a convex lens is given by

$$M = \frac{V}{f} - 1$$ **(2 marks)**

We have; $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

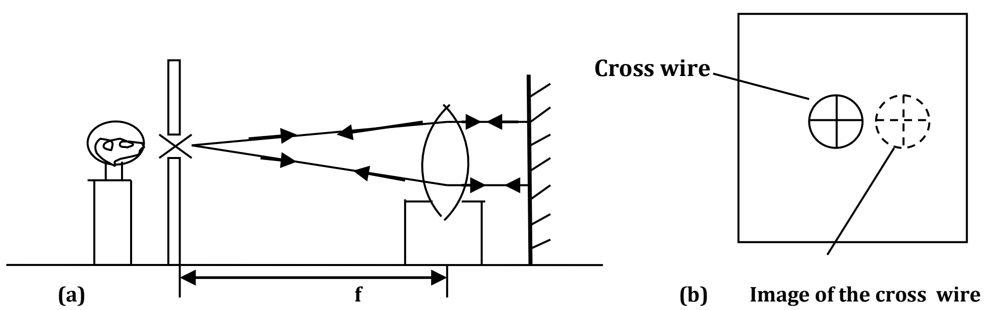
Multiply both sides by \v; $\frac{v}{f} = \frac{v}{u} + \frac{v}{v}$

But, $\frac{v}{u} = m$ and $\frac{v}{v} = 1$ *,*

therefore, $\frac{v}{f} = m + 1$

Re-arranging; $m = \frac{v}{f} - 1$

11. Describe with the aid of labeled diagram an experiment to determine the focal length of the lens when provided with the following; an illuminated object, a convex lens, a lens holder, a plane mirror and a meter rule.



- ✓ *Adjust the position of the object until a sharp image of the cross wire is formed alongside (close to) the object cross wire as shown in (b) above. The distance between the object and the center of the lens gives the focal length f of the lens.*

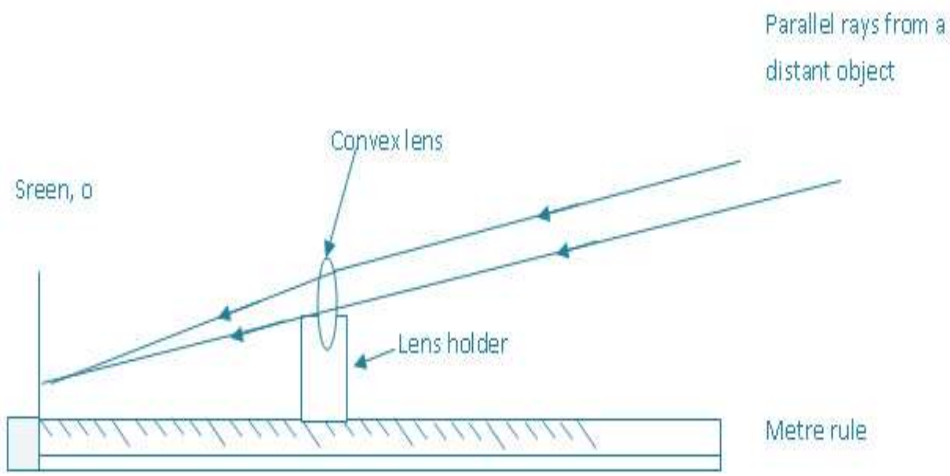
12. You are provided with a meter rule, distant object, concave mirror and a white screen. Briefly describe how you can estimate the focal length of the focal length of the concave mirror. **(3 marks)**

<u>Focusing A Distant Object</u>

Apparatus

Meter rule, lens, a lens holder, screen

Procedure



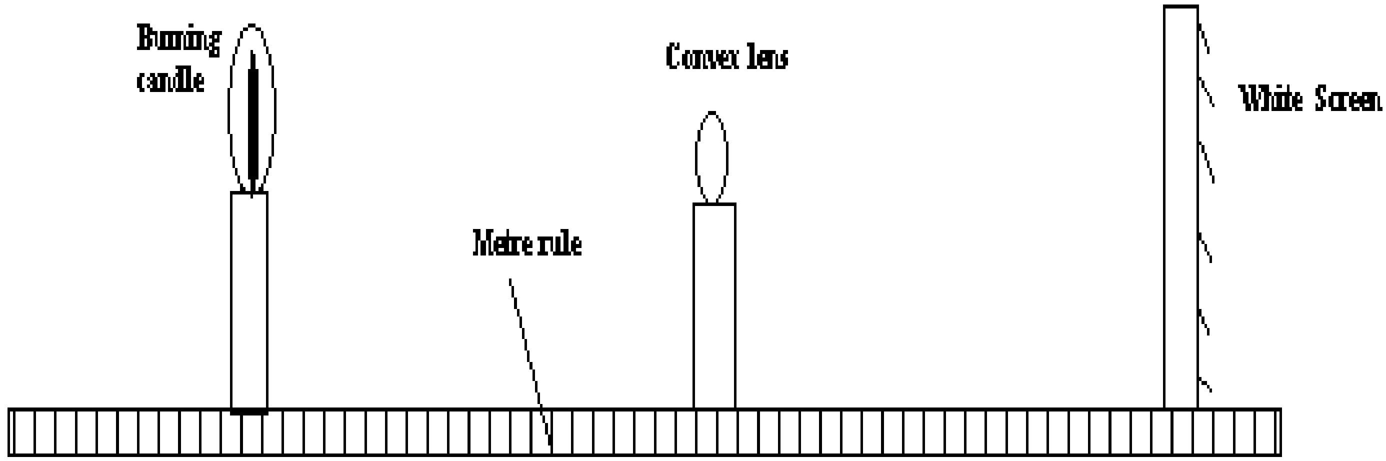
1. *Mount a convex lens on a lens holder and fix a meter rule on a bench using plasticine as shown below.*
2. *Place a white screen at one end of the metre rule*
3. *Move the lens to and fro along the metre rule to focus clearly the image of a distant object, like a tree or window frame.*
4. *Measure the distance between the lens and the screen.*
   Note: The distance between the lens and the screen gives a rough estimate of the focal length of the lens This is because parallel rays from infinity are converged at the focal point on the screen.

13. An object is placed 20cm in front of a concave lens of focal length 15cm. State two characteristics of the image formed.

Image is:

- *Real*
- *Inverted*
- *Magnified*
- *Beyond C*

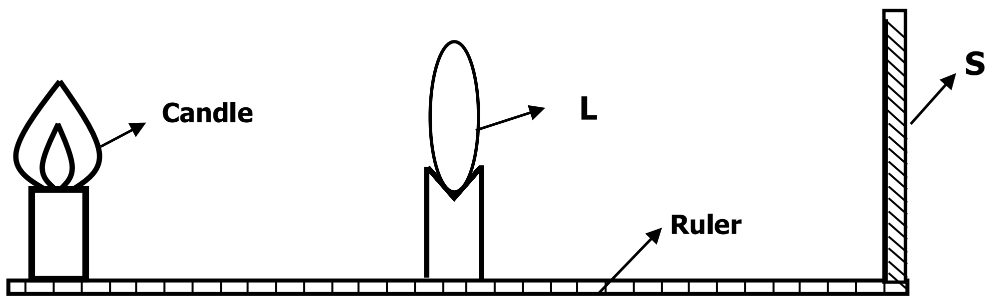
14. The diagram below shows an experiment set up to determine the focal length of a converging lens.



Describe how the set up may be used to determine the focal length, f, of the lens. (**5 marks**)

- ✓ *The candle is placed at a distance u from lens and screen position adjusted until sharp image is obtained;*
- ✓ *the distance v between lens and screen is measured;*
- ✓ *Process is repeated for other values of V;*
- ✓ *For each set of U and V, f is found from the formula* $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$;
- ✓ *average f determined*

15. The diagram below shows an experimental set up consisting of a mounted lens, L, a screen, S, a meter rule and a candle.



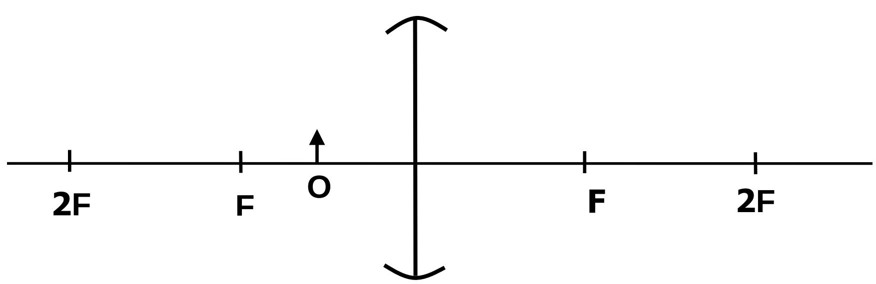
(i) Describe how the set-up may be used to determine the focal length, f of the lens. (**5 marks**)

- ✓ *The candle is placed at a distance u from lens and screen position adjusted until sharp image is obtained;*
- ✓ *the distance v between lens and screen is measured;*
- ✓ *Process is repeated for other values of V;*
- ✓ *For each set of U and V, f is found from the formula* $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$;
- ✓ *average f determined*

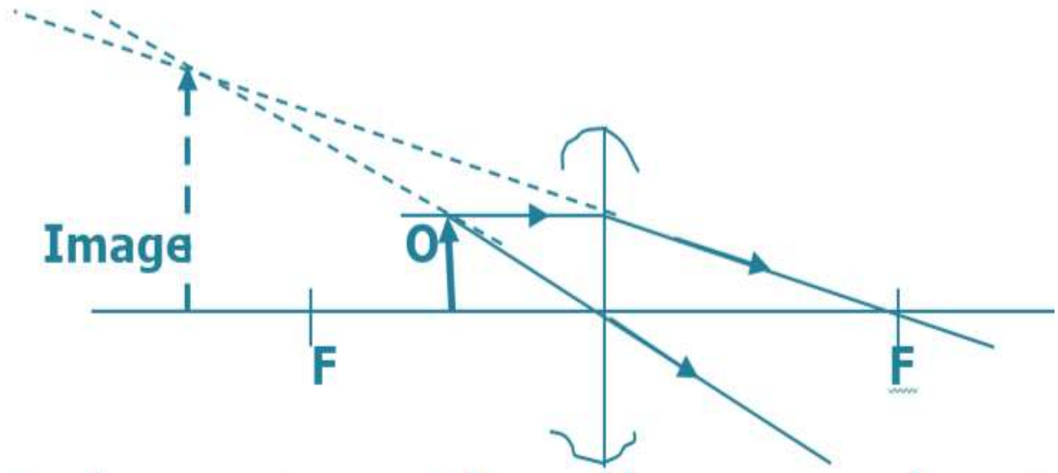
(ii) State the reason why the set-up would not work if the lens were replaced with a diverging lens. (**1 mark**)

- ✓ *Image is virtual and so not formed on screen*

16. Figure below shows an object in front of a lens.



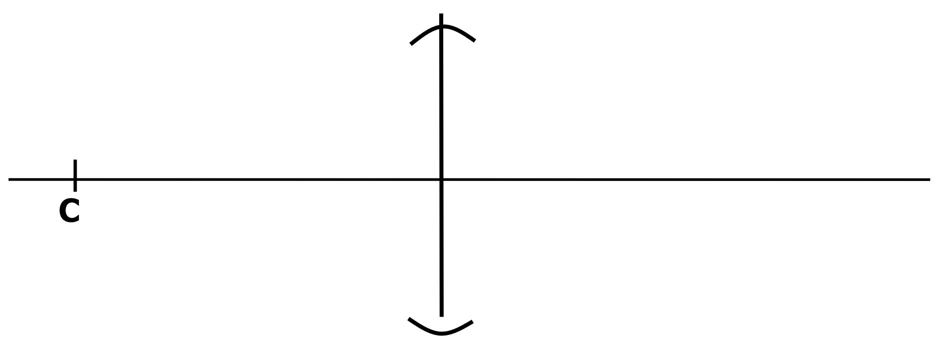
(i) Using rays locate the image of the object.

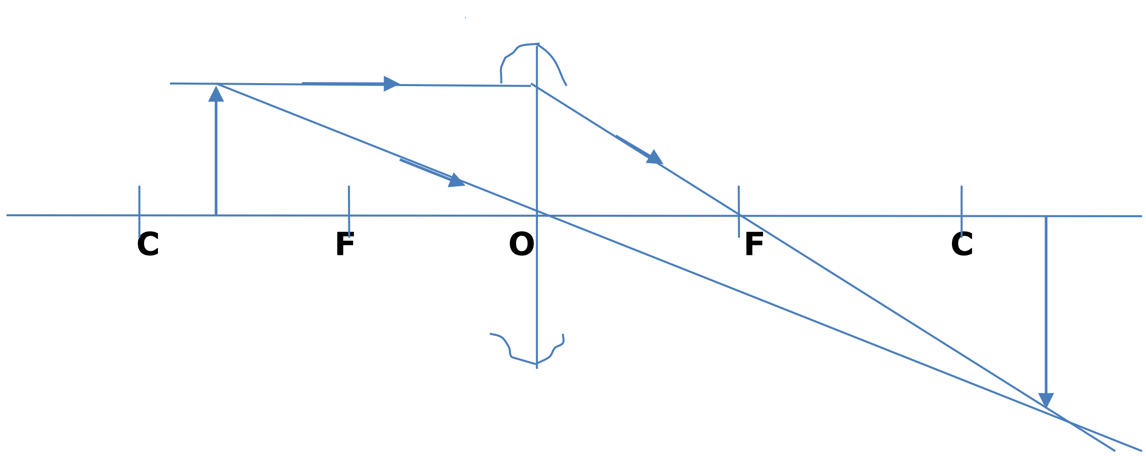


(ii) Give one application of such a lens as used above.

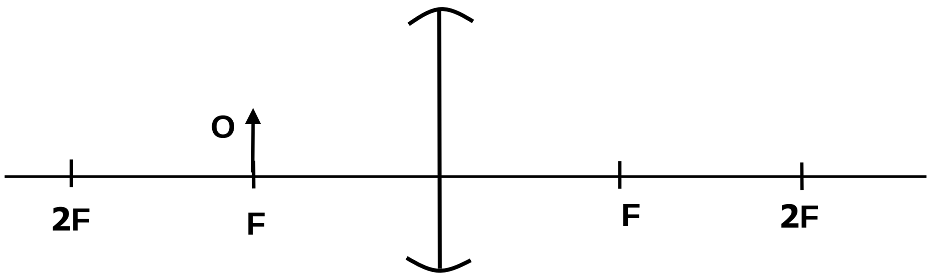
- ***A simple microscope/Magnifying lens***

17. Figure shows a convex lens. An object is placed in front of the lens such that a real magnified image is formed by the lens. Sketch on the same diagram a ray diagram to represent this

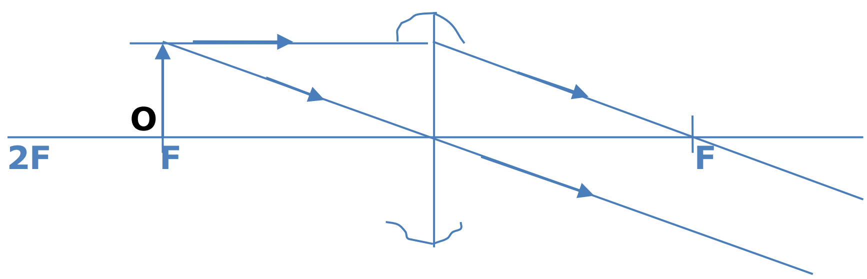




18. Figure shows an object **'O'** in front of a lens.



(i) By drawing appropriate rays on the same figure state the position of the image formed (3 mark)

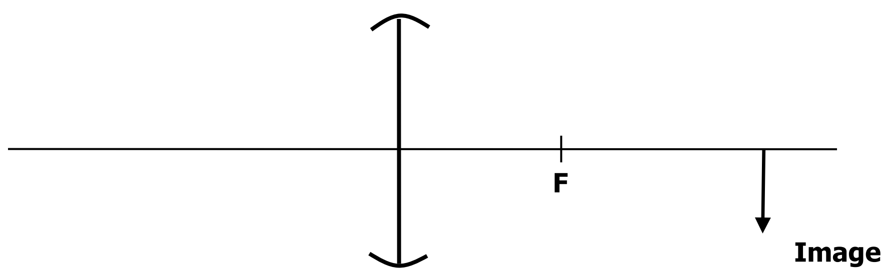


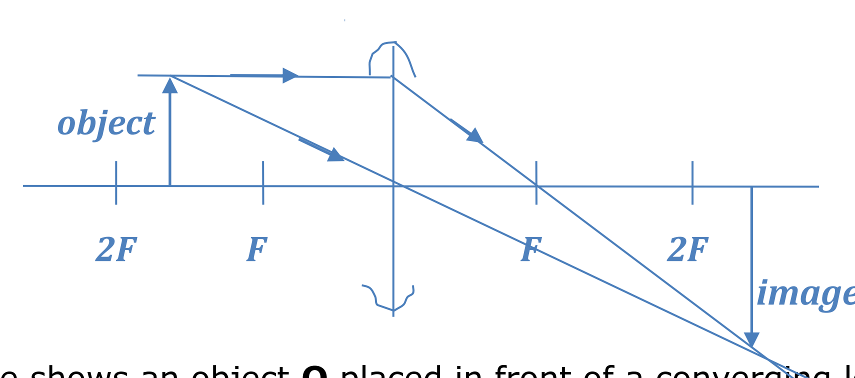
✓ *Image is formed at infinity*

(ii) Explain the adjustments you would make on the position of the object above in order to obtain a real magnified image (**2 marks**)

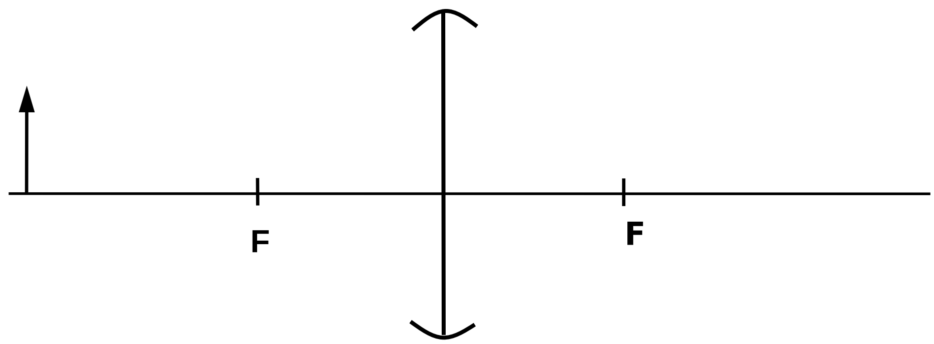
✓ *Place the object between 2f and f for an inverted image to be formed beyond 2f*

19. The sketch below shows an image formed some distance from a biconvex lens. Complete the ray diagram to locate the object.





20. The diagram in figure shows an object **O** placed in front of a converging lens. F and F are the principal foci for the lens.

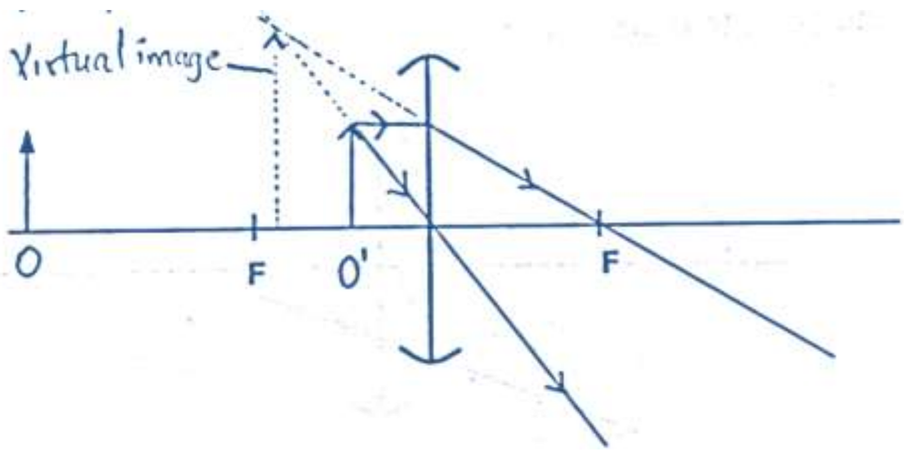


The object is now moved along the principal axis until a virtual image is produced.

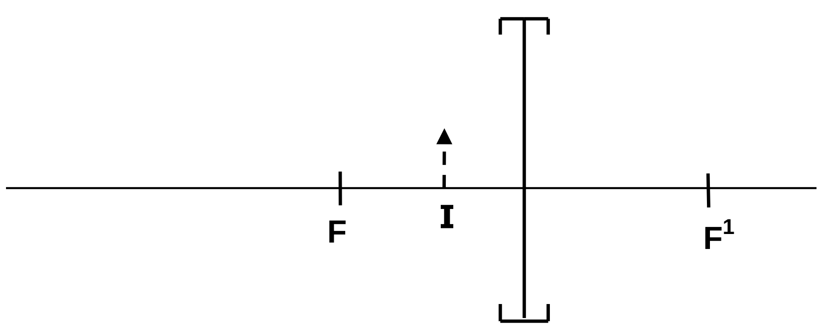
(i) Draw the object O in the new position along the principal axis. (**1 mark**)

✓ ***The new position of the object is the O' in the diagram in (ii)***

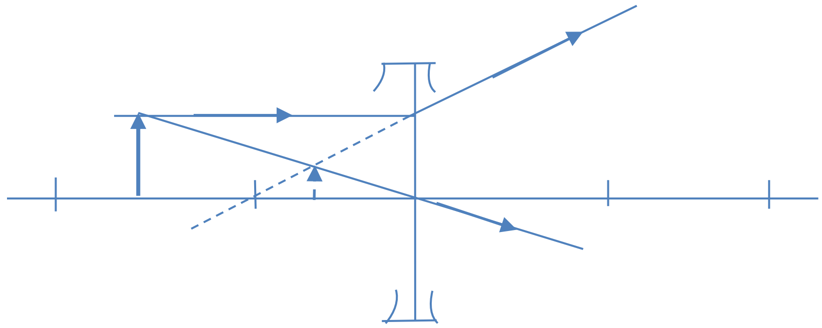
(ii) Sketch rays to show formation of the virtual image. (**2 marks**)



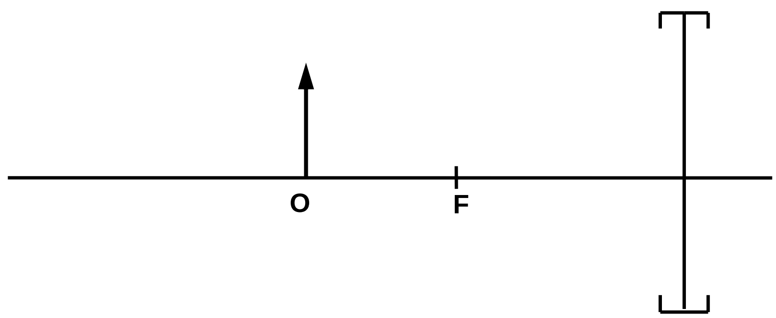
21. Fig shows an image **I** formed by a concave lens. F and F^1 are the principal foci.



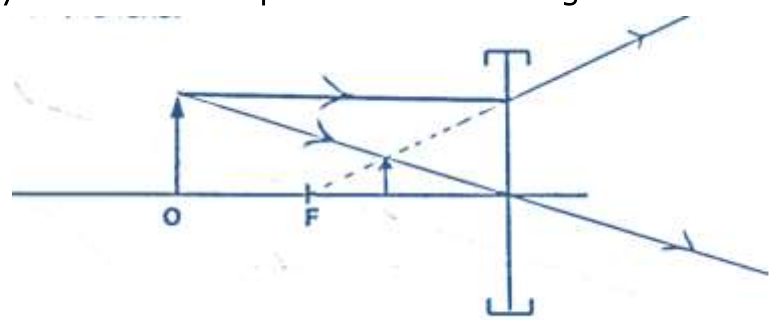
Complete the diagram to locate the position of the object. (**2 marks**)



22. The figure below represents and object O placed 10cm in front of a diverging lens. F is the focal point of the lens.

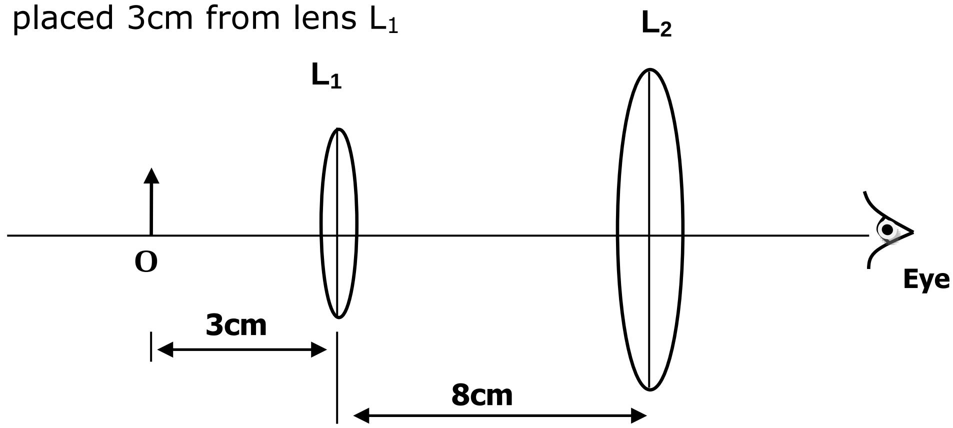


Draw rays to locate the position of the image. Determine the image distance.

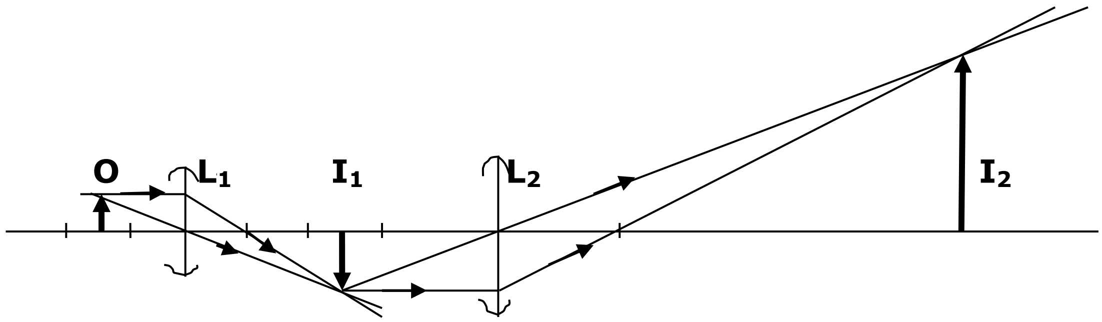


✓ *The **distance of the image is***

23. The figure below shows two converging lenses L_1 and L_2 placed 8cm from each other. The focal length of lens L_1 is 2cm and that L_2 is 2.8cm. An object 1.0cm high is placed 3cm from lens L_1



(i) On the grid below, construct a ray diagram to scale to show the position of the final image as seen by the eye of the person. (**4 marks)**



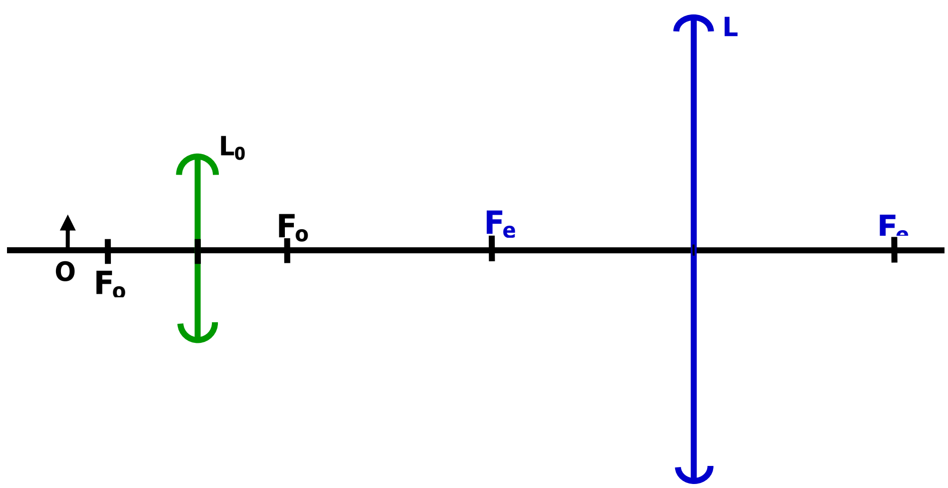
(ii) Determine the position of the final image formed from lens **L_2** and state its nature

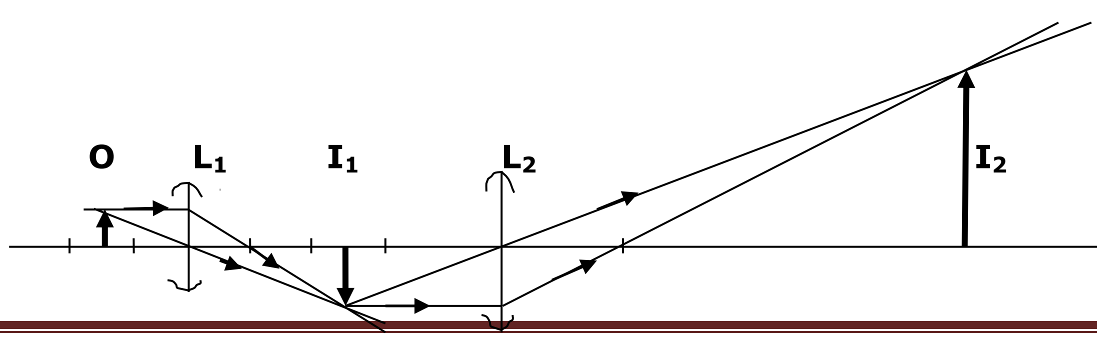
The image formed is;

- ✓ *Magnified*
- ✓ *Upright/Erect*
- ✓ *Formed beyond 2F of the L_2*

(iii) Determine the magnification obtained by this arrangement. (**4 marks**)

24. The diagram shows an arrangement of lenses; L_0 and L_e used in a compound microscope F_0 and F_e are principal foci of L_0 and L_e respectively. Draw the rays to show how the final image is formed in the microscope. (**3 marks**)





25. An object 2cm tall is placed 22.5cm from a convex lens of focal length 15cm. on the other side of the converging lens, a diverging lens of focal length 30cm is placed such that the distance between the lenses is 35cm. Determine by scale drawing on the grid provided.

(i) The position of the final image. (**4 marks**)

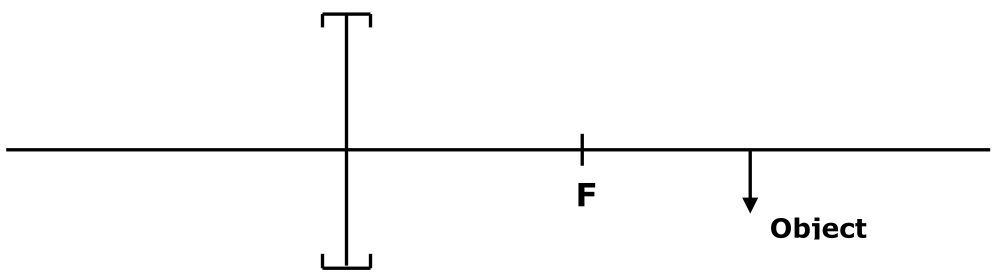
(ii) The total magnification. (**2 marks**)

26. Two lenses L_1 and L_2 placed 12cm from each other. The focal length of L_2 is 4cm. An object 5mm high is placed 4cm from L_1.

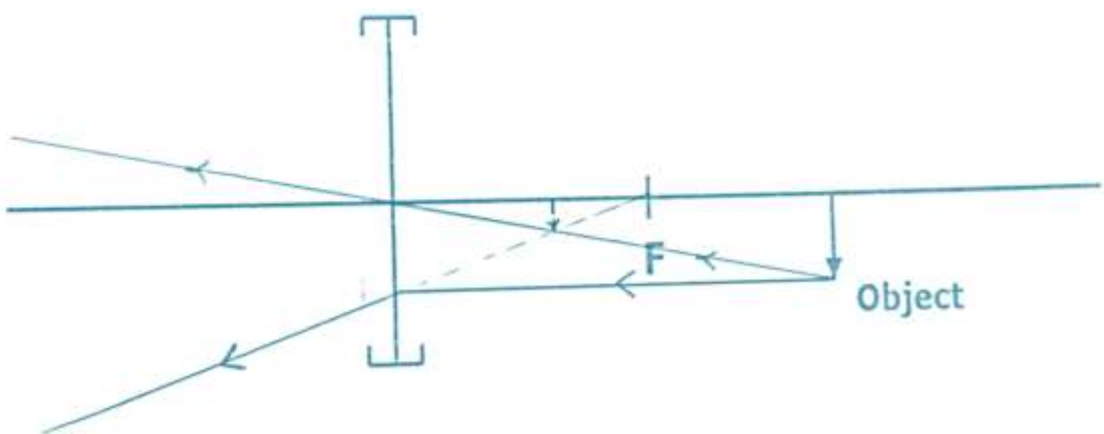
i) Construct a scaled ray diagram on a graph paper to obtain the position of the final image as would be observed by a person on the right hand side of L_2

ii) Determine the magnification obtained by the arrangement

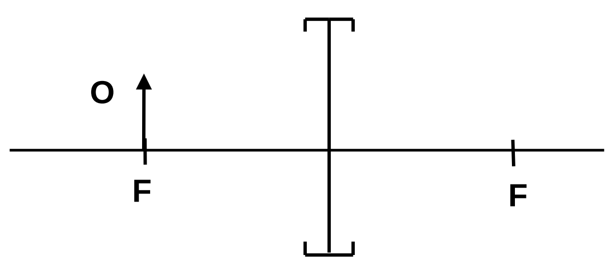
27. The sketch below shows an object placed some distance from a biconcave lens.



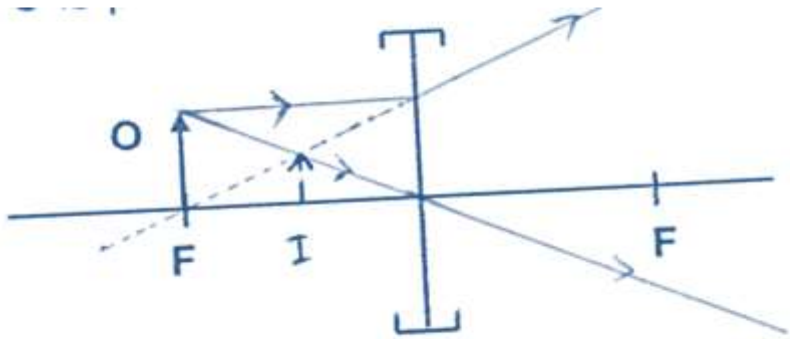
Draw rays to locate the image on the diagram (2 mark)



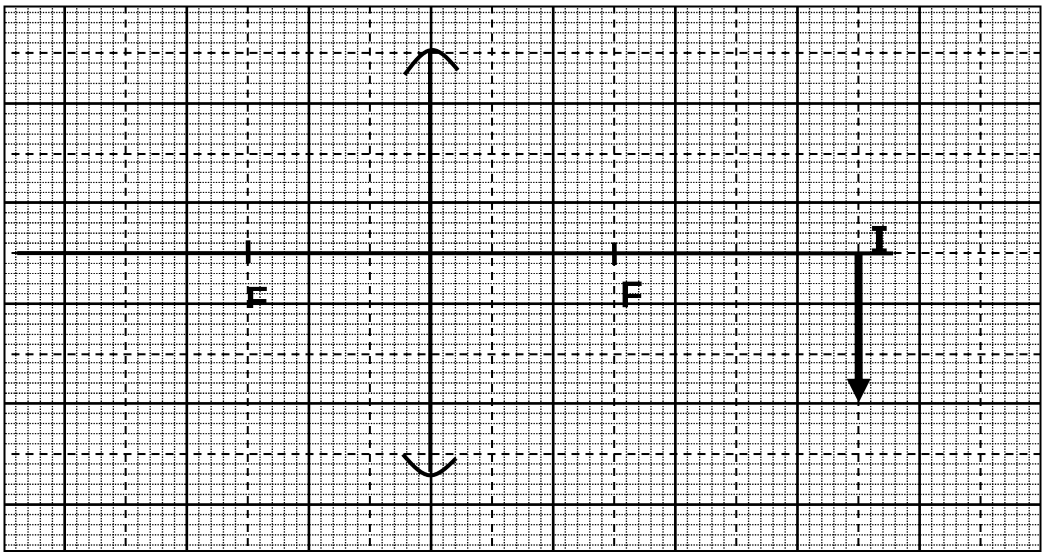
28. A vertical object O is placed at the principal focus F of a diverging lens as shown.



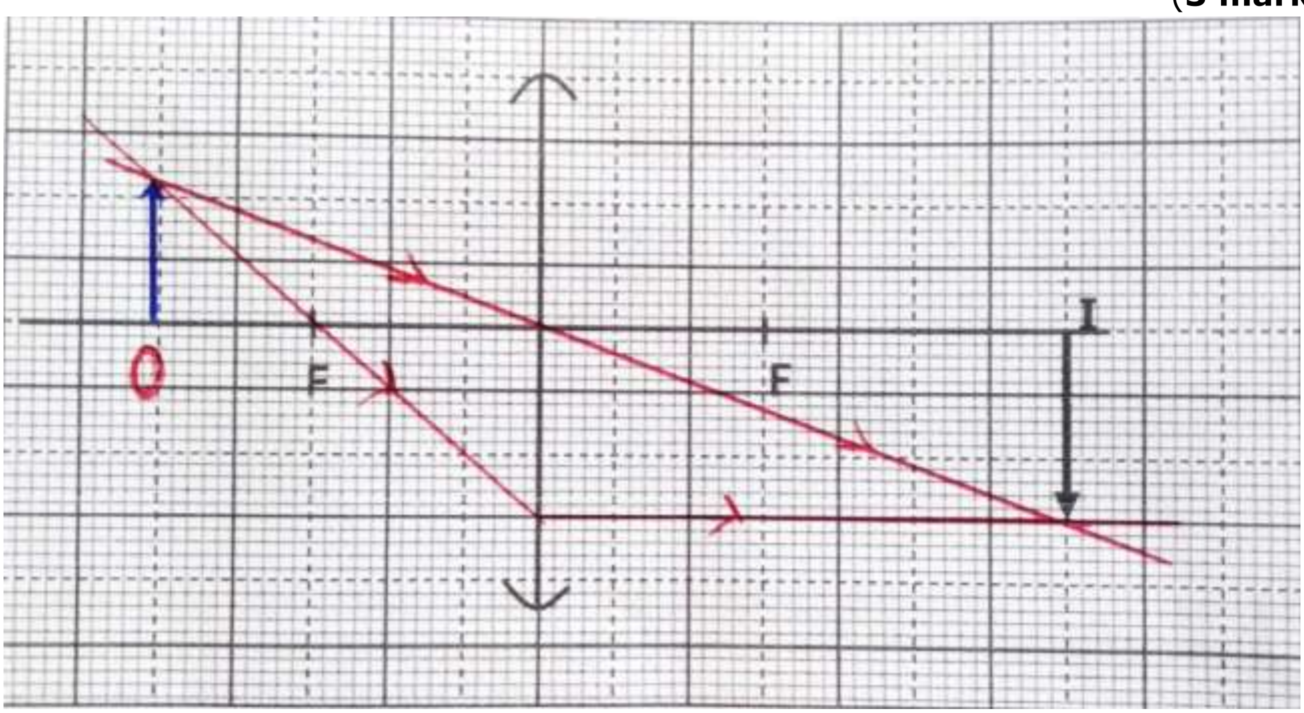
Complete the diagram by drawing appropriate rays to show the image formed.
(**3 marks**)



29. Figure below shows a real image formed by a convex lens.



On the same grid, construct a ray diagram to locate the position of the object
(**3 marks**)



THE EYE

1. Define the term "accommodation" as applied to human eye.

This automatic adjustment of the eye lens to bring to focus on the retina images of both distant and near objects

2. State ONE similarity and ONE difference between a camera and a human eye.

Similarities

(i) Both use converging lenses.

(ii) In both cases, the amount of light allowed in can be controlled. The eye does it through the iris while the camera does this through the diaphragm.

(iii) In both, a real, inverted and diminished image is formed. For the eye, the image is formed on the retina while for the camera, it is formed on a light-sensitive film.

(iv) In both cases the inner part is black; for the eye, there is the choroid layer which is black and for the camera, the inner part is painted black. This is to absorb stray rays.

Differences

(i) The focal length of the eye lens changes while that of the lens camera is constant.

(ii) The distance between the lens and film in a lens camera can be varied by zooming while the distance between the eye lens and retina is constant.

(iii) A camera can take only one photo at a time when the shutter is open while the eye forms constantly changing pictures.

3. State two possible causes of long sightedness. (**2 marks**)

(i) eyeball being too short

(ii) longer focal length

4. An optician in Eldoret Hospital examined an eye of a patient and made the following observations: Eye too short and the focal length of the eye lens too short.

(i) State the eye defect the patient could be having. (**1 mark**)

- *Myopia (shortsightedness)*

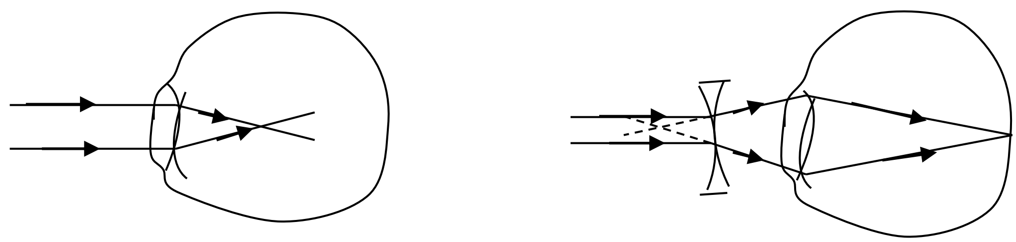
(ii) Use a diagram to describe how the defect could be corrected. (**2 marks**)

- *The defect is corrected by using a diverging lens of appropriate focal length so that the rays reaching the eye lens appear as if they are coming from a near object.*

5. A form four student resists sitting far away from the chalkboard and scrambles for the front seat all the times. What eye defect could this student be suffering from. Draw a sketch diagram to show how this defect can be corrected.

(**5 marks**)

- *Myopia (shortsightedness)*
- *The defect is corrected by using a diverging lens of appropriate focal length so that the rays reaching the eye lens appear as if they are coming from a near object.*



Defect *Correction*

6. A man needs to hold a newspaper at arm's length in order to read it.

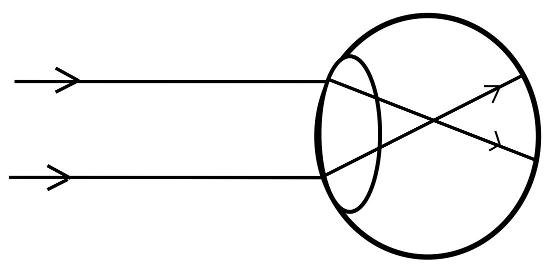
a) State a likely defect of vision which would cause this. (**1 mark**)

- *Hypermetropia (long-sightedness)*

b) State the type of spectacle lens that is required to correct this. (**1 mark**)

- *The defect is corrected by using a converging lens of appropriate focal length.*

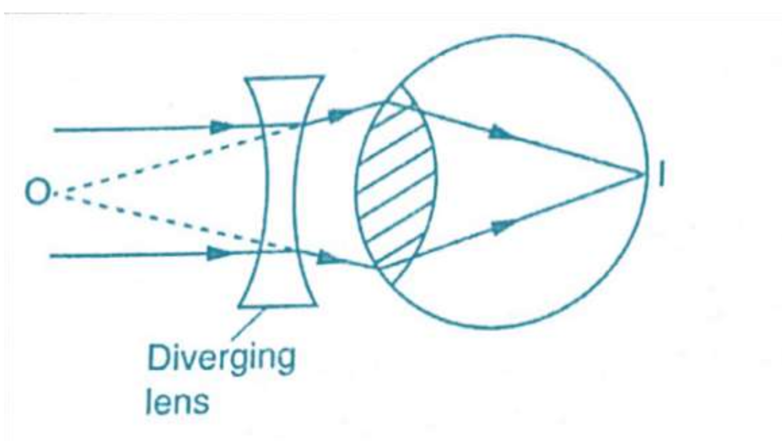
7. The figure below shows how a distant object is focused in a defective eye.



i) State the nature of the defect. (**1 mark**)

- *Myopia (shortsightedness)*

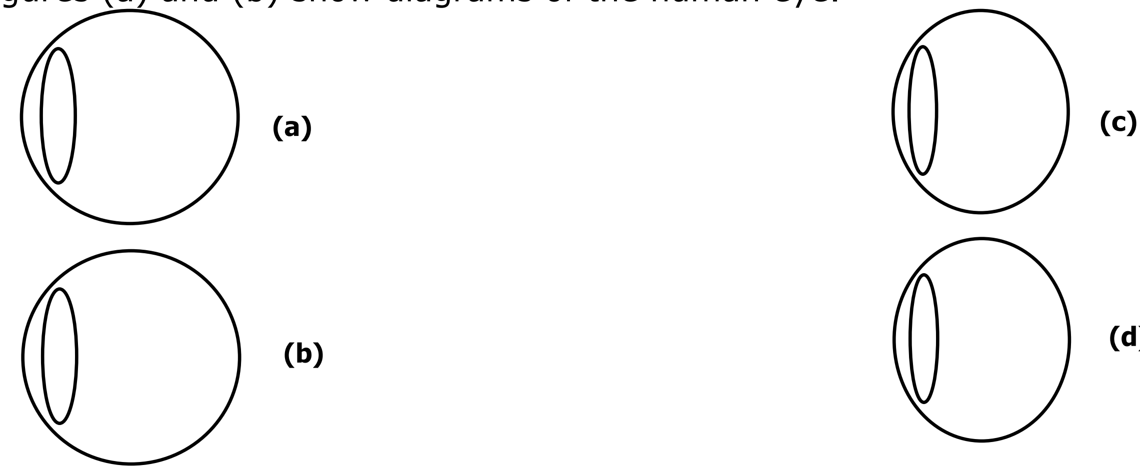
ii) On the same diagram, sketch the appropriate lens to correct the defect and sketch rays to show the effect of the lens. (**2 marks**)



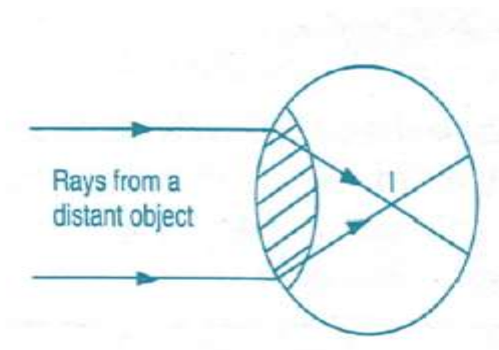
(iii) State 2 possible causes of the defect. (**1 mark**)

- *Too long focal length of the eye*
- *Too short eyeball*

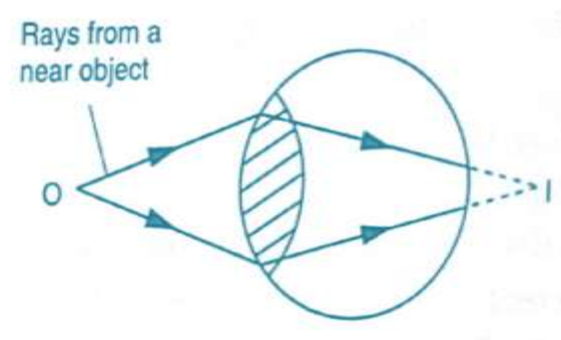
8. Figures (a) and (b) show diagrams of the human eye.



i) Sketch in figure (a) a ray diagram to show short sightedness and in (b) sketch array diagram showing long sightedness. (**2 marks**)

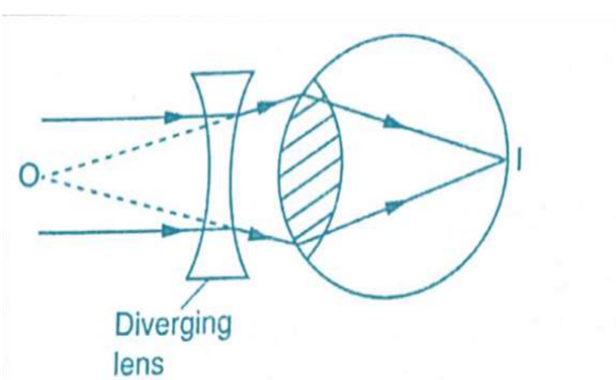


(a)Short sightedness(myopia)

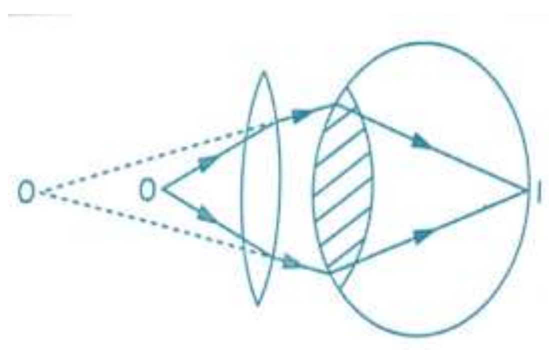


(b)Long sightedness(Hypermetropia)

ii) Sketch in figure (c) a ray diagram to show how a lens can be used to correct the shortsightedness and in (d)sketch array diagram showing how a lens is used to correct the long sightedness. (**2 marks**)

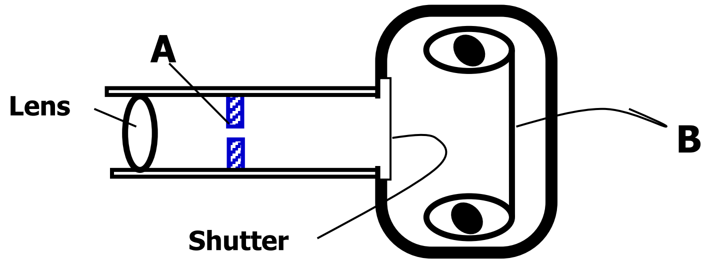


(c)Correction of short sightedness(myopia)



(d)Correction of long sightedness(Hypermetropia)

9. Figure shows the features of a simple camera.



(i) Name the parts labelled A and B. (**2 marks**)

A- *Diaphragm* **B**- *Light-sensitive film*

(ii)A still object is placed at a certain distance from the camera. Explain the adjustments necessary for a clear image of the object to be formed. (**2 marks**)

- ✓ *To clearly focus the image, the distance between the lens and film is adjusted accordingly.*

(iii) State the functions of the shutter and the parts labelled A and B. (**3 marks**)

- *A – controls the amount of light reaching the film/entering the camera.*
- *B- The film has some light- sensitive chemicals which change on exposure to light. This can then be developed and printed to get a photograph.*
- *The shutter allows light to reach the film only for a precise period when the camera is operated.*

10. Write three similarities between an eye and a camera

Similarities

- *Both use converging lenses.*
- *In both cases, the amount of light allowed in can be controlled. The eye does it through the iris while the camera does this through the diaphragm.*
- *In both, a real, inverted and diminished image is formed. For the eye, the image is formed on the retina while for the camera, it is formed on a light-sensitive film.*
- *In both cases the inner part is black; for the eye, there is the choroid layer which is black and for the camera, the inner part is painted black. This is to absorb stray rays.*

11. Explain differences between the eye and the camera. State also the similarities.

Differences

- *The focal length of the eye lens changes while that of the lens camera is constant.*
- *The distance between the lens and film in a lens camera can be varied by zooming while the distance between the eye lens and retina is constant.*
- *A camera can take only one photo at a time when the shutter is open while the eye forms constantly changing pictures.*

Similarities

- *Both use converging lenses.*
- *In both cases, the amount of light allowed in can be controlled. The eye does it through the iris while the camera does this through the diaphragm.*
- *In both, a real, inverted and diminished image is formed. For the eye, the image is formed on the retina while for the camera, it is formed on a light-sensitive film.*
- *In both cases the inner part is black; for the eye, there is the choroid layer which is black and for the camera, the inner part is painted black. This is to absorb stray rays.*

LENS FORMULAR

1. An object placed 15cm from a convex lens is magnified two times. Determine the focal length of the lens. (**3 marks**)

M =v/f – 1
M=2

V=30
2=30/f -1
2f + f =30
3f = 30
F = 10 cm

Nb: ***real is positive sign convention***

2. An object is placed 15cm from a diverging lens and the image is formed 6cm from the lens. What is the focal length of the lens?

1/f = 1/v +1/u
1/f = 1/-6 + 1/15
1/f = (-5 + 2)/30
1/f = -3/30
1/f = 1/-10

Focal length f = 10 cm

Nb: ***real is positive sign convention***

3. A biconvex lens forms an erect image twice the size of the object if the focal length of the lens is 20cm. Determine the object distance (**3 marks**)

$$u = f\frac{1}{m} + f$$

f= 20cm *m=2*

$$u = 20\ x\frac{1}{2} + 20$$

u= 10+20
u= 30cm

4. An object O is placed 15cm from a converging lens of focal length 10cm.

i) At what distance should a screen be placed so that a focused image is formed on it?

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

$$\frac{1}{10}=\frac{1}{15}+\frac{1}{v}$$

$$\frac{1}{v}=\frac{1}{10}-\frac{1}{15}$$

$$\frac{1}{v}=\frac{3-2}{30}$$

$$\frac{1}{v}=\frac{1}{30}$$

V=30cm

Screen should be placed 30 cm from the lens

ii) A diverging lens of focal length 37.5 cm is placed half way between the converging lens and the screen. How far should the screen be from the diverging leans in order to receive a focused image?

5. An object is placed 30cm in front of a concave lens of focal length 20cm. determine the magnification of the image produced. **4 marks**

$$\frac{u}{f}=1+\frac{1}{m}$$

$$\frac{30}{20}=1+\frac{1}{m}$$

$$\frac{1}{m}=\frac{3}{2}+1$$

$$\frac{1}{m}=\frac{3+2}{2}$$

$$\frac{1}{m}=\frac{5}{2}$$

m= 2/5

m=0.4

6. A luminous object and a screen are placed on an optical bench a converging lens is placed between them to throw a sharp image of the object on the screen, the magnification is found to be 2.5. The lens is now moved 30cm nearer to the screen and a sharp image is again formed. Calculate the focal length of the lens.

V= 30cm m= 2.5

$$m = \frac{v}{f} - 1$$
$$2.5 = \frac{30}{f} - 1$$
$$2.5 + 1 = \frac{30}{f}$$
$$3.5 = \frac{30}{f}$$
$$f = 8.57cm$$

7. An object is placed 16cm from a converging lens of focal length 12cm. Find.

(i) Position of image.

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

$$\frac{1}{12} = \frac{1}{16} + \frac{1}{v}$$
$$\frac{1}{v} = \frac{1}{12} - \frac{1}{16}$$
$$\frac{1}{v} = \frac{4-3}{48}$$
$$\frac{1}{v} = \frac{1}{48}$$

v=48 cm

(iii) Magnification of the image.

m=v/u
m=48/16
m=3

8. Calculate the power of a lens whose focal length is given as 10cm.

Power =1/f(m)
Power = 1/0.1
Power =10 diopters

9. A real image, half the size of the object is formed by a lens. If the distance between the objects and the image is 450mm. **Determine** the focal length of the objects. (**3 marks**)

m=1/2
m=v/u therefore v=1, u=2

$$\frac{1}{f}=\frac{1}{2}+\frac{1}{1}$$

$$\frac{1}{f}=\frac{1+2}{2}$$

$$\frac{1}{f}=\frac{3}{2}$$

f=2/3

f=0.667

10. A object of height 10.5cm stands before a diverging lens of focal length 20cm and a distance of10cm from the lens. Determine.

i) Image distance

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

$$\frac{1}{-20}=\frac{1}{10}+\frac{1}{v}$$

$$\frac{1}{v}=\frac{1}{-20}-\frac{1}{10}$$

$$\frac{1}{v}=\frac{-1-2}{20}$$

$$\frac{1}{v}=\frac{-3}{20}$$

$$v=-20/3$$

$$v=6.67\ cm\ the\ image\ is\ virtual$$

ii) Height of the image

$$\frac{h_i}{h_0}=\frac{v}{u}$$

$$\frac{h_i}{10.5}=\frac{6.67}{10}$$

$$h_i = \frac{6.67x10.5}{10}$$

$$h_i = 7cm$$

iii) Magnification

$$m = \frac{h_i}{h_0} = \frac{v}{u}$$

$$m = \frac{h_i}{h_0} = \frac{7cm}{10.5cm}$$

$$m = 0.67$$

11. A lens forms a clear image on a screen. When the distance between the screen and the object is 80cm, the image is 3 times the size of the object.

i) Explain the type of lens used. (2 marks)

- ✓ *Convex lens. The concave lens forms images that are virtual and diminished which cannot be focused on a screen.*

ii) Determine the distance of the image from the lens. (3 marks)

- ✓ *If the distance of Object to Screen = 80cm, and the distance from the lens to the screen is v, then; the distance from the distance from the object to the lens u=80-v;*
- ✓ *Magnification, m= 3*

$$3 = \frac{v}{80 - v}$$

$$3(80 - v) = v$$

$$240 - 3v = v$$

$$240 = v + 3v$$

$$240 = 4v$$

$$v = 60$$

iii) Determine the focal length of the lens. (2 marks)

v=60cm *u=20cm*

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

$$\frac{1}{f} = \frac{1}{20} + \frac{1}{60}$$

$$\frac{1}{f} = \frac{1}{15}$$

$$f = 15cm$$

12. A lens forms a focused image on a screen when the distance between the object and the screen is 100 cm. The size of the image is thrice that of the object.

i) What kind of lens was used? Give a reason. (**2 marks**)

convex lens since the image is real

ii) Determine the distance of the image from the lens. (**3 marks**)

m=3, u = 100

m=v/u therefore v=mu

v=3x100

v=300cm

iii) Determine the power of the lens. (**3 marks**)

power=1/f

f= 75cm by using the lens formula

power= 1/0.75

power=1.333D

13. An object 1cm tall standing 10cm from a converging lens produces a magnified image 2.5cm tall on the same side as the object. Determine the focal length of this lens (**5 marks**)

m=2.5 therefore v=mu

v=2.5x10

v=25

using the lens formula;

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

$$\frac{1}{f} = \frac{1}{10} + \frac{1}{-25} \text{ the image is virtual}$$

f=16.667cm

Real is positive sign convention is used

14. A lens has focal length of 12.5cm. Determine its power. (**2 marks**)

Power=1/f

Power=1/0.125

Power = 8 diopter

15. A convex lens forms an image five times the size of the object on a screen. If the distance between the object and the screen is 120cm, determine the focal length of the lens. (**3 marks**)

m=5 therefore v=mu
v=5x120
v=600
using the lens formula;

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

$$\frac{1}{f}=\frac{1}{120}+\frac{1}{600}$$

f=100 cm

Real is positive sign convention is used

16. In a compound microscope the objective lens has a focal length of 8mm and the eyepiece lens has a focal length of 25mm. An object is placed at a distance of 12mm in front of the objective lens. If the system forms a final image that is 100cm from the eyepiece, determine the distance of separation of the two lenses. (**4 marks**)

F_o=8mm	F_e=25mm
U_o=12mm	U_e=?
V_o=?	V_e=100mm

The first image formed by the objective lens gets the V_o.

$$\frac{1}{v_o}=\frac{1}{f_o}-\frac{1}{u_o}$$

$$=\frac{1}{8}-\frac{1}{12}$$

$$=\frac{1}{24}$$

Thus, V_o=24mm

The image is formed between Objective Lens(L_o) and Eyepiece Lens(L_e) thus;

Distance of separation(d)=$V_o + U_e$

Therefore, U_e=d- V_o

=d-24

Getting value of U_e by substituting the value in the equation;

$$\frac{1}{U_e}=\frac{1}{f_e}-\frac{1}{V_e}$$

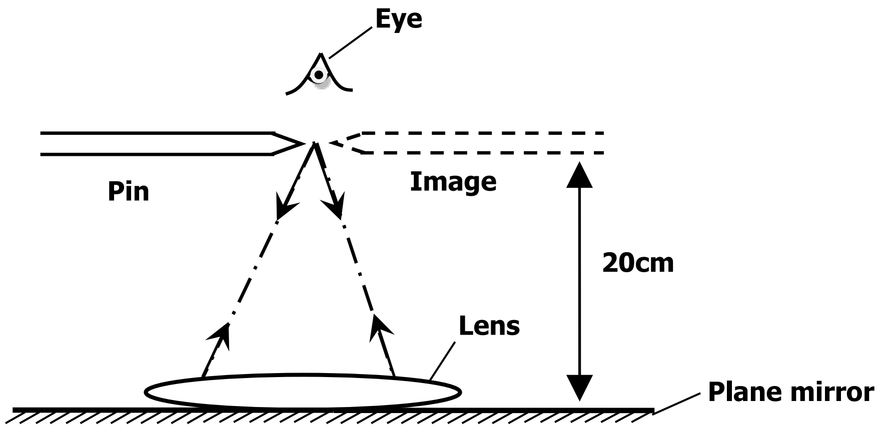
$$\frac{1}{d-24}=\frac{1}{25}-\frac{1}{100}$$

$$\frac{1}{d-24}=\frac{3}{100}$$

d-24=33.33

d= 57.33mm

17. Some students wish to determine the focal length of a convex lens of thickness 0.6cm using an optical pin and a plane mirror. Figure shows the experimental set up when there is no parallax between the pin and the image.



(i) Determine the focal length of the lens. (marks)

✓ *The focal length =20cm – 0.3cm*

=19.7cm

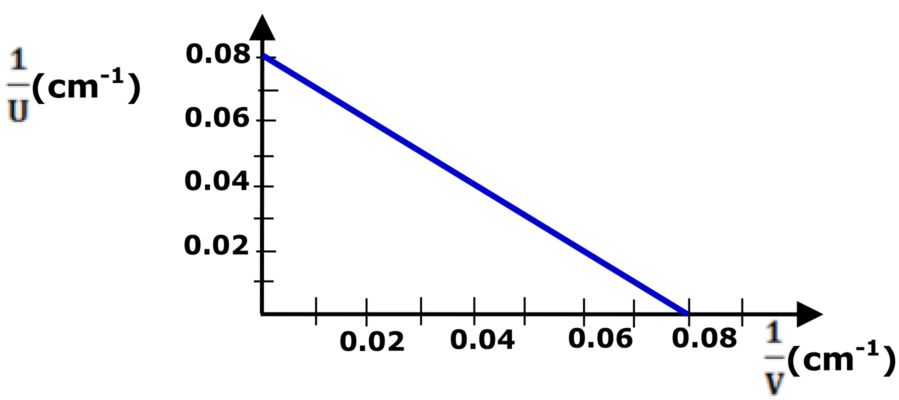
(ii) Explain how you arrive at your answer. (**3 marks**)

✓ *Focal length is the distance between the optical center(o) and the principle focus(F);*

✓ *Thickness of the lens being 0.6cm, then distance from the edge to optical center(o) is at 0.3cm.*

✓ *To get f, the distance from the edge to the center of the lens is subtracted from the distance between image and the plane.*

18. The graph below shows the variation of 1/V and 1/U in an experiment to determine the focal length of the lens. Determine the focal length.



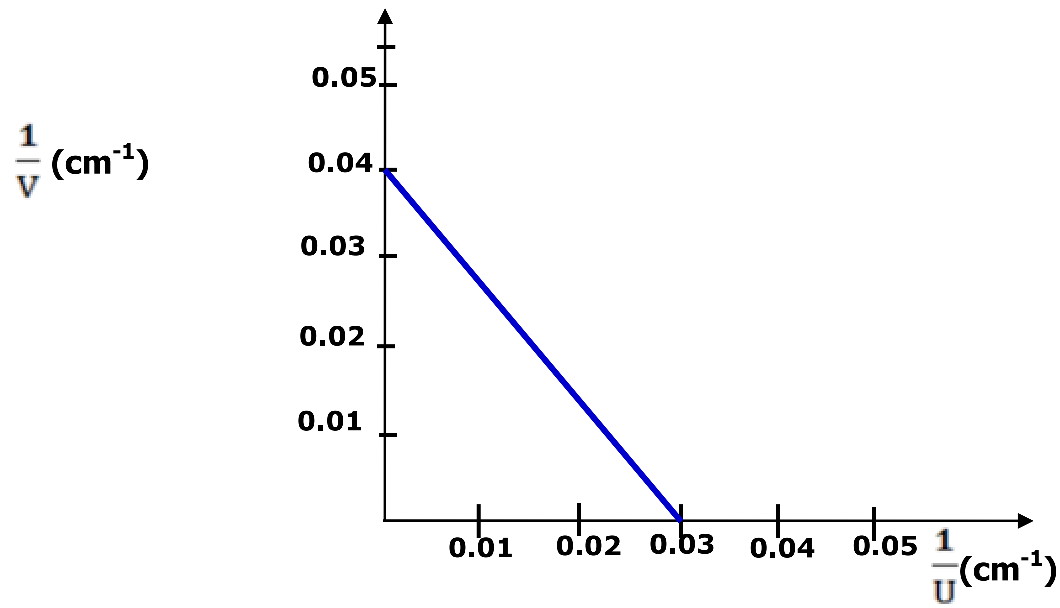
From the graph the intercepts equal to 1/f

Hence 1/f=0.08

f=1/0.08

f=12.5 cm

19. The graph below represents 1/V against1/U for an object paced in front of a From the graph determine the *focal length* of the lens and its *power* ?(**4 marks**)



$At\ \frac{1}{u}\ intercept,$

$f = 1/0.04$

$=25cm$

$At\ \frac{1}{v}\ intercept,$

$f = 1/0.03$

$=33.33cm$

$$F_{average} = \frac{25cm + 33.33cm}{2}$$

$= 29.17cm$

$$P = \frac{1}{f(m)}$$

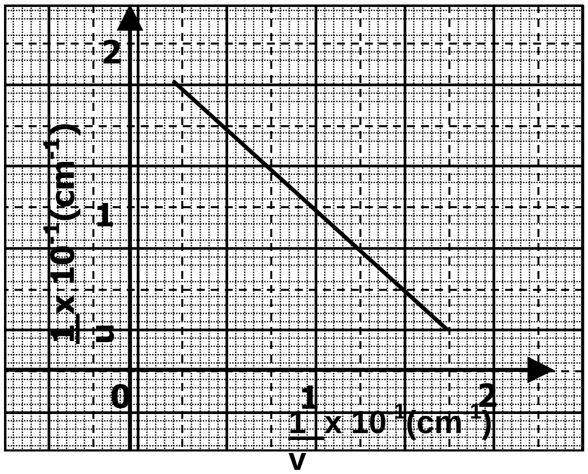
$$= \frac{1}{0.2917}$$

$= 3.429D$

20. The graph below shows the relationship between **(1/U)** and **(1/V)** for an object paced in front of a convex lens. From the graph, determine the focal length of the lens.

Graph not correctly plotted the y and x intercepts should be same value

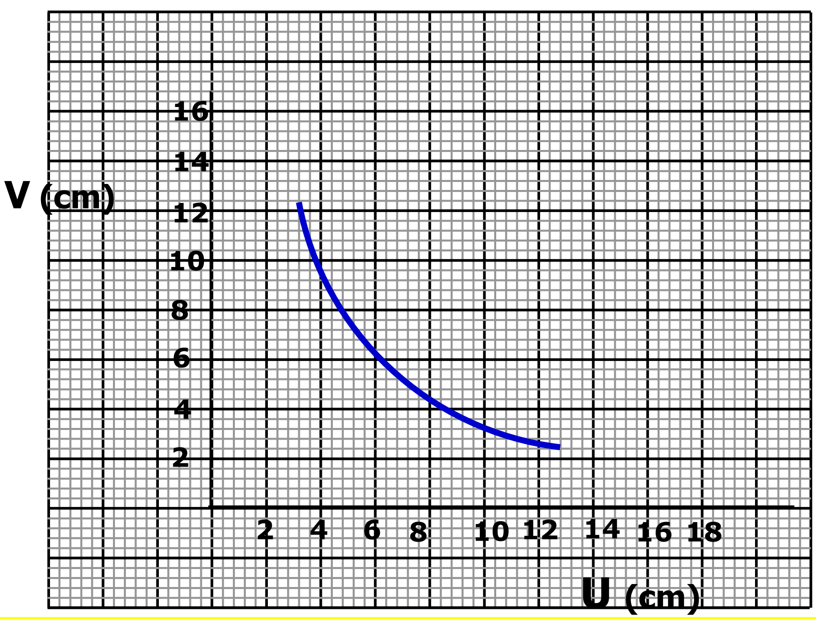
21. The graph below shows the relationship between **(1/U)** and **(1/V)** for converging lens where u and v are the object and image distances respectively.



From the graph, determine the focal length, f, of the lens. (**5 marks**)

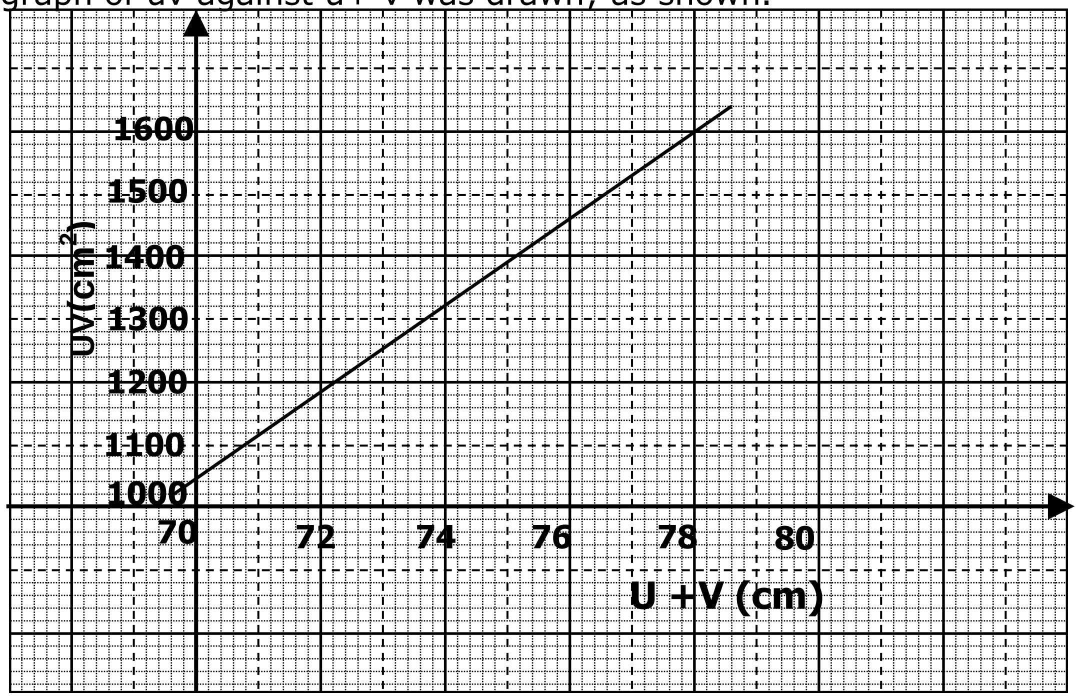
From the graph the intercepts equal to 1/f
Hence 1/f=2.0 x10^{-1}
f=1/0.2
f=5 cm

22. The graph below is a plot of image distance against the object for a concave lens



From the graph determine the focal length of the concave lens. (3 mark)

23. Joan performed an experiment to measure the focal length of a convex lens. A series of object distances (u) and image distance (v) were recorded and then a graph of uv against u+ v was drawn; as shown.



a. Show that the slope of the graph is equal to the focal length. (**2 marks**)

From the lens formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$, $\frac{1}{f} = \frac{v + u}{uv}$

$$uv = (u + v)f$$

In the form $y = mx + c$

$uv = f(u + v) + 0$

Thus gradient = f and uv intercept = 0

b. Determine the focal length of the lens from the graph. (**2 marks**)

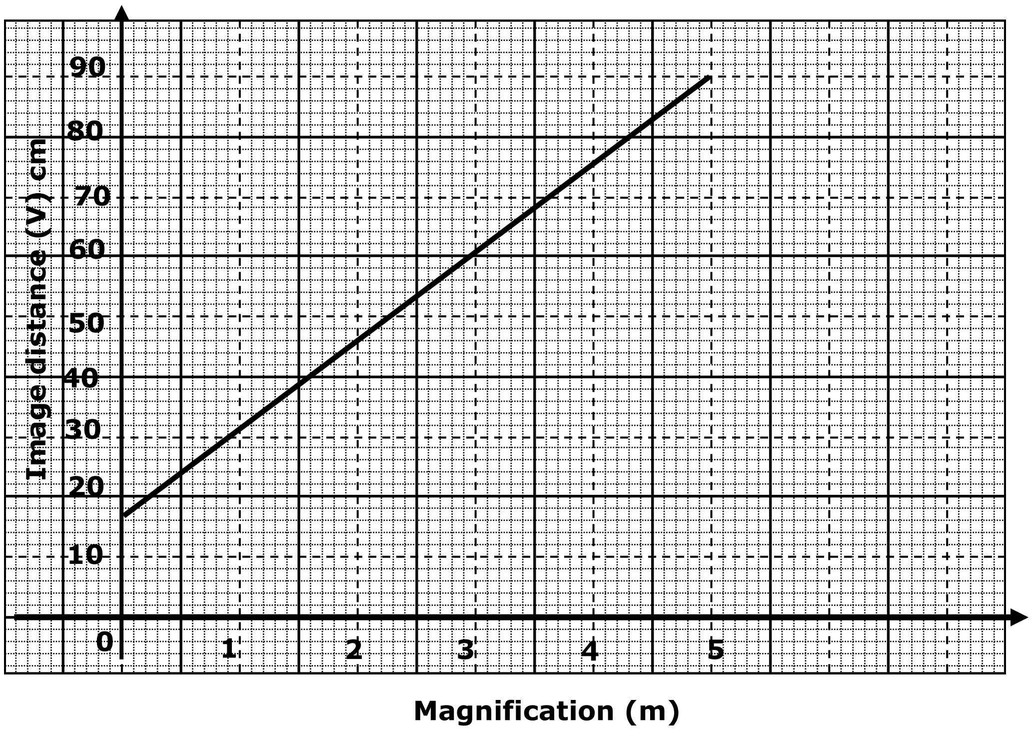
The focal length is gotten from the gradient;

$$Gradient = \frac{Change\ in\ UV}{Change\ in\ U+V}$$

$$= \frac{1460-1200}{76-70.2}$$

$$=44.81cm$$

24. In an experiment using a convex lens a graph of image distance V against the magnification m was drawn as shown, from the equation $^{V}/_{f} = m + 1$.



From the graph determine.

(i) The slope **S.** (**3 marks**)

S= (90-60)/(5-3)

S=30/2

S=15

(ii) The y-intercept (V-intercept), **C** (**1 mark**)

C=17

(ii) Calculate the value of constant n given that $\mathbf{n} = \frac{\mathbf{S+C}}{\mathbf{2}}$(2 mark)

$$\mathbf{n} = \frac{\mathbf{15 + 17}}{\mathbf{2}}$$

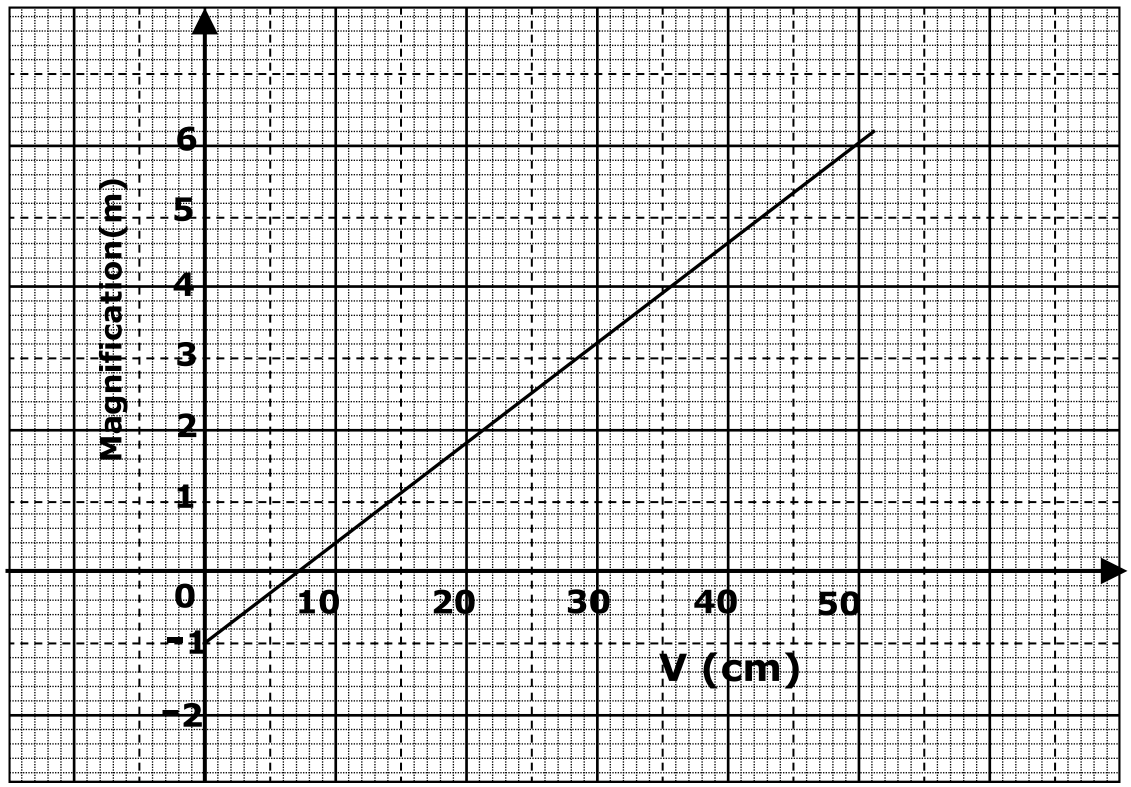
$$\mathbf{n} = \frac{\mathbf{32}}{\mathbf{2}}$$

$$\mathbf{n = 16}$$

(iv)What is the physical significance of the value **n**?

n is the focal length of the lens

25. The graph below shows the relationship between magnifications of the image against image distance of a convex lens. Use the formation on the graph to answer questions that follow



a) Given that the mirror formula is $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$, write down the equation of the graph.

(3 marks

$\boldsymbol{\frac{1}{f} = +\frac{1}{v}}$ ***multiplying both sides by v***

$\boldsymbol{\frac{v}{f} = \frac{v}{u} + \frac{v}{\frac{1}{u}v}}$ ***but*** $\boldsymbol{\frac{v}{v} = 1}$ ***and v/u =m***

$$\boldsymbol{\frac{v}{f} = m + 1 \; rearranging\ the\ eguation\ becomes.}$$

$$\boldsymbol{m = \frac{v}{f} - 1}$$

b) Determine the object distance when m =1.0 **(2 marks)**

v=14 cm from the graph

c) Determine the focal length of the lens **(3 marks)**

Focal length = reciprocal of the slope

Slope = (6-0)/(50-7)

= 6/43

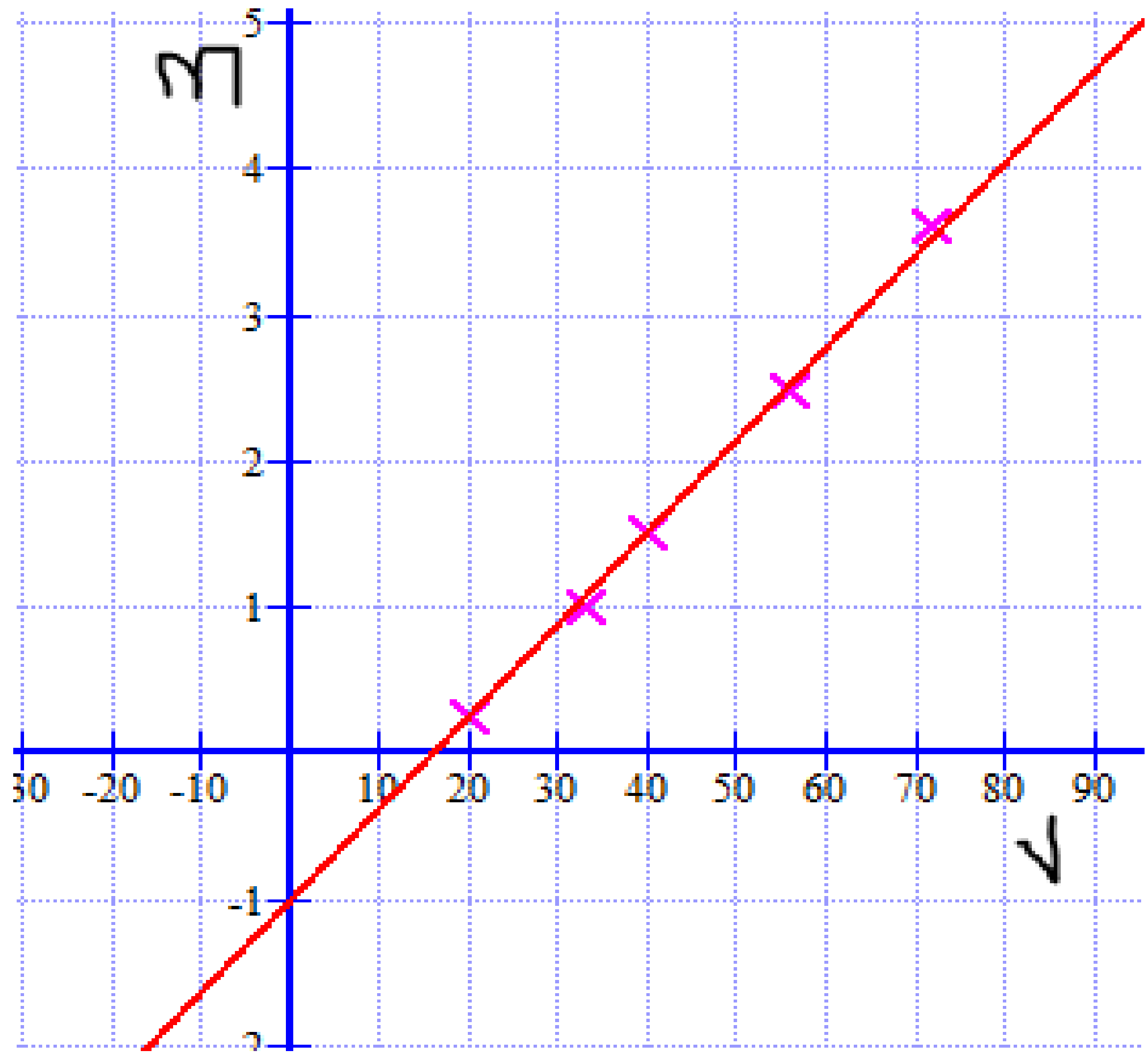
f=43/6

f=7.167 cm

26. The table below shows the object and the corresponding image distances in an experiment with a convex lens.

Object distance U cm	**80**	**33**	**26.5**	**22.5**	**20**
Image distance V cm	**20**	**33**	**40.0**	**56**	**72**
Magnification M	***0.250***	***1.000***	***1.509***	***2.489***	***3.600***

(i) Complete the table giving your answers to 3 d.p. (**3 marks**)
(ii) Plot a graph of linear magnification M against image distance V. (**4 marks**)



(i) Given that the linear magnification is related to the image distance by the formula: $f = \frac{V}{M+1}$ Determine the focal length ***f*** of the lens. (**4 marks**)

iv) Determine the image distance when the magnification is 1. (**2 marks**)

27. The table below shows the object distance, U and the corresponding image distance, V for an object placed

U (cm)	20	25	30	35	40	45
V (cm)	60.0	37.5	30.0	26.3	24.0	22.5
$\frac{1}{u}$ (cm^{-1})	*0.050*	*0.040*	*0.033*	*0.029*	*0.025*	*0.022*
$\frac{1}{V}$ (cm^{-1})	*0.017*	*0.027*	*0.033*	*0.038*	*0.042*	*0.044*

(i) **Complete** the table and plot a graph of $\frac{1}{V}$ against $\frac{1}{u}$ (**7 marks**)

Determine the focal length of the lens. (**2 marks**)

28. In a experiment to determine the focal length of a lens, the results in table 1 were obtained.

U (cm)	12.5	16.0	18.0	24.0	30.0	40.0
V (cm)	**50.0**	**27.0**	**22.5**	**17.0**	**15.0**	**13.0**

(i) Plot a graph of V (y-axis) against U (x-axis). (**5 marks**)

(ii) From your graph, determine the focal length of the lens. (**3 marks**)