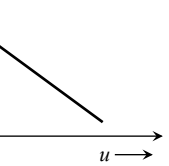
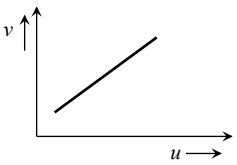
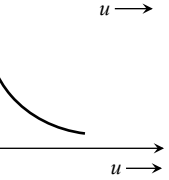
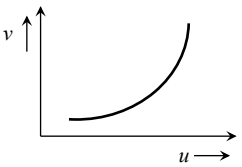
Graphical Questions

1. In an experiment of find the focal length of a concave mirror a graph is drawn between the magnitudes of u and v. The graph looks like **[AIIMS 2003]**

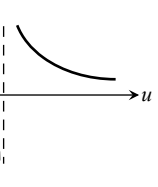
(a) 

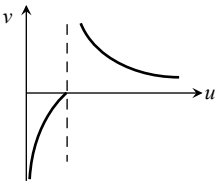
(b) 

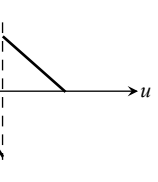
(c) 

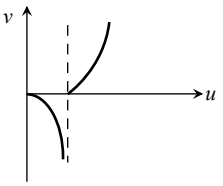
(d) 

2. As the position of an object (u) reflected from a concave mirror is varied, the position of the image (v) also varies. By letting the u changes from 0 to $+\infty$ the graph between v versus u will be

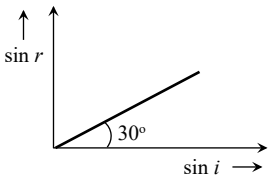
(a) 

(b) 

(c) 

(d) 

3. When light is incident on a medium at angle i and refracted into a second medium at an angle r, the graph of sin i *vs* sin$r$ is as shown in the graph. From this, one can conclude that



(a) Velocity of light in the second medium is 1.73 times the velocity of light in the I medium

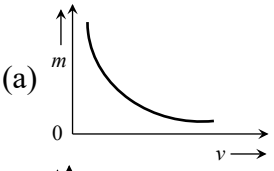
(b) Velocity of light in the I medium is 1.73 times the velocity in the II medium

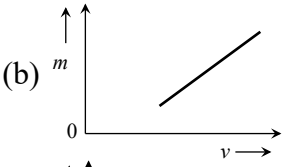
(c) The critical angle for the two media is given by

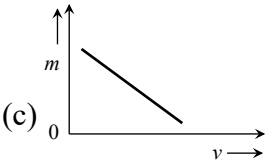
$$\sin i_c = \frac{1}{\sqrt{3}}$$

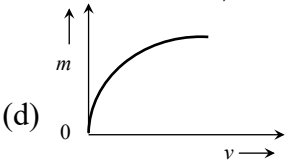
(d) $\sin i_c = \frac{1}{2}$

4. The graph between the lateral magnification (m) produced by a lens and the distance of the image (v) is given by **[MP PMT 1994]**

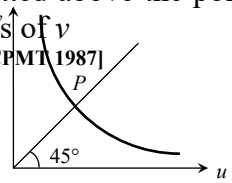
(a) 

(b) 

(c) 

(d) 

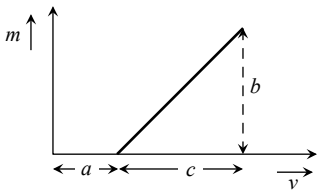
5. The graph shows variation of v with change in u for a mirror. Points plotted above the point P on the curve are for values of v **[CPMT 1987]**



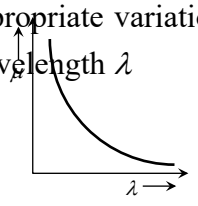
(a) Smaller then f
(b) Smaller then $2f$
(c) Larger then $2f$
(d) Larger than f

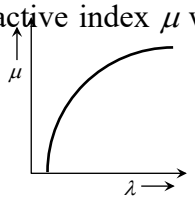
6. The graph shows how the magnification m produced by a convex thin lens varies with image distance v. What was the focal length of the used **[DPMT 1995]**

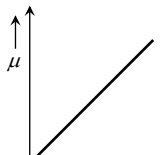
(a) $\frac{b}{c}$
(b) $\frac{b}{ca}$
(c) $\frac{bc}{a}$
(d) $\frac{c}{b}$

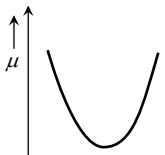


7. Which of the following graphs shows appropriate variation of refractive index μ with wavelength λ

(a) 

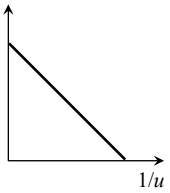
(b) 

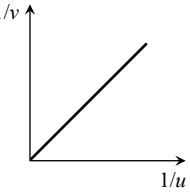


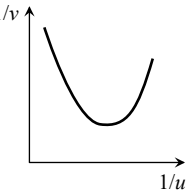


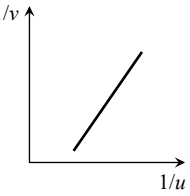
(c) (d)

8. For a concave mirror, if real image is formed the graph between $\frac{1}{u}$ and $\frac{1}{v}$ is of the form

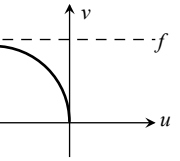
(a) 

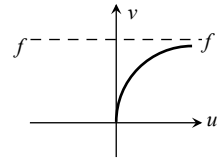
(b) 

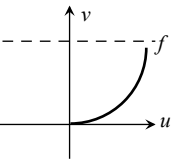
(c) 

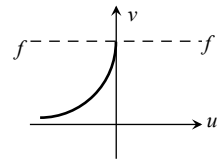
(d) 

9. The graph between u and v for a convex mirror is

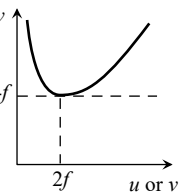
(a) 

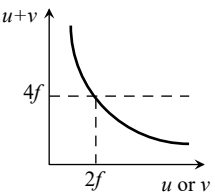
(b) 

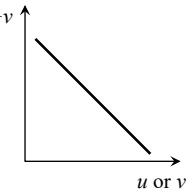
(c) 

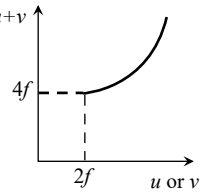
(d) 

10. For a convex lens, if real image is formed the graph between $(u + v)$ and u or v is as follows

(a) 

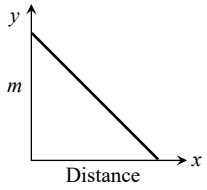
(b) 

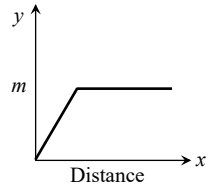


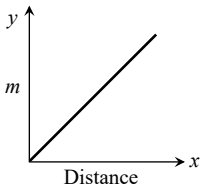


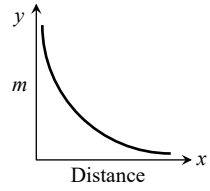
(c) (d)

11. Which of the following graphs is the magnification of a real image against the distance from the focus of a concave mirror

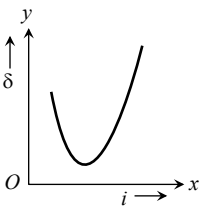
(a) 

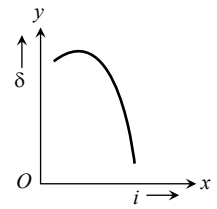
(b) 

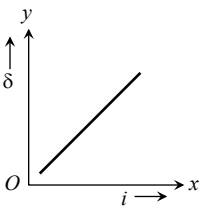
(c) 

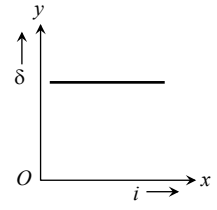
(d) 

12. A graph is plotted between angle of deviation (δ) and angle of incidence (i) for a prism. The nearly correct graph is

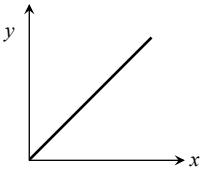
(a) 

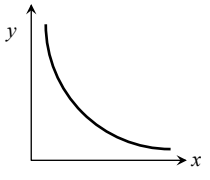
(b) 

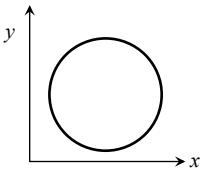
(c) 

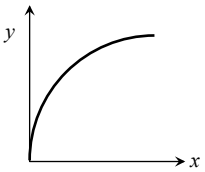
(d) 

13. If x is the distance of an object from the focus of a concave mirror and y is the distance of image from the focus, then which of the following graphs is correct between x and y

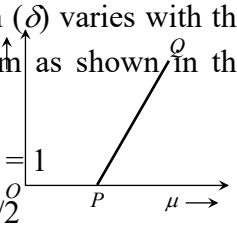
(a) 

(b) 

(c) 

(d) 

14. For a small angled prism, angle of prism A, the angle of minimum deviation (δ) varies with the refractive index of the prism as shown in the graph



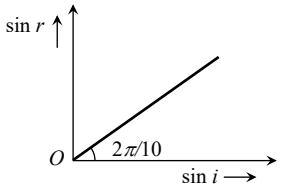
(a) Point P corresponds to $\mu = 1$

(b) Slope of the line $PQ = A/2$

(c) Slope = A

(d) None of the above statements is true

15. The graph between sine of angle of refraction (sin r) in medium 2 and sine of angle of incidence (sin i) in medium 1 indicates that ($\tan 36° \approx \frac{3}{4}$)



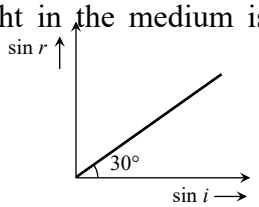
(a) Total internal reflection can take place

(b) Total internal reflection cannot take place

(c) Any of (a) and (b)

(d) Data is incomplete

16. A medium shows relation between i and r as shown. If speed of light in the medium is nc then value of n is



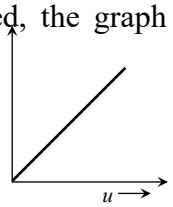
(a) 1.5

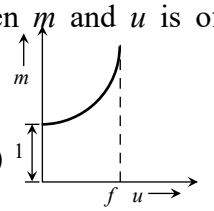
(b) 2

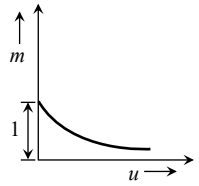
(c) 2^{-1}

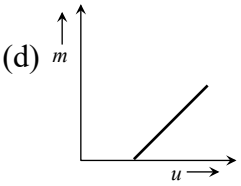
(d) $3^{-1/2}$

17. For a concave mirror, if virtual image is formed, the graph between m and u is of the form

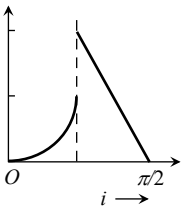
(a) 

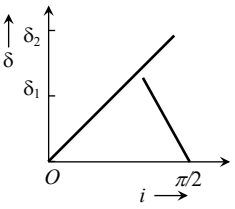
(b) 

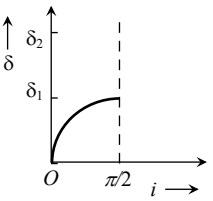
(c) 

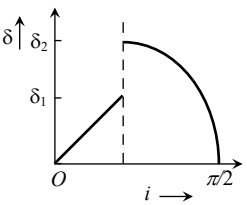
(d) 

18. A ray of light travels from a medium of refractive index μ to air. Its angle of incidence in the medium is i, measured from the normal to the boundary, and its angle of deviation is δ. δ is plotted against i which of the following best represents the resulting curve

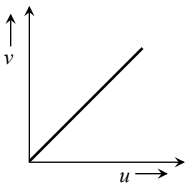
(a) 

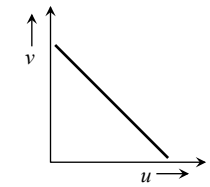
(b) 

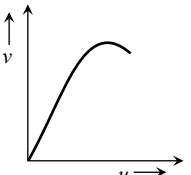
(c) 

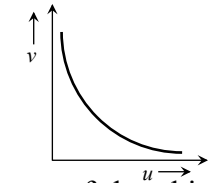
(d) 

19. The distance v of the real image formed by a convex lens is measured for various object distance u. A graph is plotted between v and u, which one of the following graphs is correct **[BVP 2003]**

(a) 

(b) 

(c) 

(d) 

20. For a convex lens the distance of the object is taken on X-axis and the distance of the image is taken on Y-axis, the nature of the graph so obtained is **[BVP 2003]**

(a) Straight line (b) Circle

(c) Parabola (d) Hyperbola

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : A red object appears dark in the yellow light
Reason : A red colour is scattered less **[AIIMS 2004]**

2. Assertion : The stars twinkle while the planets do not.
Reason : The stars are much bigger in size than the planets. **[AIIMS 2003]**

3. Assertion : Owls can move freely during night.
Reason : They have large number of rods on their retina. **[AIIMS 2003]**

4. Assertion : The air bubble shines in water.
Reason : Air bubble in water shines due to refraction of light **[AIIMS 2002]**

5. Assertion : In a movie, ordinarily 24 frames are projected per second from one end to the other of the complete film.
Reason : The image formed on retina of eye is sustained upto 1/10 second after the removal of stimulus. **[AIIMS 2001]**

6. Assertion : Blue colour of sky appears due to scattering of blue colour.
Reason : Blue colour has shortest wave length in visible spectrum. **[AIIMS 2001]**

7. Assertion : The refractive index of diamond is $\sqrt{6}$ and that of liquid is $\sqrt{3}$. If the light travels from diamond to the liquid, it will totally reflected when the angle of incidence is 30^o.
Reason : $\mu = \frac{1}{\sin C}$, where μ is the refractive index of diamond with respect to liquid. **[AIIMS 2000]**

8. Assertion : The setting sun appears to be red.
Reason : Scattering of light is directly proportional to the wavelength. **[AIIMS 2000]**

9. Assertion : A double convex lens ($\mu = 1.5$) has focal length 10 *cm*. When the lens is immersed in water ($\mu = 4/3$) its focal length becomes 40 *cm*.
Reason : $\frac{1}{f} = \frac{\mu_l - \mu_m}{\mu_m}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ **[AIIMS 1999]**

10. Assertion : Different colours travel with different speed in vacuum.
Reason : Wavelength of light depends on refractive index of medium. **[AIIMS 1998]**

11. Assertion : The colour of the green flower seen through red glass appears to be dark.
Reason : Red glass transmits only red light. **[AIIMS 1997]**

12. Assertion : The focal length of the mirror is f and distance of the object from the focus is u, the magnification of the mirror is f / u.
Reason : Magnification $= \frac{\text{Sizeof image}}{\text{Sizeof object}}$ **[AIIMS 1994]**

13. Assertion : If a plane glass slab is placed on the letters of different colours all the letters appear to be raised up to the same height.

Reason : Different colours have different wavelengths.

14. Assertion : The fluorescent tube is considered better than an electric bulb.
Reason : Efficiency of fluorescent tube is more than the efficiency of electric bulb.

15. Assertion : The polar caps of earth are cold in comparison to equatorial plane.
Reason : The radiation absorbed by polar caps is less than the radiation absorbed by equatorial plane.

16. Assertion : The illumination of earth's surface from sun is more at noon than in the morning.
Reason : Luminance of a surface refers to brightness of the surface.

17. Assertion : When an object is placed between two plane parallel mirrors, then all the images found are of equal intensity.
Reason : In case of plane parallel mirrors, only two images are possible.

18. Assertion : The mirrors used in search lights are parabolic and not concave spherical.
Reason : In a concave spherical mirror the image formed is always virtual.

19. Assertion : The size of the mirror affect the nature of the image.
Reason : Small mirrors always forms a virtual image.

20. Assertion : Just before setting, the sun may appear to be elliptical. This happens due to refraction.
Reason : Refraction of light ray through the atmosphere may cause different magnification in mutually perpendicular directions.

21. Assertion : Critical angle of light passing from glass to air is minimum for violet colour.
Reason : The wavelength of blue light is greater than the light of other colours.

22. Assertion : We cannot produce a real image by plane or convex mirrors under any circumstances.
Reason : The focal length of a convex mirror is always taken as positive.

23. Assertion : A piece of red glass is heated till it glows in dark. The colour of glowing glass would be orange.
Reason : Red and orange is complementary colours.

24. Assertion : Within a glass slab, a double convex air bubble is formed. This air bubble behaves like a converging lens.
Reason : Refractive index of air is more than the refractive index of glass.

25. Assertion : The images formed by total internal reflections are much brighter than those formed by mirrors or lenses.
Reason : There is no loss of intensity in total internal reflection.

26. Assertion : The focal length of lens does not change when red light is replaced by blue light.
Reason : The focal length of lens does not depends on colour of light used.

27. Assertion : There is no dispersion of light refracted through a rectangular glass slab.
Reason : Dispersion of light is the phenomenon of splitting of a beam of white light into its constituent colours.

28. Assertion : All the materials always have the same colour, whether viewed by reflected light or through transmitted light.
Reason : The colour of material does not depend on nature of light.

29. Assertion : A beam of white light gives a spectrum on passing through a hollow prism.
Reason : Speed of light outside the prism is different from the speed of light inside the prism.

30. Assertion : By increasing the diameter of the objective of telescope, we can increase its range.
Reason : The range of a telescope tells us how far away a star of some standard brightness can be spotted by telescope.

31. Assertion : For the sensitivity of a camera, its aperture should be reduced.
Reason : Smaller the aperture, image focussing is also sharp.

32. Assertion : If objective and eye lenses of a microscope are interchanged then it can work as telescope.
Reason : The objective of telescope has small focal length.

33. Assertion : The illuminance of an image produced by a convex lens is greater in the middle and less towards the edges.
Reason : The middle part of image is formed by undeflected rays while outer part by inclined rays.

34. Assertion : Although the surfaces of a goggle lens are curved, it does not have any power.
Reason : In case of goggles, both the curved surfaces have equal radii of curvature.

35. Assertion : The resolving power of an electron microscope is higher than that of an optical microscope.
Reason : The wavelength of electron is more than the wavelength of visible light.

36. Assertion : If the angles of the base of the prism are equal, then in the position of minimum deviation, the refracted ray will pass parallel to the base of prism.
Reason : In the case of minimum deviation, the angle of incidence is equal to the angle of emergence.

37. Assertion : Dispersion of light occurs because velocity of light in a material depends upon its colour.
Reason : The dispersive power depends only upon the material of the prism, not upon the refracting angle of the prism.

38. Assertion : An empty test tube dipped into water in a beaker appears silver, when viewed from a suitable direction.
Reason : Due to refraction of light, the substance in water appears silvery.

39. Assertion : Spherical aberration occur in lenses of larger aperture.
Reason : The two rays, paraxial and marginal rays focus at different points.

40. Assertion : It is impossible to photograph a virtual image.
Reason : The rays which appear diverging from a virtual image fall on the camera and a real image is captured.

41. Assertion : The speed of light in a rarer medium is greater than that in a denser medium
Reason : One light year equals to 9.5×10^{12} *km*
[AIIMS 1999]

42. Assertion : The frequencies of incident, reflected and refracted beam of monochromatic light incident from one medium to another are same
Reason : The incident, reflected and refracted rays are coplanar **[EAMCET (Engg.) 2000]**

43. Assertion : The refractive index of a prism depends only on the kind of glass of

which it is made of and the colour of light

Reason : The refractive index of a prism depends upon the refracting angle of the prism and the angle of minimum deviation [AIIMS 2000]

44. Assertion : The resolving power of a telescope is more if the diameter of the objective lens is more.

Reason : Objective lens of large diameter collects more light. [AIIMS 2005]

45. Assertion : By roughening the surface of a glass sheet its transparency can be reduced.

Reason : Glass sheet with rough surface absorbs more light. [AIIMS 2005]

46. Assertion : Diamond glitters brilliantly.

Reason : Diamond does not absorb sunlight. [AIIMS 2005]

47. Assertion : The cloud in sky generally appear to be whitish.

Reason : Diffraction due to cloud is efficient in equal measure at all wavelengths. [AIIMS 2005]

Answers

Plane Mirror

1	d	2	b	3	b	4	c,d	5	c
6	c	7	d	8	b	9	b	10	c
11	b	12	d	13	a	14	c	15	c
16	b	17	c	18	b	19	c	20	a
21	c	22	b	23	c	24	b	25	b
26	b	27	c	28	c	29	c	30	c
31	b	32	a	33	b	34	c		

Spherical Mirror

1	a	2	c	3	d	4	c	5	a
6	b	7	c	8	b	9	a	10	b
11	d	12	b	13	b	14	b	15	c
16	d	17	b	18	b	19	a	20	a
21	a	22	b	23	d	24	d	25	b
26	bc	27	c	28	b	29	a	30	b
31	d	32	c	33	a	34	d	35	d
36	b	37	d	38	d	39	d	40	a
41	d	42	d	43	a	44	a		

Refraction of Light at Plane Surfaces

1	d	2	a	3	b	4	a	5	d
6	a	7	c	8	d	9	c	10	a
11	b	12	d	13	b	14	a	15	b
16	a	17	c	18	c	19	d	20	a
21	b	22	b	23	c	24	a	25	c
26	a	27	b	28	d	29	a	30	c
31	c	32	c	33	b	34	b	35	b
36	b	37	a	38	b	39	c	40	d
41	a	42	d	43	c	44	c	45	a
46	a	47	c	48	a	49	c	50	c
51	d	52	b	53	b	54	b	55	b
56	a	57	d	58	b	59	c	60	b
61	d	62	a	63	b	64	d	65	b
66	a	67	b	68	b	69	a	70	d
71	c	72	c	73	d	74	d	75	b
76	d	77	c	78	c	79	b	80	b
81	a	82	a	83	b	84	b	85	c
86	b	87	d	88	d	89	b	90	d

Total Internal Reflection

1	b	2	c	3	d	4	d	5	c
6	c	7	b	8	c	9	a	10	d
11	b	12	c	13	c	14	d	15	d
16	c	17	c	18	cd	19	c	20	d
21	a	22	c	23	b	24	c	25	a
26	c	27	c	28	a	29	d	30	d
31	a	32	c	33	a	34	c	35	a
36	d	37	b	38	b	39	c	40	a
41	c	42	b	43	b	44	d	45	B
46	a								

Refraction at Curved Surface

1	a	2	a	3	d	4	c	5	a
6	d	7	b	8	a	9	c	10	c
11	c	12	d	13	b	14	c	15	b
16	d	17	c	18	d	19	c	20	c
21	c	22	a	23	d	24	a	25	d
26	a	27	b	28	a	29	a	30	c
31	c	32	d	33	d	34	c	35	b
36	b	37	c	38	d	39	b	40	d
41	a	42	c	43	a	44	c	45	d
46	d	47	c	48	b	49	a	50	b
51	c	52	a	53	a	54	b	55	a
56	b	57	a	58	a	59	d	60	c
61	b	62	b	63	d	64	d	65	d
66	a	67	d	68	c	69	c	70	b
71	d	72	b	73	a	74	c	75	a
76	c	77	a	78	b	79	b	80	d
81	c	82	a	83	d	84	a	85	c
86	c	87	b	88	a	89	a	90	b
91	b	92	d	93	c	94	a	95	c
96	c	97	c	98	a	99	d	100	a
101	a	102	d	103	c	104	d	105	a
106	c	107	b	108	a	109	d	110	b
111	c	112	c	113	c	114	d	115	a
116	c	117	a	118	d	119	c	120	b
121	c	122	d	123	a	124	b	125	d
126	c	127	d	128	b	129	b	130	c
131	b	132	b	133	b	134	d	135	b
136	d	137	d	138	b	139	a	140	c
141	b	142	b	143	c	144	b	145	c

Prism Theory & Dispersion of Light

1	b	2	b	3	b	4	c	5	c
6	a	7	a	8	d	9	d	10	d
11	c	12	b	13	b	14	a	15	a
16	b	17	d	18	a	19	d	20	b
21	a	22	c	23	a	24	a	25	b
26	c	27	c	28	b	29	a	30	a
31	c	32	b	33	a	34	c	35	d
36	a	37	b	38	a	39	d	40	b
41	b	42	b	43	a	44	c	45	a
46	c	47	b	48	a	49	c	50	c
51	c	52	a	53	d	54	d	55	a
56	c	57	a	58	a	59	a	60	c
61	c	62	b	63	d	64	d	65	a
66	b	67	c	68	c	69	b	70	c
71	a	72	d	73	a	74	b	75	a
76	b	77	b	78	b	79	d	80	a
81	b	82	a	83	b	84	c	85	a
86	c	87	c	88	a	89	b	90	b
91	c	92	a	93	c	94	c	95	b
96	c	97	c	98	a	99	a	100	c
101	a	102	b	103	a	104	b	105	d
106	b	107	b	108	a	109	b	110	a
111	a	112	d	113	a	114	b	115	a
116	d	117	d	118	d	119	c	120	d
121	a	122	d	123	c	124	d	125	b
126	a	127	c	128	c	129	d	130	a
131	a	132	c	133	a	134	c	135	b
136	c	137	a	138	d	139	c	140	b
141	a	142	a	143	b	144	b	145	a
146	a	147	d	148	b	149	c	150	a
151	c								

Human Eye and Lens Camera

1	c	2	a	3	b	4	d	5	b
6	c	7	b	8	a	9	d	10	a
11	c	12	c	13	a	14	b	15	d
16	b	17	c	18	c	19	b	20	c
21	b	22	a	23	a	24	a	25	d
26	a	27	d	28	c	29	b	30	c
31	c	32	c	33	b	34	b	35	a
36	c	37	d	38	a	39	d	40	a
41	b	42	c	43	d	44	a	45	b
46	b	47	d	48	d	49	b	50	b
51	c	52	a	53	a	54	c	55	d
56	a	57	a	58	d	59	a	60	d
61	d	62	a	63	b	64	d	65	a

Microscope and Telescope

1	c	2	b	3	b	4	b	5	b
6	d	7	c	8	a	9	b	10	b
11	a	12	b	13	b	14	a	15	c
16	d	17	a	18	b	19	b	20	b
21	a	22	d	23	c	24	a	25	d
26	c	27	c	28	d	29	d	30	b
31	a	32	d	33	d	34	c	35	d
36	b	37	a	38	a	39	b	40	d
41	d	42	b	43	d	44	a	45	c
46	b	47	b	48	d	49	b	50	d
51	c	52	a	53	a	54	a	55	b

56	a	57	d	58	d	59	c	60	c
61	c	62	a	63	b	64	a	65	b
66	a	67	a	68	c	69	a	70	b
71	c	72	b	73	a	74	a	75	b
76	d	77	c	78	b	79	a	80	c
81	b	82	b	83	b	84	a	85	b
86	abcd	87	a	88	a	89	b	90	c
91	b	92	d	93	c	94	d	95	c
96	c	97	d	98	a	99	b	100	d
101	c	102	b	103	a	104	b	105	b
106	c	107	c	108	a	109	c	110	c
111	d	112	a	113	d	114	a	115	a
116	a	117	b	118	a	119	a	120	a

Photometry

1	d	2	b	3	d	4	c	5	d
6	b	7	a	8	b	9	c	10	c
11	a	12	c	13	c	14	c	15	a
16	a	17	b	18	b	19	c	20	b
21	c	22	c	23	a	24	b	25	bc
26	c	27	d	28	b	29	d	30	b
31	d	32	a	33	d	34	d	35	a
36	c	37	c	38	d	39	d	40	c
41	c								

Critical Thinking Questions

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

Graphical Questions

1	c	2	a	3	bc	4	c	5	c
6	d	7	a	8	a	9	a	10	a
11	d	12	a	13	b	14	ac	15	b
16	d	17	b	18	a	19	d	20	d

Assertion and Reason

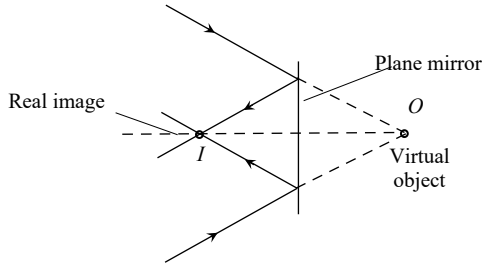
1	b	2	b	3	c	4	c	5	c
6	a	7	e	8	c	9	a	10	e
11	a	12	a	13	e	14	a	15	c
16	b	17	d	18	c	19	d	20	a
21	c	22	e	23	d	24	d	25	a
26	d	27	b	28	d	29	d	30	b
31	c	32	d	33	a	34	a	35	c
36	a	37	b	38	c	39	a	40	e
41	b	42	b	43	c	44	a	45	c
46	b	47	c						

AS Answers and Solutions

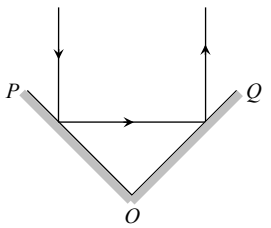
Plane Mirror

1. (d) $\delta = (360 - 2\theta) = (360 - 2 \times 60) = 240^o$

2. (b) When converging beam incident on plane mirror, real image is formed as shown

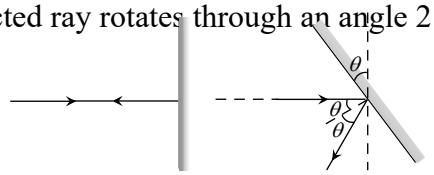


3. (b) Incident ray and finally reflected ray are parallel to each other means $\delta = 180^o$

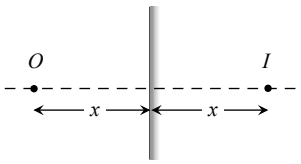


From $\delta = 360 - 2\theta \Rightarrow 180 = 360 - 2\theta \Rightarrow \theta = 90^o$

4. (c, d) By keeping the incident ray is fixed, if plane mirror rotates through an angle θ reflected ray rotates through an angle 2θ.

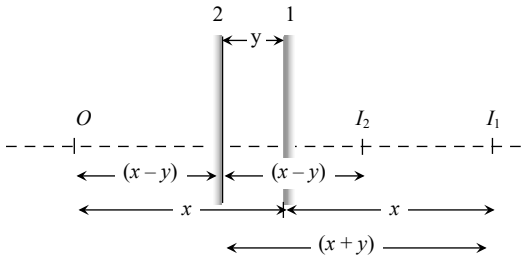


5. (c) Suppose at any instant, plane mirror lies at a distance x from object. Image will be formed behind the mirror at the same distance x.



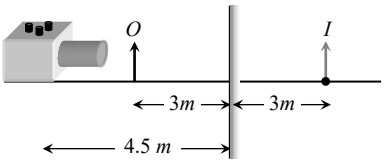
When the mirror shifts towards the object by distance 'y' the image shifts $= x + y - (x - y) = 2y$

So speed of image = 2 × speed of mirror

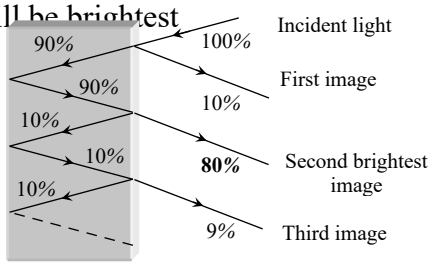


6. (c) Number of images $= \left(\frac{360}{\theta} - 1\right) = \left(\frac{360}{60} - 1\right) = 5$

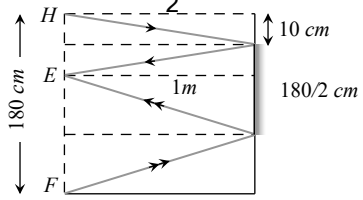
7. (d) F_o using distance of image = 4.5 m + 3 m = 7.5 m.



8. (b) Several images will be formed but second image will be brightest



9. (b) According to the following ray diagram length of mirror $= \frac{1}{2}(10 + 170) = 90\ cm$

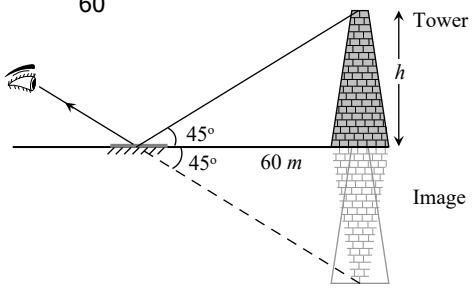


10. (c) The walls will act as two mirrors inclined to each other at $90°$ and so will form $\left(\frac{360}{90} - 1\right) = 4 - 1$ *i.e.* 3 images of the person.

Now these images with person will act as objects for the ceiling mirror and so ceiling mirror will form 4 images further. Therefore total number of images formed $= 3 + 3 + 1 = 7$

Note : He can see. 6 images of himself.

11. (b) $\tan 45° = \frac{h}{60} \Rightarrow h = 60\ m$



12. (d) $\delta = 180° - 60° = 120°$

13. (a) $< i = < r = 0°$

14. (c) When light is reflected from denser medium, a phase difference of π always occurs.

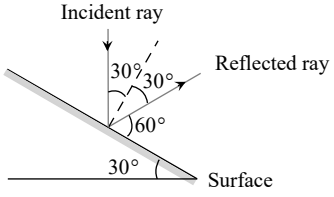
15. (c) Ray after reflection from three mutually perpendicular mirrors becomes anti-parallel.

16. (b) In two images man will see himself using left hand.

17. (c) In plane mirror, size of the image is independent of the angle of incidence.

18. (b) Size of image formed by a plane mirror is same as that of the object. Hence its magnification will be 1.

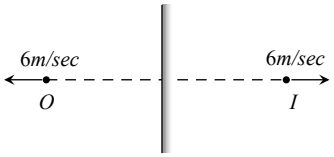
19. (c)



20. (a) Subtract the given time from $\overset{hr.}{11}:\overset{min.}{60}$

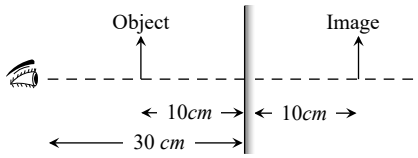
21. (c) Relative velocity of image *w.r.t.* object

$= 6-(-6) = 12\, m/\sec$



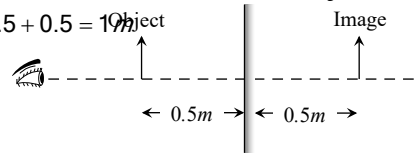
22. (b)

23. (c) See following ray diagram



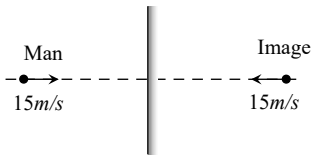
The distance focussed for eye $= 30 + 10 = 40\, cm$

24. (b) Distance between object and image $= 0.5 + 0.5 = 1m$

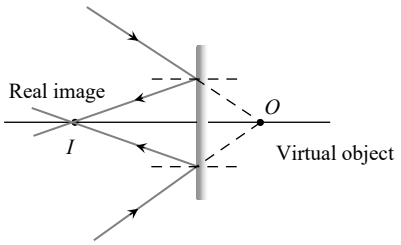


25. (b) Relative velocity of image *w.r.t.* man

$= 15-(-15) = 30\, m/s$



26. (b)



27. (c) $n = \left(\frac{360}{\theta}-1\right) \Rightarrow n = \left(\frac{360}{72}-1\right) = 4$

28. (c) $n = \left(\frac{360}{\theta}-1\right) \Rightarrow 3 = \left(\frac{360}{\theta}-1\right) \Rightarrow \theta = 90°$

29. (c)

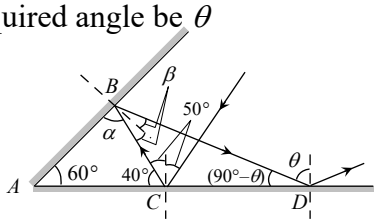
30. (c) $n = \frac{360}{45}-1 = 7$

31. (b) Diminished, erect image is formed by convex mirror.

32. (a) When a mirror is rotated by an angle θ, the reflected ray deviate from its original path by angle 2θ.

33. (b) $f = \frac{R}{2}$, and $R = \infty$ for plane mirror.

34. (c) Let required angle be θ



From geometry of figure

In ΔABC; $\alpha = 180° - (60° + 40°) = 80°$

$\Rightarrow \beta = 90° - 80° = 10°$

In ΔABD; $\angle A = 60°$, $\angle B = (\alpha + 2\beta)$

$= (80 + 2 \times 10) = 100°$ and $\angle D = (90° - \theta)$

$\because \angle A + \angle B + \angle D = 180° \Rightarrow 60° + 100° + (90° - \theta) = 180° \Rightarrow \theta = 70°$

Spherical Mirror

1. (a) $m = +\frac{1}{n} = -\frac{v}{u} \Rightarrow v = -\frac{u}{n}$

By using mirror formula $\frac{1}{f} = \frac{1}{-\frac{u}{n}} + \frac{1}{u}$

$\Rightarrow u = -(n-1)f$

2. (c)

3. (d)

4. (c) $\frac{I}{O} = \frac{f}{(f-u)} \Rightarrow \frac{I}{+5} = \frac{-10}{-10-(-100)} \Rightarrow I = 0.55\, cm$

5. (a) For real image $m = -2$, so by using $m = \frac{f}{f-u}$

$\Rightarrow -2 = \frac{-50}{-50-u} \Rightarrow u = -75\, cm$

6. (b) By using $\frac{I}{O} = \frac{f}{f-u}$

$\Rightarrow \frac{I}{+(7.5)} = \frac{(25/2)}{\left(\frac{25}{2}\right)-(-40)} \Rightarrow I = 1.78\, cm$

7. (c)

8. (b) $\frac{I}{O} = \frac{f}{f-u}$; where $u = f + x$ $\therefore \frac{I}{O} = -\frac{f}{x}$

9. (a) Image formed by convex mirror is virtual for real object placed anywhere.

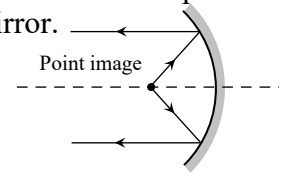
10. (b) Given $u=(f+x_1)$ and $v=(f+x_2)$

The focal length $f=\frac{uv}{u+v}=\frac{(f+x_1)(f+x_2)}{(f+x_1)+(f+x_2)}$

On solving, we get $f^2=x_1x_2$ or $f=\sqrt{x_1x_2}$

11. (d) The image formed by a convex mirror is always virtual.

12. (b) Object should be placed on focus of concave mirror.



13. (b) $m=\frac{f}{(f-u)}\Rightarrow\left(+\frac{1}{4}\right)=\frac{(+30)}{(+30)-u}\Rightarrow u=-90\ cm$

14. (b) Size is $\frac{1}{5}$. It can't be plane and concave mirror, because both conditions are not satisfied in plane or concave mirror. Convex mirror can meet all the requirements.

15. (c) Plane mirror and convex mirror always forms erect images. Image formed by concave mirror may be erect or inverted depending on position of object.

16. (d) Virtual image is seen on the photograph.

17. (b) $\because m=-\frac{v}{u}$ also $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}\Rightarrow\frac{u}{f}=\frac{u}{v}+1$

$\Rightarrow -\frac{u}{v}=1-\frac{u}{f}\Rightarrow\frac{-v}{u}=\frac{f}{f-u}$ so $m=\frac{f}{f-u}$.

18. (b) To make the light diverging as much as possible.

19. (a) Let distance $=u$. Now $\frac{v}{u}=16$ and $v=u+120$

$\therefore\frac{120+u}{u}=16\Rightarrow 15u=120\Rightarrow u=8\ cm.$

20. (a) Virtual image formed is larger in size in case of concave mirror.

21. (a) Real, inverted and same in size because object is at the centre of curvature of the mirror.

22. (b) Image is virtual so m = + 3. and $f=\frac{R}{2}=18\ cm$

So from $m=\frac{f}{f-u}\Rightarrow 3=\frac{(-18)}{(-18)-u}\Rightarrow u=-12\ cm$

23. (d) $f=\frac{R}{2}=20\,cm,\ m=2$ For real image; $m=-2$,

By using $m=\frac{f}{f-u}$, $-2=\frac{-20}{-20-u}\Rightarrow u=-30\,cm$

For virtual image; $m=+2$

So, $+2=\frac{-20}{-20-u}\Rightarrow u=-10\,cm$

24. (d) Convex mirror always forms, virtual, erect and smaller image.

25. (b) When object is placed. Between focus and pole, image formed is erect, virtual and enlarged.

26. (b, c) Convex mirror and concave lens form virtual image for all positions of object.

27. (c) Here focal length $=f$ and $u=-f$

On putting these values in $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$

$\Rightarrow\frac{1}{f}=-\frac{1}{f}+\frac{1}{v}\Rightarrow v=\frac{f}{2}$

28. (b) Erect and enlarged image can produced by concave mirror.

$\frac{I}{O}=\frac{f}{f-u}\Rightarrow\frac{+3}{+1}=\frac{f}{f-(-4)}\Rightarrow f=-6\,cm$

$\Rightarrow R=2f=-12\,cm$

29. (a)

30. (b) $m=\frac{f}{f-u}\Rightarrow -3=\frac{f}{f-(-20)}\Rightarrow f=-15\,cm$

31. (d) When object is kept at centre of curvature. It's real image is also formed at centre of curvature.

32. (c) $u=-20\,cm,\ f=+10\,cm$ also $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$

$\Rightarrow\frac{1}{+10}=\frac{1}{v}+\frac{1}{(-20)}\Rightarrow v=\frac{20}{3}\ cm$, virtual image.

33. (a) Mirror formula

$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}\Rightarrow\frac{1}{f}=\frac{1}{-20}+\frac{1}{(-10)}\Rightarrow f=\frac{20}{3}\ cm$ If object moves towards the mirror by $0.1\,cm$ then.

$u=(10-0.1)=9.9\,cm$ Hence again from mirror formula $\frac{1}{-20/3}=\frac{1}{v'}+\frac{1}{-9.9}\Rightarrow v'=20.4\ cm$ i.e. image shifts away from the mirror by $0.4\,cm$

34. (d) Image formed by convex mirror is always. Erect diminished and virtual.

35. (d) $f=\frac{R}{2}\Rightarrow R=40\,cm$

36. (b) $f=-15\,cm,\ m=+2$ (Positive because image is virtual)

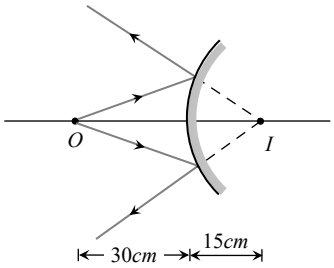
$\because m = -\frac{v}{u} \Rightarrow v = -2u$. By using mirror formula

$\frac{1}{-15} = \frac{1}{(-2u)} + \frac{1}{u} \Rightarrow u = -7.5\ cm$

37. (d) $u = -30\ cm,\quad f = +30\ cm,$ by using mirror formula

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{+30} = \frac{1}{v} + \frac{1}{(-30)}$

$v = 15\ cm,$ behind the mirror



38. (d) $R = -30\ cm \Rightarrow f = -15\ cm$

$O = +2.5\ cm,\quad u = -10\ cm$

By mirror formula $\frac{1}{-15} = \frac{1}{v} + \frac{1}{(-10)} \Rightarrow v = 30\ cm$

Also $\frac{I}{O} = -\frac{v}{u} \Rightarrow \frac{I}{(+2.5)} = -\frac{30}{(-10)} \Rightarrow I = +7.5\ cm$

39. (d)

40. (a) $\frac{I}{O} = \frac{f}{f-u} \Rightarrow \frac{I}{+6} = \frac{-f}{-f-(-4f)} \Rightarrow I = -2\ cm$

41. (d) Convergence (or power) is independent of medium for mirror.

42. (d) $\frac{I}{O} = \frac{f}{f-u} \Rightarrow \frac{I}{2} = \frac{20}{20+20} = \frac{1}{2} \Rightarrow I = 1\ mm$

43. (a) $m = \pm 3$ and $f = -6\ cm$

Now $m = \frac{f}{f-u} \Rightarrow \pm 3 = \frac{-6}{-6-u}$

For real image $-3 = \frac{-6}{-6-u} \Rightarrow u = -8\ cm$

For virtual image $3 = \frac{-6}{-6-u} \Rightarrow u = -4\ cm$

44. (a) Focal length of the mirror remains unchanged.

Refraction of Light at Plane Surfaces

1. (d)

2. (a) $\mu_{blue} > \mu_{red}$

3. (b) $\mu \propto \frac{1}{\lambda}, \lambda_r > \lambda_v$

4. (a) $\lambda_{medium} = \frac{\lambda_{air}}{\mu} = \frac{6000}{1.5} = 4000\ \AA$

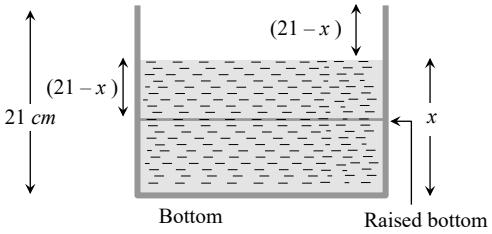
5. (d) Velocity and wavelength change but frequency remains same.

6. (a) $\mu = \frac{c}{v} = \frac{c}{\nu\lambda} = \frac{3\times10^8}{4\times10^{14}\times5\times10^{-7}} = 1.5$

7. (c) To see the container half-filled from top, water should be filled up to height x so that bottom of the container should appear to be raised upto height $(21-x)$.

As shown in figure apparent depth $H = (21-x)$

Real depth $h = x$



$\therefore \mu = \frac{h}{H} \Rightarrow \frac{4}{3} = \frac{x}{21-x} \Rightarrow x = 12\ cm$

8. (d) In vacuum, the speed of light is independent of wave length. Thus vacuum (or air) is a non dispersive medium in which all colours travel with the same speed.

9. (c) $\lambda \propto \frac{1}{\mu} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{\mu_2}{\mu_1} = \frac{\mu}{1}$

10. (a) $v \propto \frac{1}{\mu}, \mu_{rarer} < \mu_{denser}$

11. (b) $\mu \propto \frac{1}{\lambda}$

12. (d) $v = \frac{c}{\mu} = \frac{3\times10^8}{2} = 1.5\times10^8\ m/s = 1.5\times10^{10}\ cm/s$

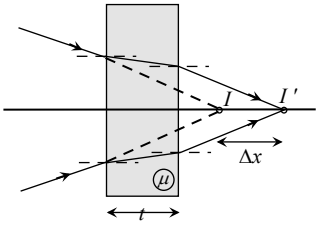
13. (b) $\because \angle i > \angle r,$ it means light ray is going from rarer medium (A) to denser medium.

So $v(A) > v(B)$ and $n(A) < n(B)$

14. (a) $\mu = \frac{h}{H} \Rightarrow H = \frac{8}{4/3} = 6\ m$

15. (b) $H = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} = d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$

16. (a) Normal shift $\Delta x = \left(1 - \frac{1}{\mu}\right)t$



and shift takes place in direction of ray.

17. (c) $\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{t}{c/x} = \frac{nt}{c}$

18. (c) Let ν' and λ' represents frequency and wavelength of light in medium respectively.

so $\nu' = \frac{v}{\lambda'} = \frac{c/\mu}{\lambda/\mu} = \frac{c}{\lambda} = \nu$

19. (d) $\mu = \frac{c_a}{c_w} = \frac{t_w}{t_a} \Rightarrow t_w = \frac{25}{3} \times \frac{4}{9} = 11\frac{1}{9} = 11 min\ 6\ sec$

20. (a) Optical path = μt

In medium (1), optical path = $\mu_1 d_1$

In medium (2), optical path = $\mu_2 d_2$

$\therefore$ Total path = $\mu_1 d_1 + \mu_2 d_2$

21. (b) Refractive index of liquid C is same as that of glass piece. So it will not be visible in liquid C.

22. (b) ${}_a\mu_g = \frac{3}{2}, {}_a\mu_w = \frac{4}{3}$

$\therefore$ ${}_w\mu_g = \frac{{}_a\mu_g}{{}_a\mu_w} = \frac{3/2}{4/3} = \frac{9}{8}$

23. (c) ${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3 = \frac{\mu_1}{\mu_2} \times \frac{\mu_2}{\mu_3} \times \frac{\mu_3}{\mu_4} = \frac{\mu_1}{\mu_4} = {}_4\mu_1 = \frac{1}{{}_1\mu_4}$

24. (a) Colour of light is determined by its frequency and as frequency does not change, colour will also not change and will remains green.

25. (c) Ray optics fails if the size of the object is of the order of the wavelength.

26. (a) ${}_a n_w \times {}_w n_{gl} \times {}_{gl} n_{gas} \times {}_{gas} n_a = \frac{n_w}{n_a} \times \frac{n_{gl}}{n_w} \times \frac{n_{gas}}{n_{gl}} \times \frac{n_a}{n_{gas}} = 1$

27. (b) $v \propto \lambda \Rightarrow \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$

$\therefore$ $v_2 = \frac{v_1}{\lambda_1} \times \lambda_2 = 3 \times 10^8 \times \frac{4500}{6000} = 2.25 \times 10^8\ m/s$

28. (d) Since ${}_a\mu_g = \sqrt{2}$, so ${}_g\mu_a = \frac{\sin i}{\sin r} = \frac{1}{\sqrt{2}}$

$\therefore$ $\sin r = 1 \Rightarrow r = 90^o$

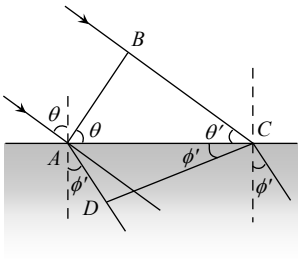
29. (a) $\mu = \frac{c}{v} = \frac{1/\sqrt{\mu_o \varepsilon_o}}{1/\sqrt{\mu\varepsilon}} = \sqrt{\frac{\mu\varepsilon}{\mu_o \varepsilon_o}}$

30. (c) $\mu \propto \frac{1}{\lambda} \Rightarrow \frac{1}{4/3} = \frac{x}{4200} \Rightarrow x = 3150\ \text{Å}$

31. (c) $\mu = \sqrt{\frac{\mu\varepsilon}{\mu_0 \varepsilon_0}} = \sqrt{\mu_r K}$

32. (c) $\mu = \frac{C}{C_m} \Rightarrow C_m = \frac{C}{1.5}$

33. (b) In the case of refraction if CD is the refracted wave front and v_1 and v_2 are the speed of light in the two media, then in the time the wavelets from B reaches C, the wavelet from A will reach D, such that



$t = \frac{BC}{v_a} = \frac{AD}{v_g} \Rightarrow \frac{BC}{AD} = \frac{v_a}{v_g}$

.....(i)

But in ΔACB, $BC = AC\sin\theta$ .....(ii)

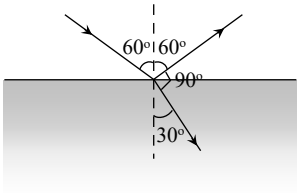
while in ΔACD, $AD = AC\sin\phi'$ .....(iii)

From equations (i), (ii) and (iii) $\frac{v_a}{v_g} = \frac{\sin\theta}{\sin\phi'}$

Also $\mu \propto \frac{1}{v} \Rightarrow \frac{v_a}{v_g} = \frac{\mu_g}{\mu_a} = \frac{\sin\theta}{\sin\phi'} \Rightarrow \mu_g = \frac{\sin\theta}{\sin\phi'}$

34. (b)

35. (b) From figure



$< i = 60^o, < r = 30^o$

so $\mu = \frac{\sin 60}{\sin 30} = \sqrt{3}$

36. (b) $\mu \propto \frac{1}{v} \Rightarrow \frac{\mu_g}{\mu_w} = \frac{v_w}{v_g} \Rightarrow \frac{3/2}{4/3} = \frac{v_w}{2 \times 10^8}$

$\Rightarrow v_w = 2.25 \times 10^8\ m/s$

37. (a) $\lambda_m = \frac{\lambda_a}{\mu} = \frac{c}{\nu\mu} = \frac{3 \times 10^8}{5 \times 10^{14} \times 1.5} = 4000\ \text{Å}$

38. (b) $\lambda_{glass} = \frac{\lambda_{air}}{\mu} = \frac{7200}{1.5} = 4800\ \text{Å}$

39. (c)

40. (d) $\frac{{}_a\mu_r}{{}_w\mu_r} = \frac{\mu_r/\mu_a}{\mu_r/\mu_w} = \frac{\mu_w}{\mu_a} = {}_a\mu_w$

41. (a) $t = \frac{\mu x}{c} = \frac{\frac{3}{2} \times 5 \times 10^{-3}}{3 \times 10^8} = 0.25 \times 10^{-10}\ s$

42. (d) Distance $= v \times t = \frac{c}{\mu} \times t = \frac{3 \times 10^8}{1.5} \times 10^{-9}$

$= 0.2\ m = 20\ cm.$

43. (c) $f \propto \frac{1}{\lambda}$. As $\lambda_b < \lambda_g \Rightarrow f_b > f_g$

44. (c) Real depth = $1\ m$

Apparent depth = $1-0.1=0.9\ m$

Refractive index $\mu=\frac{\text{Real depth}}{\text{Apparent depth}}=\frac{1}{0.9}=\frac{10}{9}$

45. (a) $\mu=\frac{h}{H}\Rightarrow H=\frac{h}{n}$

46. (a) Refractive index $\propto\frac{1}{(\text{Temperature})}$

47. (c) Snell's law in vector form is $\hat{i}\times\hat{n}=\mu(\hat{r}\times\hat{n})$

48. (a)

49. (c) $v=\frac{c}{\mu}=\frac{3\times10^8}{2.4}=1.25\times10^8\ m/s$

50. (c) Velocity of light in the window

$=\frac{3\times10^8}{1.5}ms^{-1}=2\times10^8\ ms^{-1}$

Hence $t=\frac{4\times10^{-3}}{2\times10^8}s=2\times10^{-11}s$

51. (d) Ray optics is valid when size of the objects is much larger than the order of wavelength of light.

52. (b) $v=\frac{c}{\mu}=\frac{3\times10^8}{1.33}=2.25\times10^8\ m/s$

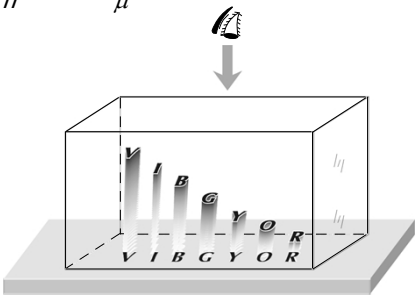
53. (b) $t=\frac{\mu x}{c}=\frac{1.5\times2\times10^{-3}}{3\times10^8}=10^{-11}\ sec$

54. (b) ${}_g\mu_w=\frac{\mu_w}{\mu_g}=\frac{4/3}{3/2}=\frac{8}{9}$

55. (b) Frequency does not change with medium but wavelength and velocity decrease with the increase in refractive index.

56. (a) $t=\frac{\mu x}{c}=\frac{3\times4\times10^{-3}}{3\times10^8}=4\times10^{-11}\ sec$

57. (d) $\mu=\frac{h}{H}\Rightarrow H\propto\frac{1}{\mu}$



$\because\ \mu_R<\mu_V$ so $H_R>H_V$

i.e. Red colour letter appears least raised.

58. (b) $\mu=\frac{c}{v}=\frac{\sin i}{\sin r}=\frac{\sin45^o}{\sin30^o}$

$\Rightarrow\ v=\frac{3\times10^8}{\sqrt{2}}=2.12\times10^8\ m/s$

59. (c) $v\propto\frac{1}{\mu}\Rightarrow\frac{v_1}{v_2}=\frac{\mu_2}{\mu_1}\Rightarrow\frac{v_g}{v_w}=\frac{\mu_w}{\mu_g}=\frac{4/3}{3/2}=\frac{8}{9}$

60. (b) Time taken by light to travel distance x through a medium of refractive index μ is

$t=\frac{\mu x}{c}\Rightarrow\frac{\mu_B}{\mu_A}=\frac{x_A}{x_B}=\frac{6}{4}\Rightarrow{}_A\mu_B=\frac{3}{2}=1.5$

61. (d) ${}_w\mu_g=\frac{{}_a\mu_g}{{}_a\mu_w}=\frac{1.5}{1.3}$

62. (a) $\mu=\frac{\text{Real depth}}{\text{apparent depth}}=\frac{120}{80}=1.5$

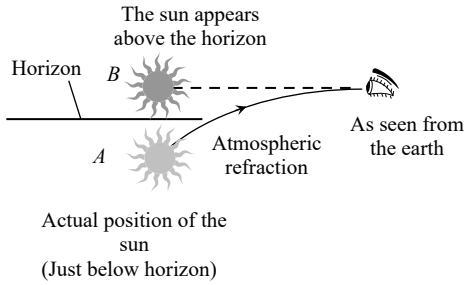
63. (b) Apparent depth of bottom

$=\frac{H/4}{\mu_1}+\frac{H/4}{\mu_2}+\frac{H/4}{\mu_3}+\frac{H/4}{\mu_4}$

$=\frac{H}{4}\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}+\frac{1}{\mu_3}+\frac{1}{\mu_4}\right)$

64. (d) For successive refraction through different media $\mu\sin\theta=$ constant. Here as θ is same in the two extreme media, $\mu_1=\mu_4$.

65. (b)



66. (a) $\mu=\frac{H}{h}\Rightarrow H=\mu h=\frac{4}{3}\times18=24\ cm$

67. (b) Optical path $\mu x=$ constant *i.e.* $\mu_1x_1=\mu_2x_2$

$\Rightarrow\ 1.53\times4=\mu_2\times4.5\Rightarrow\mu_2=1.36$

68. (b) Velocity of light is maximum in vacuum.

69. (a) $\mu=\tan i\Rightarrow i=\tan^{-1}\mu=\tan^{-1}1.62=58.3^\circ$

70. (d) Suppose water is poured up to the height *h*,

So $h\left(1-\frac{1}{\mu}\right)=1\ \Rightarrow h=4\ cm$

71. (c) $\mu\propto\frac{1}{v}\Rightarrow\frac{\mu_I}{\mu_g}=\frac{v_g}{v_I}\Rightarrow\frac{\mu_I}{1.5}=\frac{2\times10^8}{2.5\times10^8}\Rightarrow\mu_I=1.2$

72. (c) Stars twinkle due to variation in *R.I.* of atmosphere.

73. (d) Refraction at air-oil point $\mu_{oil}=\frac{\sin i}{\sin r_1}$

$\therefore\ \sin r_1=\frac{\sin40}{1.45}=0.443$

Refraction at oil-water point ${}_{oil}\mu_{water}=\frac{\sin r_1}{\sin r}$

$\therefore \frac{1.33}{1.45} = \frac{0.443}{\sin r}$ or $\sin r = \frac{0.443 \times 1.45}{1.33} \Rightarrow$ $r = 28.9^o$

74. (d) Objects are invisible in liquid of R.I. equal to that of object.

75. (b) When light ray travels from denser to rarer, it deviates away from the normal.

76. (d) $\mu = \frac{c}{v} = \frac{3 \times 10^8}{1.5 \times 10^8} = 2.$

77. (c) Frequency remain unchanged.

78. (c) ${}_w\mu_g = \frac{{}_a\mu_g}{{}_a\mu_w} = \frac{1.5}{1.2} = \frac{5}{4} = 1.25$.

79. (b) $\lambda_g = \frac{\lambda_a}{\mu_g} = \frac{5890}{1.6} = 3681 \text{Å}.$

80. (b) $t = \frac{s}{v} = \frac{1.5 \times 10^8 \times 10^3}{3 \times 10^8} = 500 \sec = 8.33\ min.$

81. (a) For vacuum $t = n\lambda_o$ .....(i)

For air $t = (n+1)\lambda_a$ .....(ii)

From equation (i) and (ii)

$t = \frac{\lambda}{\mu - 1} = \frac{6 \times 10^{-7}}{1.0003 - 1} \left(\mu = \frac{\lambda_o}{\lambda_a}\right)$

$= 2 \times 10^{-3} m = 2mm.$

82. (a) $\mu_m = \frac{c}{v} = \frac{n\lambda_a}{n\lambda_m} = \frac{\lambda_a}{\lambda_m}$

83. (b) As no scattering of light occurs. Space appears black.

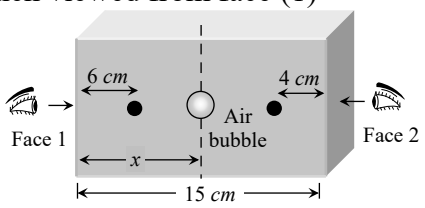
84. (b) $v \propto \frac{1}{\mu}$, μ is smaller for air than water, glass and diamond.

85. (c) In vacuum speed of light is constant and it is equal to $3 \times 10^8\ m/sec$

86. (b) $\lambda_{medium} = \frac{\lambda_{vacuum}}{\mu}$

87. (d) In vacuum speed of light is constant and is equal to $3 \times 10^8 m/s$

88. (d) When viewed from face (1)



$\mu = \frac{u}{v} = \frac{x}{v} = \frac{x}{6}$ .....(i)

Now when viewed from face (2)

$\mu = \frac{15 - x}{v} = \frac{15 - x}{4}$ .....(ii)

From equation (i) and (ii) $\mu = \frac{15 - 6\mu}{4}$

$\Rightarrow \mu = 1.5$.

89. (b) The apparent depth of ink mark

$= \frac{\text{real depth}}{\mu} = \frac{3}{3/2} = 2\ cm$

Thus person views mark at a distance $= 2 + 2 = 4\ cm$.

90. (d) Apparent rise $= d\left(1 - \frac{1}{{}_a\mu_w}\right) = 12 \times \left(1 - \frac{3}{4}\right) = 3$ cm.

Total Internal Reflection

1. (b) Due to high refractive index its critical angle is very small so that most of the light incident on the diamond is total internally reflected repeatedly and diamond sparkles.

2. (c) When incident angle is greater than critical angle, then total internal reflection takes place and will come back in same medium.

3. (d)

4. (d) ${}_a\mu_g = \frac{1}{\sin C} \Rightarrow \sin C = \frac{1}{{}_a\mu_g}$

As μ for violet colour is maximum, so sin C is minimum and hence critical angle C is minimum for voilet colour.

5. (c) The critical angle C is given by

$\sin C = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2} = \frac{3500}{7000} = \frac{1}{2} \Rightarrow C = 30^o$

6. (c) From figure given in question $\theta = 2c = 98°$.

7. (b) $\mu = \frac{1}{\sin C} = \frac{1}{\sin 30} = 2$

$\therefore v = \frac{3 \times 10^8}{2} = 1.5 \times 10^8\ m/s$

8. (c) ${}_D\mu_R = \frac{\sin i}{\sin r'} \Rightarrow {}_R\mu_D = \frac{\sin r'}{\sin i} = \frac{1}{\sin C}$

$\Rightarrow \sin C = \frac{\sin i}{\sin(90 - r)} = \frac{\sin i}{\cos r} = \frac{\sin i}{\cos i}$ (as $\angle i = \angle r$)

$\Rightarrow \sin C = \tan i \Rightarrow C = \sin^{-1}(\tan i)$

9. (a) For total internal reflection $i > C$

$\Rightarrow \sin i > \sin C \Rightarrow \sin i > \frac{1}{\mu} \Rightarrow \frac{1}{\sin i} < \mu.$

10. (d) For total internal reflection light must travel from denser medium to rarer medium.

11. (b)

12. (c) Semi vertical angle $= C = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{3}{4}\right)$

13. (c)

14. (d) $\mu = \frac{1}{\sin C} \Rightarrow C = \sin^{-1}\left(\frac{1}{2}\right) = 30^o$

15. (d)

16. (c) Critical angle = $\sin^{-1}\left(\frac{1}{\mu}\right)$

$\therefore \theta = \sin^{-1}\left(\frac{1}{\mu_{\lambda_1}}\right)$ and $\theta' = \sin^{-1}\left(\frac{1}{\mu_{\lambda_2}}\right)$

Since $\mu_{\lambda_2} > \mu_{\lambda_1}$, hence $\theta' < \theta$

17. (c)

18. (c, d) For TIR $i > C$

$\Rightarrow \sin i > \sin C \Rightarrow \sin 45° > \frac{1}{n} \Rightarrow n > \sqrt{2} \Rightarrow n > 1.4$

19. (c)

20. (d)

21. (a) ${}_w\mu_g = \frac{1}{\sin C} \Rightarrow \frac{\mu_g}{\mu_w} = \frac{5/3}{4/3} = \frac{1}{\sin C}$

$\Rightarrow \sin C = \frac{4}{5} \Rightarrow C = \sin^{-1}\left(\frac{4}{5}\right)$

22. (c) Total internal reflection occurs when light ray travels from denser medium to rarer medium.

23. (b) $\mu = \frac{c}{v} \Rightarrow \mu = \frac{c}{c/2} = 2$ also for total internal reflection

$i > c \Rightarrow \sin i \geq \sin c \Rightarrow \sin i \geq \frac{1}{\mu}$

Hence $i \geq \sin^{-1}\left(\frac{1}{\mu}\right)$ or $i \geq 30^o$

24. (c) $C = \sin^{-1}\left(\frac{1}{{}_w\mu_g}\right) = \sin^{-1}\left(\frac{\mu_w}{\mu_g}\right) = \sin^{-1}\left(\frac{8}{9}\right)$

25. (a) $\mu_w < \mu_g \Rightarrow c_w > c_g$.

26. (c) $\mu = \frac{1}{\sin C} = \frac{1}{\sin 30} = 2$

27. (c) Ray from setting sum will be refracted at angle equal to critical angle.

28. (a) Optical fibres are used to send signals from one place to another.

29. (d)

30. (d) When total internal reflection just takes place from lateral surface $i = C$ i.e. $60^o = C$

$\Rightarrow \sin 60^o = \sin C = \frac{1}{\mu} \Rightarrow \mu = \frac{2}{\sqrt{3}}$

Time taken by light to traverse some distance in a medium

$t = \frac{\mu x}{c} = \frac{\frac{2}{\sqrt{3}} \times 10^3}{3 \times 10^8} = 3.85\,\mu\,sec.$

31. (a) $\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{1}{2} \Rightarrow \frac{\mu_1}{\mu_2} = 2 (\mu_1 > \mu_2)$

For total internal reflection ${}_2\mu_1 = \frac{1}{\sin C} \Rightarrow \frac{\mu_1}{\mu_2}$

$= \frac{1}{\sin C} \Rightarrow 2 = \frac{1}{\sin C} \Rightarrow C = 30^o$

So, for total (Internal reflection angle of incidence must be greater than 30°.

32. (c)

33. (a) $\mu = \frac{1}{\sin C} = \frac{1}{\sin 60^o} = \frac{2}{\sqrt{3}}$

34. (c) ${}_a\mu_g = \frac{1}{\sin\theta} \Rightarrow \mu = \frac{1}{\sin\theta}$ .....(i)

Now from Snell's law $\mu = \frac{\sin i}{\sin r} = \frac{\sin\theta}{\sin r}$

$\Rightarrow \sin r = \frac{\sin\theta}{\mu}$ .....(ii)

From equation (i) and (ii)

$\sin r = \frac{1}{\mu^2} \Rightarrow r = \sin^{-1}\left(\frac{1}{\mu^2}\right)$

35. (a) $C = \sin^{-1}\left(\frac{1}{\mu}\right)$ and $\mu \propto \frac{1}{\lambda}$

Yellow, orange and red have higher wavelength than green, so μ will be less for these rays, consequently critical angle for these rays will be high, hence if green is just totally internally reflected then yellow, orange and red rays will emerge out.

36. (d) We know $C = \sin^{-1}\left(\frac{1}{\mu}\right)$

Given critical angle $i_B > i_A$

So $\mu_B < \mu_A$ *i.e.* B is rarer and A is denser.

Hence light can be totally internally reflected when it passes from A to B

Now critical angle for A to B

$C_{AB} = \sin^{-1}\left(\frac{1}{{}_B\mu_A}\right) = \sin^{-1}[{}_A\mu_B]$

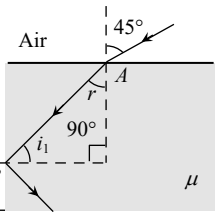
$= \sin^{-1}\left[\frac{\mu_B}{\mu_A}\right] = \sin^{-1}\left[\frac{\sin i_A}{\sin i_B}\right]$

37. (b) At point A, by Snell's law

$\mu = \frac{\sin 45}{\sin r} \Rightarrow \sin r = \frac{1}{\mu\sqrt{2}}$ .....(i)

At point B, for total internal reflection $\sin i_1 = \frac{1}{\mu}$

From figure, $i_1 = 90 - r$



$\therefore \sin(90° - r) = \frac{1}{\mu}$

$\Rightarrow \cos r = \frac{1}{\mu}$ .....(ii)

Now $\cos r = \sqrt{1 - \sin^2 r} = \sqrt{1 - \frac{1}{2\mu^2}}$

$= \sqrt{\frac{2\mu^2 - 1}{2\mu^2}}$ .....(iii)

From equation (ii) and (iii) $\frac{1}{\mu} = \sqrt{\frac{2\mu^2 - 1}{2\mu^2}}$

Squaring both side and then solving we get $\mu = \sqrt{\frac{3}{2}}$

38. (b) $_2\mu_1 = \frac{1}{\sin\theta} \Rightarrow \frac{\mu_1}{\mu_2} = \frac{1}{\sin\theta} \Rightarrow \frac{v_2}{v_1} = \frac{1}{\sin\theta} \Rightarrow \frac{v_2}{v} = \frac{1}{\sin\theta}$

$\Rightarrow v_2 = \frac{v}{\sin\theta}$

39. (c) From the formula $\sin C = \frac{1}{_1\mu_2} \Rightarrow \sin C = {}_2\mu_1$

$= \frac{u_1}{u_2} = \frac{v_2}{v_1} \Rightarrow \sin C = \frac{10x/t_2}{x/t_1}$

$\Rightarrow \sin C = \frac{10t_1}{t_2} \Rightarrow C = \sin^{-1}\left(\frac{10t_1}{t_2}\right)$

40. (a) $\sin 45^o = \frac{1}{\mu} \Rightarrow \mu = \sqrt{2} = 1.41$

41. (c)

42. (b) Critical angle C is equal to incident angle if ray reflected normally $\therefore C = 90^o$

43. (b)

44. (d) $r = \frac{3h}{\sqrt{7}} = \frac{3 \times 12}{\sqrt{7}} = \frac{36}{\sqrt{7}}$.

45. (b) Here $\sin i = \frac{1}{\mu} = \frac{3}{5}$ and hence $\tan i = \frac{3}{4} = \frac{r}{4}$

This gives $r = 3\,m$, hence diameter = $6m$

46. (a) Radius of horizon circle $= \frac{3h}{\sqrt{7}} = \frac{3\sqrt{7}}{\sqrt{7}} = 3\,cm.$

Refraction at Curved Surface

1. (a) By formula $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (1.5 - 1)\left(\frac{1}{40} + \frac{1}{40}\right) = 0.5 \times \frac{1}{20} = \frac{1}{40}$

$\therefore f = 40\ cm$

2. (a) $\frac{v}{-u} = -m$ and $v + u = x \Rightarrow u = \frac{x}{1+m}$

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow f = \frac{mx}{(m+1)^2}$.

3. (d) $I \propto A^2 \Rightarrow \frac{I_2}{I_1} = \left(\frac{A_2}{A_1}\right)^2 = \frac{\pi r^2 - \frac{\pi r^2}{4}}{\pi r^2} = \frac{3}{4}$

$\Rightarrow I_2 = \frac{3}{4} I_1$ and focal length remains unchanged.