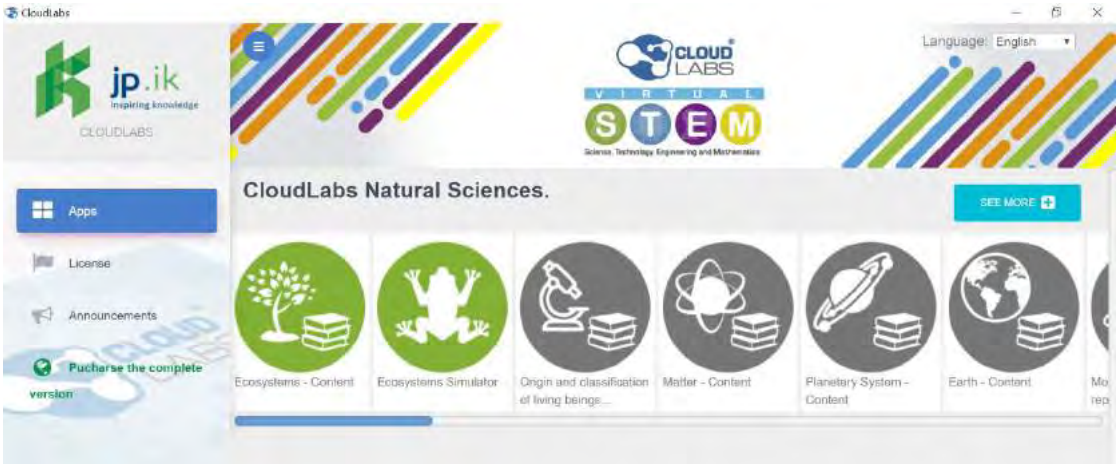
CloudLabs
User Guide

Student Guides



Contents

1. Limitation of Liability

This document and the software described in it may only be used or copied in accordance with the terms of the license. Please note that this document is for information purposes only and has been prepared for the benefit of the end user. Nevertheless, the information contained herein is subject to change without notice and is not warranted to be error-free.

2. Presentation of CloudLabs

CloudLabs is a virtual platform where it's possible to access all areas of STEM education and complete each of the corresponding laboratory practices, without needing to buy any physical equipment and without risking any accidents by your students.

CloudLabs focuses on STEM curriculum using laboratory simulators to promote the best teaching-learning experience for STEM.

CloudLabs Dashboard

Click the CloudLabs icon to access the main menu.

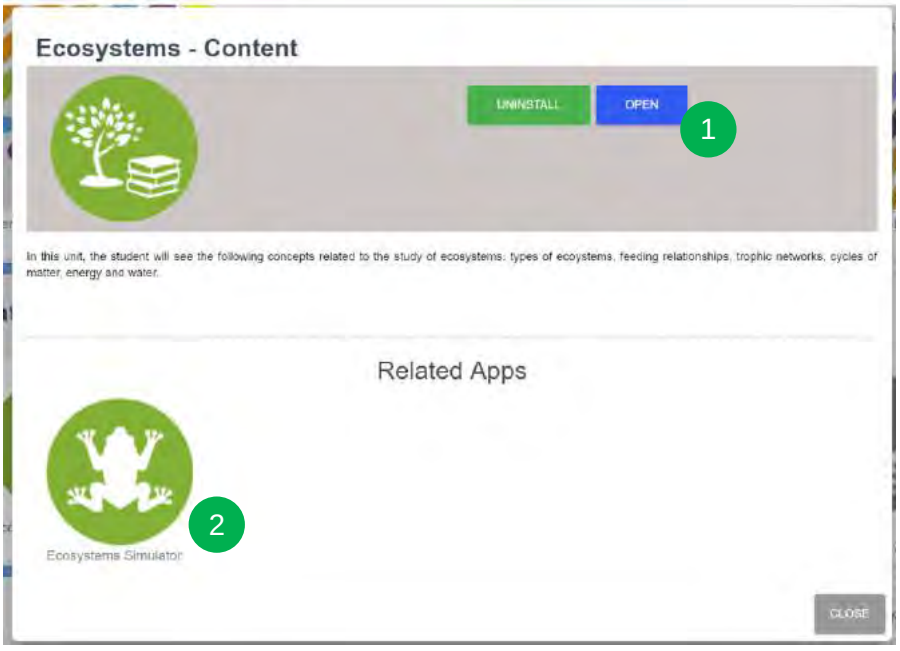
1. Apps: Find the virtual laboratories and content associated with natural science.
2. License: View the information regarding the license associated with the device.
3. Announcements: See general messages from the application.
4. Purchase the complete version of CloudLabs.
5. With this option you can change the language to English, Spanish or Portuguese.
6. Expand the contents dashboard.
7. All contents for each category are divided in two parts:

    - **Activities**: These offer the conceptual development and theoretical foundation of each concept;
    - **Laboratory practice:** The descriptions and step-by-step instructions to complete the laboratory practices proposed in the simulators. Then go to the simulator to complete each laboratory practice.

To access the content of each subject, click the icons with the names of content (for example: **Ecosystems - Content**).

To access a virtual laboratory, click on the icons with the simulator name (for example: **Ecosystems Simulator**). Then you will find a laboratory description where you can see the laboratory practices that are available.

When you open any content, you can use that content or jump to one of the related contents / simulators.



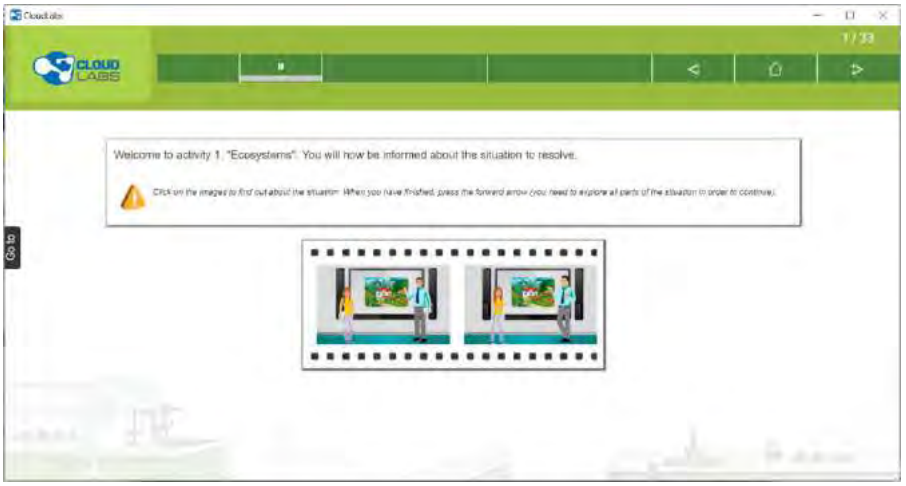
1. **Selected content** - Click open to access the selected content
2. **Related content** - This simulator is related with the content and you can use this menu to access it.

Once in the simulator, you will find a window welcoming you and will find a start of session page where you can fill in information that will appear at the end of the laboratory report.

The laboratory reports will be saved wherever you desire at the time that they are generated. You may view the report by opening the PDF document generated once the laboratory practice is complete.

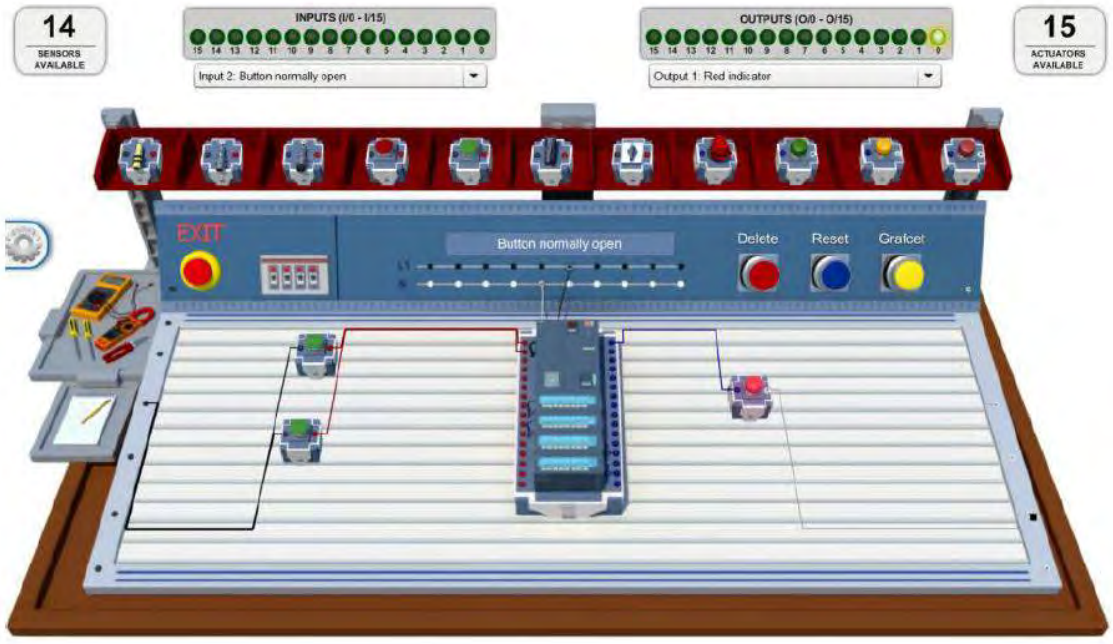
To learn more about each individual simulator, please refer to section 3 of this manual.

Content Activities



Any content you open is structured with the same template. This makes it easier to browse the different contents.

3. Digital Actuator and Sensor Workbench - Starting and Stopping a Machine



Introduction to automata-based programming

In a woodworking shop there is an electric saw for cutting wood and each time it is going to be used, the operator must press the Start button for it to operate. After it has been used, the operator must press the Stop button to turn off the machine. This must be done every time that the machine is used.

Objectives

To learn and understand the different types of PLC programming

Concepts and skills

GRAFCET programming

3.1 Laboratory equipment

Blank panel.

Functions.

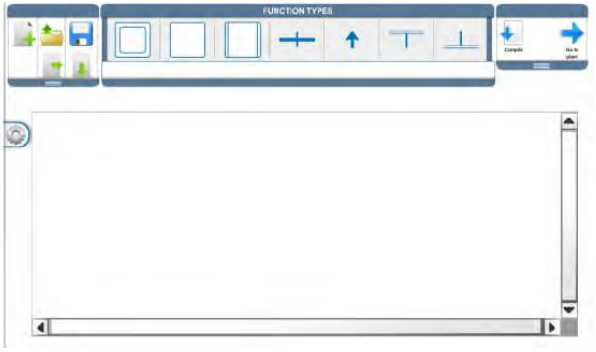
Tool panel.

3.2 Sequence of implementation

Enter the Graphic language block programmer (Grafcet) and record your personal information.

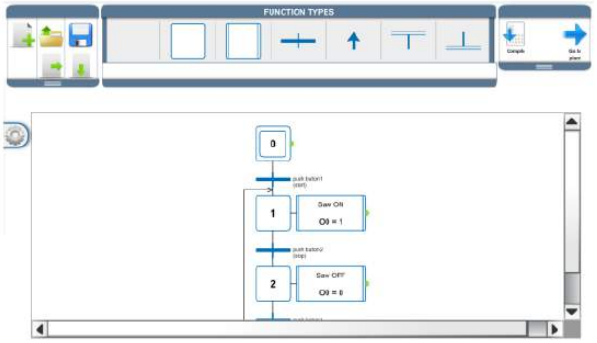
Identification of laboratory materials

- Blank panel
- Functions
- Tool panel



Assembly of the program

- The program must start at the initial step (step 0), select it from the top and drag it to the workspace.
- Then drag a step (step 1) below the initial step and connect both steps using a transition. Drag and place an action to the side of the step.
- In transitions, there are inputs and internal PLC contacts, which will be signals used for decision making within the program. The inputs can be normally open or normally closed. The proposed situation will simulate that the start button is connected to



the I0 input of the PLC.

Note: each transition can be named for easy recognition; in the proposed situation, this transition will be named Button 1 (startup)

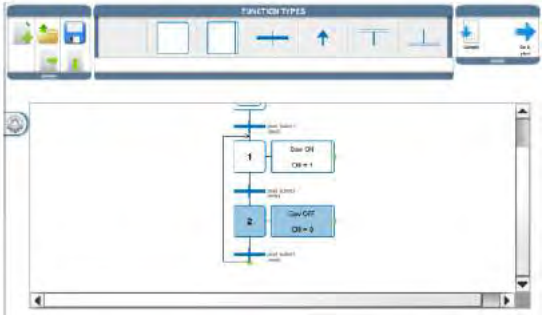
- Click on the action of step 1 and configure an activity for it. For example, activate the O0 output of the PLC which in this case represents the electric saw described in the situation. (Note that just like the transitions, each action may also be named for easy recognition, in the proposed situation this action will be named Saw ON).

- Now the saw has been programmed to turn on with the start button. Next, drag and connect a new transition and a new step.

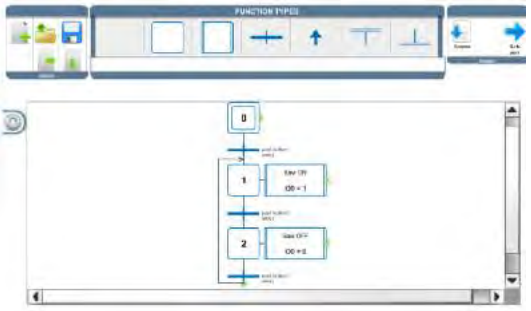
- Name and configure the second transition so that it goes with the stop button, which in this case is simulated to connect to the I1 input of the PLC.

- Connect an action to the second step and configure the activity to be implemented. In this case, as it is necessary to turn off the saw connected to the O0 output of the PLC, it will be necessary to "deny this output". This action will turn off the PLC output that was previously turned on by the action of step 1. The action will be named Saw OFF.

- Drag a transition and place it below step 2, configure it with the same condition as the first transition.

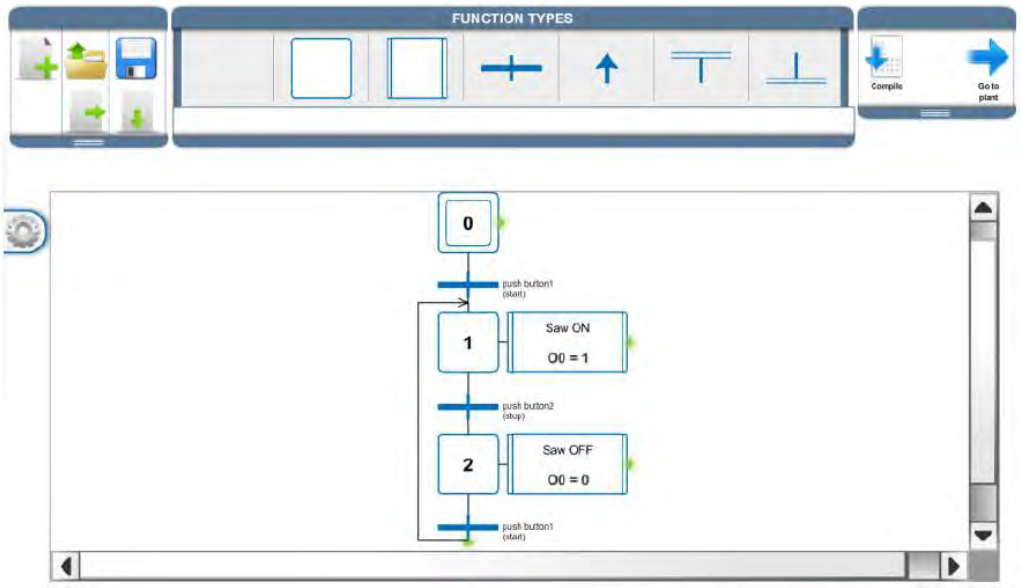


- Drag and insert the jump found in the functions panel, it should be dragged and connected to the last transition and it will connect to the first step of the program.

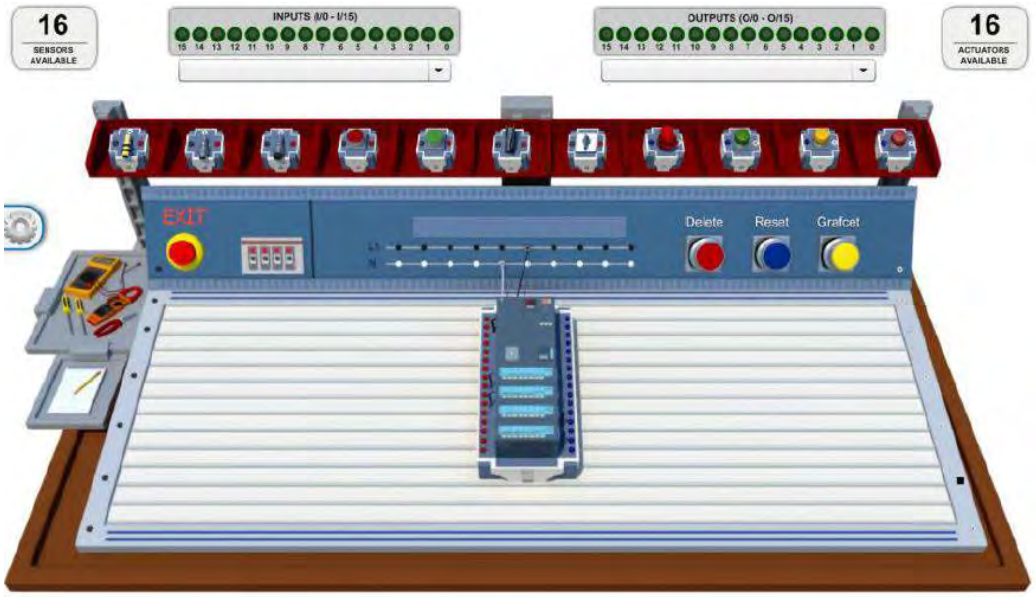


3.3 Base program

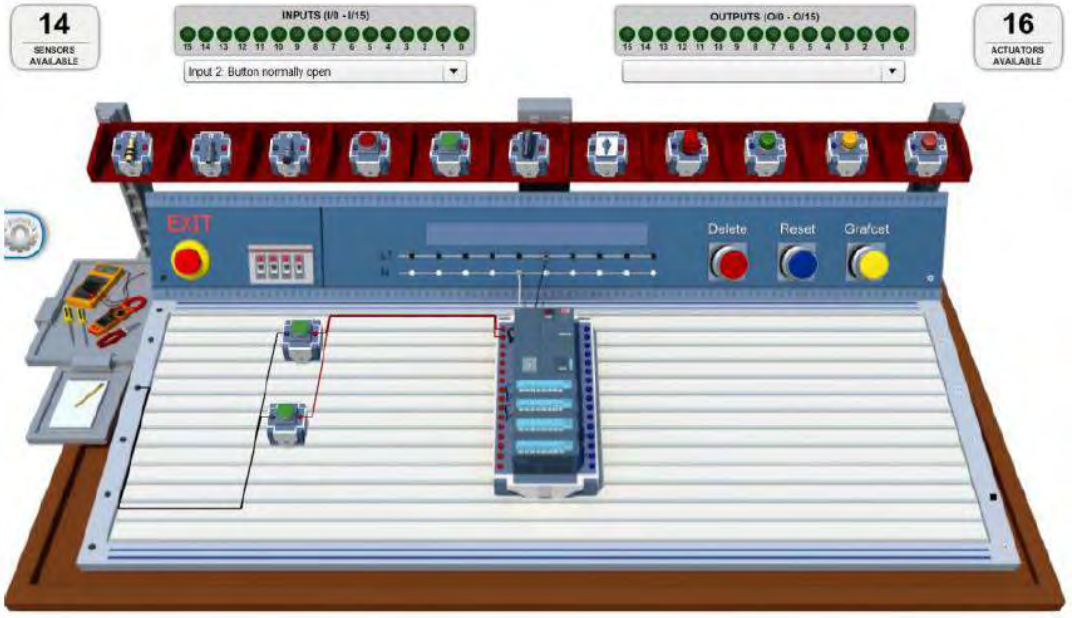
You will now see the complete image of the base program completed in the previous sequence as well as its verification in practice.

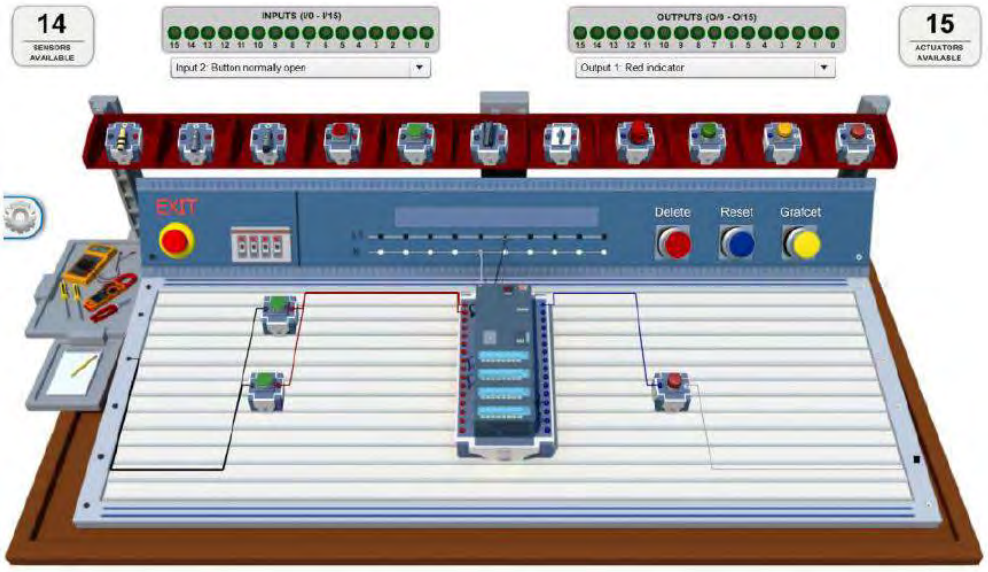


- In order to test the program once it is complete, we must click the compile button and then click save. Then, we must go to the workbench sensor and digital actuator simulator.

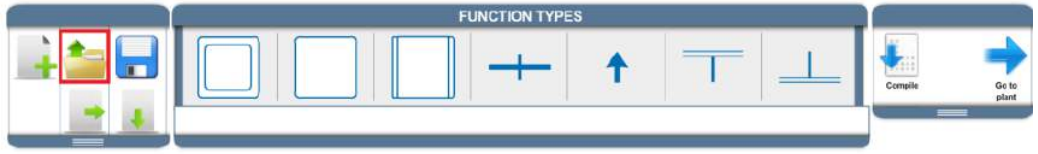


- Once in the workbench sensor and digital actuator simulator, we must drag two normally open push buttons towards the left side of the table.
- Then, we drag a pilot light of any color towards the right side and click the grafcet button.

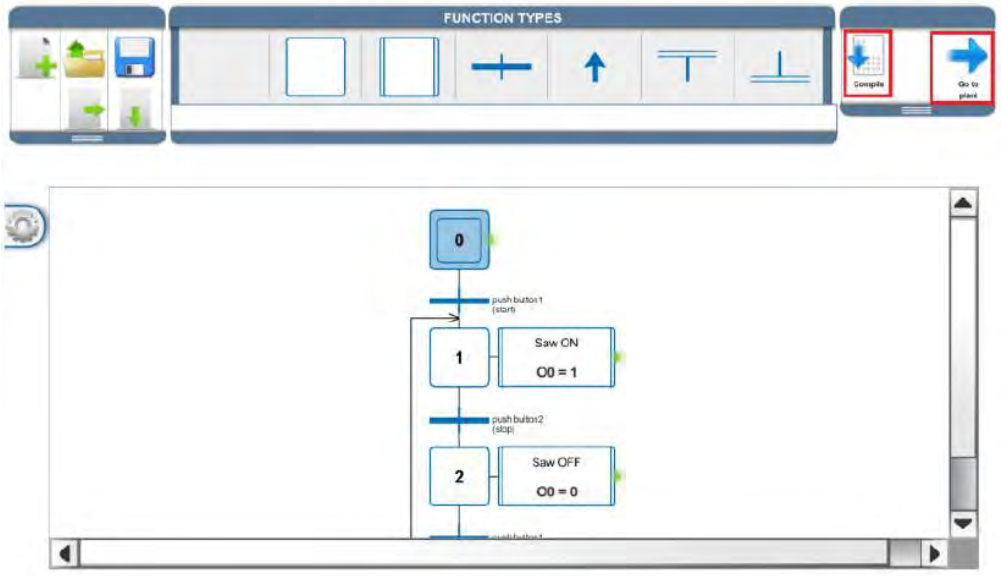




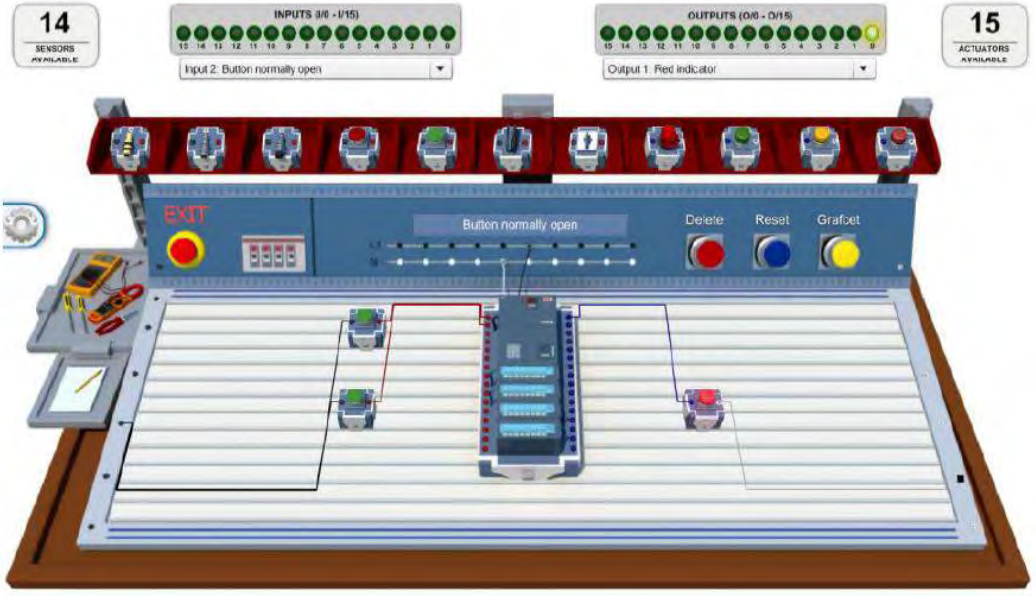
- When programming by blocks or grafcet, we must find the program by clicking Open and choosing the program that was developed.



- After finding the program, we must click compile (load program on the PLC) and then click go to the plant.

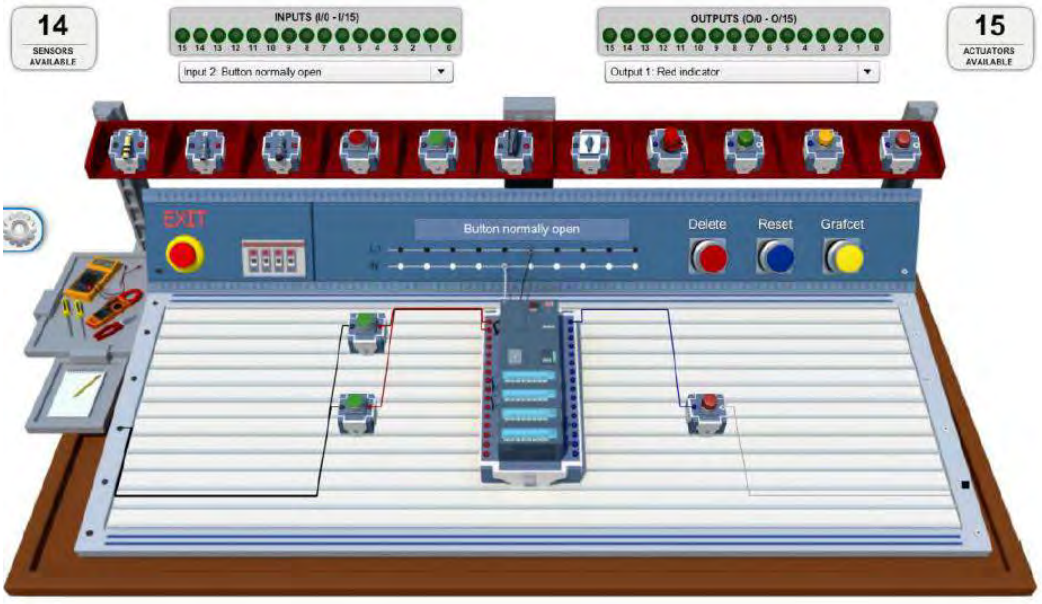


- To test the correct operation of the program we must click on the normally open push button that is connected to the I0 input of the PLC, when performing this action the pilot light should illuminate (Saw).

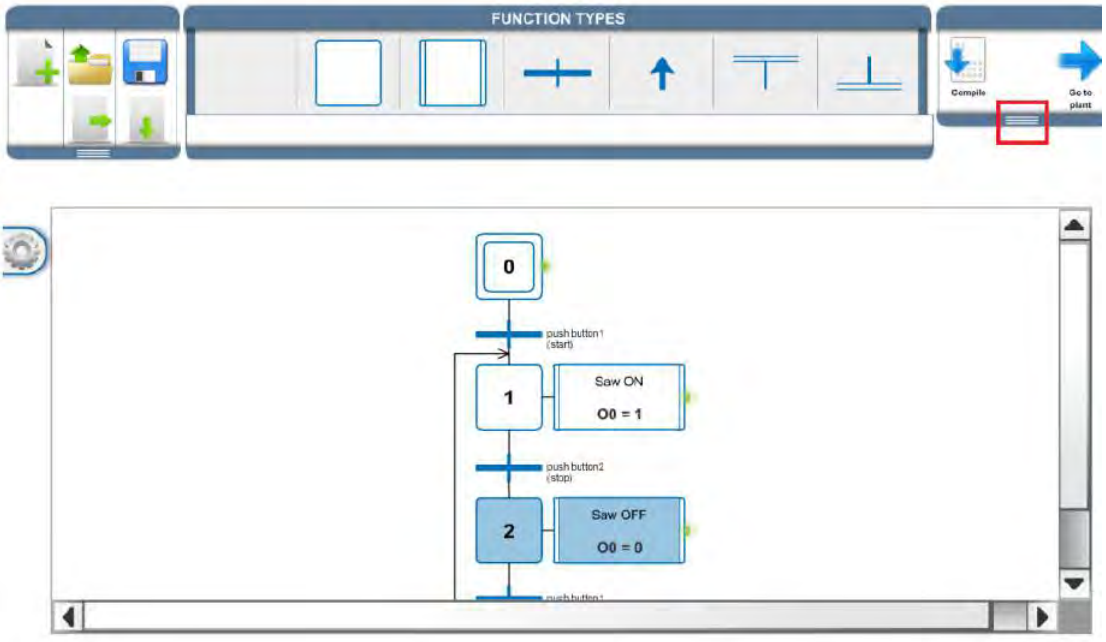


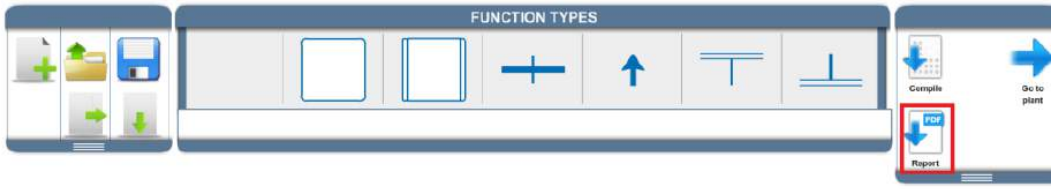
- Then we must click on the normally open push button connected to the I1 input of the PLC or the OFF button, when this action is carried out the pilot light (saw) will turn off.

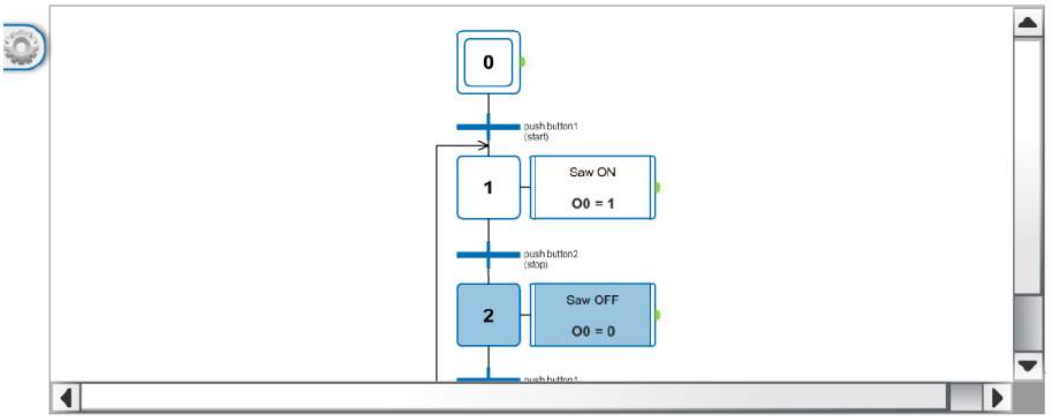
- Repeat the testing procedure of the program as many times as necessary.

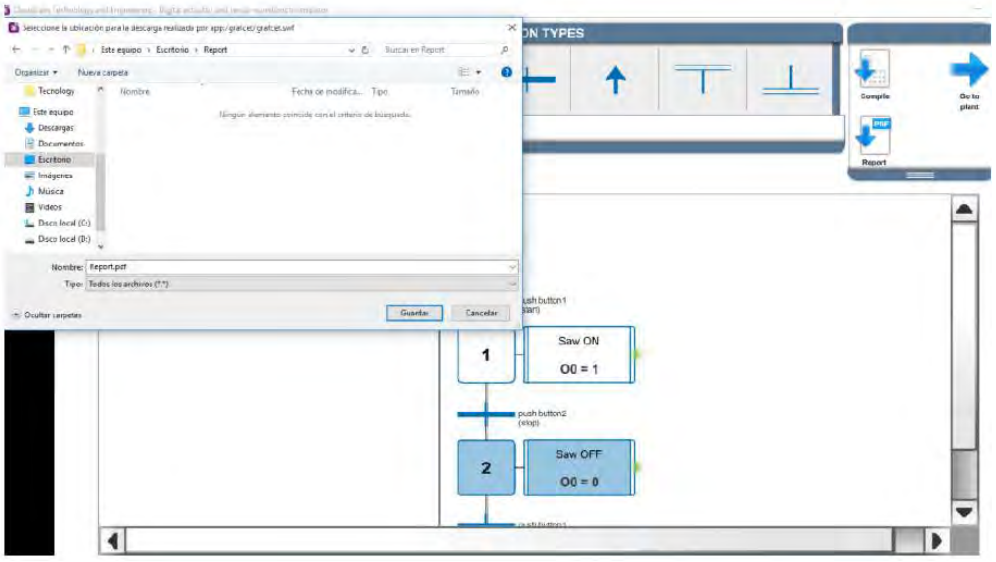


- As evidence of learning, we can return to the Grafcet screen and export the report on the program made by the user. Click on the tab found in the box with the ‘compile’ button. Once the tab is clicked, we will find the generate report button. Click this button and a popup window will appear in which we can choose the folder where we want to save the report.







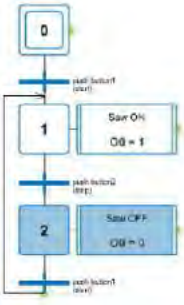


CLOUD LABS

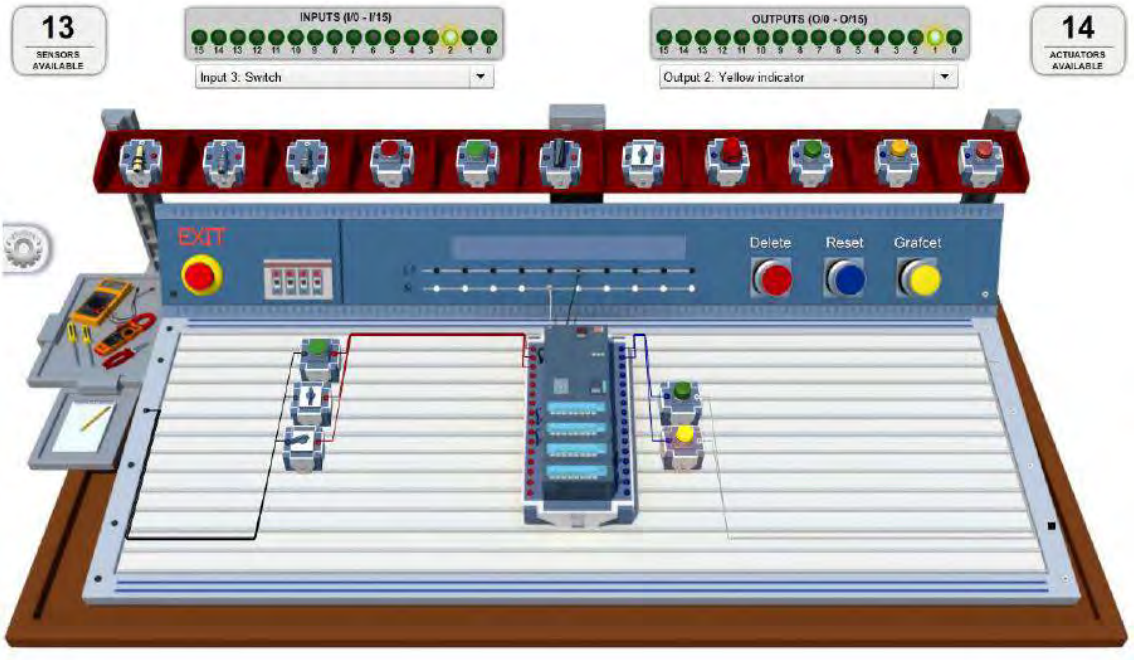
Automation simulator (Grafcet)

User: Guest

Start Date: 15/03/2019 10:00:15	Course: PLC
Session Time: 00:10:59	Course ID: plc_grafcet
Institution: IE	Attempts: N/A
Course:	Grade: N/A



4. Digital Actuator and Sensor Workbench - Forward and reverse motion on a crane motor



Introduction to automata-based programming

As the last step at a bottling plant, it is required to raise boxes full of bottles to the top of the plant in order to be dispatched by the delivery truck. The operator of the crane presses the advance and recoil of the engine to operate it. For safety reasons, the operator must be able to turn off the lift at any time (Emergency stop).

Objectives

To learn and understand the different types of PLC programming

Concepts and skills

GRAFCET programming

4.1 Laboratory equipment

Blank panel.

Functions.

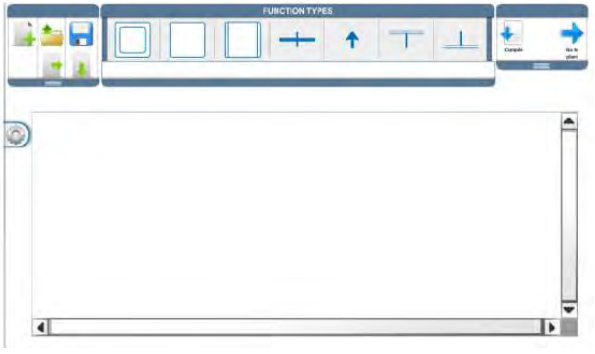
Tool panel.

4.2 Sequence of implementation

Enter the Graphic language block programmer (Grafcet) and record your personal information.

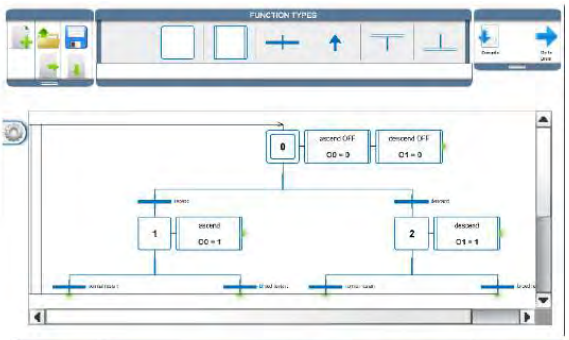
Identification of laboratory materials

- Blank panel
- Functions
- Tool panel



Assembly of the program

- The program must start at the initial step (step 0), select it from the top and drag it to the workspace.
- Then drag and place two actions at the side of the initial step.
- Click on the first action of the initial step and configure an activity for it. For example, initialize the O0 output at the low level of the PLC, which in this case will represent the start-up of the crane motor in ascending mode. (Note that just like transitions, each action can also be named for easy recognition.) In the proposed situation,



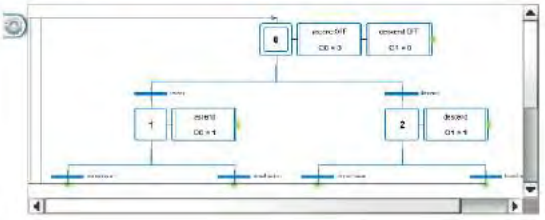
this action will be named Ascend OFF.

Note: actions allow for the generation of a system response and show it either physically or internally.

- Click on the second action of the initial step and configure an activity for it. For example, initialize the O1 output at the low level of the PLC, which in this case will represent the start-up of the crane motor in descending mode. In the proposed situation, this action will be named Descend OFF.

- Drag a divergence and place it below the initial step. Then, drag and connect two transitions to the divergence that was just placed.

- Configure the divergence.



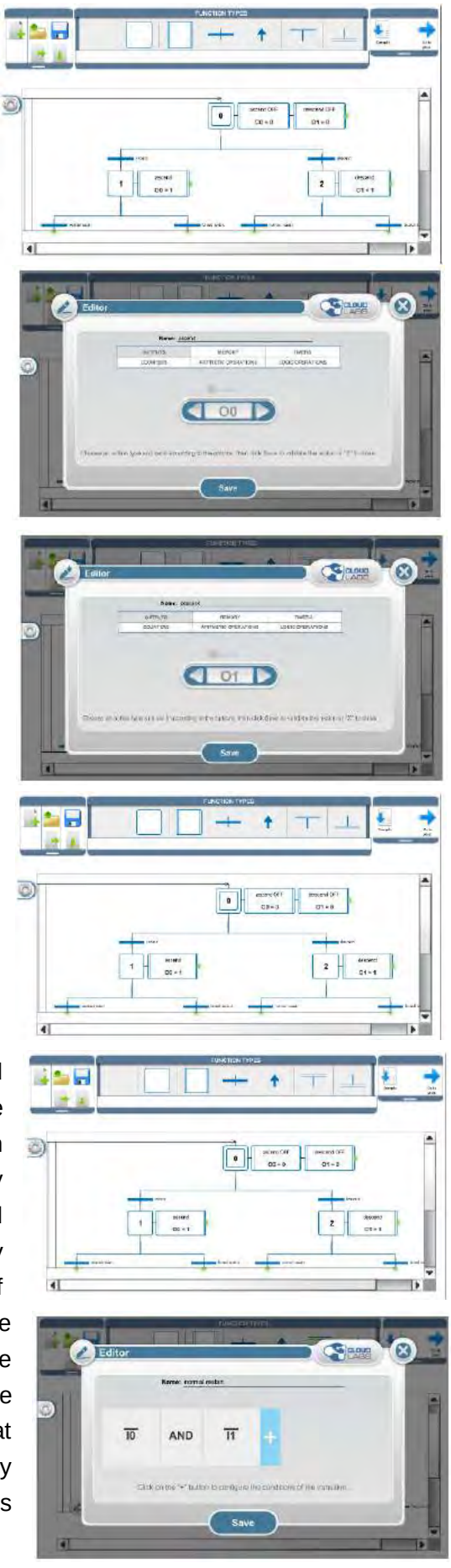
Note: the divergence allows us to take multiple routes depending on the process.

- In transitions, there are inputs and internal PLC contacts, which will be signals used for decision making within the program. The inputs can be normally open or normally closed. The proposed situation will simulate that the emergency stop button is connected to the I0 input of the PLC and that the I1 input is the ascend button. (Note that each transition can be named for easy recognition.) in the proposed situation, this transition will be named Ascend.

Note: transitions represent the conditions that the system must overcome in order to go on to the next step.

- Configure the second transition that is connected to the divergence, the proposed situation will simulate that the emergency stop button is connected to the I0 input of the PLC and that the I2 input of the PLC is the descend button.

- Drag a step and an action for each of the transitions (ascend and descend).
- Click on the action for step 1 and configure an activity for it. For example, activate the O0 output of the PLC which in this case represents the crane motor in ascending mode described in the situation. (Note that just like transitions, each action can also be named for easy recognition.) In the proposed situation, this action will be named Ascend.
- Click on the action in step 2 and set up an activity for it. For example, activate the O1 output of the PLC which in this case represents the crane motor in descending mode described in the situation. (Note that just like transitions, each action can also be named for easy recognition.) In the proposed situation, this action will be named Descend.
- Now, the crane activation has been programmed in ascending and descending mode without the emergency button pressed. Next, drag and connect two divergences to steps 1 and 2, then configure these divergences.
- Drag and connect transitions to each one of the branches of the divergences.
- In transitions, there are inputs and internal PLC contacts, which will be signals used for decision making within the program. The inputs can be normally open and normally closed. The proposed situation will simulate that the emergency stop button is connected to the I0 input of the PLC, that the I1 input of the PLC is the ascend button and that these buttons are not pressed. This configuration will be done in the ascending branch (Note that each transition can be named for easy recognition.) In the proposed situation, this transition will be named Normal restart.

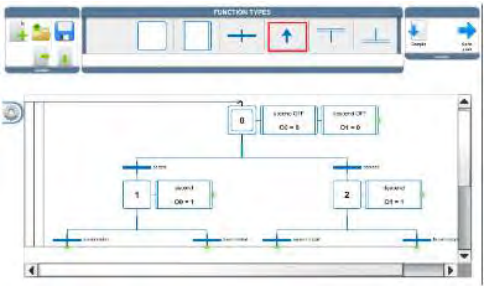


- Configure the second transition found on the ascending branch. It will be directly connected to the emergency stop so that when the button is pressed, it will cause a forced restart. For easy recognition, this transition was named Forced restart.

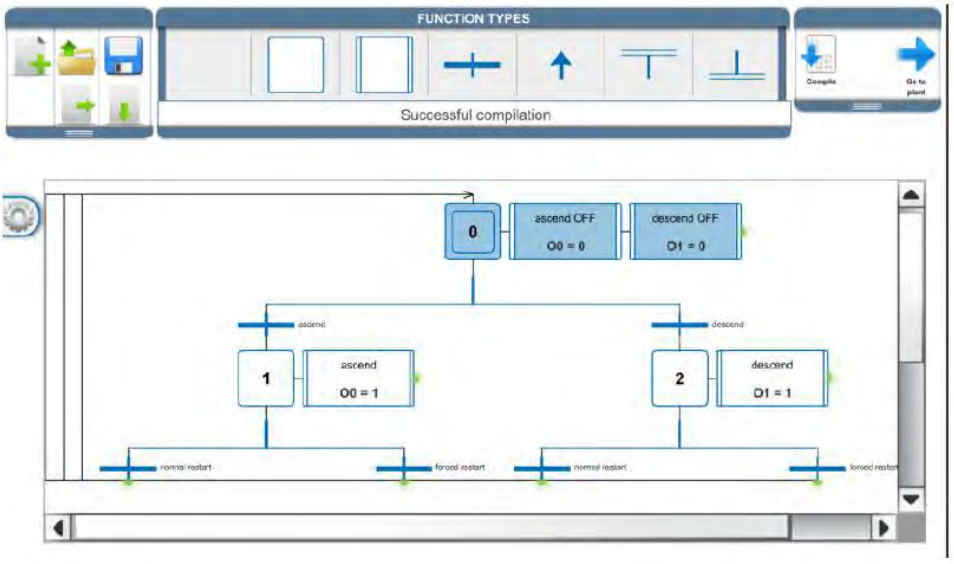
- Configure the transition. The proposed situation will simulate that the emergency stop button is connected to the I0 input of the PLC, that the I2 input of the PLC is the descend button and that these buttons are not pressed. This configuration will be done in the descending branch (Note that each transition can be named for easy recognition). In the proposed situation, this transition will be named Normal Restart.

- Configure the second transition found on the ascending branch. It will be directly connected to the emergency stop so that when the button is pressed, it will cause a forced restart. For easy recognition, this transition was named Forced restart.

- Drag and insert the jump found in the functions panel This is to be dragged and connected to all outputs of the previously configured transitions. All transitions of the last two divergences must be connected to the initial block.

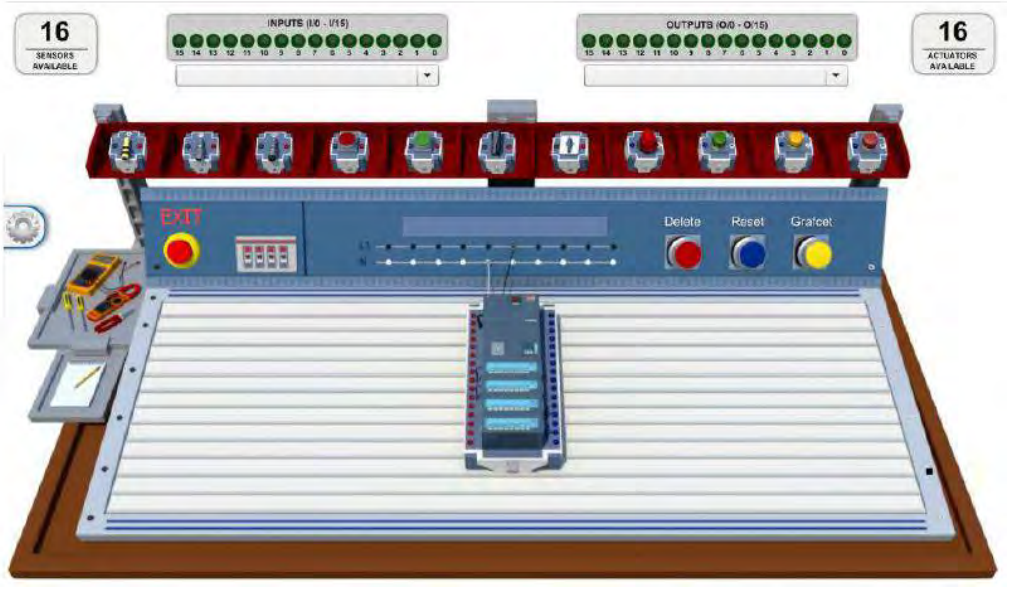


4.3 Base program

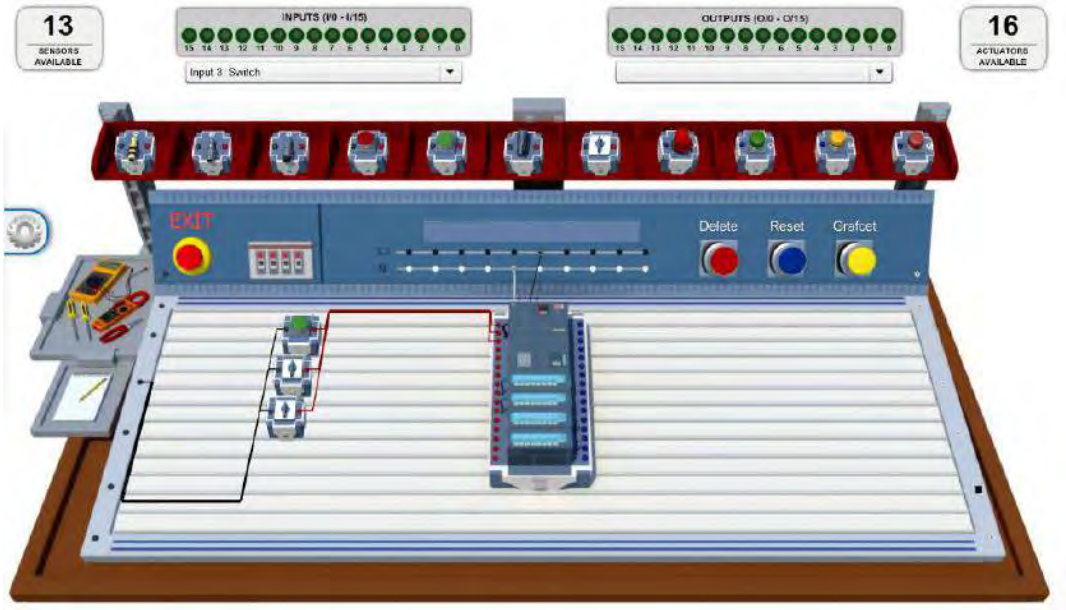


You will now see the complete image of the base program completed in the previous sequence as well as its verification in practice.

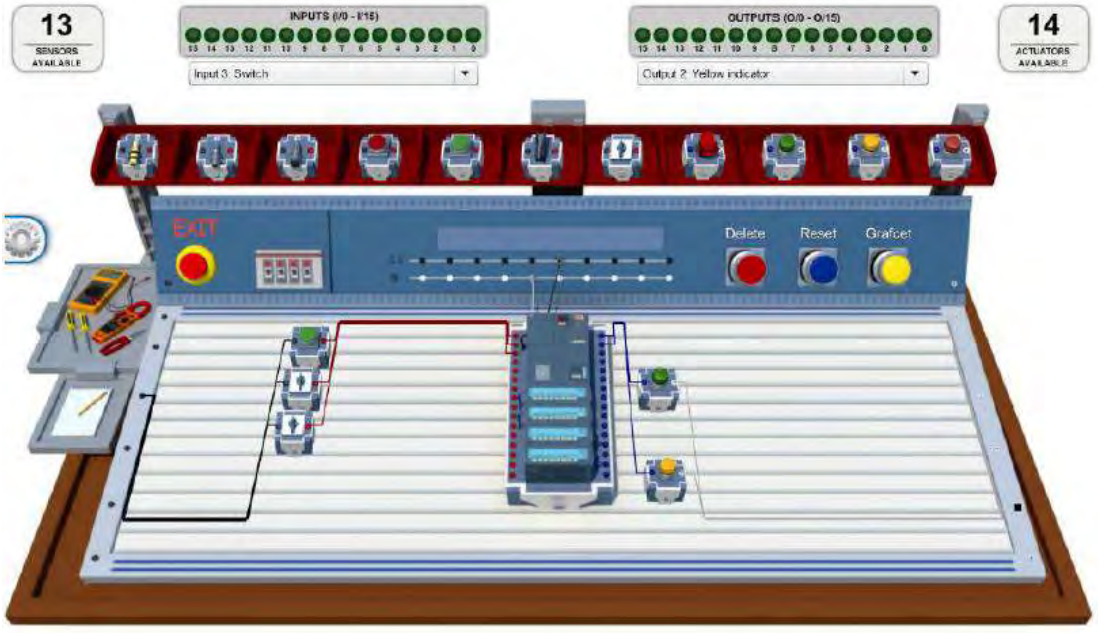
- In order to test the program once it is complete, click the compile button and then click save. Then, we must go to the workbench sensor and digital actuator simulator.



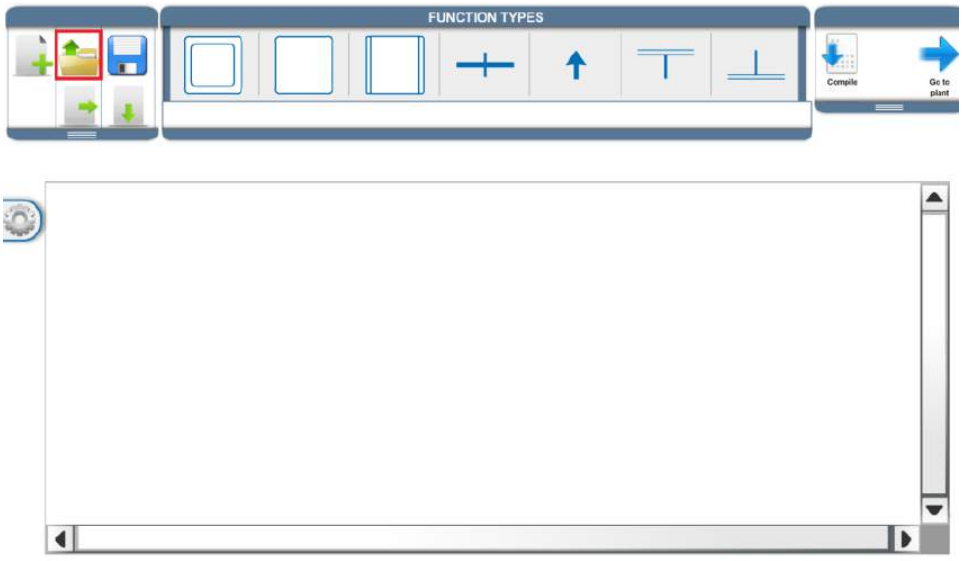
- Once in the workbench sensor and digital actuator simulator, we must drag two normally open push buttons towards the left side of the table.



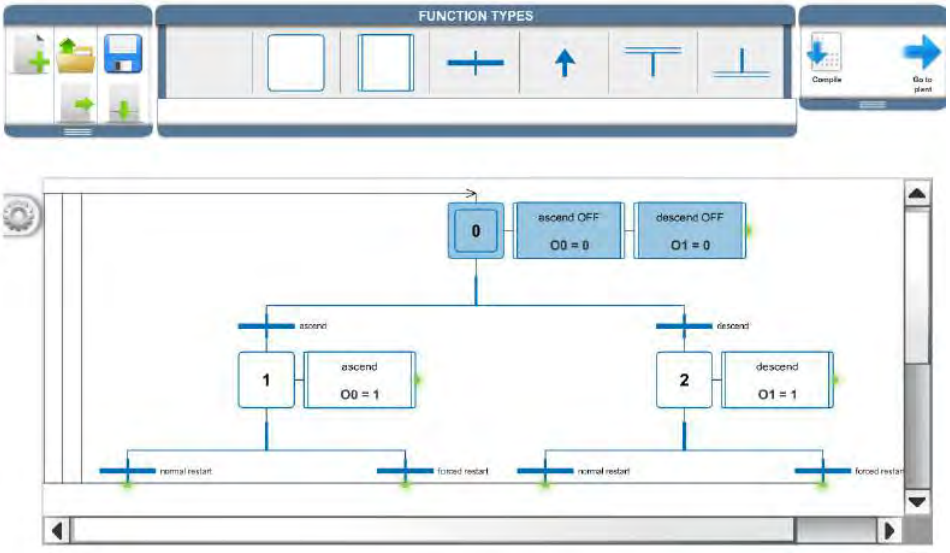
- Then, we drag a pilot light of any color towards the right side and click the grafcet button.



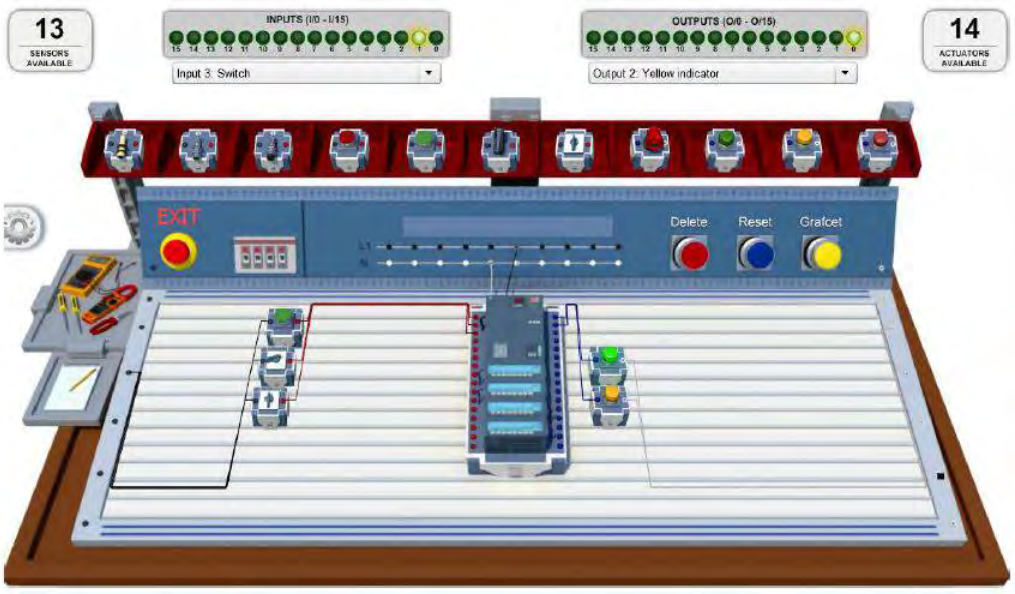
- When programming by blocks or grafcet, we must find the program by clicking Open and choosing the program that was developed.



- After finding the program, we must click compile (load program on the PLC) and then click go to the plant.

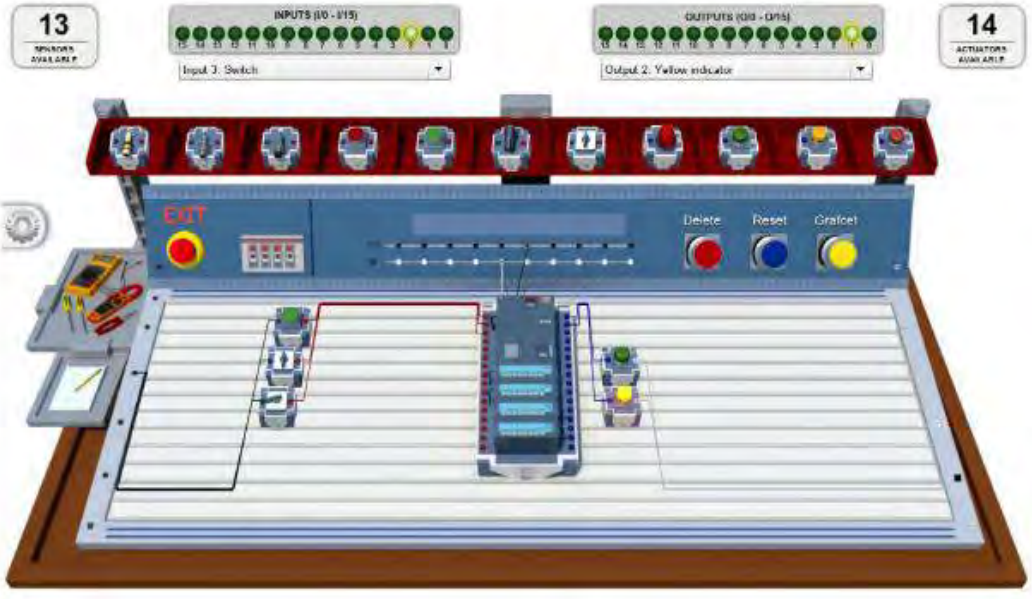


- To test the correct operation of the program we must click on the ascend switch which is connected to the I1 input of the PLC and at any time we should be able to click the switch connected to the I0 input of the PLC which is the emergency button. When doing this action, the green pilot light should illuminate.

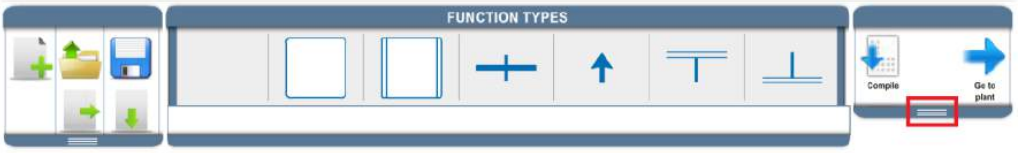


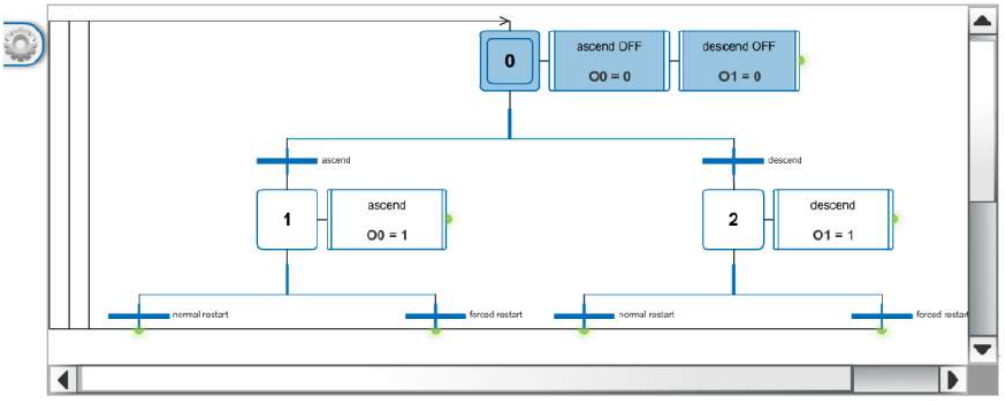
- After, we must click the ascend switch, which is connected to the I1 input of the PLC and at any time it should be possible to click on the switch that is connected to the I0 input of the PLC which is the emergency button. When performing this action, the green pilot light should illuminate.

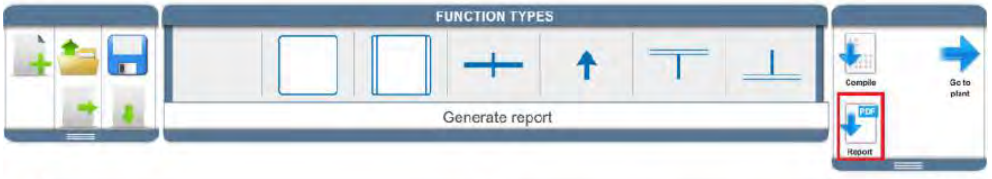
- Repeat the testing procedure of the program as many times as necessary.

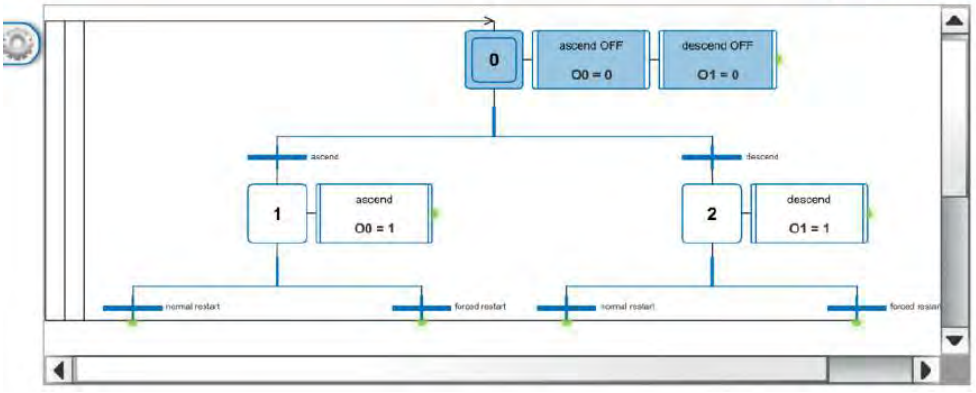


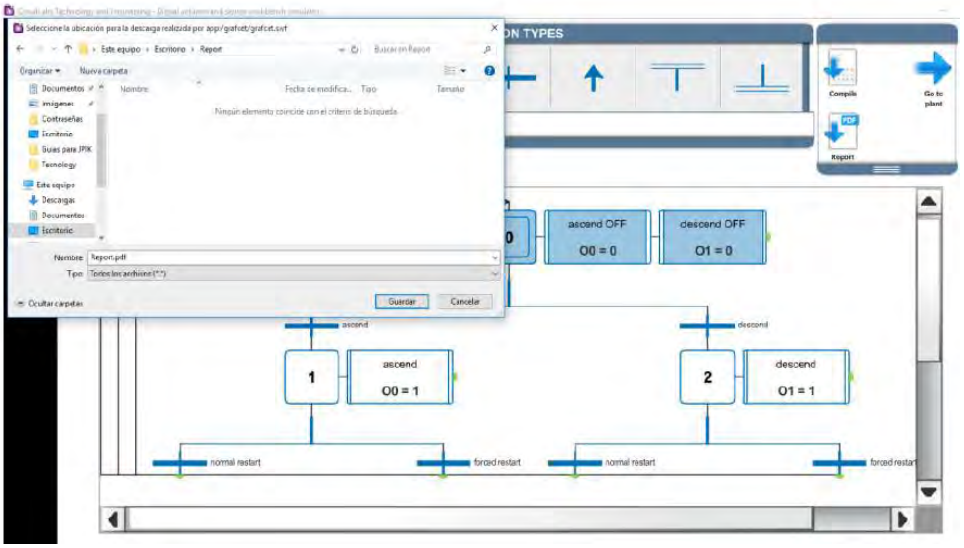
- As evidence of learning, we can return to the Grafcet screen and export the report on the program made by the user. Click on the tab found in the box with the ‘compile’ button. Once the tab is clicked, we will find the generate report button. Click this button and a popup window will appear in which we can choose the folder where we want to save the report.







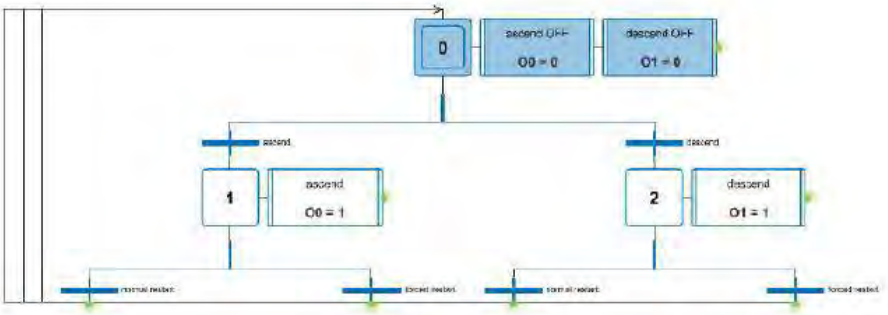




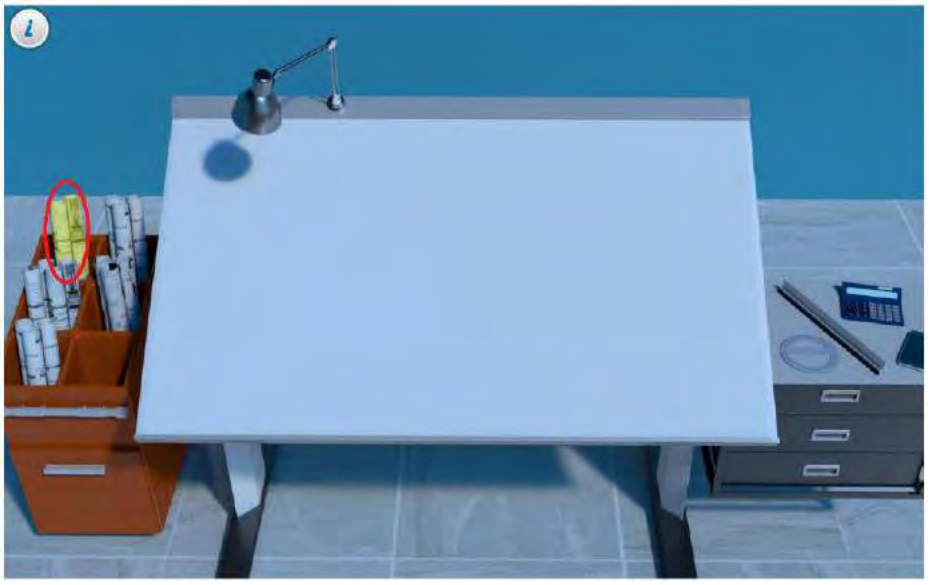
Automation simulator (Grafcet)

User: Guest

Start Date:	15/03/2019 14:06:22	Course:	PLC
Session Time:	00:48:37	Course ID:	plc_grafcet
Institution:	IE	Attempts:	N/A
Course:		Grade:	N/A



5. Simulator for Angles and Triangles – Suspension bridge



Mathematics – Angles and Triangles

A project for the construction of a suspension bridge is underway, and you have been made responsible for calculating the amount of steel cable that will be needed for the suspender cables of the bridge. Additionally, the engineers who will determine the loads supported by the bridge need to know the angles of inclination of the shortest suspender cable and the longest suspender cable Θ = greatest angle, β = smallest angle). For the activity, you have been given a scale drawing of the bridge on a scale of 1:120. You must take the corresponding measurements using this scale drawing and calculate the total length of the cable that will be needed for each section of the bridge, taking into account that a group of 50 steel wires will be used for each cable. Note that the scale drawing is on a reduced scale, but you will have to record the real measurements.

Objectives

To recognize the importance of the concept of the triangle when solving geometric problems in various contexts.

Concepts and skills

Pythagoras' theorem, triangle measurements, geometric reasoning.

5.1 Laboratory equipment

Graduated ruler.

Scale drawing of the hanging bridge.

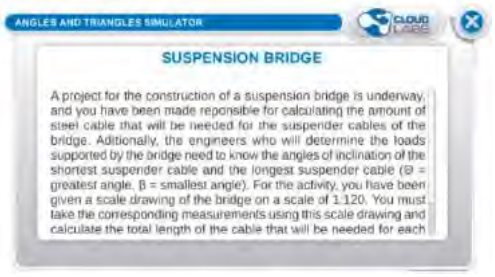
Calculator.

Celphone.

5.2 Procedures

- Enter the virtual simulator for angles and triangles, register your personal information and select the image as shown.

- Read the situation/challenge and click on the icon to close the introduction and access the laboratory.



- During the laboratory, you can click on the information icon to see the situation, the procedure or the equations as necessary. Click on the help icon for common questions. If you wish to stop the process in the laboratory and clear the work station at any time, click on the trash can icon . Clicking on the pencil icon will allow you to access the data registry. A calculator is provided at the work station and can be identified by the icon . The icon will allow you to answer the complementary questions.

Identification of laboratory materials:

- Diagram of suspension bridge
- Graduated ruler in centimeters for taking measurements
- Calculator

Measurement:

- Click on the diagram to zoom in on one of the sections of the bridge.
- Note that each suspender cable forms a right triangle with the tower and the base of the bridge.
- Drag and drop the ruler onto the catheti of the triangles formed by each suspender cable.
- Take note of the lengths of the catheti of each triangle formed on the section of the bridge.
- Register the length of each cathetus on a new page of the laboratory notebook.

Calculations:

- Use the information button “I” to see the equations related to this laboratory practice.
- Using Pythagoras’ theorem, calculate the hypotenuse of each triangle. This calculation will represent the length of each suspender cable of the bridge. You will need to calculate the length of 9 hypotenuses or suspender cables in total.
- Register the length of each hypotenuse on a new page of the laboratory notebook.

Data registry:

- Note that you will need to enter the following values into the data registry in this practice: the amount of cable necessary for each section of the bridge in kilometers and angles Θ and β for the shortest suspender cable and the longest suspender cable.
- To calculate the amount of cable for each section of the bridge, take into consideration that each suspender cable is formed of a group of 50 steel wires and that the diagram is on a reduced scale of 1:120. This means that the measurements taken in the laboratory are 120 times smaller that those of the real bridge.
- Once you have entered all of the values required into the data registry, click on the ‘Verify’ button to see if they are correct.

Complementary questions:

- Use the notebook button to answer the questions it contains.
- Note that there are four complementary questions to answer and you will need to use the arrow ▶ to go through them.
- The notebook allows you to add a new page or to delete one as necessary by using the button  .

Sending the data to the work team:

- Once the data registry is complete, click on the Report button to obtain an enlarged view of a telephone with which to send the data to the work team building the bridge.
- Check the values that will be sent in the message and click on ‘Send’. Note that the values are automatically taken from those you entered into the data registry.
- You will receive a message from the work team indicating the result of the construction according to your calculations.

Evaluation and laboratory report:

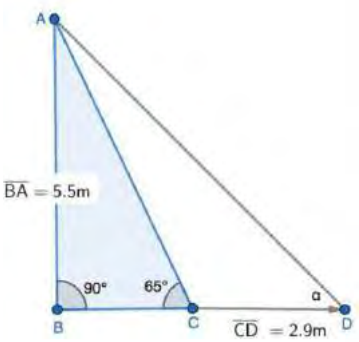
- If the values sent are correct, continue with the evaluation and then go on to generate the laboratory report.

5.3 Complementary questions

1. Can a triangle have 3 equal sides and be a right triangle? Justify your answer.
2. In what other buildings, constructions or works of engineering is it possible to see examples of the application of Pythagoras’ theorem?
3. Considering the sides and angles, what type of triangle do the suspender cables form with the base and pillar of the bridge?
4. Can the hypotenuse measure less than any of its catheti? Demonstrate your answer.

5.4 Conceptual questions

Multiple choice questions



Statement: One of the suspender cables of the bridge has moved from C to D, a total of 2.9 meters, so that the distance of (BA) is equal to the distance of (BD). Given this information, answer the following questions:

1. What does the angle a measure in degrees?

   a. 70°

   b. 45°

   c. 30°

   d. 20°

2. What does the segment $B\overline{C}$ measure in meters?

   a. 2.6 m

   b. 5.5 m

   c. 3.0 m

   d. 4.9 m

3. What does the segment $\overline{AD}$ measure in meters?

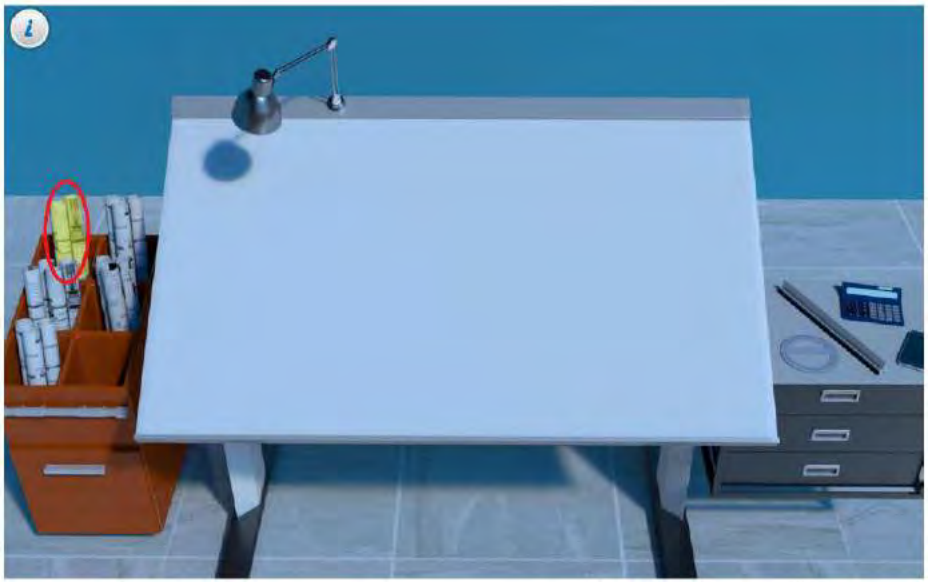
   a. 5.5√3 m

   b. 5.5√45° m

   c. 5.5√5.5 m

   d. 5.5√2 m

6. Simulator for Angles and Triangles – Maintenance at Tower Bridge



Mathematics – Angles and Triangles

A fault has occurred at the famous Tower Bridge as it was being raised to let the river traffic through. The parts of the bridge that lift stopped moving when the angle of elevation. As there is a lot of river traffic, you will need to determine the maximum height and width that the boats may have (at the top) in order to pass under the bridge. You have been given a scale drawing of the bridge on a scale of 1:150, which you will use to take the corresponding measurements and calculate the maximum dimensions that the boats may have in order to pass. Note that the scale drawing is on a reduced scale, but you must give the real measurements.

Objectives

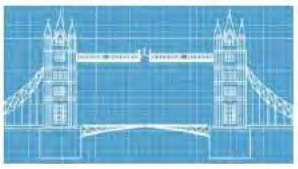
To recognize the importance of the concept of the triangle when solving geometric problems in various contexts.

Concepts and skills

Pythagoras' theorem, triangle measurements, geometric reasoning.

6.1 Laboratory equipment

Graduated ruler.



Scale drawing of Tower bridge.

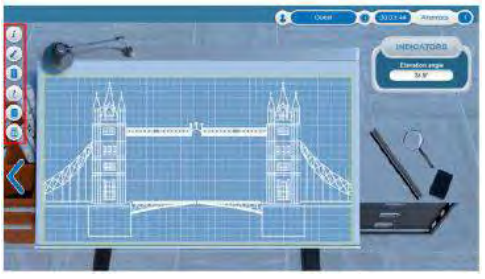
Calculator.

Celphone.

6.2 Procedures

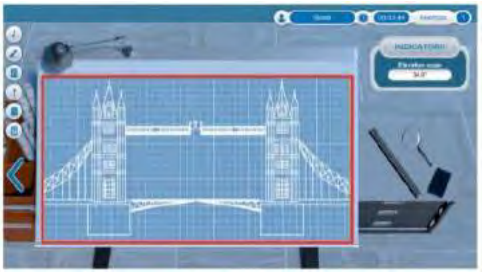
- Enter the virtual simulator for angles and triangles, register your personal information and select the image as shown.
- Read the situation/challenge and click on the icon to close the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to see the situation, the procedure or the equations as necessary. Click on the help icon for common questions. If you wish to stop the process in the laboratory and clear the work station at any time, click on the trash can icon. Clicking on the pencil icon will allow you to access the data registry. A calculator is provided at the work station and can be identified by the icon . The icon will allow you to answer the complementary questions.

Identification of laboratory materials:



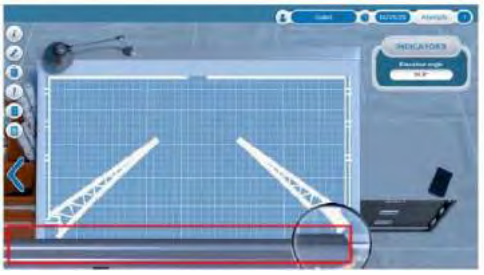
- Diagram of Tower Bridge
- Graduated ruler in centimeters for taking measurements
- Calculator

Taking measurements:



- Click on the diagram to zoom in on one of the sections of the bridge.
- Note that each suspender cable forms a right triangle with the tower and the base of the bridge.
- Drag and drop the ruler onto the catheti of the triangles formed by each suspender cable.
- Take note of the lengths of the catheti of each triangle formed on the section of the bridge.
- Register the length of each cathetus on a new page of the laboratory notebook.

Calculations:



- Use the information button “i” to see the equations related to this laboratory practice.
- To find the data required in the situation, use the value of the hypotenuses that you measured and the angle of elevation given in the situation.
- Take note of the values calculated.

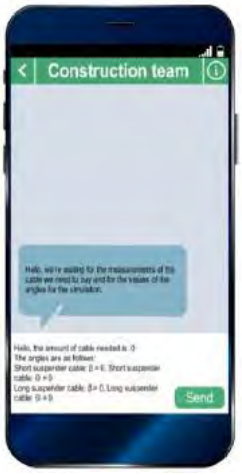
Data registry:

- Note that you will need to enter the following values into the data registry: angle of depression in degrees, width and maximum height of the boat in meters.
- For the data registry, take into consideration that the diagram is on a reduced scale of 1:150. This means that the measurements taken in the laboratory are 150 times smaller than those of the real bridge.
- Once you have entered all of the values into the data registry, click on the ‘Verify’ button to see if they are correct.

Complementary questions:

- Use the notebook button to answer the questions it contains.
- Note that there are four complementary questions to answer and you will need to use the arrow ▶ to go through them.
- The notebook allows you to add a new page or to delete one as necessary by using the button  .

Sending the data to the work team:



- Once the data registry is complete, click on the 'Report' button and you will get an enlarged view of a telephone with which to send the data to the bridge maintenance team.
- Check the values to be sent in the message and click on 'Send'. Note that the values are automatically taken from those you entered into the data registry.
- You will receive a message from the work team indicating the result of the maintenance work according to your calculations.

Evaluation and laboratory report:

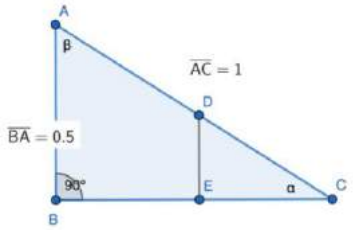
- If the values sent are correct, continue with the evaluation and then go on to generate the laboratory report.

6.3 Complementary questions

1. Considering the sides and angles, what type of triangle do the raised sections of the bridge form with the river?
2. What type of triangle does the length of the bridge form with the tower when it is not raised?
3. Can the trigonometric ratio of sine be greater than 1? Justify your answer.
4. Why do you think that the most widely used triangle rulers are 60º – 30º and 45º?

6.4 Conceptual questions

Multiple choice questions



Statement: When the sections of Tower Bridge are raised, they form a triangle with the horizontal of the bridge. The image therefore shows two equivalent triangles formed by the vertices ABC and DEC, where their hypotenuse is the section of the bridge that is raised. Given this information, answer the following:

1. What is the $\frac{\overline{DE}}{\overline{DC}}$ ratio?

   a. $\frac{1}{0.5}$

   b. 2

   c. $\sqrt{0.5}$

   d. 0.5

2. How much is sin(α)?

   a. 0.5

   b. 0.3

   c. 1

   d. $\sqrt{3}$

3. How much is cos(β)?

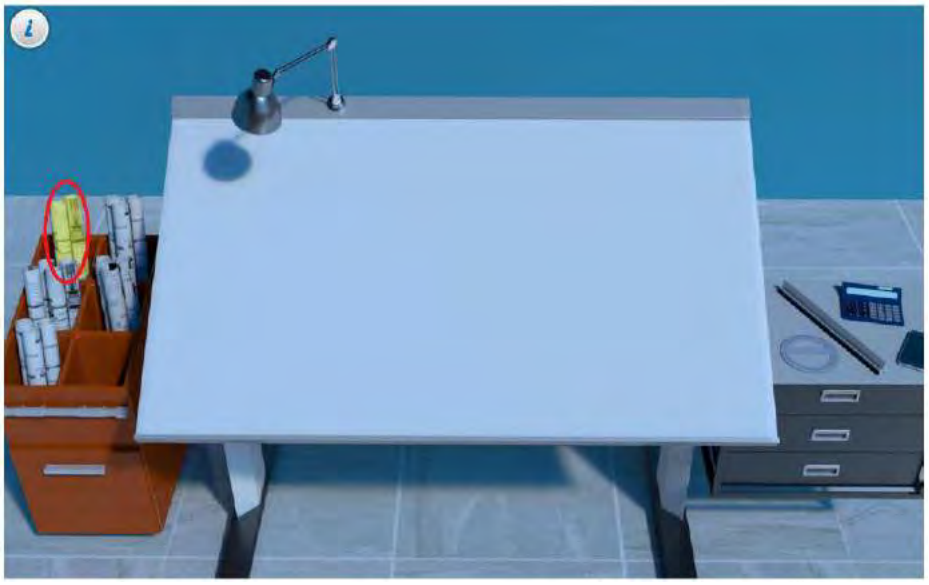
   a. 0.5

   b. $\frac{1}{0.5}$

   c. 1

   d. $\sqrt{2}$

7. Simulator for Angles and Triangles – Rescue on Tower Bridge



Mathematics – Angles and Triangles

As the bridge was being lifted, a pet got through the security fences and got onto the edge of the bridge. The authorities raised the alarm and stopped the motion of the bridge when it was at an angle of elevation. Due to the height, the animal is not able to get down on its own. The rescue team will use the upper structure of the bridge (the pedestrian walkway at a height of 35 m above the crossing of the vehicles) to lower a basket and get the pet to safety. You will need to support the rescue team by determining the distance between the point where the pet is and the upper part of the bridge (rescue distance), along with the angle between the bridge and the rescue basket (rescue angle). You have a scale drawing of the bridge on a scale of 1:150, which you will use to take the necessary measurements and calculate the distances that the rescue team require, taking into account the angle of elevation of the bridge. Note that the scale drawing is on a reduced scale, but you will have to give the rescue team the real measurements.

Objectives

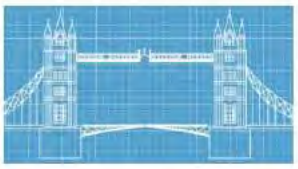
To recognize the importance of the concept of the triangle when solving geometric problems in various contexts.

Concepts and skills

Pythagoras' theorem, triangle measurements, geometric reasoning.

7.1 Laboratory equipment

Graduated ruler.



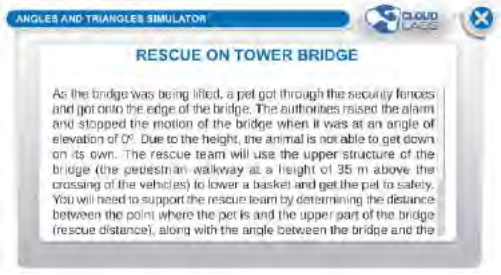
Scale drawing of Tower bridge.

Calculator.

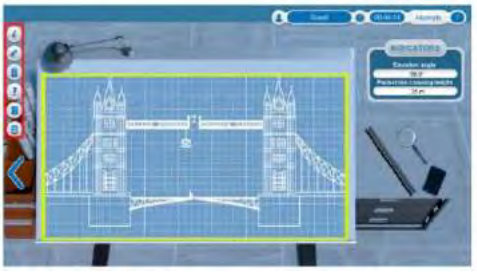
Celphone.

7.2 Procedures

- Enter the virtual simulator for angles and triangles, register your personal information and select the image as shown.
- Read the situation/challenge and click on the icon to close the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to see the situation, the procedure or the equations as necessary. Click on the help icon for common questions. If you wish to stop the process in the laboratory and clear the work station at any time, click on the trash can icon . Clicking on the pencil icon will allow you to access the data registry. A calculator is provided at the work station and can be identified by the icon . The icon will allow you to answer the complementary questions.

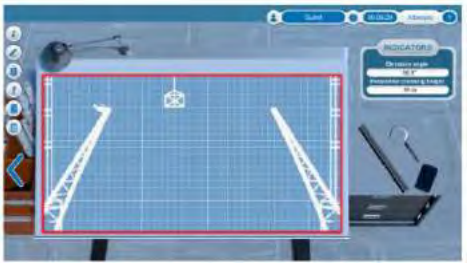


Identification of laboratory materials:



- Diagram of Tower Bridge
- Graduated ruler in centimeters for taking measurements
- Calculator

Taking measurements:



- Click on the diagram to zoom in on the central section of the bridge.
- Note that when the parts of the bridge are raised, each one forms a triangle with the base of the bridge (Figure 4).
- Drag and drop the ruler into place to measure the length of one of the raised parts of the bridge. This length will correspond to the hypotenuse of the triangle formed and its value is equal for both raised parts of the bridge (Figure 5).
- Take note of these values.

Calculations:

- Use the information button “i” to see the equations related to this laboratory practice.
- To find the data required in the situation, use the values of the hypotenuses that you measured, the angle of elevation given in the situation and the height of the pedestrian walkway, which is 35 m.
- Take note of the values calculated.

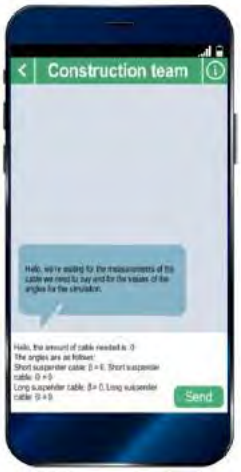
Data registry:

- Note that you will need to enter the following values into the data registry: rescue angle in degrees and rescue distance in meters.
- For the data registry, consider that the diagram is on a reduced scale of 1:150. This means that the measurements taken in the laboratory are 150 times smaller than those of the real bridge.
- Once you have entered all of the values into the data registry, click on the ‘Verify’ button to see if they are correct.

Complementary questions:

- Use the notebook button to answer the questions it contains.
- Note that there are four complementary questions to answer and you will need to use the arrow ▶ to go through them.
- The notebook allows you to add a new page or to delete one as necessary by using the button  .

Sending the data to the work team:



- Once the data registry is complete, click on the 'Report' button and you will obtain an enlarged view of a telephone with which to send the data to the rescue team.
- Check the values to be sent in the message and click on 'Send'. Note that the values are automatically taken from those you entered into the data registry.
- You will receive a message indicating the result of the rescue operation.

Evaluation and laboratory report:

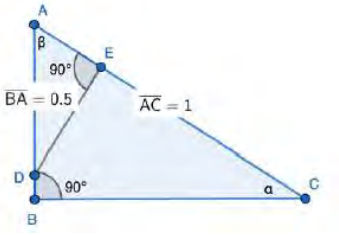
- If the values sent are correct, continue with the evaluation and then go on to generate the laboratory report.

7.3 Complementary questions

1. Considering its sides and angles, what type of triangle does the raised section of the bridge form with the river?
2. What other triangles are formed on the bridge seen in this laboratory?
3. Explain why if two triangles have two equal angles, the third one is also equal, regardless of the size of the triangles
4. Explain why if two triangles are equivalent, all of their trigonometric ratios are identical.

7.4 Conceptual questions

Multiple choice questions



Statement: There are two triangles, ABC and AED respectively, on which the right angle has been indicated. Answer the following questions:

1. What is the $\frac{\overline{ED}}{\overline{EA}}$ ratio?

   a. $\frac{1}{0.5}$

   b. 0.5

   c. 2

   d. $\sqrt{0.5}$

2. How much is cos(β)?

   a. $\frac{1}{0.5}$

   b. $\sqrt{2}$

   c. 0.5

   d. 1

3. How much is sin(α)?

   a. 0.5

   b. 0.3

   c. 1

   d. $\sqrt{2}$

8. Free Practice – Areas and Perimeters

Mathematics – Angles and Triangles

This laboratory practice will allow you to freely modify the shape and dimensions of triangles, and to measure and calculate different parameters for them.

Objectives

To recognize the importance of the concept of the triangle when solving geometric problems in various contexts.

Concepts and skills

Pythagoras' theorem, triangle measurements, geometric reasoning.

8.1 Laboratory equipment

Graduated ruler.

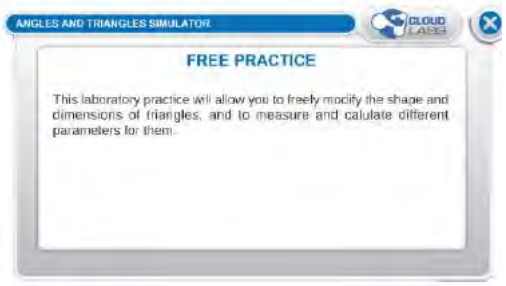
Protractor.

Work table.

Calculator.

8.2 Procedures

- Enter the virtual simulator for angles and triangles, register your personal information and select the image as shown.
- Read the situation/challenge and click on the icon to close the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to see the situation, the procedure or the equations as necessary. Click on the help icon for common questions. If you wish to stop the process in the laboratory and clear the work station at any time, click on the trash can icon . Clicking on the pencil icon will allow you to access the data registry. A calculator is provided at the work station and can be identified by the icon . The icon will allow you to answer the complementary questions.

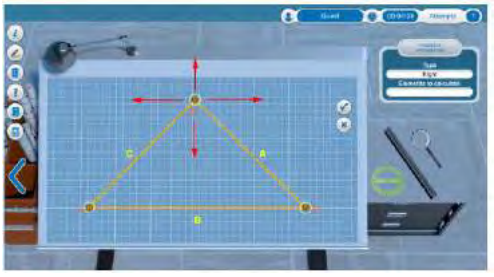


Identification of laboratory materials:

- Work table with a clear surface
- Tool for adding and modifying triangles
- Graduated ruler
- Protractor
- Calculator

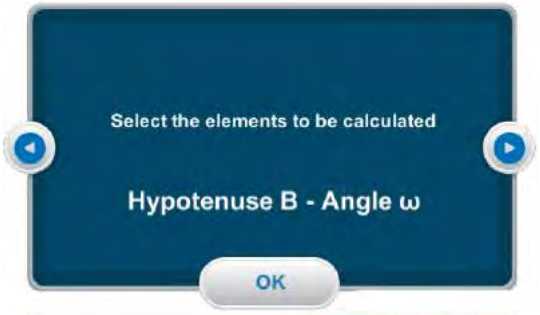
Drawing triangles:

- Click on the + button to add a triangle to the plane.
- Drag the points at the vertices of the triangle to modify its shape and size.
- Click on the check button to accept the configuration of the triangle. If you wish to delete the triangle and draw a new one, click on the X button.
- In the window that opens, select the elements you wish to calculate for the triangle drawn.



Measurements and calculations:

- Use the information button i to see the equations related to this laboratory practice.
- Use the ruler to measure the sides of the triangle. Note that there will be restrictions on measuring certain sides of the triangle, depending on how you have configured the practice.
- Use the protractor to measure the angles of the triangle. Note that there will be restrictions on measuring certain angles of the triangle, depending on how you have configured the practice.
- Take note of these values.
- Use the equations provided in the simulator to find the values of the triangle that you have selected.



Data registry:

- Remember that for the data registry in this laboratory practice, you will need to enter the data in accordance with the selection you made when you drew the triangle.
- Once you have entered all of the values into the data registry, click on the ‘Verify’ button to see if they are correct.

Evaluation and laboratory report:

- If the values registered are correct, go on to generate the laboratory report.

8.3 Equations

Perimeter of a triangle:

$P=A+B+C$

Heron's formula:

$A=\sqrt{(S-A)(S-B)(S-C)}$; $S=P2$

9. Free Practice – Law of Sines

Mathematics – Angles and Triangles

This laboratory practice will allow you to freely modify the shape and dimensions of triangles, and to measure and calculate different parameters for them.

Objectives

To recognize the importance of the concept of the triangle when solving geometric problems in various contexts.

Concepts and skills

Pythagoras' theorem, triangle measurements, geometric reasoning.

9.1 Laboratory equipment

Graduated ruler.

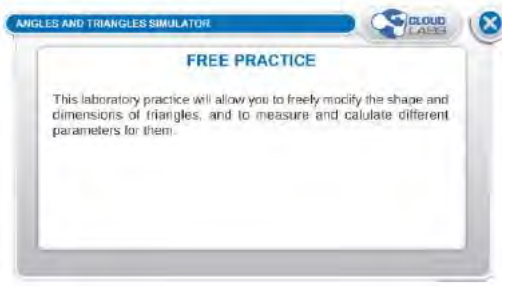
Protractor.

Work table.

Calculator.

9.2 Procedures

- Enter the virtual simulator for angles and triangles, register your personal information and select the image as shown.
- Read the situation/challenge and click on the icon to close the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to see the situation, the procedure or the equations as necessary. Click on the help icon for common questions. If you wish to stop the process in the laboratory and clear the work station at any time, click on the trash can icon . Clicking on the pencil icon will allow you to access the data registry. A calculator is provided at the work station and can be identified by the icon . The icon will allow you to answer the complementary questions.

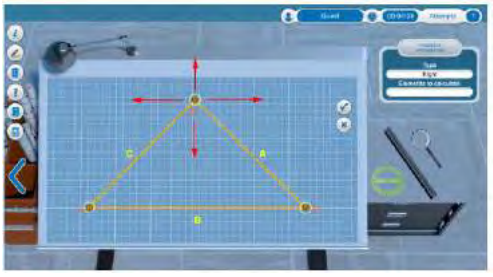


Identification of laboratory materials:

- Work table with a clear surface
- Tool for adding and modifying triangles
- Graduated ruler
- Protractor
- Calculator

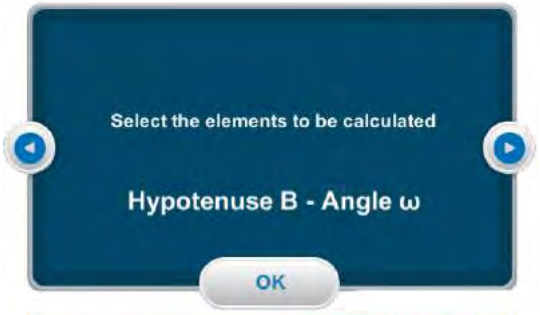
Drawing triangles:

- Click on the + button to add a triangle to the plane.
- Drag the points at the vertices of the triangle to modify its shape and size.
- Click on the check button to accept the configuration of the triangle. If you wish to delete the triangle and draw a new one, click on the X button.
- In the window that opens, select the elements you wish to calculate for the triangle drawn.



Measurements and calculations:

- Use the information button i to see the equations related to this laboratory practice.
- Use the ruler to measure the sides of the triangle. Note that there will be restrictions on measuring certain sides of the triangle, depending on how you have configured the practice.
- Use the protractor to measure the angles of the triangle. Note that there will be restrictions on measuring certain angles of the triangle, depending on how you have configured the practice.
- Take note of these values.
- Use the equations provided in the simulator to find the values of the triangle that you have selected.



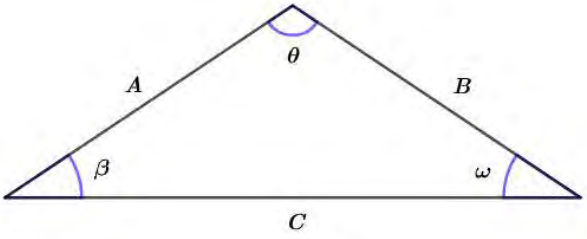
Data registry:

- Remember that for the data registry in this laboratory practice, you will need to enter the data in accordance with the selection you made when you drew the triangle.
- Once you have entered all of the values into the data registry, click on the ‘Verify’ button to see if they are correct.

Evaluation and laboratory report:

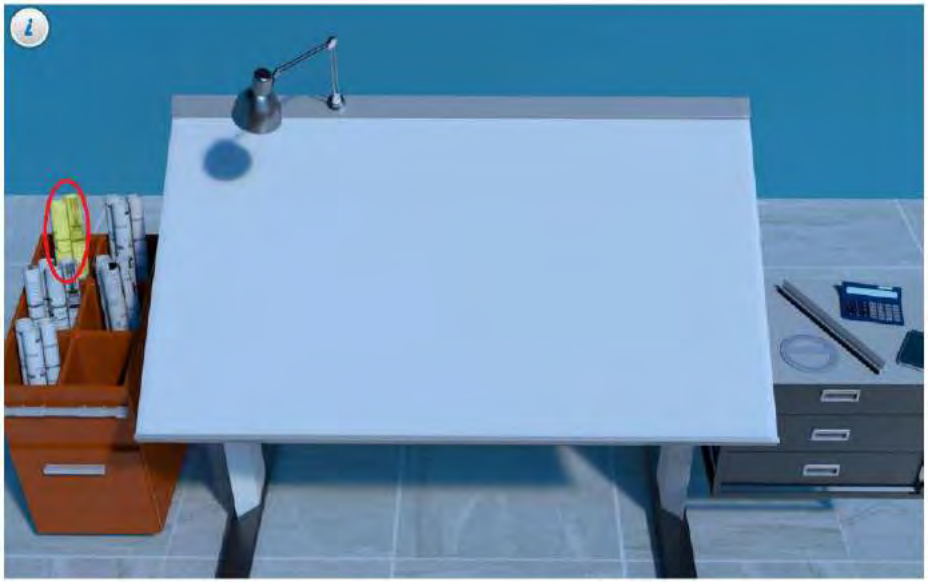
- If the values registered are correct, go on to generate the laboratory report.

9.3 Law of Sines



$$\frac{\sin(\omega)}{A} = \frac{\sin(\beta)}{B} = \frac{\sin(\theta)}{C}$$

10. Free Practice – Law of Cosines



Mathematics – Angles and Triangles

This laboratory practice will allow you to freely modify the shape and dimensions of triangles, and to measure and calculate different parameters for them.

Objectives

To recognize the importance of the concept of the triangle when solving geometric problems in various contexts.

Concepts and skills

Pythagoras' theorem, triangle measurements, geometric reasoning.

10.1 Laboratory equipment

Graduated ruler.

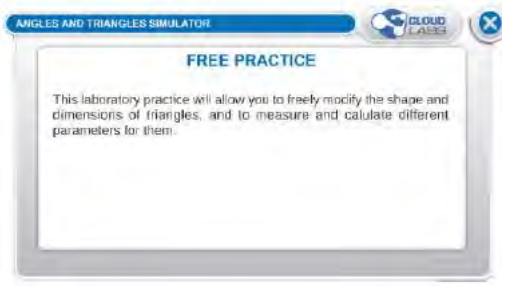
Protractor.

Work table.

Calculator.

10.2 Procedures

- Enter the virtual simulator for angles and triangles, register your personal information and select the image as shown.
- Read the situation/challenge and click on the icon to close the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to see the situation, the procedure or the equations as necessary. Click on the help icon for common questions. If you wish to stop the process in the laboratory and clear the work station at any time, click on the trash can icon . Clicking on the pencil icon will allow you to access the data registry. A calculator is provided at the work station and can be identified by the icon . The icon will allow you to answer the complementary questions.

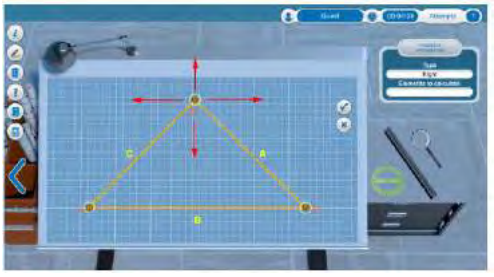


Identification of laboratory materials:

- Work table with a clear surface
- Tool for adding and modifying triangles
- Graduated ruler
- Protractor
- Calculator

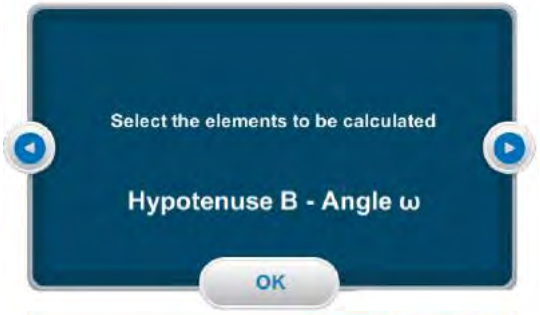
Drawing triangles:

- Click on the + button to add a triangle to the plane.
- Drag the points at the vertices of the triangle to modify its shape and size.
- Click on the check button to accept the configuration of the triangle. If you wish to delete the triangle and draw a new one, click on the X button.
- In the window that opens, select the elements you wish to calculate for the triangle drawn.



Measurements and calculations:

- Use the information button i to see the equations related to this laboratory practice.
- Use the ruler to measure the sides of the triangle. Note that there will be restrictions on measuring certain sides of the triangle, depending on how you have configured the practice.
- Use the protractor to measure the angles of the triangle. Note that there will be restrictions on measuring certain angles of the triangle, depending on how you have configured the practice.
- Take note of these values.
- Use the equations provided in the simulator to find the values of the triangle that you have selected.



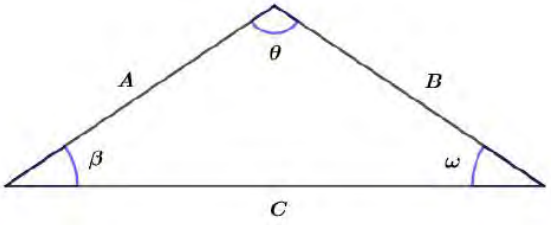
Data registry:

- Remember that for the data registry in this laboratory practice, you will need to enter the data in accordance with the selection you made when you drew the triangle.
- Once you have entered all of the values into the data registry, click on the ‘Verify’ button to see if they are correct.

Evaluation and laboratory report:

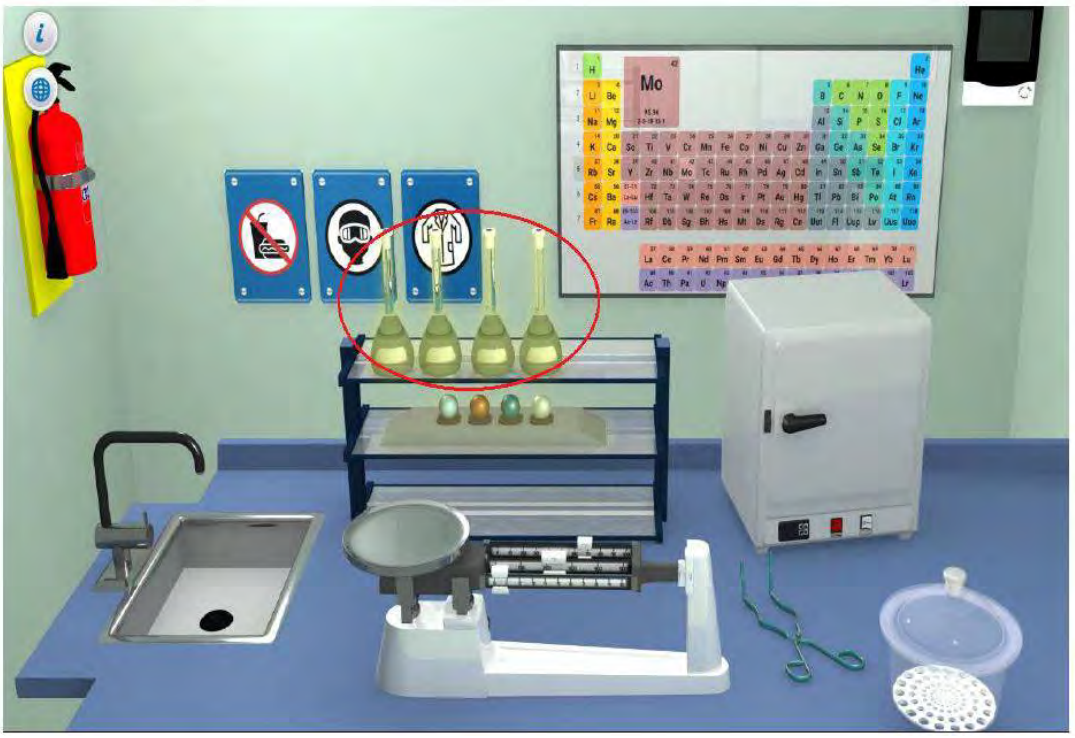
- If the values registered are correct, go on to generate the laboratory report.

10.3 Law of Cosines



$$C^2 = A^2 + B^2 - 2AB\cos\theta$$

11. Determining the Density of Liquids



Chemistry Matter

In the virtual laboratory is a work table with all the tools necessary to help solve the challenge for the density of liquids. The liquids are samples from an industry that produces saline solutions to be used in the manufacturing of serum for health institutions. The volume of the samples will be found using a pycnometer, which must be dried in the oven, weighed on the triple beam balance and then used to determine the density of the solutions available in the laboratory. Remember to record the data and fill in the data registry with the measurements obtained in the laboratory. At the end, calculate and record the density of the four saline solutions.

Objectives

Determine the density of liquid saline solutions.

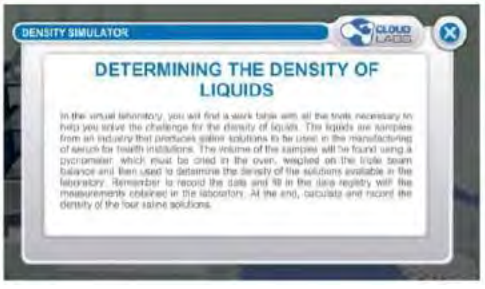
Concepts and skills

Measurement, density, volume, mass, triple beam balance, pycnometer, saline solutions.

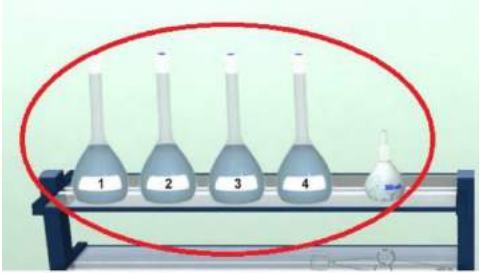
11.1 Laboratory equipment

11.2 Procedures

- Enter the virtual simulator for Density, register your personal information and select the image as shown.
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station.



1. Locate the solutions with unknown densities and the pycnometer.



2. Prepare the pycnometer.

- Click on and drag the pycnometer to the oven.
- Click on the oven door to close it. Wait for the pycnometer to dry. The elapsed time is determined by the lab simulator. When the pycnometer is ready, the oven door will open automatically.
- Take the prepared pycnometer out of the oven using the lab tongs and cool in in the desiccator on the work table. (fig. 7) After the elapsed time, click on the desiccator to remove the pycnometer to the work table.

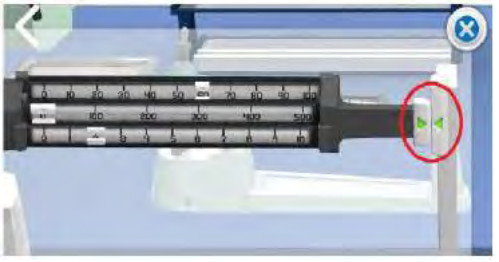
3. Mass the pycnometer.

- Place the pycnometer on the pan of the triple-beam balance (a highlighted active zone will appear for proper placement).
- Click on the rider beams of the balance to configure the mass by moving the sliding masses (riders) of the balance until the points on the two triangles match up and the balance is in equilibrium.
- The correct value is obtained when the arrows located on the right side of the balance are aligned and light up.

- Click on the pencil icon to record the mass for the pycnometer in the data registry.

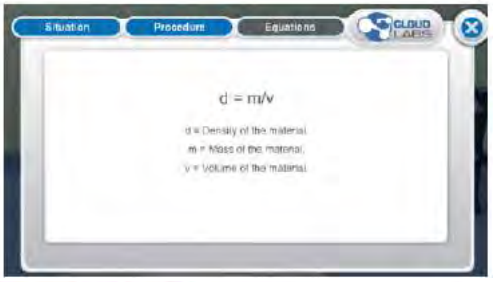
4. Mass the solution.

- Add solution 1 to the pycnometer: Click and drag the pycnometer to the highlighted active zone on the work table.
- Click and drag solution 1 to the pycnometer to fill it. Click the X to return it to the shelf.

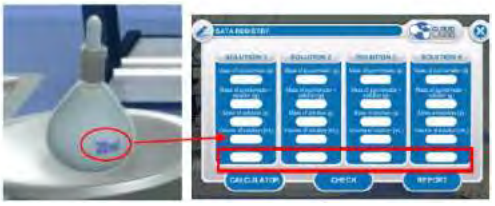


- Place the solution filled pycnometer on the triple-beam balance.
- Configure the mass the solution filled pycnometer and record the data in the data registry.
- Determine the mass of the solution by subtracting the beginning mass of the pycnometer from the ending mass of the solution filled pycnometer.

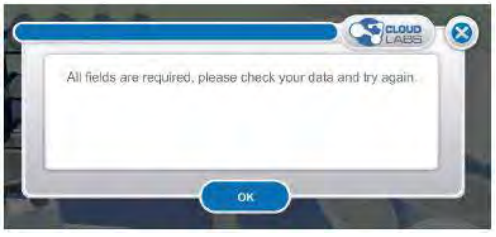
5. Calculate the density of the solution.



- Click on the ⓘ to see the equation for density.
- The volume of the solution is determined by the volume of the pycnometer – see pycnometer.
- Use the calculator to determine the density of the sample using the collected data and the equation.



6. REPEAT steps 1 through 5 for each of the other 3 samples and record the data and calculate the density of each solution.



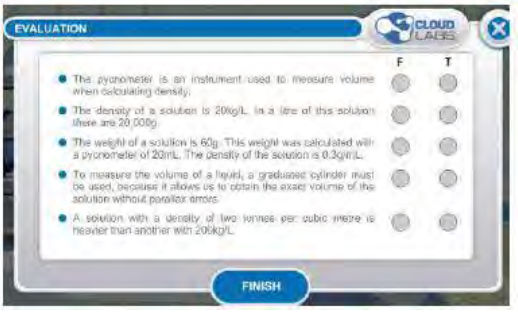
- To clear the lab for each new sample, click the trash icon .
- Click the CHECK button after entering all the data.
- The data may not be checked until all the data has been entered.

- After completing the required operations and recording, click the check button. If there is incorrect data a message will state to go back and check the data that was entered. Click OK to return to the main page.

- Check the data registry to see all incorrect data. A red 'X' appears by the areas containing incorrect information. (fig. 17)

- Each time the data is checked and new information is input, an attempt will be registered.
- If the data is correct you will get a success notice, click the REPORT button.

- Complete the T/F Evaluation and then click the FINISH button to generate a lab report to save as evidence of learning and to turn into the instructor. Optional guided questions are part of the lab report.
- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.



11.3 Evaluation Question Keys

Answer each statement as true or false.

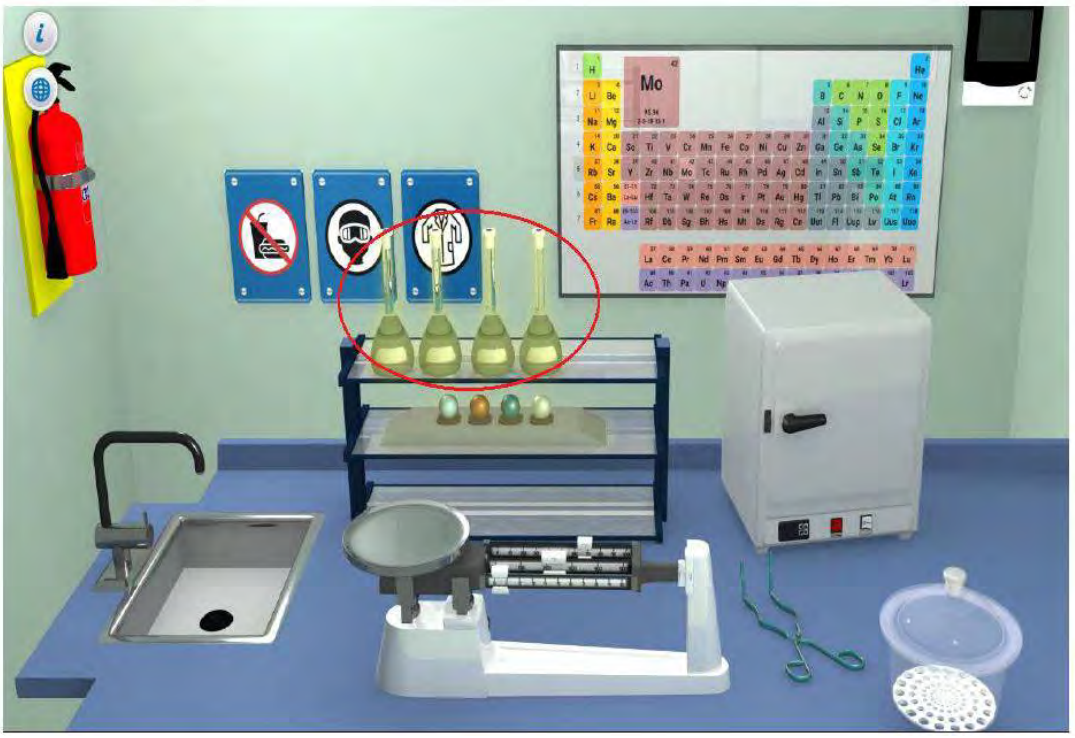
- The pycnometer is an instrument used to measure volume when calculating density.
- The density of a solution is 20kg/L. In a liter of this solution there are 20,000g.
- The weight of a solution is 60g. This weight was calculated with a pycnometer of 20mL. The density of the solution is 0.3g/mL.
- To measure the volume of a liquid, a graduated cylinder must be used, because it allows us to obtain the exact volume of the solution without parallax errors.
- A solution with a density of two tonnes per cubic meter is heavier than another with 200kg/L.

11.4 Complementary Questions

These questions appear at the end of the lab report.

- To find the density of a solid such as metallic sodium, oil must be used to indirectly obtain the volume, and not water. Why?
- For the density of a solid to be greater than a unit (one), what must the relationship be between the weight of the solid and the volume? Explain.
- What would be the density of a solid weighing 25g with a volume of 75mL?
- Name three objects, elements or devices that rely on the concept of density to function.

12. Determining the Density of Solids



Chemistry Matter

In the virtual lab is a work table with all the tools necessary determine the density of solids. The solids have been gathered from an industry that wishes to carry out a quality control of its prime materials. First, determine the mass of the solid samples using the calibrated triple beam balance; then find the volume of the samples using displacement of liquids in a graduated cylinder. Remember to register the data and fill in the tables with the measurements. At the end, calculate the density of each one of the materials: iron (Fe), copper (Cu), aluminum (Al) and metallic sodium (Na).

Objectives

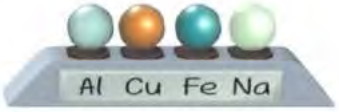
Determine the density of solids using displacement of a liquid.

Concepts and skills

Measurement, density, displacement, volume, mass, triple beam balance, graduated cylinder, solids (Al, Cu, Fe, Na).

12.1 Laboratory equipment

triple-beam balance



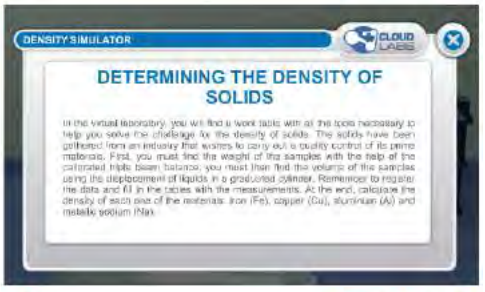
solids
(aluminum, copper, iron, metallic sodium)

graduated cylinder

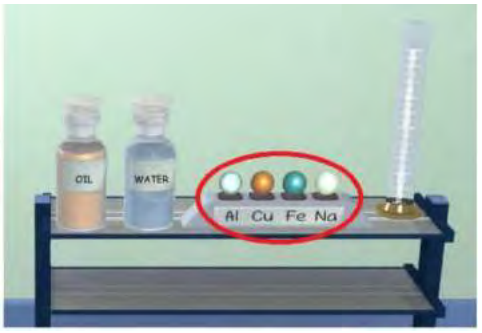
Oil, water

12.2 Procedures

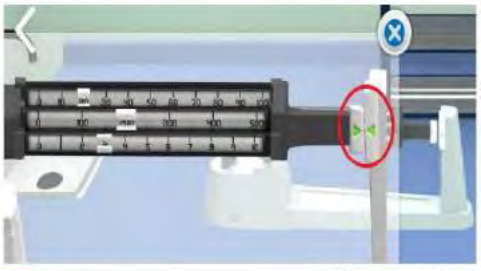
- Enter the virtual simulator for Density, register your personal information and select the image as shown.
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station.



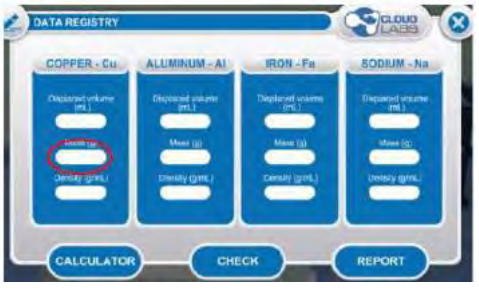
1. Identify the solid samples (aluminum, copper, iron, and metallic sodium).
2. Mass the solid sample.



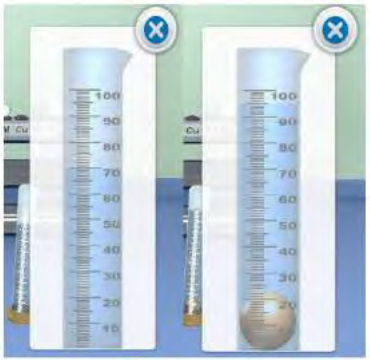
- Drag the selected solid to the triple-beam balance to determine the mass of the sample.
- Place the sample on the pan of the triple-beam balance (a highlighted active zone will appear for proper placement). Click on the rider beams of the balance to configure the mass of the solid.



- Move the sliding masses (riders) of the balance until the points on the two triangles match up and the balance is in equilibrium. The correct value is obtained when the arrows located on the right side of the balance are aligned and light up.
- Click on the pencil icon to record the mass of the sample as indicated by the triple-beam balance in the data registry.



3. Find the volume of the sample using displacement of a liquid.

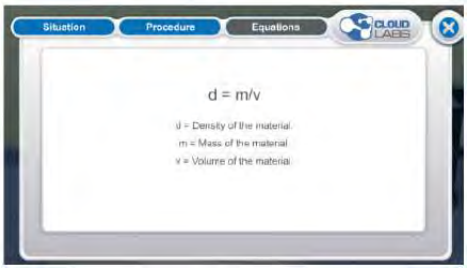


- Drag the graduated cylinder to the active zone on the work station (highlighted area).
- Add one of the liquids found in the lab (water or oil) to the graduated cylinder.
- Click on the cylinder to obtain an enlarged view of the cylinder scale. (Note the volume) Add the solid sample to the cylinder and read the volume of displaced liquid.
- To determine the volume of the solid, it is necessary to subtract the beginning volume in the cylinder from the ending volume after adding the solid sample.

- Click on the pencil icon to record the volume in the data registry.

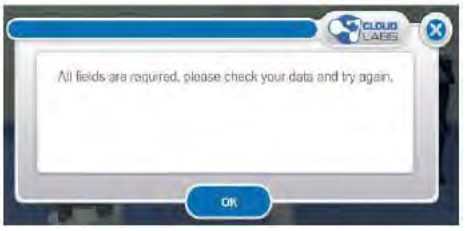
4. Calculate the density of the sample.

- Click on the ⓘ to see the equation for density.
- Use the calculator to determine the density of the sample using the collected data and the equation.
- Click on the pencil icon to record the data of the sample in the data registry.



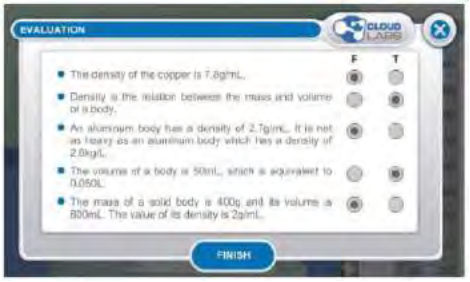
5. REPEAT steps 1 through 4 for each of the other 3 samples and record the data and calculate the density of each solid.

- To clear the lab for each new sample, click the trash icon
- Click the CHECK button after entering all of the data.
- The data may not be checked until all data has been entered.

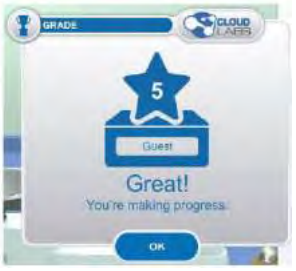


- After completing the required operations and recording, click the check button. If there is incorrect data a message will state to go back and check the data that was entered. Click OK to return to main page.
- Check the data registry to see all incorrect data. A red 'X' appears by the areas containing incorrect information.
- Each time the data is checked and new information is input, an attempt will be registered.
- If the data is correct you will get a success notice, click the REPORT button.
- Complete the T/F Evaluation and then click the FINISH button to generate a lab report

to save as evidence of learning and to turn into the instructor. Optional guided questions are part of the lab report.



- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.



12.3 Evaluation Questions

Answer each statement as true or false.

- The density of the copper is 7.8g/mL.
- Density is the relation between the mass and volume of a body.
- An aluminum body has a density of 2.7g/mL. It is not as heavy as an aluminum body which has a density of 2.6kg/L.
- The volume of a body is 50mL, which is equivalent to 0.050L.
- The mass of a solid body is 400g and its volume is 800mL. The value of its density is 2g/mL.

12.4 Complementary Questions

These questions appear at the end of the lab report.

- To find the density of a solid such as metallic sodium, oil must be used to indirectly obtain the volume, and not water. Why?
- For the density of a solid to be greater than a unit (one), what must the relationship be between the weight of the solid and the volume? Explain.
- What would be the density of a solid weighing 25g with a volume of 75mL?
- Name three objects, elements or devices which rely on the concept of density to function.

13. Adding Vectors

Physics Vectors

A small boat has gone adrift without navigation instruments, but has managed to communicate with the coastguards by radio. As the pilot of a rescue helicopter, determine the location of the boat using triangulation. However, the boat is adrift, and is moving north at 8 km/h, while the wind is blowing towards the northeast (30 degrees), displacing the boat by 12 km/h. Additionally, determine the helicopter's flight distance and the degree of the direction at which it should fly: North (N), South (S), Northeast (NE), Northwest (NW), Southeast (SE) or Southwest (SW).

Objectives

Use the parallelogram method to plot a resultant vector.

Concepts and skills

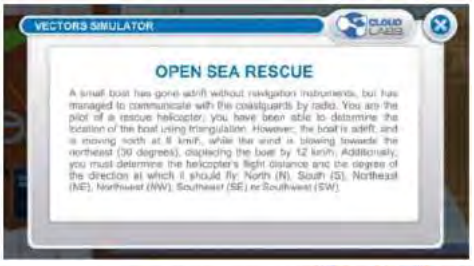
Vectors, parallelogram, method resultant vector, adding vectors.

13.1 Laboratory equipment

1. draft table with Cartesian plane
2. set-square
3. calculator

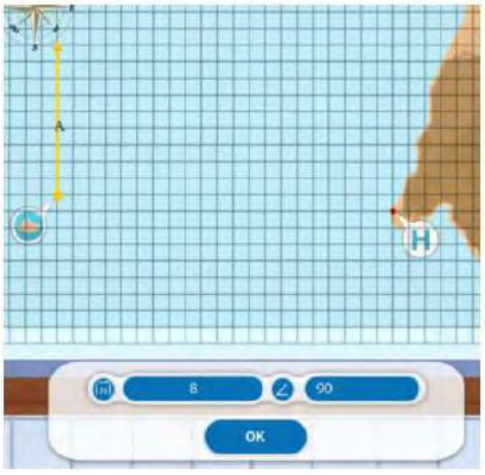
13.2 Procedures

- Enter the virtual simulator for Vectors, register your personal information and select the image as shown.
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and erase/delete any data collected in the data registry.



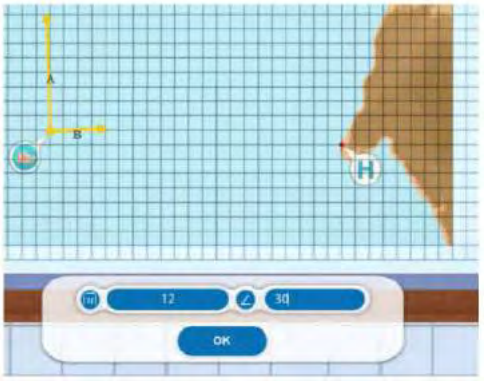
1. Identify the lab materials:
    - Locate the draft table with the Cartesian plane and the set-square.

2. Plot the first vector (A): the magnitude and direction the boat is traveling.
    - Click the information icon to see the situation.
    - Click and drag to draw the first vector (A) starting at the location of the boat on the Cartesian plane. A popup will appear to show the exact magnitude and the direction (angle) of the vector. (fig. 5)

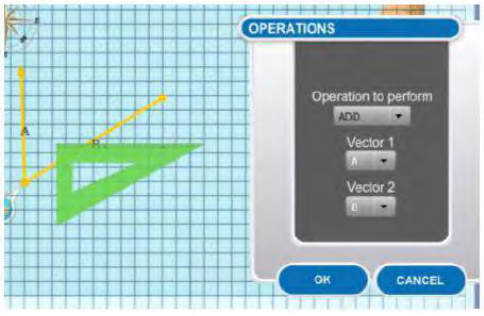


    - Adjust the vector by clicking it. Four icons will pop up to allow these operations: (+) add another vector from the same point of origin, (pencil) edit the magnitude and angle of the vector, (directional arrows) move the vector, (trash) delete the vector. If vectors have been deleted and redrawn, the corresponding letters may not be A and B.
    - Click the (pencil) icon to edit the magnitude and direction of the vector. Click in the boxes provided and type the exact measurement as needed.

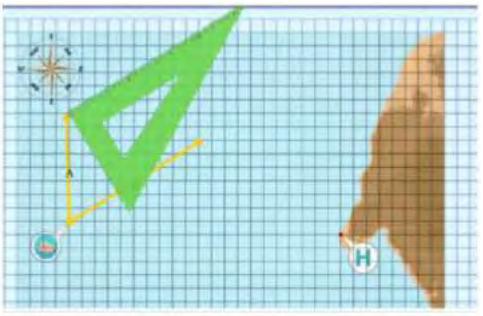
3. Plot the second vector (B): the magnitude and direction of the wind.
    - Click on the first vector (A) to access the edit icons and click on the (+) to add the second vector (B) from the same point of origin (the boat).
    - Click the approximate position of the end of the vector.
    - Click the second vector (B) to adjust the magnitude and angle.

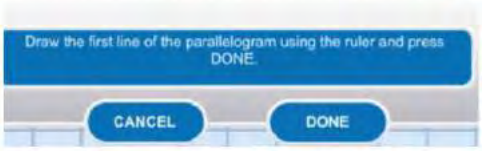


4. Use the parallelogram method to determine the location of the boat.
    - Click and drag the set-square to the table.

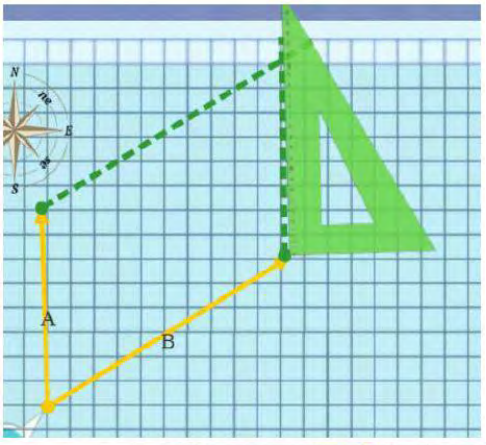


- An operations menu will appear, select the operation (add) and the vectors to add (letters representing the two vectors).
- Directions will appear to guide the process of drawing the parallels (A and B) and the resulting vector (fig. 9 &10)
- (A + B). Click and drag along the dotted line on the set-square to draw.

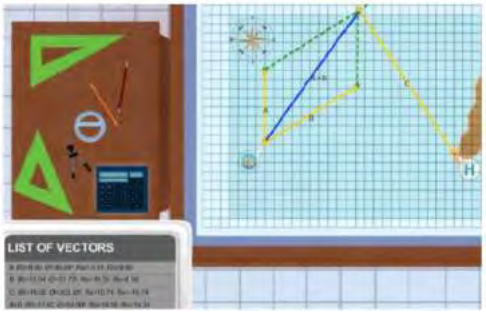




5. Plot the third vector (C): the trajectory that the helicopter must follow to reach the boat.
   - Click and draw the vector from the heliport (H) to the boat location as determined by previous steps.

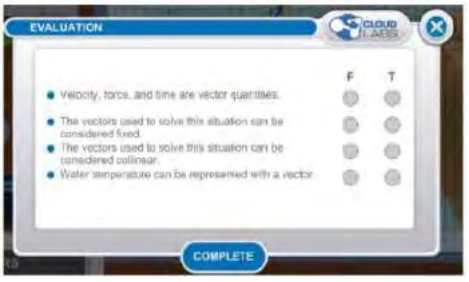


6. Complete the data registry and check.
   - Use the data in the table at the bottom left of screen under “List of Vectors”.
   - Register the magnitude IRI and the angle øof the boat.
   - Register the magnitude IRI, the angleø, and the direction (N, S, E, W, NE, NW, SE, or SW) of the helicopter.
   - After entering the data, click the check button.
   - If there is incorrect data, a message will state to go back and check the data that was entered. (fig. 13)
   - To see the incorrect data, click on the pencil icon, a red X will appear by areas containing incorrect information.
   - Each time an unsuccessful message appears and the lab is restarted, an attempt will appear in the lab report.
   - If the data is correct, you will get a success notice, click the report button.
   - Complete the T/F Evaluation and then click the finish button to generate a lab report to save as evidence of



learning and to turn into the instructor. Optional guided questions are part of the lab report.

- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.



13.3 Evaluation Questions

Answer each statement as true or false.

- Velocity, force and time are vector quantities.
- The vectors used to solve this situation can be considered fixed.
- The vectors used to solve this situation can be considered collinear.
- Water temperature can be represented with a vector.

13.4 Complementary Questions

These questions appear at the end of the lab report.

1. In this situation, is it possible to include vectors in the Z axis? Please explain.
2. If you had to analyze the rescue time in this situation, could you represent it with a vector?
3. Besides a number and a direction, what else do you need for representing a vector quantity?

14. Subtracting Vectors (Adding Head-to-Tail)

Physics Vectors

A new hanging bridge is being built in a settlement which has a river running through it. Calculate the maximum weight tolerated by a section of the bridge by subtracting the upward force of the structure of the bridge from the downward force applied by the vehicles crossing the bridge. For the bridge to maintain equilibrium, the result of the subtraction must equal zero (0). There are 5 vectors with positive (upward) force that correspond to the bridge's cables. Add these vectors using the head-to-tail method to find a resultant vector with negative (downward) force that represents the weight of the bridge. Keep in mind that the subtraction of the vector with downward force from the 5 vectors with upward force will need to equal zero (0).

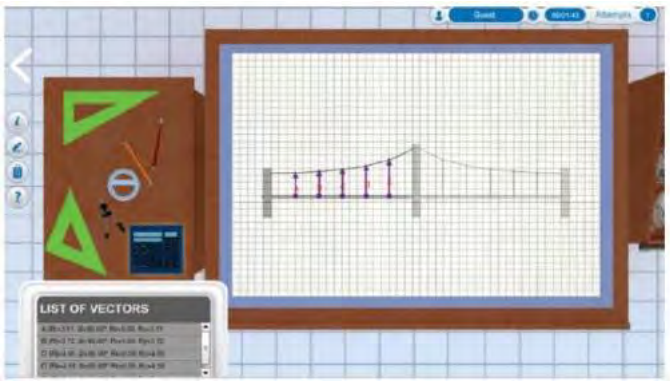
Objectives

Use the head-to-tail method to add vectors and subtracting vectors.

Concepts and skills

Vectors, adding (head-to-tail method), subtracting.

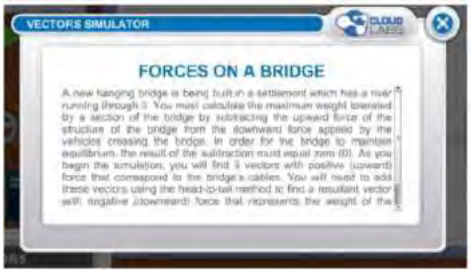
14.1 Laboratory equipment



1. draft table with Cartesian plane
2. calculator

14.2 Procedures

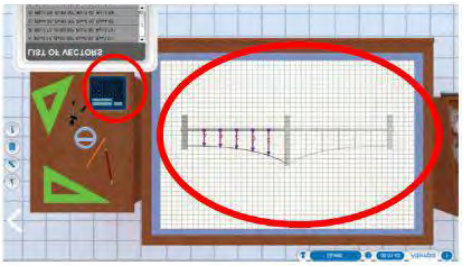
- Enter the virtual simulator for Vectors, register your personal information and select the image as shown.



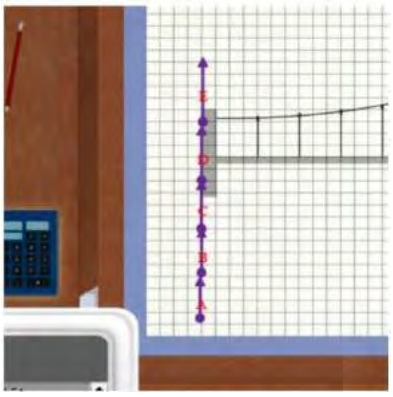
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.

- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and erase/delete any data collected in the data registry.

1. Identify the lab materials:
    - Locate the Cartesian plane and the calculator.

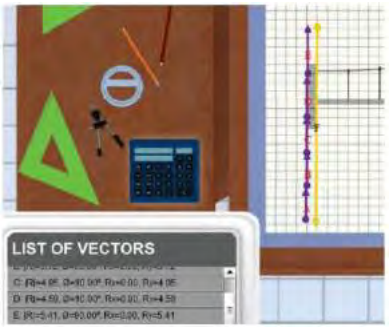


2. Add the vectors (A-E) using the head-to-tail method.



- Use the 5 vectors drawn on the bridge that represent the force that each cable applies to the bridge (a positive upward force).
- Click on vector A and an icon menu will appear.
- Click on the (directional arrows) icon to move the vector to the side of the drawing to allow for space to place all the vectors stacked head-to-tail.
- Click on vector B, move it and place the head of the vector B to the tail of vector A.
- Continue this same procedure until all the vectors have been placed head-to-tail.
- Avoid erasing the vectors. If this happens, the practice must be restarted by using the trash icon on the main screen.

3. Plot a vector (F) that represents the downward force on the bridge.

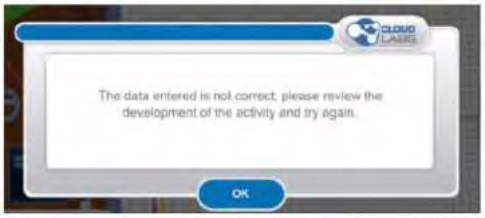


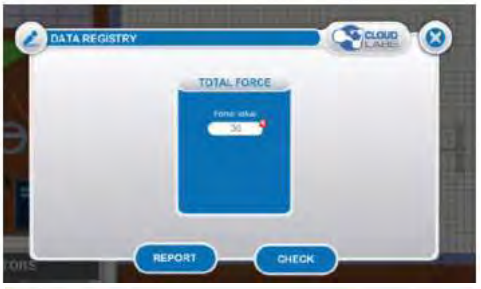
- This is the negative downward force that the bridge can withstand. It must be subtracted from the sum of the vectors that represent the bridge cables to obtain a zero (0).
- Click and drag next to the stacked vectors to draw a vector (F) that extends the same distance from the head of the first vector (A) to the tail of the last vector (E).

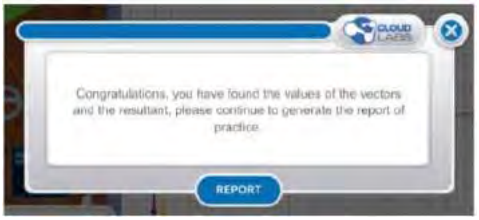
4. Record the magnitude of vector (F) and check.

- Refer to the List of Vectors in the bottom left of screen.
- Record the magnitude IRI of vector (F) in the data registry.
- After entering the data, click the check button.

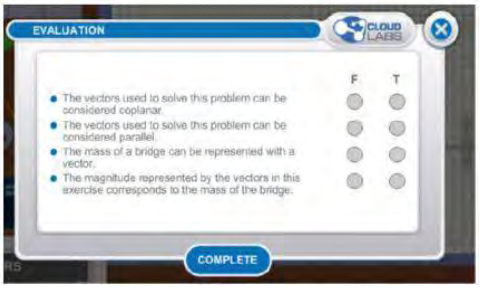
- If there is incorrect data a message will state to go back and check the data that was entered.
- To see the incorrect data, click on the pencil icon, a red X will appear by areas containing incorrect information. (fig. 9)
- Each time an unsuccessful message appears and the lab is restarted, an attempt will appear in the lab report.
- If the data is correct, you will get a success notice, click the report button.







- Complete the T/F Evaluation and then click the (finish) button to generate a lab report to save as evidence of learning and to turn into the instructor. Optional complementary questions are part of the lab report.



- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.

14.3 Evaluation Questions

Answer each statement as true or false.

- The vectors used to solve this problem can be considered coplanar.
- The vectors used to solve this situation can be considered parallel.
- The mass of a bridge can be represented with a vector.
- The magnitude represented by the vectors in this exercise corresponds to the mass of the bridge.

14.4 Complementary Questions

These questions appear at the end of the lab report.

1. In this situation, what is the result of a subtraction which gives a negative number?
2. Is the downward force on the bridge and the weight of the vehicles directly proportional magnitudes? Please explain.
3. In this situation, what is the sum of all the magnitudes represented on the X axis?

15. Subtracting Vectors (Free Practice)

Physics Vectors

In this free practice lab, plot and draw the various types of vectors. This laboratory may also be used as an interactive space to facilitate and solve class assigned problems.

Objectives

Draw and identify various types of vectors.

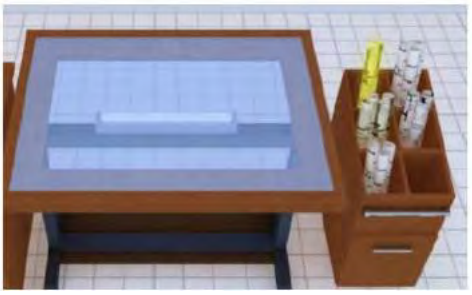
Concepts and skills

Cartesian plane, types of vectors (fixed, free, coplanar, collinear, sliding, parallel, concurrent).

15.1 Laboratory equipment

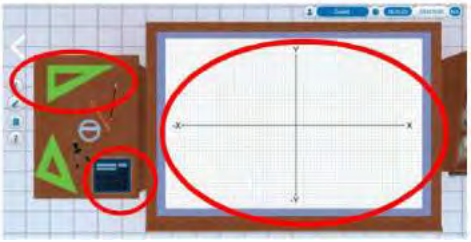
1. draft table with Cartesian plane
2. set-square
3. calculator

15.2 Procedures

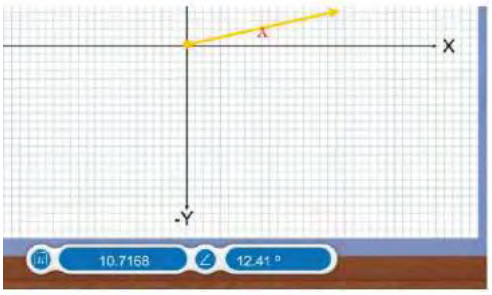


- Enter the virtual simulator for Vectors, register your personal information and select the image as shown.
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and erase/delete any data collected in the data registry.

1. Identify the lab materials:
   - Locate the Cartesian plane, the set square and the calculator.

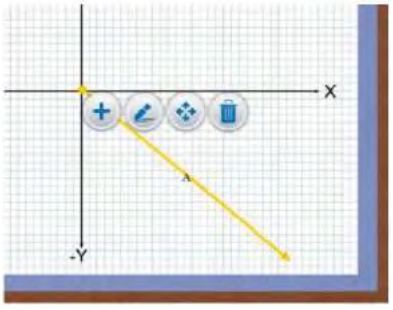


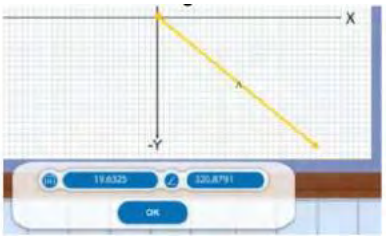
2. Drawing a vector.



- To draw a vector, click and drag on the Cartesian plane from where you desire the point of origin to be located.
- The magnitude is determined by how long the line is drawn on the plane.
- The direction (angle) is determined by the direction in which you draw the line.
- As you draw the vector a pop up will appear giving the magnitude and angle as you draw.
- Once the vector is complete, this information is generated in a table at the left of the screen (List of Vectors).

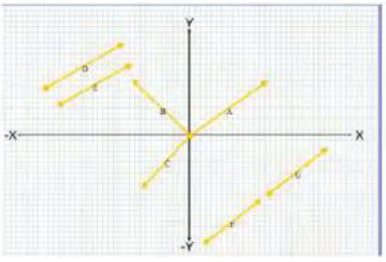
3. Editing a drawn vector.





- Click on the vector you wish to edit and a menu will appear by the vector with the following operations:
  - The(+)allows a vector to be added with the same point of origin.
  - The (pencil) allows the magnitude and angle to be adjusted by typing in the desired values.
  - The (directional arrows) allow the vector to be moved.
  - Use the (trash can) to delete the vector.

4. Practice drawing the following types of vectors:



- Fixed, free, coplanar, collinear, sliding, parallel, and concurrent.

5. Submit the lab report.

- Click on the pencil icon on the main screen to generate the lab report.
- The report will contain a snapshot of the Cartesian plane and any vectors drawn and the data collected in the List of Vectors table.

Note: This lab may be used to practice adding vectors (head-to-tail method or the parallelogram method), subtracting vectors, or to solve problems assigned by the instructor. See the other lab guides for practices with detailed instructions on the head-to-tail or

parallelogram methods.

15.3 Evaluation Questions

There are no evaluation questions for this lab practice.

15.4 Complementary Questions

There are no evaluation questions for this lab practice.

16. Resultant of Two Forces (Free Practice)

Physics Vectors

In this free practice lab, draw two vectors that are representative of forces with magnitudes and direction and determine the resultant vector of the two forces. This laboratory may also be used as an interactive space to facilitate and solve class assigned problems.

Objectives

Draw vectors and solve for the resultant vector of two forces.

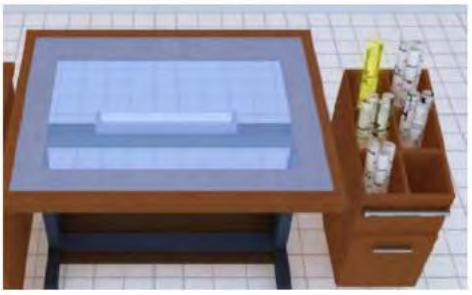
Concepts and skills

Cartesian plane, set-square, resultant vector.

16.1 Laboratory equipment

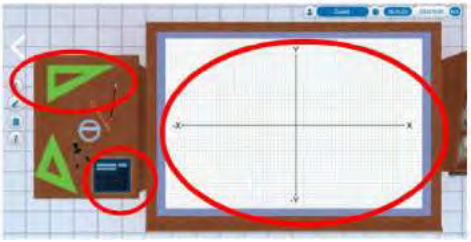
1. draft table with Cartesian plane
2. set-square
3. calculator

16.2 Procedures

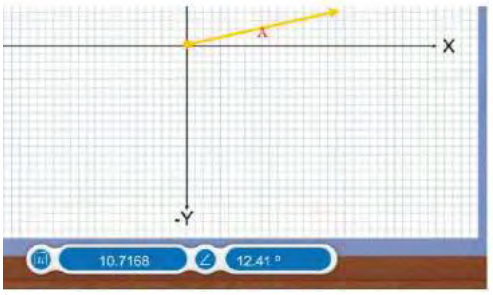


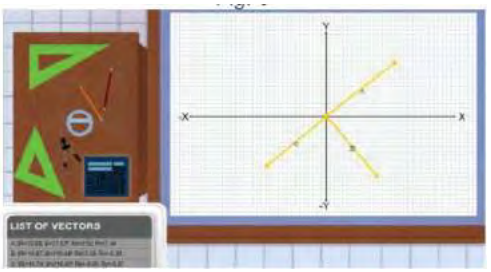
- Enter the virtual simulator for Vectors, register your personal information and select the image as shown.
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and erase/delete any data collected in the data registry.

1. Identify the lab materials:
   - Locate the Cartesian plane, the set square and the calculator.



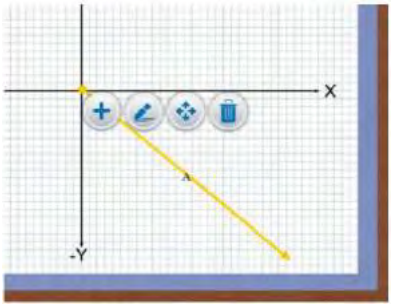
2. Drawing a vector.

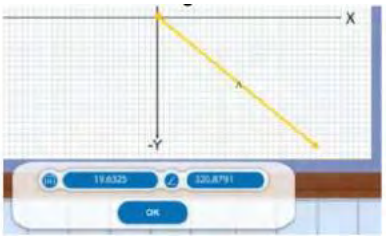




- To draw a vector, click and drag on the Cartesian plane from where you desire the point of origin to be located.
- The magnitude is determined by how long the line is drawn on the plane.
- The direction (angle) is determined by the direction in which you draw the line.
- As you draw the vector a pop up will appear giving the magnitude and angle as you draw.
- Once the vector is complete, this information is generated in a table at the left of the screen (List of Vectors).

3. Editing a drawn vector.

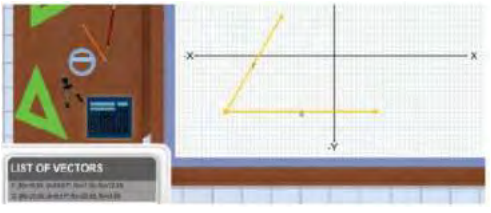




- Click on the vector you wish to edit and a menu will appear by the vector with the following operations:
  - The(+)allows a vector to be added with the same point of origin.
  - The (pencil) allows the magnitude and angle to be adjusted by typing in the desired values.
  - The (directional arrows) allow the vector to be moved.
  - Use the (trash can) to delete the vector.

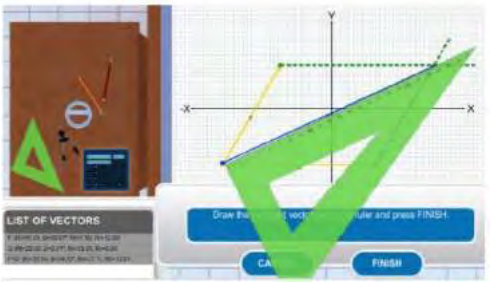
4. Draw the vectors for this situation:

A block is being pushed by two forces. The first is on the horizontal plane and measures 20N, and the second is at 60° and measures 15N.



- Using the directions above draw a vector with the first measurements.
- Click on this vector to edit, then click the (+) to add the second vector from the same point of origin.

5. Draw the resultant vector of the two forces.



- Click and drag the set-square (top) to the table.
- An operations menu will appear, select the operation (add) and the vectors to add (letters representing the two vectors).
- Directions will appear to guide the process of drawing the parallels of the two vectors and the resulting vector.Click and drag along the dotted line on the set-square to draw.

6. Submit the lab report.

- Click on the pencil icon on the main screen to generate the lab report.
- The report will contain a snapshot of the Cartesian plane and any vectors drawn and the data collected in the List of Vectors table.

Note: This lab may be used as directed by the instructor to solve additional problem sets.

16.3 Evaluation Questions

There are no evaluation questions for this lab practice.

16.4 Complementary Questions

There are no evaluation questions for this lab practice.

17. Types of Ecosystems

Natural Sciences Ecosystems

In this laboratory build an aquatic ecosystem and a terrestrial ecosystem, identifying the renewable and non-renewable resources in each one. Specify the roles and relationships of each species within both ecosystems. In the aquarium and a terrarium place living species according to the ecosystem that each species belongs. After configuring the ecosystem, click “Check” to see if the setup is correct. If it is not, the ecosystem will die and a failed attempt will be recorded in the laboratory report.

Objectives

Identify types of ecosystems (aquatic and terrestrial). Identify renewable and non-renewable resources.

Concepts and skills

Classification, biomes, ecosystems, terrestrial, aquatic, renewable, nonrenewable, consumers, producers, decomposers.

17.1 Laboratory equipment

1. Ecosystems A (Aquatic)
2. Ecosystems B (Terrestrial)
3. Various Species

17.2 Procedures

- Enter the virtual simulator for Ecosystems, register your personal information and select the image as shown.

- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.

- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station.

1. Identify the types of the two ecosystems: A and B as either aquatic or terrestrial.

- Identify the types of species found in each type of ecosystem.
- Click on a species and drag and drop it into the appropriate ecosystem
- Some species may belong in both types of ecosystems
- As you place a species, a table will be generated in the digital journal of each species placed. To view this table, click the digital journal icon.

2. Continue placing all species.

   - Continue placing species until each specie has been placed in an ecosystem.
   - Once a specie has been placed into an ecosystem, it may not be changed or removed.
   - If an error or mistake is made, click the trash icon to clear ALL previous selections on the lab table and digital journal. This will not register an attempt.

3. Check lab.

   - After placing all the species, click on the check button on the middle of the lab table.
   - If there is incorrect data, a message will appear that the species have not been placed correctly and the ecosystems will die. Click OK to return to main screen.
   - The lab may be redone by clicking the trash icon. This will result in an attempt.
   - If all species are placed correctly, a success window will appear. Click OK.

- Complete the digital notebook.
   - **Page 1:** Type of ecosystems and their characteristics.
   - **Page 2:** Identify renewable and non-renewable resources in each type of system.
   - **Page 3 and 4:** Identify each species as either a producer, a consumer, or a decomposer.

- After completing click the “report” button and answer the T/F evaluation questions.
- After answering the questions, click the FINISH button and save the report as evidence of learning to turn into the instructor. Optional guided questions are part of the lab report.

- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.

17.3 Evaluation Questions

Answer each statement as true or false.

- Ecosystems can be natural or artificial.
- Water is a non-renewable and limited resource.
- There is no difference between a marine ecosystem and a freshwater ecosystem, because both are aquatic ecosystems.
- A fish tank is considered a biome.
- All elements of an ecosystem are related to each other and if one of them becomes extinct, the relationship between the remaining species can be affected.

17.4 Complementary Questions

These questions appear at the end of the lab report.

1. What is the difference between the terms “biocenosis” and “biotope”?
2. What is the relationship between the biotic and abiotic factors in an ecosystem?
3. Why is there greater availability of light and oxygen and nitrogen sources in a terrestrial ecosystem?
4. What are the types of terrestrial ecosystems?
5. Explain why an artificial or urban ecosystem depends on the natural environment that surrounds it.
6. What are the relationships between the species in an ecosystem?

18. Food Chains

Natural Sciences Ecosystems

This laboratory has a terrestrial ecosystem and various species which belong to it. Using the species available, configure food chains that consist of four, five, and six links. After creating the food chains, each species must be classified according to their role in the ecosystem and trophic level from decomposer to consumer. In the digital journal, a diagram must be created showing the relationship of each species in the food chain and ecosystem.

Objectives

Identify the flow of energy in an ecosystem by creating food chains and classify trophic levels.

Concepts and skills

Classification, flow of energy, food chains, trophic levels, consumers, producers, decomposers.

18.1 Laboratory equipment

Terrestrial ecosystem

Ants

Butterflies

Frog

Grasshopper

Worm

Snake

Plant

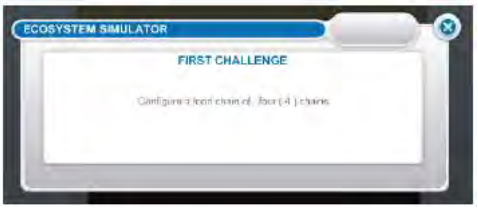
Grass

Bacteria

18.2 Procedures

- Enter the virtual simulator for Ecosystems, register your personal information and select the image as shown.
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and may add an attempt.

1. Configure a food chain. First Challenge: 4 links.



- Using four of the various species in the work station, create a food chain with 4 links by dragging each species into the terrestrial ecosystem.
- After placing 4 species in the terrarium, click on the cog icon . It will begin flashing once the required number of species has been selected.

2. Classify each species by trophic level.

- After clicking the cog, a new window appears with the roles of the species in the chain.
- Each of the selected species will be in the circle at the bottom right corner. Drag each species to one of the trophic levels in the diagram as either a decomposer, producer, or type of consumer. The species on the diagram may be rearranged as needed.
- Click on the save button to save choices.

3. Repeat steps 1-2 with the second and third challenge: configuring food chains for 5 and 6 links respectively.

- After complete each link, a new window appears with new challenge. Click X to return to the main screen.

4. Repeat steps 1-2 with the second and third challenge: configuring food chains for 5 and 6 links respectively.

- After completing the last challenge, a new window appears.
- Use the tools on the right to draw each of the three food chains configured in the steps above. Click on the pencil and

select a color to connect the species in each food chain. Use a different color for each chain. To finish, click the continue button.

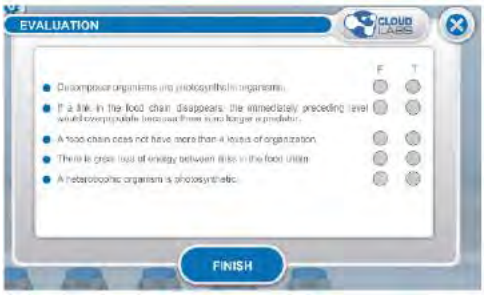
- Complete the digital journal.

  - It will appear automatically, but may also be accessed at any time in the lab by clicking on the journal icon

  - **Page 1:** Describe the effects on the ecosystem of eliminating each of the trophic levels.

  - **Page 2:** Classify each species in the lab as a consumer, producer, or decomposer.

- A new window will appear to answer the T/F evaluation questions. Choose the correct answer.



- After answering the questions, click the FINISH button and save the report as evidence of learning to turn into the instructor. Optional guided questions are part of the lab report.

- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.

18.3 Evaluation Questions

Answer each statement as true or false.

- Decomposer organisms are photosynthetic organisms.
- If a link in the food chain disappears, the immediately preceding level would overpopulate because there is no longer a predator.
- A food chain does not have more than 4 levels of organization.
- There is great loss of energy between links in the food chain.
- A heterotrophic organisms photosynthetic.

18.4 Complementary Questions

These questions appear at the end of the lab report.

- What are the levels of a food chain?
- Explain the energy differences that exist in the links of a food chain.
- What is the importance of photosynthesis in a food chain?
- The food chain can be explained as an interdependent relationship. Why?

19. Balancing an Ecosystem

Natural Sciences Ecosystems

This laboratory consists of a balanced ecosystem with little pollution and good natural reserves. The challenge is to maintain the ecosystem balance as the population increases by monitoring and manipulating the abiotic factors (contamination, temperature, light, amount of food, and oxygen). Failure to maintain ideal conditions or equilibrium by altering the variables will cause the ecosystem to die.

Objectives

Identify and manipulate factors (abiotic and biotic) in an ecosystem that affect the equilibrium.

Concepts and skills

Observation, test/outcome, equilibrium, abiotic and biotic factors.

19.1 Laboratory equipment

- An aquarium with variable controls for the following abiotic factors:

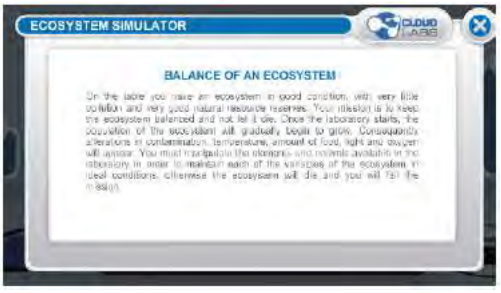
  1. Temperature
  2. Oxygen
  3. Light
  4. Filter (contamination)

- Variable indicators:

  5. Amount of food
  6. Amount of light
  7. Temperature
  8. Oxygen
  9. Contamination
  10. Population

19.2 Procedures

- Enter the virtual simulator for Ecosystems, register your personal information and select the image as shown. **Then choose Situation 2**.

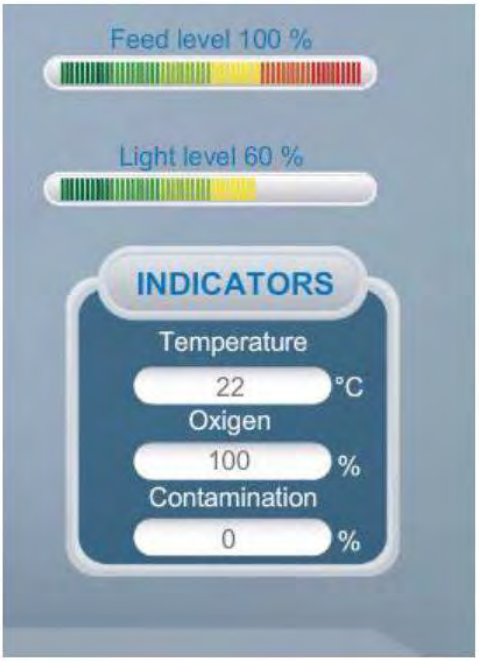


- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.

- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and may add an attempt.

Note: This lab contains a play/pause button that may be activated to pause the lab progress at any point in the lab.

1. Identify the ranges for conditions of equilibrium for the species in the ecosystem.



As the population in the ecosystem grows, changes in conditions such as pollution, food, and oxygen. The temperature and light will vary randomly during the simulation. Below are the conditions for equilibrium of the ecosystem.

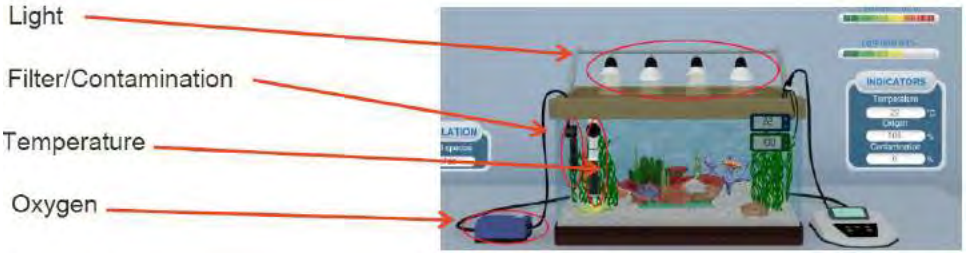
- Contamination: Over 60% animals die, over 90 % plants die.
- Oxygen: Under 80% fish die, under 60% crustaceans die, under 30% plants die.
- Temperature: Over 30’ and under 15’ fish die, over 40’ and under 10’ coral dies, under 8’ crustaceans die.
- Food: Under 20% animals gradually begin to die.
- Light: Under 50% plants gradually begin to die and die completely if 0%.

2. Observe and monitor the ecosystem conditions.

- Use the indicators to monitor the ecosystem conditions.
- The equilibrium should be maintained based on the acceptable ranges in step 1.

3. Manipulate the variables/conditions of the ecosystem.

- Click on the various instruments to access the variable controls to increase or decrease individual variables.



- After clicking on a variable instrument, a control button for that instrument will appear to allow the adjustment of the variable.
- For the variables of light, temperature, and oxygen, it will allow the variable to be increased or decreased.
- For contamination, a trash can will appear allowing the filter to be cleaned.

Note: This lab contains a play/pause button that may be activated to pause the lab progress at any point in the lab. This may be used during adjustment of variables to momentarily stop the play action.

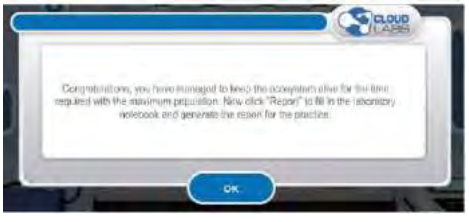
4. Monitor the ecosystem of equilibrium and species repopulation.

The goal is to keep the system in balance based on the range conditions for each species and promote species repopulation (reproduction).

- A warning will appear to notify if the ecosystem is not in equilibrium; signifying there are unfavorable conditions and a variable change is needed.
- Species repopulation can be monitored by the species indicator.

5. Completing the challenge.

- The challenge is to repopulate the ecosystem with 20 animal species and maintain that equilibrium for a minimum time frame.
- When the 20th species joins the ecosystem, an indicator with the remaining time will appear at the top of the lab.
- Equilibrium must be maintained during this time frame to successfully complete the challenge.



- The following window will appear when the challenge has been successfully completed. Click OK.

6. Complete the digital journal.

Enter the journal by clicking on the journal icon.

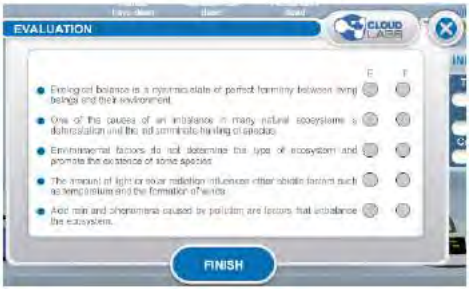
- **Page 1**: Name the abiotic and biotic factors in the ecosystem and describe the initial and ecosystem conditions.

- **Page 2**: Describe the final ecosystem conditions, the species affected by the modifications, name the renewable resources, and alternatives for conservation.

- Generate the lab report after checking and completing the journal. Click REPORT.

- A new window will appear to answer the T/F evaluation questions. Choose the correct answer.

- After answering the questions, click the FINISH button and save the report as evidence of learning to turn into the instructor. Optional guided questions are part of the lab report.



- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.

19.3 Evaluation Questions

Answer each statement as true or false.

- Ecological balance is a dynamic state of perfect harmony between living beings and their environment.
- One of the causes of an imbalance in many natural ecosystems is deforestation and the indiscriminate hunting of species.
- Environmental factors do not determine the type of ecosystem and promote the existence of some species.
- The amount of light or solar radiation influences other abiotic factors such as temperature and the formation of winds.
- Acid rain and phenomena caused by pollution are factors that unbalance the ecosystem.

19.4 Complementary Questions

These questions appear at the end of the lab report.

- What are the different natural and artificial changes that unbalance ecosystems?
- What are the environmental factors that characterize ecosystems and how do they relate to each other?
- What are the main causes of the extinction of a species?
- How are the amount of energy available, the environmental conditions and the interrelationships between species in an ecological balance related?
- How do temperature and precipitation influence the equilibrium of the ecosystem?

20. Environmental factors in an Ecosystem

Natural Sciences Ecosystems

A portion of the sea that had major pollution problems and in which there were no living species has been cleaned and restored. The challenge is to find the limits in which the new introduced species can tolerate. In the laboratory is a controlled aquatic ecosystem in which environmental factors such as oxygen, temperature, and light may be varied. Each factor should be varied to extremes and its effect on the ecosystem noted. A report with maximum and minimum limits tolerated by the ecosystem and its species will need to be generated to determine if the recovered part of the sea can accommodate the species studied in the lab.

Objectives

Identify and manipulate factors (abiotic and biotic) in an ecosystem that affect the equilibrium. Determine tolerances of ecosystem species to environmental conditions.

Concepts and skills

Observation, test/outcome, equilibrium, abiotic and biotic factors.

20.1 Laboratory equipment

- An aquarium with variable controls for the following abiotic factors:

1. Temperature
2. Oxygen
3. Light

- Variable indicators:

4. Temperature
5. Oxygen
6. Light

20.2 Procedures

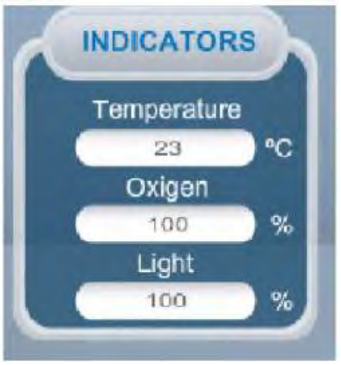
- Enter the virtual simulator for Ecosystems, register your personal information and select the image as shown. **Then choose Situation 4**.

- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.

- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on the trash can icon to stop the lab process and clean the work station and may add an attempt.

Note: This is an experimental lab to explore the conditions of the aquarium species as variables in the ecosystem change.

1. Identify the ranges for conditions or variables in the ecosystem.



Below are the variables that may be manipulated and the ranges of variations.

- Oxygen: 0% to 100%, default starts at 100%
- Temperature: 0’ to 80’, default starts at 23’
- Light: 0% to 100%, default starts at 100%

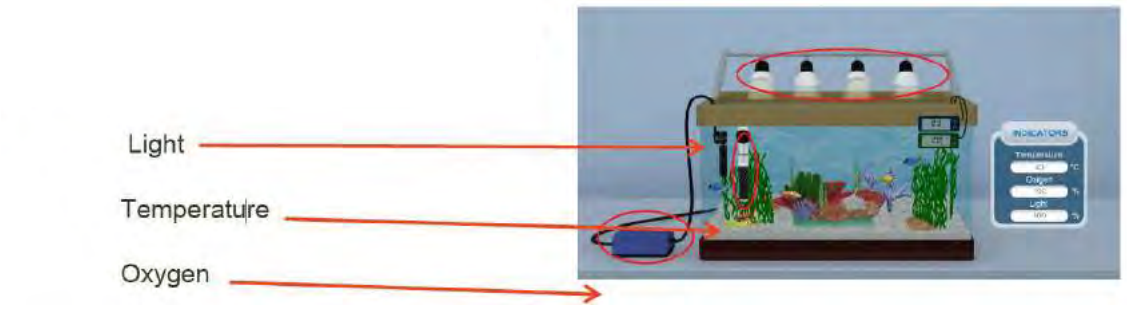
2. Observe and monitor the ecosystem conditions.

- Use the indicators for temperature, oxygen, light, and food to monitor the ecosystem conditions.
- Observe species in aquarium for changes.

3. Manipulate a variable or condition of the ecosystem.

To maintain a controlled experiment, manipulate one variable at a time to observe changes in the ecosystem. Each variable should be taken from the maximum to minimum and any changes noted.

- Click on the various instruments to access the variable controls to increase or decrease individual.



- Click on the blue air pump to vary oxygen, the lamps to vary the amount of light, and the white heater to vary the temperature.
- After clicking on a variable instrument, a control button for that instrument will appear to allow the adjustment of the variable.

4. Monitor and note changes in the ecosystem and the species as the environmental factors change.

- A warning will appear to notify if the environmental factors approach a critical level for one of the species in the ecosystem.
- Continue varying the factor, taking note of each change and at what range the change takes place for one variable at a time.

5. Repeat steps 1- 4 for each of the variables. (One variable at a time).

- Complete the digital journal.

Enter the journal by clicking on the journal icon.

Page 1:

What happens when excessive and deficit temperatures exist within this ecosystem?

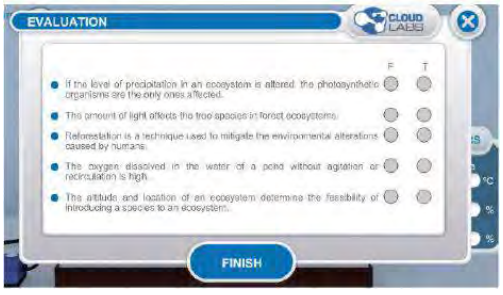
What happens when an oxygen deficiency exists within this ecosystem?

Page 2:

What happens when there is a deficit of light within the ecosystem?

What environmental factor presented do you consider as the most critical in the ecosystem and why?

- Generate the lab report after checking and completing the journal. Click REPORT.



- A new window will appear to answer the T/F evaluation questions. Choose the correct answer.
- After answering the questions, click the FINISH button and save the report as evidence of learning to turn into the instructor. Optional guided questions are part of the lab report.

- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the

evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.

20.3 Evaluation Questions

Answer each statement as true or false.

- If the level of precipitation in an ecosystem is altered, the photosynthetic organisms are the only ones affected.
- The amount of light affects the tree species in forest ecosystems.
- Reforestation is a technique used to mitigate the environmental alterations caused by humans.
- The oxygen dissolved in the water of a pond without agitation or recirculation is high.
- The altitude and location of an ecosystem determine the feasibility of introducing a species to an ecosystem.

20.4 Complementary Questions

These questions appear at the end of the lab report.

- What would happen if a species is moved from an ecosystem in a cold climate to an ecosystem in a warm climate? Please explain your answer.
- What is the characteristic temperature and humidity for the different types of terrestrial ecosystems?
- What are the physical differences between the surface and the bottom of a marine ecosystem?
- How does an ecosystem affect a natural phenomenon?
- How is an ecosystem affected if the water cycle is altered?

21. Classification of Living Beings

Natural Sciences Ecosystems

The virtual laboratory has various samples of living species. Classify and separate the samples by the following characteristics: vertebrates, invertebrates, eukaryotes, prokaryotes, multicellular, unicellular, photosynthetic, non-photosynthetic, autotrophs and heterotrophs. Living being may belong to several classifications.

Objectives

Classification of organisms by cell type, how they obtain or make energy, etc.

Concepts and skills

Classification, prokaryotes, eukaryotes, heterotrophic, autotrophic, invertebrates, vertebrates, photosynthetic, unicellular, multicellular.

21.1 Laboratory equipment

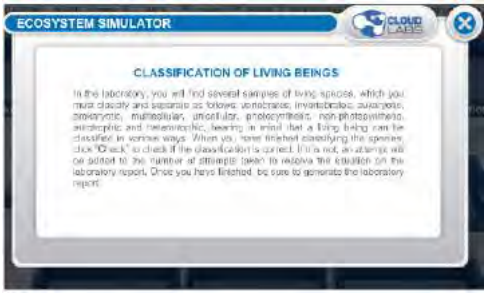
- Living Beings: (organisms)

Fish, crustacean, algae frog, ants, snake, worm, grasshopper, butterflies, bacteria, plant grass

- Classification characteristic collection trays:

Prokaryotic, eukaryotic, autotrophic, heterotrophic, multicellular, unicellular, photosynthetic, non-photosynthetic, vertebrates, invertebrates

21.2 Procedures



- Enter the virtual simulator for Ecosystems, register your personal information and select the image as shown..
- Read the situation/challenge and the procedures, then click on the icon to exit the introduction and access the laboratory.
- During the laboratory, you can click on the information icon to read the situation, procedures, or to access equations as needed. Click on the help icon for common questions. At any time, click on

the trash can icon to stop the lab process and clean the work station and may add an attempt.

1. Identify the organisms and the classification characteristics.

The following living beings / organisms can be found on the lab table.

- Fish, crustacean, algae frog, ants, snake, worm, grasshopper, butterflies, bacteria, plant, grass

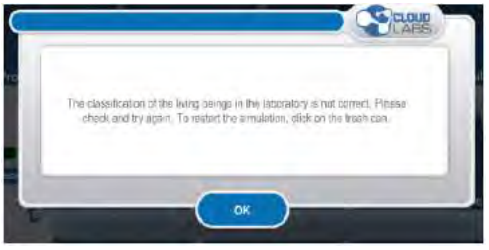
The following characteristic trays are located on the lab table for classification of organisms.

- Prokaryotic, eukaryotic, autotrophic, heterotrophic, multicellular, unicellular, photosynthetic, non-photosynthetic, vertebrates, invertebrates

2. Classify each organism by one or more traits.

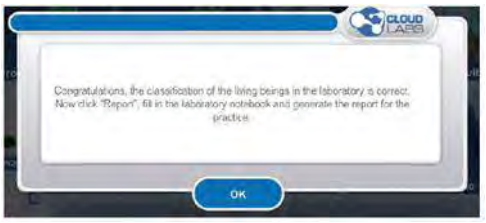
- Click on an organism and drag it to the appropriate tray based on whether that organism has that characteristic.
- An organism may belong to more than one classification characteristic.
- If an error or mistake is made and an organism is placed into the wrong tray, click and drag it back to the shelf. This does not result in an attempt.

3. Check classifications.



- Click on the green CHECK button on the left side of the table.
- If, there is incorrect data, a message will state that one or more of the

organisms have not been correctly classified. Click OK to return to main screen.



- The lab may be redone by clicking the trash icon. This will register an attempt.

- If organisms have been identified correctly, a success window will appear. Click OK.

- Complete the digital journal.

It will appear automatically, but may also be accessed at any time in the lab by clicking on the journal icon.

- **Page 1:** Common characteristics of vertebrates and invertebrates.

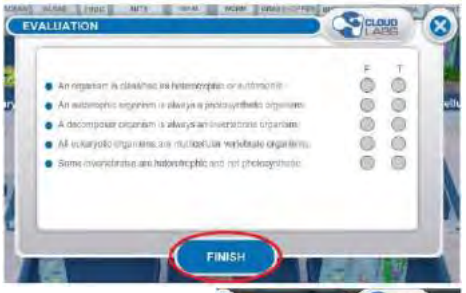
- **Page 2:** Photosynthetic species, non-photosynthetic species, and photosynthetic unicellular species.

- Generate the lab report after checking and completing the journal. Click OK.

- A new window will appear to answer the T/F evaluation questions. Choose the correct answer.

- After answering the questions, click the FINISH button and save the report as evidence of learning to turn into the instructor. Optional guided questions are part of the lab report.

- The simulator will automatically generate a grade from 0 to 5 based on the procedures carried out by the student, the data registered and the answers to the evaluation questions. The grade will be both shown at the end of the practice and printed in the laboratory report.



21.3 Evaluation Questions

Answer each statement as true or false.

- An organism is classified as heterotrophic or autotrophic.
- An autotrophic organism is always a photosynthetic organism.
- A decomposer organism is always an invertebrate organism.
- All eukaryotic organisms are multicellular vertebrate organisms.
- Some invertebrates are heterotrophic and not photosynthetic.

21.4 Complementary Questions

- Identify an ecosystem in your surroundings and classify the living beings that inhabit it.
- Why do you think it is important to classify living beings?
- Do you think that the size of living beings has anything to do with whether it is a vertebrate or invertebrate? Explain.
- Think about your pet or that of a friend and classify it according to the options given in this laboratory.