**Physics summary chapter 3 light and lenses**

**Section 1. Refraction**

Light moves in straight lines, but when a thin beam of light falls on the boundary layer between transparent substances, the rule no longer applies: the light then changes direction. This effect is called ***refraction***.

The ***normal*** is the dotted line that is perpendicular to the boundary, and this has been drawn at the point where the ray hits the Perspex. The angle between the incoming and the normal is called the ***angle of incidence (∠ i)***. The angle between the refracted ray and the normal is called the ***angle of refraction (∠ r)***.

When rays go from air into Perspex, they are always refracted towards the normal: ∠ r is always smaller than ∠ i.

When rays go from Perspex into air, they are always refracted away from the normal: ∠ r is always greater than ∠ i.

A magnifying glass is a convex lens made of glass or plastic that changes the direction of the rays. Before the rays fall onto the lens, they are parallel to its ***main axis***, the line that runs through the centre of the lens perpendicular to the lens. After passing the lens, the rays converge and all meet at one point, the ***focal point*** (F).

The distance from the centre of the lens to the focal point (F) is called the ***focal length (f)***.

The shorter the focal length, the more strongly the lens refracts the light.

**Section 2. Lenses**

Lenses can be classified in 2 groups: positive and negative lenses.

***Positive lenses*** are thinner at the edges than in the middle. This shape is a ***convex lens***.

***Negative lenses*** are thicker at the edges than in the middle. This shape is called a ***concave lens***.

Positive lenses are ***convergent***, this means that rays that fall on the lens are deflected inwards, towards the main axis. The more convex the lens, the stronger is converging effect.

Negative lenses are ***divergent***., this means that rays fall on the lens are deflected outwards, away from the main axis. The more concave the lens, the stronger its diverging effect.

When you take a photograph, light from the object falls on the lens. This could be reflected light or light is emitted by the object itself. The lens makes sure that all the light from any one point on the object comes together at a single point again. This point is called the ***image (I***).

**Section 3. Cameras and projectors.**

When you focus a camera or projector, 2 distances are important:

1. The distance between the lens and the object, this is the ***object distance (v)***.
2. The distance between the lens and the sharp image, this is the ***image distance (b)***.

For every object distance, there is precisely on image distance. You can only have a sharp image at that distance.

The important formulas for lenses:

N (index of refraction) = B1B2 (height of the image) : V1V2 (height of the object)

1:f (1 : focal length) = 1:v (1 : voorwerpsafstand)+ 1:b (1 : beeldafstand)

N (index of refraction) = b (beeldafstand) : v (voorwerpsafstand)

M (magnification) = v (voorwerpsafstand) : b (beeldafstand)

**Natuurkunde samenvatting hoofdstuk 3 Light and lenses**

**Section 4. Eyes and spectacles.**

You can see the things around you because they reflect light towards your eyes. After that the light passes through the transparent parts of your eye: it goes through the cornea, then lens of the eye and the vitreous body. Finally, the light reaches the retina.

The ***retina*** contains a huge number of light-sensitive sensory cells. These cells give off electrical impulses when light falls on the. The impulses are passed on to the brain by the optic nerve.

The ***pupil*** is an opening in the ***iris***. In bright sunlight, the iris is wide, and your pupils are small.

In dim light, the iris is narrow, and your pupils are large.

Your eyes have to adjust their focal length to see properly this is done by a ring of little muscles around the lens of the eye. These muscles can make the lens of the eye more or less convex. This is called the ***accommodation*** of the eye.

If you are ***nearsighted***, the lenses in your eyes are too strong. You can therefore not see distant object properly. Someone who is nearsighted needs negative spectacle lenses or contact lenses.

If you are ***farsighted***, your eye lenses are too weak. You can therefore not see nearby objects properly. Someone who is farsighted needs positive spectacle lenses or contact lenses.

You can determine the power of a lens as follows.

1. Convert the focal length into metres.
2. Then calculate 1/f
3. The resulting number is the power of the lens in dioptres.

P (Power; given in D dioptres) = 1 : f