Reflection – wave or particle

Teacher Notes (with answers)

7 8 9 10 11 **12**

TI-Nspire | Navigator | Student | 30min

Introduction

Which model, particle or wave, provides the best representation for the behaviour of light? History is scattered with famous mathematicians and philosophers (Physicists) that have supported either the wave or particle model for light; Isaac Newton, Rene DesCartes, Robert Hooke, Augustin-Jean Fresnel, Christiaan Huygens, James Clerk Maxwell and Thomas Young to name a few. This investigation looks at the subject of reflection to see if it is best suited to a particular model. The purpose of a model is to provide a tool to help conceptualise what is happening and potentially predict other behaviour, most models however have their limitations.

This activity can be run without Navigator; however one of the purposes of the activity is to check if the student's view changes as a result of completing the activity. Questions exist in the document and can be recalled and student responses checked and summarised at the conclusion of the activity.

If the TI-Navigator is being used with this activity, send the file to students. The question can be copied and used as a quick poll prior to the activity to gain the view of all students initially.

If this activity is being conducted without the TI-Navigator system, files can be transferred using the Transfer Tool in the teacher software or it can be used as a demonstration tool for the whole class.

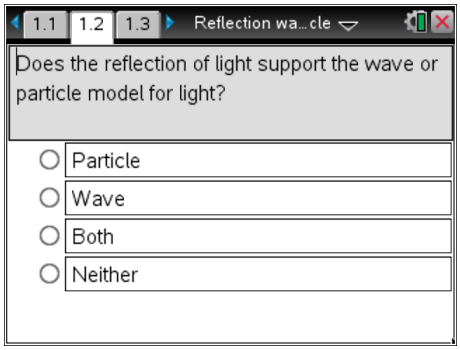
Answers provided in this document should be used as a guide.

Time for Reflection

In this activity the reflection of light is examined to see how well the wave and particle models accommodate observations.

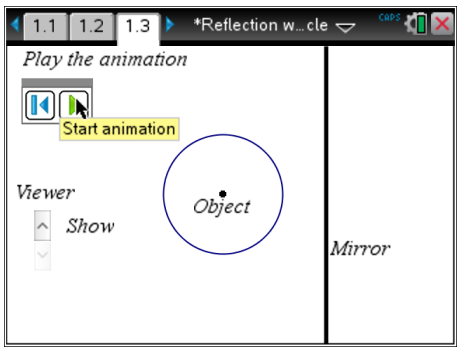
Open the TI-Nspire file: **Reflection Wave or Particle**

Navigate to page 1.2 and respond to the question, select your response by pressing enter. Your teacher will collect your response later. The purpose of this initial question is to establish your current view.



Author: P Fox

Navigate to page 1.3 to investigate the interactive model available for the reflection of an object in a mirror.



The animation shows an object with a wave (circle) moving away from the object in much the same way as ripples move outward from a disturbance in a pond. This wave represents the movement of light coming from the object travelling out in all directions.

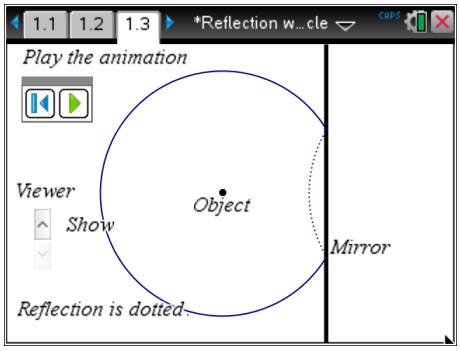
Click on the animation button to observe the wave as it progresses towards the mirror.

The animation provides an accurate representation of the reflection of a circular wave striking a reflective surface. There are also photographs on the web that show 'ripple tank images':

http://www.vias.org/physics/bk3_04_02.html

While there are numerous applets on website that provide a similar animation to the one provided in this activity, this version is particularly convenient as it is not blocked by school servers... because its on a calculator!

Once the wave hits the mirror it is reflected back. Allow the animation to continue, it will restart once the wave becomes too big to display.



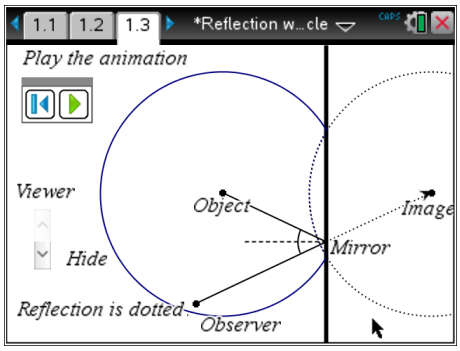
Once you have finished observing the wave, click on the pause button.

Question 1. Does the reflection accurately model how a wave is reflected when it strikes a wall?

Yes... The reflected wave looks just like one produced in a ripple tank or other body of water.

Extended Answer: Consider the wave as an infinite set of points, as each point strikes the wall it is reflected back such that the angle of incidence is equal to the angle of reflection.

The next thing to consider is whether this model describes how light behaves when it is reflected from a surface.

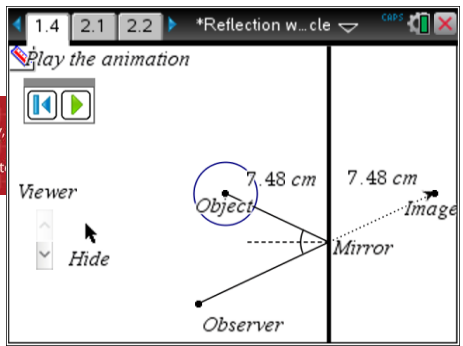


To see a more familiar diagram of the reflection of light add in the viewer by clicking on the show option next to 'Viewer'.

The position of the viewer can be changed by dragging the point to a new location. The normal to the mirror is shown as a dotted line and the apparent location of the wave source is shown as 'image'.

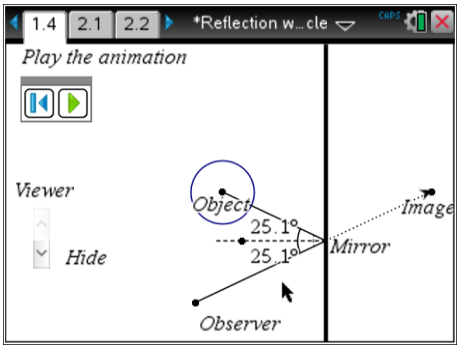
Note: The animation is still available whilst the viewer is displayed.

Question 2. Is the image located the same distance from the mirror as the object?



Distances can be measured using the measurement tools.
Yes... Using the measurement tools the image is located the same distance from the mirror as the object. When the object is move the image moves accordingly maintaining an equal distance.

Question 3. Is the angle between the incident light ray and the normal the same as the angle between the reflected ray and the normal?
Angles can be measured using the measurement tools.
Yes... Using the measurement tool the angle between the incident ray and the normal is equal to the angle between the reflected ray and the normal, regardless of where the object is placed.



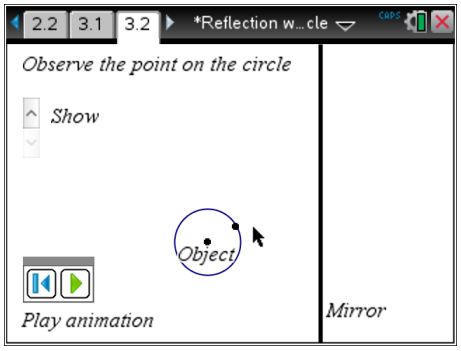
Question 4. Explain how the reflected wave can be used to locate the image.
The reflected wave is also circular in shape, the centre of the reflected wave represents the apparent origin of the light source, the virtual image.

Question 5. Does the wave model accurately replicate the reflection of light?
The circular wave represents light travelling out in all directions from the object. When the light strikes a smooth surface the reflected wave appears to be centred at the appropriate location of the image. This is an accurate representation of the reflection of light.

Navigate to page 3.1, read the instructions and then move to page 3.2.

Activate the animation button and observe the movement of a point (particle model) that is located on a wave propagating from the object.

To see this from a viewer's perspective click on the 'show' option.



Question 6. In this animation the particle appears to be 'riding the crest of a wave'. In the context of this animation, explain the 'duality' principal in reltaion to the reflection of light from a mirror (smooth surface).
The wave can be considered as many points travelling out in all directions. The point in this animation is positioned on the wave, however if the wave were removed from the animation it would represent the particle model. Both models appear to accurately represent the reflection of light... so both models are acceptable (dual).

Question 7. What would it mean practically if a different point on the wave was displayed?
A different point on the wave will reflect to a different location so that an observer at that location would see the reflected light. Regardless of where this point is on the wave, it appears to come from the same location (image) which is consistent with the reflection of light.