**Grade 8 SCIENCE Unit 2: OPTICS Chapter 5 CHAPTER QUESTIONS**

**Page 173 5-1A Absorb, Reflect, Transmit**

**What Did You Find Out? Answers**

1. Opaque refers to the ability of an object to **completely block all rays of light that strike it, by reflecting and/or absorbing the light.**

2. Translucent materials allow some light to pass through them but cause the light rays to scatter in different directions, which prevents an object from being distinctively seen through them.

Transparent materials allow light rays to pass through freely, allowing an object to be seen clearly through them.

**Reading Check Answers, p. 175**

1. Three uses for the ray model are the following:
   (1) explaining how light reflects off mirrors;
   (2) explaining how light passes through different materials; and
   (3) predicting how shadows are formed.

2. An opaque material prevents any light from passing through it, while a translucent material allows most light rays to get through but scatters them in all directions.

3. A glass of water with red food colouring in it is transparent, as an object can still be clearly seen through it, though it is coloured.

4. The farther an object is from a source of light, the smaller its shadow will be.

**Reading Check Answers, p. 177**

1. Specular reflection occurs when an image of the surroundings is reflected from a very smooth, mirror-like surface, while diffuse reflection occurs when light is reflected off a rough surface. An image is not clearly produced but allows what is on the surface to be seen.

2. A rough surface is responsible for diffuse reflection. It reflects light randomly which does not produce a clear image.

3. The green “T” absorbs all colours of light except green, which is reflected from the print to your eyes. The rest of the page reflects white light to your eyes.

**Reading Check Answers, p. 181**

1. The crest of a wave is perpendicular to the direction of the wave.

2. The direction of a ray of light changes when the light travels from one medium to another medium having a different density because its speed changes.

3. The angle of refraction is the acute angle formed by the refracted ray and the normal.

**Reading Check Answers, p. 182**

1. If a ray of light passes from a more dense medium into a less dense medium, the refracted ray will bend away from the normal.

2. Since the light is travelling from the water (denser medium), through the air (less dense medium) to reach your eye, the coins will look like they are above their actual position (just as the fish do in Figure 5.16 on page 182).

## Page 183 5-1c When light reflects

**What Did You Find Out? Answers**

1. (a) The light ray passing through the glass block changes direction twice, once at the air-to-glass boundary as the light enters the block, and a second time at the glass-to-air boundary as the light exits.

(b) The path of the light is visible at the base of the glass, where the glass meets the table.

2. (a) The light ray entering the block bends toward the normal.

(b) The light ray leaving the block bends away from the normal.

(c) The speed of light is slower in glass than in air.

3. If the two sides of the block are parallel, then the direction in which the light ray travels after it leaves the block is parallel to the direction of the ray before it entered the block.

**Page 163 5-1c WHEn light reflects**

1. (a) Some of the light that struck the lower flat surface between the air and water reflected back down, though some also passed through to the top side.

(b) Students will find some answers to this question on BLM 2-24, How Do Two-way Mirrors Work? include reflective sunglasses, two-way mirrors, and teleprompters.

3. (a) Tapping the glass caused small waves to form on the surface of the water.

(b) The small waves made the surface of the water uneven, causing the reflection of the pencil to become distorted.

3. During reflection, the direction in which the light travels is changed after hitting the surface. If the light strikes the surface at an angle, then it bounces off at the same angle but on the other side of the normal.

4. Light reflects off both liquid and solid surfaces according to the same reflection principle; that is, the angle of incidence equals the angle of reflection.

Page 185 5-1D Follow that refracted ray

**Analyze Answers**

1. The normal should always be perpendicular to the edge of the new medium.

2. Students' answers will vary, depending on where they positioned the ray box.

**Conclude and Apply Answers**

3. In this investigation, light bends toward the normal when it travels from air into another medium such as water. Students should have observed similar results. However, students' results may or may not have supported their group's hypothesis.

3. When the angle of incidence increases, the size of the angle of refraction also increases.

4. When the angle of incidence is the same, the size of the angle of refraction will decrease if the liquid it enters is denser than water. If the liquid is less dense than water, the angle of refraction will increase.

5. A light ray moves away from the normal when it travels from a medium such as water into air.

6. Yes, there is an angle of incidence for which there is no change in the direction of the light. This situation occurs when the angle of incidence is 0˚—that is, when the incident ray falls along the normal itself, so too will the refracted ray.

7. Students' answers may vary slightly, but should convey the pattern that describes the path of light during **refraction:**

**(1) light bends toward the normal when it enters a denser medium, and**
**(2) light bends away from the normal when it enters a less dense medium.**

**Science Math Connect Answers**

1. Since Earth is a sphere, with a curved surface, two vertical flagpoles in different locations cannot be parallel. If they were, they could not both point to the centre of the Earth.

2. Since the Sun is very far away, we can assume that all of the Sun's rays that strike the Earth's surface are essentially parallel. A straight line that passes through the top of the flagpole in Alexandria and the centre of Earth crosses the parallel light rays coming in from the Sun (see diagram on page 186 of the student textbook).

The angles formed by the extensions of the flagpoles to the centre of the Earth and by the shadow of the flagpole at Alexandria are therefore alternate interior angles, which have been proven to be equal in geometry.

3. The alternate interior angle was one fiftieth the circumference of the Earth. If the distance between Syene and Alexandria had been 500 km, then the circumference of Earth would be 50 × 500 km, or 25 000 km.

Section 5.1 A ssessment, p. 187

Check Your Understanding A nswers

**Checking Concepts**

1. (a) Translucent and transparent objects both can transmit light, but an object can be seen clearly through a transparent material.

Translucent materials scatter the light rays in all directions.

(b) Transmitted and absorbed light rays both enter an object, but only transmitted light rays continue to pass through the object, while absorbed light rays are not allowed to pass through.

(c) Reflection and refraction are both processes that affect the direction in which light travels. Reflection causes the light rays to bounce off a surface, according to the law of reflection, while refraction causes the light rays to be bent as they pass through a medium of different density.

3. Students' answers could include the following:
Imagine the movement of light using the wave model. As the front of the light wave moves into water, it begins to slow down. However, the part of the light wave that has not yet hit the water is still moving quickly, which causes the light wave to turn, changing the direction of the light wave.

4. You can see your reflection in a smooth piece of aluminum foil because all the light rays striking the surface reflect uniformly, allowing an image to be seen in its reflection. You cannot see your reflection in a crumpled ball of foil because the light rays bounce off the uneven surface randomly, preventing the formation of a clear reflected image.

5. Specular reflection produces an image of the surroundings, while diffuse reflection allows you to see what is on the surface itself. If you see your own reflection in a shiny object, you are experiencing specular reflection.

**Understanding Key Ideas**

6. **Shadows demonstrate rectilinear propagation** because they are cast when an object blocks the light rays striking it. These light rays do not curve around the object, so a dark area forms behind the object, while the light rays on either side of the object continue in a straight line until they hit a surface.

7. (a) In a ray diagram, the normal is an imaginary line that is perpendicular to the reflecting surface. It is usually drawn where the incident ray meets the surface.

(b) The term “normal” has the same meaning when representing refraction as when representing reflection. In a ray diagram showing refraction, this normal is extended on the other side of the surface where the incident ray strikes it.

8. Students’ explanations will vary, but should mention that the light rays from the part of the pencil above the water will travel in a straight line to the eye. The light rays from the part of the pencil under the water, however, will refract when they travel from water to air. Our eye will interpret the light rays it sees as being straight, and will perceive the pencil to be in a different place than where it actually is.

9. (a) and (b)

incident light ray
flat mirror
normal line i
r
reflected ray

10.

incident light ray
glass mirror
mirror surface
normal line
reflected ray
refracted ray
air

11. When the pages of a book are too smooth or glossy, the text can be difficult to read because of the high amount of specular reflection.

Slightly rougher paper does not have the same glare, as the reflected light is scattered in different directions.

**What Did You Find Out? Answers**

1. Students’ answers could include the following:

The smaller the angle between the mirrors, the greater the number of reflections, or vice versa (the larger the angle between the mirrors, the fewer the number of reflections).

2. Two mirrors could be used to see the back of your head, but only from an angle. To be able to look straight ahead and see the back of your own head as if you were directly behind it, a minimum of four mirrors is needed.

4 mirrors How to view the back of your head

**Reading Check Answers, p. 191**

1. Your brain sees an image behind a plane mirror because it knows that light travels in straight lines so it traces the path of the reflected rays and extends them until they meet behind the mirror.

2. A virtual image is an image located behind the mirror. It is virtual because no rays actually go to or from the image. TR 2-38 MHR • Optics 5

3. An image in a plane mirror can be described as being the same size as the object, the same distance from the mirror, standing upright (if the object is upright), virtual, and reversed.

**Analyze Answers**

1. There would be an unlimited or infinite number of possible rays that could be drawn from point P to the mirror.

2. The angle of reflection equals the angle of incidence.

Optics 5 • MHR TR 2-39

3. The distance between the object and the mirror is equal to the distance between the image and the mirror.

**Conclude and Apply Answers**

1. The angle of incidence is equal to the angle of reflection. This pattern may or may not agree with students' hypothesis, depending on what they wrote.

2. A flat surface is called a plane. The incident ray, reflected ray, and the normal all lie in the same plane.

3. The distance from the image to the mirror is equal to the distance from the object to the mirror.

Core L ab

Analyze Answers

1. Students′ answers will vary, depending on how accurately they drew the incident and reflected rays, and measured the angles of incidence and reflection.

2. Students′ answers will vary, depending on the accuracy of the image that they drew.

Conclude and Apply Answers

3. Students' answers could include the following:

The angle of incidence and/or angle of reflection was measured incorrectly.

The reflecting surface (usually the back) of the plane mirror was not placed exactly on the line drawn.

TR 2-40 MHR • Optics 5

4. Students' answers could include the following:

Measure angles carefully. It could be helpful to use a sharp pencil to draw the rays of light.

Place the plane mirror exactly on the line.

Section 5.2 A ssessment, p. 195

Check Your Understanding A nswers

Checking Concepts

1. (a) The light rays appear to be coming from behind the mirror.

(b) The light rays are actually reflecting off the object, then the surface of the mirror.

2. Student's diagrams will depend on the object chosen. Sample answer:

object image

normal

35° (angle of incidence

and angle of reflection)

normal

normal

normal

object length = 32 mm

image length = 32 mm

35° (angle of incidence

and angle of reflection)

35° (angle of incidence

and angle of reflection)

35° (angle of incidence

and angle of reflection)

3. The image produced by a plane mirror is reversed, right to left and left to right, compared to the object it reflects.

3. Image size is equal to object size. Image distance is equal to object distance. Image is upright. (It has the same orientation as that of the object.)

4. . Students′ answers could include the following:
bathroom mirror, rearview mirror in a car,dental mirror, vehicle inspection mirror, periscope.

Understanding Key Ideas

5. In order to shoot the ball into the desired pocket, you can aim at the "image" of that pocket, using the side of the table as a mirror.

In this way, the ball will bounce off the side of the table at the same angle at which it strikes the side of the table, allowing it to head straight into the target pocket.

image of
pocket A
image of
pocket B
A B

7. That person should be able to see your face. The light that travels from that person and reflects off the mirror to your eyes would be the same path as the light that travels from you to the mirror to that other person.

Activity 5-3A

**What Did You Find Out? Answers**

1. In a plane mirror, the image size and orientation is the same as the object being reflected. However, the image on the inside of the spoon is smaller and inverted, unless you are very close to the spoon. Then the image is larger and upright.

2. The image in the bottom of the spoon is smaller than the object being reflected, but upright, as in a plane mirror.

**Reading Check Answers, p. 202**

1. If an object is between the focal point and the mirror, you need to extend the rays behind the mirror to find the image point. If the object is not between the focal point and the mirror, the image point is found where the reflected rays meet.

2. A **virtual image** is an image created by **extending the reflected rays behind the mirror**.
   A **real image** is formed when **reflected rays** (not extended rays) **meet in front of the mirror**.

3.

| Image Features | | | |
|---|---|---|---|
| Object is located between F and V . | | | |
| Object is located between F and 2F. | | | |
| Object is located beyond 2F. | | | |
| Size | Image is larger than object. | | |
| | Image is larger than object. | | |
| | Image is smaller than object. | | |
| Position | Image distance is larger than object distance. | | |
| | Image distance is larger than object distance. | | |
| | Image distance is smaller than object distance. | | |
| Orientation | Upright | Inverted | Inverted |
| Type | Virtual | Real | Real |

4. When the object is at a distance of twice the focal length from the mirror, the image is the same size as the object and inverted. The image is located the same distance from the mirror, directly beneath the object on the other side of the principal axis.

principal axis
F
concave mirror
object
image
2F

**Reading Check Answers, p. 206**

1. **The focal point of a convex mirror** is found behind the mirror, while the focal point of a concave mirror is found in front.

2. Although the rays of light that reflect from a convex mirror never meet, their extended rays do meet behind the mirror. You can use these extended rays to find the image.



3. The characteristics of an image in a convex mirror do not depend on the distance of the object from the mirror. The image is smaller, upright, closer to the mirror than the object is, and virtual in all cases.

principal axis
F
convex mirror
object close to mirror
principal axis
F
convex mirror

Section 5.3 Assessment, p. 209

Check Your Understanding Answers

**Checking Concepts**

1. The three rays that allow you to predict an image in a curved mirror are the following:

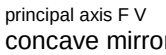
(1) The ray that travels from the top of the object parallel to the principal axis.

(2) The ray that travels through the focal point and the top of the object before hitting the mirror (or whose extension travels through the focal point).

(3) The ray that travels from the top of the object to the vertex.

2. To find the focal point of a concave mirror, draw rays parallel to the principal axis. Then draw their reflections. The reflections will converge at the focal point.

3.




4. Step 1: Draw a ray from the top of the tree parallel to the principal axis. Draw a reflected ray.

For the concave mirror, the reflected ray will pass through the focal point.

For the convex mirror, the extension of the reflected ray will pass through the focal point.

Step 2: For the convex mirror, draw a ray from the top of the tree through the focal point.

For the concave mirror, the ray will need to be extended to go through the focal point. Draw a reflected ray parallel to the principal axis.

Step 3: For both mirrors, draw a ray from the top of the tree to the vertex, and reflecting at the same angle.

Step 4: For both mirrors, extend reflected rays behind the mirror to find the object point.

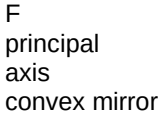
5. Students' answers could include the following:

spotlights, flashlights, overhead projectors, car headlights, lighthouses, telescopes, and satellite dishes.



6. The reflecting surface of a convex mirror bulges outward, while the reflecting surface of a concave mirror curves inward.

7. A convex mirror always forms a virtual image since reflected rays diverge in front of the mirror, and only their extended rays meet behind the mirror.

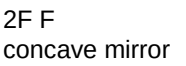


8. Students' answers could include the following:

Convex mirrors allow observers to see a larger area from a single location, such as security mirrors and side mirrors on automobiles, trucks, and buses.

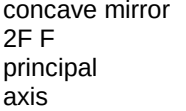
**Understanding Key Ideas**

9. An object placed exactly at the focal point of a concave mirror would not produce an image because the incident ray that passes through the top of the object and the focal point is perpendicular to the principal axis, and does not go to the mirror. The other two reflected rays are parallel to each other.



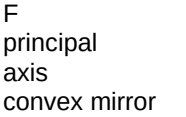

10. Concave Mirror

Depending on where students draw the object, placement and characteristics of the image will vary. For example, the image of an object more than 2 focal lengths from the mirror is smaller than the object, closer to the mirror, inverted, and real.



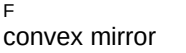

Convex Mirror

The image is smaller than the object, closer to the mirror, upright, and virtual.




11. By placing the bottom of the object on the principal axis, the image of the bottom of the object is also on the principal axis. This means that you do not have to draw three rays to locate it.

12. To find the focal point of a convex mirror, draw a set of parallel rays to the mirror's surface. The reflected rays will diverge (never meet), but their extended rays will meet at the mirror's focal point.



Prepare Your Ow n Su mmary Students' summaries should incorporate the following main ideas:

1. **Law of Reflection**

• When an incident ray hits a reflecting surface, the reflected ray bounces off the surface in a predictable manner.

• The law of reflection states that "the angle of reflection equals the angle of incidence."

• The law of reflection holds true for plane and curved mirrors.

2. **Specular and Diffuse Reflection**

• A specular reflection is a reflection from a mirror- like surface which produces an image of the surroundings.

• A diffuse reflection is a reflection from a rough surface, which does not produce a clear image but instead allows you to see what is on the surface.

• Diffuse reflection allows us to read the print on the page because the reflected light from the white parts of the page go out in all directions; otherwise, we would see our image behind the print on the page, making it difficult to read it.

**3. Refraction of Light**

• When light travels from a less dense medium to a more dense medium, it bends toward the normal.

• When light travels from a more dense medium to a less dense medium, it bends away from the normal.

• Refraction can cause optical illusions, such as a pencil in a glass of water that can appear to be broken or bent.

**4. Plane, Concave, and Convex Mirrors**

• A plane mirror is a flat mirror. The image formed in a plane mirror appears to be the same size as the object, the same distance from the mirror as the object is, upright, and virtual.

• A concave mirror is a mirror that curves inward. The characteristics of the image formed in a concave mirror depend on the distance the object is from the mirror.

• A convex mirror is a mirror that bulges outward. The characteristics of the image formed in a convex mirror are the same regardless of the distance the object is from the mirror (image is smaller than object, image distance is smaller than object distance, image is upright, image is virtual).

• A real image is an image that forms in front of the mirror, where the reflected rays meet. This image can be captured on a screen placed in the correct position.

• A virtual image is an image that forms behind the mirror. The reflected rays do not actually meet; only the extended rays meet.

## 5. Ray Diagrams

• In the ray model of light, light is represented by a straight line with an arrow on it (ray).

• Ray diagrams indicate the path that light takes when it reflects off a surface, or refracts when travelling between two media of different densities.

• Ray diagrams are used to show how images in a mirror or a lens are formed.

## 6. Uses of Mirrors

• Some examples of **plane mirrors** include the following: **bathroom mirror, rearview mirror, dental mirror, vehicle inspection mirror, and periscope.**

• Some examples of **concave mirrors** include the following: spotlights, flashlights, overhead projectors, car headlights, lighthouses, telescopes, and satellite dishes.

• Some examples of **convex mirrors** include the following: security mirrors; sideview mirrors on cars, trucks, and buses; streetlights; and a disco ball.

Chapter R eview A nswers

### Checking Concepts

1. (a)

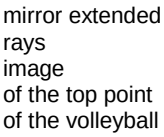
normal
angle of reflection
angle of incidence
*r i*
reflected ray incident ray
reflecting surface

(b) The angle between the incident ray and the normal is equal to the angle between the reflected ray and the normal. This result leads to the law of reflection: the angle of reflection equals the angle of incidence.

2. A specular reflection is a reflection from a mirror-like surface which produces an image of the surroundings. A diffuse reflection is a reflection from a rough surface, which does not produce a clear image but instead allows you to see what is on the surface. An image of yourself in a mirror is produced by specular reflection.

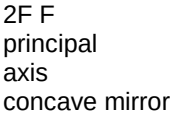
3. The reflected light from all of the white parts of the page goes out in all directions and reaches our eyes, while the black print absorbs all the light that hits it. The white paper produces diffuse reflection and allows you to see the surface of the paper, rather than a reflection of yourself on the page.

4.

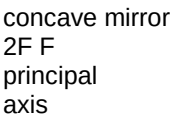



5. The image in of the volleyball is virtual since it is located behind the mirror, where the extended rays meet.

6. When the object is located between the focal point and concave mirror, the image is upright and virtual.



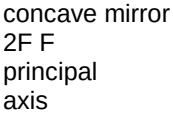

When the object is located between the focal point and two times the focal point of a concave mirror, the image is inverted and real.




7. Concave mirrors are often used for makeup mirrors or shaving mirrors because the image is larger than the object if the object is located between the focal point and the mirror.

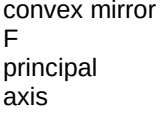
8. At arm's length, the image of your face in a shaving mirror is smaller and inverted. As the mirror is brought closer to your face, the image becomes larger and upright.

9. In order for the image to be real, inverted, and smaller than the object, the object must be located beyond two times the focal point.




10. Since the outer surface of a piece of shiny sphere is curved outwards, it can be used to make a convex mirror.

11. The image in a convex mirror is virtual, upright, and smaller than the object.



**Understanding Key Ideas**

12. In **specular reflection**, the normals are perpendicular to the smooth surface, so all the reflected rays bounce off the surface at the same angle.
In **diffuse reflection**, the normal point in different directions where they touch the rough surface, so the angles of reflection are different for each incoming incident ray.

Nonetheless, each individual ray still obeys the law of reflection.

13. If an image appears on a screen placed in front of the mirror, the **image is real**.
If no image appears on the screen at any point in front of the mirror, **the image is virtual**.

14. Placing the bottom of an object on the principal axis makes it easier to locate an image in a ray diagram because in doing so, the image of the bottom of the object will also be along the principal axis. You will not need to draw three rays to locate it.



15. The flashlight bulb is placed at the focal point of the curved reflector in a flashlight because the light emitted by the bulb at the focal point is reflected as parallel rays that provide a bright beam of light directed in front of the flashlight.

Pause and R eflect A nswer

When two mirrors are used at angles with each other, we can say “the image of the girl in one mirror becomes the object for the second mirror.” This result is because when the girl (original object) stands in front of one mirror, the light hitting the back of her head bounces to the mirror and produces an image of her. The second mirror treats this image as the object to be reflected.