Use the following data wherever necessary :

Speed of light in vacuum $c = 3 \times 10^8 \text{ m s}^{-1}$

The following list of formulae may be found useful :

Equation for a single lens $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

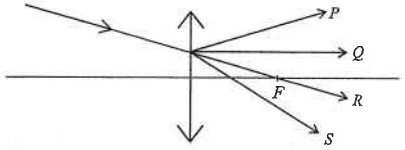
Part A : HKCE examination questions

1. < HKCE 1980 Paper II - 26 >

A convex lens is used to form an image of a bright object on a screen. The effect of covering the top half of the lens with a card is to

A. remove the top half of the image.
B. remove the bottom half of the image.
C. make the image smaller.
D. make the image dimmer.

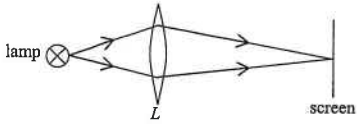
2. < HKCE 1981 Paper II - 16 >



A ray of light falls on a convex lens as shown in the figure. F is the principal focus of the lens. Which of the following represents the path of the emergent ray ?

A. P
B. Q
C. R
D. S

3. < HKCE 1982 Paper II - 25 >

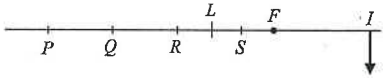


A convex lens L is placed between a screen and a lamp. A sharp image is formed on the screen as shown in the above figure. Which of the following statements concerning the image are correct ?

(1) The image is larger than the object.
(2) The image is real.
(3) The image is inverted.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

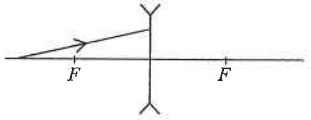
4. < HKCE 1982 Paper II - 24 >



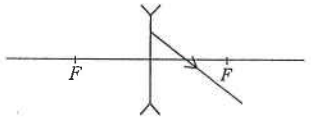
A real image of an object is formed at I by a lens placed at L. If the focus of the lens is at F, the object must have been placed near to

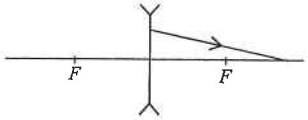
A. P
B. Q
C. R
D. S

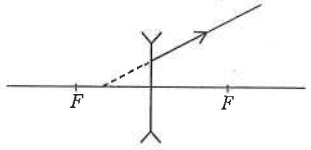
5. < HKCE 1982 Paper II - 19 >

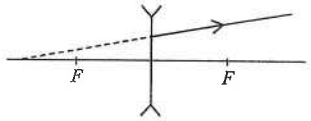


A ray of light is incident at a concave lens. F is the focus of the lens. Which of the following diagrams correctly shows the path of the emergent ray ?

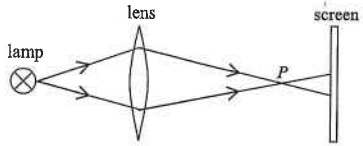
A.


B.


C.


D.


6. < HKCE 1983 Paper II - 17 >



A lens gives a sharp image of the lamp at P as shown in the figure above. Which of the following methods could give a sharp image of the filament on the screen ?

(1) Move the screen towards the lens.
(2) Move the lamp closer to the lens.
(3) Replacing the lens by another lens of longer focal length.

A. (1) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

7. **< HKCE 1983 Paper II - 19 >**

Which of the following statements concerning the properties of virtual images formed by a lens is/are correct ?

(1) Virtual images can be seen by the naked eye.

(2) Virtual images can be formed on a screen.

(3) Virtual images can be photographed with a camera.

A. (1) only
B. (3) only
C. (1) & (3) only
D. (2) & (3) only

8. **< HKCE 1983 Paper II - 20 >**

An object is placed 20 cm in front of a converging lens of focal length 30 cm. Which of the following statements about its image is/are correct ?

(1) The image is real.

(2) The image is magnified.

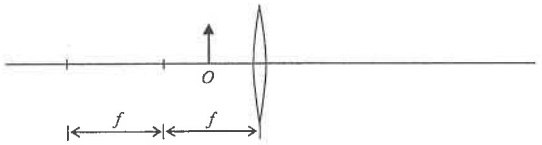
(3) The image is erect.

A. (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

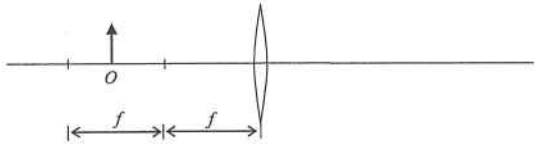
9. **< HKCE 1984 Paper II - 18 >**

Which of the following will produce a diminished image of an object O ? (f is the focal length)

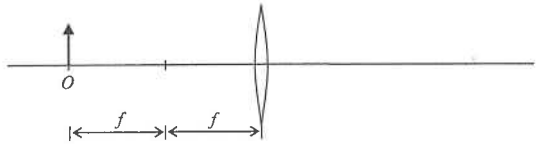
A.



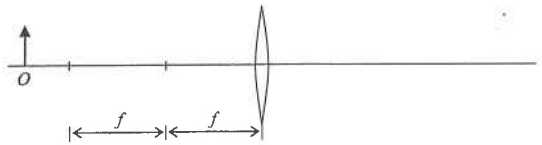
B.



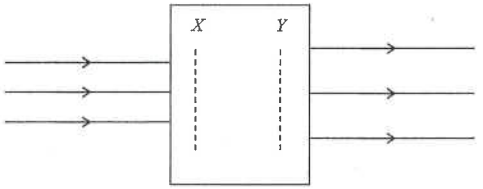
C.



D.



10. **< HKCE 1984 Paper II - 14 >**

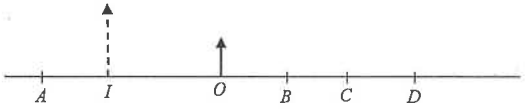


As shown in the diagram, a narrow parallel beam of light is converted to a wider parallel beam by placing two lenses X and Y in the positions shown. Which of the combinations below when correctly chosen and installed could produce the effect required ?

	Lens X	Lens Y
(1)	convex	concave
(2)	concave	concave
(3)	concave	convex

A. (2) only
B. (3) only
C. (1) & (3) only
D. (2) & (3) only

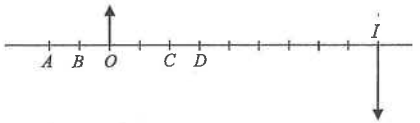
11. **< HKCE 1985 Paper II - 17 >**



In the above figure, the image I of an object placed at O is produced by a single lens. If the magnification is 2, what kind of lens has been used and where must it have been placed ?

A. a concave lens placed at A
B. a concave lens placed at B
C. a convex lens placed at C
D. a convex lens placed at D

12. **< HKCE 1986 Paper II - 11 >**



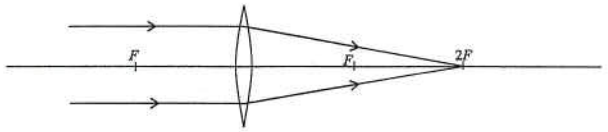
In the diagram shown, the image I is produced by a lens. The object is placed at O. What is the nature and position of this lens ?

A. concave and placed at A
B. convex and placed at B
C. concave and placed at C
D. convex and placed at D

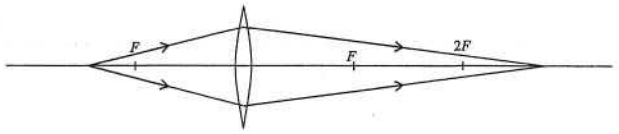
13. **< HKCE 1986 Paper II - 12 >**

Which of the following ray diagrams correctly show(s) the paths of light rays through the lens ?

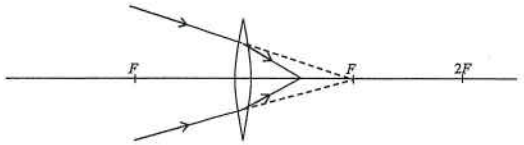
(1)



(2)



(3)

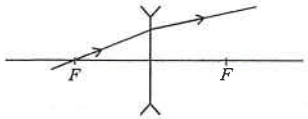


A. (3) only
B. (1) & (2) only
C. (2) & (3) only
D. (1), (2) & (3)

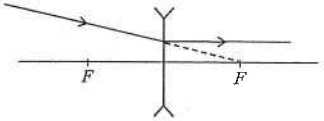
14. **< HKCE 1986 Paper II - 14 >**

If points F and F' represent the focal points of a concave lens, which of the following ray diagrams correctly shows the path of a light ray through the lens ?

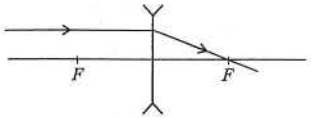
A.



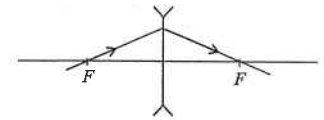
B.



C.



D.



15. **< HKCE 1987 Paper II - 21 >**

d

A concave lens is placed above the letter " d " which has the size shown in the above figure. The image of the letter " d " appears as

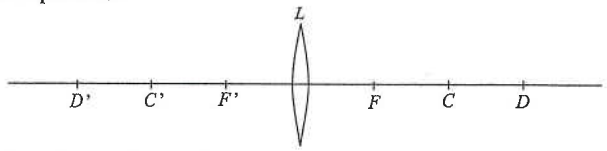
A. **d**

B. **p**

C. **d**

D. **p**

16. **< HKCE 1987 Paper II - 19 >**



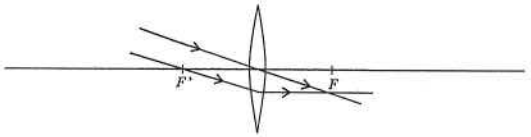
An object is placed in front of a convex lens L in the region $D'C'$, as shown in the diagram. If F is the focus of the lens, where should the image lie ?

A. between C' and F'
B. between F' and L
C. between L and F
D. between F and C

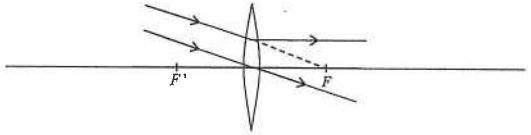
17. **< HKCE 1987 Paper II - 22 >**

Which of the following ray diagrams is/are correct ?

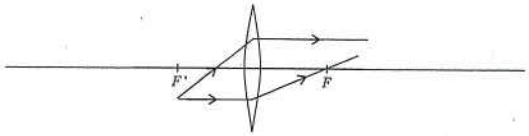
(1)



(2)

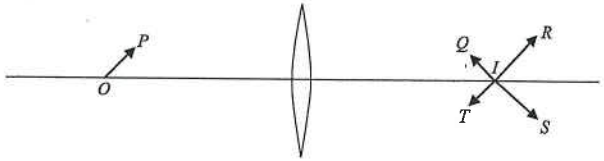


(3)



A. (1) only
B. (1) & (2) only
C. (2) & (3) only
D. (1), (2) & (3)

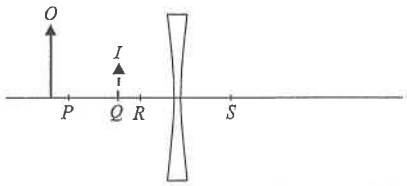
18. **< HKCE 1988 Paper II - 19 >**



The figure shows an object OP placed in front of a convex lens. Which of the following should be its most probable image ?

A. IQ
B. IR
C. IS
D. IT

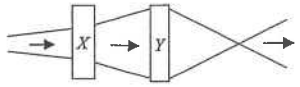
19. **< HKCE 1988 Paper II - 21 >**



The figure shows an object *O* placed in front of a concave lens to give an image *I*. What is the most probable position of the focus ?

A. *P*
B. *Q*
C. *R*
D. *S*

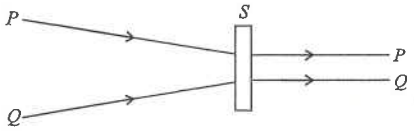
20. **< HKCE 1988 Paper II - 22 >**



The above figure shows a beam of light passing through devices *X* and *Y*. What could *X* and *Y* be ?

	X	*Y*
A.	concave lens	concave lens
B.	concave lens	convex lens
C.	convex lens	concave lens
D.	convex lens	convex lens

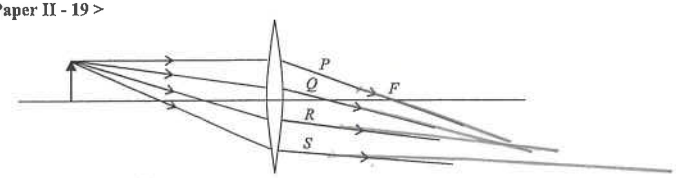
21. **< HKCE 1989 Paper II - 18 >**



Two light rays *P* and *Q* pass through an optical system *S* as shown in the figure above. *S* probably is

A. 
B.
C. 
D.

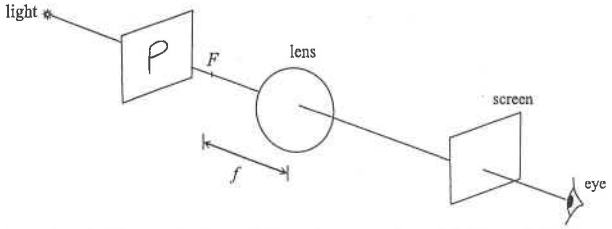
22. **< HKCE 1989 Paper II - 19 >**



Which of the 4 light rays *P*, *Q*, *R* and *S* drawn above is **NOT** possible ?

A. *P*
B. *Q*
C. *R*
D. *S*

23. **< HKCE 1989 Paper II - 20 >**



A slide illuminated by a light source is placed in front of a convex lens of focal length *f* as shown in the figure above. The image seen on the translucent screen is probably

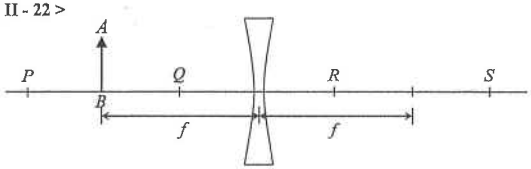
A. 

B. 

C. 

D. 

24. **< HKCE 1989 Paper II - 22 >**

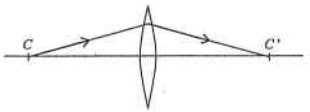


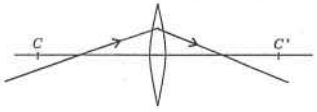
An object *AB* is placed at a distance of one focal length *f* in front of a concave lens as shown in the figure above. What is the position and the nature of the image ?

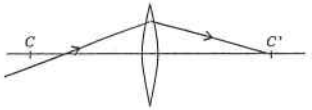
	Position	**Nature**
A.	at *P*	virtual and erect
B.	at *Q*	virtual and erect
C.	at *R*	real and inverted
D.	at infinity	-----

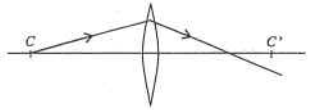
25. **< HKCE 1989 Paper II - 23 >**

If *C*, *C'* are both at a distance of 2 times the focal length from a convex lens, which of the following ray diagrams is correct ?

A. 

B. 

C. 

D. 

26. **< HKCE 1990 Paper II - 15 >**

A convex lens is used as a magnifying glass to read small printing in a book. Which of the following statements is/are true ?

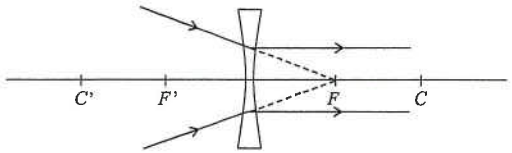
(1) The image distance is greater than the object distance.
(2) The image of the printing is real.
(3) The image of the printing is erect.

A. (1) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

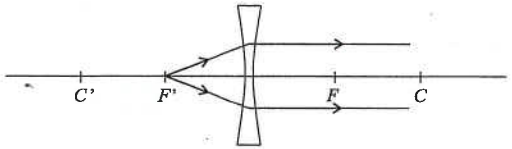
27. **< HKCE 1990 Paper II - 14 >**

If F, F' are foci and C, C' are both at a distance of two times the focal length from the lens, which of the following ray diagrams is/are correct ?

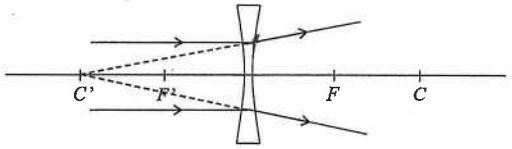
(1)



(2)

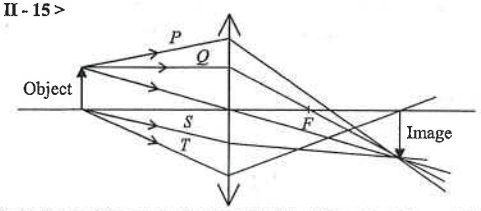


(3)



A. (1) only
B. (1) & (2) only
C. (2) & (3) only
D. (1), (2) & (3)

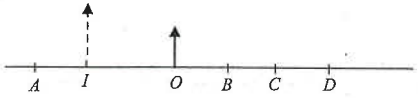
28. **< HKCE 1991 Paper II - 15 >**



In the figure above, F is the focus of the converging lens. Which of the refracted rays is INCORRECTLY drawn ?

A. P
B. Q
C. S
D. T

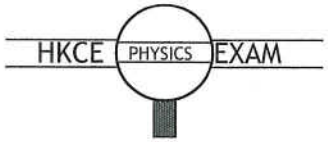
29. **< HKCE 1991 Paper II - 13 >**



In the diagram, the image I of an object O is produced by a lens. What is the nature and position of this lens ?

A. concave and placed at A
B. concave and placed at B
C. convex and placed at C
D. convex and placed at D

30. **< HKCE 1993 Paper II - 12 >**



A lens is used to look at some print on a paper. The image of the word "PHYSICS" is shown above. Which of the following statements is/are true ?

(1) The lens is a converging lens.
(2) The image lies between the paper and the lens.
(3) The image is real.

A. (2) only
B. (1) & (2) only
C. (1) & (3) only
D. (1), (2) & (3)

31. **< HKCE 1994 Paper II - 11 >**

Which of the following statements concerning real images formed by a lens is/are correct ?

(1) Real images are always diminished.
(2) Real images can be photographed with a camera.
(3) Without a screen, real images cannot be seen by the eye.

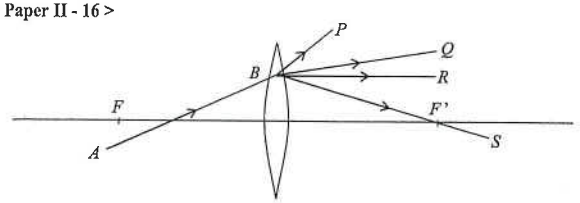
A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

32. **< HKCE 1995 Paper II - 13 >**

A convex lens is used as a magnifying glass to read some small print in a book. The glass is placed 3 cm from the book and the magnification is 3. What is the distance between the book and the image of the print ?

A. 3 cm
B. 6 cm
C. 9 cm
D. 12 cm

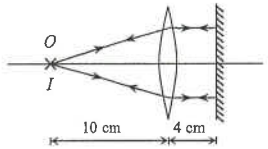
33. **< HKCE 1995 Paper II - 16 >**



In the above diagram, F, F' are the foci of the convex lens and AB is an incident ray. Which of the following paths best represents the emergent ray ?

A. P
B. Q
C. R
D. S

34. **< HKCE 1996 Paper II - 15 >**



When an object O is placed in front of a convex lens and a plane mirror as shown above, an image I is formed at the same positions as the object. Which of the following statements is/are correct ?

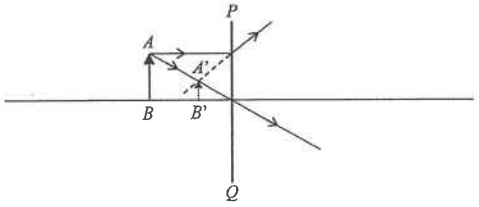
(1) The image I is real.

(2) The focal length of the lens is 10 cm.

(3) If the distance between the lens and the plane mirror is changed to 2 cm, the position of the image I would remain unchanged.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (1), (2) & (3)

35. **< HKCE 1997 Paper II - 12 >**



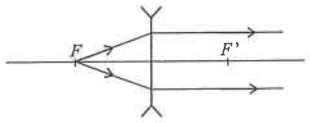
In the above diagram, $A'B'$ is the image of an object AB formed by an optical device PQ. What is PQ ?

A. a plane mirror
B. a glass block
C. a concave lens
D. a convex lens

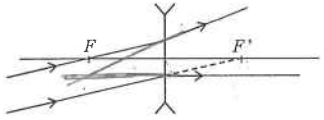
36. **< HKCE 1998 Paper II - 15 >**

If F and F' are the foci of the concave lens, which of the following ray diagrams is **incorrect** ?

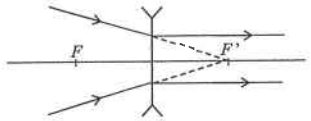
A.



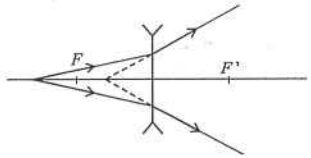
B.



C.

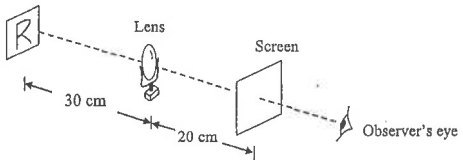


D.



For questions 37 and 38

An illuminated letter 'R' is placed in front of a lens as shown below and an image is formed on a translucent screen. The object distance is 30 cm and the image distance is 20 cm.



37. **< HKCE 1999 Paper II - 11 >**

Which of the following statements is/are correct ?

(1) The lens is a converging lens.

(2) The image is diminished.

(3) The shape of the image seen by the observer is 'Ꞵ'.

A. (1) only
B. (1) & (2) only
C. (2) & (3) only
D. (1), (2) & (3)

38. **< HKCE 1999 Paper II - 12 >**

If a piece of paper is used to cover one-half of the lens, which of the following describes the change in the image as seen by the observer ?

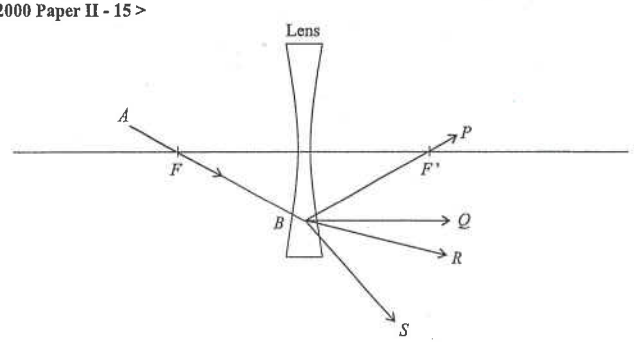
A. The whole image can still be seen but the image becomes dimmer.

B. The whole image can still be seen and its brightness remains unchanged.

C. Only half of the image can be seen and the image becomes dimmer.

D. Only half of the image can be seen but its brightness remains unchanged.

39. **< HKCE 2000 Paper II - 15 >**



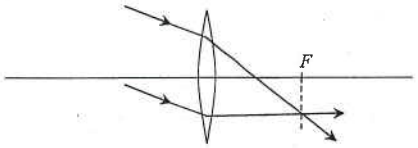
In the above figure, F and F' are the foci of the above lens and AB is an incident ray. Which of the following paths best represents the emergent ray ?

A. P
B. Q
C. R
D. S

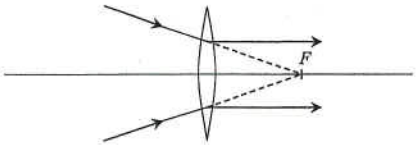
40. **< HKCE 2003 Paper II - 15 >**

Which of the following ray diagrams concerning the refraction of light ray by a converging lens is/are **incorrect** ? F denotes the focus of the lens.

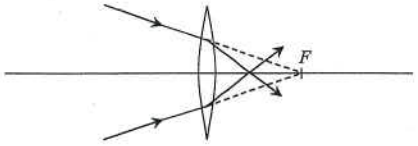
(1)



(2)



(3)



A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

41. **< HKCE 2003 Paper II - 16 >**

The photograph shows a student using a convex lens of focal length 20 cm to view a distant object. Which of the following statements about the image formed is/are correct ?

(1) The image will be erect.

(2) The image will be diminished.

(3) The student must use a screen in order to see the image.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

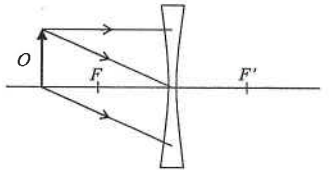
42. **< HKCE 2004 Paper II - 17 >**

The photograph shows a watch with a lens positioned over the date-display. Which of the following statements are correct ?

(1) The lens is a convex lens.
(2) The image of the date-display formed by the lens is virtual.
(3) The date-display and its image lie on the same side of the lens.

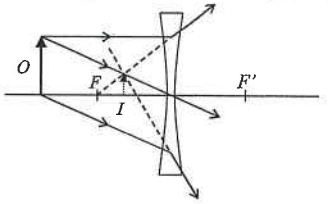
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

43. **< HKCE 2004 Paper II - 16 >**

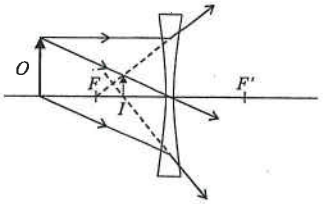


An object O is placed in front of a concave lens. F and F' are the foci of the lens. Which of the following diagrams shows the refracted rays of the three incident rays and the image I formed ?

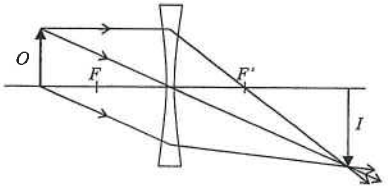
A.



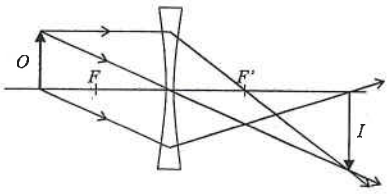
B.



C.



D.



44. **< HKCE 2004 Paper II - 15 >**

An object is placed in front of a concave lens. Which of the following statements about the properties of the image formed in the lens must be correct ?

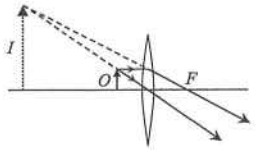
(1) The image is diminished.
(2) The image is virtual.
(3) The image distance is smaller than the focal length of the lens.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

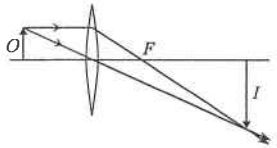
45. **< HKCE 2005 Paper II - 11 >**

Cecilia uses a magnifying glass to read some small print. Which of the following diagrams shows how the image of the print is formed ?

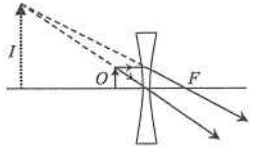
A.



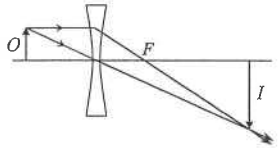
B.



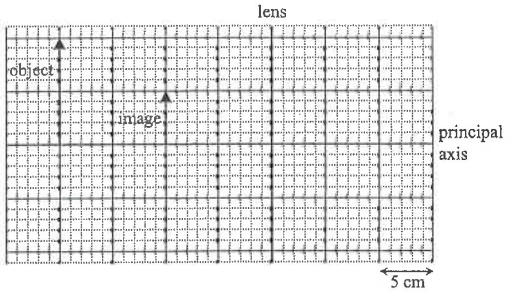
C.



D.



46. **< HKCE 2005 Paper II - 12 >**



An object is placed near a lens and an image is formed as shown. Which of the following statements are correct ?

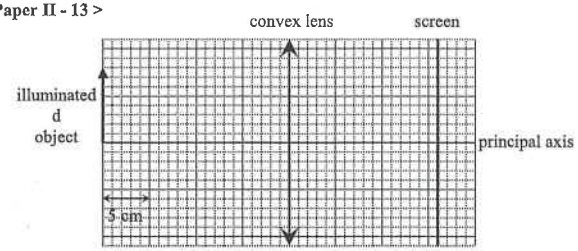
(1) The height of the image is half that of the object.

(2) The lens is a concave lens.

(3) The focal length of the lens is 20 cm.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

47. **< HKCE 2006 Paper II - 13 >**



As shown above, an illuminated object is placed at a distance 20 cm in front of a convex lens and a sharp image is formed on a screen at a distance of 16 cm from the lens. The focal length of the convex lens is

A. less than 8 cm.
B. between 8 cm and 10 cm.
C. between 10 cm and 16 cm.
D. between 16 cm and 20 cm.

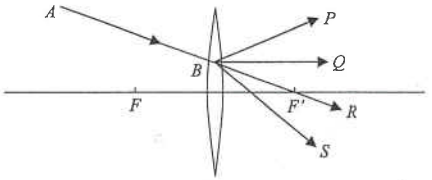
48. **< HKCE 2006 Paper II - 14 >**

Which of the following examples illustrate(s) a real image ?

(1) a fish in a pond being observed from above the water
(2) a fingerprint left at a crime scene being observed through a magnifying glass
(3) a motion picture on the screen being watched in a cinema

A. (1) only
B. (2) only
C. (3) only
D. (1), (2) & (3)

49. **< HKCE 2007 Paper II - 12 >**



F and *F'* are the foci of the above lens and *AB* is an incident ray. Which light ray best represents the emergent ray ?

A. *P*
B. *Q*
C. *R*
D. *S*

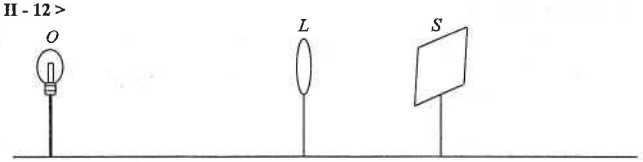
50. **< HKCE 2007 Paper II - 15 >**

The figure shows a web cam. A web cam typically includes a lens and an image sensor.
The function of the image sensor is similar to that of a film in a conventional camera.
The image is formed on the sensor and is then digitised.
Which of the following statements is/are correct ?

(1) The lens is a convex lens.
(2) The lens is a concave lens.
(3) Image formed on the image sensor is real.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

51. **< HKCE 2008 Paper II - 12 >**



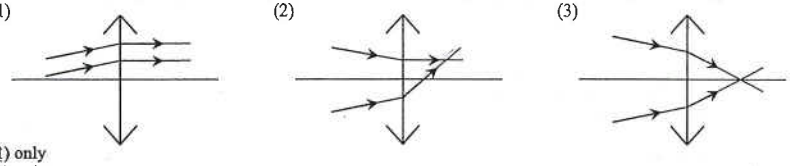
A light bulb O is placed in front of a lens L as shown above. A sharp and diminished image is formed on the screen S. With the position of L fixed, which of the following methods can form a sharp and magnified image on the screen ?

A. Move O and S towards L.
B. Move O and S away from L.
C. Move O towards L and move S away from L.
D. Move O away from L and move S towards L.

52. **< HKCE 2008 Paper II - 15 >**

Which of the following ray diagrams concerning the refraction of two light rays by a converging lens is/are possible ?

(1) (2) (3)



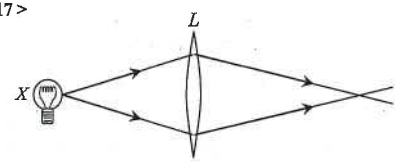
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

53. **< HKCE 2009 Paper II - 13 >**

A student puts a lens at a certain distance above a paper with the word "TEST" written on it as shown in the figure. What is the lens ? If the student moves the lens further away from the paper, what will be the change in the size of the image ?

	lens	change in size of the image
A.	convex	increases
B.	convex	decreases
C.	concave	increases
D.	concave	decreases

54. **< HKCE 2009 Paper II - 17 >**

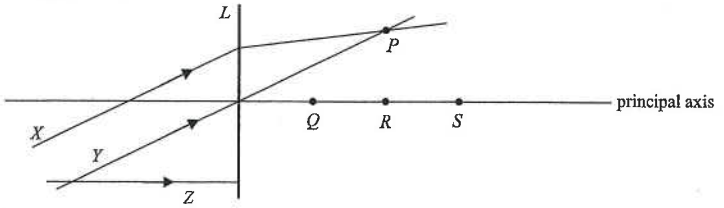


In the above figure, X is a light bulb and L is a convex lens. Which of the following ways can be used to produce a parallel beam of light rays ?

(1) Moving L closer to X.
(2) Replacing L with another convex lens of longer focal length
(3) Replacing L with another concave lens of shorter focal length

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

55. **< HKCE 2010 Paper II - 14 >**



Two parallel rays X and Y meet at P after passing through lens L as shown. Another ray Z parallel to the principal axis is directed to lens L. Which point in the figure will ray Z pass through ?

A. P
B. Q
C. R
D. S

56. **< HKCE 2011 Paper II - 16 >**

An object is placed in front of a concave lens. Which of the following descriptions about the image formed by the lens is **incorrect** ?

A. It is always virtual.
B. It is always diminished.
C. It is always between the object and the lens.
D. It will be formed at infinity if the object is placed at the focus of the lens.

57. **< HKCE 2011 Paper II - 17 >**

The figure above shows an object O and its image I formed by a lens. Which of the following about the lens used and its position is correct ?

	Type of lens	Position of lens
A.	concave	X
B.	concave	Y
C.	convex	X
D.	convex	Y

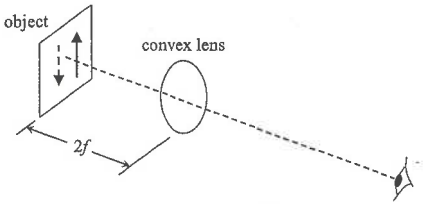
Part B : HKAL examination questions

58. **< HKAL 1980 Paper I - 15 >**

An object is placed in front of a converging lens of focal length 30 cm. For which of the following object distances would the image be real and magnified ?

A. 10 cm
B. 20 cm
C. 40 cm
D. 80 cm

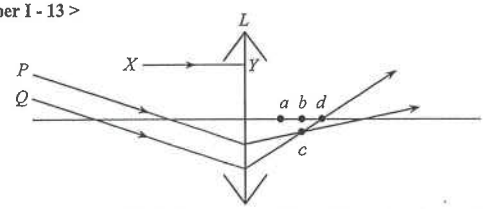
59. **< HKAL 1983 Paper I - 15 >**



An object with two arrows drawn on a screen is placed at a distance $2f$ from a convex lens of focal length f. Which of the following diagrams correctly represents the image seen by the eye when the object is viewed through the lens ?

A. 
B. 
C. 
D. 

60. **< HKAL 1984 Paper I - 13 >**



Two parallel light rays P and Q are incident onto a convex lens. After refraction, the two light rays meet at the point c. The ray XY parallel to the principal axis after passing through the lens will pass through the point

A. *a*.
B. *b*.
C. *c*.
D. *d*.

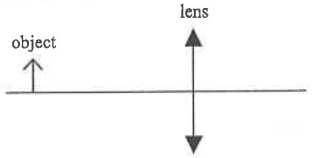
61. **< HKAL 2007 Paper IIA - 12 >**

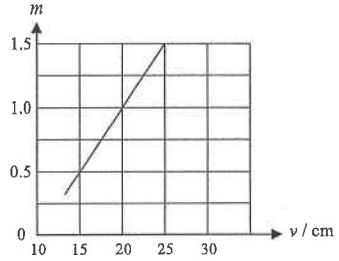
An object is placed at the focus of a diverging lens of focal length 10 cm. What is the magnification of the image formed ?

A. 0.5
B. 1.0
C. 2.0
D. infinite

62. **< HKAL 2009 Paper IIA - 20 >**

An object is placed at different distances in front of a converging lens. The image is formed on the other side of the lens. The graph shows the variation of the linear magnification m of the image with the image distance v. Find the focal length of the converging lens.





A. 10 cm
B. 15 cm
C. 20 cm
D. 30 cm

63. **< HKAL 2011 Paper IIA - 17 >**

An object is placed at 15 cm from a lens. A virtual image magnified 2 times is produced. The lens is a

A. concave lens of focal length 10 cm.
B. convex lens of focal length 10 cm.
C. concave lens of focal length 30 cm.
D. convex lens of focal length 30 cm.

64. **< HKAL 2013 Paper IIA - 18 >**

An object is placed 12 cm in front of a converging lens. An image is formed 24 cm from the lens. Find the focal length of the converging lens if the image is

(1) real ;
(2) virtual ?

	image is real	**image is virtual**
A.	24 cm	8 cm
B.	12 cm	8 cm
C.	8 cm	12 cm
D.	8 cm	24 cm

Part C : Supplemental exercise

65. An object is placed at 15 cm from a lens. A real image magnified 2 times is produced. The lens is a

A. concave lens of focal length 10 cm.
B. convex lens of focal length 10 cm.
C. concave lens of focal length 30 cm.
D. convex lens of focal length 30 cm.

66. An object is placed in front of a convex lens of focal length 20 cm. For which of the following object distances would the image be erect ?

A. 10 cm
B. 30 cm
C. 40 cm
D. 60 cm

67. An object is moving at constant speed away from a convex lens of focal length 20 cm. At the moment when it is at 30 cm from the lens, which of the following descriptions of the image is correct ?

	direction of image movement	**speed of the image**
A.	away from the lens	faster than that of the object
B.	towards the lens	faster than that of the object
C.	away from the lens	slower than that of the object
D.	towards the lens	slower than that of the object

Part D : HKDSE examination questions

68. **< HKDSE Sample Paper IA - 21 >**

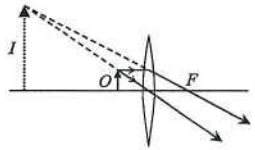
An object is placed at the focus of a concave lens of focal length 10 cm. What is the magnification of the image formed ?

A. 0.5
B. 1.0
C. 2.0
D. infinite

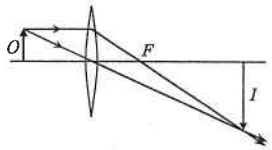
69. **< HKDSE Sample Paper IA - 16 >**

Cecilia uses a magnifying glass to read some small print. Which of the following diagrams shows how the image of the print is formed ?

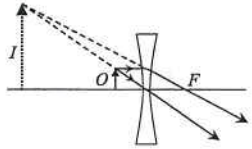
A.



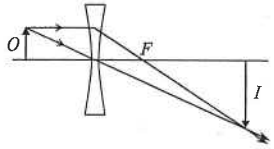
B.



C.



D.



70. **< HKDSE Practice Paper IA - 21 >**

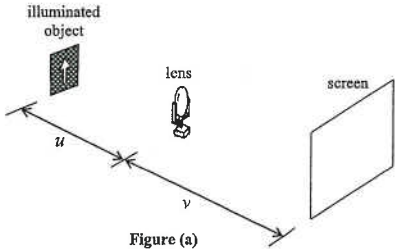


Figure (a)

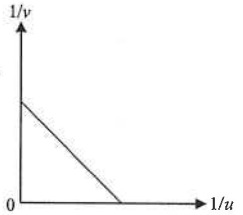
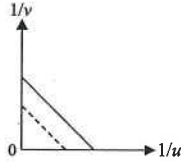


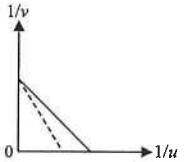
Figure (b)

A student uses the set-up in Figure (a) to study the relationship between the object distance u and the image distance v of a convex lens. A graph of $1/v$ against $1/u$ is plotted in Figure (b). If the lens is replaced by another convex lens of shorter focal length, which of the following graphs (in dotted lines) would be obtained ?

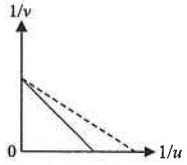
A.



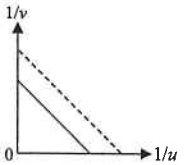
B.



C.



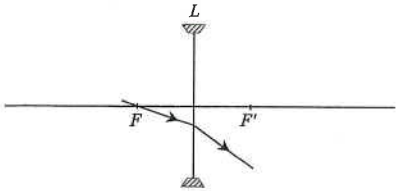
D.



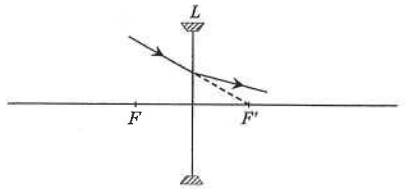
71. **< HKDSE 2012 Paper IA - 21 >**

In each of the following diagrams, L is a concave lens and its two principal foci are denoted by F and F'. Which of the ray diagrams is/are possible ?

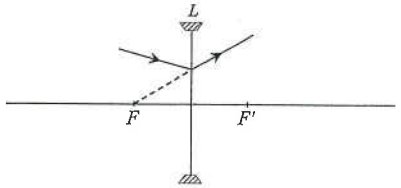
(1)



(2)

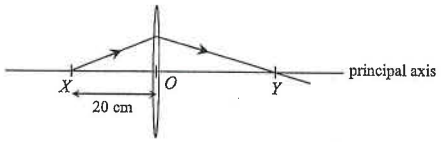


(3)



A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

72. **< HKDSE 2013 Paper IA - 22 >**



A point light source at X on the principal axis of a thin convex lens emits a ray of light. The ray passes through the lens and reaches the principal axis at point Y as shown. O is the optical centre of the lens such that $OX = 20$ cm and $OY > OX$. Which of the following statements is/are correct ?

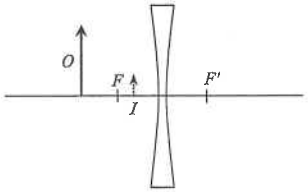
(1) The focal length of the lens is shorter than 20 cm.

(2) If the point light source is shifted away from the lens, separation OY would increase.

(3) An object placed at Y would give a diminished image at X.

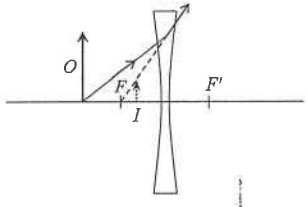
A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

73. **< HKDSE 2015 Paper IA - 15 >**

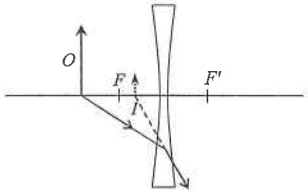


An object O placed in front of a concave lens forms an image I as shown. F and F' are the foci of the lens. Which ray diagram is correct ?

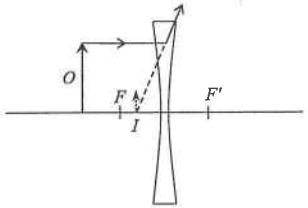
A.



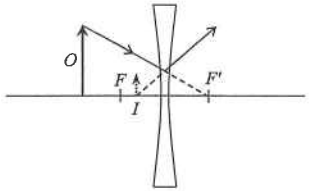
B.



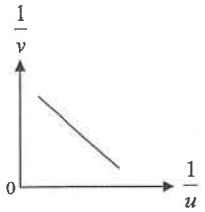
C.



D.

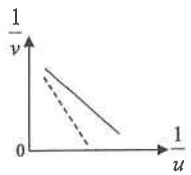


74. **< HKDSE 2015 Paper IA - 16 >**

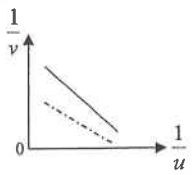


A student uses a convex lens to investigate the variation of image distance v with object distance u for real image. The graph of $\frac{1}{v}$ plotted against $\frac{1}{u}$ is shown above. If a convex lens of longer focal length is used, what would be the expected result (in dotted lines) ?

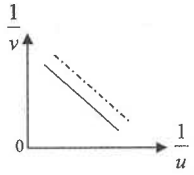
A.



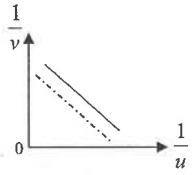
B.



C.



D.



75. **< HKDSE 2016 Paper IA - 22 >**

An object is moving at constant speed towards a convex lens of focal length 10 cm. At the moment when it is at 100 cm from the lens, which of the following descriptions of the image is correct ?

	direction of image movement	speed of the image
A.	away from the lens	faster than that of the object
B.	towards the lens	faster than that of the object
C.	away from the lens	slower than that of the object
D.	towards the lens	slower than that of the object

76. **< HKDSE 2017 Paper IA - 19 >**

When an object is placed 30 cm in front of a concave lens, an image is formed 20 cm away from the lens. If the concave lens is replaced by a convex lens of the same focal length and the object distance remains unchanged, which of the following descriptions about the image formed is correct ?

	nature of the image	image distance
A.	real	20 cm
B.	real	60 cm
C.	virtual	20 cm
D.	virtual	60 cm

77. **< HKDSE 2018 Paper IA - 19 >**

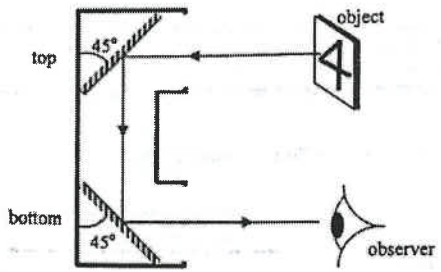
An object placed 25.0 cm in front of a lens forms a virtual image at a distance 11.1 cm from the lens. The lens is a

A. concave lens of focal length 7.7 cm.
B. concave lens of focal length 20 cm.
C. convex lens of focal length 7.7 cm.
D. convex lens of focal length 20 cm.

78. **<HKDSE 2019 Paper IA-20>**

79. <HKDSE 2019 Paper IA-17>

The figure shows a periscope designed by a student. An object is observed via the periscope.



Which image will the observer see ?

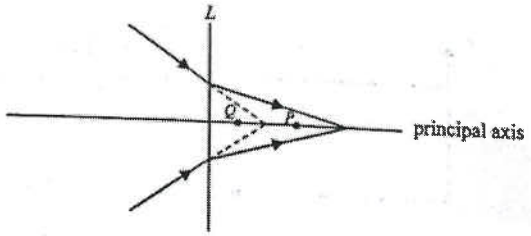
A. 

B. 

C. 

D. 

80. <HKDSE 2020 Paper IA-18>

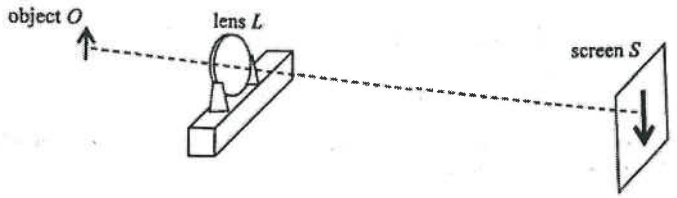


Referring to the above ray diagram, what kind of lens is represented by L ? Which point, P or Q, can be its focus ?

	lens L	focus
A.	concave	P
B.	convex	P
C.	concave	Q
D.	convex	Q

81. <HKDSE 2020 Paper IA-20>

The figure shows an enlarged sharp image of an object O formed on a screen S by a convex lens L.



Which of the following can give a diminished sharp image on the screen ?

(1) Keeping the positions of O and L unchanged, move S suitably closer to L.
(2) Keeping the positions of L and S unchanged, move O suitably farther away from L.
(3) Keeping the positions of O and S unchanged, move L suitably closer to S.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

M.C. Answers

1. D	11. C	21. C	31. B	41. B	51. C
2. D	12. D	22. D	32. B	42. D	52. B
3. D	13. C	23. C	33. B	43. B	53. D
4. B	14. B	24. B	34. D	44. D	54. A
5. C	15. A	25. A	35. C	45. A	55. C
6. D	16. D	26. B	36. A	46. D	56. D
7. C	17. A	27. A	37. B	47. B	57. D
8. C	18. C	28. C	38. A	48. C	58. C
9. D	19. A	29. D	39. D	49. D	59. D
10. B	20. B	30. A	40. A	50. C	60. B
61. A	71. A	81. B			
62. A	72. C				
63. D	73. B				
64. D	74. D				
65. B	75. C				
66. A	76. D				
67. B	77. B				
68. A	78. A				
69. A	79. D				
70. D	80. A				

M.C. Solution

1. D

Covering top half of the lens means that only half of the lens can refract light to form the image.

Therefore, less light passes through the lens, thus the image becomes dimmer.

However, the shape and size of image remain unchanged, that is, the whole image can still be seen.

2. D

Since convex lens is a converging lens, the ray after refraction must bend towards the principal axis.

3. D

✓ (1) Since the image distance is larger than the object distance, the image is larger than the object.

✓ (2) Since the image can form on the screen, it must be a real image

✓ (3) Since the image is real, it must be inverted.

4. B

Since the position of image is beyond $2F$,

thus the position of object should be between F and $2F$ ∴ the object is placed near to Q

5. C

Since concave lens is a diverging lens, the ray after refraction must bend away from the principal axis.

6. D

✓ (1) If the screen is moved towards the lens until it is at P, the sharp image would be formed at the screen.

✓ (2) Since image and object move at the same distance, if the object is moved to the right, the image would also move to the right and formed at the screen.

✓ (3) If the focal length is increased, then the refracted light would be converged to a less extent and the image may form on the screen.

7. C

✓ (1) naked eye can see virtual images directly

× (2) light rays diverging from virtual images cannot be captured by screen

✓ (3) camera can take a picture of virtual image directly

8. C

× (1) Object placed between convex lens and focus ⇒ image is virtual

✓ (2) Object placed between convex lens and focus ⇒ image is magnified

✓ (3) Virtual image ⇒ image is erect

9. D

× A. Object placed between the lens and F will give a magnified and virtual image

× B. Object placed between F and $2F$ will give a magnified and real image

× C. Object placed at $2F$ will give a same size and real image

✓ D. Object placed beyond $2F$ will give a diminished and real image

10. B

Lens X should be concave to give a divergent beam of rays.

Lens Y must be convex so that the divergent beam of light bends towards the principal axis to give a parallel beam of rays.

∴ (3) is the only correct answer.

11. C

Draw a line joining the head of the object and the image.

The intersection point of the line with the principal axis gives the position of the lens.

Thus C is the correct position of the lens.

On the other hand, since the image is magnified, the lens must be convex.

12. D

Draw a line joining the head of the object and the image.

The intersection point of the line with the principal axis gives the position of the lens.

Thus D is the correct position of the lens.

On the other hand, since the image is inverted, the lens must be convex.

13. C

× (1) Parallel beam of light should converge to the focus F, not to $2F$.

✓ (2) Object between F and $2F$ give the image beyond $2F$.

✓ (3) Light rays after refracted by a converging lens must bend towards the principal axis.

14. B

× A. Light passing through the lens bends to the principal axis ⇒ property of converging lens

✓ B. Incident light through focus on the other side of lens ⇒ emerge as ray parallel to principal axis

× C. Light parallel to principal focus converges to focus ⇒ property of converging lens

× D. Light passing through the lens bends to the principal axis ⇒ property of converging lens

15. A

The image formed by a concave lens must be erect and diminished.

16. D

For a convex lens, if the object is placed beyond $2F$,

the image must form between F and $2F$ at the other side of the lens.

17. A

✓ (1) Parallel incident rays must converge to a focus on the focal plane.

× (2) The two rays should not diverge after passing through a convex lens, which is a converging lens.

× (3) Since the upper ray does not come from the focus, it should not emerge as light ray parallel to the axis.

18. C

As real image must be inverted, thus IS and IT may be possible.

When point P of the object is shifted closer to the lens,

the image should be shifted in the same direction, that is, further away from the lens.

Thus, IS is the possible one.

19. A

By drawing light ray parallel to principal axis from object, the light ray should diverge from image.

By extending this line, it would meet the principal axis at P, thus P is the focus.

20. B

Light rays diverge after passing through X, thus X is a concave lens.

Light rays converge after passing through Y, thus Y is a convex lens.

21. C

Treat right side parallel rays as **incident** rays, they diverge after passing the lens.

Thus the lens must be a diverging lens, that is, a concave lens.

22. D

All the light rays emitting from the same point must meet also at the same point after passing through the lens.

Extending rays P, Q and R would meet at a point to give the image,

but ray S would not meet at that point.

23. C

As the object is placed between F and $2F$,

the image must be real, inverted and magnified.

24. B

Nature : Concave lens ⇒ image must be virtual and erect

Position : Concave lens

⇒ image must be virtual ⇒ on the same side as object

⇒ image must be diminished ⇒ $v < u$ ⇒ Q is the position

25. A

✓ A. Light ray emitted from C should converge to C'

× B. Incident light ray from a point between C and F
⇒ refracted ray should converge to a point beyond C'

× C. Incident light ray from a point between C and F
⇒ refracted ray should converge to a point beyond C'

× D. Light ray emitted from C should converge to C'

26. B

✓ (1) $v > u \Rightarrow h_i > h_o$ ∴ image is magnified

× (2) Image formed behind the lens ⇒ virtual image

✓ (3) Virtual image ⇒ erect

27. A

✓ (1) Treat right side as parallel incident lights, they should diverge from focus.

× (2) Light rays should not converge after passing a concave lens, which is a diverging lens.

× (3) Parallel incident lights should diverge from focus, not C'.

28. C

The incident light ray S comes from the bottom of the object,

thus it must refract towards the bottom of the image, not towards the head of the image.

29. D

Nature of lens : Since the image is magnified, thus the lens must be convex.

Position of lens : Draw a line joining the head of the object and the image.

The intersection point of the line with the principal axis gives the position of the lens.

Thus D is the correct position of the lens.

30. A

× (1) As the image is erect and diminished, the lens must be a concave lens, that is, diverging lens.

✓ (2) As the image is diminished, magnification $m < 1$,
thus $v < u$, the image distance is shorter than the object distance, the image is closer than the object.

× (3) Since the image is erect, it must be virtual.

31. B

× (1) Real images may be magnified or diminished

✓ (2) Camera can take picture for both real and virtual images

× (3) Human eye can see real images directly

32. B

$v = mu = 3 \times 3 = 9$ cm

$\therefore$ Distance between the book and the print $= v - u = 9 - 3 = 6$ cm

33. B

× A. P is not correct since it bends away from the principal axis

✓ B. Q is correct since it bends towards the principal axis

× C. R is not correct since the incident ray does not pass through the focus F

× D. S is not correct since the incident ray is not parallel to the principal axis.

34. D

✓ (1) Since refracted light rays actually pass through the image, thus the image is real.

✓ (2) Parallel incident rays converge to focus $\Rightarrow f = 10$ cm

✓ (3) Light rays between lens and mirror is still parallel, regardless of the distance between mirror and lens.

35. C

As the image is virtual, erect and diminished,

the lens must be a concave lens.

36. A

× A. Light ray parallel to principal axis diverge from focus

✓ B. Light ray extension passes through F' $\Rightarrow$ emerge as parallel ray $\Rightarrow$ lower light ray is correct

✓ C. Light ray extension passes through F' $\Rightarrow$ emerge as parallel ray

✓ D. Emerged light ray bends away from the side of the principal axis.

37. B

✓ (1) Real image formed from lens $\Rightarrow$ converging lens

✓ (2) $u > v \Rightarrow m < 1 \Rightarrow$ image diminished

× (3) Real image $\Rightarrow$ inverted $\Rightarrow$ image seen on the screen is Ꙅ

38. A

If half of the lens is covered,

only half of the lens can refract light to form the image,

thus the image must become dimmer.

39. D

For concave lens which is diverging lens, the refracted ray must bend away from the principal axis.

Rays P, Q and R bend towards the principal axis.

Only ray S bends away from the principal axis.

40. A

✓ (1) The two parallel light rays converge to a point on the focal plane.

× (2) It is not correct since the light rays diverge after passing through the convex lens.

✓ (3) The two light rays converge after passing through the convex lens.

[Note that the question asks you to find out the ray diagram which is NOT correct]

41. B

For a distant object, the image must be real, inverted and formed at the focus of the convex lens.

× (1) The image should be inverted.

✓ (2) The image must be diminished since the image distance is less than the object distance.

× (3) The student can see the real image directly without the use of screen.

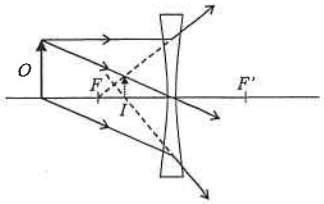
42. D

✓ (1) Since the image is magnified, it must be a convex lens. Only convex lens can give magnified image.

✓ (2) Since the image is erect, the image must be virtual.

✓ (3) Since the image is virtual, it must be at the same side as the object.

43. B



A ray parallel to the principal axis should be diverged from the focus F.

A ray through the optical centre should pass without bending.

A ray emitted from the bottom of the object should seem to be emitted from the bottom of the image.

44. D

Images formed by a concave lens have the following properties :

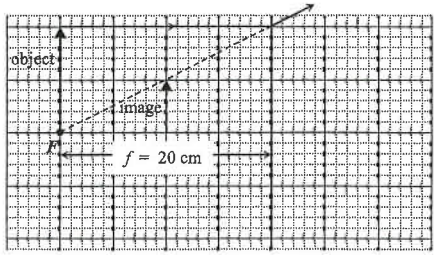
* virtual
* erect
* diminished
* form in the region between the focus and the lens

45. A

A magnifying glass is a convex lens.

The image formed is virtual, erect and magnified.

46. D

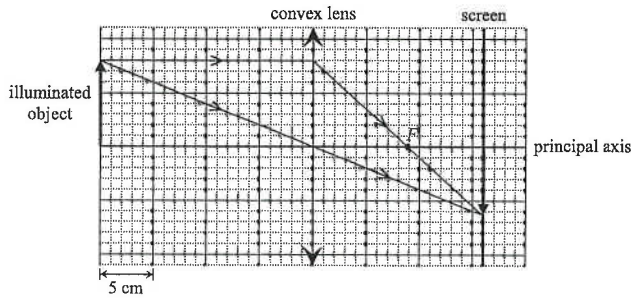


✓ (1) Height of image is half of that of object, giving a magnification of 0.5.

✓ (2) Only concave lens can give a diminished and virtual image.

✓ (3) Draw a ray parallel to the principal axis and diverge from the image, the intersection with the axis gives the focus. The focal length is 20 cm.

47. B



From the above figure, the focal length is about 9 cm, i.e. between 8 cm and 10 cm.

48. C

× (1) The image of the fish at the apparent depth is a virtual image.

× (2) The image given by a magnifying glass must be virtual, erect and magnified.

✓ (3) The image formed on the screen is a real image.

49. D

The lens is a convex lens, i.e. a converging lens. Only ray S bends towards the principal axis.

50. C

✓ (1) Only convex lens can form real image onto the film.

× (2) Concave lens cannot form real image onto the film.

✓ (3) The image is real since the sensor (film) has to receive light to record the information.

51. C

To give a magnified image, the linear magnification $m > 1$, and image distance $v >$ object distance u.

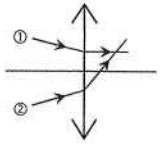
Thus, the distance LS should be increased and the distance OL should be decreased.

Therefore, move O towards L and move S away from L can achieve this.

52. B

× (1) The parallel rays should converge to a point at the focal plane after passing through the converging lens.

× (2) In this figure, ray ① is not correct since it bends away from the principal axis.
However, ray ② is correct since it bends towards the principal axis.



✓ (3) Both two rays are correct since they bend towards the principal axis after refraction.

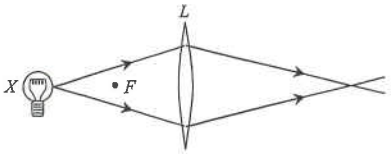
53. D

As the image is erect (virtual) and diminished, the lens must be a concave lens.

If the lens is moves away from the paper, object distance increases, image distance would also increase.

As the image moves closer to the focus, the image size would decrease.

54. A



✓ (1) The light bulb is now beyond the focus F.
If the lens L is moved closer to X, X can then be at the focus and gives a parallel beam of light rays.

✓ (2) If the convex lens has a focal length longer so that the light bulb X is at the focus, then a parallel beam of light rays can be produced.

× (3) Concave lens is a diverging lens, and it can never produce a parallel beam of light rays.

55. C

The two parallel rays X and Y meet at P, thus P is one of the focus on the focal plane, and R is the principal focus.

For a light ray parallel to the principal axis, the refracted ray must pass the principal focus R, thus ray Z will pass through R.

56. D

✓ A. The image of a concave lens must always be virtual and erect.

✓ B. The image of a concave lens must always be diminished.

✓ C. Since the image must be diminished, $m < 1$, $v < u$, thus the image distance must be shorter than the object distance.

× D. Even the object is placed at the focus, the image is still between the lens and the focus.

57. D

Since the image is magnified, the lens must be convex since only convex lens can give a magnified image.

Since the image is virtual, it must be at the same side as the object, thus the lens must be at position Y.

58. C

For a converging lens, $f < u < 2f$ gives a real and magnified image.

Thus, object distance 40 cm that is greater than f of 30 cm but less than $2f$ of 60 cm will give a real and magnified image.

59. D

A real image formed by the convex lens must be inverted.

Thus, the dotted arrow shifts from the left to the right and the head of the dotted arrow shifts from the bottom to the top.

60. B

As the two incident rays are parallel, the two refracted rays must meet at the focal plane.

Thus, the vertical plane containing b and c is the focal plane and b is the principal focus.

As the ray XY is parallel to the principal axis, the refracted ray must pass through the principal focus b.

61. A

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

$\therefore \frac{1}{(-10)} = \frac{1}{(10)} + \frac{1}{v}$

$\therefore v = -5\text{ cm}$

$\therefore m = \frac{v}{u} = \frac{(5)}{(10)} = 0.5$

62. A

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

$\therefore \frac{v}{f} = \frac{v}{u} + \frac{v}{v} \quad \therefore \frac{v}{f} = m + 1 \quad \therefore m = \frac{1}{f}v - 1$

By slope-intercept form : $y = mx + c$, slope of the graph is $\frac{1}{f}$.

$\therefore$ slope $= \frac{1}{f} = \frac{1.5 - 0.5}{25 - 15} \quad \therefore f = 10\text{ cm}$

OR

When $m = 1$, $v = 20$ cm.

When $m = 1$, $u = v = 2f \quad \therefore f = 10\text{ cm}$

63. D

By $v = mu = (2)(15) = 30$ cm

For a virtual image, v is (–) in the lens formula.

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \quad \therefore \frac{1}{f} = \frac{1}{(15)} + \frac{1}{(-30)} \quad \therefore f = +30\text{ cm}$

The lens is convex with focal length 30 cm.

64. D

Image is real : $\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{(12)} + \frac{1}{(24)} \quad \therefore f = +8\text{ cm}$

Image is virtual : $\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{(12)} + \frac{1}{(-24)} \quad \therefore f = +24\text{ cm}$

65. B

By $v = m u = (2)(15) = 30$ cm

For a real image, the image distance is (+) in the lens formula.

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{f} = \frac{1}{(15)} + \frac{1}{(30)}$ $\therefore f = +10$ cm

The lens is convex with focal length 10 cm.

66. A

For a convex lens, $u < f$ gives a virtual, erect and magnified image.

Thus, object distance 10 cm that is less than f of 20 cm will give a virtual, erect and magnified image.

67. B

Assume the object is at the left hand side of the convex lens.

Since the object distance $2f > u > f$, the image is real, inverted, magnified and at the right hand side of the lens.

When the object moves leftwards away from the lens,

① the real image at the other side also moves leftwards, that is, towards the lens

② as the image is magnified, the speed of the image is faster than that of the object

68. A

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{(-10)} = \frac{1}{(10)} + \frac{1}{v}$ $\therefore v = -5$ cm

$\therefore m = \frac{v}{u} = \frac{(5)}{(10)} = 0.5$

69. A

A magnifying glass is a convex lens. The image formed is virtual, erect and magnified.

70. D

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{v} = -\frac{1}{u} + \frac{1}{f}$

Compared with the slope-intercept form of a straight line : $y = mx + c$

The slope of the line must be equal to – 1 and the y-intercept is $1/f$.

If the lens is replaced by another lens of shorter focal length, the slope is still equal to – 1.

As f is decreased, $1/f$ is increased, therefore, the y-intercept should increase, as shown in option D.

71. A

✓ (1) Concave lens is a diverging lens, thus the light ray bends away from the principal axis.

× (2) Since the ray is incident towards the focus F', the refracted ray should be parallel to the principal axis.

× (3) If the refracted ray is diverged from the focus F, the incident ray should be parallel to the principal axis.

72. C

✓ (1) If an object is placed at X, the image is real and formed at Y.
To give a real image, the object must be placed beyond the focus.
Thus, OX is longer than the focal length, that is, f is shorter than 20 cm.

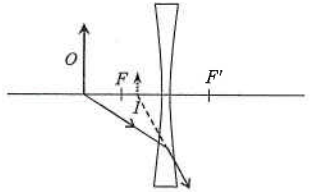
× (2) If the object is shifted towards the left, the image would also shift towards the left,
thus OY should decrease.

✓ (3) If an object is placed at Y, the image would form at X.
As the image distance OX is shorter than the object distance OY,
that is, $v < u$, thus $m < 1$, the image is diminished.

73. B

× A. The incident ray emitting from the bottom of the object should diverge from the bottom of the image,
not from the top of the image.

✓ B. The incident ray emitting from the bottom of the object correctly diverge from the bottom of the image.



× C. The incident ray emitting from the top of the object should diverge from the top of the image,
not from the bottom of the image.

× D. The incident ray emitting from the top of the object should diverge from the top of the image,
not from the bottom of the image.

74. D

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{v} = -\frac{1}{u} + \frac{1}{f}$

Compared with the slope-intercept form of a straight line : $y = mx + c$

The slope of the line must be equal to – 1 and the y-intercept is $1/f$.

If the lens is replaced by another lens of longer focal length, the slope is still equal to – 1.

As f is increased, $1/f$ is decreased, therefore, the y-intercept should decrease, as shown in option D.

75. C

Assume the object is at the left hand side of the convex lens.

Since the object distance $u > 2f$, the image is real, inverted, diminished and at the right hand side of the lens.

When the object moves rightwards towards the lens,

① the real image at the other side also moves rightwards, that is, away from the lens

② as the image is diminished, the speed of the image is slower than that of the object

76. D

For a concave lens, the image must be virtual, thus v is negative.

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{f} = \frac{1}{(30)} + \frac{1}{(-20)}$ $\therefore f = -60$ cm

For a convex lens, the focal length must be positive, thus f is + 60 cm.

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{(60)} = \frac{1}{(30)} + \frac{1}{v}$ $\therefore v = -60$ cm

Since v is negative, the image is virtual, and the image distance is 60 cm.

77. B

By $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{f} = \frac{1}{(25)} + \frac{1}{(-11.1)}$ $\therefore f = -20$ cm

Since the focal length is (–), it is a concave lens.

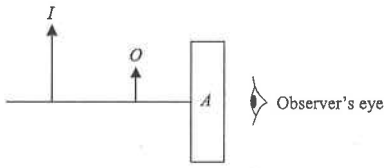
The following list of formulae may be found useful :

Equation for a single lens $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

Part A : HKCE examination questions

1. **< HKCE 1979 Paper I - 5 >**

The box A in the Figure below represents an optical device capable of forming an image I of a given object O as shown.



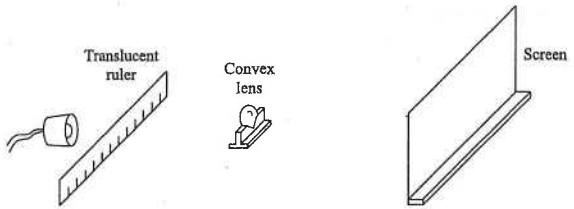
(a) What is the optical device as represented by A ? (1 mark)

(b) State whether the image formed is real or virtual. (1 mark)

2. **< HKCE 1984 Paper I - 6 >**

(a) Describe briefly with the aid of a ray diagram, a simple laboratory method that can be used to determine the focal length of a convex lens. (4 marks)

2. (b)



The figure shown above is a simple experimental set-up to study the image formed by a convex lens. The translucent ruler is an illuminated object, the position of which remains unchanged throughout the experiment. The position of the lens is adjusted so that a sharp image of the ruler is formed on the screen.

(i) Suppose that the distance between the lens and the ruler is 25 cm and that the focal length of the lens is 20 cm. What must be the distance between the lens and the screen? Draw a scaled diagram in the figure below to find the answer. What is the magnification of the image ? (4 marks)

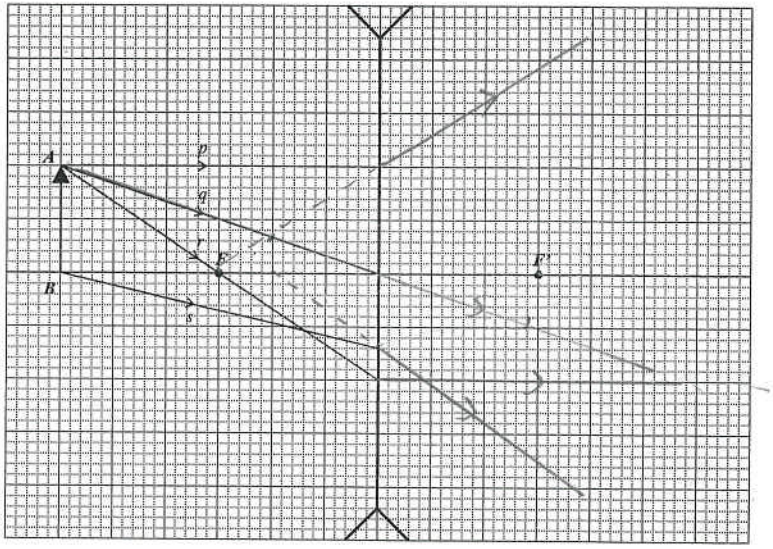
(ii) If the screen is now moved a few centimetres towards the object, how would you adjust the position of the lens to give a sharp image on the screen again ? (2 marks)

(iii) Keeping its position unchanged, the lens is now replaced by another convex lens of shorter focal length, and the screen is adjusted to give a sharp image. How would the magnification of the image be affected ? Explain briefly. (2 marks)

2. (b) (iv) Explain, with the aid of a ray diagram, why an image cannot be formed on the screen when the distance between the lens and the ruler is smaller than the focal length of the lens. (3 marks)

3. **< HKCE 1987 Paper I - 5 >**

The figure below shows an object AB in front of a concave lens with foci F and F'. p, q, r and s are incident rays.



(a) Draw the refracted rays of p, q, r and s and the image of AB on the above figure. (5 marks)

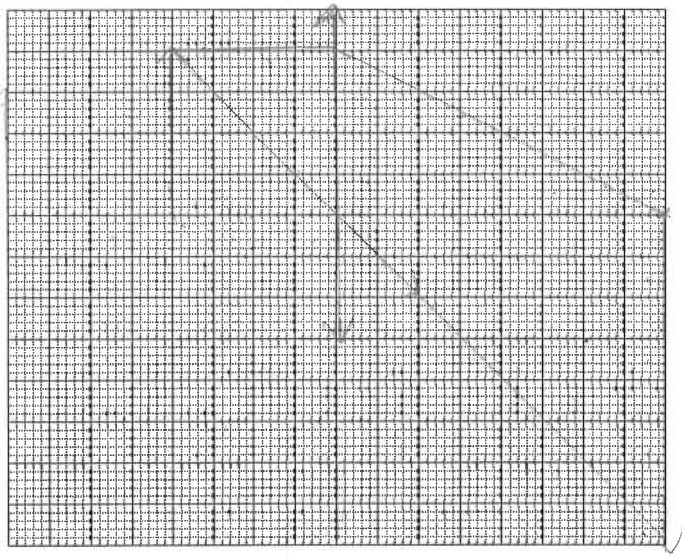
(b) State the nature (real or virtual, erect or inverted) of the image. (2 marks)

(c) Find the magnification. (2 marks)

4. **< HKCE 1989 Paper I - 6 >**

An object of height 4 cm placed in front of a lens produces an image of height 8 cm on a screen. The object and the image are 60 cm apart.

(a) (i) Draw a ray diagram on a graph paper, using a scale of 1 cm representing 5 cm for the object and image distances and a scale of 1 cm representing 1 cm for the object and image heights to show TWO rays between the object and the image. (3 marks)



(ii) From the ray diagram, measure (3 marks)

(1) the object distance,

(2) the image distance, and

(3) the focal length of the lens.

(iii) What is the

(1) magnification and

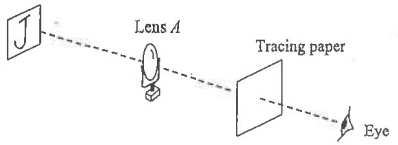
(2) nature

of the image? (3 marks)

(b) Describe the change in the magnification and nature of the image when the object is moving from nearly touching the lens to far away from the lens. (6 marks)

5. **< HKCE 1990 Paper I - 6 >**

The figure below shows an experimental set-up to study image formation by convex lens *A* of focal length 40 cm. The object is an illuminated letter 'J' placed a few metres away. The tracing paper is moved to catch a sharp image.



(a) (i) What is the approximate distance between lens *A* and the image ? Explain briefly. (2 marks)

(ii) Sketch the shape of the image seen by the observer. (2 marks)

(b) If the experiment is repeated with a convex lens of longer focal length, what will be the change in the size of the image ? Illustrate your answer with a ray diagram. (4 marks)

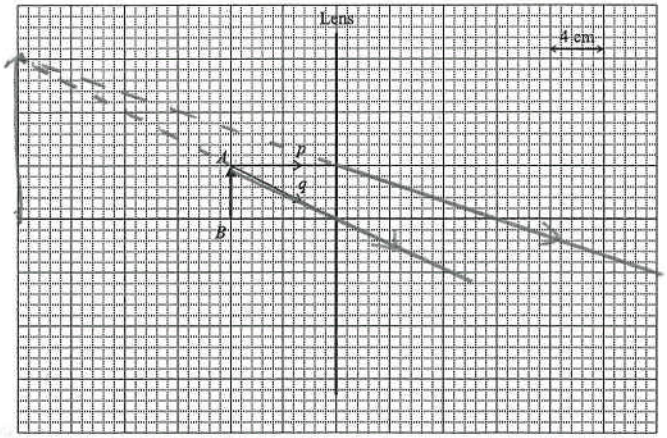
6. **< HKCE 1992 Paper I - 3 >**

A student holds a lens close to his eye to look at some small print on a paper. The image of the letters "EX" is shown in the Figure below. The magnification is 3.

(a) What kind of lens is used in the above figure ? Explain briefly. (2 marks)

(b) State the nature (real or virtual, erect or inverted) of the image. (2 marks)

6. (c) The paper is placed at a distance of 8 cm from the lens. In the figure below, *AB* represents the object, and *p*, *q* are two incident rays. A scale of 1 cm representing 4 cm for the object distance is used.



(i) Draw the refracted rays of *p* and *q* and the image of *AB* in the above figure. (4 marks)

(ii) From the ray diagram, measure

(1) the image distance,

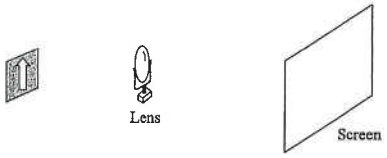
(2) the focal length of the lens. (2 marks)

(d) If the paper is placed closer to the lens, how would the size of the image and the image distance be affected ? Illustrate your answer with a ray diagram. (4 marks)

(e) If the paper is moved away from the lens to a position beyond the focus, the student finds that a clear image cannot be observed. Explain briefly. (2 marks)

7. **< HKCE 1994 Paper I - 3 >**

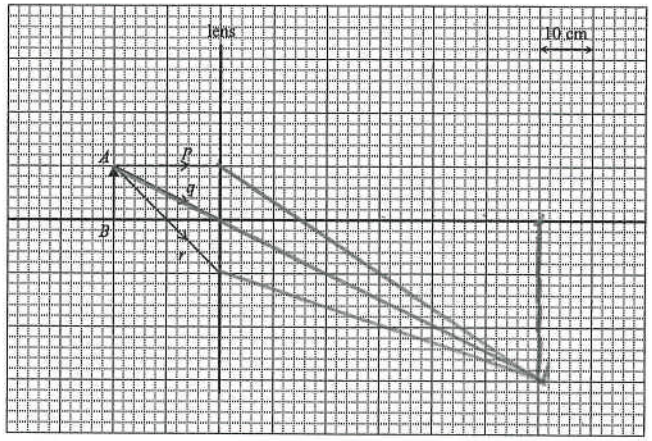
A student uses the set-up shown below to study the image formation of a lens. An illuminated object is placed a distance of 20 cm from the lens. A screen is placed on the other side of the lens. When the screen is moved to a point 60 cm from the lens, a sharp image is formed on the screen.



(a) What kind of lens is used in the experiment ? (1 mark)

(b) Is the image real or virtual ? (1 mark)

(c) In the Figure shown below, *AB* represents the illuminated object and *p*, *q* and *r* represents the incident rays.



(i) Draw the refracted rays of *p*, *q* and *r* and the image of *AB* in the figure above. (4 marks)

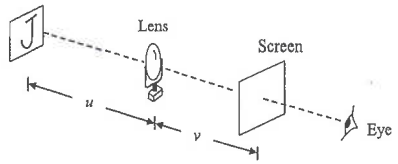
(ii) Find the magnification of the image. (2 marks)

(iii) Find the focal length of the lens. (1 mark)

(d) How would the image formed on the screen be affected when the upper half of the lens is covered by opaque paper ? (2 marks)

(e) Describe briefly a simple laboratory method to measure directly the focal length of the lens. Illustrate your answer with a ray diagram. (4 marks)

8. **< HKCE 1996 Paper I - 1 >**

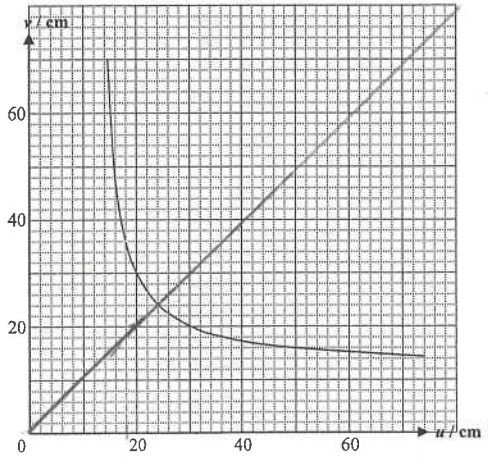


In Figure 1, the image of an illuminated letter 'J ' formed by a lens is caught by a translucent screen.

(a) (i) What kind of lens is being used ? Explain your answer. (2 marks)

(ii) Sketch the shape of the image seen by the observer. (2 marks)

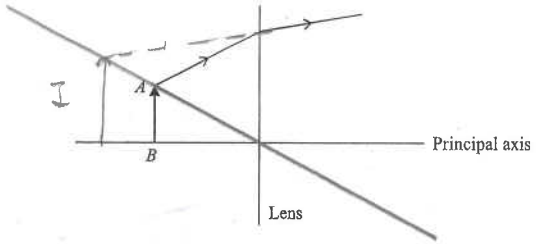
(b) Figure 2 shows the relation between the image distance v and the object distance u.



(i) Find the magnification of the image when $u = 18$ cm. (2 marks)

(ii) Find the value of u when $u = v$. Hence find the focal length of the lens. (3 marks)

8. (c) The illuminated letter is now placed closer to the lens. In the Figure below, AB represents the letter and the path of a ray from A through the lens is shown.



(i) In the above Figure, draw the path of ray from A which passes through the optical centre of the lens and construct the image of AB. (3 marks)

(ii) State an application of the lens in which an image like that shown in the above Figure is formed. (1 mark)

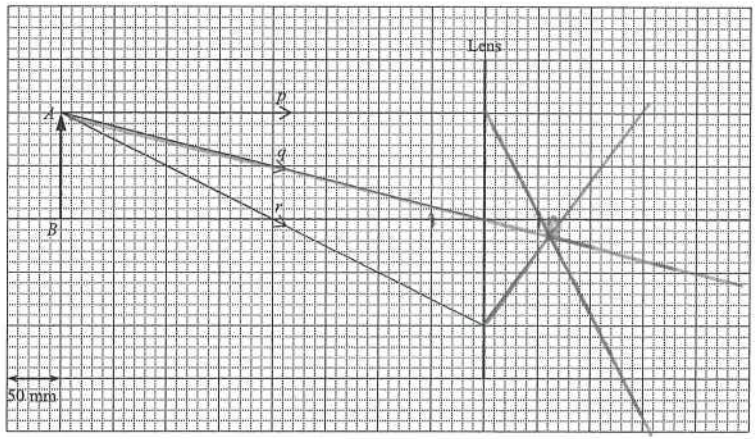
(iii) Comment on the following statement :

After adjusting the position of the screen, the image formed in the above Figure can still be caught. (2 marks)

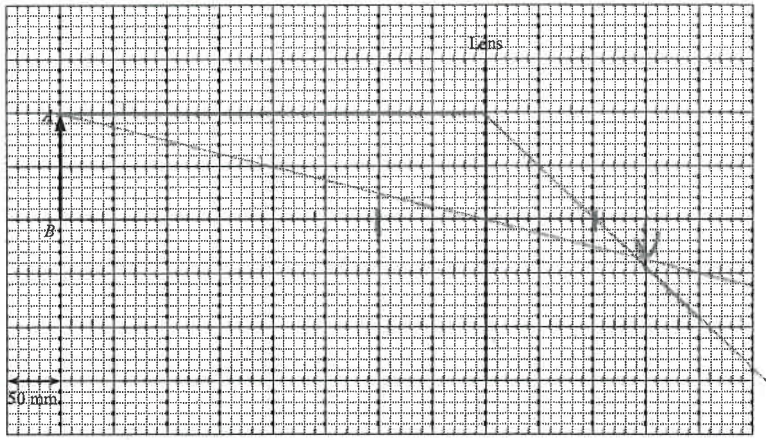
9. **< HKCE 1999 Paper I - 8 >**

An object is placed 40 cm in front of a convex lens of focal length 50 mm. In the following figure, AB represents the object and p, q and r are incident rays. A scale of 1 cm representing 50 mm is used.

(a) Draw the refracted rays of p, q and r and the image of AB in the below figure. (4 marks)



9. (b) If the convex lens is replaced by another convex lens of focal length 100 mm and the object remains at 40 cm from the lens, how would the size of the image be affected ? Illustrate your answer with a ray diagram. (4 marks)

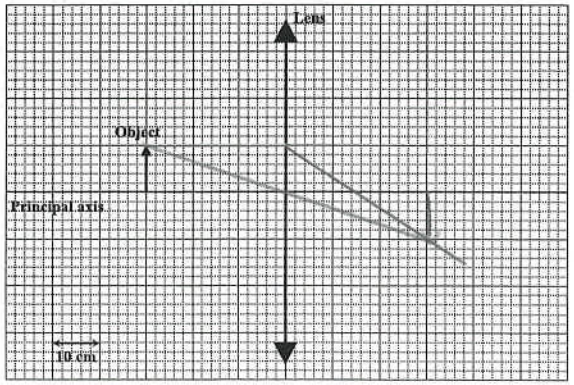


10. **< HKCE 2000 Paper I - 1 >**

An illuminated object is placed 30 cm in front of a convex lens and a sharp image is formed on a screen on the other side of the lens. The image is of the same size as the object.

(a) Is the image real or virtual ? Explain your answer. (2 marks)

(b) In the below figure, draw a ray diagram to show how the image of the illuminated object is formed.



Hence, or otherwise, determine the focal length of the lens. (4 marks)

11. **< HKCE 2001 Paper I - 3 >**

A student holds a lens above a picture and the image observed is shown in the above figure.

(a) What kind of lens is used by the student ? Explain your answer. (2 marks)

(b) Sketch a ray diagram to show how the image in the above figure is formed. (3 marks)

12. **< HKCE 2002 Paper I - 11 >**

Kitty designs a simple peephole as shown in the above figure which is installed at an entrance door to identify visitors. The peephole consists of a metal tube with a concave lens of focal length 10 cm fixed inside.

(a) A visitor stands at a distance 30 cm in front of the peephole (see Figure 1).

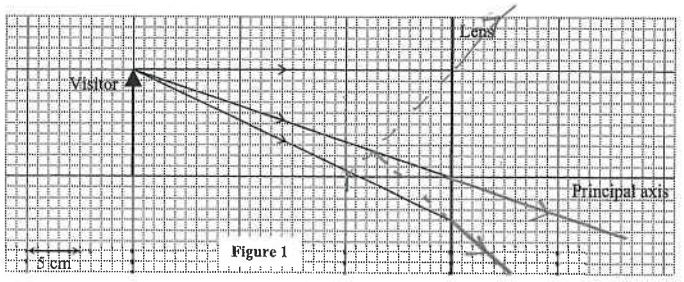


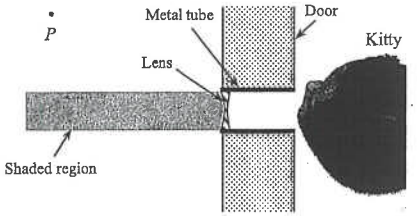
Figure 1

(i) In Figure 1, draw the refracted rays of the three incident rays and the image formed. (4 marks)

12. (a) (ii) Find the magnification of the image formed. (2 marks)

(b) Suggest one reason to explain why the concave lens inside peephole cannot be replaced by a convex lens. (2 marks)

(c)



The Figure above shows the top-view of the peephole. The metal tube will only allow Kitty to see those images formed in the shaded region. Now a visitor stands at a point *P* and Kitty cannot see him through the peephole.

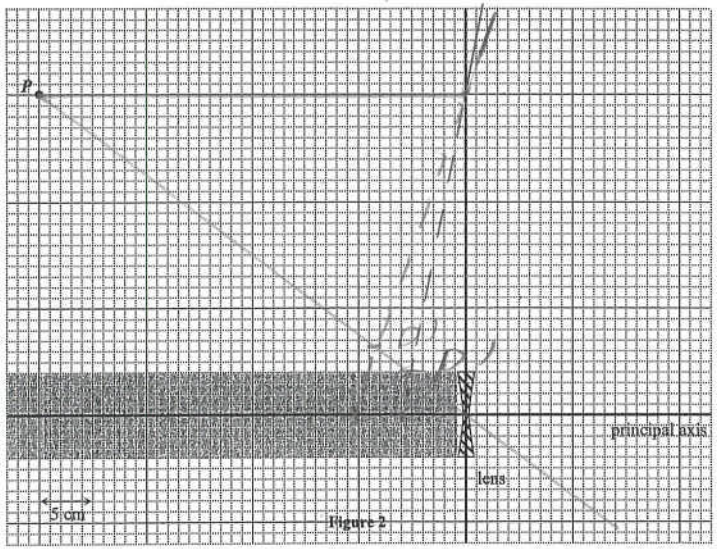


Figure 2

(i) Explain, by drawing a ray diagram in Figure 2, why Kitty cannot see the visitor. (3 marks)

(ii) The lens is now replaced by another concave lens of a shorter focal length and Kitty can **just** see the visitor at *P*. In Figure 2, locate the image observed and find the focal length of this lens. (4 marks)

13. **< HKCE 2004 Paper I - 11 >**

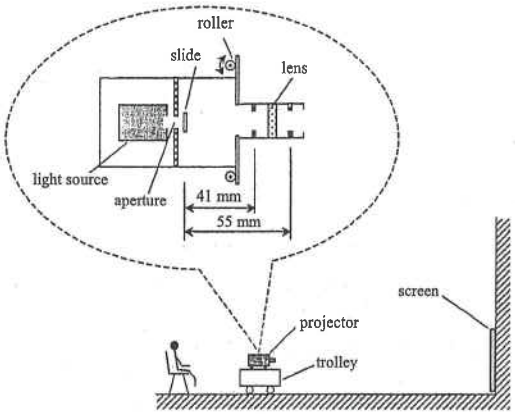


Figure 1

Peter designs a simple slide projector (see Figure 1). A slide is placed in front of a bright light source. A sharp image of the slide formed by a lens is projected onto a screen. The focal length of the lens is 40 mm and the distance between the slide and the lens can be adjusted within the range of 41 to 55 mm.

(a) What kind of lens is used in the projector ? Explain your answer. (2 marks)

(b) The projector is placed on a trolley in front of a screen (see Figure 1). The lens is placed at 50 mm from the slide.

(i) In Figure 2, draw a ray diagram to show how the image of the slide is formed by the lens. (4 marks)

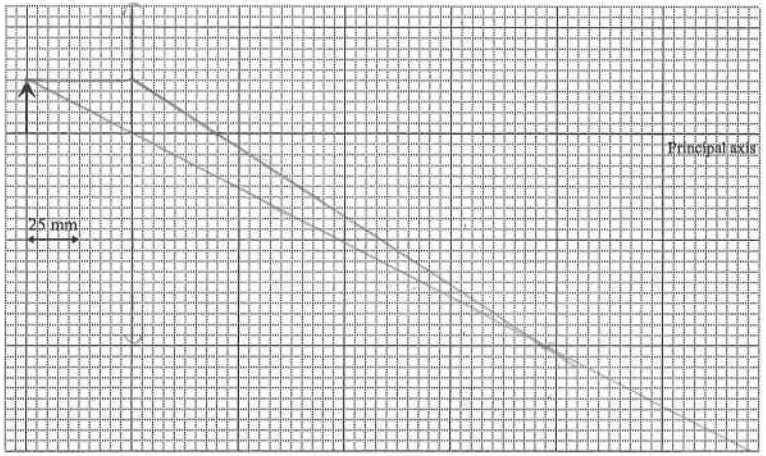


Figure 2

13. (b) (ii) Find the magnification of the image formed. (2 marks)

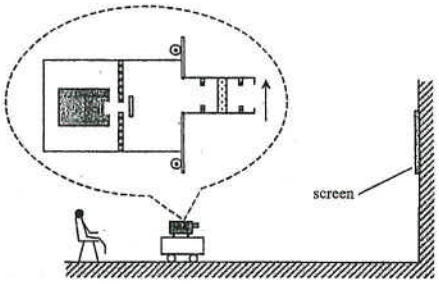
(iii) Peter finds that the size of the image formed on the screen is too small.

(1) Without replacing the lens, describe a method to increase the size of the image formed on the screen. (2 marks)

(2) Karen suggests that the size of the image can also be increased by replacing the lens with one that has a focal length of 60 mm. Explain whether Karen's suggestion will work or not. (2 marks)

(c)

Figure 3



The projector is designed so that the lens can be moved up and down by adjusting the rollers. The screen is now hung at a higher position. In order to project the image onto the screen again, Karen suggests that the lens should be moved up (see Figure 3). Is Karen correct ? Sketch a ray diagram to illustrate your answer. (3 marks)

14. **< HKCE 2005 Paper I - 4 >**

Figure 1

Figure 2

Figure 1 shows a paper with some letters 'J' printed on it. The paper is placed behind a glass filled with water. Figure 2 shows the image of the letters formed by the glass of water.

(a) State the nature of the image formed (erect or inverted, magnified or diminished, real or virtual). (2 marks)

(b) Jason holds a lens in front of the paper in Figure 1 and finds that the image formed is of the same nature as that formed by the glass of water.

(i) What kind of lens is held by Jason ? (1 mark)

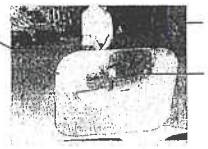
(ii) Sketch a ray diagram to show how the image of the letters is formed by the lens. (3 marks)

15. **< HKCE 2006 Paper I - 5 >**

Figure 1 below shows a plastic lens L mounted on the rear window of a car. The driver can view his friend David, and the surroundings at the back of the car through either the rear window or lens L as shown in Figure 2.

Figure 1

lens L



David and the surroundings viewed through the rear window of the car

David and the surroundings viewed through lens L

Figure 2

(a) What kind of lens is L ? Explain your answer. (2 marks)

(b) Suppose that David in Figure 2 stands at 60 cm from lens L of focal length 30 cm. In Figure 3, David is plotted as AB. Draw a ray diagram to show how the image of David is formed by lens L. Use a horizontal scale of 1 cm to 10 cm. (4 marks)

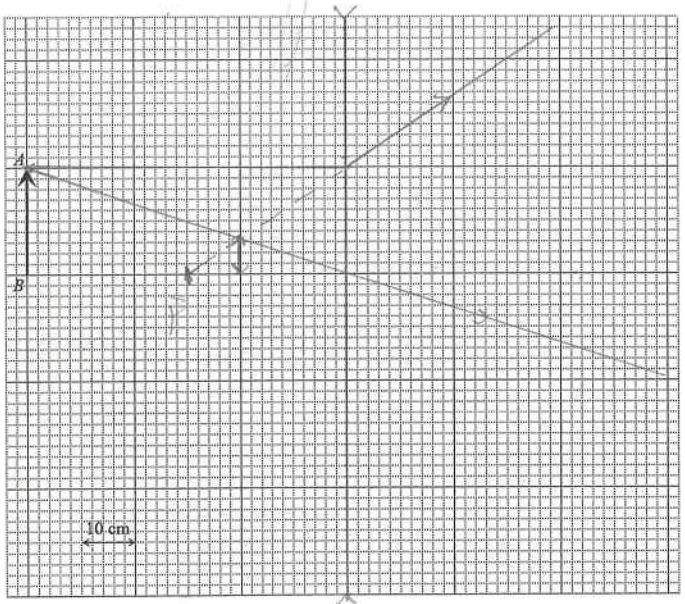


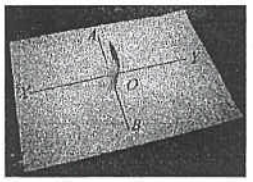
Figure 3

(c) State one advantage of using lens L. (1 mark)

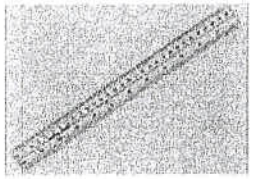
16. **< HKCE 2008 Paper I - 6 >**

Using the apparatus in the following figures, describe the procedures of an experiment to find the focal length of a cylindrical convex lens. (4 marks)

ray box with a **single slit** connected to a 12 V power supply



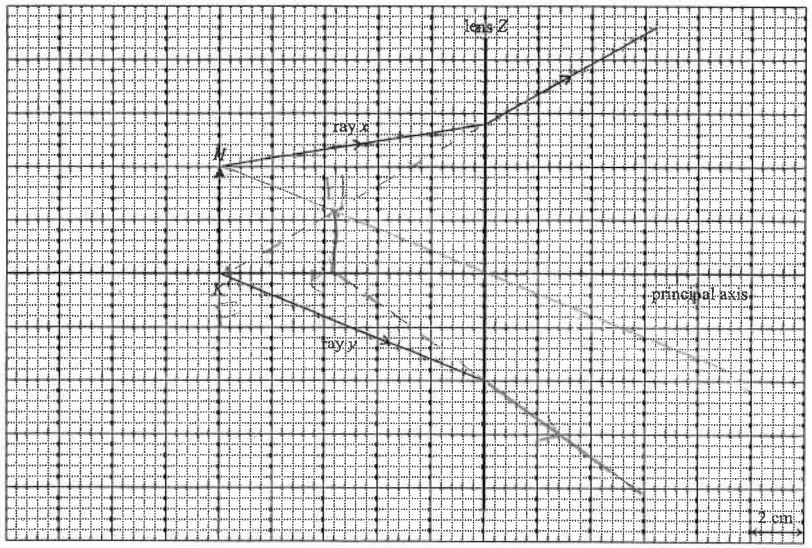
cylindrical convex lens on a paper with its optical centre at the intersection O of two perpendicular lines AB and XY, the line XY is the principal axis of the lens



ruler

17. **< HKCE 2009 Paper I - 5 >**

An object *HK* is placed in front of a lens *Z*. A light ray *x* from *H* passes through the lens as shown in the Figure below.



(a) Explain whether the lens is convex or concave. (2 marks)

(b) (i) Construct the image of *HK* in the above Figure. (3 marks)

(ii) Hence, find the linear magnification of the image. (1 mark)

(c) Mark the position of the principal focus *F* in the above Figure. (1 mark)

(d) Draw the refracted ray of ray *y* in the above Figure. (1 mark)

18. **< HKCE 2010 Paper I - 5 >**

Identical letters are printed on a paper. One of the letters is observed under a lens as shown in Figure 1.

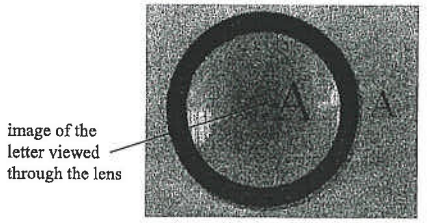


Figure 1

(a) What kind of lens is used ? Explain you answer. (2 marks)

(b) The height of the printed letter "A" is 2 cm. The lens is placed 4 cm above the paper. The linear magnification of the image is found to be 1.5. In Figure 2, *O* and *L* show the positions of the printed letter "A" and the lens respectively.

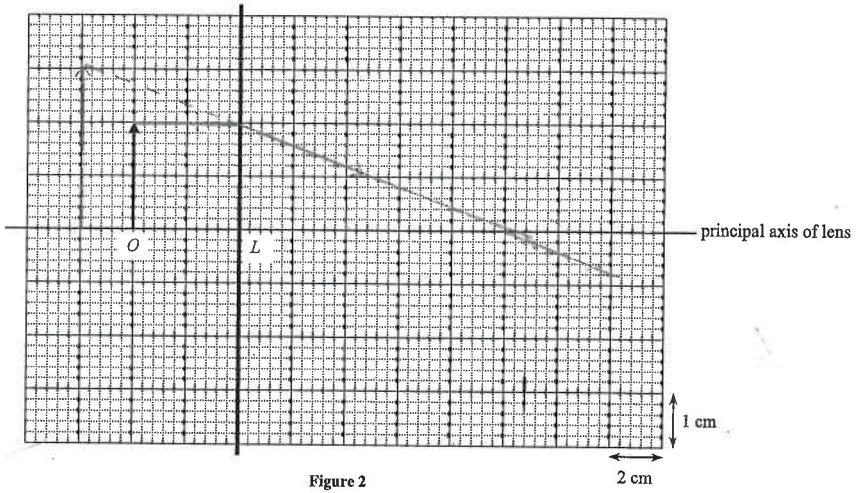


Figure 2

In Figure 2,

(i) draw an arrow to show the image of *O*. (2 marks)

(ii) add one suitable light ray to find the focal length of the lens. (2 marks)

Focal length = _____ cm.

(c) The lens is then placed at a distance twice the focal length above the paper. State the nature of the Image. (2 marks)

19. **< HKCE 2011 Paper I - 4 >**

It is known that the refractive index of glass is different for light of different wavelengths. Figure (a) shows a blue light ray passing through a glass prism. Some angles are measured as shown.

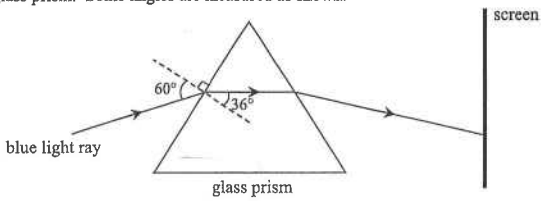


Figure (a)

(a) Determine the refractive index of glass for blue light. (2 marks)

(b) Now, the blue light ray is replaced by a red light ray as shown in Figure (b). The dotted line (– · – · – · –) shows the original path of the blue light ray. It is known that the refractive index of glass for red light is smaller than that for blue light. Sketch the path of the red light ray in Figure (b). (2 marks)

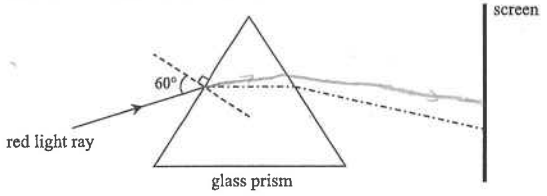


Figure (b)

(c) An object emitting red light is placed in front of a convex lens as shown in Figure (c). The lens is made of glass. A sharp image is formed on the screen. The positions of the object and the lens remain unchanged.

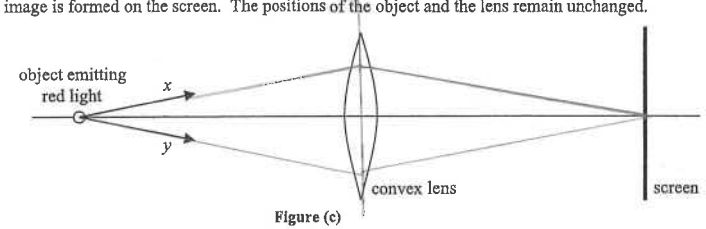


Figure (c)

(i) Complete the paths of rays *x* and *y* in Figure (c). (1 mark)

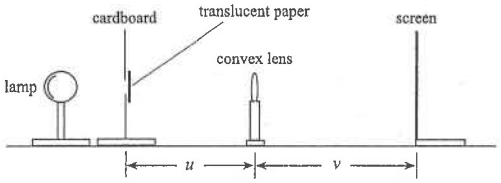
(ii) When the object is replaced by one emitting blue light, the image on the screen becomes blurred. Explain in which direction should the screen be moved in order to form a sharp image. (2 marks)

(iii) Now the object is replaced by one emitting white light. Theoretically, it is impossible to form a sharp image on the screen. Explain why. (2 marks)

Part B : HKAL examination questions

20. **< HKAL 2007 Paper IA - 5 >**

A student performs an experiment on an optical bench to measure the focal length of a convex lens. He places a lamp behind a sheet of cardboard with a circular hole covered by a piece of translucent paper and tries to locate a sharp image of the edge of the hole on a screen. The object distance and image distance are denoted by *u* and *v* respectively.



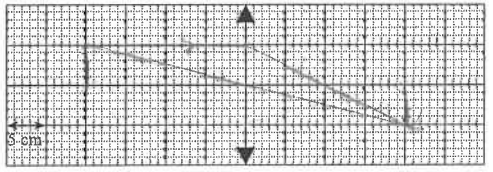
(a) Suggest **ONE** way to make it easier to focus the image on the screen. (1 mark)

(b) For a certain object distance, the student cannot obtain an image on the screen no matter how he adjusts the screen's position. What would most likely be the reason ? Explain briefly. (2 marks)

(c) If the centre of the lens is covered by a small coin, what would be the effect on the image formed on the screen ? Explain briefly. (2 marks)

(d) Suppose the object distance is exactly equal to the image distance and the separation between the object and the real image is 40 cm.

(i) Draw a ray diagram to show the formation of the image by the object. (2 marks)



(ii) From the ray diagram, write down the focal length of the lens. (1 mark)

Part C : HKDSE examination questions

21. < HKDSE Practice Paper IB - 7 >

A drop of liquid is placed on a thin glass slide above a plastic ruler. The side view of the set-up is shown in Figure (a). Looking through the liquid drop, a magnified image of the number '9' on the ruler is seen as shown in Figure (b).

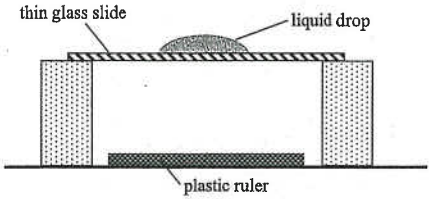


Figure (a)

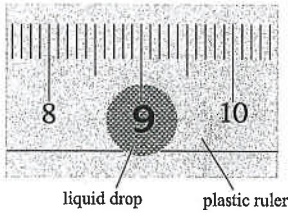


Figure (b)

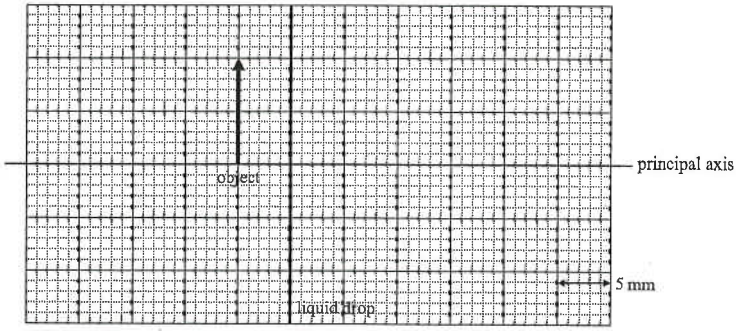
(a) A lens can be used to produce an image with the same nature as that produced by the liquid drop. State the type of lens and explain your answer. (2 marks)

(b) The linear magnification of the number '9' is 1.4. Take the number '9' as the object, use the graph paper below to

(i) draw the image of the object, and

(ii) draw **one** light ray to find the focal length of the liquid drop.

You may neglect the effect due to the thin glass slide. (3 marks)



Focal length of the liquid drop = _____ mm

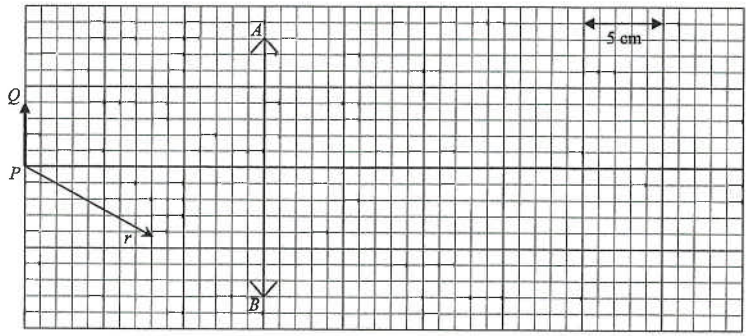
(c) If the refractive index of the liquid becomes smaller, explain the change, if any, in the focal length of the liquid drop. (2 marks)

22. < HKDSE 2012 Paper IB - 7 >

A luminous object *PQ* is placed 15 cm in front of a convex lens *AB* as shown in the Figure below.

(a) The focal length of the lens is 5 cm.

(i) Use a graphical method to find the location of the image of the object. Clearly draw all the construction lines on the Figure and state the nature of the image. (4 marks)



(ii) Complete the path of ray *r* on the Figure to show how it travels after passing through the convex lens. (1 mark)

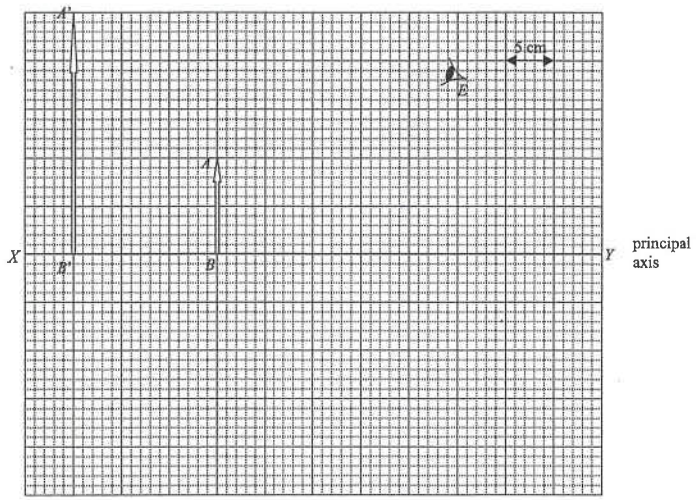
(b) Suppose that a lens of focal length 10 cm is used instead while the size of the lens and the object distance of *PQ* from the lens remain unchanged.

(i) Use the lens formula to find the image distance. Find also the linear magnification of the image. (3 marks)

(ii) Compare the brightness of this image with that in (a). Explain. (2 marks)

23. **< HKDSE 2013 Paper IB - 8 >**

In the Figure below, *A'B'* represents the image of an object *AB* formed by a lens *L* (not shown) where *XY* is the principal axis of the lens.



(a) (i) Is the image real or virtual ? (1 mark)

(ii) What kind of lens is used ? Explain your answer. (2 marks)

(b) (i) Locate the optical centre *O* of lens *L* and draw on the above Figure the position of lens *L*. (1 mark)

(ii) By drawing an additional light ray, mark the principal focus *F* of the lens and find its focal length. The horizontal scale is 1 cm to 5 cm. (2 marks)

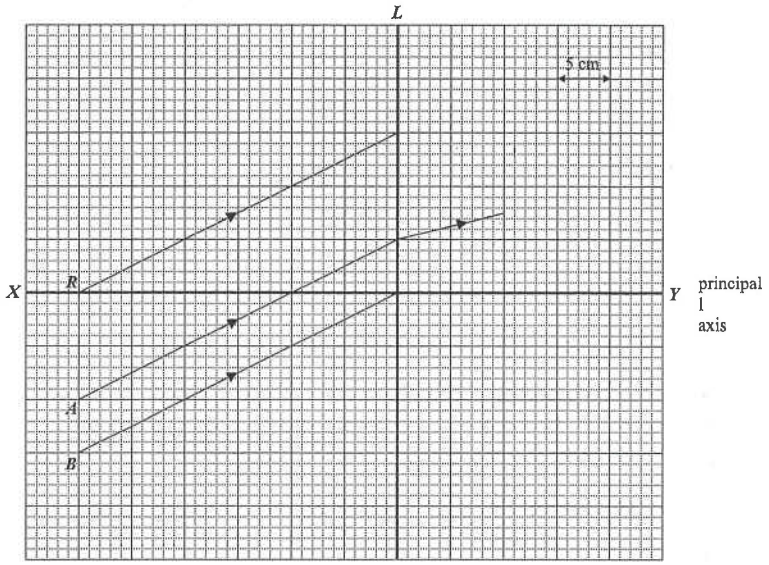
Focal length = _____

(c) Draw a light ray to show how the eye *E* shown can see the image of head *A* through lens *L*. (2 marks)

(d) State an application of lens *L* in the situation as shown above. (1 mark)

24. **< HKDSE 2014 Paper IB - 6 >**

In the below Figure, *XY* is the principal axis of a thin spherical lens *L* while *A*, *B* are two parallel rays coming from a *point P* of a distant object (**NOT** shown).



(a) What kind of lens is *L* ? Explain. (2 marks)

(b) (i) Locate the image of *P* (denoted it as point *P'*). (2 marks)

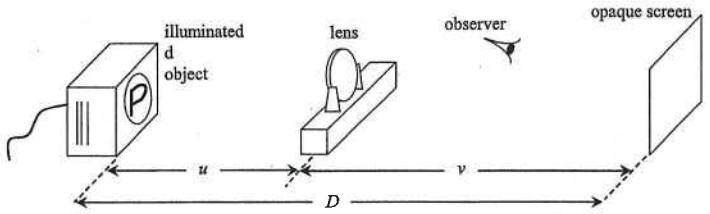
(ii) Hence, determine the focal length of the lens. (1 mark)

Focal length = _____

(c) *R* is a ray coming from the same point *P* ; complete its path after passing through the lens. (1 mark)

(d) Based on the situation shown in the ray diagram above, describe a simple experimental method to determine the focal length of lens *L*. (2 marks)

25. **< HKDSE 2016 Paper IB - 5 >**



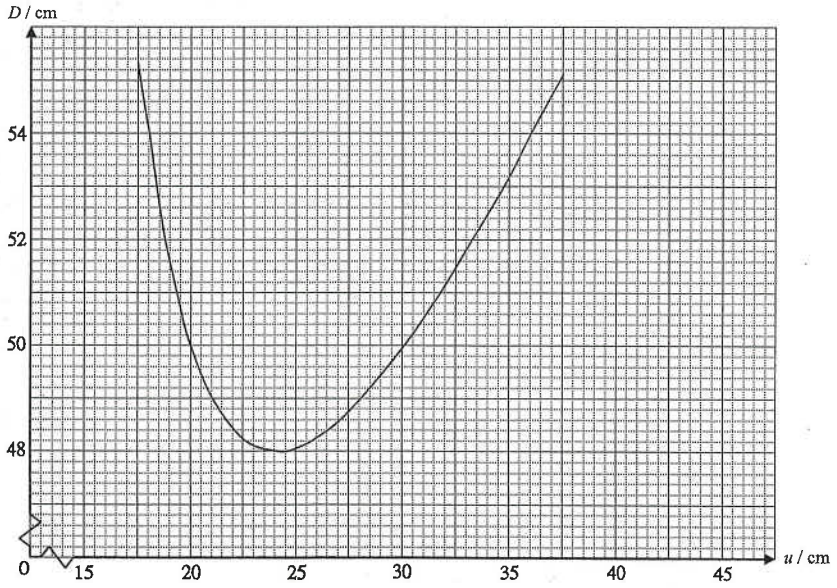
Kitty uses the set-up in the above Figure to study the image formation of a lens. The lens is placed at a distance u from an illuminated object (letter 'P'). An opaque screen is placed at a distance D from the object so as to capture the image.

(a) (i) State the kind of lens used. Explain your answer. (2 marks)

(ii) Sketch the image on the screen seen by the observer. (1 mark)

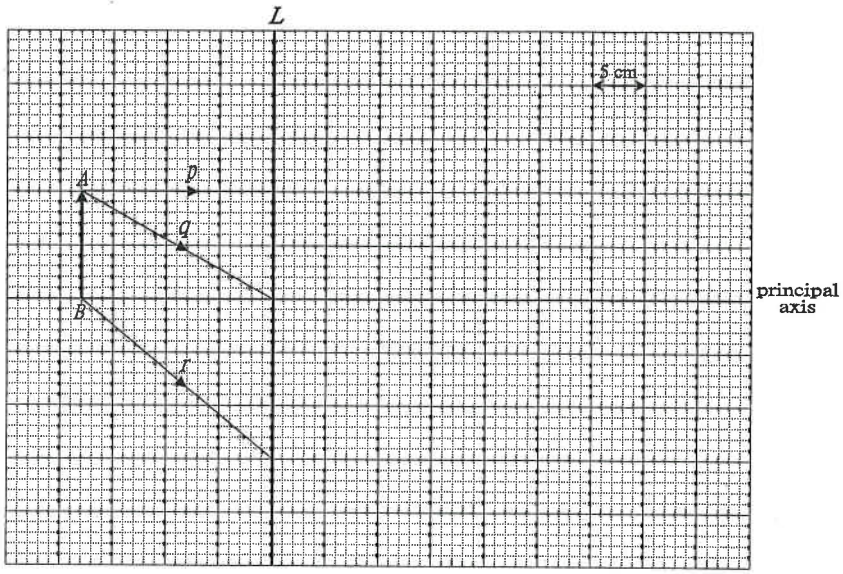
opaque screen

(b) The separation D is varied while the position of the lens is adjusted to form an image once again on the screen. The corresponding object distance u is obtained for plotting a graph of D against u as shown below.



25. (b) (i) When the lens is placed at 18 cm from the object, use the graph to find the corresponding separation between the lens and the screen. Hence calculate the magnification of the image. (2 marks)

In the Figure below, AB represents the illuminated object which is at 18 cm from the lens L. p, q and r are light rays from AB.



(ii) Indicate the image formed by AB (denote it as I) and draw the refracted rays of p, q and r. (3 marks)

(iii) Hence find the focal length of the lens. The horizontal scale is 1 cm to 5 cm. (1 mark)

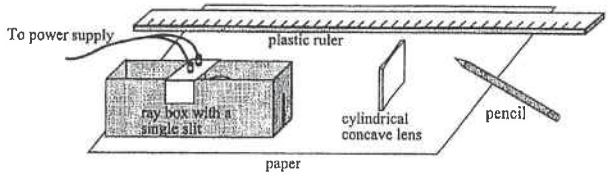
Focal length = _____

(iv) Keeping the object and screen fixed in position, suggest where Kitty should move the lens to such that an image can be formed again on the screen.

State the ratio $\frac{\text{height of this new image}}{\text{height of the original image}}$. (2 marks)

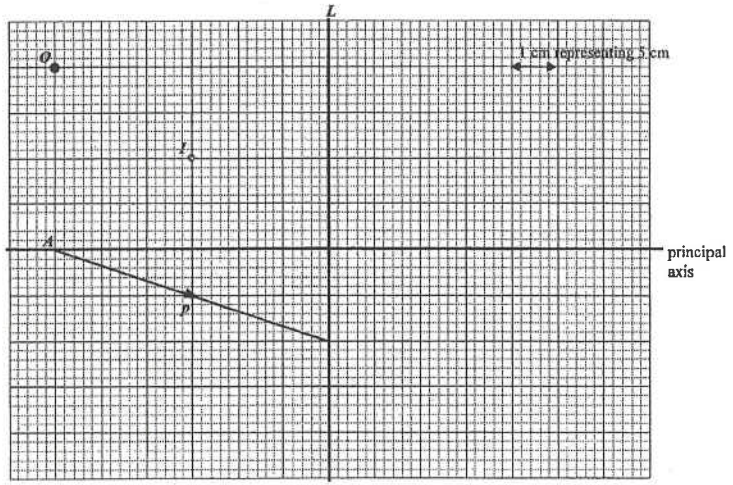
26. **< HKDSE 2018 Paper IB - 6 >**

(a) You are given a ray box with a single slit (producing a fine light beam), a cylindrical concave lens, a plastic ruler, a pencil and a piece of paper as shown in the Figure.



Describe how you would use the above apparatus to find the focal length of the lens and state **ONE** possible source of error in the experiment. (5 marks)

(b) In the figure below, L represents another cylindrical lens. A vertical pin used as the object is placed at O, the image is formed at I by the lens. The horizontal scale is 1 cm to 5 cm.



(i) What kind of lens is used ? Explain. (2 marks)

(ii) Draw a suitable light ray to locate the principal focus F of lens L. Find its focal length.

Focal length = _____ (2 marks)

(iii) Complete the path for the ray p from point A. (1 mark)

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

Question Solution

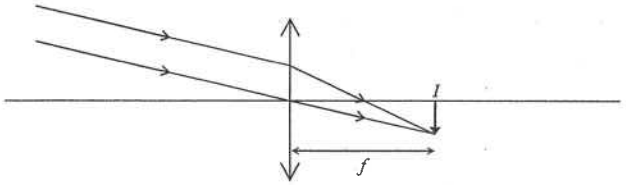
1. (a) A is a convex lens. < **OR** converging lens > [1]

(b) The image is virtual. [1]

2. (a) The convex lens is used to face a distant object [1]

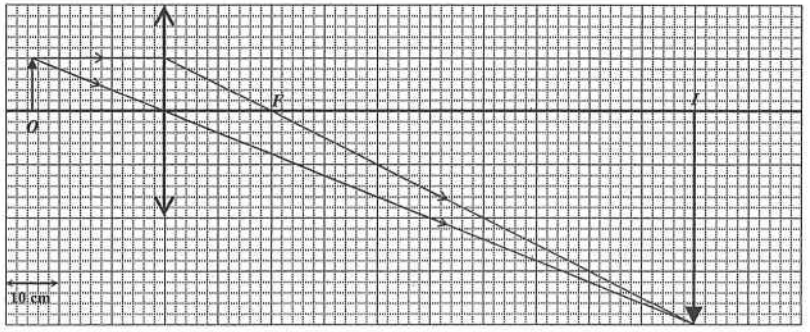
and the image is captured by a screen. [1]

The distance between the lens and the screen is equal to the focal length of the lens. [1]



[1]

(b) (i)



< a light ray parallel to principal axis refracts to F correctly drawn > [1]

< a light ray passing through optical centre without change of direction correctly drawn > [1]

< if any one arrow is missed, deduct one mark >

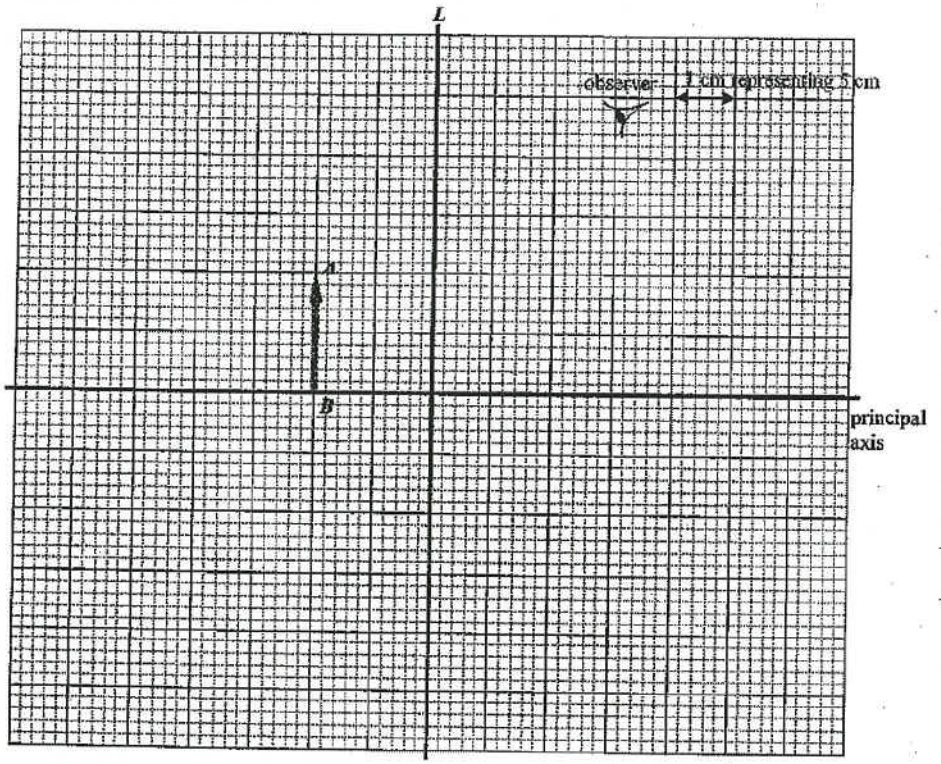
Distance between the lens and the screen = 100 cm < accept 90 cm to 110 cm > [1]

Magnification of the image = 4 < accept 3.5 to 4.5 > [1]

(ii) The lens should be moved away from the ruler. [2]

27. <HKDSE 2019 Ppaper-IB-6>

In Figure 6.1, AB represents the virtual image of an object formed by lens L. The magnification of the image is 0.4. The horizontal scale is 1 cm to 5 cm.



(a) What kind of lens is used ? Explain. (2 marks)

.....

.....

.....

(b) Indicate on Figure 6.1 the position and height of the object. (2 marks)

(c) By drawing a suitable light ray, locate and mark the position of the focus, F, of the lens. Find the focal length of the lens. (3 marks)

Focal length = ...

(d) Draw a light ray emerging from the object to illustrate how the observer in the figure can see the tip A of the image. (2 marks)

28. < HKDSE 2020 Paper 1B -7>

Figure 7.1 shows an optical fibre which consists of a cylindrical glass core of refractive index n_g enclosed by a transparent cladding of refractive index n_c.

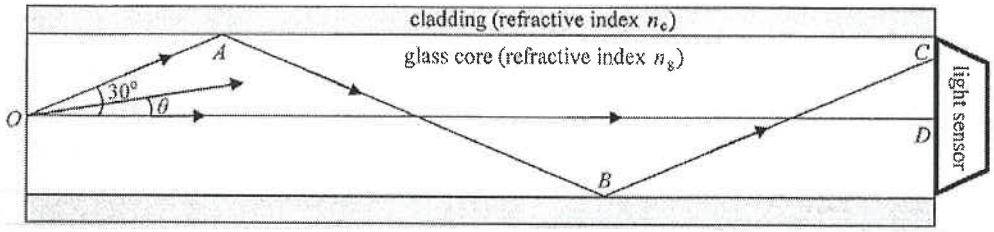


Figure 7.1

As shown in Figure 7.1, a point light source at O emits monochromatic light in all directions. Inside the fibre, light can reach the right end of the fibre through many different paths making angles θ with the axis OD. Two of these paths, OD and $OABC$, have been drawn for reference. Light ray OA makes an angle of 30° with the axis OD and is incident at the core-cladding boundary at A with an angle of incidence i_A.

(a) (i) Find i_A. (1 mark)

.....

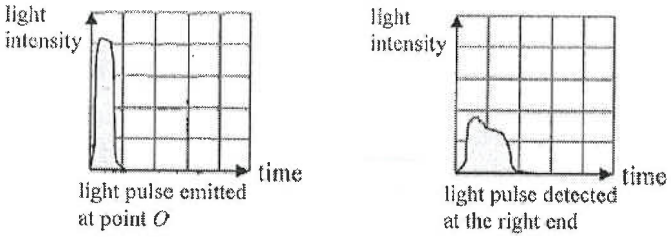
.....

(ii) If i_A is just greater than the critical angle of that boundary, estimate $\frac{n_g}{n_c}$. (2 marks)

(iii) What phenomenon occurs at point A ? State the condition needs to be satisfied by θ such that this phenomenon **fails to occur**. (2 marks)

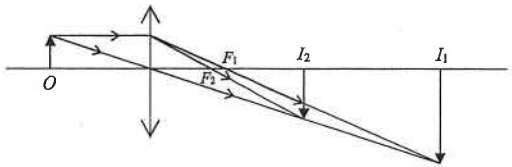
(b) A narrow monochromatic light pulse (i.e. of a short duration) emitted at point O propagates with its energy within $\theta = \pm 30°$ towards a light sensor located at the right end of the optical fibre. The respective emitted and detected light pulses are represented below using the same scales.

gure 7.2



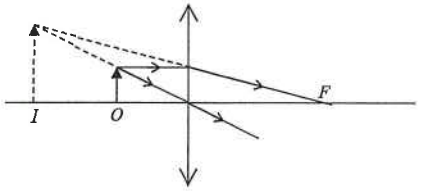
(i) Explain why the light pulse detected is **broader** (i.e. of a longer duration) and with **lower intensity**. Assume that the loss of energy of the light pulse due to absorption by glass is negligible. (2 marks)

2. (b) (iii) The magnification decreases. [1]



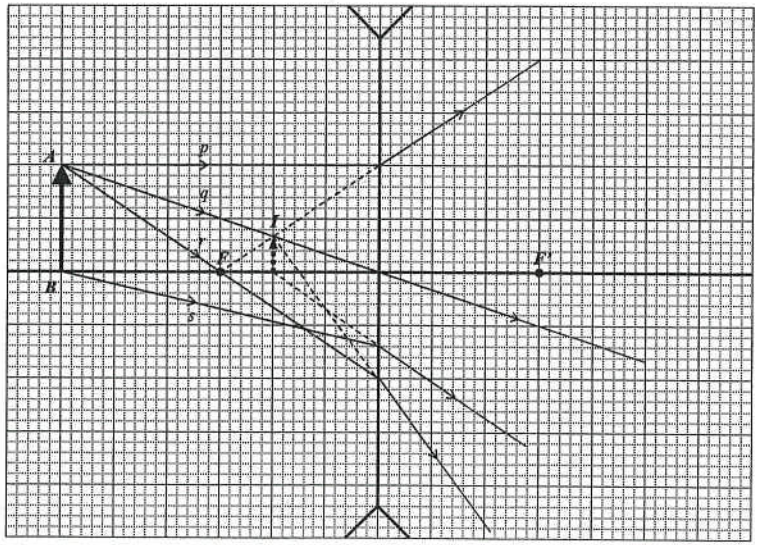
[1]

(iv) The image becomes virtual. [1]



[2]

3. (a)



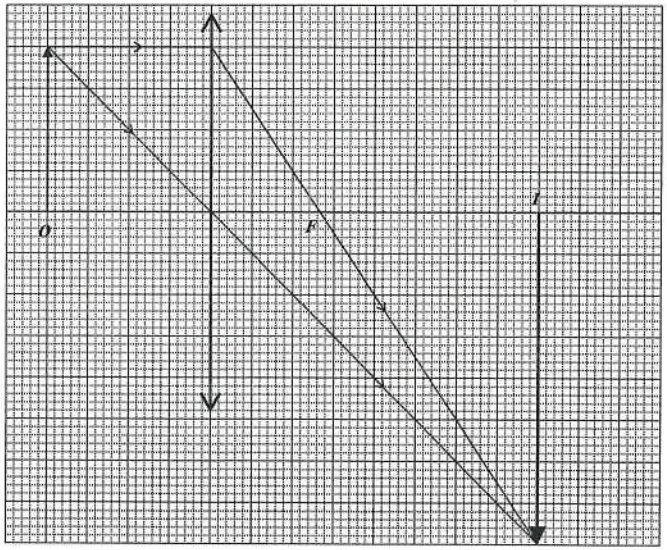
< Each correct ray 1 mark × 4 > [4]

< Correct position of image > [1]

(b) The image is virtual and erect. [2]

(c) Magnification m = 0.33 (± 0.03) [2]

4. (a) (i)



< Correct scale > [1]

< Light ray passing through the optical centre correctly drawn > [1]

< Light ray passing through the focus F correctly drawn > [1]

(ii) (1) object distance = 20 cm [1]

(2) image distance = 40 cm [1]

(3) focal length = 13.3 cm [1]

< accept 13.0 cm to 14.0 cm >

(iii) (1) magnification = 2 [1]

(2) natures of the image are real [1]
and inverted [1]

(b) The magnification increases first [1]
and then decreases finally. [1]

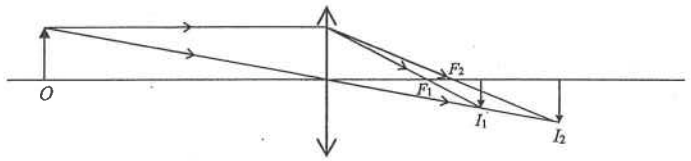
The nature of image is virtual [1]
and erect at first [1]

and then become real [1]
and inverted finally. [1]

5. (a) (i) The approximate distance is 40 cm. [1]

For a distant object, image is formed at the focal plane of the lens. [1]

(ii)  [2]

(b) 

[3]

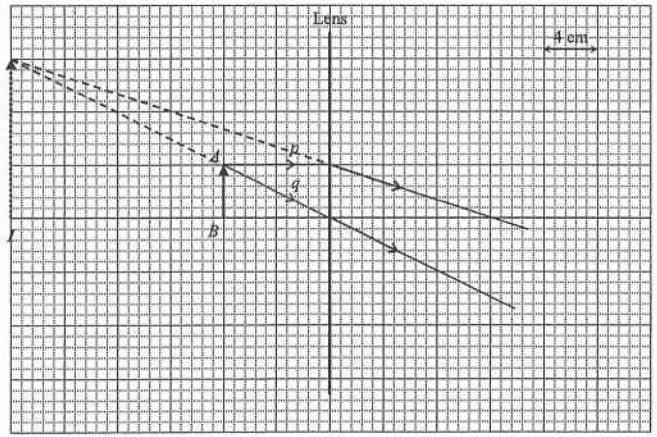
Image size increases. [1]

6. (a) Convex lens (**OR** Converging lens) [1]

Since only a convex lens can give a magnified image. [1]

(b) The image is virtual [1]

and erect [1]

(c) (i) 

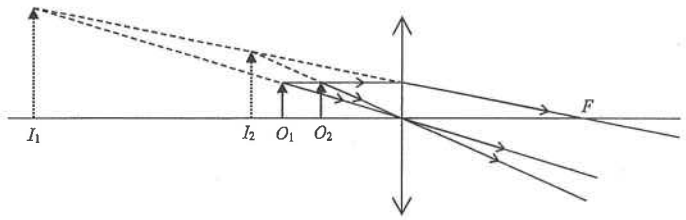
< Image behind object > [1]

< Magnification = 3 > [1]

< 2 correct rays > [2]

(ii) (1) Image distance = 24 cm [1]

(2) Focal length = 12 cm [1]

6. (d) 

[2]

Size of image decreases [1]

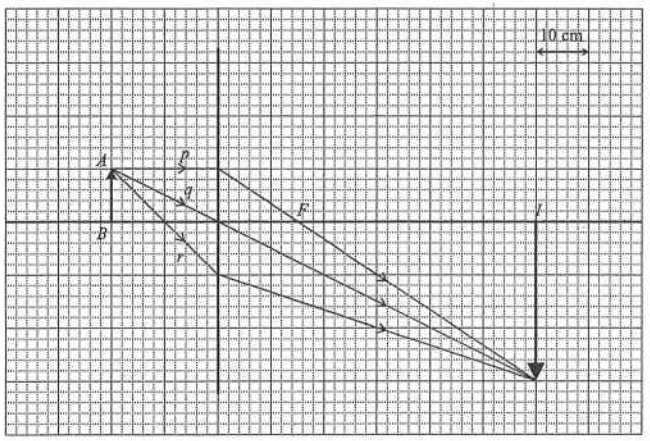
Image distance decreases [1]

(e) When object distance is greater than the focal length, the image becomes real [1]

and forms behind the observer's eye. [1]

7. (a) A convex lens is used. [1]

(b) The image is real. [1]

(c) (i) 

< 1 mark for each ray (solid line) > [3]

< Image at right position (solid inverted arrow) > [1]

(ii) $m = \frac{v}{u}$ (**OR** $m = \frac{h_i}{h_o}$) [1]

$= 3$ [1]

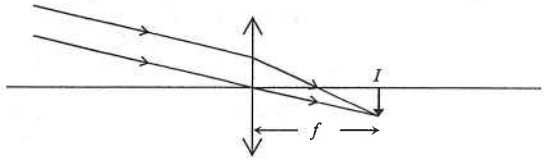
(iii) Focal length = 15 cm < from 14 cm to 16 cm is acceptable > [1]

7. (d) The brightness of the image decreases. [2]

OR

The image becomes dimmer. [2]

(e)



[1]

The lens is used to view a distant object and [1]

the image is caught by a screen. [1]

The distance from the lens to the screen is equal to the focal length of the lens. [1]

8. (a) (i) Convex lens [1]

Only convex lens can form real image [1]

(ii)  [2]

(b) (i) When $u = 18$ cm, $v = 36$ cm [1]

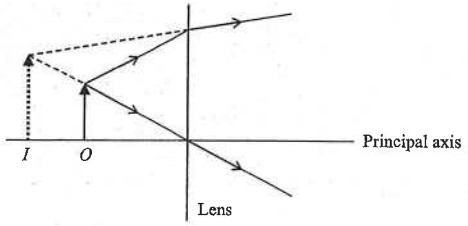
$m = \frac{v}{u} = \frac{36}{18} = 2$ [1]

(ii) $u = 24$ cm [1]

$f = 24 \times \frac{1}{2}$ [1]

$= 12$ cm [1]

(c) (i)



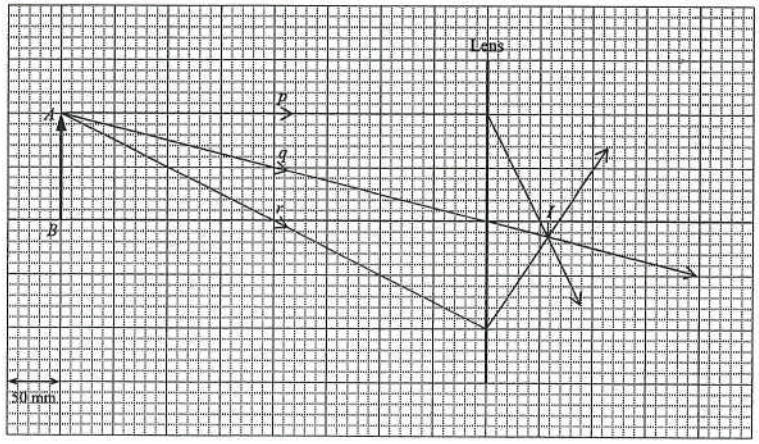
[3]

(ii) Magnifying glass [1]

(iii) False [1]

The image is virtual and cannot be formed on a screen. [1]

9. (a)



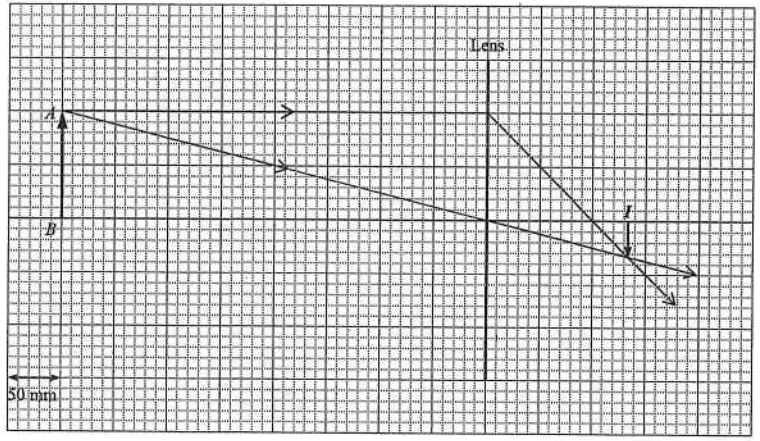
< ray p correctly drawn > [1]

< ray q correctly drawn > [1]

< ray r correctly drawn > [1]

< image correctly drawn > [1]

(b) As shown in the ray diagram, the size of the image is increased. [1]



< ray diagram correct > [1]

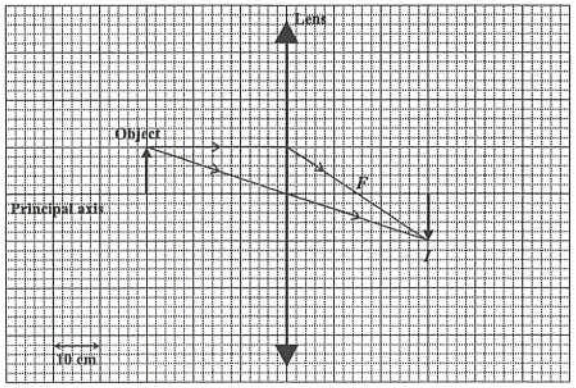
< two rays correctly drawn > [1]

< image correctly drawn > [1]

10. (a) The image is real [1]

because it can be formed on the screen [1]

(b)



< Image correctly drawn > [1]

< The ray passing through optical centre drawn > [1]

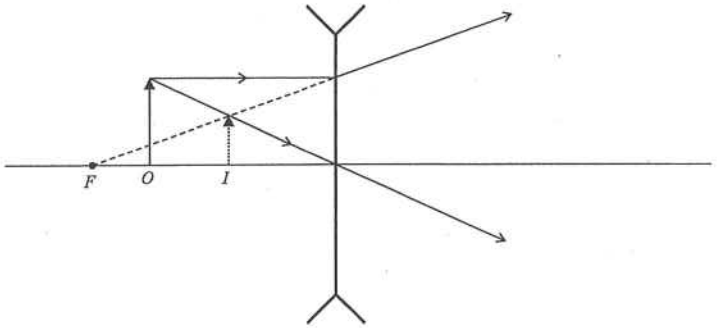
< The ray parallel to the principal axis drawn > [1]

The focal length of the lens is 15 cm. [1]

11. (a) It is a concave lens. [1]

The image is erect and diminished. [1]

(b)



< A ray passing through the optical centre correctly drawn > [1]

< A ray parallel to the principal axis correctly refracted > [1]

< Image correctly shown > [1]

12. (a) (i)

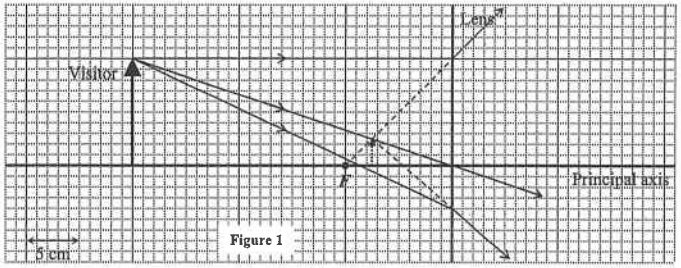


Figure 1

< 3 correct rays > (no mark for dotted rays or wrong direction) [3]

< image correct > (no mark for solid lines or inverted image) [1]

(ii) $m = \frac{v}{u} = \frac{7.5}{30}$ **OR** $m = \frac{h_i}{h_o} = \frac{2.5}{10}$ [1]

$= 0.25$ $= 0.25$ [1]

< m = 0.2 to 0.3 are acceptable >

(b) (i) Any **ONE** of the following : [2]

- The image formed by a convex lens may be inverted.
- The image formed may be magnified and it is difficult for Kitty to observe the image.
- The image formed may be real and forms behind Kitty and thus difficult for Kitty to observe the image.
- The field of view of the peephole would become narrower when a convex lens is used.

(c)

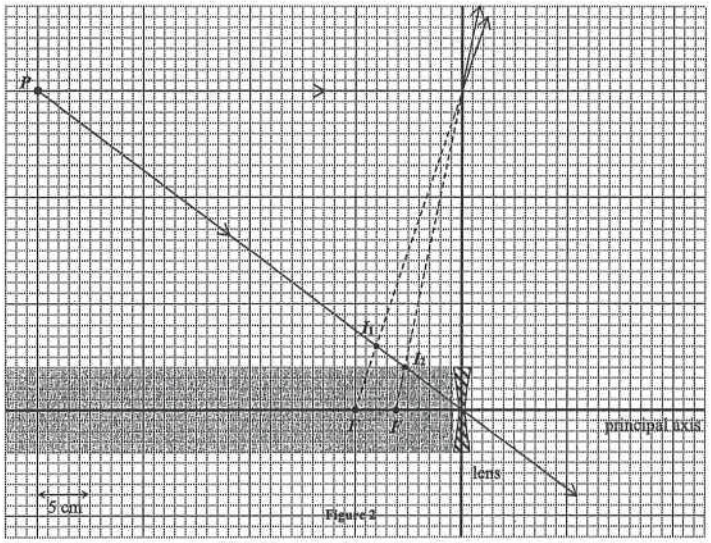


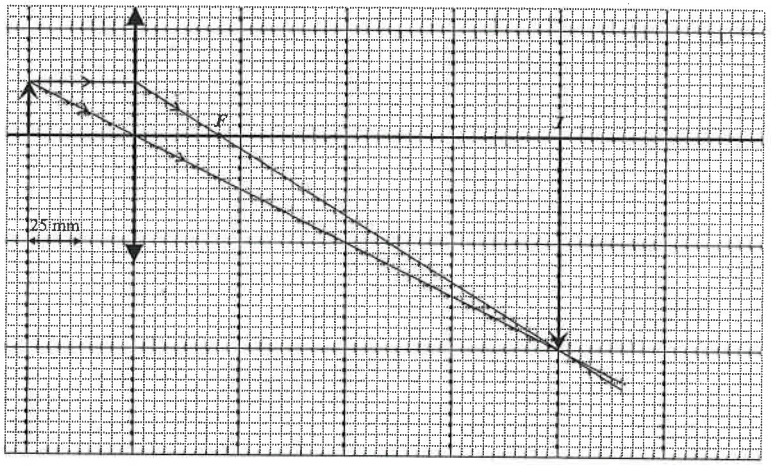
Figure 2

12. (c) (i) Since the image I_1 is outside the shaded region, Kitty cannot see the visitor. [1]
< Two correct rays > [1]
< Position of the image I_1 correctly marked > [1]

(ii) Focal length of the lens = 6 cm < 5 cm to 7 cm is acceptable > [2]
< The image I_2 should be formed at the boundary of the shaded region > [1]
< Correct ray to locate the point of focus F' > [1]

13. (a) It is a convex lens. [1]
Since only convex lens can give a real image that can form on the screen. [1]

(b) (i)



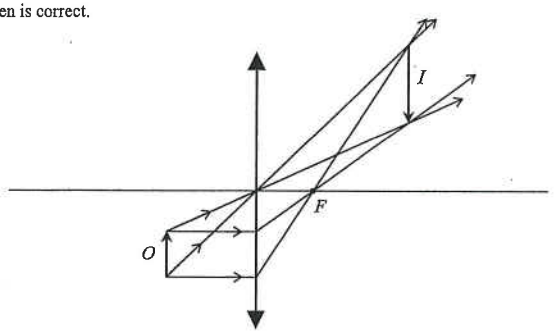
< Correct position of the lens > [1]
< 2 refracted rays correctly drawn > [1]
< Rays use solid line with arrows > [1]
< Image correctly drawn > [1]

(ii) $m = \frac{v}{u}$ (**OR** $m = \frac{h_i}{h_o}$) [1]
$= 4$ (Accept 3.2 to 4.5) [1]

(iii) (1) The projector should be moved away from the screen. [1]
The lens-to-slide distance should be decreased to re-focus the image onto the screen. [1]

(2) Since the focal length is larger than the object distance (41-55 mm) [1]
the image will become virtual that cannot be captured by the screen, thus it does not work. [1]

13. (c) Karen is correct. [1]

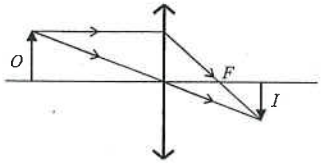


[2]

14. (a) The image is inverted, diminished [1]
and real. [1]

(b) (i) convex lens < **OR** converging lens > [1]

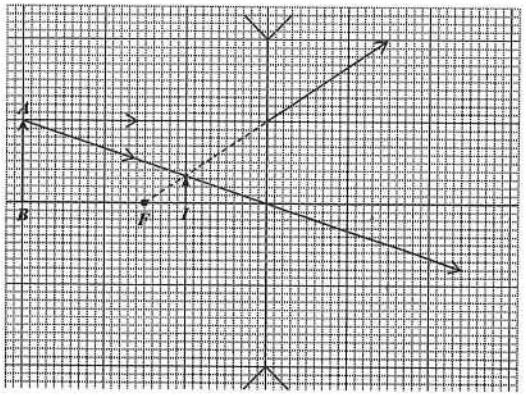
(ii)



[3]

15. (a) L is a concave lens. [1]
Since the image is erect and diminished. [1]

(b)



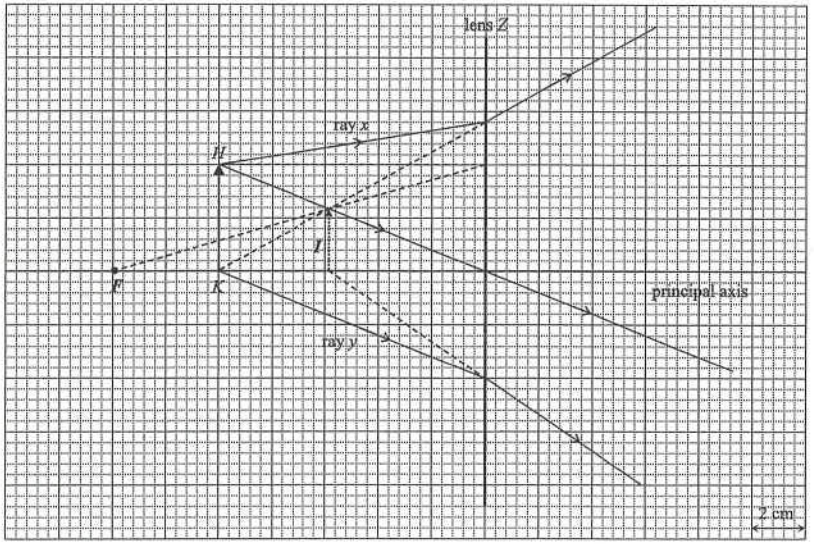
15. (b) < correct position of the lens and the its correct symbol > [1]
< correct ray passing through the optical centre > [1]
< correct ray parallel to the principal axis > [1]
< correct position of the image at about 20 cm (no mark if solid line is used) > [1]

(c) It can increase the field of view of the driver. [1]

16. Direct a light ray to the lens [1]
which is parallel to *XY*. [1]
Mark on the blank paper the point of intersection of the emerged light ray and the principal axis. [1]
Measure the distance between the point of intersection and the optical centre by the ruler to give the focal length. [1]

17. (a) Since the ray *x* diverges from the principal axis, [1]
it is a concave lens. [1]

(b) (i)



< refracted ray of *x* extended backwards > [1]
< ray passing through optical centre is drawn > [1]
< correct image marked > [1]

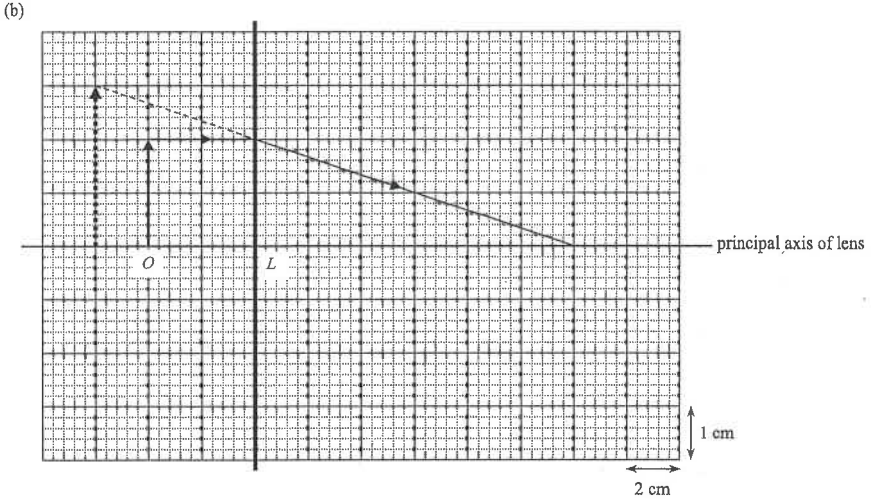
(ii) m = 0.58 < accept 0.50 to 0.62 > [1]

(c) < *F* marked at the left side of the lens, at around 13 to 15 cm > [1]

(d) < The refracted ray correctly drawn > [1]

18. (a) Convex lens [1]
Only convex lens can produce magnified image. [1]

(b)



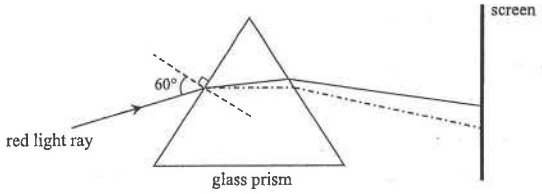
(i) < correct image distance and image size > [1]
< erect, same side as the object > [1]

(ii) < correct light ray > [1]
Focal length = 12 cm < accept 10.8 – 13.2 cm > [1]

(c) Real, inverted [1]
same size [1]

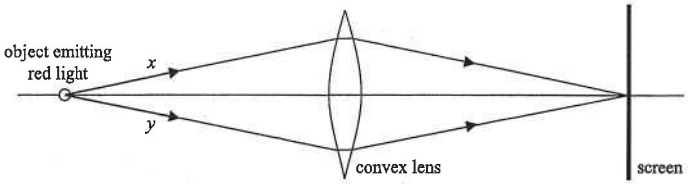
19. (a) $n = \frac{\sin i}{\sin r}$ [1]
$= \frac{\sin 60°}{\sin 36°}$
$= 1.47$ [1]

(b)



[2]

19. (c) (i)



< after refraction, the two light rays meet at a point at the principal axis on the screen > [1]

< no mark is given if there is no arrow >

(ii) It is because blue light bends more in glass, the focal length of blue light is shorter. [1]

The screen should be moved towards the lens. [1]

(iii) White light consists of light of different colours. [1]

Image positions for light of different colours are different. [1]

20. (a) Add a mark, e.g. a cross, on the translucent paper. [1]

(b) The object distance is less than the focal length of the lens. [1]

The image would be virtual and cannot be formed on the screen. [1]

OR

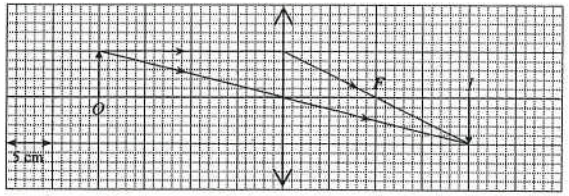
The object distance is equal to the focal length of the lens. [1]

The image would be at infinity and cannot be formed on the screen. [1]

(c) The whole image can be seen but become dimmer (less bright), [1]

since less light is refracted by the lens. [1]

(d) (i)



< object and image correctly drawn > [1]

< two rays correctly drawn > [1]

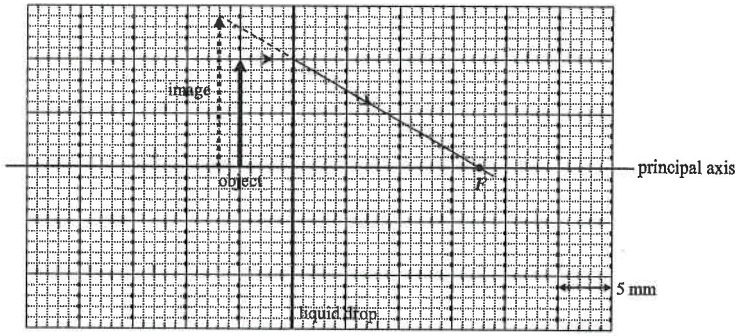
< if any one arrow is missed, deduct one mark >

(ii) f = 10 cm [1]

21. (a) Convex lens < **OR** converging lens > [1]

Only a convex lens can produce magnified image. [1]

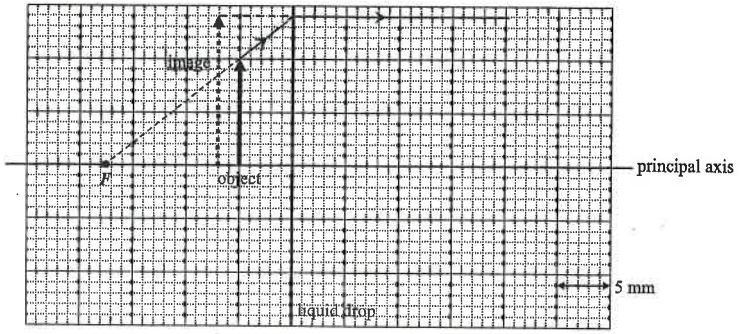
(b)



(i) < image position and height correct > [1]

(ii) < construction ray correct drawn > [1]

< the following construction ray is also acceptable to find the focal length >

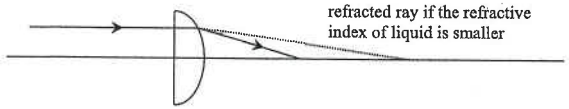


Focal length = 17.5 mm < accept 17 – 18 mm > [1]

(c) The focal length of the liquid will increase, [1]

since an incident ray parallel to the principal axis of the liquid will bend towards the principal axis less after passing through the liquid. [1]

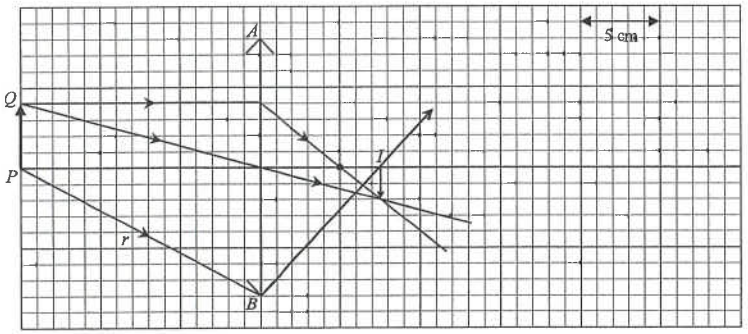
< accept the explanation by drawing >



22. (a) (i) Nature of image :

real [1]

inverted, diminished [1]



< A light ray passing through the optical centre > [1]

< A light ray parallel to the principal axis converges to the focus > [1]

(ii) < ray *r* correctly completed > [1]

(b) (i) $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\therefore \frac{1}{(10)} = \frac{1}{(15)} + \frac{1}{v}$ [1]

$\therefore v = 30$ cm [1]

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

$= \frac{30}{15} = 2$ [1]

(ii) Same amount of light is refracted by the lens in both cases.

For the magnified image in (b) (i), same amount of light is distributed over a larger image, [1]

thus, the image is dimmer compared to that in (a). [1]

OR

Same amount of light is refracted by the lens in both cases.

For the image in (b) (i), the image distance is greater, light intensity decreases as distance increases, [1]

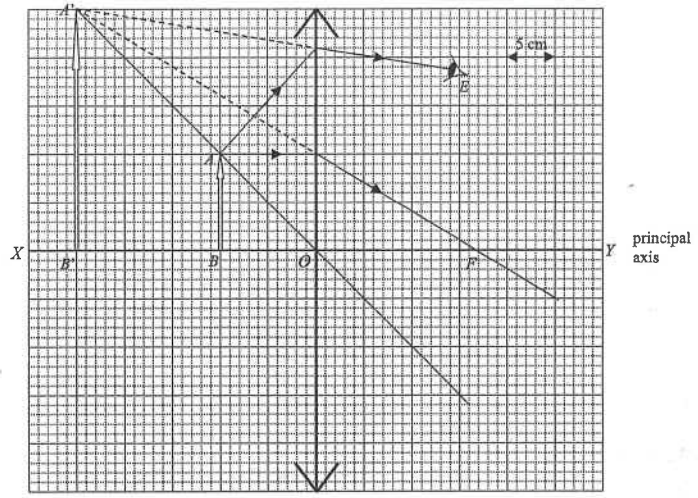
thus, the image is dimmer compared to that in (a). [1]

23. (a) (i) Virtual [1]

(ii) It is a convex lens. < **OR** converging lens > [1]

Only convex lens can give a magnified image. < virtual and erect image is **NOT** accepted > [1]

(b)



(i) < correct position of *O* marked in the figure and lens drawn correctly > [1]

(ii) < correct light ray drawn to locate *F* > [1]

Focal length = 17 cm < accept 16.0 to 17.5 cm > [1]

(c) < correct light ray drawn from *A'* to *E* > [1]

< incident light drawn from *A*, all correct, including solid line and dotted line > [1]

(d) Any **ONE** of the following : [1]

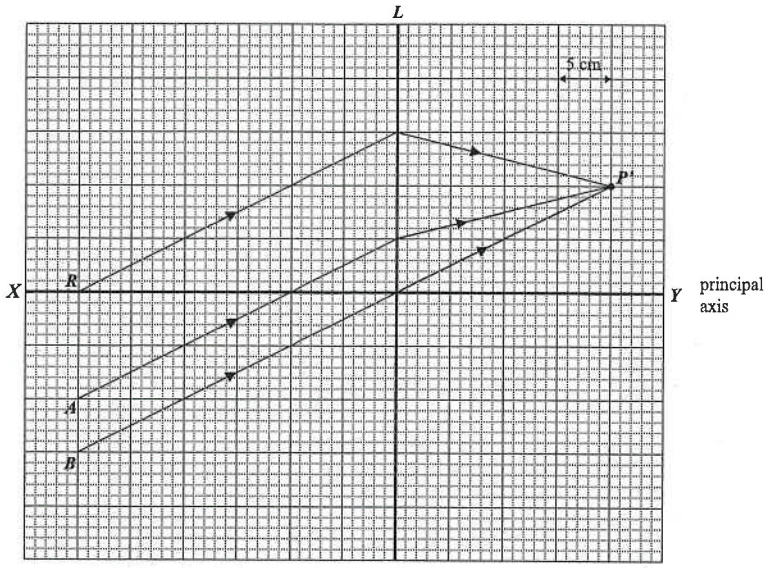
* magnifying glass
* glasses for long-sighted eye
* simple microscope

24. (a) *L* is a convex lens < accept converging lens > [1]

Reason (any **ONE** of the following) [1]

* since the ray *A* converged (**OR** bent) to the principal axis after refracted by *L*
* a real image (**OR** inverted image) can be formed
* the object and the image are at the opposite sides of the lens

24. (b)



(i) < the ray A passing through the lens without bending > (no mark is awarded if no arrow) [1]

< the position of P' correctly marked > [1]

(ii) Focal length = 20 cm [1]

(c) < refracted ray of R travels to P' > [1]
(no mark is awarded if no arrow)

(d) Face the convex lens towards a distant object. Capture the sharp image onto a screen. [1]

The distance between the lens and the screen is the focal length of the lens. [1]

25. (a) (i) Convex lens [1]

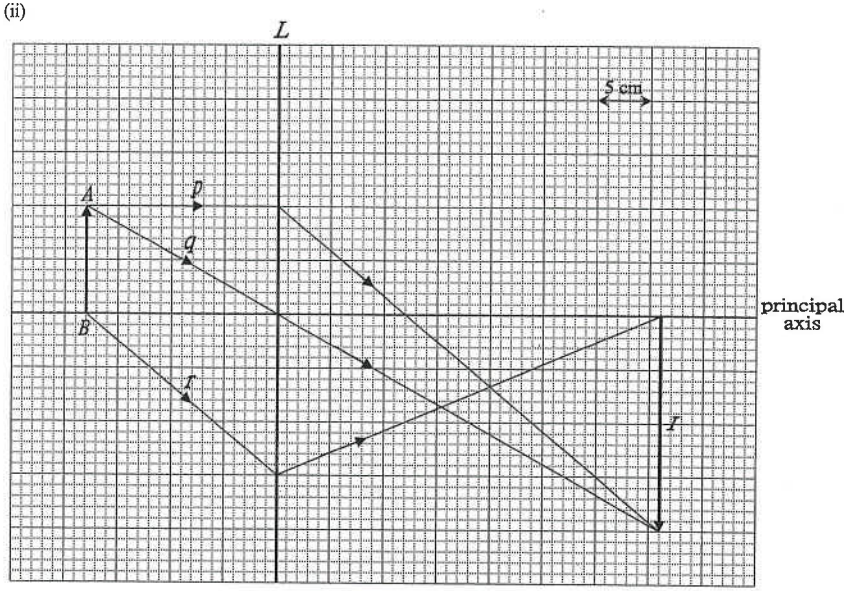
Only convex lens can form real image that can be captured by the screen [1]

(ii) b [1]

(b) (i) image distance : $v = 54 - 18 = 36$ cm [1]

Magnification : $m = \frac{v}{u} = \frac{36}{18} = 2$ [1]

25. (b) (ii)



< Image I correctly drawn > [1]

< Rays p and q correctly drawn with arrows > [1]

< Ray r correctly drawn with arrow > [1]

(iii) f = 12 cm < accept 11.5 cm to 12.5 cm > [1]

(iv) Move the lens 18 cm farther away from the object (**OR** towards the screen). [1]

Height ratio = 1 : 4 [1]

26. (a) On the paper, draw a straight line to represent the principal axis, mark a point O to represent the optical centre.
Place the lens on the paper so that the lens is perpendicular to the principal axis and its optical centre on O. [1]
Direct a light ray parallel to the principal axis to the lens and trace the path of the emergent ray on the paper. [1]
Extend the path of the emergent ray backwards and locate the intersection point F on the principal axis. [1]
Measure the distance of F from O, which gives the focal length of the lens. [1]

< accept using diagram to simplify the description >

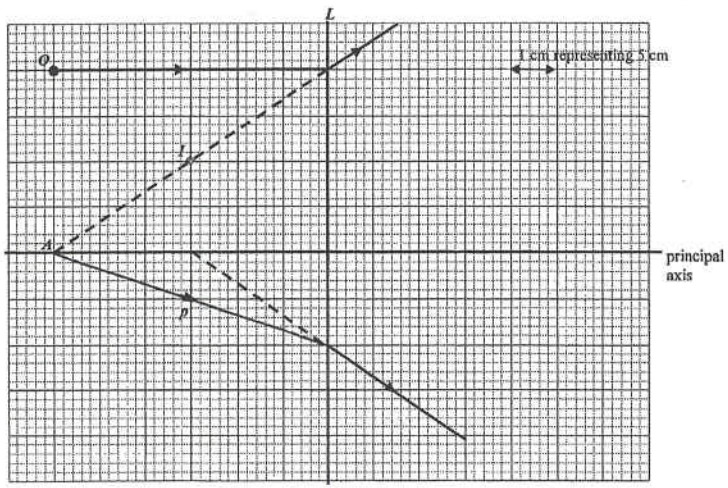
Source of error (Any **ONE** of the following) : [1]

* The light ray may not be parallel to the principal axis.
* Due to the thickness of the beam of light, the path of ray may not be marked correctly.
* There is uncertainty in the reading of the focal length by using the plastic ruler.

< accept other reasonable answer >

WA4 : Lenses

26. (b)



(i) *L* is a concave lens (**OR** divergent lens) [1]

Since the image is erect (**OR** virtual) and diminished. [1]

(ii) Focal length = 30 cm < accept 29 to 31 cm > [1]

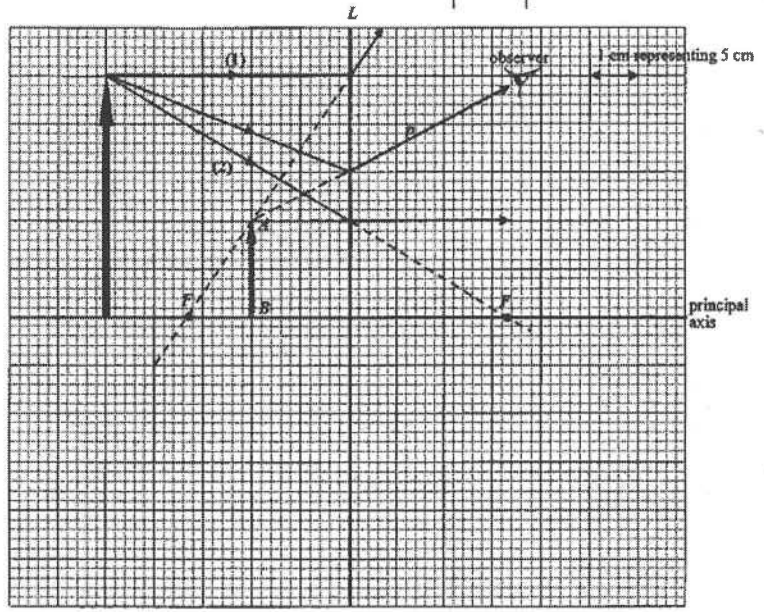
< ray to find *F* correctly drawn > [1]

(iii) < refracted light ray of *p* correctly drawn and extended backwards > [1]

27.

27. (a) *L* is diverging / concave. 1A
Only diverging / concave lens forms diminished, virtual image. 1A
2

(b)



Correct position and height of object 2A
2

(c) Correct ray to locate *F* and focus *F* correctly marked. 2M
Focal length = 16.5 cm 1A
Accept: (15.5 ~ 17.5) cm
3

(d) Correct ray *p* from tip of object 2A
2