Pedagogical Usage of Virtual Lab-Science

Prof. Shashi Prabha
shashi.prabha@ciet.nic.in
Central Institute of Educational Technology
National Council of Educational Research and Training

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- **Virtual Labs: Existing e-learning platforms such as DIKSHA, SWAYAM and SWAYAMPRABHA will also be leveraged for creating virtual labs so that all students have equal access to quality practical and hands-on experiment-based learning experiences.(p 59)**
- **Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable. (p.3)**

Objectives of laboratory work

Textbook of Pedagogy of Science (NCERT, 2013) suggests that use of laboratory must be focused towards achieving the objectives of developing

(a) cognitive abilities, i.e. principles and laws discussed in the classroom may precede or follow the laboratory work or it may be carried out during discussion;

(b) process skills of science;

(c) scientific attitude and

(d) understanding nature of science.

Objectives of laboratory work

objectives.

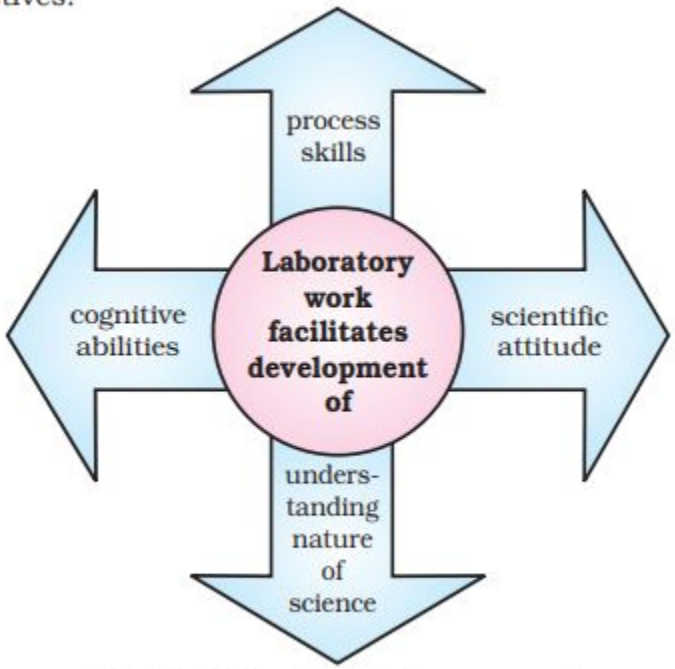


Fig. 9.4 *Objectives of laboratory work*

Emphasis should be given to the first five letters of LABORATORY rather than the last seven letters.

Virtual laboratory is used to …

- Enhance conceptual understanding
- Integrate it with relevant concepts
- Illustrate various concepts
- Familiarise with apparatus and equipment
- Develop science process skills
- Develop independent thinking and decision making

Science process skills

Basic Process Skills

- Observation
- Communication
- Classification
- Measurement
- Inference
- Prediction

Integrated Process Skills

- Controlling variables
- Defining operationally
- Formulating hypotheses
- Experimenting
- Interpreting Data
- Formulating models

Role of the laboratory

- enhanced learning outcomes
- development of scientific attitude
- critical thinking,
- conceptual understanding
- development of science process and inquiry skills,
- manipulative skills,
- interests
- retention of students in science education
- ability to become independent learnrs

Why virtual lab?

- Makes education learner centred.
- Learning-teaching time is reduced. Students learn faster.
- Students find virtual lab more engaging and interesting.
- Students find fun and learning becomes joyful.
- Many skills learnt during virtual lab is transferable.
- Builds resilience.
- Students learn to take initiatives.
- Develops scientific temper.
- Encourages equality and equity.

Multiple usage of virtual lab

- Laboratory work
- Classroom learning-teaching
- Inquiry
- Home work
- Exercise
- Demonstration + discussion
- Prediction and testing/retesting
- Group work
- Individual work
- Investigatory project

Teacher role in virtual lab

- Being a co-learner in the inquiry process
- Facilitate students to express their existing ideas
- Create outcome oriented learning environment by adapting to emergent student ideas

Pedagogical approaches to virtual lab

- Inquiry based
- Integrative
- Collaborative
- Intertwined with assessment
- Reflective

Embedding assessment

The test items should include six cognitive aspects-

- **Remembering**
- **Understanding**
- **Applying**
- **Analyzing**
- **Evaluating**
- **Creating**

Pedagogy of virtual lab

Pre-lab session –Students formulate and ask questions. They brainstorm the ideas and plan for experiment. They discuss functionality feature, menu and experimental design. Teacher does pre- assessment underlying relevant concepts of experiments.

Performance session –Students perform experiment. They record observations and analyse data to get result.

Post lab session- Students construct relationship of result with the relevant concept. Share their work,discuss and make presentation. Post assessment is done.

Exploration; Experimentation;Communication

Pre-lab session:exploration

Students

- Read the theory,procedure and instructions to perform virtual experiment
- formulate and ask questions.
- brainstorm the ideas and plan for experiment.
- discuss functionality feature,menu and experimental design;make predictions
- explore the simulations.

Teacher

- does pre- assessment underlying relevant concepts of experiments.
- starts with challenging question
- elicits existing ideas
- facilitates selection of tasks aligned to LO

Examples:virtual lab

a)Determine accelerationdueto gravity using a simple pendulum
Simple pendulum (Simulator) : Class 11 : Physics : Amrita Online Lab (olabs.edu.in)

b) Study that leaves prepare starch by photosynthesis- class 7
https://diksha.gov.in/play/collection/do_31358984474433126413 24?contentId=do_31358759000558796812382
c) Show that metallic oxides are basic in nature- class 8
https://diksha.gov.in/play/collection/do_31358984859535769613 39?contentId=do_31358692647115980812205

Example:Simple pendulum pre-lab session

- Simple pendulum (Procedure) : Class 11 : Physics : Amrita Online Lab (olabs.edu.in)

- **Students play with the simulations. They explore the virtual lab to develop their ideas.They explain and justify their ideas.**

- **Teacher starts with challenging question,e.g. “does the time period of a simple pendulum increase or decrease with increase of the length of the pendulum? ”; “does time period of a simple pendulum depend on the material of the bob?”**

Performance session of virtual lab : Experimentation

Students-

- Use simulations appropriately.
- Design experiments to determine the factors affecting the time period of a simple pendulum.
- Shows perseverance in performing experiments.
- Interpret, predict, record observations, do calculation and draw graph.
- Reason abstractly, qualitatively and quantitatively.

Performance session of virtual lab Experimentation

Students

- test prediction
- identify dependent nd independent variables
- identify cause and effect relationship
- design experiment controlling variables
- record observations
- do calculation
- Plot graph
- present result
- Make interpretation of the data and the result

Integrating Concepts with virtual Lab

- Motion and measurement of distance : Oscillatory motion; motion of a pendulum; periodic motion Class VI

- Motion and Time :Pendulum; time period; oscillatory motion; mean position; extreme position, finding time period of a simple pendulum, unit of time Class VII

- Oscillations: periodic motion; time period and frequency; displacement; SHM; simple pendulum; free oscillation; torque Class IX

Post lab session

Communication

- Whole class discussion, oral and written presentation of the work.
- reflecting ,constructing and evaluating of alternative explanations, using of evidences to justify their ideas, presenting sources of errors and precautions, connecting experimental work with the relevant concepts,relating the experiment with everyday life experiences.

Post lab session

- Return to the ‘concept/learning outcomes’ at the end and let the students explain to you the sense they have made of the experiment.

- Help students to submit assessment sheet and web capture of the observations and calculation in shared Google document.

Post lab session:Communication

Discussion questions

- What do you mean by period of a simple pendulum? Explain how energy is conserved in pendulum oscillations? Where the potential energy is maximum and minimum?Where kinetic energy is maximum and minimum? Show the direction of the velocity and acceleration at various points along the pendulum oscillations.
- What is the relationship between *L* and *T* ?
- Students may try to use the formula for *g* by increasing amplitude of oscillation and examine whether the formula still hold?
- Describe the relationship between kinetic and potential energy of an oscillating pendulum?

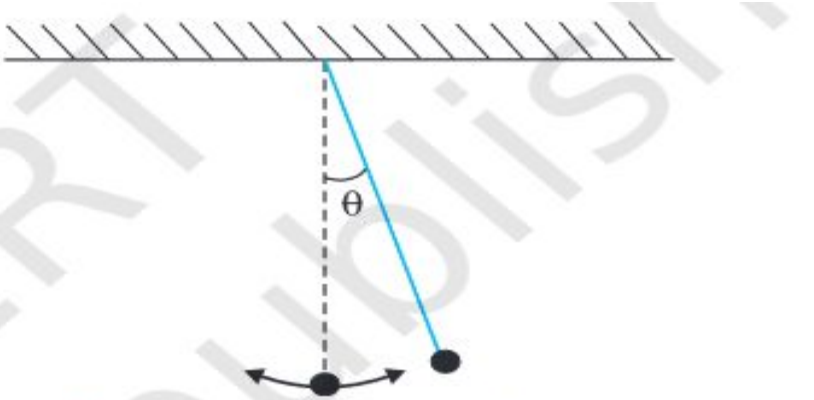
Example:Simple pendulum

- Simple pendulum (Procedure) : Class 11 : Physics : Amrita Online Lab (olabs.edu.in)

To study

- Effect of amplitude of oscillation on the time period
- Effect of bob mass on the time period
- Effect of bob length on the time period
- Effect of thread/copper wire twined thread on the time period
- Effect of material of the bob on the time period
- Effect of shape of the bob on the time period
- Effect of location of the bob (earth, moon, planets) on the time period
- Draw L- T^2 graph and calculate *g*
- Find effective length of the pendulum using L- T^2graph

Example:simple pendulum



b) An oscillating simple pendulum; its motion can be described in terms of angular displacement θ from the vertical.

A point mass suspended by an inextensible, massless string from a rigid point support. The motion of a simple pendulum is simple harmonic for small angular displacement.

The simple pendulum executes Simple Harmonic Motion (SHM) as the acceleration of the pendulum bob is directly proportional to its displacement from the mean position and is always directed towards it.

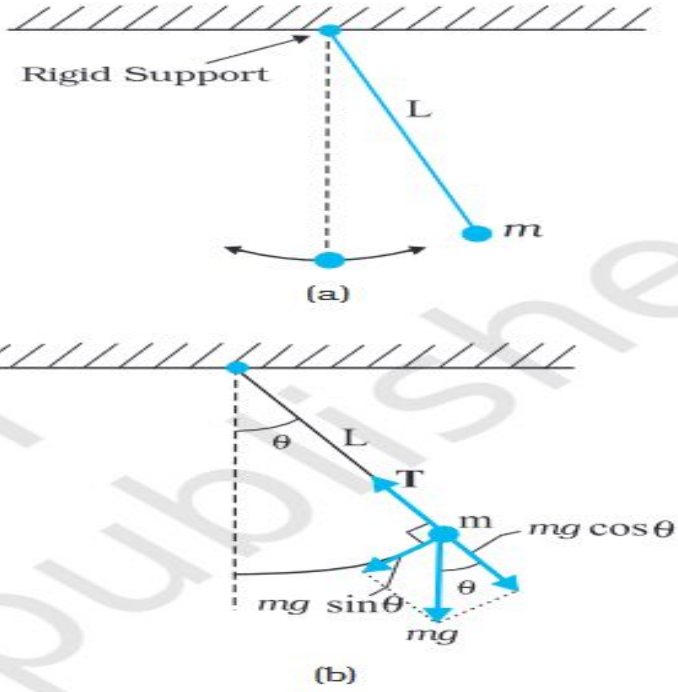


Fig. 13.17 (a) A bob oscillating about its mean position. (b) The radial force T-mg cosθ provides centripetal force but no torque about the support. The tangential force mg sinθ provides the restoring torque.

Example :simple pendulum

The force acting in a simple harmonic motion is proportional to the displacement and is always directed towards the centre of motion.

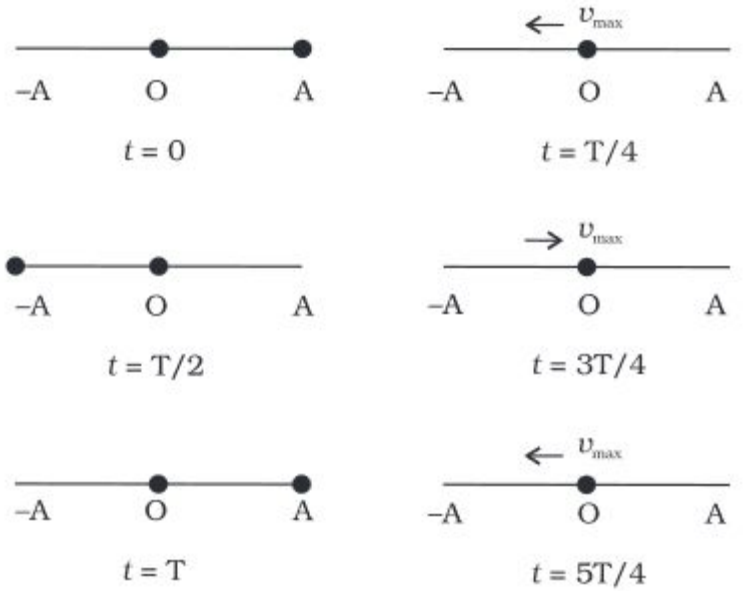


Fig. 13.4 *The location of the particle in SHM at the discrete values t = 0, T/4, T/2, 3T/4, T, 5T/4. The time after which motion repeats itself is T. T will remain fixed, no matter what location you choose as the initial (t = 0) location. The speed is maximum for zero displacement (at x = 0) and zero at the extremes of motion.*

Integrating virtual lab with relevant cocepts

- At what point amplitude is maximum for a body executing SHM?
- Can a body has zero velocity and finite amplitude ?
- What is a second pendulum? Calculate length of a simple pendulum.
- What is the quantity that remains constant during the motion of a simple pendulum? Show direction of velocity of the bob at its different positions.
- Can a motion be periodic but not oscillatory?
- What is the total distance covered by the bob if one time period is T and amplitude is A?
- At what position of the bob it has acceleration without having velocity?
- What will be the effect on the time period of the metallic sphere is replaced by a wooden sphere of the same diameter?
- At what position of the bob tension is maximum along the thread? Is the motion of a simple pendulum is perfectly SHM?
- Is the motion of a simple pendulum a example of acceleration that is changing in magnitude and direction?

Objectives of laboratory work

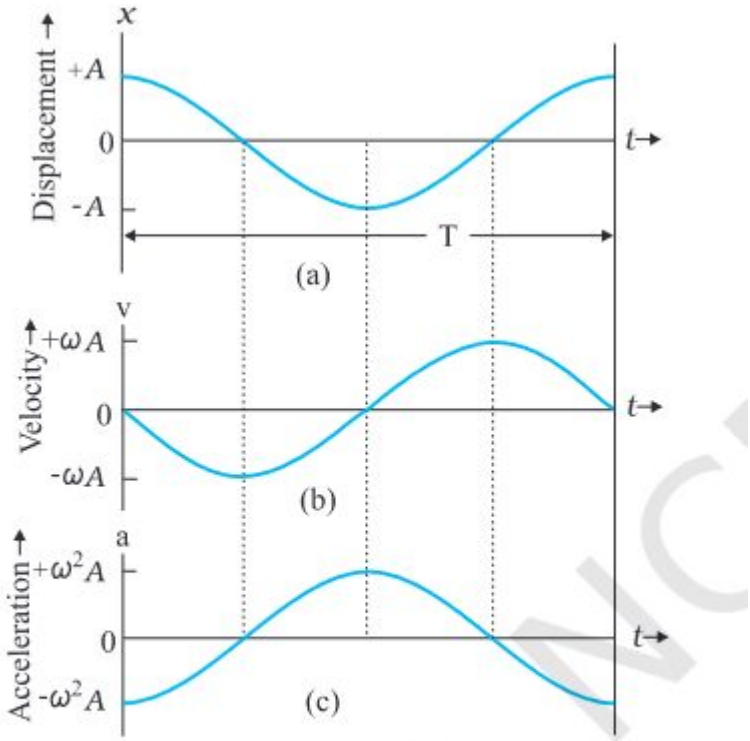
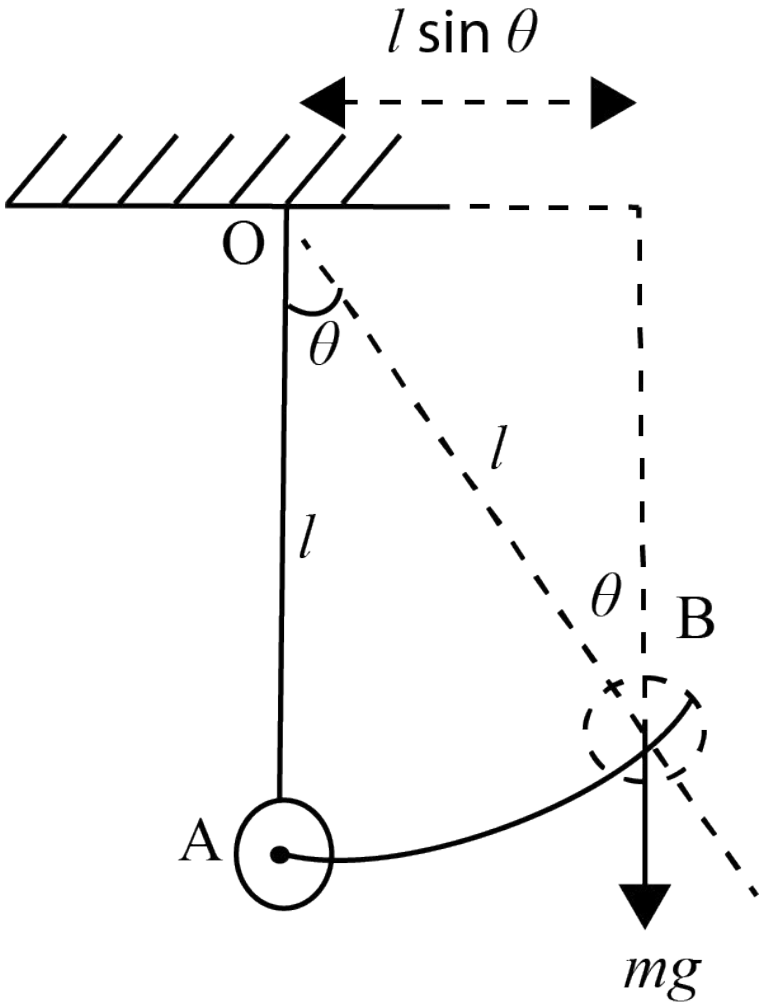


Fig. 13.13 *Displacement, velocity and acceleration of a particle in simple harmonic motion have the same period T, but they differ in phase*

Simple pendulum: torque



τ = Force × perpendicular distance of the axis of rotation from line of action of force

Role of virtual lab in Developing Scientific attitude

- Scientific attitude denotes an attitude of logical, rational and scientific thinking.
- A person having scientific attitude inquire, search for evidences, reasons before accepting anything.
- She/he does not accept anything simply because it has come from an authority or someone she/he has faith.
- A person having scientific attitude makes informed decisions and possess a rational outlook towards life.

Attributes of scientific attitude

- Curiosity
- Open mindedness
- Suspended judgement
- Critical thinking
- Logical thinking
- Ability to sieve relevant information, facts, concepts from the pool of irrelevant ones
- Scepticism
- Objectivity, unbiasness
- Truthfulness in reporting observations
- Aversion to superstitions
- Perseverance

Length of the ...	Time for 20 os...	Time Period, T...	T^2	Acceleration ...
0.6	32.29	1.61	2.59	9.14
0.7	34.84	1.74	3.03	9.11
0.8	36.21	1.81	3.28	9.62
0.9	38.44	1.92	3.69	9.62
1	40.23	2.01	4.04	9.76
1.1	42.14	2.11	4.45	9.75
1.2	44.11	2.21	4.88	9.70
1.3	46.73	2.34	5.48	9.36

Objectives of laboratory work

Length of the pendulum, l (m)	T^2
0.6	2.59
0.7	3.03
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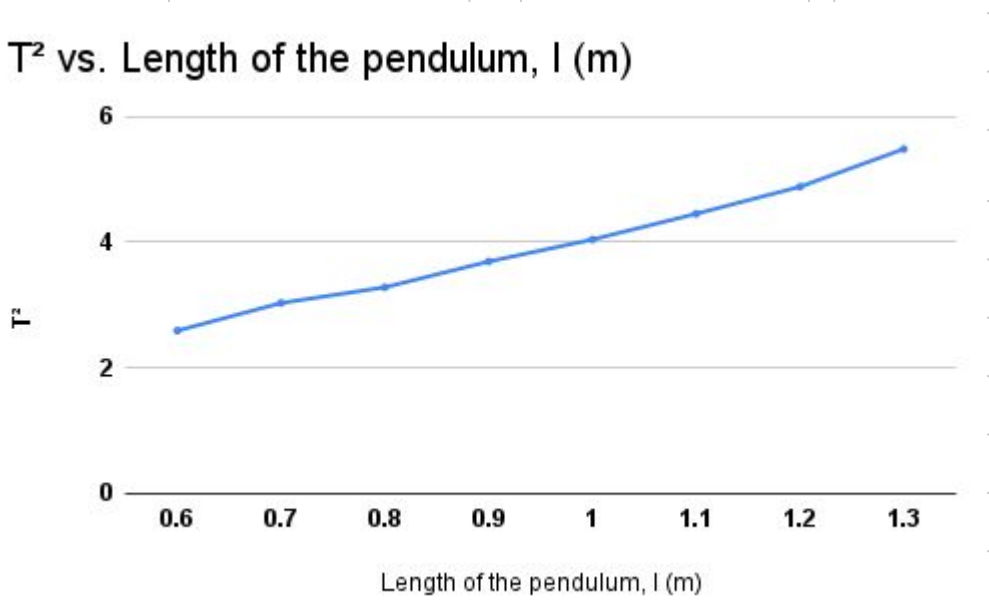


Post lab session : self assessment

Self-assess and assign marks for correct answer.

Viva voce title :

Name of student :

Exp no	Name of exp	First attempt	Second attempt	Third attempt
1.	Simple pendulum	08	09	10
2.	-----	---	---	---
3.	-----	----	----	----

Simple pendulum:learning outcomes

- determine acceleration due to gravity using a simple pendulum

- describe that the period of a pendulum is only dependent on its length and the local acceleration due to gravity

- explain that the period of a pendulum is independent of the mass of the bob
- Plot l-t2 graph

eaves Prepare Starch by the Process of Photosynthesis

Theory | Procedure | Simulator | Viva Voce | Resources | Fe

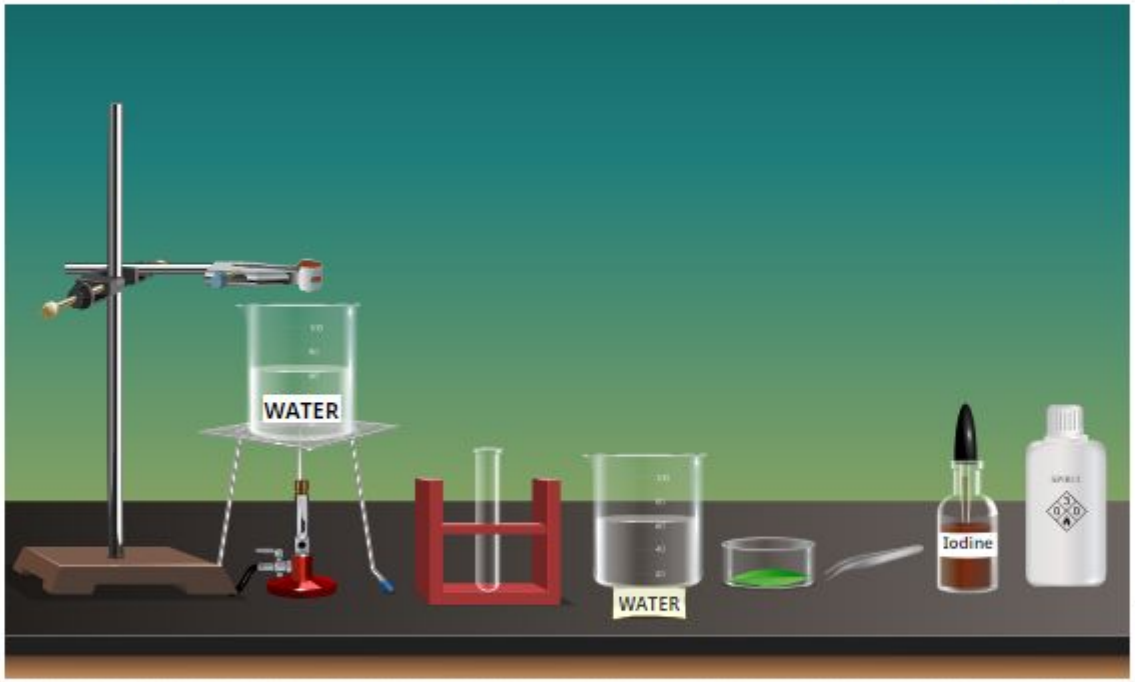
To study that leaves prepare starch by the process of photosynthesis

HELP

Instructions

1. Drag the forceps towards the petriplate to collect the leaf
2. Drag the forceps with leaf towards the top of the test tube
3. Click on the spirit bottle cap to open

Reset



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Ministry of Electronics and Information Technology

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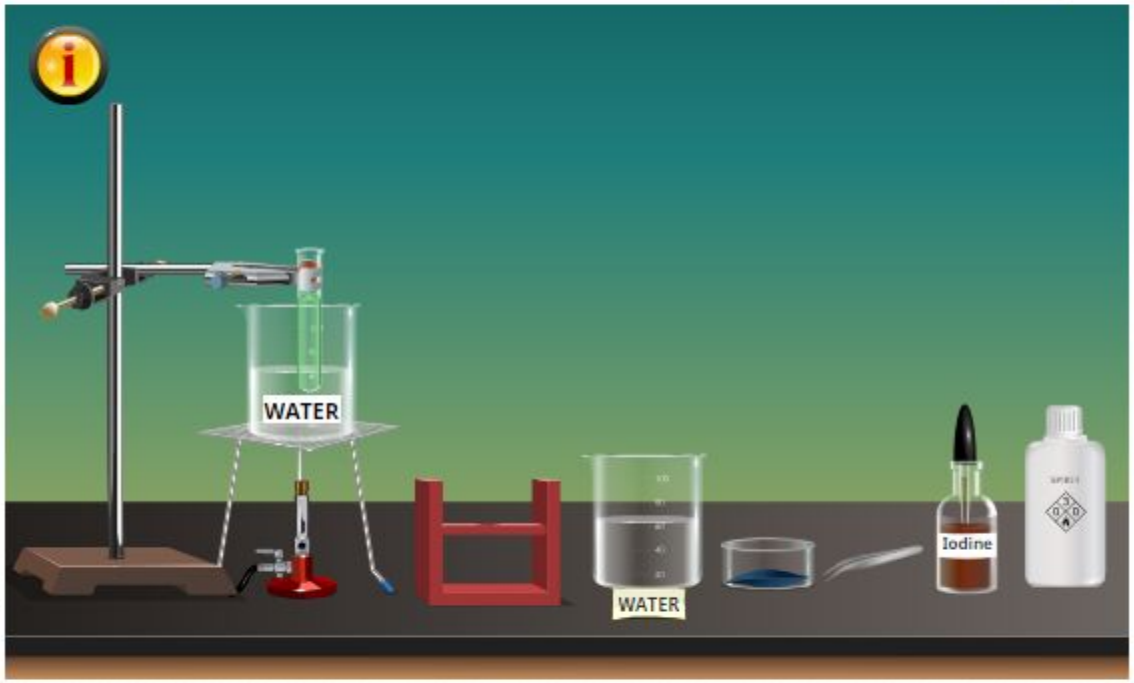

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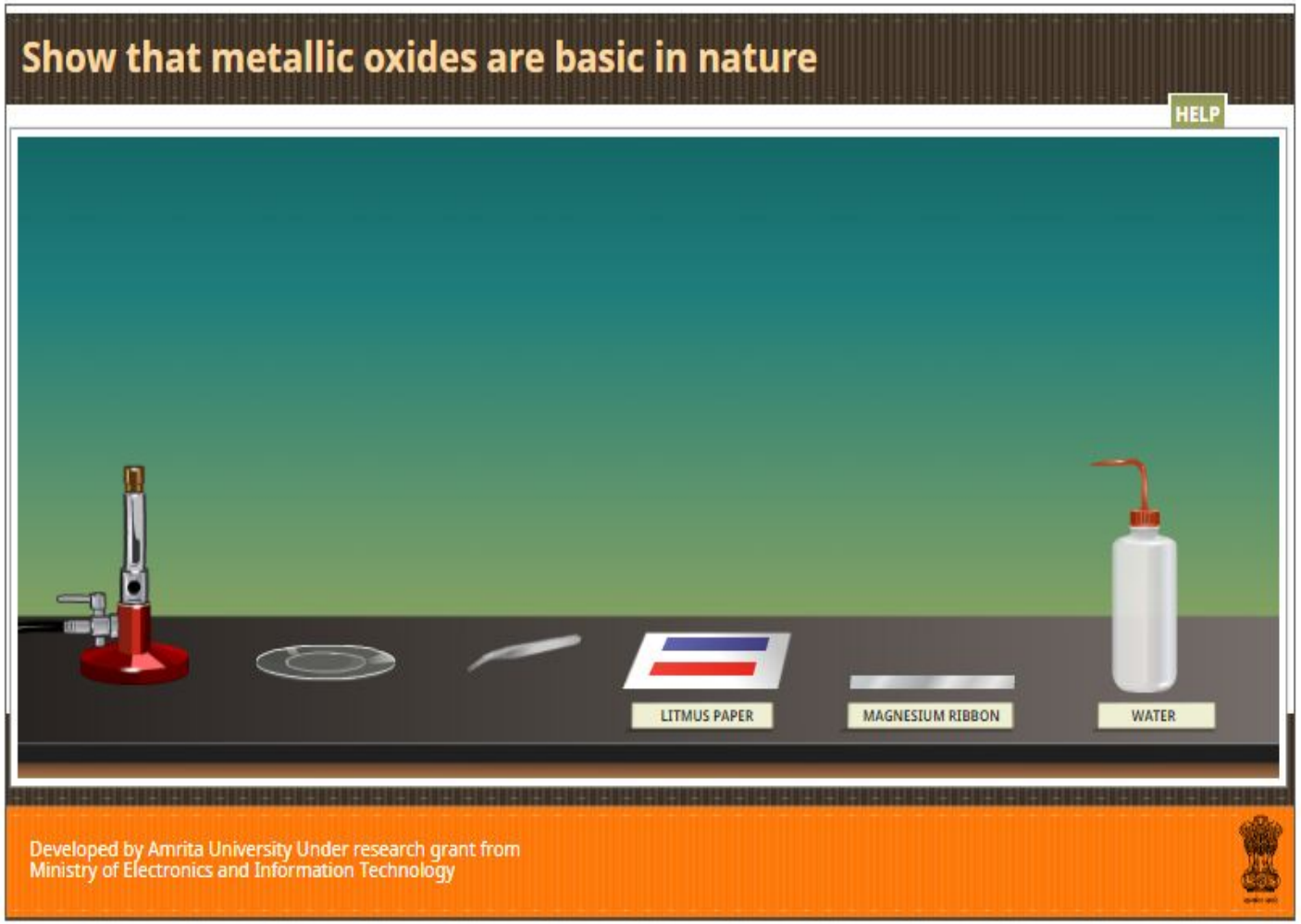
Show that metallic oxides are basic in nature

Theory | Procedure | Simulator | Viva Voce | Resources | Feedback



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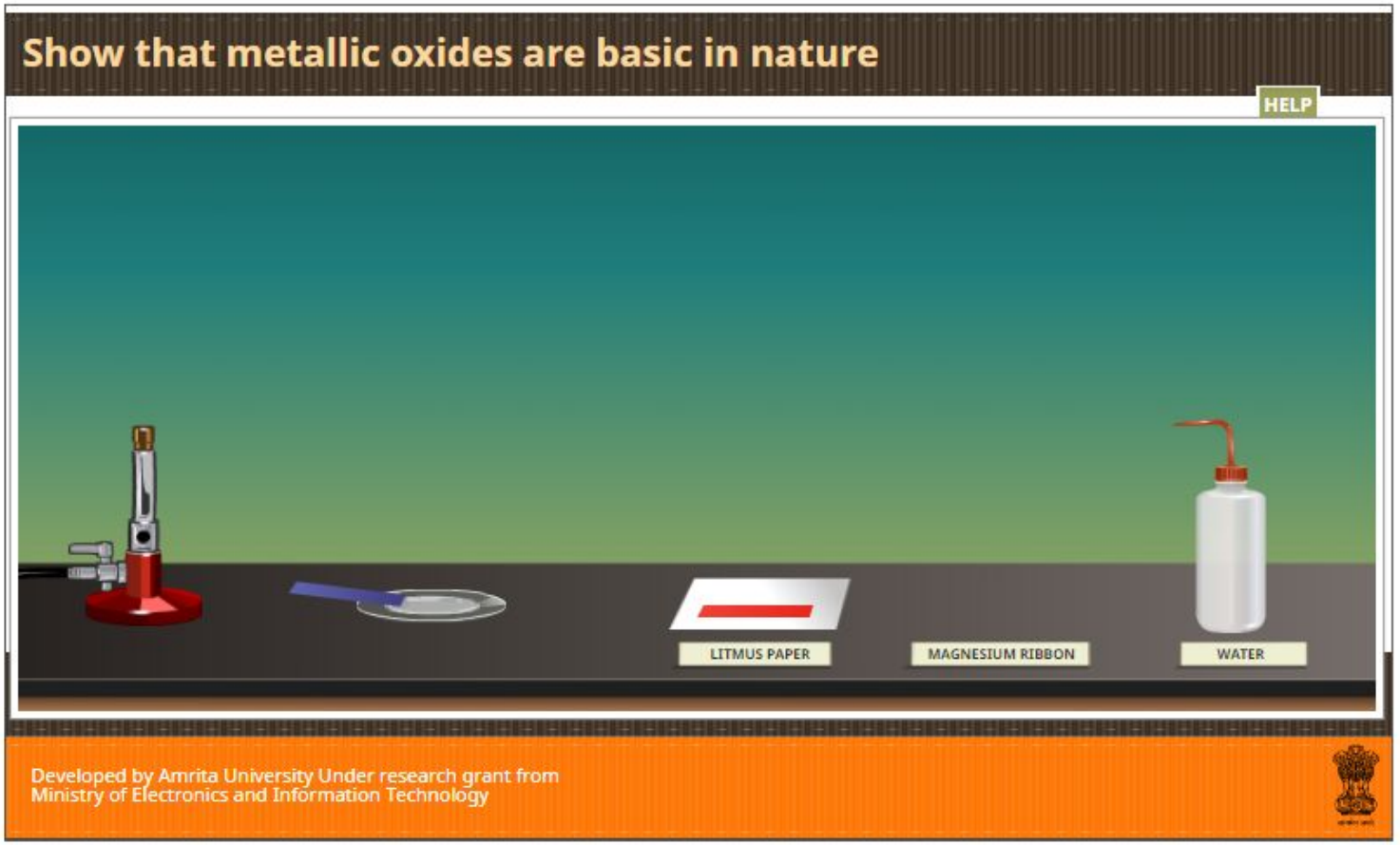

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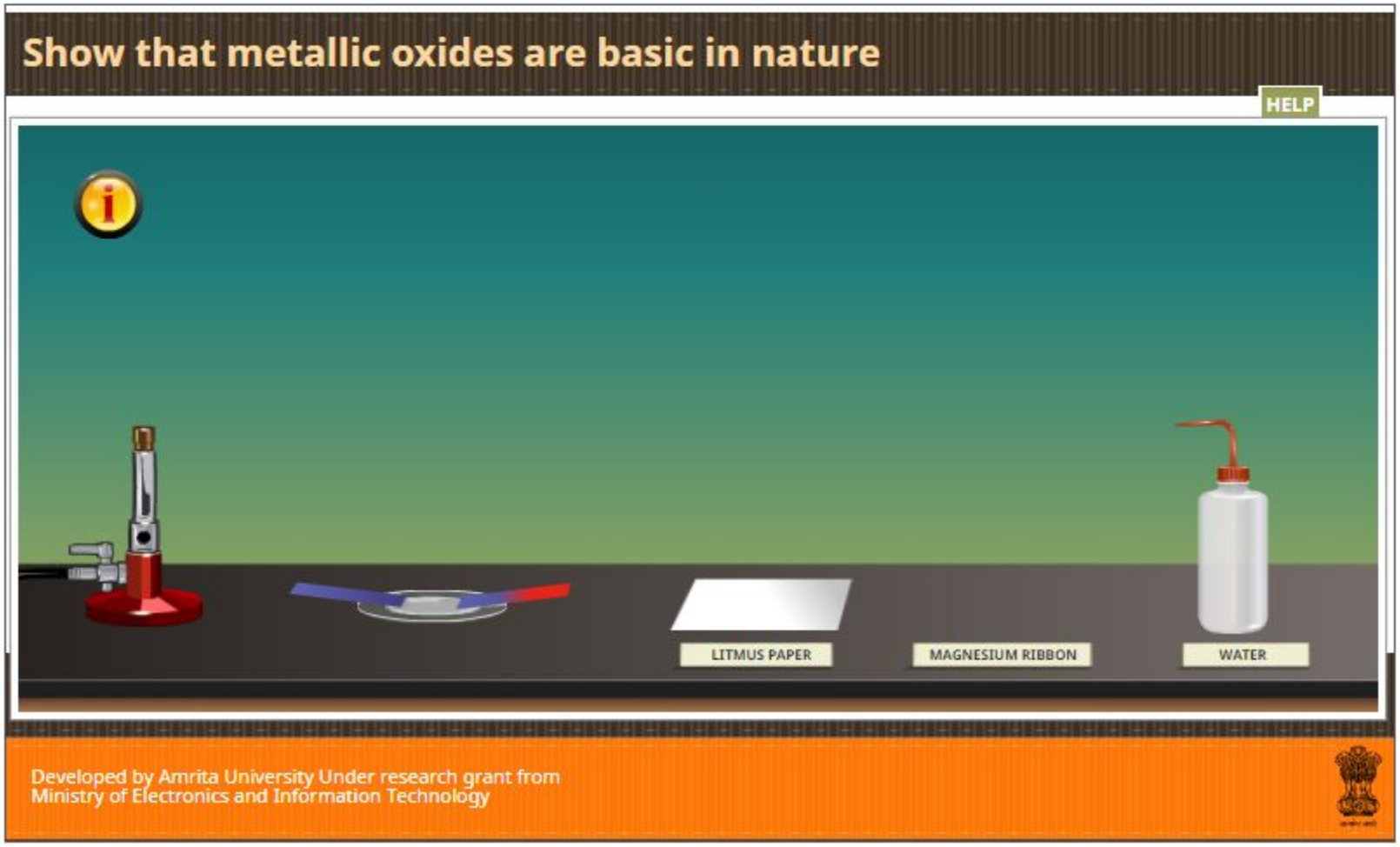

Difference between metal and non-metal oxides

- Basic compounds
- Inorganic chemical compound containing metal bound to oxygen
- Forms alkaline solution
- Mostly ionic compounds
- Reacts with acid to form salt

- Acidic compounds
- Inorganic chemical compounds having non-metal bound to oxygen
- Forms acidic solutions
- Covalent compound
- Reacts with bases to form salts

General properties of ionic compound

(i) Physical nature: Ionic compounds are solids and are somewhat hard because of the strong force of attraction between the positive and negative ions. These compounds are generally brittle and break into pieces when pressure is applied.

(ii) Melting and Boiling points: have high melting and boiling points . This is because a considerable amount of energy is required to break the strong inter-ionic attraction.

(iii) Solubility: Electrovalent compounds are generally soluble in water and insoluble in solvents such as kerosene, petrol, etc.

(iv) Conduction of Electricity : Ionic compounds in the solid state do not conduct electricity . But ionic compounds conduct electricity in the molten state.