VANIER COLLEGE

420-204-RE

Section 00002

Integrative Project in Computer Science and Mathematics

User Guide

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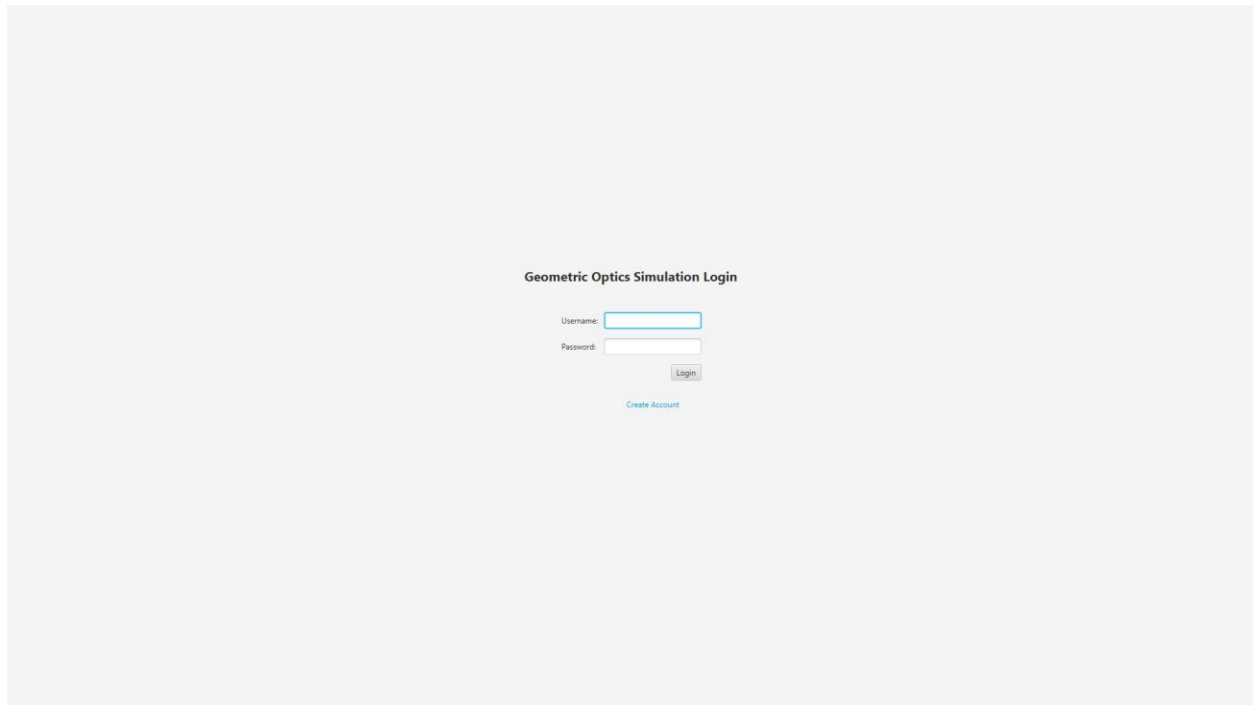Farhan Haque -6231353
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Table of Content

Program Description

The Geometric Optics Simulator is an educational tool designed to help students better understand and visualize fundamental concepts in geometric optics. Aimed at people who struggle with abstract optical concepts, the simulator features four interactive scenes, each dedicated to a specific topic. The first is an Education Scene, where users can quiz themselves with questions to reinforce their theoretical knowledge. The second is a Refraction Scene that visually demonstrates how light bends when transitioning between different materials, complete with real-time animations. The third, the Lens Scene, allows users to simulate thin lenses by adjusting parameters such as focal length and object distance; it also supports multi-lens configurations for more advanced simulations. The final Mirror Scene provides animations of concave and convex mirrors, giving users control over variables like mirror type, focal length, and object position. Overall, this software is designed to allow students to have hands-on experience whilst learning these concepts.

Display of the login page. Users can either sign in or create an account
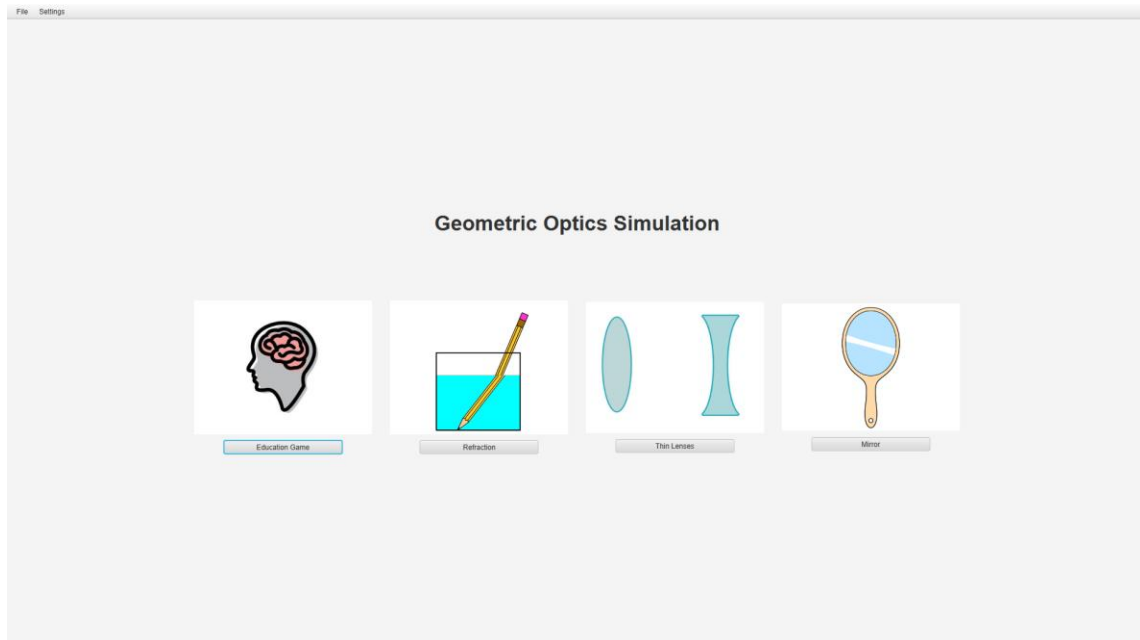

Display of the account creation page where the user can create a username and password which then allows to further proceed.
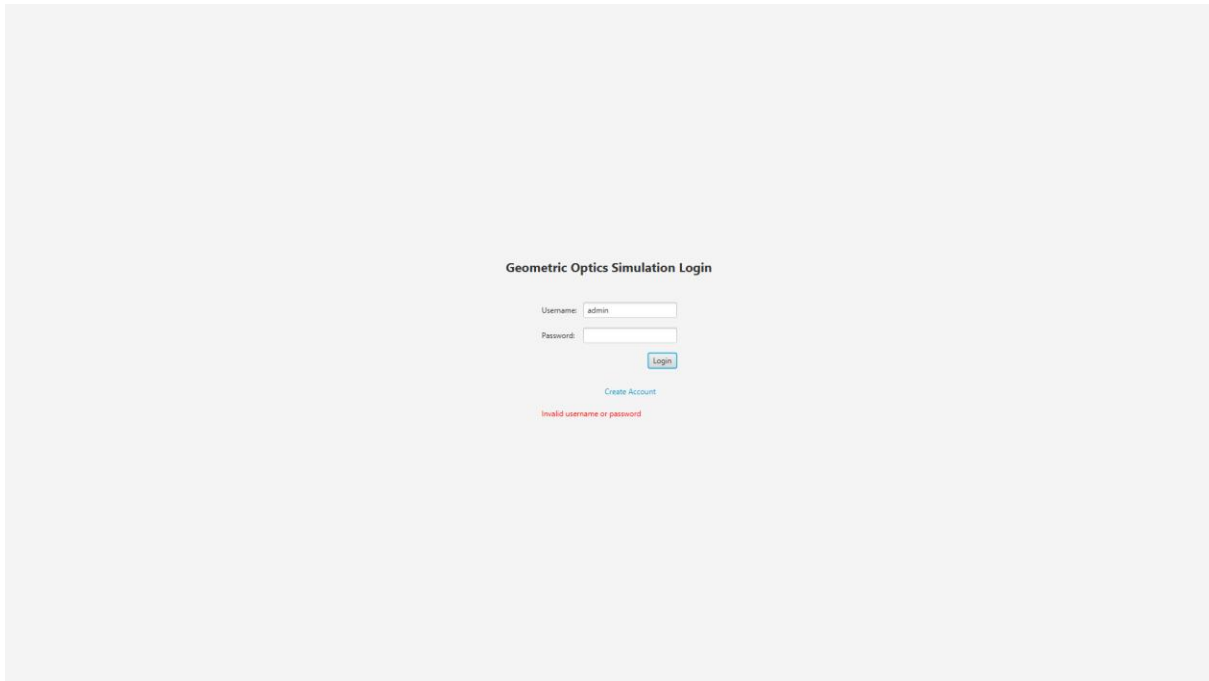
Display of the login page if the user puts an incorrect username or password

Display of the main page. The user has the option to go into four different scenes: Education Mode, Refraction, Thin Lenses and Mirror.
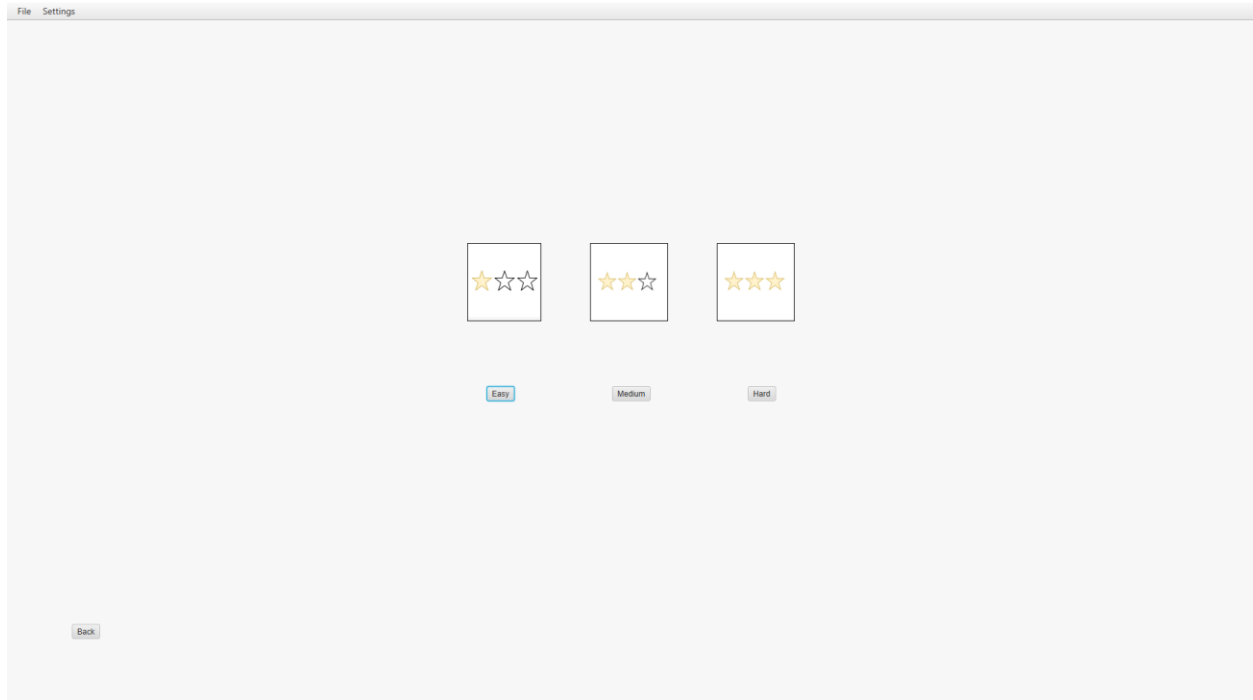
Display the difficulty selection screen whenever a user enters the education mode, they can choose between easy, medium and hard.
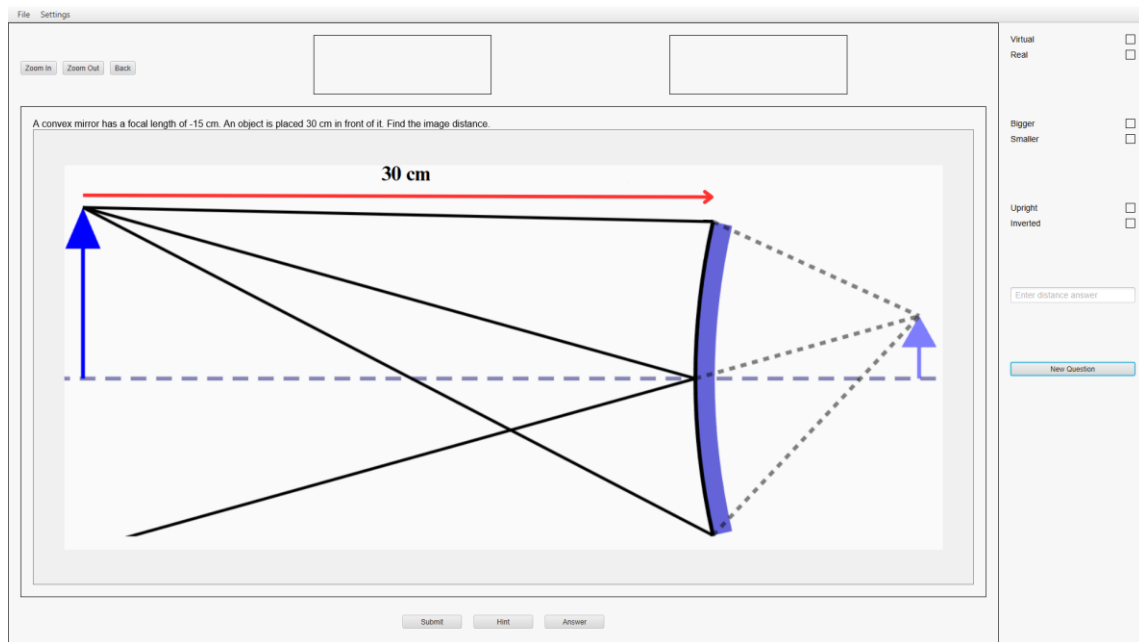
Wherever users enter a difficulty of the education mode they are presented with a randomly selected question from a bank of questions.

File   Settings

Zoom In   Zoom Out   Back

Use the mirror equation: 1/f = 1/do + 1/di (remember f is negative for convex mirrors)

Answer:-10 cm,virtual,smaller,upright

Virtual ☐
Real ☐

Bigger ☐
Smaller ☐

Upright ☐
Inverted ☐

Enter distance answer

New Question

A convex mirror has a focal length of -15 cm. An object is placed 30 cm in front of it. Find the image distance.

30 cm

Submit   Hint   Answer

Each question has a specific image to help users visualize the problem. Whenever they click the hint button, they are presented with a custom hint that helps the user solve that specific problem. If the user is not able to figure out the question, they can click the answer but see the solution.

File   Settings

Zoom In   Zoom Out   Back

Correct! Answer: -10 cm,virtual,smaller,upright

Virtual ■
Real ☐

Bigger ☐
Smaller ■

Upright ■
Inverted ☐

-10 cm

New Question

A convex mirror has a focal length of -15 cm. An object is placed 30 cm in front of it. Find the image distance.

30 cm

Submit   Hint   Answer

Each question has a different answer type, in this case, the user can write their answers in the Text Field and choose between the selection of buttons. Whenever the user gets the correct answer, the text appears green.

File   Settings

Zoom In   Zoom Out   Back

Incorrect image type. Incorrect size.

Virtual ☐
Real ■

Bigger ■
Smaller ☐

Upright ■
Inverted ☐

-10 cm

New Question

A convex mirror has a focal length of -15 cm. An object is placed 30 cm in front of it. Find the image distance.

30 cm

Submit   Hint   Answer

When the user gets the answer wrong, it shows what exact part of the solution is incorrect.

File   Settings

Zoom In   Zoom Out   Back

Virtual ☐
Real ☐

Bigger ☐
Smaller ☐

Upright ☐
Inverted ☐

Enter distance answer

New Question

A converging lens of focal length 5 cm is used as a magnifier. If the object is placed at 3 cm, find the image distance.

3 cm

5 cm

Submit   Hint   Answer

Example question that could appear in medium difficulty.

Example question that could appear in hard difficulty.
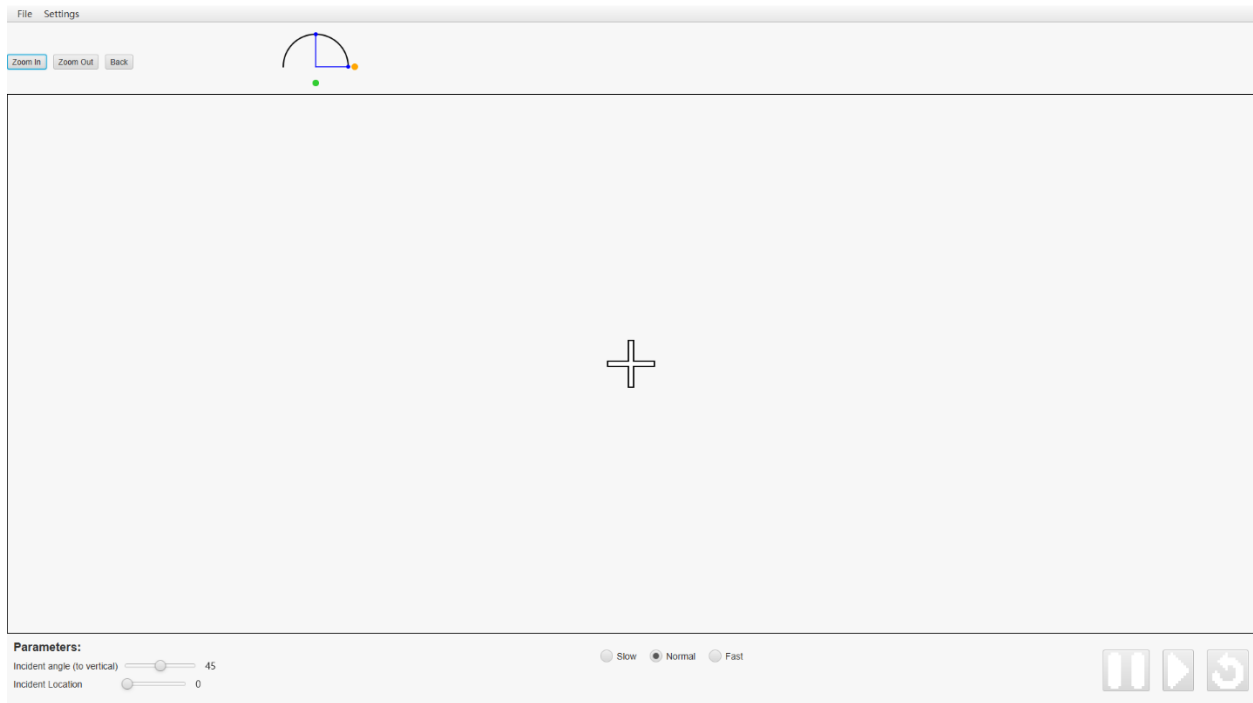
Display of Refraction Scene
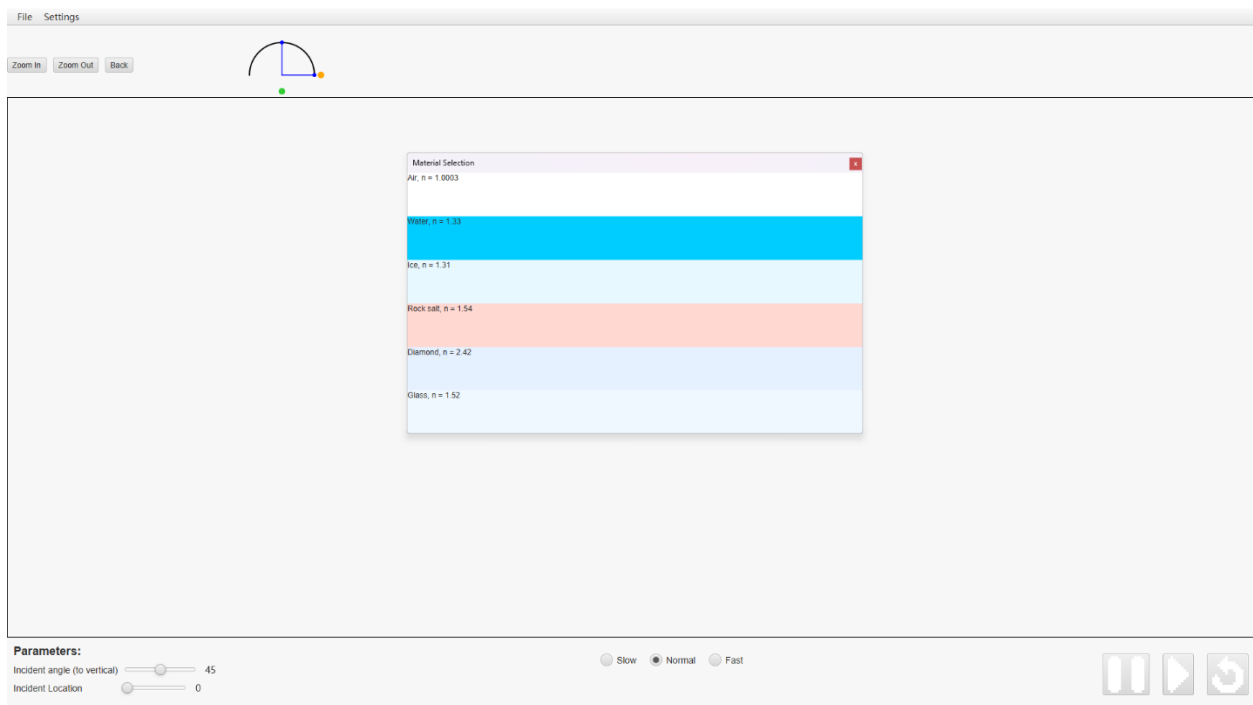
Click the plus button to add new layers (max 3)

Rock salt, n = 1.54

Glass, n = 1.52

Air, n = 1.0003

Parameters:
Incident angle (to vertical) —————○——— 45
Incident Location ○——————— 0

○ Slow ● Normal ○ Fast

Rock salt, n = 1.54

Glass, n = 1.52

Air, n = 1.0003

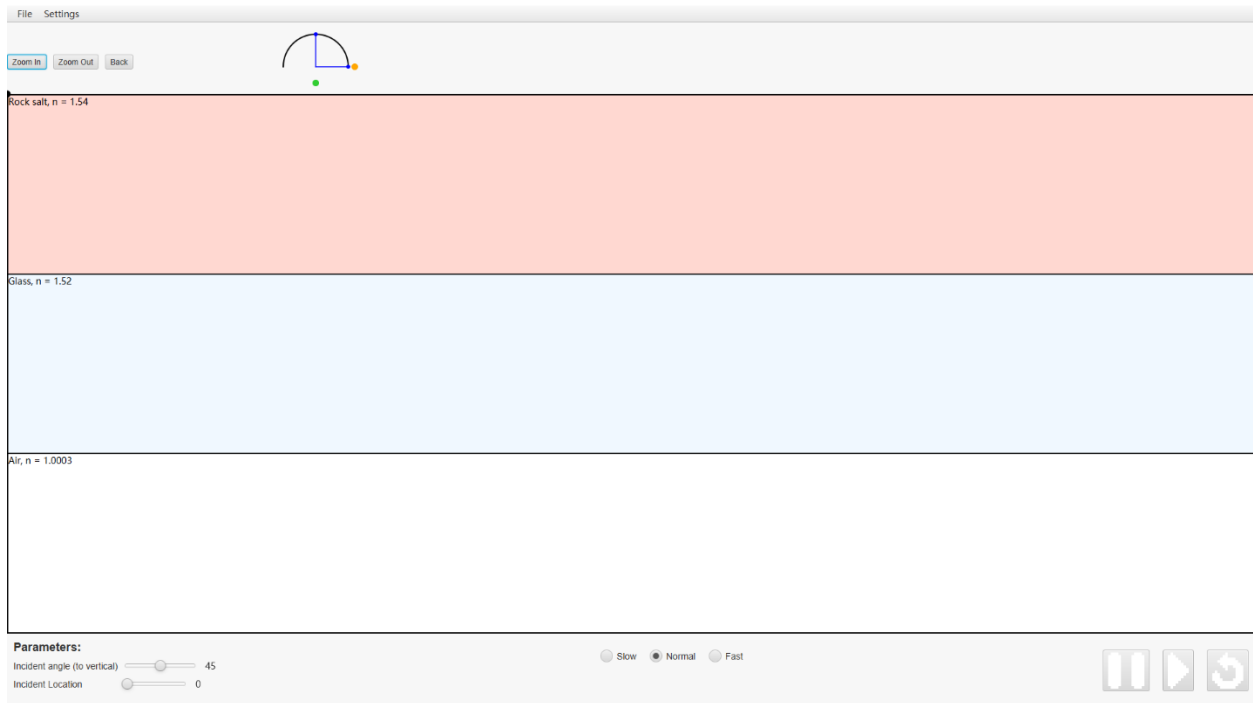**Parameters:**
Incident angle (to vertical) ═════○═══ 52.5
Incident Location ═○══════ 310

○ Slow ● Normal ○ Fast

Use the slider at bottom left to adjust the initial position and initial angle of the object
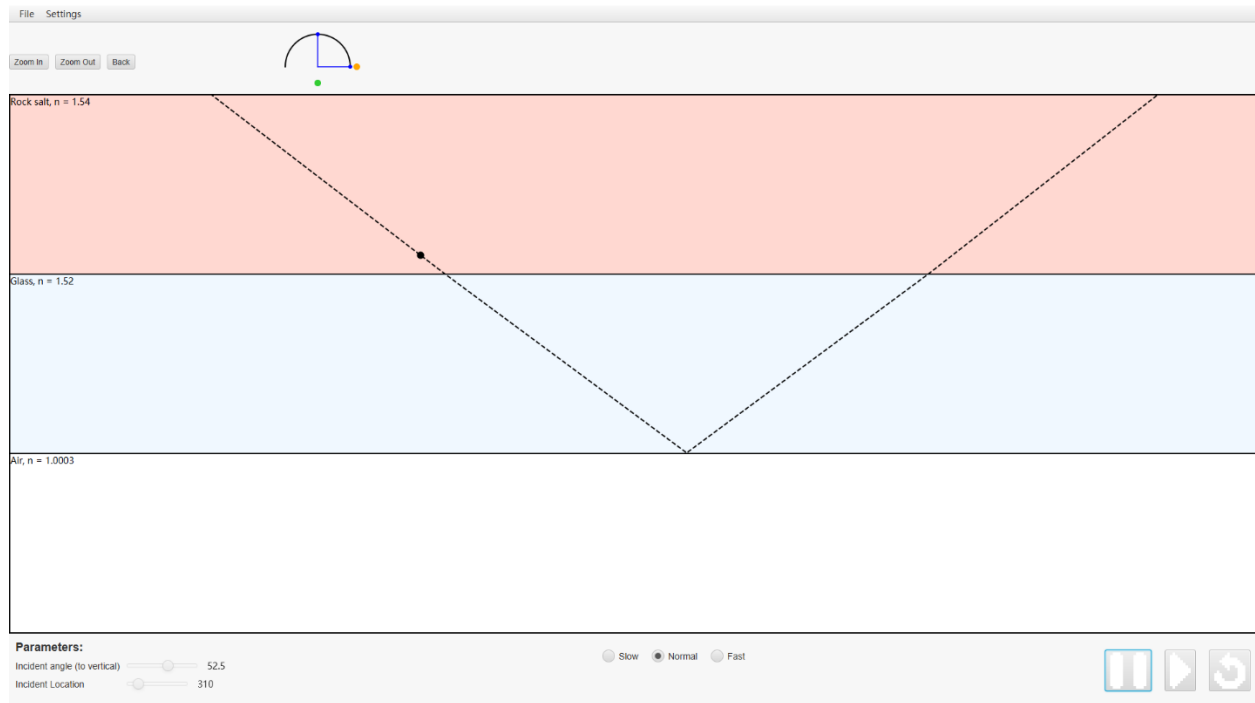
On the bottom right, stop button, start button and refresh button

In the bottom middle of the page there are three radio buttons that allow users to adjust the speed of animation
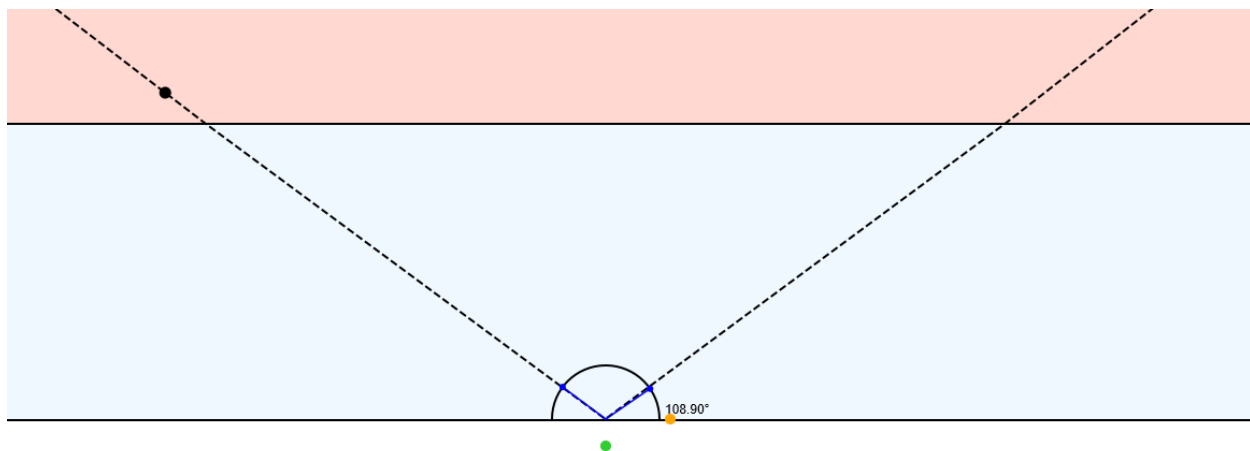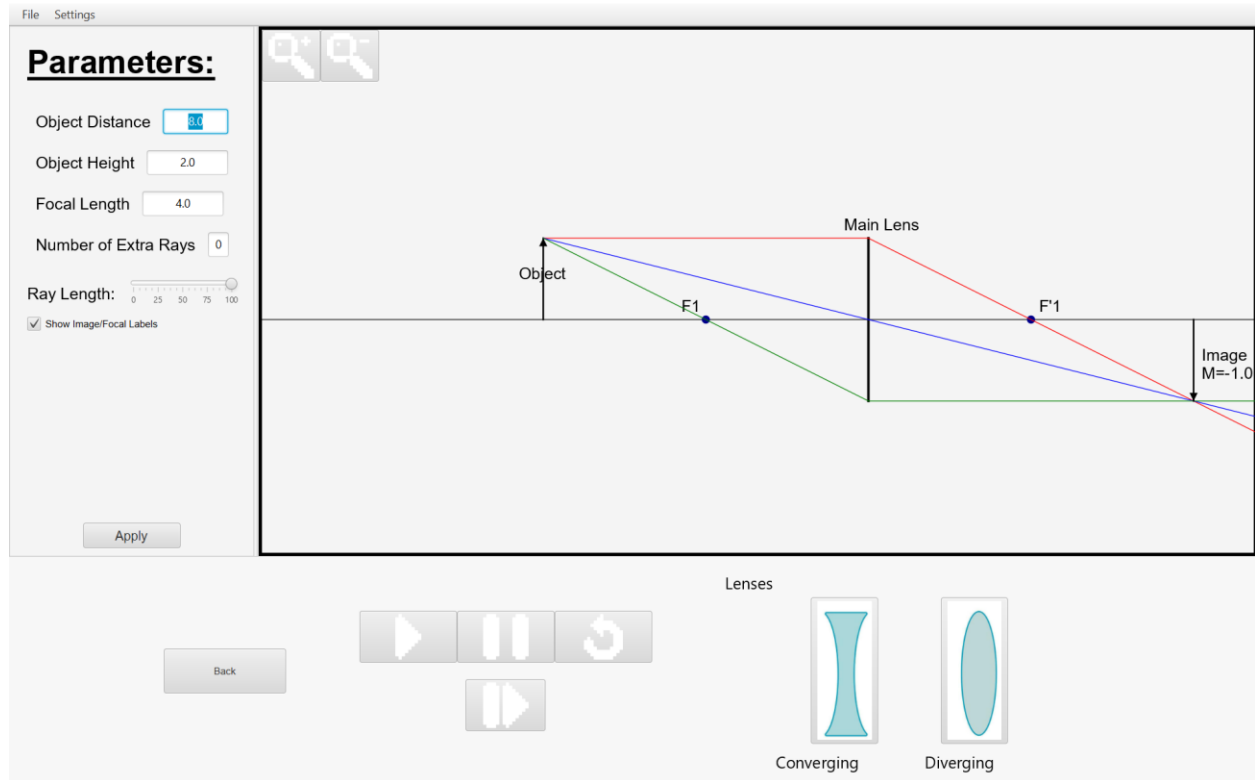
One audio is played when the animation starts. Another audio is played when the animation finishes.

108.90°

A protractor that can be dragged and rotated that measures the angle between two lines

Thin Lenses Screenshots

Display of Thin Lenses scene.

Contains a parameter pane, an animation pane and a bottom control pane. The parameter pane and animation pane are inside of a split pane to enable the user to shift the size of either pane.

Parameters:

Object Distance   8.0

Object Height   2.0

Focal Length   4.0

Number of Extra Rays   0

Ray Length: 0   25   50   75   100

☑ Show Image/Focal Labels

Apply

Parameter pane serves as the UI for configuring the lens simulation.

- *Object Distance determines how far the object is from the main lens.*
- *Object Height determines the height of the object.*
- *Focal length determines the optical power of the main lens. Positive makes the lens convergent and negative makes it divergent.*
- *Number of rays determines how many extra orange rays go from the first object to the first image only.*

- *Ray length slider has the option between 0 and 100. At 0, the rays won't extend past where the important point they need to reach. Above 0 to 100, the rays extend.*
- *When adding converging or diverging lenses, a new table appears which lets the user change the new lens position and focal length for the lens.*

Object Height	2.0
Focal Length	4.0
Number of Extra Rays	0

Ray Length: 0   25   50   75   100

Converginglens #1   X

Position	10.0
Focal Length	4.0

Diverginglens #2   X

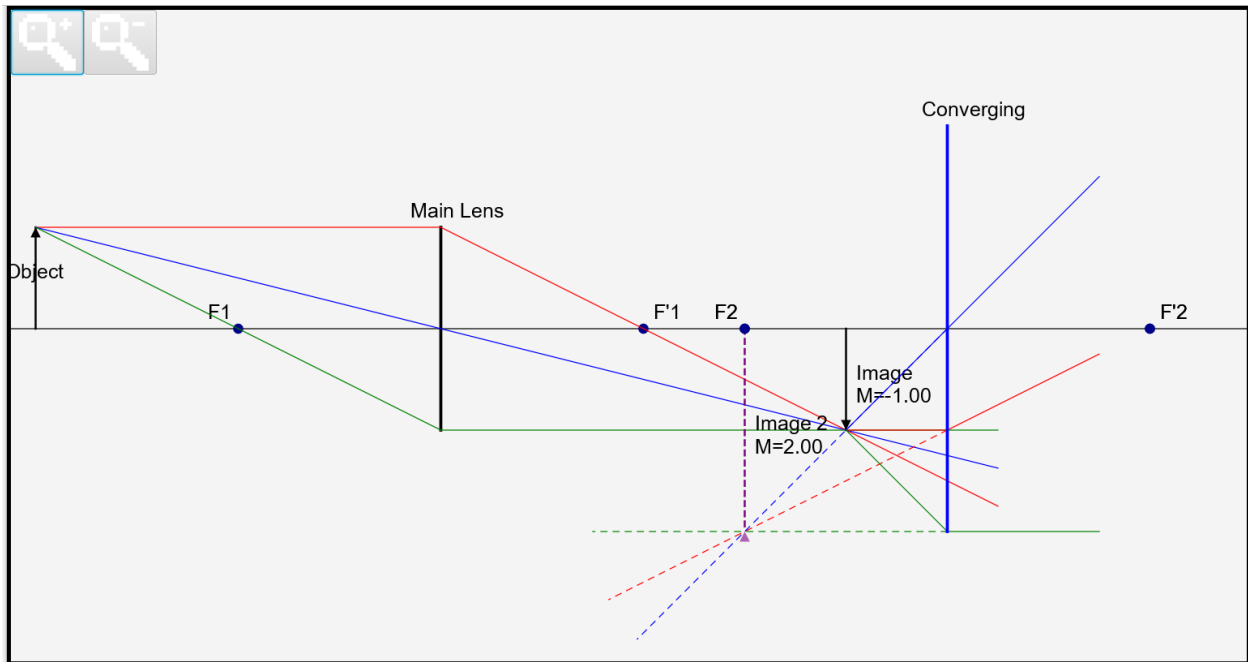| Position	10.0
Focal Length	-4.0

☑ Show Image/Focal Labels

Apply

Example of adding converging and diverging lens
- *Checkbox Image/Focal Labels turns on or off the labels in the animation pane*
- *Apply button remakes the lens system*

Example of a lens system in the animation pane with one converging lens at 10 units position right of the main lens and with a focal length of 4 units.

Animation pane features zoom buttons to zoom in or out the lens system, also includes a dragging feature to move the system.
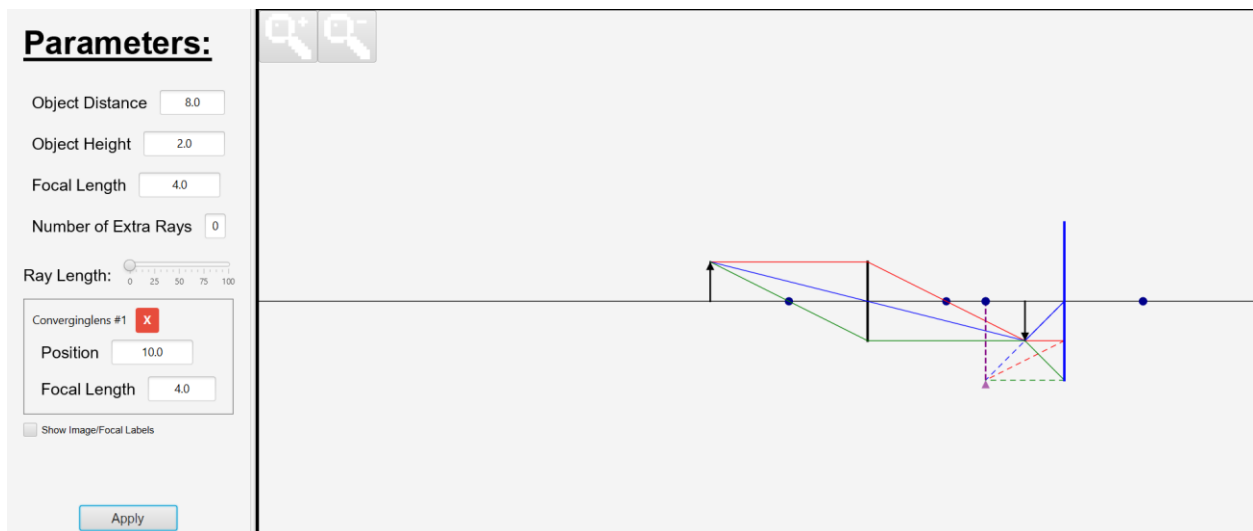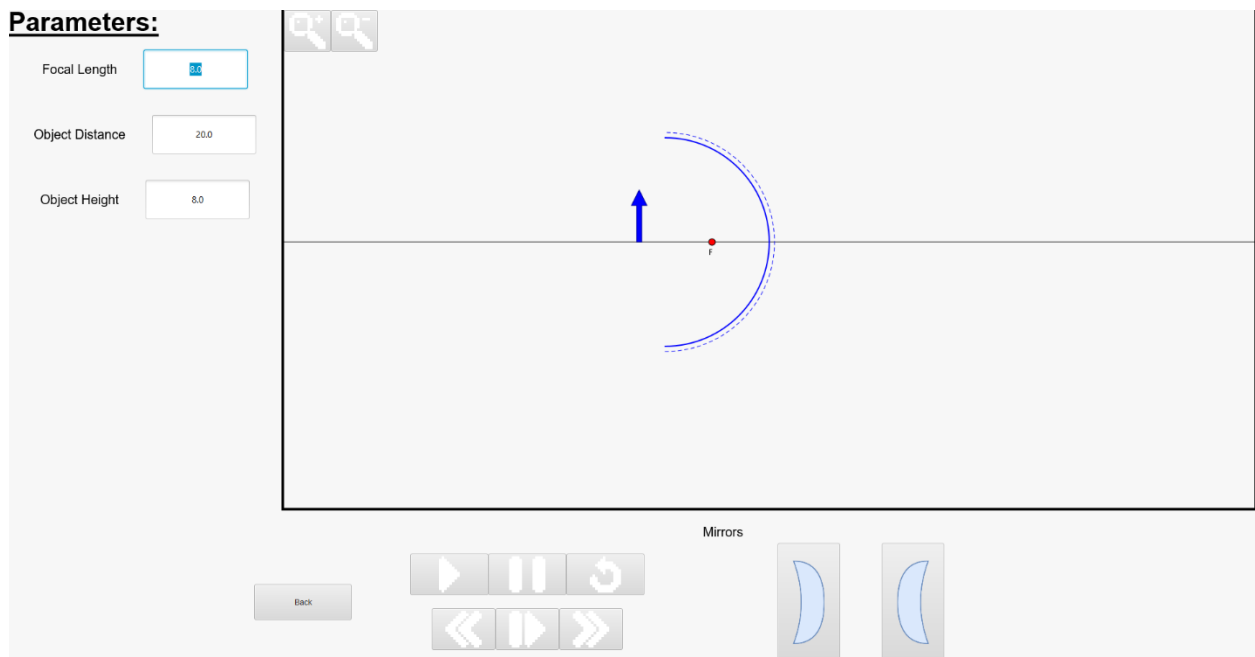

Example of the same lens system but zoomed out, labels hidden and ray length slider set to 0 instead of 100.

Bottom control pane. It contains a back button which leads back to the 4 choices scene. The 4 animation buttons are the play button, pause button, restart button and loop button.

Mirror Screenshots

Parameters:

Focal Length: 8.0

Object Distance: 20.0

Object Height: 8.0

Mirrors

Display of Thin Lenses scene.

Scene that contains the parameters of the mirror and the animation of how the rays travel when reflected from the mirror generating an animation the user can control.
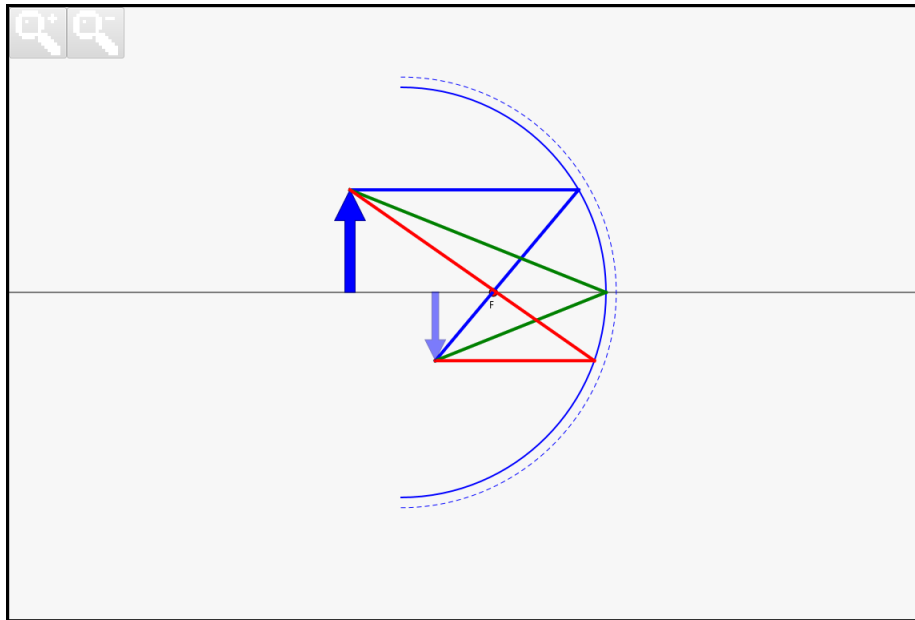
Mirror Animation Pane

A central pane that contains interactable buttons in the top right that allows you to increase or decrease the scale of the animation and the objects present in the scene. Furthermore, the scene contains an animation that displays the path taken by the rays generated by the object leading to the display of the image by the mirror.

Parameters:

Focal Length	8.0
Object Distance	20.0
Object Height	8.0

Mirror parameters Pane

The parameters available can change the animation leading to a change in where the image is generated. Some examples are the image being inverted, magnified or even generated at infinity.

-The focal length, adjust the size of the mirror and affects the equation $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ which alters the animation.

-The object distance affects the placement of the object in the scene and the equation ⍰

-The object height affects the length of the object and the equation $M = \frac{hi}{ho}$ which changes the magnification of the image generated.

*Mirror Animation parameters bottom pane*

-the back button allows users to return to the previous page to select a different scene
- the center section allows transformation of the animation, the top section play, pause and reset. While the bottom section is speed; each being slow, normal, fast (from left to right).
-The right section allows the user to change the mirror type updating the scene whenever selected changing the animation.
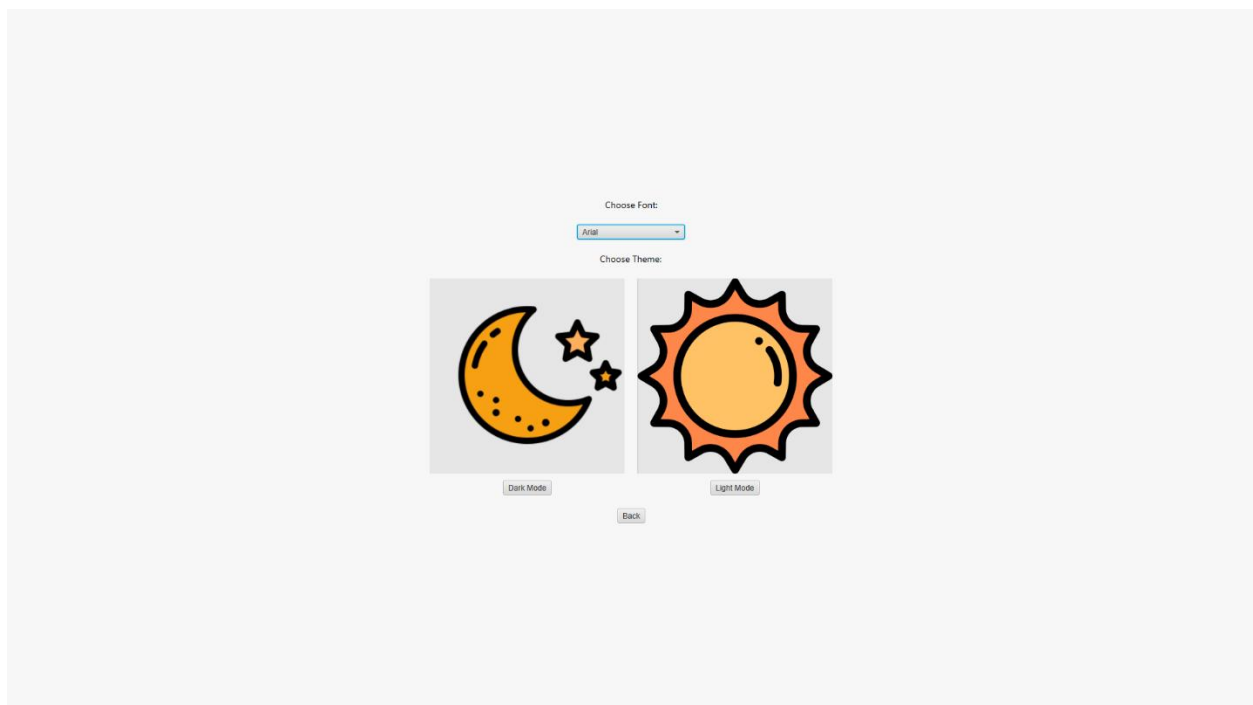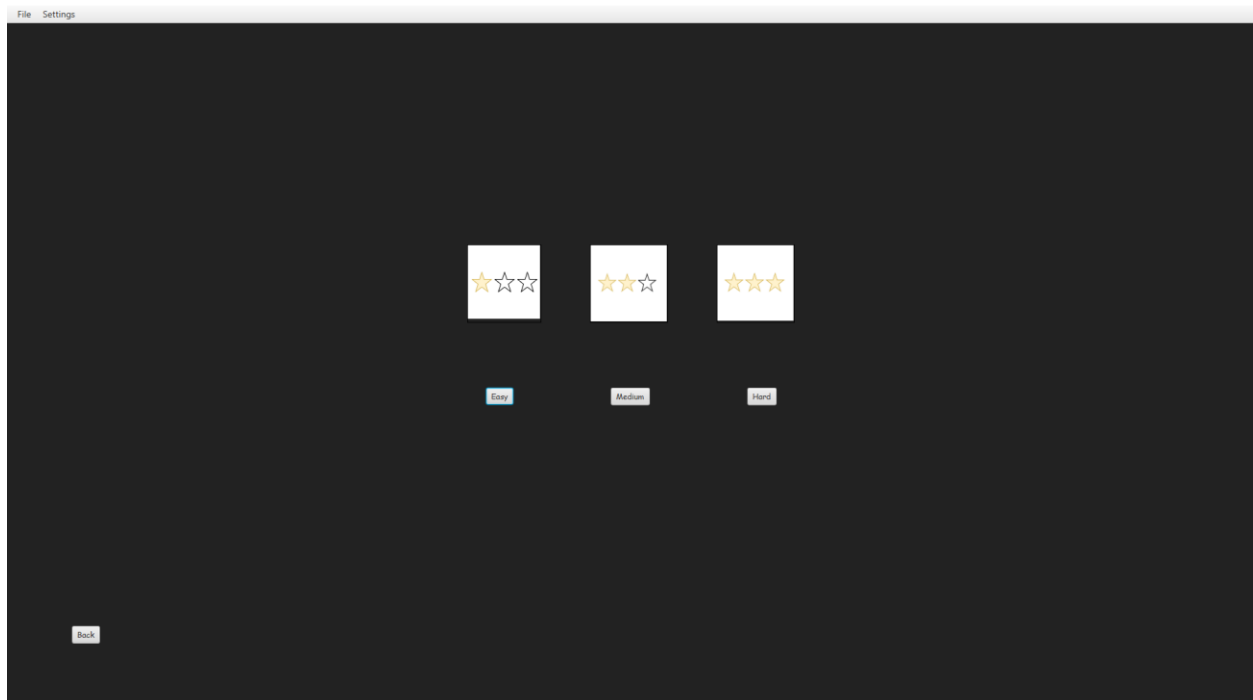
Display of the theme settings page where users can choose between dark mode and light mode (default). They can also choose between a variety of fonts including arial, comic sans, times new roman and verdana.
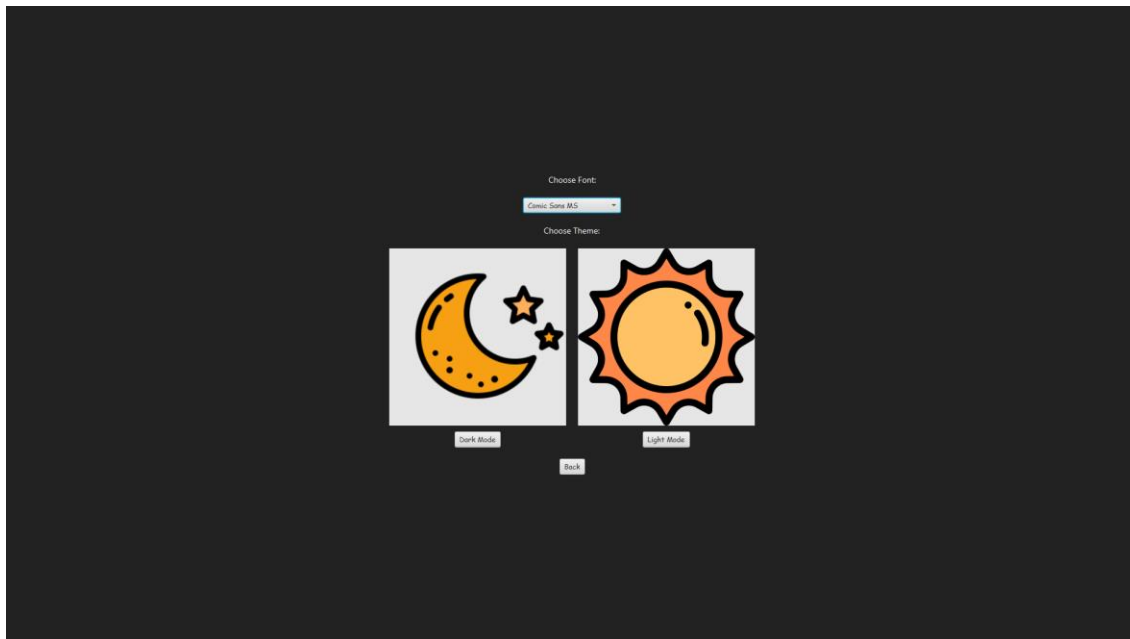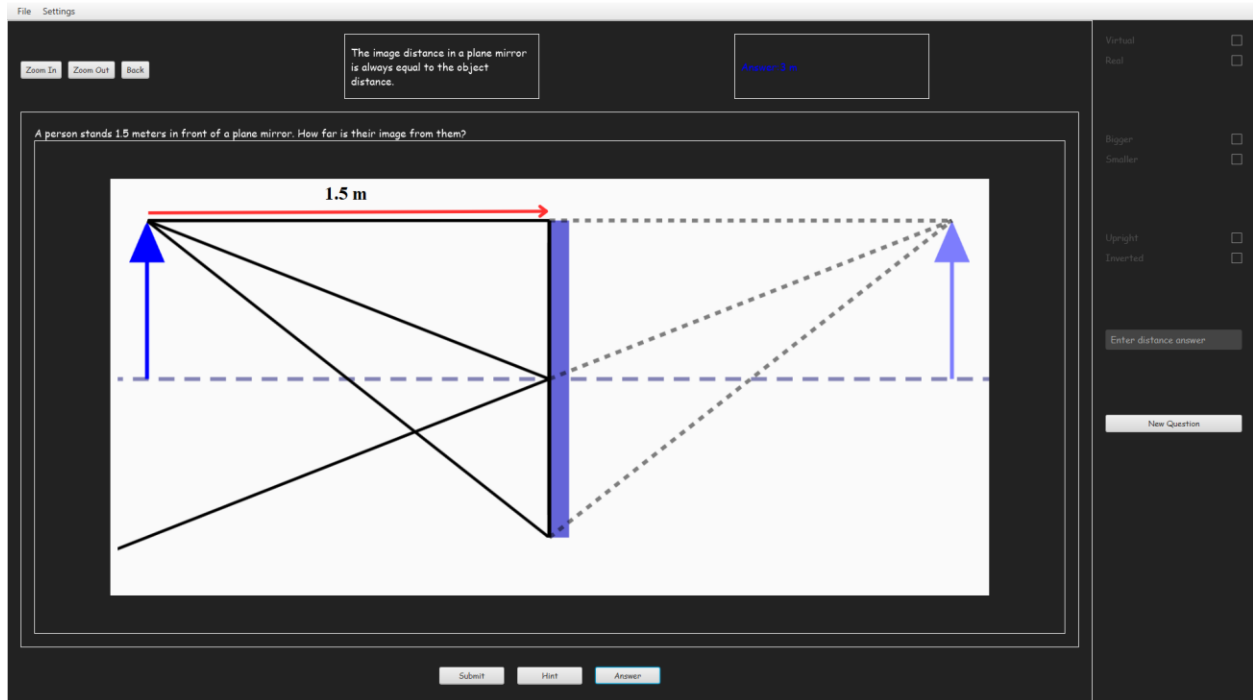

Display of the theme settings page in dark mode and in the comic sans font
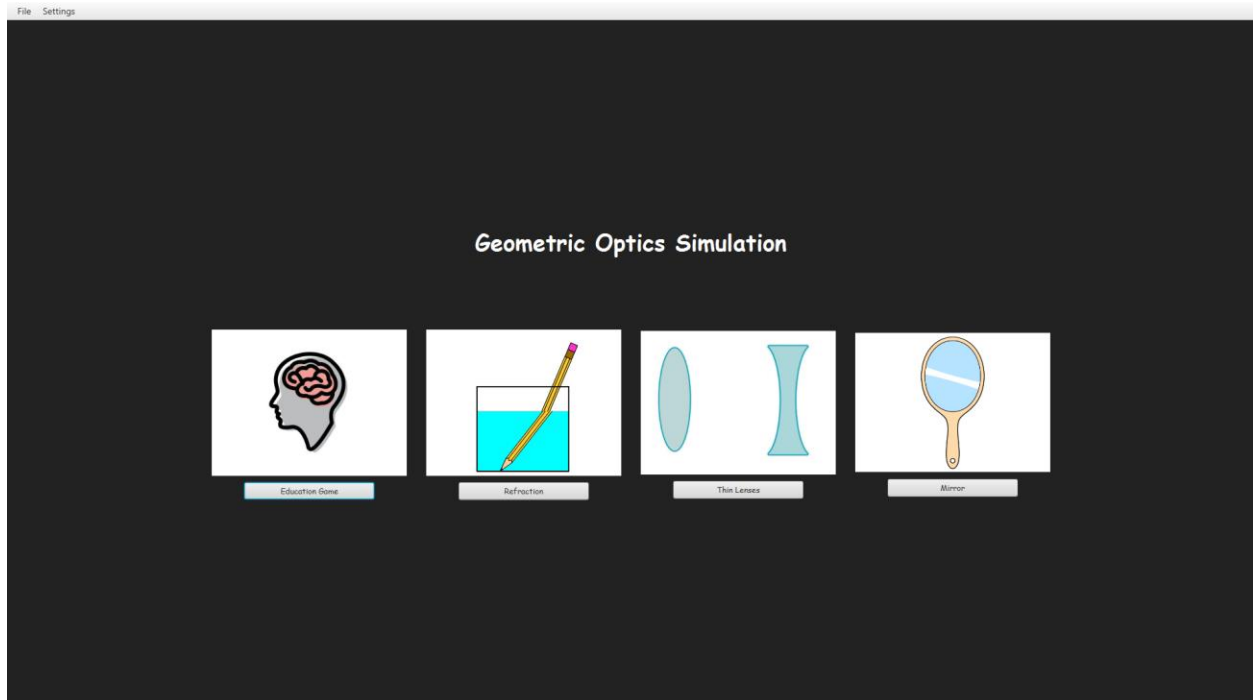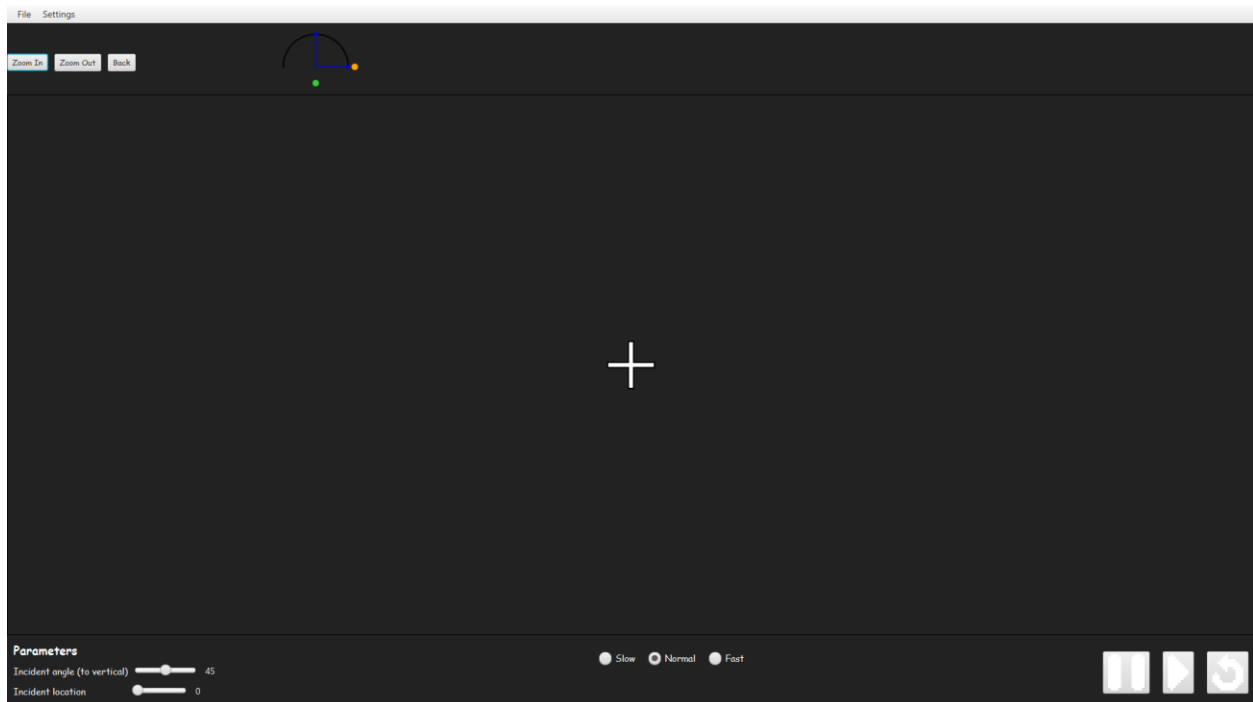
Display of the main page in dark mode and in the comic sans font

Display of the difficulty selection scene in dark mode and in the comic sans font
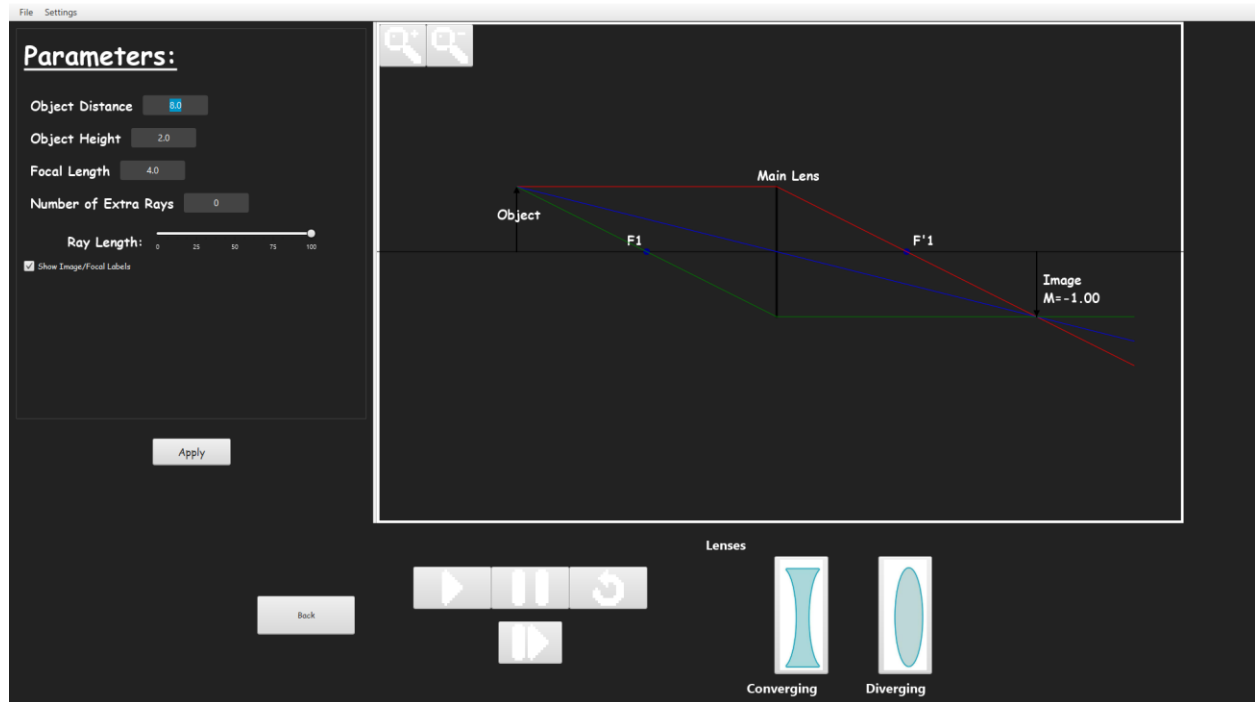
Zoom In Zoom Out Back

The image distance in a plane mirror is always equal to the object distance.

Virtual ☐
Real ☐

Bigger ☐
Smaller ☐

Upright ☐
Inverted ☐

A person stands 1.5 meters in front of a plane mirror. How far is their image from them?

1.5 m

Enter distance answer

New Question

Submit Hint Answer

Display of the education mode in dark mode and in the comic sans font

File Settings

Zoom In Zoom Out Back

Parameters
Incident angle (to vertical) ——●—— 45
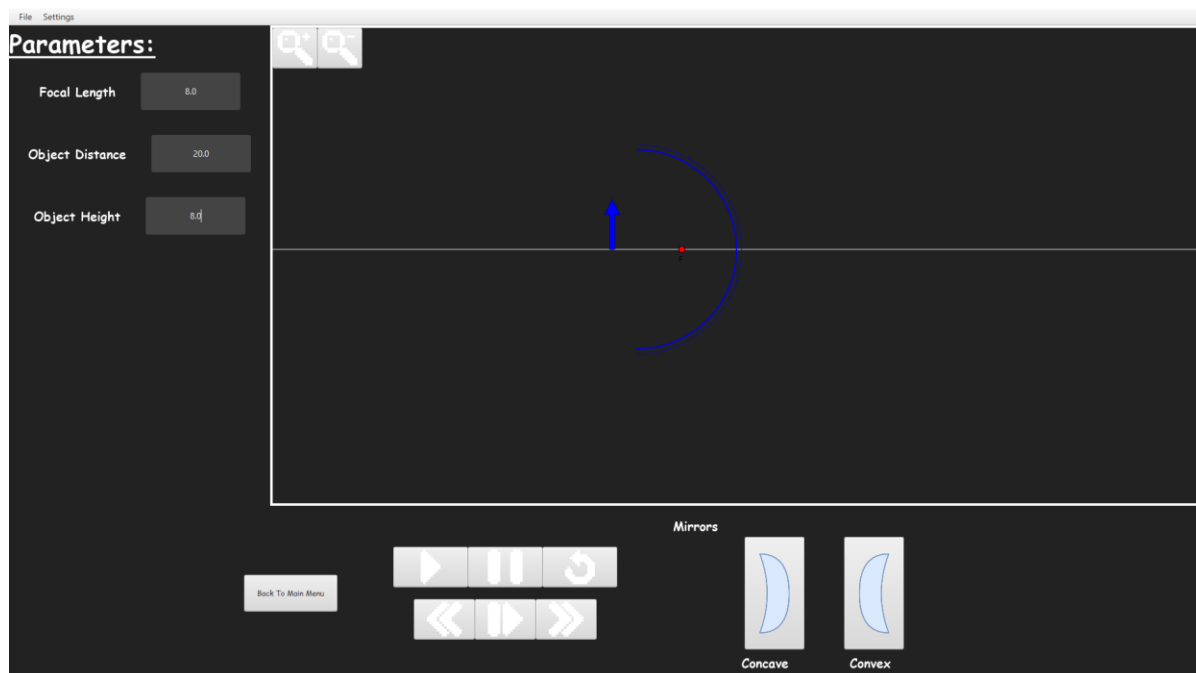Incident location ●——— 0

○ Slow ◉ Normal ○ Fast

Display of the refraction scene in dark mode and in the comic sans font
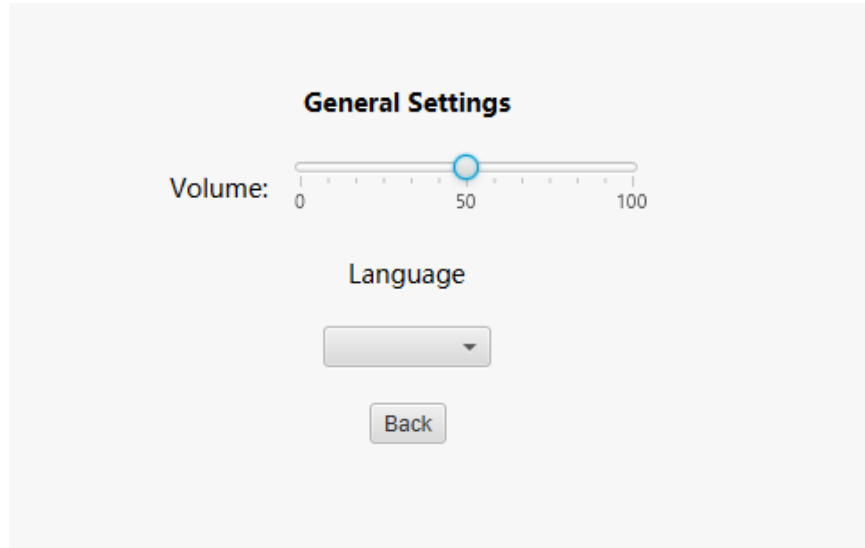
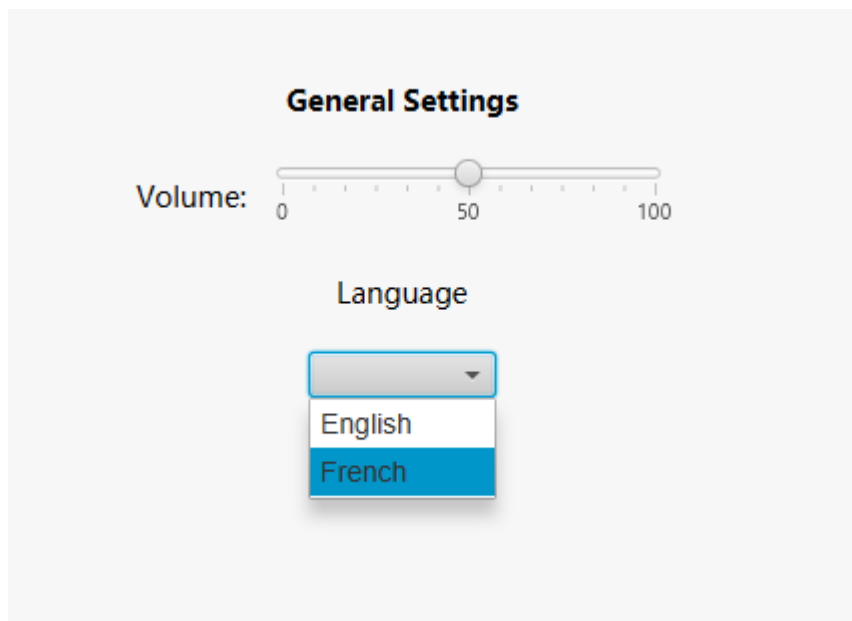*Display of the thin lens scene in dark mode and in the comic sans font*

Display of the mirror scene in dark mode and in the comic sans font

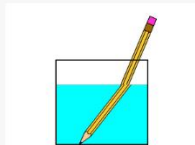*General Setting*

A slider that allows you to adjust the volume.

A combo box that contains two options: English and French. Once selected, the language of the application is changed.
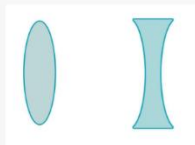
Application in French

Display of refraction scene in French
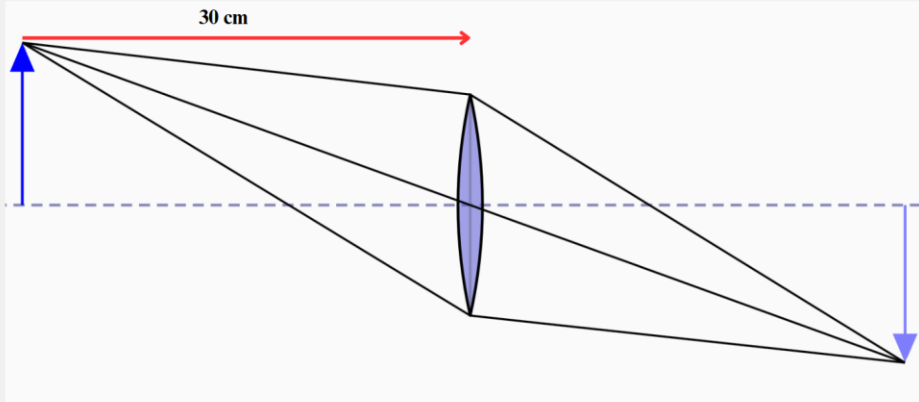
Zoom avant   Zoom arrière   Retour

Utilisez l'équation des lentilles minces :
1/f = 1/do + 1/di et le grandissement :
-di/do

Réponse : -1,réel,any,inversé

Virtuel
Réel

Plus grand
Plus petit

Droit
Inversé

Entrez la réponse (distance)

Nouvelle question

Une lentille convergente a une distance focale de 15 cm. Un objet est placé à 30 cm. Quelles sont les caractéristiques de l'image (réelle/virtuelle, droite/inversée) et quel est le grandissement ?

30 cm

Soumettre   Indice   Réponse

Display of education mode in French

About us

Welcome to our application! We are a team of passionate developers dedicated to creating amazing software. Our mission is to provide users with the best experience possible. Thank you for using our app!

Back

Display of about us page

Help - Geometric Optics Formulas

Welcome to the Help section!

This program is designed to help you learn and visualize geometric optics concepts.

Refraction (Snell's Law):
$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$

- n_1, n_2: Refractive indices of the two media
 - θ_1, θ_2: Angles of incidence and refraction

Thin Lens Formula:
$1/f = 1/v - 1/u$
- f: Focal length of the lens
 - v: Image distance
 - u: Object distance

Mirror Formula:
$1/f = 1/v + 1/u$
- f: Focal length of the mirror
 - v: Image distance
 - u: Object distance

Magnification (m):
$m = h'/h = -v/u$
- h': Height of the image
 - h: Height of the object

Back

Display of help page