Revision for the 1st small test on:..

1. Light sources – bodies that emit light

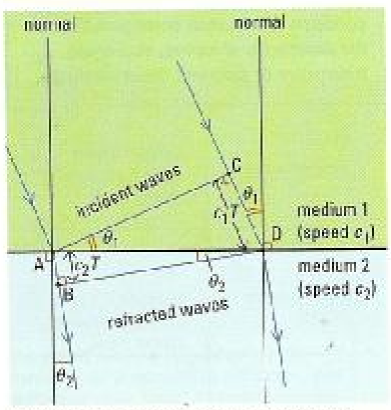
Optical medium:
Transparent medium: light travels without absorbtion
Non-transparent medium: light is absorbed or reflected
Translucent: light goes through with scattering
Homogeneous optical medium – same optical properties
In homogeneous optical medium light has a stright path.
Equiphase - line perpendicular to the direction of beam of light
Speed of light in vacuum – 3 x 108 m.s-1

2. Law of reflection

The incident and reflected rays make equal angles to a normal to the surface at the reflection point $\alpha = \alpha'$, where α – incidence angle
α'- angle of reflection

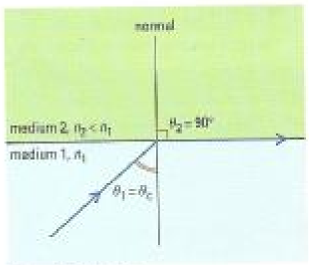
3. If a radar reflection takes 14 minutes to complete a return trip to mercury, how far is mercury from the earth at the time of experiment?
4. Law of refraction (Snell´s law): $\sin \Phi 1 / \sin \Phi 2 = c1 / c2 = n2 / n1$, $n1 \sin \Phi 1 = \sin \Phi 2\ n2$
5. If c1 › c2 the refractive index is greater than 1 and the wave moves towards the normal. This occurs whenever wave velocity reduces as the wave crosses the boundary, as with light travelling from air into glas or water waves approaching a beach. The waves then refract towards the normal. In optics the velocity of light depends on the electron density in the medium – the greater the density the slower the light.
6. Light rays bend toward the normal when light enters an optically denser medium.
7. Light rays bend away the normal when leaving an optically denser medium.
8. Absolute refractive index - n: $n = n_{vac\ med} = c / c_{med}$

$n_{12} = c_1 / c_2 = c_1 / c \times c / c_2 = n_2 / n_1$



Light travelling from one medium to another.

9.
10. A ray of light travels from water into a glas block at an angle of 15° to the normal to the boundary between the two media. In what direction does it travel inside the glas? (take $_{nwater}$=1.33 and n_{glas}=1.53)
11. What is the speed of light in diamond? (take $n_{diamond}$=2.42)
12. Total internal reflection: $\sin \Phi C = n2 / n1$
13.
14.



The critical angle.

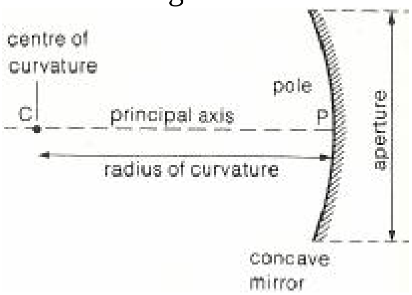
15. Light is travelling along an optical fibre made of glas of relative index 1.52, What is the index of cladding material if the critical angle is 82°?
16. Plane mirror:

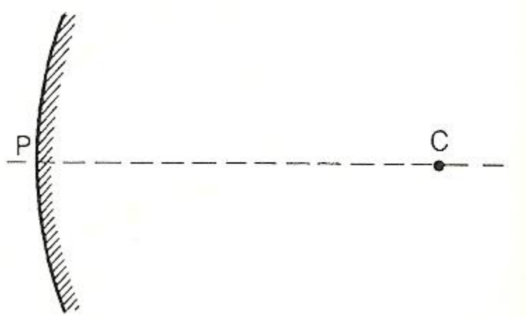
Image is always:
Unreal
Of the same size
Symetrical with the object according the mirror plane

17. Curved mirrors:

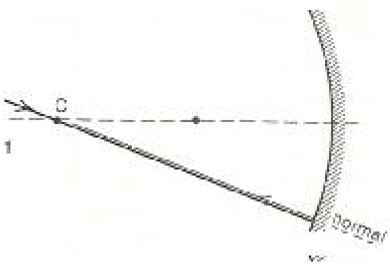
Concave mirror – caves inwards
Convex mirror – bulges outwards

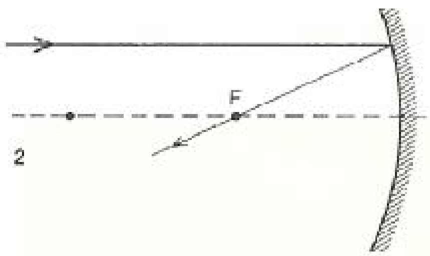
18.

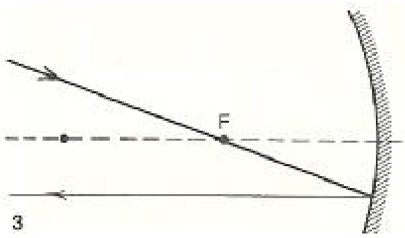




19. F – the principal focus, FP distance – focal length
20. focal length = ½ radius of curvature - f = ½ r
21.



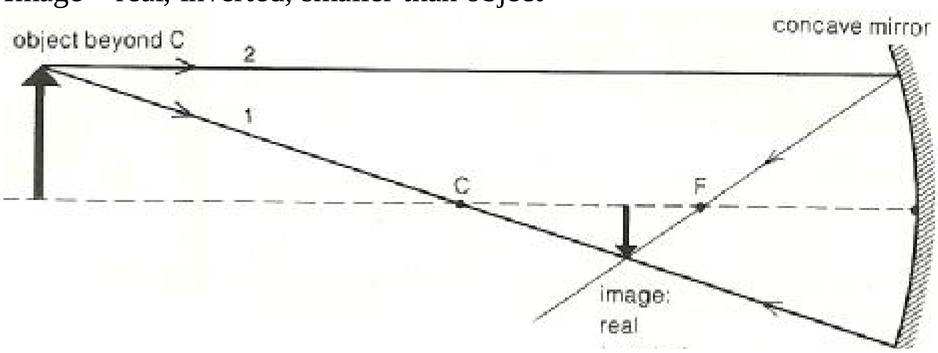




22. Images formed by concave mirrors

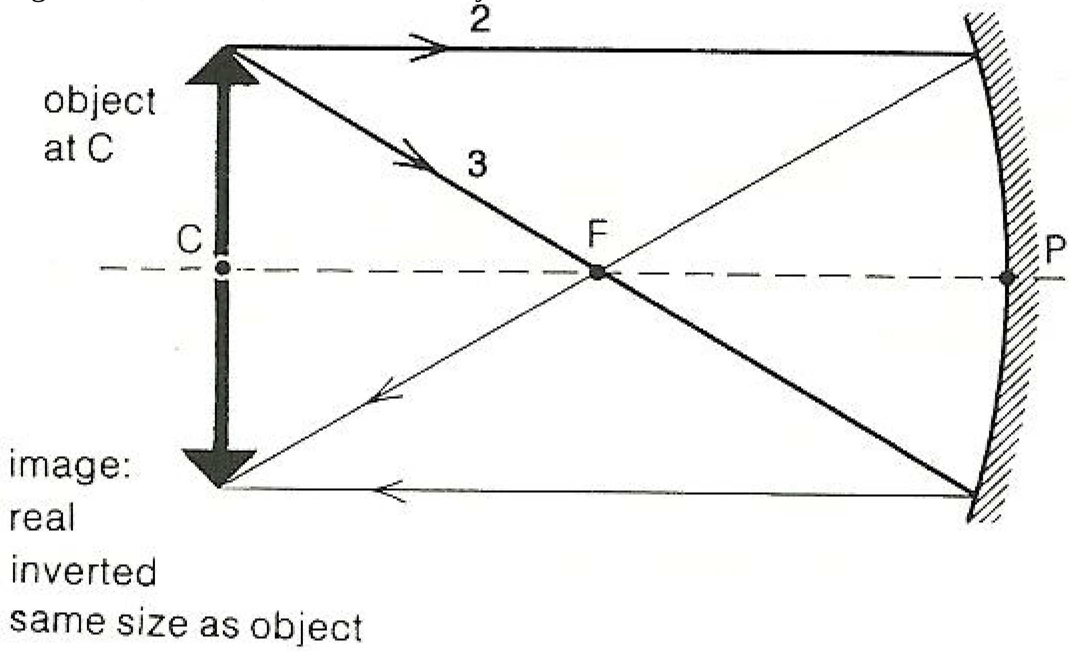
- Distant object (beyond C):

Image – real, inverted, smaller than object



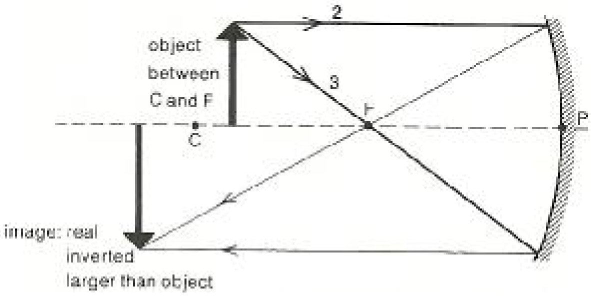
- Object at C:

Image – real, inverted, same size as object



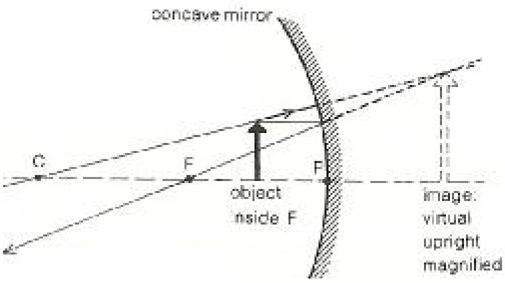
- Object between C and F:

Image – real, inverted, larger than object



- Close object (between F and P):

Image – virtual, upright, magnified



23. 1/a + 1/a´ = 2/r = 1/f

a – distance of the object from the mirror
a´ - distance of the image from the mirror
r – radius of curvature
f – focal length
y´, y – height of the image and of the object
Z = y´/y = - a´/a = - (a´- f) / f = - f/ (a – f), Z - linear magnification

24. An object 2 cm high is placed 12 cm away from a curved mirror. Radius of curvature is 16 cm. Calculate the position of the image and describe it in both of cases of convex and concave mirror.

25. Uses of curved mirrors

Convex mirror gives a wider angle of view than a plane mirror

Shaving and make-up mirrors are often concave in shape because of the magnification they give close up.

Car headlight – concave reflector – to produce a parallel beam of light from a small bulb placed at the principal focus of the reflector.

The satellite tracking dish – to bring microwave signals from satellites to a focus.

26. Lenses:

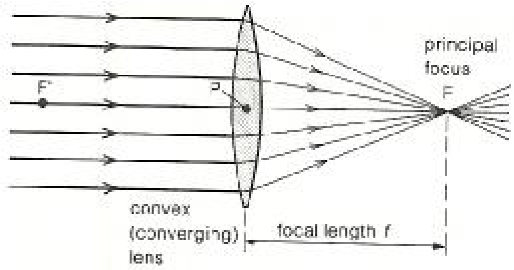
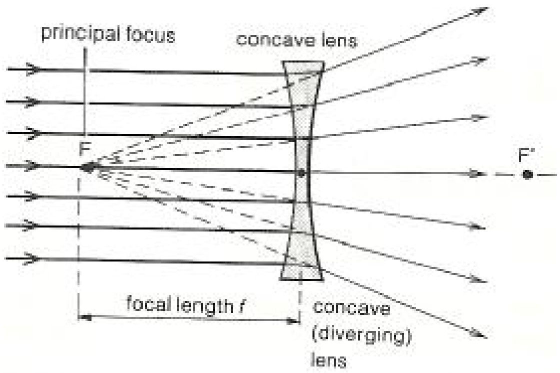


Figure 3a Parallel rays are brought to a focus on the far side of a convex lens

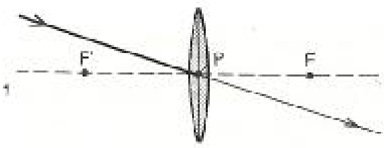


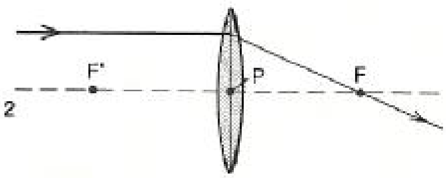
27. Images formed by convex lenses

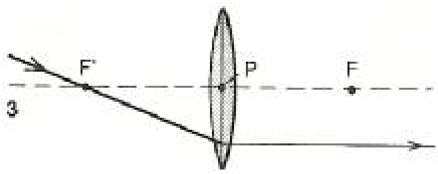
A ray of light through the optical centre of the lens, P. This passes through the lens unbent.

A ray of light parallel to the principal axis. This passes through F when it leaves the lens.

A ray of light F´. This leaves the lens parallel to the principal axis. It is equivalent to ray number 2 in reverse.







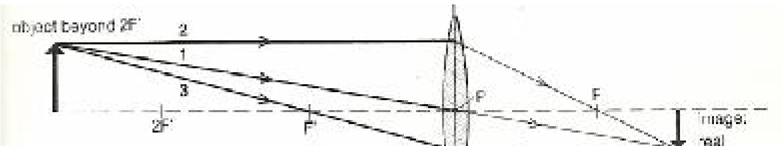


Figure 7 A ray diagram showing the three rays of figure 6: object beyond 2F'

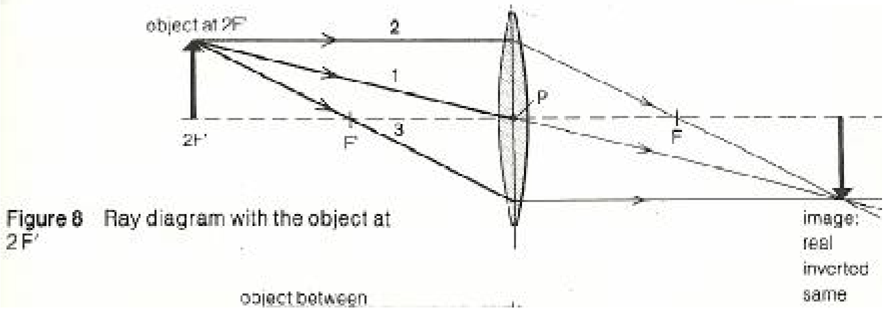


Figure 8 Ray diagram with the object at 2 F'

object between

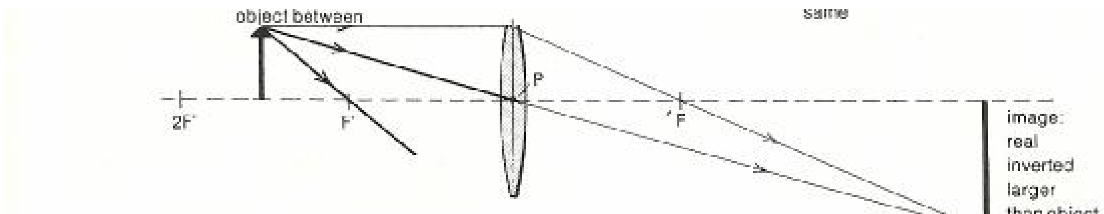
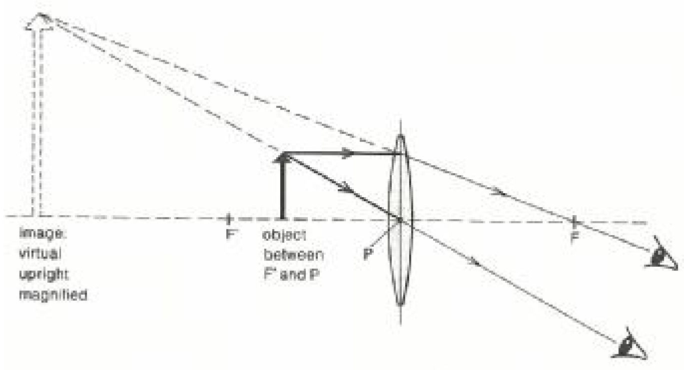
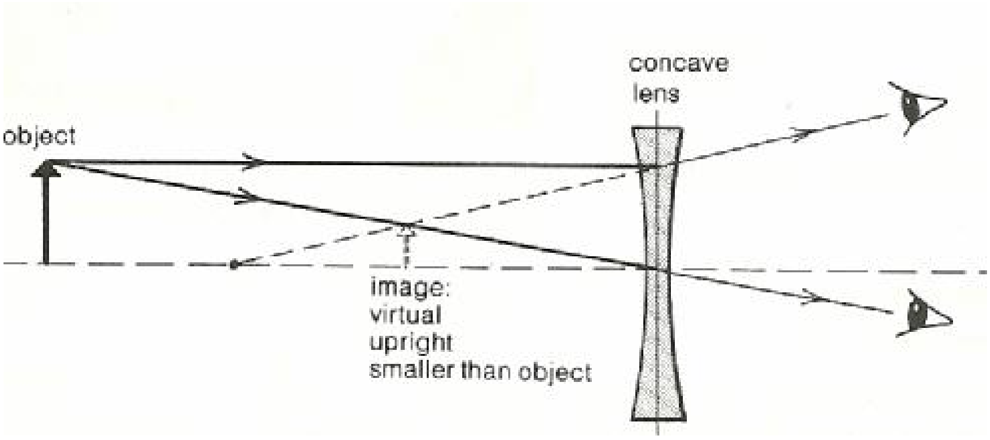


Figure 9 Ray diagram with object between 2F' and F'



A concave lens form an upright, virtual image of any object placed in front of it. The image is always smaller than the object and closer to the lens.
Changing the position of the object changes the position and size of the image, but the basic form of the diagram is unchanged.



28. Calculating image positions

The equation used to find the position and nature of th eimage:
$1/u + 1/v = 1/f$
u – distance from the object to the lens
v - distance from the image to the lens
Note the following
If the lens is convex, f is taken as positive.
If the lens is concave, f is taken as negative.
When v is positive, the image is real.
When v is negative, the image is virtual.
Z - linear magnification

$$Z = y'/y = v/u = - a'/a = - (a' - f) / f = - f/ (a - f)$$

power of lens – $\Phi = 1/f$

29. An object 2cm high stands on the principal axis at a distance of 9 cm from a convex lens. If the focal length of the lens is 6cm, what is the position and nature of the image?
30. The eye: Accommodation – light entering the eye is converged mainly by the cornea and the watery liquid behind it. The lens itself is used to make focusing adjustments - a process called accommodation.
31. Short-sighted people

Cannot see distant objects clearly
The eye-ball is too long for the lens system and rays from any distant object come to a focus just in front of the retina.
A concave lens is placed in front of the eye to correct the fault.

32. Long-sighted people

Cannot see close objects clearly
The eye-ball is too short for the lens system and rays from a close object converge towards a point just beyond the retina.
A convex lens is placed in front of the eye to correct the fault.

33. Power of lens

$\Phi = 1 / f = 1/d - 1/ a$
d – convenctional distance (25 cm)
a – distance of the object from the lens (m)
Φ – power of lens (dioptry, D)
f – focal length of the lens (m)

Short-sighted people – concave lens – Φ = negative values of D
Long-sighted people – convex lens – Φ = positive values of D

34. What is the power of glasses for short-sighted eye with a close point of 10cm.
35. What about power of glasses for long-sighted eye with a close point of 50cm.
36. Viewing angle: $\mathrm{tg}\ \tau = y / d$

y – length of an object
d – conventional distance (25cm)
Two objects can be seen as two different points only in the case that the viewing angle is greater or equal to 1´!

37. Magnifying glass: Angular magnification: $\gamma = d / a$

a – distance of the object from the lens
d – convectional distance (25 cm)

38. <u>The microscope</u>:

Angular magnification of microscope:
$\gamma = \Delta d / (f1\ f2)$
Δ – optical interval – distance between the f1 and f 2 (m)
d – conventional length (25cm)
f1 – focal length of the eyepiece (m)
f2 - focal length of the objective (m)

39. Calculate distance between the f1 and f 2 of the microscope and length of its tube, if f1=5mm and f2=2.5cm. The angular magnification of the microscope is γ=320.
40. Telescope:

Objective – objektív
Image of distant object:
Smaller
Real
Inverted

Eyepiece – okulár (magnifying glass)
Image of close object:
Upright
Virtual
Magnified image

f1 – focal length of objective
f2 – focal length of eyepiece
Angular magnification: $\gamma = \mathrm{tg}\,\varphi' / \mathrm{tg}\,\varphi = f1 / f2$

41. Calculate the focal length of objective and eyepiece, if the distance between them is 38 cm. Angular magnification of the telescope is 20.
42. Dispersion of light:

$v = \lambda f$
v – velocity of wave (m s-1)
λ – wavelength (m) – distance between two maximum
f – frequency (Hz = s-1) – number of complete cycles per a time
Colour
Magnitude of velocity of light depends on frequency – this phenomenon is called dispersion of light.
index of refraction: $n = c / v$ =>is also frequency depending
Using Snell´s law:
$\sin\alpha / \sin\beta r = nr / na$
$\sin\beta r = (na \sin\alpha) / nr$

$\sin\alpha$ - incidence angle of white sunlight
$\sin\beta r$ - angle of refraction for the
red component of the white light
nr – index of refraction of the red component in the glass
na - index of refraction of the light in air (na = 1)
$\sin\beta r = \sin\alpha / nr$

For the violet component of white sunlight:
$\sin\beta v = (na \sin\alpha) / nv$
$\sin\beta v = \sin\alpha / nv \Rightarrow \beta_r > \beta_v$ and $n_r < n_v$ and $v_r > v_v$

43. Frequency of a light stays constant as it passes through different mediums, wavelength changes:

$v = \lambda f \Rightarrow f = v / \lambda = c / \lambda 0$ (wavelength of light in vacuum)
$\lambda = \lambda 0 / n$
wavelength is n-times smaller as light passes the medium from vacuum.

44. A wavelength of yellow sodium light in air is $\lambda =$ 589.593 nm, refractive index of carbon disulphide is n = 1.626. Calculate frequency , wavelength and speed of the yellow sodium light in carbon disulphide. Is the colour of the light changed as it passes the Carbon disulphide?
45. Interference: the waves have the same frequency and wavelength is exactly in phase.

$\Delta l = 2\, n\, d$ (n – index of refraction of given medium, d – thickness of planparallel plane)
maximum: $2\, n\, d = (2k - 1)\, \lambda / 2$
minimum: $2\, n\, d = 2k\, \lambda / 2$

46. Calculate thickness of soap bubble with n = 1.350 and wavelength λ = 589.3 nm.

47. Pollarization: Light - transverse waves or longitudinal waves, P – polarizer (incident unpolarized waves are polarized and polarized waves are passing through it), A - analyzer

Light is a transverse wave.
Linear polarized light – vector of strength of light oscillates in the perpendicular plane to the direction of the wave.
Polarization of the light by reflection:
Brewster angle – light is partially polarized (unpolarized wave + linear polarized wave of light)

48. Polarization of the light by double reflection:

Icelandic limestone (unisotropic medium – speed of light changes according to the direction)