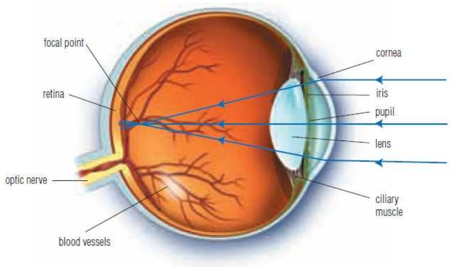
SNC2D PHYSICS

LIGHT & GEOMETRIC OPTICS
- The Human Eye (P.470-477)

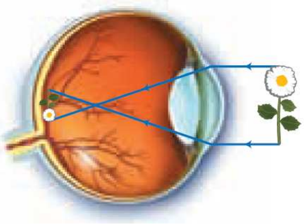
The Human Eye

The human eye is the optical instrument that helps most of us learn about the external world. It is a remarkable apparatus that acts as our window on the universe.



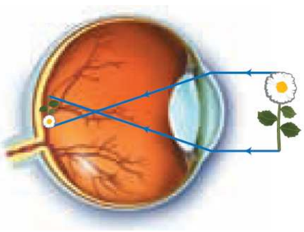
The Human Eye

NOTE!
Most people think that they see with their eyes. In reality, the eye acts as a light gathering instrument. We actually "see" with our brain.



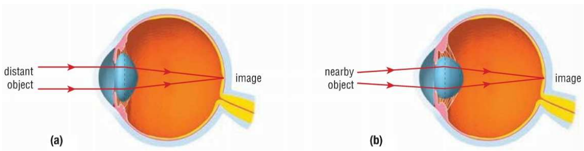
The Human Eye

The cornea-lens combination of the eye acts like a converging lens and produces a smaller, real, inverted image on the retina that is flipped left to right. Electrical impulses from the retina travel through the optic nerve to the brain. The brain then interprets the electrical signal, so that we see the image properly.



Accommodation

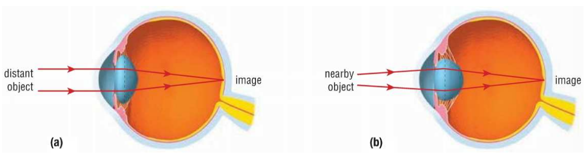
Muscles in our eye, called ciliary muscles, help the eye focus on (a) distant and (b) nearby objects by changing the shape of the lens. This change in shape of the lens changes the focal length of the lens to allow focusing of the image on the retina. This process is called ***accommodation****.*



Accommodation

NOTE!

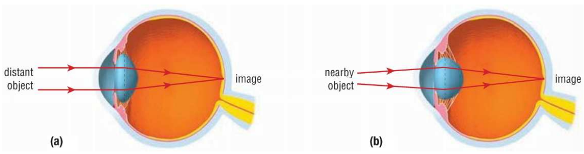
The lens is slightly fatter when the eye is focused on nearby objects!



Accommodation

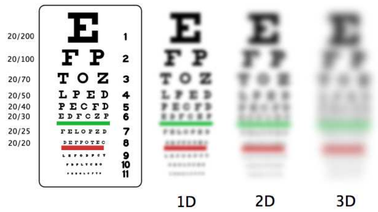
ACCOMMODATION

- process whereby the eye uses the ciliary muscles to change the shape of the lens in order to focus an image clearly on the retina



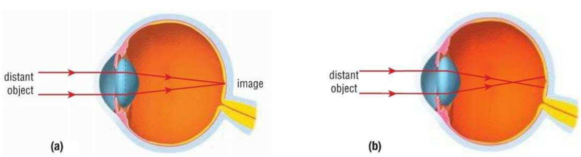
Focusing Problems

For some people, though, the process of accommodation does not work as well as it should. These people's eyes cannot focus on objects at every distance. This can result in blurred vision. The difficulty might be with focusing on nearby objects or on distant objects.



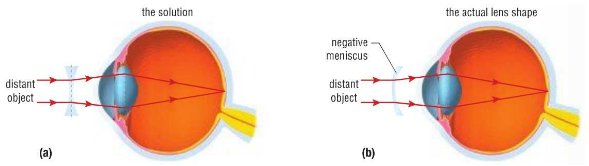
Focusing Problems – Myopia

*Someone who has **myopia** (near-sightedness) can see nearby objects clearly, but distant objects appear out of focus. In a normal, healthy eye (a) light from a distant object is focused onto the retina. However, in a myopic eye (b), light rays from distant objects meet in front of the retina.*



Focusing Problems – Myopia

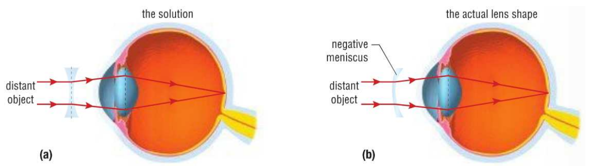
Diverging lenses can correct myopia by spreading out the incoming light rays before they enter the eye. The light rays can now meet on the retina, allowing the person to see a clear image.



Focusing Problems – Myopia

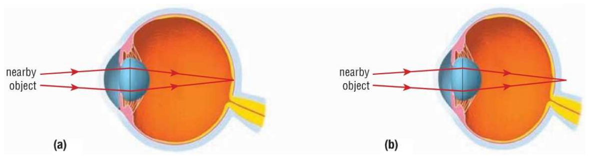
MYOPIA (NEAR-SIGHTED)

- inability to see far objects
- rays are focused in front of the retina
- corrected using a diverging lens



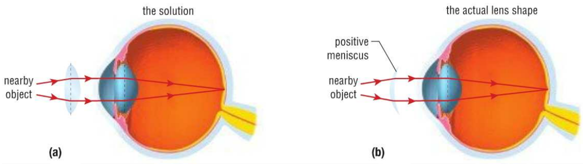
Focusing Problems – Hyperopia

*Someone who has **hyperopia** (far-sightedness) can see distant objects clearly, but nearby objects appear out of focus. In a normal eye (a) light from a nearby object is focused onto the retina. However, in a hyperopic eye (b), light rays from distant objects meet behind the retina.*



Focusing Problems – Hyperopia

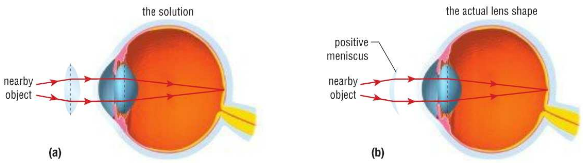
Converging lenses can correct hyperopia by refracting the incoming light rays before they enter the eye. The light rays can now meet on the retina, allowing the person to see a clear image.



Focusing Problems – Hyperopia

HYPEROPIA (FAR-SIGHTEDNESS)

- inability to see near object
- light rays are focused behind the retina
- corrected using converging lens

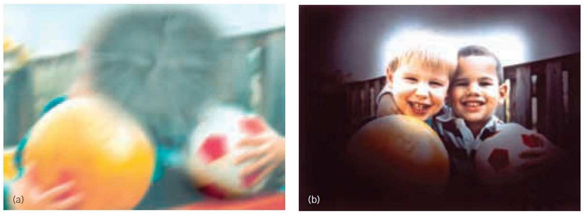


Contact Lenses

*A **contact lens** is a lens that is placed directly on the cornea of the eye. Contact lenses serve the same purpose as glasses. Contact lenses can also be used for cosmetic purposes (ie to change the colour of the eye).*

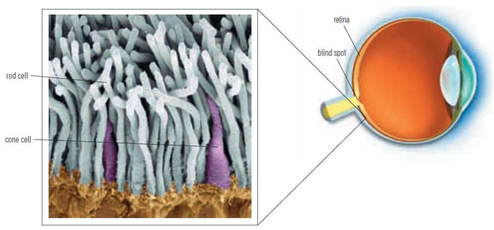
Other Defects – Blindness

*"**Blindness**" refers to any type of vision problem that prevents someone from being able to do important activities. For some, they might not be able to form an image in the centre of their visual field. For others, they might see only a tiny spot at the centre of their visual field.*



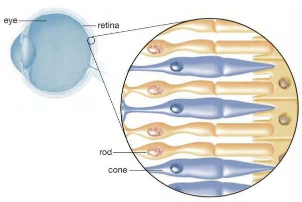
Detecting Light

*Getting light into the eye and focusing it onto the retina are only part of the task of seeing an image. In order for you to see, light rays must be absorbed by **photoreceptors** – cells in the retina sensitive to light. Photoreceptors include rod and cone cells.*



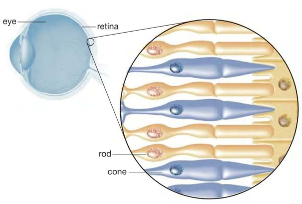
Detecting Light

***Rods** are able to detect low levels of light and so we use them for "night vision." Once our eyes adapt to very dim light, we can see shapes and movement fairly well. Astronomers have found that red light does not interfere with the eye's ability to see in low light so they use red light to illuminate their workplaces at night.*



Detecting Light

Cones *are less sensitive to light than rods, but allow us to see colour. We normally have three types of cones – each sensitive to a particular primary colour of light (ie red, green, and blue). Our eyes are most sensitive to the yellow part of the spectrum – so yellow appears very bright to most people.*



Detecting Light

HUMAN VISION

- the back of the eye has a layer of specialized tissue called the retina
- the retina contains two types of light-sensitive cells – rods and cones

RODS

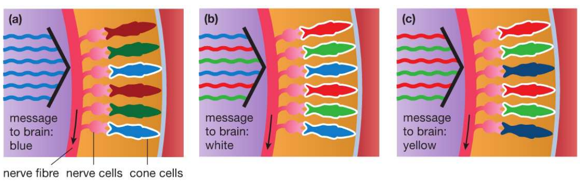
- are able to detect low levels of light
- used for "night vision"

CONES

- are less sensitive to light than rods, but allow us to see colour
- humans normally have three types of cones – each sensitive to a particular primary colour of light (i.e. red, green, and blue)

Seeing Colours

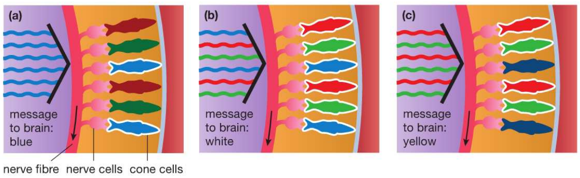
Most people's eyes can detect every colour in the spectrum using only three types of cones. Each type of cone detects a certain colour best. Some cones detect red light. Others detect green or blue light. When a cone detects its own particular colour of light, it sends a nerve signal to the brain. As different proportions of red, green, and blue light enter your eye, different cone cells send nerve signals. Your brain is able to interpret the signals as different colours. But why?



Seeing Colours

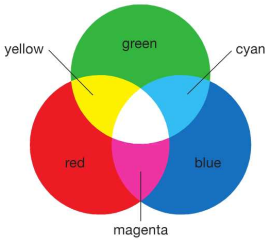
SEEING COLOUR

- when cone cells detect their own particular colour of light, they send a nerve signal to the brain
- your brain interprets these signals as different colours



Seeing Colours

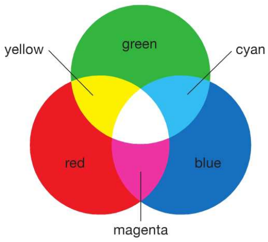
Scientists investigating colour and light discovered that mixing red, green, and blue light produces white light. The scientists called red, green, and blue the ***primary colours of light*** *because they cannot be formed from other colours. The three primary colours can, however, be mixed to produce all the colours of the spectrum, including white light.*



Seeing Colours

NOTE!

Your eye and many common light sources, such as televisions and computer monitors, use just the three primary colours of light to create a wide range of colours.



Colours of Objects

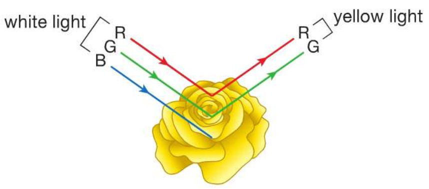
But what makes a butterfly's wing so colourful. Although the wing does not produce light, it reflects light from other sources. The butterfly's wing contains chemicals called pigments. ***Pigments*** *absorbs some of the colours of light that strike the wing, and reflect other colours of light. Your eyes see only the colours of the reflected light.*

PIGMENT

- chemical that absorbs some colours of light and reflects other colours

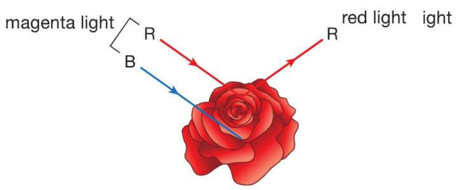
Colours of Objects

For example, when white light (RGB) shines on a yellow rose, only the red light and green light are reflected (the blue light is absorbed). We see the red and green light as yellow.



Colours of Objects

However, in magenta light (RB), the blue light is again absorbed and red light is reflected, so now the same rose appears red.



Colours of Objects

So, is the rose yellow or red? It is neither. Non-luminous objects do not have a particular colour. Their colours change depending on the colour of light shining on them. A rose that is yellow in white light will appear green in cyan light, green in green light, and black in blue light. However, white light is the most common light in everyday life. We, therefore, call the colour of a non-luminous object in white light its ***true colour****. The rose's true colour is yellow.*

COLOURED OBJECTS

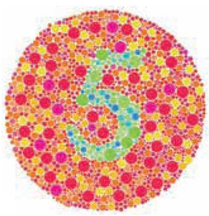
- the colours we see depend on the transmission, absorption, and reflection of light by objects

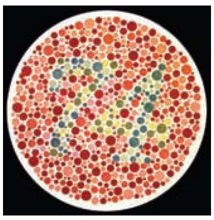
Other Defects – Colour Blindness

True ***colour blindness****, which is the ability to only see shades of grey, is very rare, occurring in about 1 person in 40 000. Colour-blind persons are able to see which traffic light in a stop light is on, but they cannot tell whether it is red or green. They must be careful to remember the position of the red and green relative to each other.*

Other Defects – Colour Blindness

Colour vision deficiency*, a more common condition, is the ability to distinguish some colours but not others. In one form of colour vision deficiency, often referred to as red-green colour deficiency, red and green appear to be the same colour. This is due to a lack of cones sensitive to red. Many people are not even aware that they have a colour vision deficiency until they are in their teens or later.*

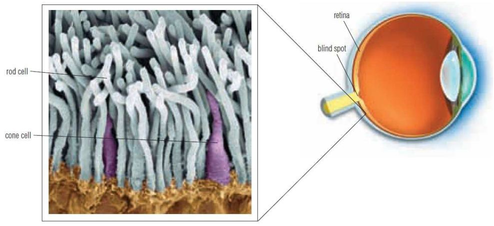




Activity: The Blind Spot

ISSUE

There is one spot on the retina that has no photoreceptors and so cannot detect light – the blind spot. The blind spot is the place where the optic nerve attaches to the retina.



Activity: The Blind Spot

INSTRUCTIONS

A. Draw a dot about 2 mm to 3 mm in diameter on the left side of a blank piece of paper. Draw a + of similar size 10 cm to the right of this dot.

B. Hold the paper at arm's length in your right hand. Close your left eye and look at the dot with your right eye. You should also be able to see the + while staring at the dot.

C. Keep looking at the dot and slowly bring the paper toward you. At a certain point, the + should disappear. Keep moving the paper until the + reappears.

● +

Activity: The Blind Spot

QUESTIONS

1. Why do we not notice this blind spot?

   because each eye compensates for the blind spot of the other eye

✔ Check Your Learning

1. (a) Where do light rays meet in a healthy eye?
   (b) Why do we not "see" images upside down?

   (a) on the retina
   (b) our brain takes the image and flips it right-side up

✔ Check Your Learning

2. (a) Where does the image form in persons who are far-sighted? near-sighted?
   (b) What type of lens is used to correct far-sightedness? near-sightedness?

   (a) behind the retina
   in front of the retina
   (b) converging
   diverging

✔ Check Your Learning

WIKI (PHYSICS)

✎.... 2DPHYS - WS10 (Reflection & Refraction)
✎.... 2DPHYS - QUIZ4 (Lenses & The Eye)