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CONCEPT REVIEW 13

THE CHARACTERISTICS OF WAVES

PAGES 92 to 95

Complete this concept review handout and keep it as a record of what you have learned.

DEFINITIONS

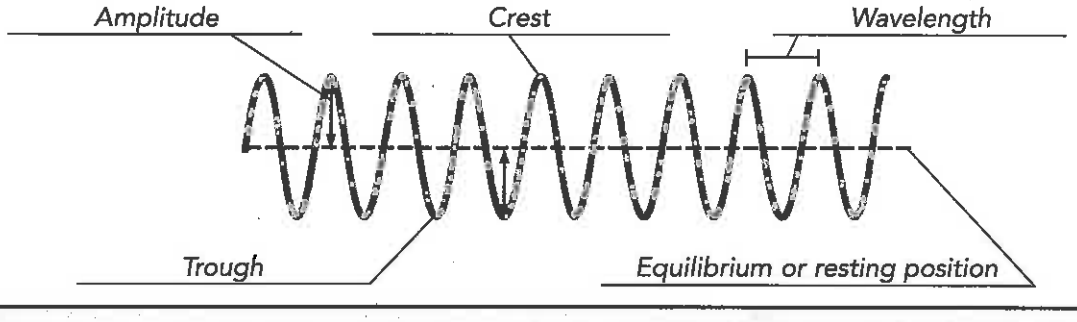
- A wave is *a disturbance that travels through a medium. A wave transports energy; it does not transport matter.*
- A transverse wave is *a wave that propagates perpendicular to the motion of its medium.*
- A longitudinal wave is *a wave that propagates parallel to the motion of its medium.*
- The amplitude of a wave corresponds to *the maximum distance travelled by a particle in the medium compared to its position at equilibrium.*

  Symbol: *A*
- The amplitude of a wave corresponds to *the length of a wave's complete cycle.*

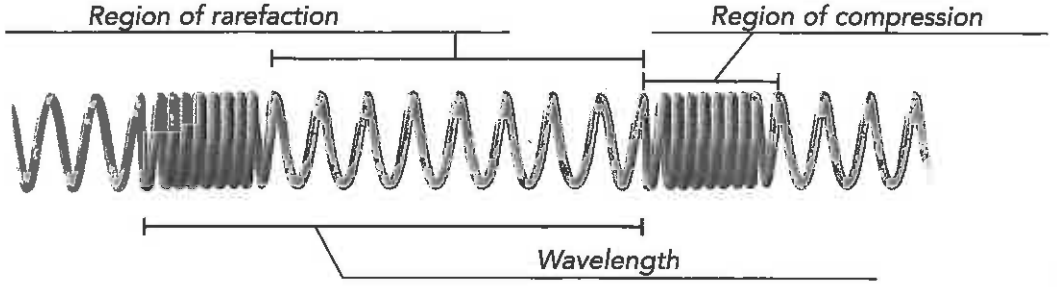
  Symbol: *λ*
- Frequency corresponds to *the number of cycles per unit of time.*

  It is measured in *hertz (Hz).*

CHARACTERISTICS OF TRANSVERSE WAVES



CHARACTERISTICS OF LONGITUDINAL WAVES



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13 INTEGRATION QUESTIONS • THE CHARACTERISTICS OF WAVES

1. In an earthquake, seismic waves transport energy to the surface. These waves are divided into two types. What we call the primary wave shakes the Earth's crust forwards and backwards in the direction it is moving. What is called the secondary wave shakes rock from top to bottom as it moves along.

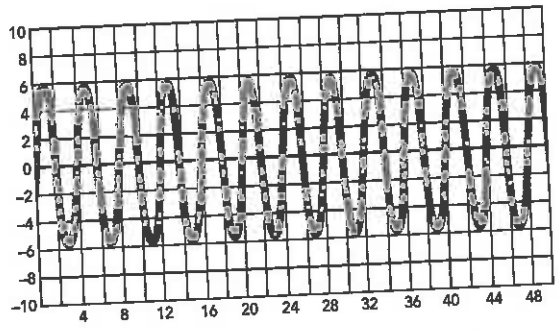
   What type of wave is each: transversal or longitudinal?
   Explain your answers.

   a) The primary wave is: *longitudinal because it acts on the Earth's crust in the same direction it is moving.*

   b) The secondary wave is: *transversal because it shakes the rock from top to bottom. The movement of the rocks is therefore perpendicular to the direction of the wave.*

2. Measure the amplitude and length of each wave illustrated below. (Unit of measurement is centimetres.)

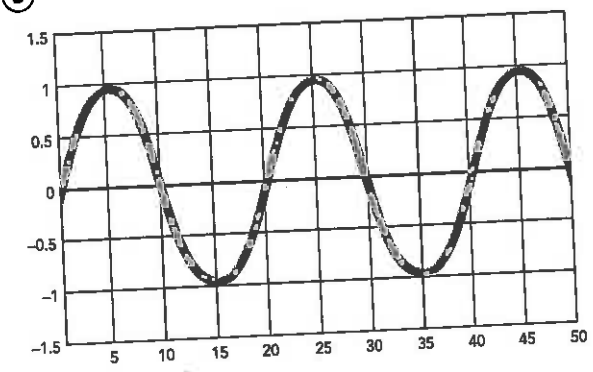
   (A)



   A. Amplitude: *6 cm*

   Wavelength: *4 cm*

   (B)



   B. Amplitude: *1 cm*

   Wavelength: *20 cm*

3. Look closely at the following illustrations:

   (A)

   (B)

   (C)

   a) Which of the three waves illustrated has the longest wavelength? *A*

   b) Which wave has the greatest amplitude? *B*

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CONCEPT REVIEW 14

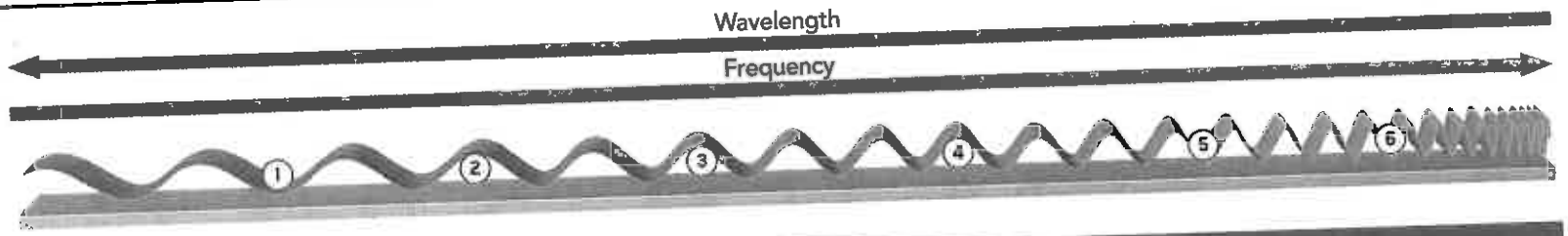
WAVES AND THE ELECTROMAGNETIC SPECTRUM

Complete this concept review handout and keep it as a record of what you have learned.

DEFINITIONS

- A mechanical wave is *a wave that requires a medium in order to propagate.*
- An electromagnetic wave is *a wave that can travel in both a vacuum and a medium.*
- The electromagnetic spectrum *organizes all electromagnetic waves according to their wavelength and their frequency.*

THE ELECTROMAGNETIC SPECTRUM



Types of wave	Examples of applications
1. *Radio waves*	*Radios, microwave ovens, etc.*
2. *Infrared*	*Night vision goggles, remote controls, etc.*
3. *Visible light*	*Lighting, photography, etc.*
4. *Ultraviolet rays*	*Sterilization of surgical instruments, treatment of certain ailments, etc.*
5. *X-rays*	*Radiography, baggage inspection, etc.*
6. *Gamma rays*	*Cancer treatment, food preservation, etc.*

Name: _____ Class: _____ Date: _____

14 INTEGRATION QUESTIONS • WAVES AND THE ELECTROMAGNETIC SPECTRUM

1. The statements below describe waves. Specify if the statements describe mechanical or electromagnetic waves.

a) They only travel through material media. *Mechanical waves.*

b) These waves are produced by earthquakes. *Mechanical waves.*

c) A microwave oven uses this type of wave. *Electromagnetic waves.*

d) Plucking the strings on a violin produces this type of wave. *Mechanical waves.*

e) They can travel in a vacuum. *Electromagnetic waves.*

f) This type of wave can come from the Sun's rays. *Electromagnetic waves.*

2. The electromagnetic spectrum is made of different electromagnetic waves. Specify the type of wave in each of the following examples.

a) Waves that give you an image of the bones in your body. *X-rays.*

b) Waves that allow you to take photos. *Visible light.*

c) Waves emitted by a warm body. *Infrared rays.*

d) Deeply penetrating waves used in medicine to treat cancer. *Gamma rays.*

e) Waves used in radar. *Microwaves.*

f) Waves that give us television image. *Radio waves.*

g) Waves that give you a tan. *Ultraviolet rays.*

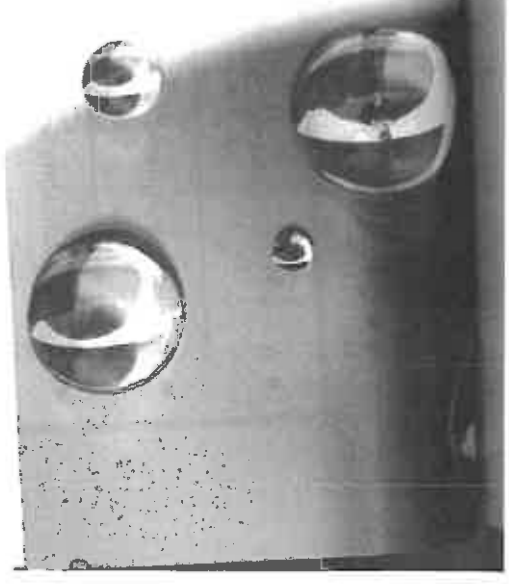
3. Visible light separates into various colours.

a) What are these colours?
Red, orange, yellow, green, blue and violet.

b) What colour has the highest frequency?
Violet.

c) What colour has the lowest frequency?
Red.

d) What colour has the longest wavelength?
Red.



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CONCEPT REVIEW 15

SOUND WAVES AND THE DECIBEL SCALE

PAGES 100 TO 105

Complete this concept review handout and keep it as a record of what you have learned.

DEFINITIONS

- Sound is *a longitudinal mechanical wave produced by the vibration of an object and transmitted to the object's environment.*
- The decibel scale is *a relative scale that represents the perception of the intensity of sound by the human ear.*

CHARACTERISTICS OF SOUND

- The speed of sound varies *quite a bit from one medium to another*.
  In the air, the speed of sound is *1224 km/h or 340 m/s*.
- The intensity of sound depends on *the amplitude* of the sound wave.
  The intensity of sound is measured in *decibels (dB)*.
- Sound tones correspond to the *frequency*, which is measured in *hertz (Hz)*.

THE DECIBEL SCALE

Intensity (dB)	How much louder than 0 dB	Example	Hearing damage
20	100	Murmur (2 m away)	None
40	*10 000*	*Calm classroom*	*None*
70	*10 000 000*	*Intense road traffic (3 m away)*	*None*
110	*100 000 000 000*	*Rock music concert*	*Long term*
120	*1 000 000 000 000*	*Jet motor (14 m away)*	*Immediate*

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15 INTEGRATION QUESTIONS • SOUND WAVES AND THE DECIBEL SCALE

1. Can sound travel through a vacuum? Explain your answer.
No, because it is a mechanical wave, sound cannot travel through a vacuum. It needs a medium such as air.

2. What determines the amplitude of a sound wave?
The intensity of the sound.

3. What is the unit of measurement for intensity? *Decibels.*

4. Does sound always travel at the same speed? Explain your answer.
No, because the speed of sound is determined by the medium through which it is travelling.

5. What is sound under 20 Hz called? *Infrasound.*

6. What is sound over 20 000 Hz called? *Ultrasound.*

7. You are listening to music with an intensity of 30 dB.
   a) Someone makes a 30 dB sound beside you. Does the intensity of the two sounds equal 60 dB? Explain your answer.
   No, because the decibels are not combined.
   b) You raise the volume of the music to 60 dB. How much more intense is the new sound than the sound that measured 30 dB?
   It is 1000 times higher.

8. Indicate which characteristic of waves the following statements refer to.

Frequency Amplitude Speed

   a) Bertrand has a low voice. *Frequency.*
   b) Annie talks twice as loud as I do. *Amplitude.*
   c) Some sounds hurt your ears. *Amplitude.*
   d) Ultrasounds are very helpful in medicine. *Frequency.*
   e) You usually see lightening before you hear thunder. *Speed.*
   f) Some devices drive insects away by emitting sounds we can't hear. *Frequency.*

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CONCEPT REVIEW 16

LIGHT WAVES AND REFLECTION

PAGES 106 TO 110

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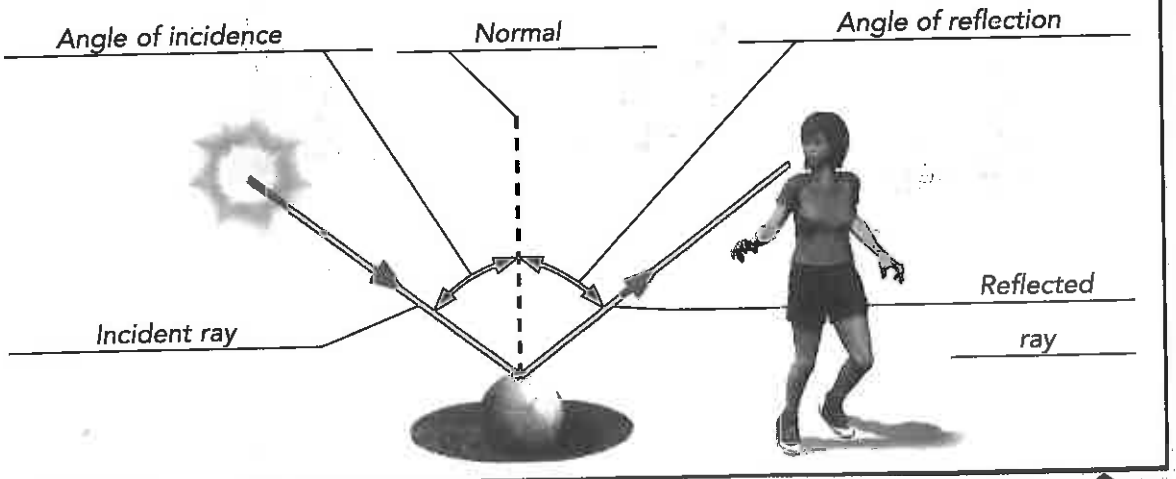
DEFINITIONS

- Light is *an electromagnetic wave that is visible to the human eye.*
- Reflection is *the rebounding of light that occurs when a light ray hits a different medium and "bounces back" to the medium from which it came.*
- The incident ray is *the ray that contacts the surface of an object.*
- The reflected ray is *the ray that rebounds.*
- The normal is *a line perpendicular to the surface at the point of reflection.*
- The angle of incidence is *the angle formed by the incident ray and the normal.*
- The angle of reflection is *the angle formed by the reflected ray and the normal.*

LAWS OF REFLECTION

- The angle of incidence is always *equal to the angle of reflection*.
- The incident ray and the reflected ray are always *on the same plane*.



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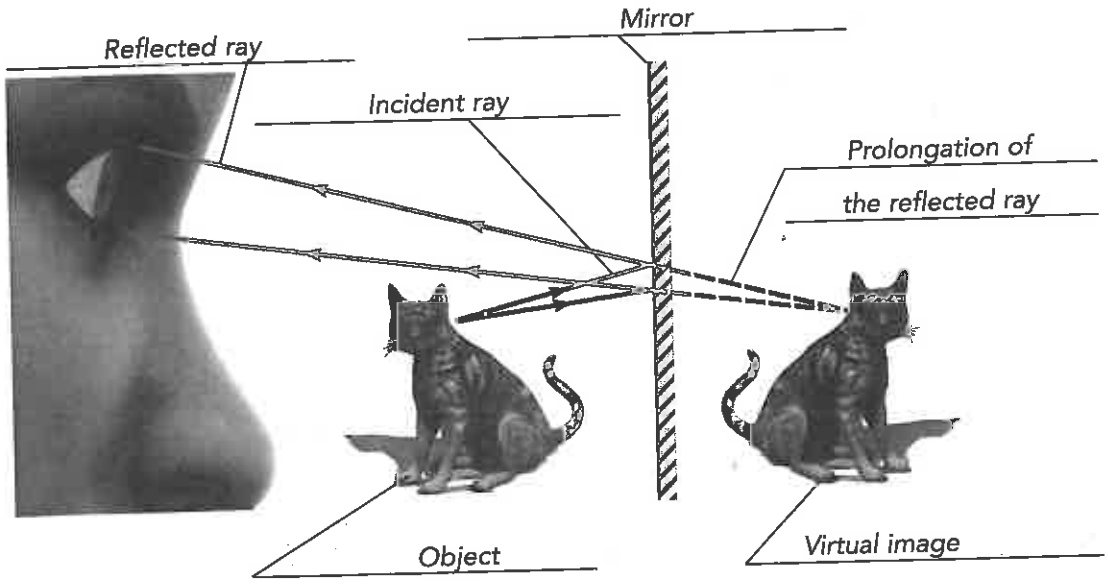
TYPES OF REFLECTION

Reflection	Behaviour of light rays	Image formation (yes or no)
Diffuse	Parallel light waves are reflected in all directions.	No
Specular	When parallel light waves contact a smooth surface their reflections are parallel.	Yes

CHARACTERISTICS OF A REFLECTED IMAGE IN A PLANE MIRROR

- The image appears to be behind the mirror, at a distance equal to the distance between the mirror and the reflected object.
- The image is virtual.
- The image is the same size as the object.
- The image is horizontally inverted.



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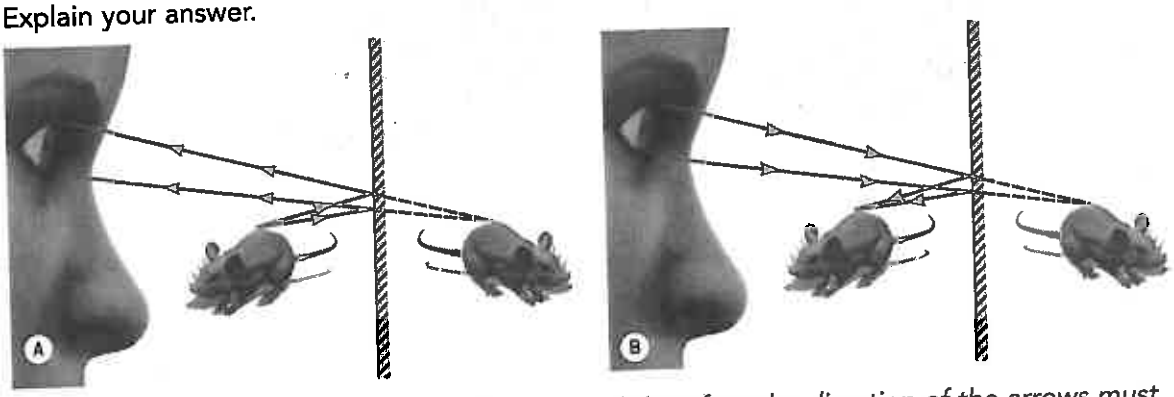
16 INTEGRATION QUESTIONS • LIGHT WAVES AND REFLECTION

1. True or false?
   a) A light ray usually changes direction when it enters a new media. — *True.*
   b) A triangular object reflects more light than a square object. — *False.*
   c) A piece of fabric produces a diffuse reflection. — *True.*
   d) Liquid mercury produces specular reflection. — *True.*

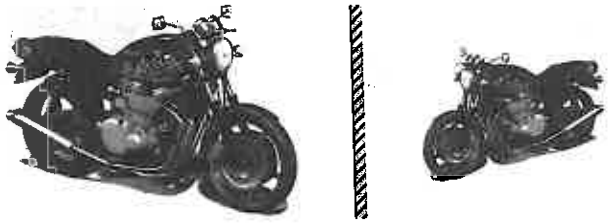
2. Which of the two figures below represents the image formed by a plane mirror? Explain your answer.



A, because the rays are captured by the eye and therefore the direction of the arrows must show that the rays travel from the object to the eye.

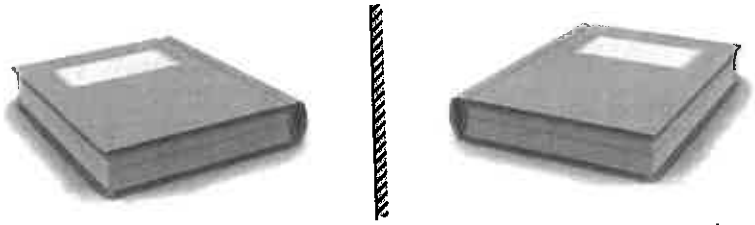
3. Does the image in the following illustrations follow the principles of reflection in a plane mirror? Explain your answer.

a)



No, because the image is smaller.

b)



Yes, because the image is inverted and is the same size as the object and the distance of the image from the mirror is equal to the object's distance from the mirror.

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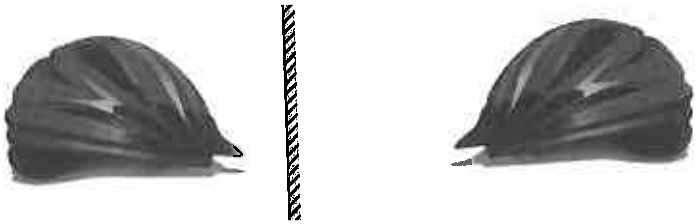
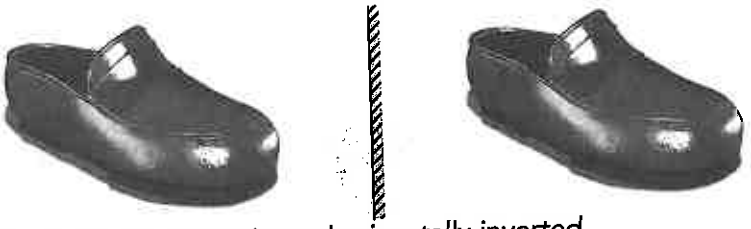
c)



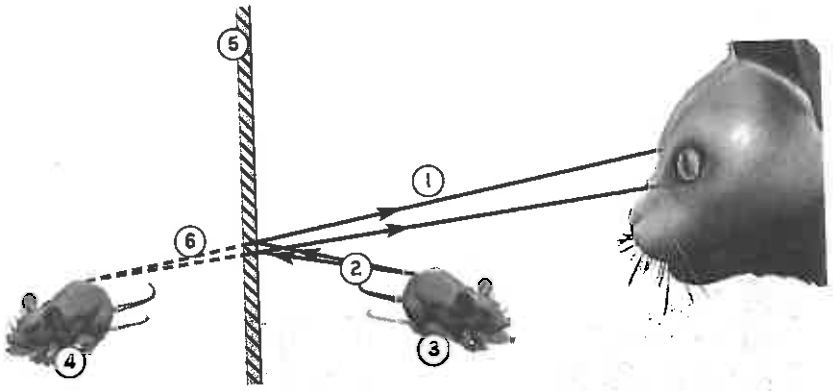
No, because the image is not the same distance from the mirror as the object.

d)



No, because the image is not horizontally inverted.

4. This illustration represents a cat's perception of an image. Identify each element.



(1) *Reflected rays.*

(2) *Incident rays.*

(3) *Object.*

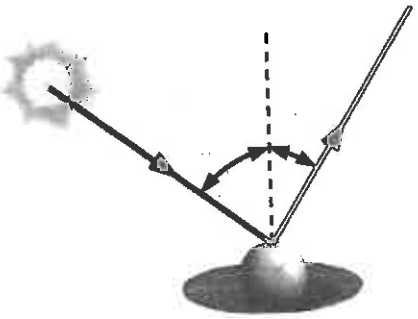
(4) *Virtual image.*

(5) *Mirror.*

(6) *Extension of reflected rays.*

5. Does the path of the rays respect the laws of reflection in this illustration? Explain your answer.

No, because the angle of reflection is not equal to the angle of incidence.



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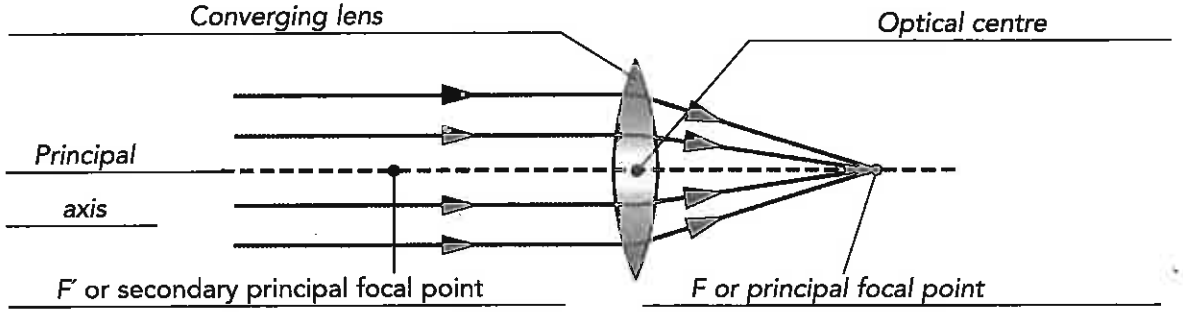
- A lens is *an object made of transparent materials that has at least one curved surface, and the ability to refract light as it passes through them.*

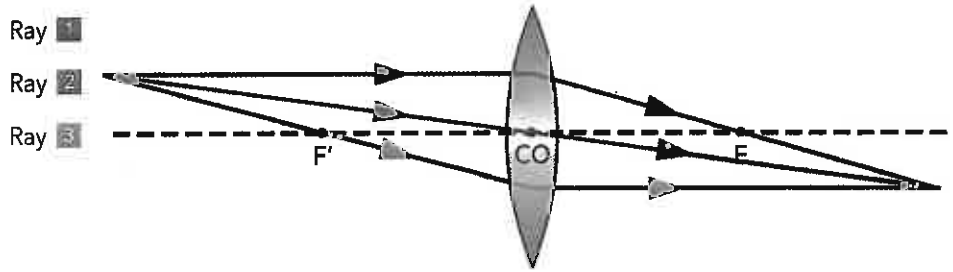
CONVERGING LENS

Focal point of a converging lens

The focal point of a converging lens is *the real point where the refracted rays actually meet when the incident rays run parallel.*



Basic rays to determine the location of the image



Ray 1 A ray that travels parallel to the principal axis is refracted *through the principal focal point.*

Ray 2 A ray that travels straight through the optical centre of a lens *is not refracted.*

Ray 3 A ray that travels straight through the secondary focal point is refracted *parallel to the principal axis.*

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CONVERGING LENS (CONT.)

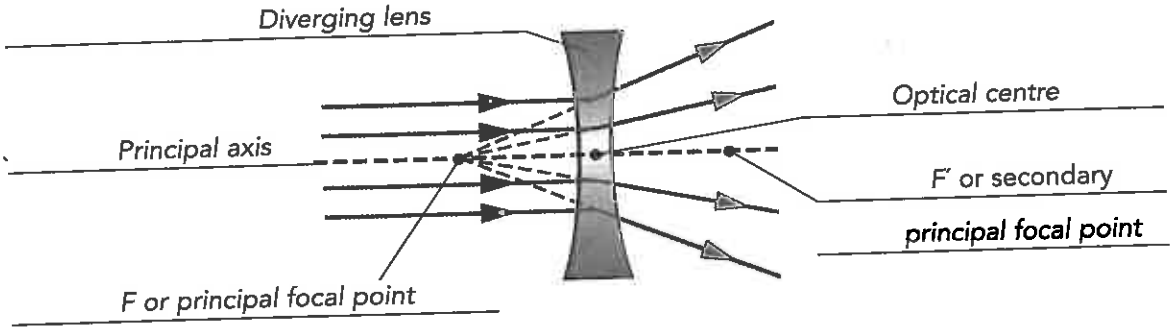
Image produced by the lens

- The final image formed by a converging lens has different characteristics depending on *the location of the object in relation to the lens.*
- The characteristics, which can vary, are: *the type of image (real or virtual), its position, its size and its orientation.*

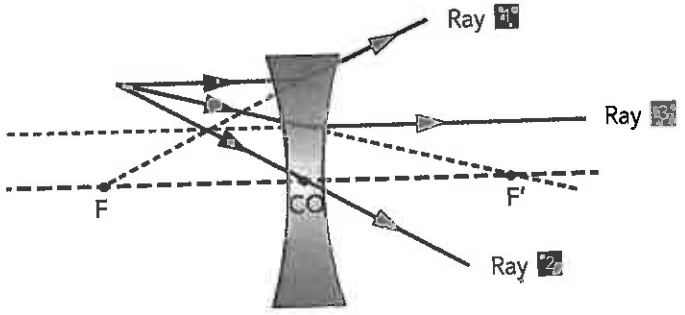
DIVERGING LENS

Focal point of a diverging lens

The focal point of a diverging lens is *is the virtual point from which the refracted light rays appear to emanate when the incident rays run parallel.*



Basic rays to determine the location of the image



Ray 1 A ray running parallel to the principal axis is refracted, *appearing to originate from the focal point.*

Ray 2 A ray passing through the optical centre of the lens *does not deviate.*

Ray 3 A ray travelling toward the secondary focal point is refracted *parallel to the principal axis.*

Image produced by the lens

- The images obtained by a diverging lens are always *virtual, not inverted and smaller than the object.*
- The image is always located *between the principal focal point and the lens.*

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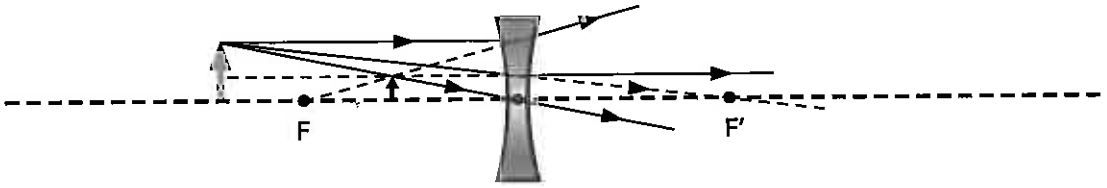
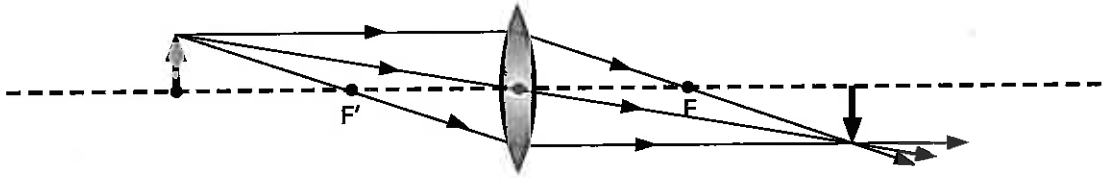
2. Draw two of the three basic rays to position the image in each of the following examples:

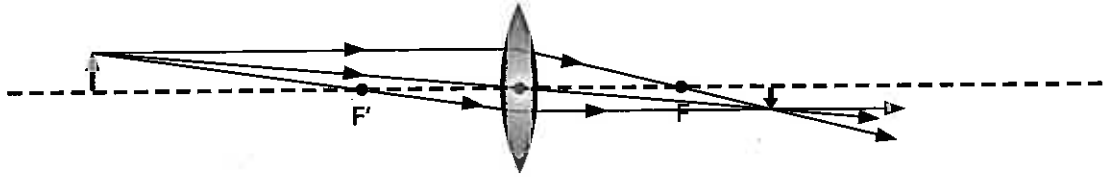
a)



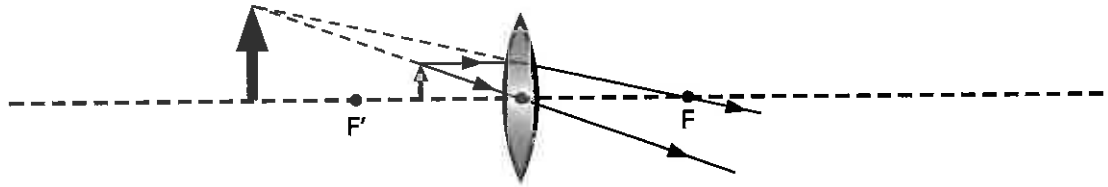
b)



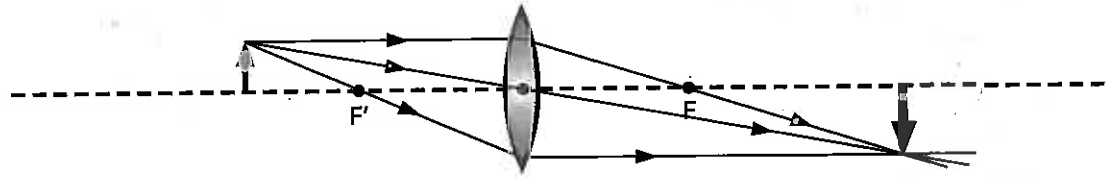
c)



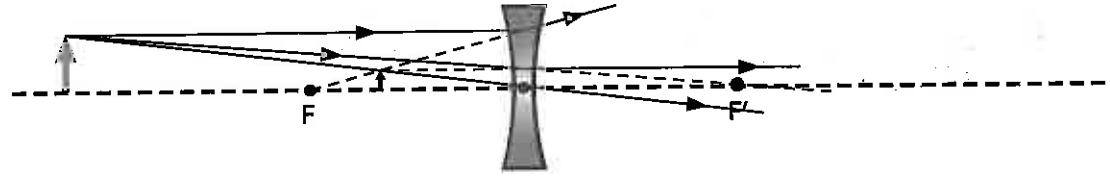
d)



e)



f)



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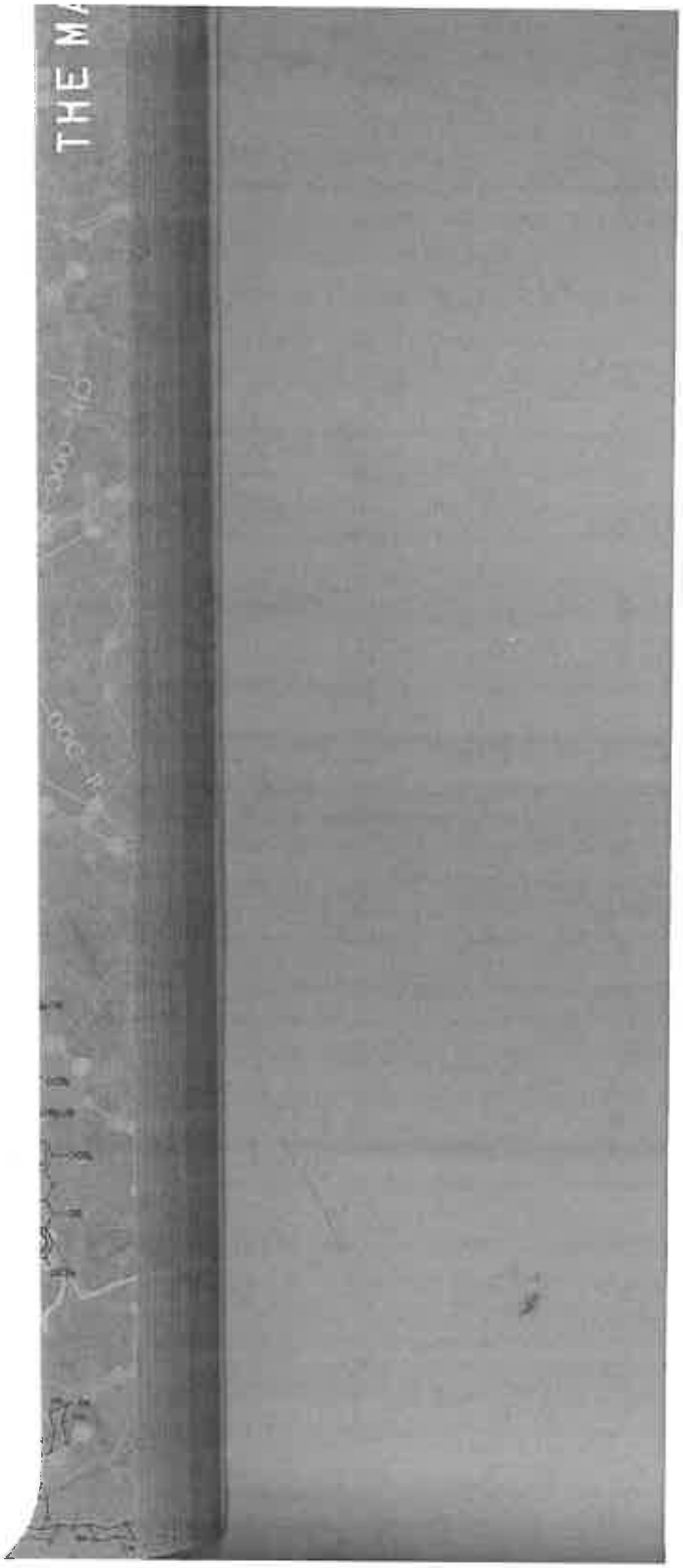

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3. Specify the types of lens described in the following statements.

a) It allows refracted rays to meet at a specific point. *Converging lens.*

b) It always give a virtual image. *Diverging lens.*

c) It does not allow refracted rays to meet. *Diverging lens.*

d) It is used to make magnifying glasses. *Converging lens.*

4. Specify which characteristics of the image will be obtained in each of the situations below.

a) An object placed between the focal point of a convergent lens and the lens.
Virtual image, not inverted, on the same side as and larger than the object.

b) An object placed between the focal point of a diverging lens and the lens.
Virtual image, not inverted and smaller than the object.

c) An object placed at the focal point of a converging lens.
There is no image.

d) An object placed at the focal point of a diverging lens.
Virtual image, not inverted and smaller than the object.

e) An object placed at more than twice the distance from the focal point to a converging lens.
Real image, inverted and smaller than the object.

f) An object placed more that twice the distance from the focal point to a diverging lens.
Virtual image, not inverted and smaller than the object.

5. Indicate what type of lens is demonstrated in each of the illustrations below.

a) 
Diverging lens.

b) 

c) 
Converging lens.

d) 

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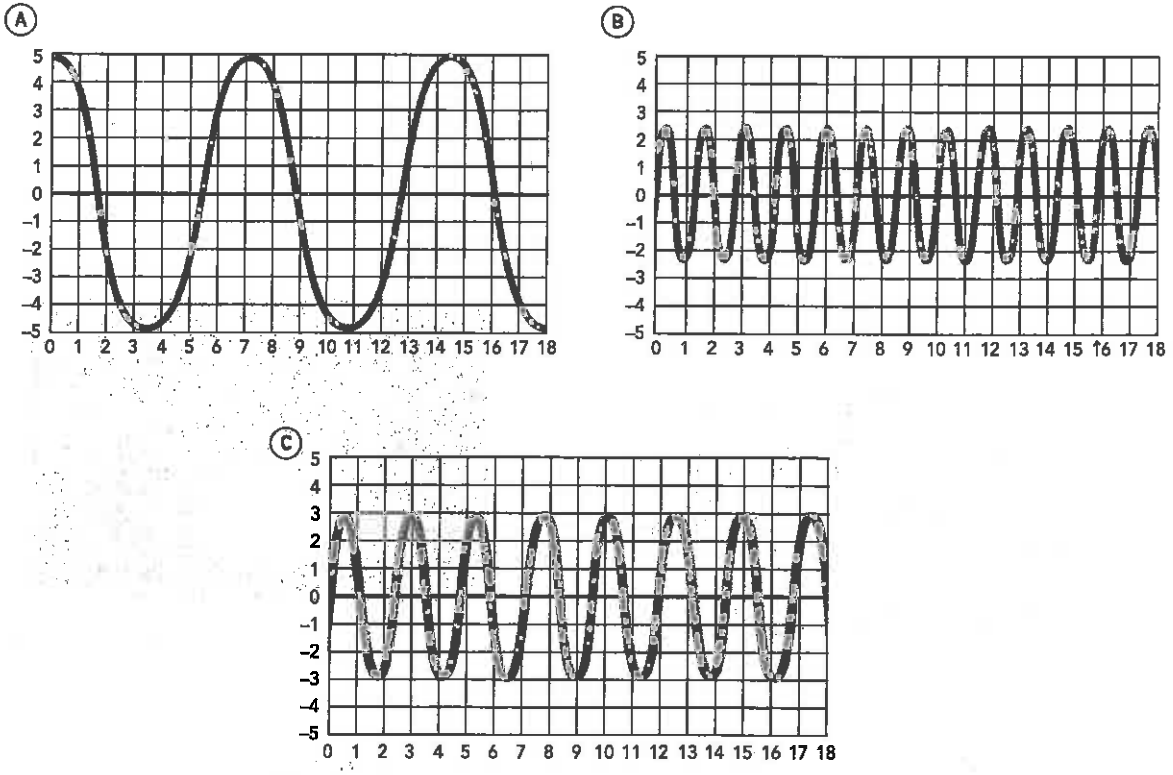
d) I correspond to the maximum distance travelled by a particle in the medium compared to its position at equilibrium. *Amplitude.*

e) I correspond to the distance that separates two consecutive crests on a transverse wave. *Wavelength.*

f) I affect the energy transmitted by a wave. *Amplitude.*

2. Look at the waves illustrated here (measurements are in centimetres).



a) Which of these waves has the longest wavelength? *A*

b) Which has the largest amplitude? *A*

3. The sun gives us light, heats and tans us. What are the electromagnetic waves responsible for these effects?

Visible light, infrared rays and ultraviolet rays.

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4. If a wave completes six cycles per minute, what is its frequency in hertz? Show your calculations.

$$f = \frac{6 \text{ cycles}}{60 \text{ s}} = 0.1 \text{ Hz}$$

5. Machines vibrate at 15 vibrations per second.

a) What is the frequency of the sound produced by these machines? *15 Hz.*

b) Can this sound be perceived by the human ear? *No, because the frequency is below 20 Hz, which is the threshold of hearing of the human ear.*

6. You hear three different sounds measuring 20 dB, 40 dB and 50 dB.

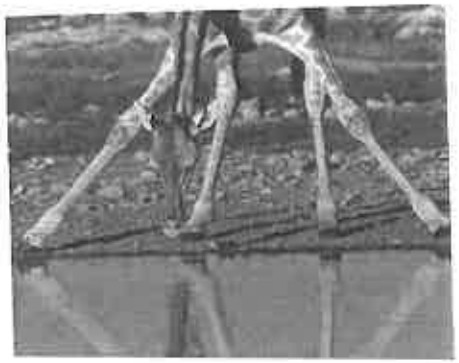
a) Which sound has the greatest intensity? *The 50 dB sound.*

b) How much lower is the 20 dB sound than the 50 dB sound?
It is 1/1000 as loud.

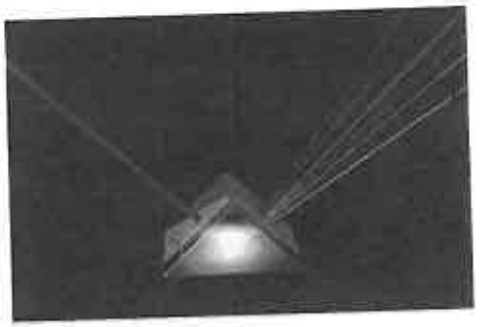
c) Is the sound that measures 40 dB twice as loud as the sound measuring 20 dB?
No, it is 100 times louder.

7. Specify if the following examples are refraction or reflection.

a)



b)



Refraction.

c)

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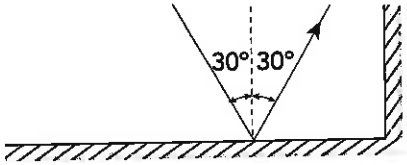


9. A woman is standing 3 m from a mirror.

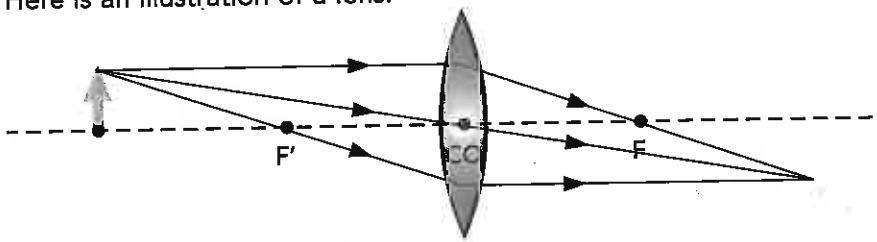
a) How far is she from her image?

6 m

b) If she backs up 1 m, what distance separates her from her image?

8 m

10. Here is an illustration of a lens.



a) What type of lens is this?

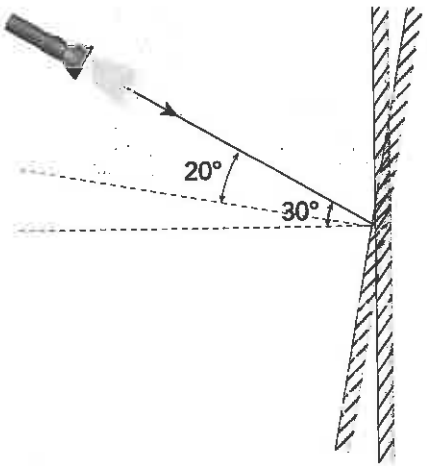
Converging lens.

b) In the illustration, draw the three basic rays that determine the position of the image.

11. You want to obtain a virtual image smaller than the object. Why type of lens will you use?

A diverging lens.

12. A ray hits a plane mirror at a 30° angle. The mirror is tilted 10° without moving the light source.



a) Draw the new normal on the illustration.

b) What will the new angle of reflection be?

It will be 20°.

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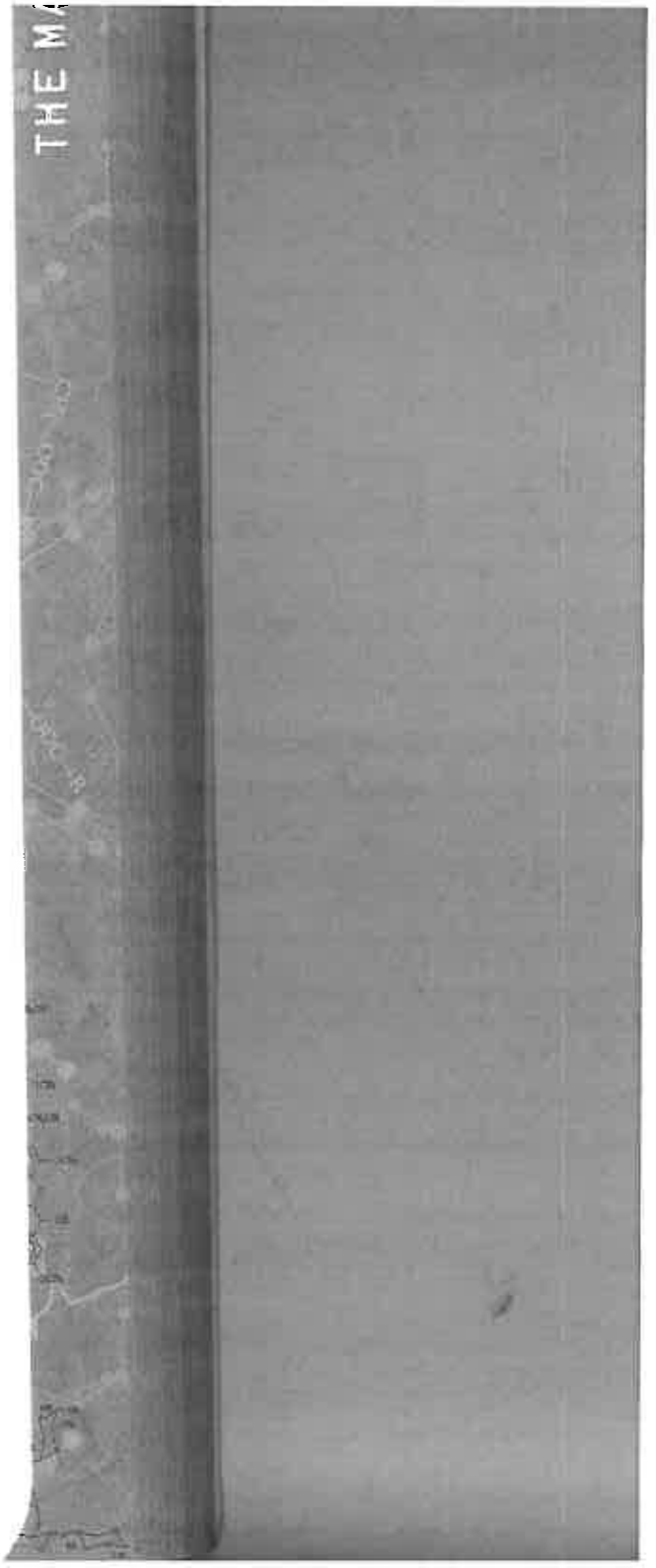

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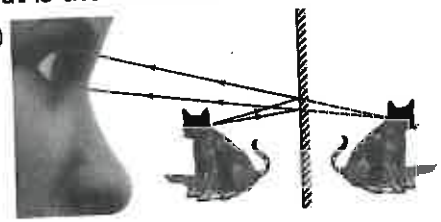
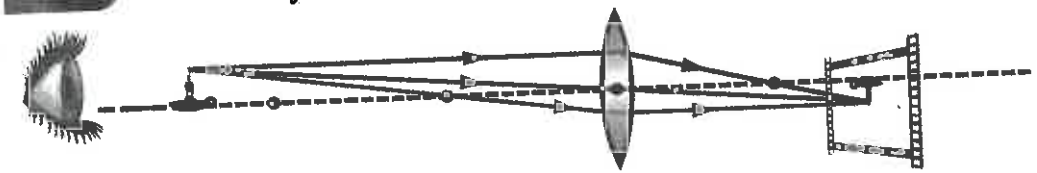
13. Look at the following illustrations. The first represents the formation of a virtual image by a plane mirror. The second represents the formation of a real image by a converging lens. What is the difference between a virtual image and a real image? Explain your answer.

A



B



- *Sample answer: A virtual image is located where the extensions of the reflected rays meet. As the light doesn't actually go through this point, the image is said to be virtual. It cannot be captured directly on a screen either.*
- *A real image is located at the spot where the refracted rays meet. As the light actually passes through this point, the image is said to be real. This image can also be captured directly on a screen.*

14. In the following vision problems, specify which lens you would recommend to correct the problem.

a) This photo represents the vision of a myopic 30-year-old adult.

b) This photo represents the vision of a 15-year-old teenager with hyperopia.

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