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Program Support Notes

29 mins

The Physics of Light

Program Support Notes by ***John Nicholson,***
B Sc (Hons), Dip Ed, Ph D (La Trobe); Grad Dip Comp Ed, M Ed (Melbourne)

Produced by ***VEA Pty Ltd***
Commissioning Editor ***Sven Shepherd*** B.Ed.
Executive Producer ***Simon Garner*** B.Ed.

Suitable for:

Physics

To order or inquire please contact VEA:

VEA (Video Education America)
6902 Hawthorn Park Dr
Indianapolis, IN 46220
Tel 1.866.727.0840
Fax 1.866.727.0839

E-mail
orders@veavideo.com

Website
www.veavideo.com

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Introduction

This program introduces the topic of light as a wave, and explores the properties of light using the wave model. These include propagation, reflection, and refraction. These properties are used to explain such phenomena as total internal reflection and its use with fiber optics in communication and optical instruments such as endoscopes.
The program explores propagation, reflection, refraction using a wave model including the wave equation $v = f \times \lambda$. The use of Total Internal Reflection (TIR) is demonstrated with medical endoscopes. Lenses are demonstrated through the use of the Human eye. The color spectrum is explained and then demonstrated with rainbows with total internal reflection within raindrops.
In the program a presenter discusses and explores the concepts using simple graphics and demonstrations. Some use of actual endoscope video is used to demonstrate this technology.

Program Timeline

00:00:00	Copyright VEA Splash
00:00:00	Introduction
00:01:12	The facts about light waves
00:06:24	The basic properties of light waves
00:12:36	Light and lenses
00:18:41	Light and fiber optics
00:22:32	Light and Color
00:27:31	Conclusion
00:28:53	Credits
00:29:23	End Program

Website References

- http://www.gtc.iac.es/en/pages/multimedia.php
- http://eo.ucar.edu/rainbows/
- http://amazing-space.stsci.edu/resources/explorations/groundup/
- http://www.explainthatstuff.com/endoscopes.html
- http://theory.uwinnipeg.ca/physics/light/index.html

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Student Worksheet:

Before Viewing the Program

1. Name the colors of the rainbow in order as they appear in the spectrum.
2. Name possible "moods" associated with the following colors:
   - Red
   - Blue
   - Yellow
3. When you look in a mirror and raise your right hand, which hand does your image raise.
4. What is the fastest speed possible known to man?
5. When you look in to the bottom of a swimming pool does an object on the bottom of the pool look closer, further away or the correct distance from you?

While Viewing the Program

1. Circle the correct response. The wavelength of the visible spectrum of light is:

   400 → 700 micrometers 400 → 700 millimeters

   400 → 700 nanometers 400 → 700 centimeters

2. Circle the correct response. Hippolyte Fizeau carried out his experiment to find the speed of light in which year?

   1749 1949

   1849 2009

3. Name three of the five elements of a light wave as given in this program.

   _____

   _____

   _____

4. In reflection the angle between the Normal Ray and the surface is _____ .

5. The law of Reflection states that the angle of incidence is equal to the angle of …?

   _____

6. Circle the correct response. In refraction the light ray is bent towards the normal when the speed of light in the incident medium is:

   Faster than in the refracting medium Slower than in the refracting medium

   Of equal speed to that in the refracting medium

7. Circle the correct response. Who discovered the law stated in question 6?

   Snell Newton Einstein

8. Circle the correct response. A convex lens:

   Spreads light out Concentrates light to a focused point

   Uses reflection to bend the light

9. Circle the correct response: A concave lens

   Spreads light out Concentrates light to a focused point

   Uses reflection to bend the light

10. Circle the correct response. In bright light the pupil in your eye will:

    Shrink Dilate Stay the same size

11. Circle the correct response. Rods and cones are found in the retina of the eye. There are approximately:

    Six million rods and twenty million cones in your retina.

    Sixty million rods and twenty million cones in your retina.

    Six million cones and twenty million rods in your retina.

12. Circle the correct response. The transmission of light energy by Optical fiber relies on:

    Total Internal Reflection (TIR) of light to transmit light energy.

    Total Internal Refraction (TIR) of light to transmit light energy.

    Total Internal Deflection (TID) of light to transmit light energy.

13. Name the three things that medical endoscopes provide:

    _____

    _____

    _____

14. Circle the correct response. LED stands for:

    Long Eye Dudes. Light Enduring Diodes. Light Emitting Diodes.

15. Circle the correct response. LED's give out light when:

    Electrons combine to give off light energy.

    Negative holes and positive electrons combine giving off light energy.

    Positive holes and negative electrons combine giving off light energy.

16. Why is it not possible to find a 'pot of gold' at the "end" of a rainbow?

    _____

    _____

    _____

17. Circle the correct response. Which famous Physicist demonstrated the splitting of white light into the colors of the spectrum, and, even more cleverly showed, that by re-combing colored light he recreated white light?

    Einstein. Snell. Galileo. Newton

After Viewing the Program

1. Think of your own mnemonic that helps to remember the order of colors in the Rainbow.

   Red Orange Yellow Green Blue Indigo Violet (ROYGBIV)

2. Use a white light source and a prism to create rainbows.

3. Use three white light sources and three colored filters (colored plastic) one red, one blue and one green, to mix light and recombine the three colors (RGB) into white light.

4. Look carefully into a television screen to see that the picture is made up of only three colors (RGB) mixed to make up a full color spectrum (ROYGBIV)

5. Look through a microscope, a telescope or a magnifying glass to experience the different effects of lenses.

6. Place a pencil in a glass of water and recreate refraction as shown in the program.

Suggested Student Responses

While Viewing the Program

1. Circle the correct response. The wavelength of the visible spectrum of light is:

   400 → 700 micrometers 400 → 700 millimeters

   400 → 700 nanometers 400 → 700 centimeters

2. Circle the correct response. Hippolyte Fizeau carried out his experiment to find the speed of light in which year?

   1749 1949

   1849 2009

3. Name three of the five elements of a light wave as given in this program.
   Longitudinal or transverse
   Wavelength
   Amplitude
   Frequency
   Speed

4. In reflection the angle between the Normal Ray and the surface is **90^{o}**.

5. The law of Reflection states that the angle of incidence is equal to the angle of …?
   Reflection

6. Circle the correct response. In refraction the light ray is bent towards the normal when the speed of light in the incident medium is:

   Faster than in the refracting medium **Slower than in the refracting medium**

   Of equal speed to that in the refracting medium

7. Circle the correct response. Who discovered the law stated in question 6?

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8. Circle the correct response. A convex lens:

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11. Circle the correct response. Rods and cones are found in the retina of the eye. There are approximately:

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    Sixty million rods and twenty million cones in your retina.

    Six million cones and twenty million rods in your retina.

12. Circle the correct response. The transmission of light energy by Optical fiber relies on:

    Total Internal Reflection (TIR) of light to transmit light energy.

    Total Internal Refraction (TIR) of light to transmit light energy.

    Total Internal Deflection (TID) of light to transmit light energy.

13. Name the three things that medical endoscopes provide:
    Better navigation
    High quality pictures
    Smaller wounds

14. Circle the correct response. LED stands for:

    Long Eye Dudes. Light Enduring Diodes. **Light Emitting Diodes.**

15. Circle the correct response. LED's give out light when:

    Electrons combine to give off light energy.

    Negative holes and positive electrons combine giving off light energy.

    Positive holes and negative electrons combine giving off light energy.

16. Why is it not possible to find a 'pot of gold' at the "end" of a rainbow?
    A rainbow does not exist at a particular location in the sky rather its apparent position depends on the relative positions of the observer, the rain drops and the sun.

17. Circle the correct response. Which famous Physicist demonstrated the splitting of white light into the colors of the spectrum and even more cleverly showed that by re-combing colored light he recreated white light?

    Einstein. Snell. Galileo. **Newton**