Senior High School

Physical Science

Quarter 2 – Module 3:
Reflection of Light

ALTERNATIVE DELIVERY MODE
ADM

Department of Education • Republic of the Philippines

Science – Grade 12
Alternative Delivery Mode
Quarter 2– Module 3: Reflection of Light
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Authors: Abigael M. Manzano

Editors: Joey H. Villanueva, Arlene C. Malaybalay

Reviewers: Tommy R. Rico, Emiterio D. Macarubbo, Maricris N. Surigao

Illustrator: Abigael M. Manzano

Layout Artist: Justine C. Montoya

Management Team: Wilfredo E. Cabral, Director IV
Jennifer F. Vivas, CLMD Chief
Dennis M. Mendoza, Regional EPS in-charge of LRMS
Micah S. Pacheco, Regional ADM Coordinator
Jocelyn M. Aliñab, CID Chief
Tommy R. Rico, Division in-charge of LRMS
and Division ADM Coordinator

Department of Education – National Capital Region

Office Address: Misamis St., Bago Bantay, Quezon City

Telefax: 02-929-0153
E-mail Address: depedncr@deped.gov.ph

Physical Science

Quarter 2 – Module 3:
Reflection of Light

This instructional material was collaboratively developed and reviewed by educators from public and private schools, colleges, and or/universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at action@deped.gov.ph.

We value your feedback and recommendations.

Department of Education • Republic of the Philippines

Introductory Message

For the facilitator:

Welcome to Physical Science Grade 11/12 Alternative Delivery Mode (ADM) Module on the topic Reflection of Light!

This module was collaboratively designed, developed, and reviewed to assist the teachers/facilitators in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners in guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st - century skills while taking into consideration their needs.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator, you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to Physical Science Grade 11/12 Alternative Delivery Mode (ADM) Module on the topic Reflection of Light!

Our hands are the most represented parts of the human body. It is often used to depict skill, action, and purpose. With our hands, we create, accomplish and learn. Hence, you are capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be able to process the contents of the learning resource while being an active learner.

This module has the following parts:

 **What I Need to Know**	This will give you an idea of the skills or competencies you are expected to learn in the module.
 **What I Know**	This part includes activity that will check what you already know about the lesson. If you get all the correct answer (100%), you may decide to skip this module.
 **What's In**	This is a brief drill or review to help you link the current lesson with the previous one.
 **What's New**	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity, or a situation.
 **What is It**	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
 **What's More**	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
 **What I Have Learned**	This includes questions or blank sentences/paragraphs to be filled in to process what you learned from the lesson.
 **What I Can Do**	This section provides an activity that will help you transfer your new knowledge or skills into real-life situations.

 **Assessment**	This is a task which aims to evaluate your level of mastery in achieving the learning competency.
 **Additional Activities**	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned.
 **Answer Key**	This contains answers to all activities in the module.

At the end of this module you will also find:

References	This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and in checking your answers.
5. Finish the task at hand before proceeding to the next activity.
6. Return this module to your teacher/facilitator once done.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain a deep understanding of the relevant competencies. You can do it!

What I Need to Know

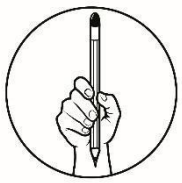
This module was designed and written with you in mind. It is to help you understand the nature of light. This module focuses on how light behaves as it encounters a boundary. It is called *reflection of light* which is fundamental in explaining the nature of light. In this module, the ray model of light will be used to help you comprehend the basics of image formation. You will be provided with different activities to help you master the concept. You can perform the activities according to your pace. You can use this module along with your Physical Science textbook or other learning resources.

This module has a single lesson:

- Lesson 1 – Reflection of Light

After going through this module, you are expected to:

1. Describe what happens when light is reflected;
2. Draw the path of light rays as they are reflected;
3. Identify and describe the following terms:
    a. incident ray;
    b. reflected ray;
    c. the normal;
    d. the angle of incidence; and
    e. the angle of reflection.
4. Relate the angle of incidence and the angle of reflection;
5. Distinguish between diffuse and specular reflection;
6. Locate the image in a plane mirror; and
7. Explain how reflection can be used in an everyday object.

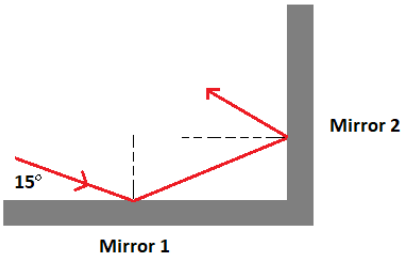


What I Know

DIRECTIONS: Read each question carefully. Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. What do you call a phenomenon by which the incident light falling on the surface is sent back into the same medium?
    A. Absorption
    B. Polarization2
    C. Reflection
    D. Refraction
2. What angle is formed by an incoming ray with the normal?
    A. Angle of incidence
    B. Angle of reflection
    C. Angle of refraction
    D. Angle of equivalence
3. Which statement correctly describes the "Law of reflection"?
    A. The angle of reflection is perpendicular to the normal.
    B. The angle of incidence is equal to the angle of reflection
    C. The angle of reflection is parallel to the angle of incidence
    D. Both the angle of incidence and reflection lie in different planes.
4. What type of reflection is produced by rough surfaces?
    A. Diffuse reflection
    B. Dispersion
    C. Specular reflection
    D. Total internal reflection
5. Which of the following best describes a *Normal* line?
    A. The path is taken by the rays of light as it approaches the surface
    B. Line parallel to the incident and reflected ray
    C. The total distance traveled by light upon reflecting
    D. An imaginary line is drawn perpendicular to the reflecting surface
6. Which of the following pairs perfectly describe the reflection produced by a smooth surface?
    A. Diffuse reflection: clear and precise
    B. Specular reflection: clear and precise
    C. Diffuse reflection: not clear and vague
    D. Specular reflection: not clear and vague

7. An incoming ray of light strikes the mirror at an angle of 30˚ relative to the normal. What is the angle between the incident ray and the reflected ray?
    A. 15 ˚
    B. 30 ˚
    C. 60 ˚
    D. 90 ˚
8. A ray of light strikes a polished surface at an angle of 37˚. What is the angle of reflection and location of the reflected ray?
    A. 37.0˚ on the same side with the incident ray
    B. 37.0˚ on the other side of the normal line
    C. 53.0˚ on the same side with the incident ray
    D. 53.0˚ on the other side of the normal line
9. Two flat mirrors are perpendicular to each other as shown in the figure. An incoming beam of light makes an angle of 15˚ with the first mirror. What angle will the outgoing beam make with the second mirror?



    A. 15 ˚
    B. 30 ˚
    C. 75 ˚
    D. 90 ˚
10. The angle between a horizontal ruler and a vertical plane mirror is 30◦. What is the angle between the ruler and its image?
    A. 15˚
    B. 30˚
    C. 60˚
    D. 90˚

Lesson 1 Light: Reflection

Understanding light is essential. Light plays a significant role on how we perceive the world around us. We see things when light enters our eyes. Light interacts with the matter around us. We begin our understanding of light when we investigate its properties. One of which is reflection.

What's In

Light travels in a straight line. These straight-line paths are called *rays*. Light also travels through the shortest path possible. When we approximate the treatment of light in which light waves are represented as straight-line rays, we call it Geometric Optics. You have learned in Grade 10 that light can be considered as an electromagnetic wave; however, we will not deal with this aspect. In this module, we will use the ray model of light to describe the many aspects of light such as reflection and refraction.

What's New

Activity 1: Where is my reflection?

You will need a flat mirror, a laser, and a partner for this activity. Put your mirror carefully on the line labeled "mirror". Ask your partner to shine the laser light in each of the dotted lines as represented with numbers 1 to 4. Observe and draw a straight line using a ruler to show the location of the laser light after it hits the mirror. Label the lines you draw with letters A to D.

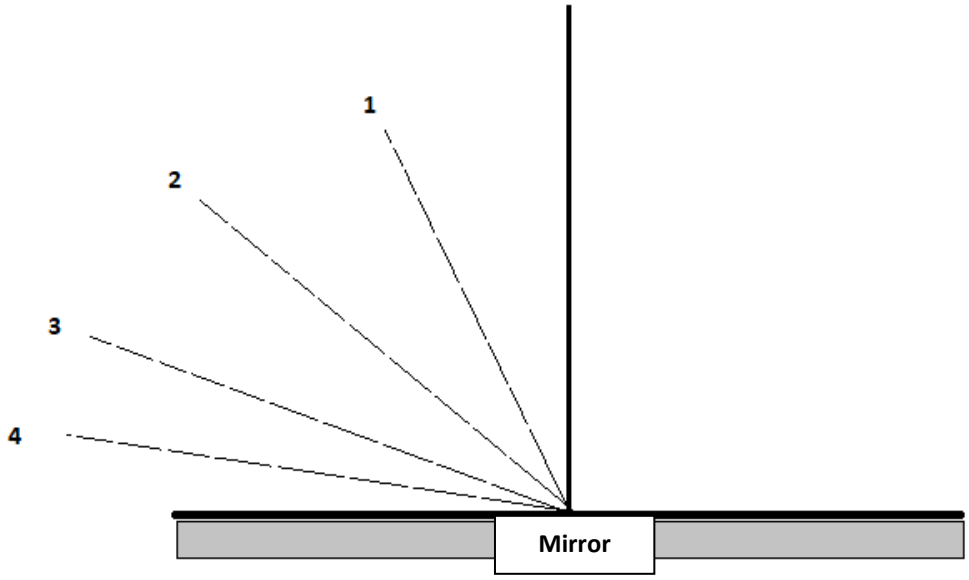


Figure 1. Light Activity

Label the diagram with the following words: **incident ray** and **reflected ray**

How will you describe light rays 1 to 4 in relation to the mirror?_____

_____

How will you describe the light rays that you labeled as A to D? _____

_____

What do you call the ray going into the mirror? _____

What do you call the ray coming out of the mirror? _____

What behavior of light was exhibited in the activity above? _____

What is It

Reflection of Light

What happens when light strikes a surface? Some of the light is reflected as evidenced by the laser activity while others are transmitted or absorbed. This behavior of light to bounce as it strikes a surface is called reflection, as a result, it enables us to see images being reflected from a surface. As the light approaches a reflecting surface, it obeys the *Law of Reflection.* It tells us that the angle of reflection is equal to the angle of incidence.

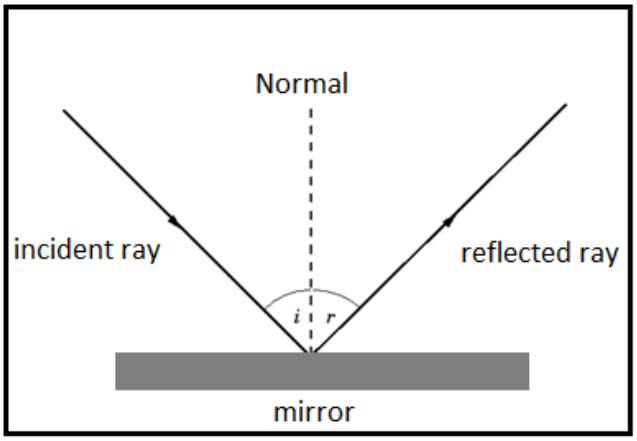


Figure 2. Light-reflecting from a surface

For you to fully understand the law of reflection, analyze *Figure 2*. It illustrates the incident ray as a light ray approaching the surface or mirror that creates an *angle of incidence (i)* with the *Normal line (N)* which is an imaginary line drawn perpendicularly from the point of incidence on the surface or mirror. On the other side of the Normal (N) line is the reflected ray that leaves the surface or mirror. The distance between the reflected ray and the Normal line is called the *angle of reflection (r)*. Therefore, the normal (N) divides the incident ray and reflected ray into two equal angles. The incident rays, reflected rays, and the normal line all lie on the same plane.

Here is the mathematical representation of the Law of Reflection:

$$\theta_r = \theta_i$$

Remember: The Law of reflection is always observed regardless of the orientation of the surface.

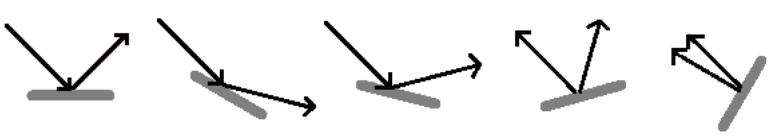


Figure 3. Light-reflecting on surfaces with different orientation.

The figure above shows different reflecting surfaces with varying orientations. You will notice that the incident ray will always have the same angle as the reflected ray relative to the imaginary normal line.

How to draw a light ray reflection diagram?

Here are the steps to help you remember how to draw a light ray reflection diagram.

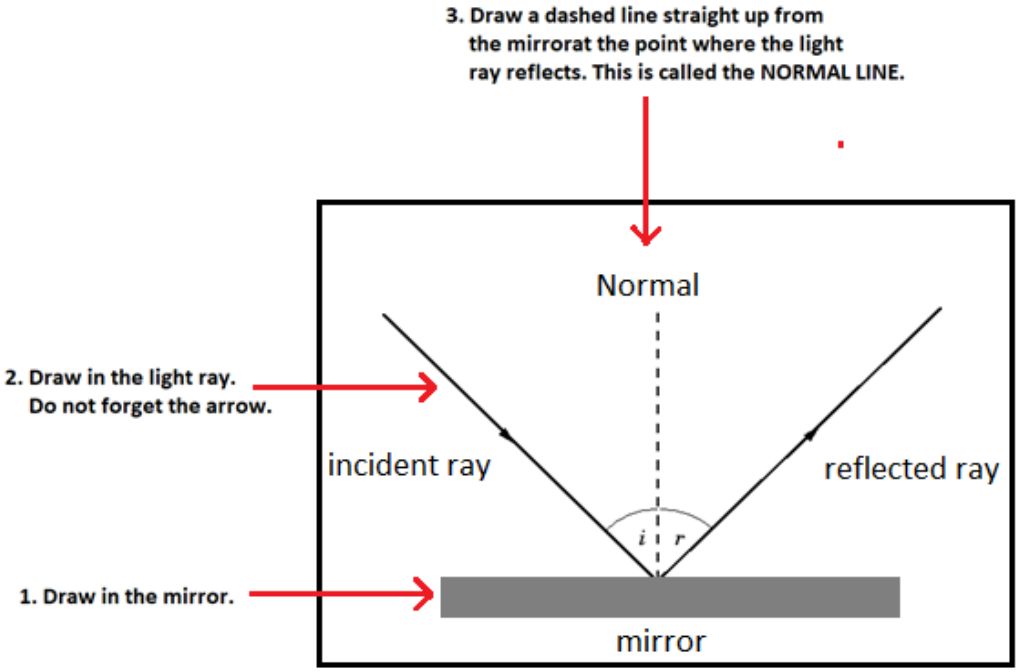
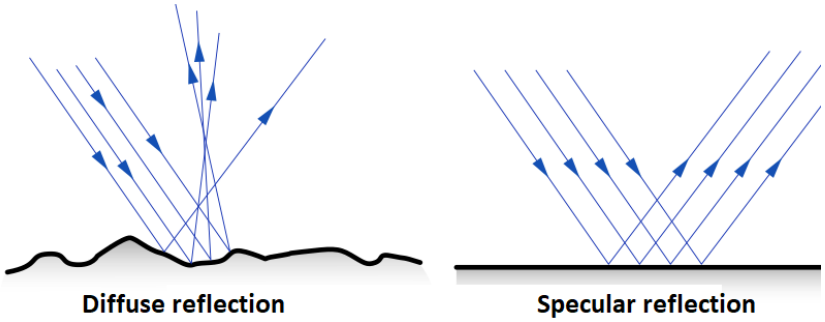


Figure 4. Drawing ray diagrams

Diffuse vs. Specular Reflection

Mirrors are typical examples of a reflecting surface. Mirrors have a very smooth surface that give individual rays of light in the same surface orientation. Thus, when you look into a mirror, you can see a clear image of yourself. However, mirrors are not the only type of material that demonstrates a reflection of light. Most of the objects around us do! As you read this module, light is reflected from the pages, allowing you to read the written information.

Analyze figure 5, distinguish the difference between diffuse and specular reflection.

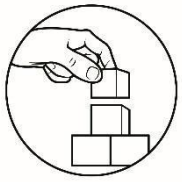


https://commons.wikimedia.org/wiki/File:Regular-and-diffuse-reflection.svg

Figure 5. Diffuse and Specular Reflection

Smooth surface bounces light in one direction creating a clear and vivid reflection of the image which is called specular reflection. On the other hand, a rough surface reflects light in various directions due to the uneven orientation of the surface, which will result in a hazy or unclear image of the object.

These two types of reflection have many practical applications, let us cite some common examples. Night driving on a wet asphalt road becomes difficult due to glare produced by headlights of incoming vehicles. This is because the rough surface was filled with rainwater making the surface smooth, instead of a diffuse reflection, a more concentrated beam of light produces specular reflection. In the same manner, photography also takes advantage of specular and diffuse reflection in taking images of a subject. A picture of a beautiful mountain being reflected in the calm and still water is a classic example.



What's More

Activity 1.1 Mirror Maze

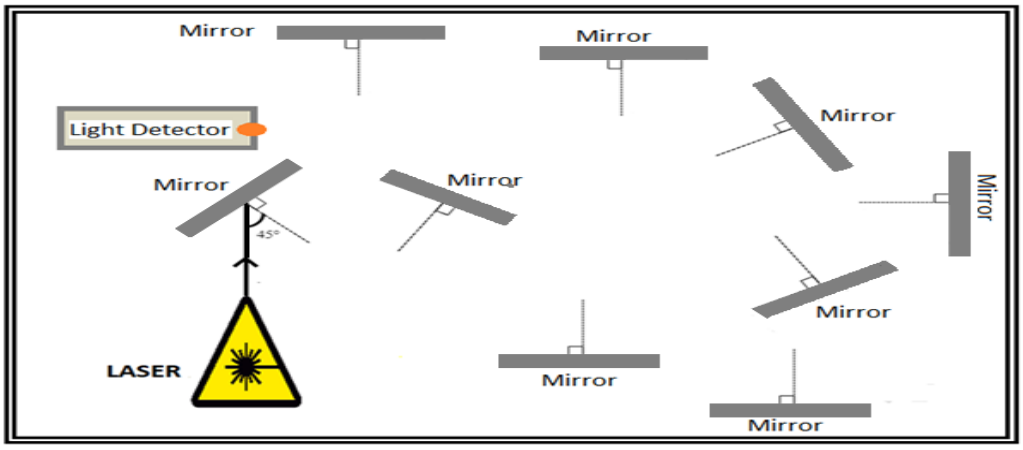
Let's see if you have mastered the concept. Can you work out the reflections to show the path taken by the laser for it to be detected?

Note:

Not all mirrors are used

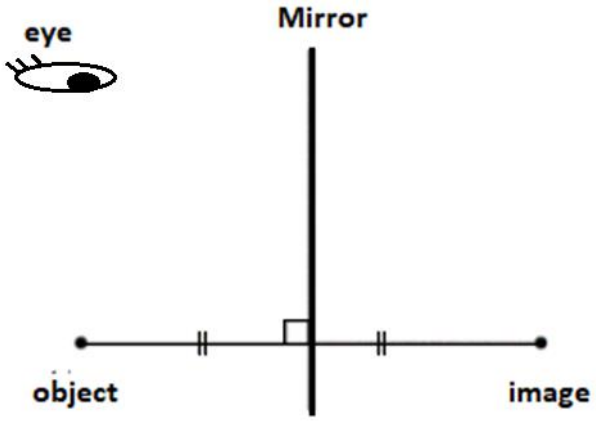
Write on the angle of incidence and reflection per mirror used.

Draw arrows to show the direction of the laser.



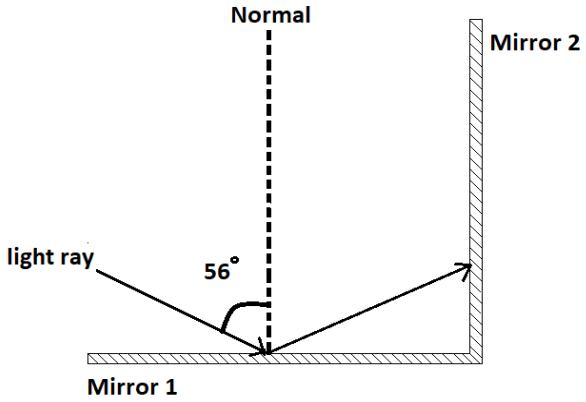
Activity 1.2 Locating the Image in a Plane Mirror

Here, you have a plane mirror and a point image. Draw the ray diagram to show how our eyes see point objects.



Activity 1.3 Mirror, Mirror on the wall...

Two plane mirrors are positioned perpendicular to each other as shown below. A ray of light is incident to mirror 1 with an angle of incidence of 56˚. This ray was then reflected and stroke mirror 2.



What is the angle of reflection in mirror 1? _____

What is the angle of incidence in mirror 2? _____

On the diagram use a ruler to draw the reflected ray in mirror 2.

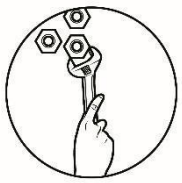
What is the angle of reflection in mirror 2? _____

What I Have Learned

1. The assumption that light travels in a straight line is the basis of the *Ray model of light.*
2. The straight-line path traversed by light is called a *ray.*
3. A light ray approaching the surface is *incident ray* while the light leaving the surface is called *reflected ray*.
4. The normal line is the imaginary line drawn from the point of incidence perpendicular to the surface that bisects the diagram into two equal parts.
5. The angle an incident ray makes with the normal is called the *angle of incidence.*
6. The angle the reflected ray makes with the normal is called the *angle of reflection*
7. The *Law of Reflection* states that the angle of incidence is equal to the angle of the reflected ray

   The mathematical representation of the law of reflection is $\theta_r = \theta_i$

8. *Diffuse reflection* is when light is incident upon a rough surface and is reflected in many directions creating a hazy and not so clear image of the object.
9. *Specular reflection* occurs when light is incident upon a smooth surface and angle is reflected on the same angle creating a clear and precise image of the object.
10. *Mirrors* are good example of reflecting devices.
11. The image is formed because of reflection.



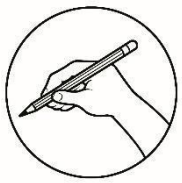
What I Can Do

Now that you have learned the concept of reflection, it's your turn to apply what you have learned. Answer the following questions using your understanding of the reflection of light.

1. How will you use the Law of reflection to show how image forms on a plane mirror? _____
   _____
   _____
   _____

2. Why do you think you see a full image of yourself when you look at the mirror but you cannot see a reflection of yourself when you look at a book?
   _____
   _____
   _____
   _____

3. Do you think the law of reflection supports the wave theory or the particle theory of light? Explain your answer. _____
   _____
   _____
   _____

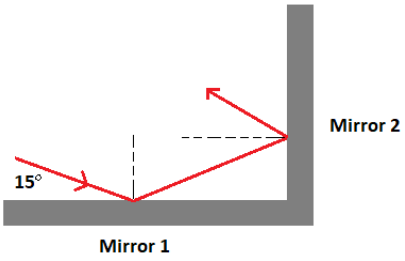


Assessment

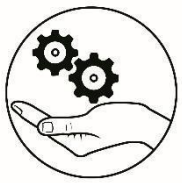
Multiple Choice. Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. What do you call the phenomenon by which the incident light falling on the surface is sent back into the same medium?
    A. Absorption
    B. Reflection
    C. Polarization
    D. Refraction
2. What angle is formed by an incoming ray with the normal?
    A. Angle of reflection
    B. Angle of refraction
    C. Angle of incidence
    D. Angle of equivalence
3. Which statement best describes the "Law of reflection"?
    A. The angle of incidence is equal to the angle of reflection
    B. The angle of reflection is perpendicular to the normal.
    C. The angle of reflection is parallel to the angle of incidence
    D. Both the angle of incidence and reflection lie in different planes.
4. What type of reflection is produced by rough surfaces?
    A. Total internal reflection
    B. Dispersion
    C. Diffuse reflection
    D. Specular reflection
5. Which of the following best describes a *Normal* line?
    A. The path is taken by the rays of light as it approaches the surface
    B. Line parallel to the incident and reflected ray
    C. An imaginary line is drawn perpendicular to the reflecting surface
    D. The total distance traveled by light upon reflecting
6. Which of the following pairs perfectly describes the reflection produced by a smooth surface?
    A. Diffuse reflection: clear and vivid
    B. Diffuse reflection: unclear and vague
    C. Specular reflection: unclear and vague
    D. Specular reflection: clear and vivid

7. An incoming ray of light strikes the mirror at an angle of 30˚ relative to the normal. What is the angle between the incident ray and the reflected ray?
    A. 15 ˚
    B. 30 ˚
    C. 60 ˚
    D. 90 ˚
8. A ray of light strikes a polished surface at an angle of 37˚. What is the angle of reflection and location of the reflected ray?
    A. 37.0˚ on the same side with the incident ray
    B. 37.0˚ on the other side of the normal line
    C. 53.0˚ on the same side with the incident ray
    D. 53.0˚ on the other side of the normal line
9. Two flat mirrors are perpendicular to each other as shown in the figure. An incoming beam of light makes an angle of 15˚ with the first mirror. What angle will the outgoing beam make with the second mirror?



    A. 15 ˚
    B. 30 ˚
    C. 75 ˚
    D. 90 ˚
10. The angle between a horizontal ruler and a vertical plane mirror is 30◦. What is the angle between the ruler and its image?
    A. 90˚
    B. 60˚
    C. 30˚
    D. 15˚



Additional Activities

Draw my rays

You will need your drawing materials to complete this task.

Column A gives you the important concepts of reflection of light. In Column B, draw how the concept can be represented.

Concept	Drawing/Illustration
Specular Reflection: Occurs when light rays reflect on a smooth surface at the same angle	
Diffuse reflection: Occurs when light rays reflect on a rough surface at many different angles	
Angle of incidence: The angle between the incoming rays and the normal	
Angle of reflection: The angle between the reflected rays and the normal.	

Answer Key

What I Know	What's More	Assessment
C A B A D B C D C C		B D A C C D C D C B

References

Salreid. “Reflection.” TES Resources. Accessed November 5, 2019. https://www.tes.com/teaching-resource/reflection-6191696.

WonderCaliban. “Reflection of Light - Mirror Maze.” TES Resources. Accessed November 5, 2019. https://www.tes.com/teaching-resource/reflection-of-light-mirror-maze-6325368.

Maarseveen, Van. “Plane Mirror Reflection Worksheet - .” studylib.net. Accessed November 5, 2019. https://studylib.net/doc/7543104/worksheet---van-maarseveen.

Erhgiez. “Law of Reflection Investigation DCJSSS.” TES Resources. Accessed November 5, 2019. https://www.tes.com/teaching-resource/law-of-reflection-investigation-dcjsss-6162626.

Admin, and Admin. “Snell's Law Archives - Page 2 of 3.” Regents Physics, April 21, 2015. https://aplusphysics.com/wordpress/regents/tag/snells-law/page/2/.

“The Physics Classroom Tutorial.” The Physics Classroom. Accessed November 5, 2019. https://www.physicsclassroom.com/class/refln/u13l1d.cfm.

Giancoli, Douglas C. Physics: Principles with Applications. Singapore: Pearson Education South Asia Pte Ltd, 2016.

Hewitt, Paul G. Conceptual Physics. San Francisco: Pearson/Addison-Wesley, 2006.

For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph