Sparkuna
BY EDUVERSAL

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Success is the sum of details

FOR TEACHERS · EDITION 3 · AY 2026–27

Lab Valley Handbook

31 investigations for Grades 1–12: what students do, a lesson in five steps, the misconception to watch for, an exit question and a real practical for each one.



Predict · test fairly · explain

10–15 minutes a lab

Free, not part of grades

WWW.SPARKUNA.COM

LAB MODELS AS OF 24 OCTOBER 2026 (31 LABS)

START HERE

How a lab works.

The Lab Valley is part of each student's own island in Sparkuna. On its lab bench are 31 short investigations on small computer models. Every lab is written five times, once for each grade band, with the band's own words and its own conclusion question.

1
Predict
Before touching anything, the student picks what they think will happen.

2
Test fairly
Three set-ups that each change exactly ONE thing from the starting set-up. Change two at once and the lab says so.

3
Explain
One conclusion question, then the reason, shown next to their prediction.

4
Finish
The lab becomes a page in their lab notebook (page 37). The first finish gives two garden seeds; after that it is just for learning.

🔒 One lab opens the next

Each grade band has its own order of labs (page 3). The first is open from the start; finishing a lab opens the next. Labs do not follow any school's pacing, so use them when the topic comes up, or as a starter or a homework task once a student has reached that lab.

🧑‍🏫 What you can see

Teachers Hub → Help → Lab Valley guide: every lab as students see it, for your band. **My classes**: the students table has a Lab Valley column (labs done and the next one); **Labs & activities** shows each lab. Nothing from the labs goes into grades.

🧪 Honest models

Each lab runs on a small model that says it is a model, with numbers chosen to show the science clearly. They are not field data. The real practical on each page lets students check the idea with their own hands.

🦺 Practicals

Every practical uses school-lab or kitchen materials. Follow your school's safety rules: eye protection with acids, care with hot water and lamps, hand-washing after soil or pond water, and never drinking anything made in a lab.

Using a lab in class: the lesson in five steps

1
Hook
A question, object or photo. Do not give the answer yet.

2
Predict together
Ask the lab's question, take a show of hands and write the answers and votes on the board.

3
Test
Students run the lab on their own devices or in pairs; you circulate with the prompts given.

4
Explain
Go through the conclusion question and compare it with the votes on the board.

5
Extend
The real practical, then the exit question. Watch for the misconception named on each page.

Students find the labs at **www.sparkuna.com** → My Island → Lab Valley → the lab bench. The valley opens after a student's first careful practice runs.

THE CHAINS

Which lab comes when.

Each band has its own order, mixing subjects. A student sees every lab in their chain by name; later ones are locked until the one before is finished.

Grades 1–3
Primary Science

1. Leaf
2. Pollinator
3. Mangrove
4. Weather
5. Solar
6. Oxygen
7. Soil
8. Cool Classroom
9. Kitchen
10. Turbidity
11. Thirsty-leaf
12. Rust
13. Cable
14. Rice Breeding
15. Lime
16. Sasando
17. Jukung
18. Harvest slide
19. Batik dye
20. Tide
21. Stove
22. Hydrogen
23. Fertiliser
24. Sundial
25. Micro-hydro
26. Fisher's lamp
27. Palm oil
28. Heart
29. Night market
30. Salted fish
31. Radon

31 of 32 syllabus units touched

Grades 4–6
Primary Science

1. Leaf
2. Pollinator
3. Weather
4. Solar
5. Mangrove
6. Soil
7. Oxygen
8. Turbidity
9. Cable
10. Kitchen
11. Cool Classroom
12. Thirsty-leaf
13. Rust
14. Lime
15. Rice Breeding
16. Jukung
17. Sasando
18. Batik dye
19. Harvest slide
20. Tide
21. Hydrogen
22. Stove
23. Fertiliser
24. Night market
25. Sundial
26. Heart
27. Fisher's lamp
28. Micro-hydro
29. Palm oil
30. Salted fish
31. Radon

33 of 34 syllabus units touched

Grades 7–8
Lower Secondary

1. Leaf
2. Solar
3. Oxygen
4. Weather
5. Soil
6. Mangrove
7. Pollinator
8. Lime
9. Cable
10. Thirsty-leaf
11. Rust
12. Kitchen
13. Cool Classroom
14. Turbidity
15. Rice Breeding
16. Sasando
17. Harvest slide
18. Batik dye
19. Jukung
20. Stove
21. Tide
22. Hydrogen
23. Fertiliser
24. Heart
25. Micro-hydro
26. Night market
27. Fisher's lamp
28. Salted fish
29. Radon
30. Palm oil
31. Sundial

33 of 36 syllabus units touched

Grades 9–10
IGCSE

1. Leaf
2. Oxygen
3. Solar
4. Soil
5. Pollinator
6. Weather
7. Mangrove
8. Lime
9. Cable
10. Kitchen
11. Rust
12. Thirsty-leaf
13. Cool Classroom
14. Turbidity
15. Rice Breeding
16. Stove
17. Harvest slide
18. Hydrogen
19. Sasando
20. Fertiliser
21. Jukung
22. Batik dye
23. Tide
24. Radon
25. Night market
26. Micro-hydro
27. Heart
28. Fisher's lamp
29. Salted fish
30. Palm oil
31. Sundial

77 of 168 syllabus units touched

Grades 11–12
AS & A Level

1. Leaf
2. Solar
3. Oxygen
4. Mangrove
5. Weather
6. Soil
7. Pollinator
8. Lime
9. Cable
10. Kitchen
11. Rust
12. Thirsty-leaf
13. Cool Classroom
14. Turbidity
15. Rice Breeding
16. Hydrogen
17. Harvest slide
18. Fertiliser
19. Sasando
20. Stove
21. Jukung
22. Batik dye
23. Tide
24. Night market
25. Micro-hydro
26. Radon
27. Heart
28. Fisher's lamp
29. Salted fish
30. Palm oil
31. Sundial

58 of 210 syllabus units touched

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The labs in this handbook.

	Lab	Subject	Zone	Time	Page
1	🌿 **Leaf lab** what do plants need?	Biology	Garden Terraces	15 min	5
2	🫘 **Soil lab** the nitrogen cycle	Biology · Earth	Garden Terraces	10 min	6
3	💧 **Oxygen lab** the paddy by day and night	Biology	Rice-Fish Paddy	15 min	7
4	🐝 **Pollinator lab** bees and fruit	Biology	Orchard	10 min	8
5	☀️ **Solar lab** power from the sun	Physics · Earth	Energy Yard	15 min	9
6	🌊 **Mangrove lab** roots against the waves	Biology · Earth	Mangrove Coast	10 min	10
7	🌧️ **Weather lab** up the volcano	Earth · Physics	Volcano Lookout	10 min	11
8	🪨 **Lime lab** sweeten a sour terrace	Chemistry	Garden Terraces	15 min	12
9	🔩 **Rust lab** the yard's iron by the sea	Chemistry	Energy Yard	10 min	13
10	🧪 **Turbidity lab** clear or safe?	Chemistry · Biology	Rice-Fish Paddy	10 min	14
11	🍚 **Kitchen lab** starch to sugar	Biology · Chemistry	Garden Terraces	10 min	15
12	🍃 **Thirsty-leaf lab** transpiration	Biology	Garden Terraces	10 min	16
13	🌾 **Rice Breeding lab** the best seed	Biology	Garden Terraces	10 min	17
14	🔌 **Cable lab** power to the fans	Physics	Energy Yard	15 min	18
15	🏫 **Cool Classroom lab** beat the heat	Physics	Energy Yard	10 min	19
16	🎶 **Sasando lab** strings that sing	Physics	Orchard	15 min	20
17	🌙 **Tide lab** the Moon and the mangrove	Earth · Physics	Mangrove Coast	10 min	21
18	🚣 **Jukung lab** how much can it carry?	Physics	Mangrove Coast	15 min	22
19	🥔 **Harvest slide lab** sacks down the slope	Physics	Volcano Lookout	15 min	23
20	🔥 **Stove lab** which fuel cooks best?	Chemistry	Garden Terraces	15 min	24
21	🍼 **Fertiliser lab** where does the nitrogen go?	Chemistry · Biology	Rice-Fish Paddy	15 min	25
22	🫧 **Hydrogen lab** store the sun in a gas	Chemistry · Physics	Energy Yard	15 min	26
23	🎨 **Batik dye lab** colours apart	Chemistry	Orchard	15 min	27
24	🌞 **Sundial lab** shadows on the Equator	Earth · Physics	Energy Yard	15 min	28
25	💡 **Night market lab** light up the stalls	Physics	Energy Yard	15 min	29
26	🌀 **Micro-hydro lab** light the village	Physics	Garden Terraces	15 min	30
27	🎣 **Fisher's lamp lab** where is the fish?	Physics	Mangrove Coast	15 min	31
28	❤️ **Heart lab** up the volcano path	Biology	Volcano Lookout	15 min	32
29	🐟 **Salted fish lab** why salt keeps fish	Biology · Chemistry	Mangrove Coast	15 min	33
30	📟 **Radon lab** counting the volcano's gas	Physics · Earth	Volcano Lookout	15 min	34
31	🌴 **Palm oil lab** from oil to fuel	Chemistry	Energy Yard	15 min	35

Codes in this handbook: Cambridge Primary and Lower Secondary Science learning objectives, IGCSE 0610 / 0620 / 0625 and AS & A Level 9700 / 9701 / 9702 sections. An alignment aid for planning, not an endorsement.



LAB 1 OF 31 · BIOLOGY

Leaf lab

what do plants need?

📍 Garden Terraces ⏱ about 15 minutes

Grades 1–12, five versions

Students move a lamp, add baking soda (carbon dioxide) and warm the water, then count the oxygen bubbles a water plant gives off in one minute.

They learn Photosynthesis needs light and carbon dioxide; the factor in shortest supply limits the rate; the enzymes have a best temperature.

The lesson, in the lab's own steps

1 Hook

Show a photo of bubbles rising from water plants in a pond on a sunny day. Ask: what is in the bubbles, and why only in the sun? Do not answer yet.

2 Predict together

Before anyone taps: "If the lamp comes closer, what happens to the bubbles?" Take a show of hands and write the three answers with their votes on the board.

3 Test

While students test, ask: "What did you keep the same?" and "Why count for a whole minute?" Each student needs two counts at different lamp distances with the same soda and water.

4 Explain

Go through the conclusion question together and compare it with the votes on the board. Ask why more light stopped helping once carbon dioxide ran short.

5 Extend: the real practical

Real version: Elodea or Cabomba in water with a pinch of sodium hydrogen carbonate under a desk lamp; count the bubbles for one minute at three distances. Keep water away from the lamp cable and let the lamp cool before moving it.

⚠ Watch for

Students who think plants get their food from the soil, or that plants only photosynthesise and never respire. Plants make their food by photosynthesis, and they respire day and night.

✅ Check (exit question)

Name one factor that can limit the rate of photosynthesis, and say how you would test it fairly.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why does moving the lamp from 10 cm to 20 cm cut the light to a quarter?

What could limit photosynthesis in a crowded, shady rice field?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 1 in the chain	no. 1 in the chain	no. 1 in the chain	no. 1 in the chain	no. 1 in the chain
1Bp.03 · 3Bp.03	4Bp.03	9Bp.06 · 9Bp.07	0610 6.1.7 · 6.1.8 · 6.1.11	9700 13.2.1 · 13.2.2 · 13.2.4



LAB 2 OF 31 · BIOLOGY · EARTH

Soil lab

the nitrogen cycle

📍 Garden Terraces ⏱ about 10 minutes

Grades 1–12, five versions

Students tap through the steps of the nitrogen cycle, then look at the nitrogen numbers of their own garden beds.

They learn How nitrogen moves between the air, soil, plants and animals; nitrogen-fixing, nitrifying and decomposing microorganisms; crop rotation and compost.

The lesson, in the lab's own steps

1 Hook
Hold up a peanut or bean plant (or a photo) with its roots. Ask: why would a farmer plant peanuts in a tired rice field?

2 Predict together
Ask: "Can a plant take nitrogen straight from the air through its leaves?" Write the yes and no votes on the board.

3 Test
As students tap the steps, ask them to say which living things do each one: bacteria, fungi, plants or animals.

4 Explain
Draw the cycle on the board from what the class found. Ask which steps put nitrogen into the soil and which take it out.

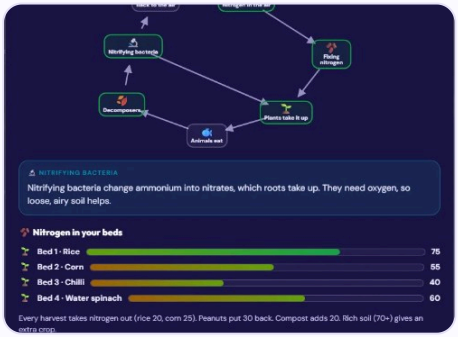
5 Extend: the real practical
Real version: dig up a peanut or bean plant and look for the root nodules with a hand lens; compare with a corn root. Wash hands after handling soil.

⚠ Watch for

Students who think plants take nitrogen gas from the air through their leaves, or that all bacteria are harmful. Most plants rely on nitrate from the soil, and many soil bacteria are essential.

✅ Check (exit question)

Why does a crop of peanuts help the next crop of rice?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why do farmers plant peanuts after rice?

What happens to the nitrogen in a flooded paddy?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 7 in the chain	no. 6 in the chain	no. 5 in the chain	no. 4 in the chain	no. 6 in the chain
3Bp.03	6ESp.03 · 6ESp.04	7Be.01	0610 19.3.2 · 19.3.3 · 20.1.1	*none in this syllabus*



LAB 3 OF 31 · BIOLOGY

Oxygen lab

the paddy by day and night

📍 Rice-Fish Paddy ⏱ about 15 minutes

Grades 1–12, five versions

Students change the fish, the rice, fresh water and the weather in a rice-fish paddy and read the dissolved oxygen hour by hour over one day.

They learn Photosynthesis adds oxygen only in the light; respiration uses it day and night; why the lowest oxygen comes at dawn.

The lesson, in the lab's own steps

1 Hook
Tell the class: fish in a crowded pond are sometimes found gasping at the surface at dawn, but not in the afternoon. Ask: why then?

2 Predict together
Ask when the oxygen in a crowded pond is lowest: early morning, midday or afternoon. Write the votes on the board.

3 Test
Remind students to change one thing at a time from their own paddy. Ask: "What happens to the line at night, and why?"

4 Explain
Discuss the conclusion question and the lowest point of the line. Link it to the two processes: photosynthesis only in the light, respiration all the time.

5 Extend: the real practical
Real version: if the school has a dissolved-oxygen meter or test kit, measure a fish pond or an aquarium at the start and at the end of the school day. Wash hands after touching pond water.

⚠️ **Watch for**
Students who think the oxygen is lowest at midnight, or that fish and plants stop using oxygen at night. Respiration goes on all night, so the oxygen keeps falling until the sun rises.

✅ **Check (exit question)**
Why is the oxygen in a pond lowest just before sunrise?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about

Why do fish in a crowded pond sometimes gasp at the surface before sunrise?

How does rice in the paddy help the fish?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 6 in the chain	no. 7 in the chain	no. 3 in the chain	no. 2 in the chain	no. 3 in the chain
3Be.01	6Be.01 · 6Be.03	8Bp.04 · 8Bp.05 · 9Bp.07	0610 12.2.1 · 6.1.8 · 20.3.4	9700 13.2.2



LAB 4 OF 31 · BIOLOGY

Pollinator lab

bees and fruit

📍 Orchard | ⏱ about 10 minutes | Grades 1–12, five versions

Students change the kinds of flowers, add a bee hotel, spray insecticide or make it rain, and compare the bee visits and the fruits from 20 flowers.

They learn Pollination, why many fruits need insects, how insecticides harm pollinators, and diminishing returns.

The lesson, in the lab's own steps

1 Hook
Show a flowering chilli or mango tree with a bee on it (a photo is fine). Ask: why does the farmer want bees here?

2 Predict together
Ask what a bee hotel will do to the number of fruits. Write the votes on the board.

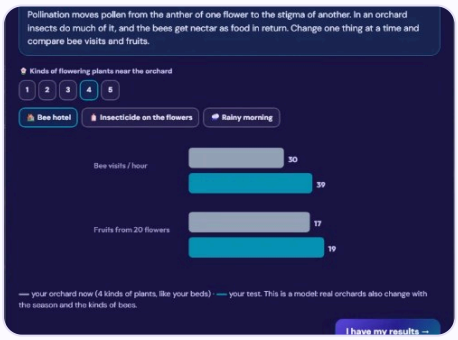
3 Test
Ask students to change one thing at a time and compare the bars. Prompt: "Why do the fruits stop rising when the visits keep rising?"

4 Explain
Discuss the conclusion question. Link the levelling off to the 20 flowers: there cannot be more fruits than flowers.

5 Extend: the real practical
Real version: watch one flowering plant in the school garden for ten minutes and tally the insect visits; repeat on a cloudy day. Students allergic to stings watch from a distance.

⚠️ **Watch for**
Students who think pollination and fertilisation are the same thing, or that bees make the fruit. Pollination moves the pollen; fertilisation comes after it, and only then does a fruit form.

✅ **Check (exit question)**
Why can spraying insecticide on open flowers mean fewer fruits?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 **Talk about** Why do more kinds of flowers bring more bees?

What could a farmer do instead of spraying open flowers?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 2 in the chain	no. 2 in the chain	no. 7 in the chain	no. 5 in the chain	no. 7 in the chain
3Bs.01	5Bp.03 · 5Be.02 · 6Be.02	*none in this syllabus*	0610 16.3.5 · 16.3.7 · 16.3.10	*none in this syllabus*



LAB 5 OF 31 · PHYSICS · EARTH

☀️ Solar lab

power from the sun

📍 Energy Yard · ⏱ about 15 minutes · Grades 1–12, five versions

Students tilt a solar panel, add cloud, dust or an air gap, and compare the power at midday and the fans it runs.

They learn Energy transfer from light to electrical energy, efficiency, why a hot panel is less efficient, and the angle of the sunlight.

The lesson, in the lab's own steps

1. **Hook**
   Show a small solar panel or a solar garden lamp. Ask: why do the panels on Indonesian roofs lie almost flat?

2. **Predict together**
   Ask what standing the panel upright (90°) does to the power at midday. Write the votes on the board.

3. **Test**
   Remind students to change one thing at a time from the yard's panel. Grades 9–12 also work out the efficiency from the numbers shown.

4. **Explain**
   Discuss where the energy goes that does not become electricity. Use the class's efficiency numbers.

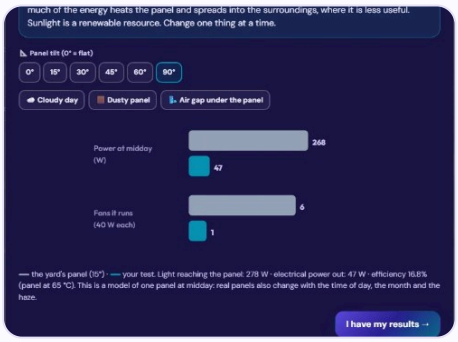
5. **Extend: the real practical**
   Real version: connect a small solar cell to a multimeter or a small motor and compare the output at different angles to a lamp or the sky; cover half of the cell with paper. Never look at the Sun.

⚠️ Watch for

Students who think energy is used up or destroyed in the panel, or that a hotter panel gives more electricity. Energy is conserved and much of it becomes heat; a hot panel is less efficient.

✅ Check (exit question)

Name one way to get more power from the same panel, and say why it works.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about Why is a panel tilted only a little close to best in Indonesia?

Why do people wash solar panels in the dry season?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 5 in the chain	no. 4 in the chain	no. 2 in the chain	no. 3 in the chain	no. 2 in the chain
1ESs.02	4Pf.01 · 4Pf.02 · 4Pf.03 · 4Pf.04	7Pf.01 · 7Pf.02 · 8ESp.02 · 9Pf.03	0625 1.7.3.3 · 1.7.3.7	9702 5.1.3



LAB 6 OF 31 · BIOLOGY · EARTH

Mangrove lab

roots against the waves

📍 Mangrove Coast ⏱ about 10 minutes

Grades 1–12, five versions

Students change the width of a mangrove forest, add a storm or a high tide, or replant it, and compare the waves at the village with the young fish in the roots.

They learn Habitats and ecosystems, what clearing a habitat does, conservation, and (Grades 11–12) exponential decay.

The lesson, in the lab's own steps

1 Hook
Show two photos after a storm: a village behind a mangrove forest and one without. Ask: where would you rather live, and why?

2 Predict together
Ask what cutting the forest from 100 m to 50 m will do to the young fish. Write the votes on the board.

3 Test
Remind students to change one thing at a time. Prompt: "Does each extra 100 m of forest cut the waves by the same number of centimetres?"

4 Explain
Discuss the conclusion question. Link the forest to both jobs it does: it protects the village and it is a habitat.

5 Extend: the real practical
Real version: in a long tray of water, make waves with a ruler and let them pass through rows of sticks pushed into clay; compare the waves at the far end with no sticks, a few and many.

⚠ **Watch for**
Students who think a new planting protects the shore as well as a grown forest, or that mangroves are just useless swamp. Young trees protect far less, and a grown forest is both a habitat and a shield.

✅ **Check (exit question)**
Give two reasons why a coastal village should protect its mangroves.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about

Why is protecting an old mangrove forest better than planting a new one?

Who in a coastal village depends on the mangroves?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 3 in the chain	no. 5 in the chain	no. 6 in the chain	no. 7 in the chain	no. 4 in the chain
2Be.01 · 2Be.02	4Be.01 · 4SIC.05	8Be.01 · 9Be.01 · 9ESc.02	0610 20.2.4 · 20.4.4	9700 18.3.2



LAB 7 OF 31 · EARTH · PHYSICS

Weather lab

up the volcano

📍 Volcano Lookout · ⏱ about 10 minutes

Grades 1–12, five versions

Students carry a weather station up a volcano, move it to the rain-shadow side or switch to the dry season, and compare the temperature and the rain.

They learn The water cycle, why air cools as it rises, rain shadows, and weather compared with climate.

The lesson, in the lab's own steps

1 Hook
Ask who has been to Bromo, Dieng or Puncak. Was it warmer or cooler than at home? Why?

2 Predict together
Ask how warm it will be at 2000 m compared with the coast. Write the guesses on the board.

3 Test
Remind students to change one thing at a time from the lookout station. Prompt: "Which side of the volcano gets more rain, and why?"

4 Explain
Discuss the conclusion question. Draw damp air rising up the slope, cooling, forming cloud and dropping rain on the side facing the wind.

5 Extend: the real practical
Real version: keep a class weather log for two weeks (the temperature at the same time each day, the rain in a gauge made from a cut plastic bottle) and compare it with the nearest BMKG station.

⚠ Watch for

Students who think it is colder higher up because it is further from the Sun, or who mix up weather and climate. Rising air expands and cools; climate is the usual pattern over many years.

✅ Check (exit question)

Why does the side of a mountain facing the wind usually get more rain?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why are cabbages and potatoes grown on the mountains of Java?

Is it weather or climate when someone says "it rained yesterday"?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 4 in the chain	no. 3 in the chain	no. 4 in the chain	no. 6 in the chain	no. 5 in the chain
2Be.03	5ESc.01 · 5Cc.01 · 4ESp.02	7ESc.01 · 8ESc.03 · 7ESp.02	0625 2.1.2.3 · 2.2.3.3	9702 16.2.2



LAB 8 OF 31 · CHEMISTRY

Lime lab

sweeten a sour terrace

📍 Garden Terraces · ⏱ about 15 minutes · Grades 1–12, five versions

Students spread lime (calcium carbonate) on an acid terrace: they change the amount, grind it to a powder, try a hot week or acid rain, and compare the soil pH after a week and the rice from the bed.

They learn Acids and bases, pH, neutralising an acid with a carbonate, and how surface area and temperature change the rate of a reaction.

The lesson, in the lab's own steps

1 Hook
Show a bag of agricultural lime (kapur pertanian or dolomit) or a photo of one. Ask: why would a farmer spread a white powder on a rice field?

2 Predict together
Ask what grinding the lime to a powder (the same amount) will do to the soil after one week. Write the three answers with their votes on the board.

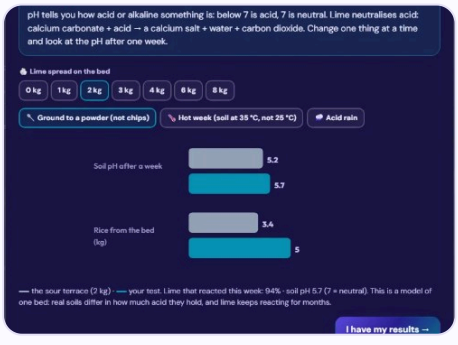
3 Test
Remind students to change one thing at a time from the terrace. Prompt: "Is more lime always better for the rice?"

4 Explain
Discuss the conclusion question. Write the word equation on the board: calcium carbonate + acid → a calcium salt + water + carbon dioxide, and link the carbon dioxide to the fizz.

5 Extend: the real practical
Real version: drop a spoon of chalk or eggshell pieces, and the same mass as a powder, into two cups of vinegar and compare the fizz; test the vinegar with universal indicator before and after. Wear eye protection.

⚠️ **Watch for**
Students who think more of a base always pushes the pH higher without limit, or that the gas comes out of the soil. The carbon dioxide comes from the carbonate, and an insoluble carbonate cannot make soil strongly alkaline.

✅ **Check (exit question)**
Give two ways to make lime neutralise an acid soil faster.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why do farmers grind lime into a fine powder?

Why is too much lime bad for rice?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 15 in the chain	no. 14 in the chain	no. 8 in the chain	no. 8 in the chain	no. 8 in the chain
1ESp.02 · 2Cc.01	4Cc.03 · 6Cc.04 · 6Cc.05 · 6ESp.04	7Cp.02 · 7Cp.03 · 7Cc.04 · 9Cc.03 · 9Cc.04	0620 7.1.1 · 7.1.7 · 6.2.1	9701 7.2.5 · 8.1.2 · 8.2.3



LAB 9 OF 31 · CHEMISTRY

Rust lab

the yard's iron by the sea

📍 Energy Yard ⏱ about 10 minutes

Grades 1–12, five versions

Students compare a bare, a painted and a zinc-coated iron gate, add salty sea spray or a roof, or mend a scratch, then compare the rust and the iron eaten away after two years.

They learn The conditions for rusting, barrier methods, sacrificial protection by zinc, the reactivity series and (Grades 11–12) electrode potentials.

The lesson, in the lab's own steps

1 Hook
Show something rusty from school or home next to something galvanised (a roof sheet or a bucket). Ask: why did one rust and not the other?

2 Predict together
Ask what a zinc coat instead of paint will do at the scratch. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the painted, scratched gate. Prompt: "Where does the rust start on the painted gate?"

4 Explain
Discuss the conclusion question. Compare paint (a barrier only) with zinc (a barrier that is also oxidised first).

5 Extend: the real practical
Real version: put iron nails in four test tubes (tap water, salty water, boiled water under a layer of oil, dry air with calcium chloride) and a galvanised nail in tap water; look after a week. Label the tubes and wash hands afterwards.

⚠ Watch for
Students who think rust is just dirt, that iron rusts without water or oxygen, or that zinc only covers the iron. Rust is a new substance, and zinc also protects by being oxidised instead of the iron.

✅ Check (exit question)
Why does a scratched galvanised roof not rust at the scratch?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why do bicycles and roofs by the sea rust so quickly?

Which would you choose for a school gate, paint or a zinc coat, and why?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 12 in the chain	no. 13 in the chain	no. 11 in the chain	no. 11 in the chain	no. 11 in the chain
1Cm.01 · 2Cp.02 · 2Cc.01	4Cc.03 · 6Cc.05	7Cc.01 · 8Cc.01 · 8Cc.03	0620 9.5.1 · 9.5.2 · 9.4.1 · 6.4.2	9701 24.2.6 · 6.1.1



LAB 10 OF 31 · CHEMISTRY · BIOLOGY

Turbidity lab

clear or safe?

📍 Rice-Fish Paddy ⏱ about 10 minutes

Grades 1–12, five versions

Students add mud to a water sample, filter it, boil it or add chlorine, and compare the light getting through the sample with the germs left in it.

They learn Mixtures and separating them, concentration, how drinking water is treated, how diseases spread in water and (Grades 11–12) exponential attenuation.

The lesson, in the lab's own steps

1 Hook
Show two glasses of clear water. Ask: can you tell by looking which one is safe to drink? (You cannot.)

2 Predict together
Ask whether the filtered water will be safe to drink. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the paddy water. Prompt: "Which change makes the water clear? Which change kills the germs? Is it the same one?"

4 Explain
Discuss the conclusion question. Make two columns on the board: what takes the mud out, and what kills germs.

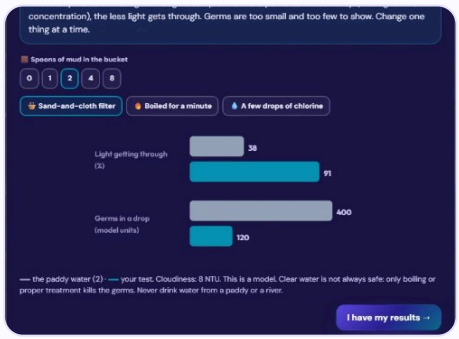
5 Extend: the real practical
Real version: pour muddy water through a cut plastic bottle filled with cloth, sand and gravel, and compare it with the start against white paper with a black cross. Never drink the filtered water; wash hands afterwards.

⚠ Watch for

Students who think clear water is clean water, or that a filter kills germs. A filter takes out particles; boiling or chlorine kills germs, and chlorine works badly in muddy water.

✅ Check (exit question)

Name one thing that makes water clear and one thing that makes it safe, and say why they are different.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

- Why do water works filter the water before they add chlorine?
- What should a family do with water from a well after a flood?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 10 in the chain	no. 8 in the chain	no. 14 in the chain	no. 14 in the chain	no. 14 in the chain
3Cp.04 · 2Bp.01	5ESp.02 · 5ESp.03 · 6Bp.03	8Cp.01 · 8Cm.04 · 7Cm.04	0620 10.1.4 · 10.1.7 · 0610 10.1.5	9702 24.2.3 · 9700 10.1.3



LAB 11 OF 31 · BIOLOGY · CHEMISTRY

Kitchen lab

starch to sugar

📍 Garden Terraces ⏱ about 10 minutes

Grades 1–12, five versions

Students warm or cool an enzyme (amylase) with cooked rice, add lime juice, boil the enzyme first or leave it longer, and compare the starch turned to sugar with the enzyme still working.

They learn Enzymes as biological catalysts, the digestion of starch, optimum temperature and pH, denaturation, and the iodine test for starch.

The lesson, in the lab's own steps

1 Hook
Ask students to chew a plain cracker or a spoon of rice for a minute without swallowing. What happens to the taste?

2 Predict together
Ask what boiling the enzyme first will do. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the kitchen set-up (30 °C, 5 minutes). Prompt: "What happens to the second bar when it gets too hot?"

4 Explain
Discuss the conclusion question. Draw an enzyme and its active site before and after heating.

5 Extend: the real practical
Real version: mix starch solution with amylase solution in a water bath and put a drop on a tile of iodine every minute until it stays orange-brown; compare a cold, a warm and a hot bath. Use a thermometer and take care with hot water.

⚠ **Watch for**
Students who think enzymes are alive and are killed by heat, or that heat always makes enzymes work faster. Enzymes are proteins; too much heat changes their shape for good (denaturation).

✅ **Check (exit question)**
Why does an enzyme stop working when it is boiled?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 **Talk about** Why does rice taste sweet if you chew it for a long time?

Why does a fever above 40 °C worry doctors?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 9 in the chain	no. 10 in the chain	no. 12 in the chain	no. 10 in the chain	no. 10 in the chain
1Bp.02 · 3Bs.03	5Bs.04 · 5Bp.01	8Bp.01 · 8Bp.02 · 7Cc.01 · 9Cc.04	0610 5.1.5 · 4.1.3 · 7.4.3	9700 3.2.1 · 3.1.1 · 2.1.1



LAB 12 OF 31 · BIOLOGY

Thirsty-leaf lab

transpiration

📍 Garden Terraces ⏱ about 10 minutes

Grades 1–12, five versions

Students put a leafy shoot in a potometer and change the temperature, the light, the wind and the humidity, then compare how far the bubble moves and how open the stomata are.

They learn How water moves from the roots to the leaves, transpiration through the stomata, and the effects of temperature, wind, humidity and light.

The lesson, in the lab's own steps

1. **Hook**
   Show a plant that has wilted on a hot afternoon (or a photo of one). Ask: where did its water go?

2. **Predict together**
   Ask what a fan blowing over the leaves will do. Write the votes on the board.

3. **Test**
   Remind students to change one thing at a time from the shoot on a warm, still, sunny day. Prompt: "Why does the bubble almost stop in the dark?"

4. **Explain**
   Discuss the conclusion question. Draw the path of the water: root hair cell, xylem, leaf, stomata, air.

5. **Extend: the real practical**
   Real version: tie a clear plastic bag over a leafy branch in the sun and another in the shade, and compare the water collected after an hour; or weigh two potted plants, one with petroleum jelly on its leaves, over a day.

⚠ Watch for

Students who think plants take in water through their leaves, or that transpiration is the plant breathing. Water goes in at the roots and evaporates out of the leaves through the stomata.

✅ Check (exit question)

Give two conditions that make a plant lose water fastest.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why do farmers water seedlings early in the morning or in the evening?

Why do some desert plants have tiny leaves?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 11 in the chain	no. 12 in the chain	no. 10 in the chain	no. 12 in the chain	no. 12 in the chain
1Bs.01 · 3Bs.01 · 1Bp.03	5Cc.01 · 4Bp.03	9Bs.01 · 7Bs.03 · 9Pf.06	0610 8.3.1 · 8.3.3 · 8.2.3 · 3.1.1	9700 7.2.3 · 7.2.4



LAB 13 OF 31 · BIOLOGY

Rice Breeding lab

the best seed

📍 Garden Terraces ⏱ about 10 minutes

Grades 1–12, five versions

Students choose what share of the rice plants to keep for seed, try a field with uneven soil or ten generations, and compare the rice per plant at the end and the gain each generation.

They learn Variation, inheritance, selective breeding (artificial selection) compared with natural selection, and (Grades 11–12) heritability and the breeder's equation $R = h^2S$.

The lesson, in the lab's own steps

1 Hook
Show two kinds of rice (or photos): a local variety and a modern one. Ask: how did farmers get rice that gives more grain?

2 Predict together
Ask what sowing seed from all the plants, not just the best, will do. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the farmer's plan (keep the best 25%, five generations). Prompt: "Why does uneven soil make choosing harder?"

4 Explain
Discuss the conclusion question. Write the two causes of variation on the board: genes and environment.

5 Extend: the real practical
Real version: measure the length of 20 rice grains (or bean seeds) from one bag and make a tally chart; discuss which differences could be passed on. Or compare grains of two varieties.

⚠ **Watch for**
Students who think plants change on purpose to become better, or that every difference, even one caused by the soil, is passed on. Only genetic differences are inherited, and in selective breeding people do the choosing.

✅ **Check (exit question)**
Why does choosing seed from the best plants improve the rice, and why can it fail on uneven soil?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why do breeders test new rice in fields with even soil?

What could farmers lose if every field grows the same variety?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 14 in the chain	no. 15 in the chain	no. 15 in the chain	no. 15 in the chain	no. 15 in the chain
2Bp.04	5Bp.02	9Bp.03 · 9Bs.03 · 9Bp.01 · 7Bp.03	0610 18.3.2 · 18.3.3 · 18.1.4	9700 17.2.6 · 17.2.7 · 17.1.1



LAB 14 OF 31 · PHYSICS

Cable lab

power to the fans

📍 Energy Yard | ⏱ about 15 minutes | Grades 1–12, five versions

Students run a cable from a 24 V supply to 12 fans and change its length, its thickness, the metal and whether a transformer steps the voltage up, then compare the power reaching the fans with the power wasted in the cable.

They learn Conductors, current and resistance, how length, thickness and material change resistance, power lost as heat ($P = I^2R$) and why electricity is sent at high voltage.

The lesson, in the lab's own steps

1 Hook
Show a long extension cable, or a photo of high-voltage pylons. Ask: why are power lines high-voltage?

2 Predict together
Ask which cable brings more power to the fans: copper or aluminium of the same size. Write the votes on the board.

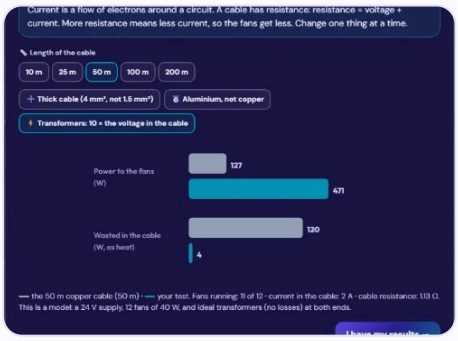
3 Test
Remind students to change one thing at a time from the 50 m copper cable. Prompt: "Where does the missing power go?" Grades 9–12 work out the current and I^2R from the numbers shown.

4 Explain
Discuss the conclusion question. Link the wasted power to the warm cable.

5 Extend: the real practical
Real version: in a circuit with a cell, an ammeter and a lamp, add 1 m and then 2 m of thin resistance wire and record the current and the brightness; repeat with a thicker wire. Use cells or a low-voltage supply only, never the mains.

⚠️ **Watch for**
Students who think the current gets used up along a wire, or that a thicker wire has more resistance. The current is the same all round a series circuit; energy is transferred to heat in the resistance.

✅ **Check (exit question)**
Give two ways to waste less energy in a long cable.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 **Talk about**

Why do power stations send electricity at a very high voltage?

Why does a long extension cable feel warm?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 13 in the chain	no. 9 in the chain	no. 9 in the chain	no. 9 in the chain	no. 9 in the chain
1Pe.01 · 2Pe.01	4Pe.03 · 4Pe.04 · 6Cp.03	7Pe.01 · 7Pe.02 · 7Pe.03 · 9Pe.03	0625 4.2.4.3 · 4.2.5.2 · 4.5.6.2 · 4.5.6.4	9702 9.3.6 · 9.2.3



LAB 15 OF 31 · PHYSICS

Cool Classroom lab

beat the heat

📍 Energy Yard · ⏱ about 10 minutes

Grades 1–12, five versions

Students change the roof of a classroom (white paint, shiny bare metal), add insulation, shade trees or a cross-breeze, and compare how much warmer the classroom is than the air outside, and the roof temperature.

They learn Thermal energy transfer by conduction, convection and radiation, absorbers and emitters of infrared, insulation, and a steady temperature as a balance of energy in and out.

The lesson, in the lab's own steps

1 Hook
Ask: which classroom in our school is the hottest after lunch? What is its roof made of?

2 Predict together
Ask what painting the dark roof white will do to the classroom. Write the votes on the board.

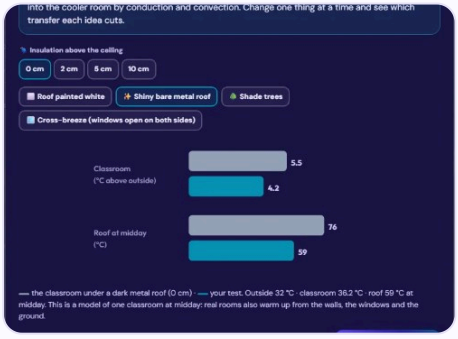
3 Test
Remind students to change one thing at a time from the classroom under a dark metal roof. Prompt: "Why does the shiny roof get hotter than the white one?"

4 Explain
Discuss the conclusion question. Mark the three kinds of transfer on a drawing of the classroom: radiation from the Sun, conduction through the roof, convection of the air.

5 Extend: the real practical
Real version: put a thermometer in each of three cans (painted black, painted white, shiny) in the sun and read them every 5 minutes for 30 minutes; then let them cool in the shade. Do not touch hot cans.

⚠ **Watch for**
Students who think insulation makes cold, or that shiny surfaces always stay coolest. Insulation only slows the flow of heat; a shiny surface reflects well but emits badly, so it holds on to its heat.

✅ **Check (exit question)**
Name two cheap ways to keep a classroom cooler, and the kind of heat transfer each one cuts.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why are many houses in hot places painted white?

How could our school make its hottest classroom cooler?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 8 in the chain	no. 11 in the chain	no. 13 in the chain	no. 13 in the chain	no. 13 in the chain
2Ps.01 · 1Cp.02	6Cp.03 · 4Ps.02	9Pf.05 · 9Pf.04 · 8Ps.04	0625 2.3.3.3 · 2.3.1.1 · 2.3.4.1	9702 14.1.1 · 14.1.2



LAB 16 OF 31 · PHYSICS

Sasando lab

strings that sing

📍 Orchard · ⏱ about 15 minutes · Grades 1–12, five versions

Students change the length, tension and thickness of a sasando string, pluck it harder or listen from further away, and compare the pitch (Hz) and the loudness (dB).

They learn Sound from vibrating sources, pitch and frequency, loudness and amplitude, sound spreading out as it travels, and (Grades 9–12) v = fλ and stationary waves on a string.

The lesson, in the lab's own steps

1 Hook
Play a short recording of a sasando (or any string instrument) and ask: how does one instrument make so many different notes?

2 Predict together
Ask what a shorter string does to the note. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the 40 cm string. Prompt: "Which changes moved the pitch, and which moved the loudness?"

4 Explain
Discuss the conclusion question. Sort the changes into two lists on the board: pitch (length, tension, thickness) and loudness (pluck, distance).

5 Extend: the real practical
Real version: stretch a rubber band or fishing line over a box and pluck it; shorten it with a pencil as a bridge, then tighten it; a free tuner app shows the frequency. Keep faces away from stretched lines.

⚠ **Watch for**
Students who think a louder sound is also a higher sound, or that sound needs nothing to travel through. Pitch and loudness change separately; sound needs particles to carry the vibration.

✅ **Check (exit question)**
Give two ways to make a string play a higher note.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about

Why do guitar and sasando strings have different thicknesses?

Why does music sound quieter from the back of the hall?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 16 in the chain	no. 17 in the chain	no. 16 in the chain	no. 19 in the chain	no. 19 in the chain
1Ps.01 · 1Ps.02 · 1Cc.01	5Ps.01 · 5Ps.02 · 5Ps.03	7Ps.01 · 9Ps.01	0625 3.4.1 · 3.4.7 · 3.1.4	9702 8.1.2 · 7.1.5



LAB 17 OF 31 · EARTH · PHYSICS

🌙 Tide lab

the Moon and the mangrove

📍 Mangrove Coast ⏱ about 10 minutes

Grades 1–12, five versions

Students move through the Moon's month, put the Moon at its closest to Earth or add a strong wind from the sea, and compare the high tide and the tide range at the mangrove.

They learn The phases of the Moon, the Moon as a satellite, gravity and the tides, spring and neap tides, and (Grades 11–12) why tides depend on M/r^3.

The lesson, in the lab's own steps

1 Hook

Show a tide table for a nearby harbour, or photos of a mangrove at low and at high tide. Ask: who needs to know when the tide will be high?

2 Predict together

Ask whether the high tide at full moon will be higher than at half moon. Write the votes on the board.

3 Test

Remind students to change one thing at a time from the half moon. Prompt: "What do new moon and full moon have in common?"

4 Explain

Discuss the conclusion question. Draw the Sun, the Earth and the Moon in a line (new and full moon) and at right angles (half moon).

5 Extend: the real practical

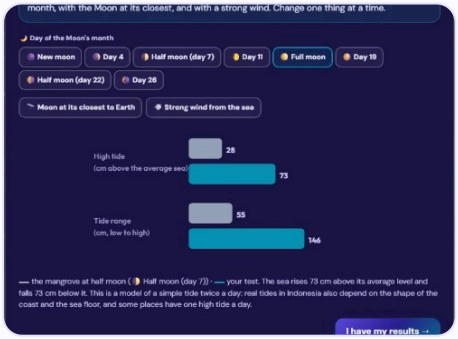
Real version: keep a Moon diary for a month (draw its shape each evening) and write the high-tide heights of a nearby harbour beside it. Model the phases with a ball and a torch in a dark room.

⚠️ Watch for

Students who think the Moon is not there at new moon, that the Earth's shadow makes the phases, or that the wind makes the daily tides. The phases come from how much of the Moon's lit half we can see.

✅ Check (exit question)

Why are the tides biggest at new moon and full moon?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why do mangrove planters choose their planting day by the tides?

Why do fishers need a tide table?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 20 in the chain	no. 20 in the chain	no. 21 in the chain	no. 23 in the chain	no. 23 in the chain
3ESs.01 · 3ESs.02 · 1ESp.01	5ESs.03 · 6ESs.01 · 6ESs.02	7ESs.03 · 7ESs.02	0625 6.1.1.3 · 6.1.2.3	9702 13.2.2 · 13.3.2



LAB 18 OF 31 · PHYSICS

Jukung lab

how much can it carry?

📍 Mangrove Coast ⏱ about 15 minutes

Grades 1–12, five versions

Students load a fishing canoe (jukung), make its hull wider or of heavy ironwood, or move it to fresh river water, and compare how deep it sits and how much side is left above the water.

They learn Floating and sinking, upthrust and weight, density, pressure in a liquid, and (Grades 11–12) Archimedes' principle.

The lesson, in the lab's own steps

1 Hook
Float a plastic tub in a bowl of water and add coins one at a time. Ask: how many coins before it sinks?

2 Predict together
Ask what will happen if we keep loading the canoe. Write the votes on the board.

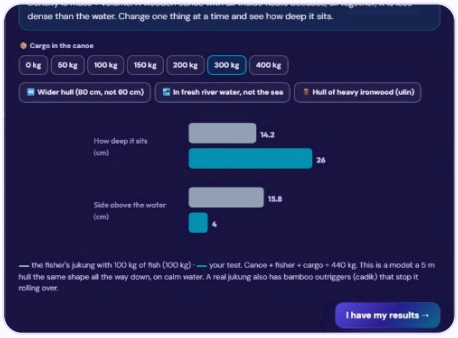
3 Test
Remind students to change one thing at a time from the canoe with 100 kg of fish. Prompt: "How many centimetres deeper did 50 kg more make it?"

4 Explain
Discuss the conclusion question. Draw the canoe with two arrows of the same length: weight down, upthrust up.

5 Extend: the real practical
Real version: float a foil or plastic tray in water and add washers or coins, marking the waterline after each one; then dissolve salt in the water and repeat. Mop up spills.

⚠ **Watch for**
Students who think heavy things always sink, or that boats float because they are made of wood. Ironwood is denser than water, yet an ironwood canoe floats: with the air inside, it pushes aside its own weight of water.

✅ **Check (exit question)**
Why does a canoe float a little higher in the sea than in a river?

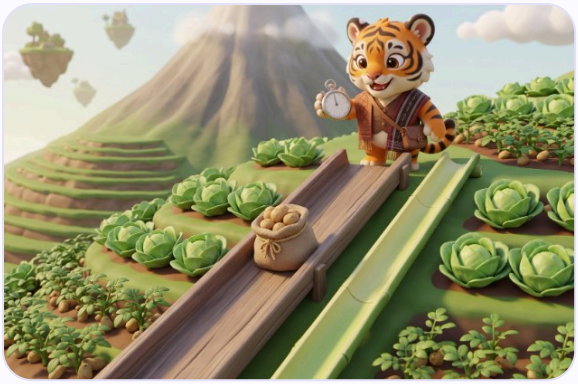


The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about How does a big steel ship float?

Why do fishers always keep some side above the water?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 17 in the chain	no. 16 in the chain	no. 19 in the chain	no. 21 in the chain	no. 21 in the chain
1Pf.03 · 2Cp.02	5Pf.01 · 5Pf.02 · 6Pf.05	9Pf.01 · 9Cp.02 · 9Cp.03	0625 1.4.3 · 1.8.3 · 1.8.4	9702 4.3.5 · 4.3.6 · 4.2.2



LAB 19 OF 31 · PHYSICS

Harvest slide lab

sacks down the slope

📍 Volcano Lookout · ⏱ about 15 minutes · Grades 1–12, five versions

Students change the slope of a harvest slide, make it smooth bamboo, use a heavier sack or a longer slide, and compare the speed at the bottom and the time it takes.

They learn Pushes and pulls, gravity and friction, speed = distance ÷ time, balanced and unbalanced forces, F = ma, energy transfers, and (Grades 11–12) motion on a slope with friction.

The lesson, in the lab's own steps

1 Hook
Slide a pencil case down a tilted book, then a heavier one. Ask: which one gets to the bottom first?

2 Predict together
Ask whether a sack twice as heavy will arrive sooner, later or at the same time. Write the votes on the board.

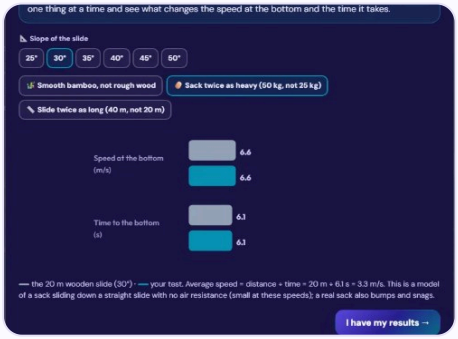
3 Test
Remind students to change one thing at a time from the 20 m wooden slide at 30°. Grades 7–12 work out the average speed from the time.

4 Explain
Discuss the conclusion question. Draw the forces on the sack: its weight, the push of the slide (the normal force) and friction.

5 Extend: the real practical
Real version: tilt a board on a pile of books, time a small box sliding down it, then cover the board with sandpaper or a smooth plastic sheet, and add a mass to the box. Keep the board low and catch the box at the bottom.

⚠ **Watch for**
Students who think heavier things always slide or fall faster, or that only rough surfaces have friction. The mass cancels out; smooth surfaces have friction too, just less.

✅ **Check (exit question)**
Give two ways to make the sack arrive faster, and the force each one changes.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why are playground slides smooth?

Why do mountain roads zig-zag instead of going straight down?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 18 in the chain	no. 19 in the chain	no. 17 in the chain	no. 17 in the chain	no. 17 in the chain
1Pf.01 · 2Pf.03 · 3Pf.03 · 3Pf.04	5Pf.01 · 5Pf.03 · 6Pf.04	8Pf.01 · 8Pf.03 · 7Pf.01	0625 1.2.9 · 1.5.1.6 · 1.5.1.11 · 1.7.1.3	9702 2.1.7 · 3.1.2 · 5.2.2



LAB 20 OF 31 · CHEMISTRY

Stove lab

which fuel cooks best?

📍 Garden Terraces ⏱ about 15 minutes

Grades 1–12, five versions

Students burn 100 g of wood, charcoal, biogas or LPG under a pot of water, add a lid or a wind shield, or half close the air vents, and compare the heat that reaches the water and the carbon monoxide made.

They learn Burning as a chemical reaction, exothermic reactions, renewable and fossil fuels, complete and incomplete combustion, carbon monoxide, and q = mcΔT.

The lesson, in the lab's own steps

1 Hook
Ask: what fuel does your family cook with? Make a quick tally on the board: LPG, wood, charcoal, electricity.

2 Predict together
Ask which fuel will heat the water most. Write the votes on the board.

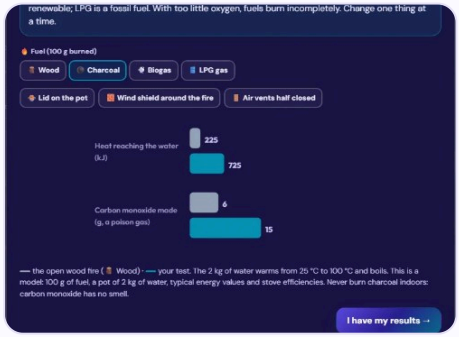
3 Test
Remind students to change one thing at a time from the open wood fire. Prompt: "Which fuel makes the most carbon monoxide, and does it look smoky?"

4 Explain
Discuss the conclusion question. Write the word equations for complete and incomplete combustion of methane on the board.

5 Extend: the real practical
Real version (a teacher demonstration, or Grades 9–12 with supervision): heat 100 g of water in a metal can over a spirit burner for 2 minutes, weigh the burner before and after, and work out the energy the water took in; repeat with a lid and a foil shield. Tie hair back, wear eye protection, keep a fire blanket near.

⚠ **Watch for**
Students who think a fuel's energy is used up or destroyed, or that no smoke means no harmful gas. The energy is transferred, much of it to the surroundings; carbon monoxide cannot be seen or smelled.

✅ **Check (exit question)**
Give two ways to get more of a fuel's energy into the cooking pot.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why is charcoal never used to cook inside the house?

Why might a village build a biogas digester?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 21 in the chain	no. 22 in the chain	no. 20 in the chain	no. 16 in the chain	no. 20 in the chain
2Cc.01 · 2Cp.02	6Cc.04 · 6Cc.05 · 4Pf.04	8Cc.02 · 8ESp.02 · 9ESc.01 · 9Pf.02	0620 5.1.1 · 10.3.2 · 11.3.7 · 0625 2.2.2.3	9701 5.1.7 · 9702 14.3.1



LAB 21 OF 31 · CHEMISTRY · BIOLOGY

Fertiliser lab

where does the nitrogen go?

📍 Rice-Fish Paddy ⏱ about 15 minutes

Grades 1–12, five versions

Students change the pH of the paddy water, make it hot or windy, or press the urea into the mud, and compare the nitrogen lost to the air with the nitrogen kept for the rice after one week.

They learn Fertilisers and pollution, pH, reversible reactions and the position of equilibrium, and (Grades 11–12) Ka, pKa and Le Chatelier's principle.

The lesson, in the lab's own steps

1 Hook
Show a bag of urea, or a photo of one. Ask: where does a farmer's fertiliser go after it is thrown on the field?

2 Predict together
Ask what pressing the urea into the mud will do. Write the votes on the board.

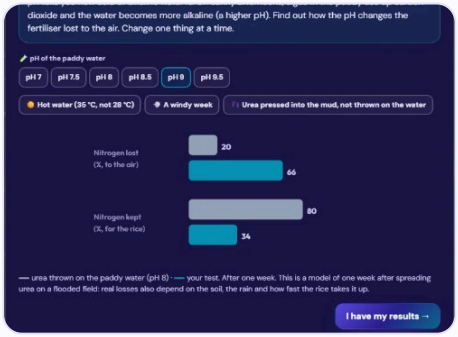
3 Test
Remind students to change one thing at a time from urea thrown on the water at pH 8. Prompt: "At which pH is about half of the ammonium turned into ammonia?"

4 Explain
Discuss the conclusion question. Write $NH_4^+ \rightleftharpoons NH_3 + H^+$ on the board and mark what pushes it each way.

5 Extend: the real practical
Real version (a teacher demonstration, outdoors or in a fume cupboard): warm a little ammonium chloride with sodium hydroxide solution in a test tube and hold damp red litmus paper at its mouth: it turns blue. Never smell the gas directly; wear eye protection.

⚠ **Watch for**
Students who think more fertiliser always means more rice, or that pH only matters for acids. Alkaline water releases ammonia; fertiliser that escapes is wasted and pollutes the air and water.

✅ **Check (exit question)**
Give two ways a farmer can lose less fertiliser to the air.



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why might a farmer spread fertiliser early in the morning?

Where does ammonia that escapes from fields end up?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 23 in the chain	no. 23 in the chain	no. 23 in the chain	no. 20 in the chain	no. 18 in the chain
2ESp.03	5ESp.03 · 6ESp.04 · 5Cm.02	7Cp.02 · 8Cc.01	0620 6.3.1 · 6.3.4 · 10.2.1	9701 7.1.4 · 7.1.5 · 25.1.3 · 12.1.3



LAB 22 OF 31 · CHEMISTRY · PHYSICS

Hydrogen lab

store the sun in a gas

📍 Energy Yard | ⏱ about 15 minutes | Grades 1–12, five versions

Students split water with electricity from a solar panel: they change the current, run it for longer, or use salt water or pure water, and compare the gas collected at each electrode.

They learn Electrolysis of water, elements and compounds, the tests for hydrogen and oxygen, conductors, current and charge (Q = It), and (Grades 11–12) Faraday's laws.

The lesson, in the lab's own steps

1 Hook

Ask: solar panels make electricity only in the daytime. How could a village keep the sun's energy for the night?

2 Predict together

Ask how much hydrogen they expect compared with oxygen. Write the votes on the board.

3 Test

Remind students to change one thing at a time from the cell at 2 A for 1 hour. Grades 9–12 work out Q = It for each test.

4 Explain

Discuss the conclusion question. Write water → hydrogen + oxygen on the board (and $2H_2O \rightarrow 2H_2 + O_2$ for Grades 9–12).

5 Extend: the real practical

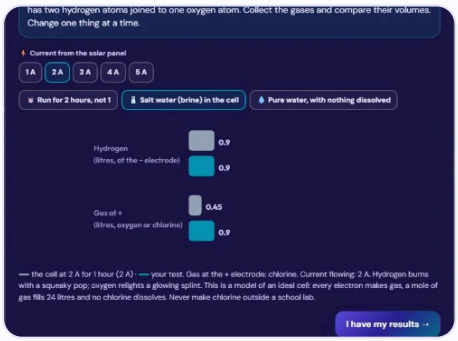
Real version (a teacher demonstration, or Grades 9–12 with supervision): electrolyse dilute sodium sulfate solution with carbon electrodes and a 6–12 V supply in two upturned test tubes; compare the volumes and test the gases. Never electrolyse salt water outside a fume cupboard: it makes chlorine.

⚠ Watch for

Students who think the bubbles are air or steam, or that pure water conducts well. The gases come from the water molecules; dissolved ions carry the current.

✅ Check (exit question)

Why do you get twice as much hydrogen as oxygen from water?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why could hydrogen be a good way to store solar energy, and what makes it hard?

What is the only product when a fuel cell uses hydrogen?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 22 in the chain	no. 21 in the chain	no. 22 in the chain	no. 18 in the chain	no. 16 in the chain
3Cm.01 · 2Pe.01	5Cm.02 · 4Pe.04 · 6Cc.04	7Cp.04 · 7Cm.04 · 8Cc.01 · 9Cm.02	0620 4.1.3 · 4.1.4 · 4.2.1 · 0625 4.2.2.5	9701 24.1.3 · 24.1.4 · 9702 9.1.3



LAB 23 OF 31 · CHEMISTRY

Batik dye lab

colours apart

📍 Orchard ⏱ about 15 minutes Grades 1–12, five versions

Students run a paper chromatogram of a green batik dye: they change the solvent, put on a big blob, draw the start line in ink, let the solvent cover the start line or stop early, and compare how many colours they see apart.

They learn Mixtures and pure substances, solvents and dissolving, paper chromatography, Rf values, and (Grades 11–12) partition between a stationary and a mobile phase.

The lesson, in the lab's own steps

1 Hook
Show a piece of batik (or a photo) and a green felt-tip pen. Ask: is this green one colour or a mix? How could we find out?

2 Predict together
Ask whether the green dye is one colour or a mix. Write the votes on the board.

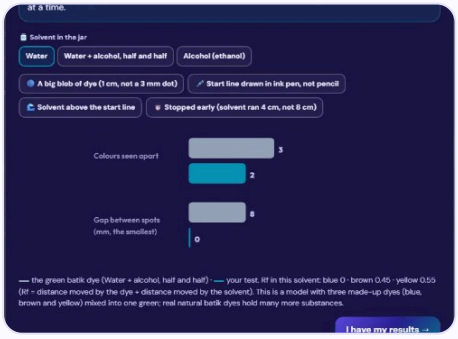
3 Test
Remind students to change one thing at a time from the green dye in water + alcohol. Grades 9–12 write down the Rf values.

4 Explain
Discuss the conclusion question. Draw a chromatogram on the board and mark the start line, the solvent front and how to measure Rf.

5 Extend: the real practical
Real version: put a small dot of water-soluble felt-tip ink (green or black) on a pencil line on filter paper or a coffee filter, stand it in a little water with the line above the water, and watch for 10 minutes; then try a second solvent. Ethanol is flammable: no flames nearby.

⚠ **Watch for**
Students who think the colours are made by the paper or the water, or that one spot always means a pure substance. The colours were in the mixture; one spot in one solvent can still hide two substances.

✅ **Check (exit question)**
Why must the start line stay above the solvent, and why is it drawn in pencil?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about

How could chromatography show that two batik dyes are the same?

Why do forensic scientists use chromatography on inks?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 19 in the chain	no. 18 in the chain	no. 18 in the chain	no. 22 in the chain	no. 22 in the chain
3Cm.02 · 3Cp.02 · 3Cc.01	5Cp.01 · 5Cc.03	8Cp.02 · 8Cm.04 · 7Cm.04	0620 12.3.1 · 12.3.2 · 12.3.4 · 2.1.1	9701 37.1.1 · 37.1.3 · 25.2.3



LAB 24 OF 31 · EARTH · PHYSICS

Sundial lab

shadows on the Equator

📍 Energy Yard | ⏱ about 15 minutes | Grades 1–12, five versions

Students move the time of day for a 1 m pole in Pontianak, on the Equator, and compare the length and direction of its shadow; then they change the date to 21 June, move the pole to Jakarta or make it taller.

They learn The Sun's path across the sky, how shadows form and change through the day, the Earth spinning on its axis, the seasons from the Earth's tilt, and (Grades 11–12) angular speed.

The lesson, in the lab's own steps

1 Hook
Show a photo of the Equator Monument (Tugu Khatulistiwa) in Pontianak and say: twice a year, at noon, people there stand in the sun and have no shadow. Ask: how can that be?

2 Predict together
Ask what the pole's shadow looks like at noon on 21 March in Pontianak. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the 1 m pole at noon on 21 March. Prompt: "Which way does the shadow point in the morning, and which way in the afternoon?"

4 Explain
Discuss the conclusion question. Draw the Sun's path as an arc over a stick figure: low in the east, high at noon, low in the west, with the shadow on the other side each time.

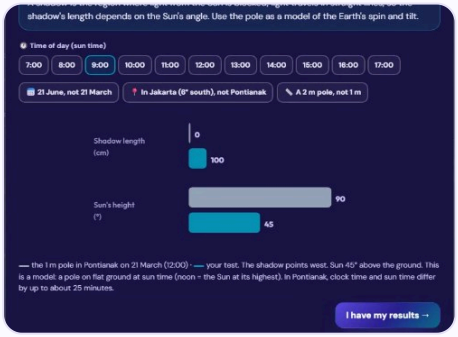
5 Extend: the real practical
Real version: stand a stick or a pencil upright on a sheet of paper in the school yard and mark the tip of its shadow every hour from 8:00 to 15:00 (sun time is about local clock time; noon is when the shadow is shortest). Never look straight at the Sun.

⚠ Watch for

Students who think the Sun moves around the Earth, or that the noon Sun is always straight overhead. The Sun only seems to move because the Earth spins; it is overhead at noon only on the days its path crosses your latitude.

✅ Check (exit question)

Why is a shadow longest early in the morning and late in the afternoon?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why can people in Pontianak have no shadow at noon in March, but people in Jakarta cannot?

How could you use a shadow to tell the time without a clock?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 24 in the chain	no. 25 in the chain	no. 31 in the chain	no. 31 in the chain	no. 31 in the chain
2ESs.01 · 3Ps.02 · 3Ps.03	4ESs.01 · 5ESs.02 · 4Ps.01	7TWSm.01 · 8TWSa.02	0625 6.1.1.1 · 6.1.1.2	9702 12.1.1 · 12.1.2 · 12.1.3



LAB 25 OF 31 · PHYSICS

Night market lab

light up the stalls

📍 Energy Yard | ⏱ about 15 minutes | Grades 1–12, five versions

Students light the lamps of a night-market stall from a battery: they change the number of lamps, wire them in parallel instead of in series, use four cells instead of two or add a long thin cable, and compare how bright each lamp is and how long the battery lasts.

They learn Simple circuits, series and parallel circuits, cells and lamps, current and resistance, using a fuse safely, and (Grades 11-12) internal resistance and Kirchhoff's laws.

The lesson, in the lab's own steps

1 Hook
Show a picture of a night market (pasar malam) with strings of lights. Ask: when one bulb in a string breaks, why do the others often stay on?

2 Predict together
Ask what adding more lamps in a row (in series) does to each lamp. Write the votes on the board.

3 Test
Remind students to change one thing at a time from three lamps in series on two cells. Prompt: "Which change made the lamps brighter, and what did it cost the battery?"

4 Explain
Discuss the conclusion question. Draw the series and the parallel circuit side by side and trace the path of the current through each lamp.

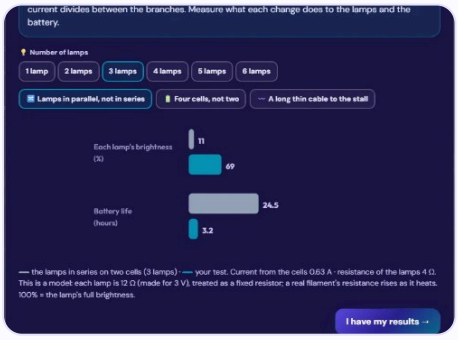
5 Extend: the real practical
Real version: build both circuits with two 1.5 V cells, three torch bulbs in holders and wires, and compare the brightness; unscrew one bulb in each. Use only low-voltage cells, never the mains; cells and wires can get warm if shorted.

⚠ Watch for

Students who think the current is used up by the first lamp, or that lamps in parallel share the same small current. The current is the same all round a series loop; each parallel branch gets the full voltage of the cells.

✅ Check (exit question)

Why do houses wire their lights in parallel?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why does a battery run down faster when the lamps are brighter?

What is a fuse for, and what would happen without one?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 29 in the chain	no. 24 in the chain	no. 26 in the chain	no. 25 in the chain	no. 24 in the chain
2Pe.01 · 2Pe.02 · 2Pe.03	4Pe.03 · 6Pe.01 · 6Pe.02	7Pe.04 · 9Pe.01 · 9Pe.02 · 9Pe.03	0625 4.3.2.1 · 4.3.2.5 · 4.3.2.7 · 4.2.3.1 · 4.3.1.1 · 4.4.3	9702 10.1.5 · 10.2.1 · 10.2.2 · 10.2.6



LAB 26 OF 31 · PHYSICS

Micro-hydro lab

light the village

📍 Garden Terraces ⏱ about 15 minutes

Grades 1–12, five versions

Students change the number of turns on the coil of a small water-wheel generator, use a stronger magnet, open the sluice so it spins faster or stop the water, and compare the peak voltage and how many times a second the current changes direction.

They learn Magnets and magnetic fields, how a moving magnet or coil makes electricity (electromagnetic induction), the factors that set the induced voltage, alternating current, and (Grades 11–12) Faraday's law and r.m.s. values.

The lesson, in the lab's own steps

1 Hook
Some villages in the mountains of Indonesia get their electricity from a small water wheel in a stream (micro-hydro). Ask: how can moving water turn into light?

2 Predict together
Ask what doubling the number of turns on the coil does to the voltage. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the 100-turn coil and the ordinary magnet. Prompt: "Which changes moved the voltage, and which also changed how often it swaps direction?"

4 Explain
Discuss the conclusion question. List the three things that raise the voltage (more turns, a stronger magnet, faster turning) and the one that changes the frequency (faster turning).

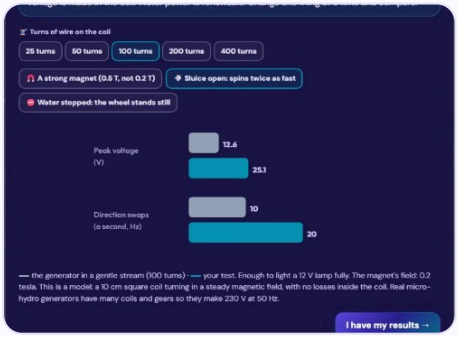
5 Extend: the real practical
Real version: push a bar magnet in and out of a coil of wire connected to a sensitive meter (a galvanometer or a multimeter on the mV range); try faster, slower, more turns and a stronger magnet. Keep strong magnets away from phones and cards.

⚠ Watch for

Students who think a magnet alone makes electricity, or that the generator makes energy from nothing. A still magnet makes no voltage: the magnetic field through the coil must change, and the energy comes from the moving water.

✅ Check (exit question)

Why does the lamp go out when the water stops?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Where does the energy for the village's lamps really come from?

Why do bicycle dynamo lights get brighter when you ride faster?

Grades 1–3
no. 25 in the chain
3Pe.01 · 3Pe.02 · 1Pe.01

Grades 4–6
no. 28 in the chain
5Pe.02 · 5Pe.03

Grades 7–8
no. 25 in the chain
8Pe.01 · 8ESp.02

Grades 9–10
no. 26 in the chain
0625 4.5.1.1 · 4.5.1.3 · 4.5.2.1 · 4.5.2.2 · 4.1.5

Grades 11–12
no. 25 in the chain
9702 20.1.1 · 20.5.2 · 20.5.3 · 20.5.5 · 21.1.1 · 21.1.4



LAB 27 OF 31 · PHYSICS

Fisher's lamp lab

where is the fish?

📍 Mangrove Coast ⏱ about 15 minutes

Grades 1–12, five versions

Students look at a fish 50 cm under calm water from different angles, move it deeper, put on polarised sunglasses or come back at night with a lamp, and compare where the fish seems to be and how much glare comes off the water.

They learn Light sources and darkness, how we see objects, reflection, refraction at a water surface, and (Grades 11–12) polarisation and Malus's law.

The lesson, in the lab's own steps

1 Hook
Put a coin at the bottom of an empty cup and move back until it just disappears behind the rim. Pour water in slowly: the coin comes back into view. Ask: how?

2 Predict together
Ask where a fish under the water will seem to be: deeper, shallower or exactly where it is. Write the votes on the board.

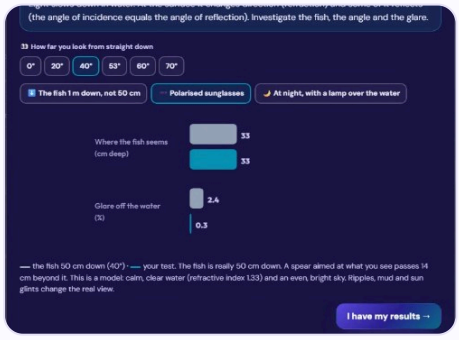
3 Test
Remind students to change one thing at a time from the fish 50 cm down, seen at 40°. Prompt: "Which changes moved the fish, and which only changed the glare?"

4 Explain
Discuss the conclusion question. Draw the ray from the fish bending away from the normal as it leaves the water, then extend it straight back to where the fish seems to be.

5 Extend: the real practical
Real version: the coin in the cup (above), or a pencil in a glass of water; look at the reflection from a window or a puddle through polarising sunglasses and turn them. Do not look at the Sun or its reflection.

⚠ **Watch for**
Students who think light bends when it enters the eye, or that the fish really is higher up. The fish stays where it is: the light bends at the water surface, and our brain assumes light travels in straight lines.

✅ **Check (exit question)**
Why should a fisher aim below where the fish seems to be?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about

Why do swimming pools always look shallower than they are?

Why do fishers who fish at night use bright lamps over the water?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 26 in the chain	no. 27 in the chain	no. 27 in the chain	no. 28 in the chain	no. 28 in the chain
2Ps.01 · 2Ps.02 · 3Ps.01	4Ps.02 · 4Ps.03 · 6Ps.01 · 6Ps.02	8Ps.01 · 8Ps.02	0625 3.2.1.3 · 3.2.2.1 · 3.2.2.3 · 3.2.2.4 · 3.2.2.7	9702 7.4.1 · 7.5.1 · 7.5.2



LAB 28 OF 31 · BIOLOGY

Heart lab

up the volcano path

📍 Volcano Lookout · ⏱ about 15 minutes

Grades 1–12, five versions

Students change how hard a 14-year-old walks up the volcano path, from sitting still to running, then give them 8 weeks of training, take them up to 2 000 m or add a 10 kg pack, and compare the heart rate and breaths a minute.

They learn The heart, lungs and blood, why muscles need more oxygen when they work harder, the effect of exercise on the heart rate and breathing, fitness, and (Grades 9-12) anaerobic respiration, lactic acid and the oxygen debt.

The lesson, in the lab's own steps

1 Hook
Ask everyone to find their pulse at the wrist or neck and count it for 15 seconds. Ask: what would this number be at the top of a steep path?

2 Predict together
Ask what happens to the heart rate on a steep path. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the brisk walk. Prompt: "Which change raised the heart rate without the walk getting any harder?"

4 Explain
Discuss the conclusion question. Draw the chain on the board: muscles working → need more oxygen and make more carbon dioxide → breathe faster and deeper → heart pumps faster.

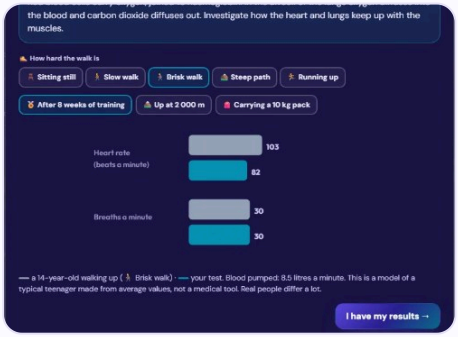
5 Extend: the real practical
Real version: a step test. Students count their resting pulse, step up and down on a low step for 2 minutes, count the pulse at once and every minute until it is back to resting, and draw the graph. Students with a health condition watch or time instead; nobody is pushed, and it is never a race.

⚠ Watch for

Students who think the heart makes oxygen or that fit people need less oxygen for the same work. The work sets the oxygen needed; training makes each heartbeat push out more blood, so the heart beats fewer times.

✅ Check (exit question)

Why does your heart beat faster when you climb a steep path?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Why do climbers breathe harder near the top of a high mountain?

Why do you keep breathing hard for a while after you stop running?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 28 in the chain	no. 26 in the chain	no. 24 in the chain	no. 27 in the chain	no. 27 in the chain
3Bs.03	4Bs.02 · 6Bs.01 · 6Bs.02	8Bs.02 · 8Bs.03 · 8Bs.04	0610 9.1.1 · 9.2.3 · 9.2.4 · 9.2.12 · 9.4.3 · 11.1.5 · 11.1.10 · 12.3.4 · 12.3.6	9700 8.1.1 · 8.2.1 · 8.3.3 · 9.1.7 · 12.2.10



LAB 29 OF 31 · BIOLOGY · CHEMISTRY

🐟 Salted fish lab

why salt keeps fish

📍 Mangrove Coast ⏱ about 15 minutes

Grades 1–12, five versions

Students soak slices of fish for a day in brines from 0% to 26% salt, use sugar instead of salt, cut the slice thicker or keep it warmer, and compare how much water is drawn out of the fish and how many germs grow on it.

They learn Testing materials, mixtures and solutions, concentration, osmosis through cell membranes, water potential, and why salt and drying keep food safe.

The lesson, in the lab's own steps

1 Hook
Show a piece of dried salted fish (ikan asin) and a fresh one. Ask: the salted fish can sit in a market for weeks; the fresh one goes bad in a day. Why?

2 Predict together
Ask what a salty brine does to the water in the fish. Write the votes on the board.

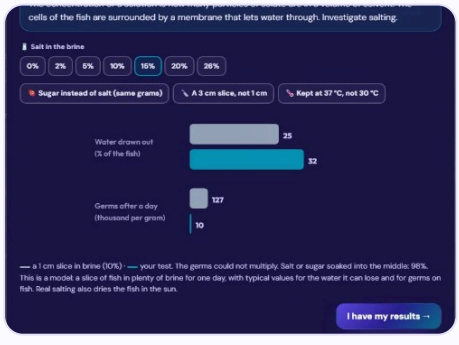
3 Test
Remind students to change one thing at a time from a 1 cm slice in 10% brine at 30 °C. Prompt: "At what salt level do the germs stop?"

4 Explain
Discuss the conclusion question. Draw a fish cell with its membrane in a beaker of strong brine and arrows for water moving out.

5 Extend: the real practical
Real version: put equal cylinders of potato (or slices of cucumber) in water and in 5%, 10% and 20% salt solutions; weigh them before and after an hour and work out the percentage change in mass. Do not taste the samples.

⚠️ **Watch for**
Students who think the salt soaks in and pushes the water out, or that salt kills germs like poison. Water moves out by osmosis towards the lower water potential; germs cannot get enough water to multiply when it is too salty.

✅ **Check (exit question)**
Why does salted fish keep for weeks without a fridge?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about Why do jams with lots of sugar keep for a long time?

Why does a thick piece of fish need longer in the salt?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 30 in the chain	no. 30 in the chain	no. 28 in the chain	no. 29 in the chain	no. 29 in the chain
2Cp.03 · 3Cp.02	4Cm.03 · 5Cp.01 · 5ESp.02	8Cp.01 · 7Bs.03	0610 2.1.4 · 3.2.2 · 3.2.5 · 3.2.7 · 3.2.8	9700 2.4.1 · 4.2.1 · 4.2.5 · 4.2.6



LAB 30 OF 31 · PHYSICS · EARTH

Radon lab

counting the volcano's gas

📍 Volcano Lookout ⏱ about 15 minutes

Grades 1–12, five versions

Students count the radiation from a sealed jar of soil gas from the volcano with a counter, wait some days, put paper or aluminium between the jar and the counter or move the counter away, and compare the count rate and the share of radon atoms left.

They learn Rocks and gases from the Earth, atoms and their nuclei, background radiation, alpha, beta and gamma radiation and what stops them, half-life, and (Grades 11–12) the decay constant and exponential decay.

The lesson, in the lab's own steps

1 Hook
Scientists who watch volcanoes also count radon, a radioactive gas that comes out of the ground. Ask: how can you measure something you cannot see, smell or feel?

2 Predict together
Ask what the count rate will be after waiting 4 days. Write the votes on the board.

3 Test
Remind students to change one thing at a time from the fresh jar with the counter 2 cm away. Prompt: "Which changes lowered the count, and which ones changed the radon atoms left?"

4 Explain
Discuss the conclusion question. Sketch the decay curve: the count rate halves every 3.8 days, down towards the background.

5 Extend: the real practical
Real version without a source: model half-life with 100 dice or coins. Roll them all, remove the sixes (or the heads), count those left, repeat and plot the number left against throws. Only trained staff may use real radioactive sources.

⚠️ **Watch for**
Students who think shielding the jar makes the radon decay more slowly, or that radioactive things glow. Shielding only stops the radiation reaching the counter; the atoms decay at their own rate, whatever we do.

✅ **Check (exit question)**
Why is there still a count when the jar is shielded and far away?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

Talk about
- Why do we always measure the background count first?
- Why are radioactive sources kept in lead boxes and handled with tongs?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 31 in the chain	no. 31 in the chain	no. 29 in the chain	no. 24 in the chain	no. 26 in the chain
1ESp.02 · 3ESp.01	4ESp.02 · 5ESp.01	7ESp.02 · 8Cm.01 · 8Cm.02	0625 5.1.2.5 · 5.2.1.1 · 5.2.1.2 · 5.2.1.5 · 5.2.2.2 · 5.2.3.1 · 5.2.4.1 · 5.2.4.2 · 5.2.5.3	9702 11.1.7 · 23.2.1 · 23.2.3 · 23.2.5 · 23.2.6



LAB 31 OF 31 · CHEMISTRY

🌴 Palm oil lab

from oil to fuel

📍 Energy Yard | ⏱ about 15 minutes | Grades 1–12, five versions

Students make biodiesel from palm oil and methanol with a catalyst, change the amount of methanol, warm it, give it longer, use oil with some water in it or leave out the catalyst, and compare the biodiesel made and the soap formed.

They learn Natural and made materials, chemical and physical properties, molecules, esters and the reaction of an ester with an alcohol, rates of reaction, catalysts, reversible reactions and percentage yield.

The lesson, in the lab's own steps

1 Hook
Indonesia makes more palm oil than any other country, and some of it is turned into biodiesel and mixed into the diesel for lorries and buses. Ask: how can cooking oil be turned into a fuel?

2 Predict together
Ask what using more methanol does to the biodiesel made. Write the votes on the board.

3 Test
Remind students to change one thing at a time from 6 to 1 methanol at 40 °C for 30 minutes. Prompt: "Which change did nothing at all, and why?"

4 Explain
Discuss the conclusion question. Write the word equation on the board: oil + methanol ⇌ biodiesel (methyl esters) + glycerol, and mark the catalyst over the arrow.

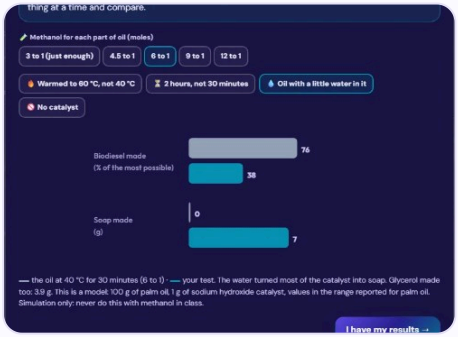
5 Extend: the real practical
Do NOT make biodiesel in class: methanol is toxic and flammable, and the catalyst is corrosive. Real version: compare the runniness of cooking oil and water (time a drop down a tilted tile), and shake oil with water, then with dish soap, to see the layers that biodiesel and glycerol also form.

⚠ Watch for

Students who think a catalyst is used up or that adding more of a reactant always gives more product without limit. The catalyst comes out unchanged (unless water turns it into soap); a reversible reaction levels off at equilibrium.

✅ Check (exit question)

Why do biodiesel makers dry the oil before they start?



The student's screen (Grades 7–8): grey = the starting set-up, blue = their test.

💬 Talk about

Is biodiesel from palm oil good for the environment? What else would you need to know?

Why do factories use extra methanol and then recover it?

Grades 1–3	Grades 4–6	Grades 7–8	Grades 9–10	Grades 11–12
no. 27 in the chain	no. 29 in the chain	no. 30 in the chain	no. 30 in the chain	no. 30 in the chain
2Cm.01 · 2Cp.02	4Cm.02 · 4Cp.01	7Cp.01 · 9Cm.02 · 8ESp.02	0620 11.1.3 · 11.1.4 · 11.7.3 · 6.2.1 · 6.2.2 · 6.3.4 · 3.3.8	9701 13.2.1 · 18.2.1 · 18.2.2 · 26.1.11 · 8.2.3

Mina Padi Rescue: a full investigation.

Bigger than a lab: about 30–40 minutes, eight steps, and the server checks the evidence students give. It opens with the rice-fish paddy, at the top of the lab bench. Same model as the Oxygen lab, so the two never disagree.

1 Brief
Pak Darto keeps fish in his rice field (mina padi). He wants more fish, but too many stay small.

2 Research
Three short cards with their sources; sort observations from opinions.

3 Predict
3, 5 or 8 fish: which gives the most food, and what result would change their mind?

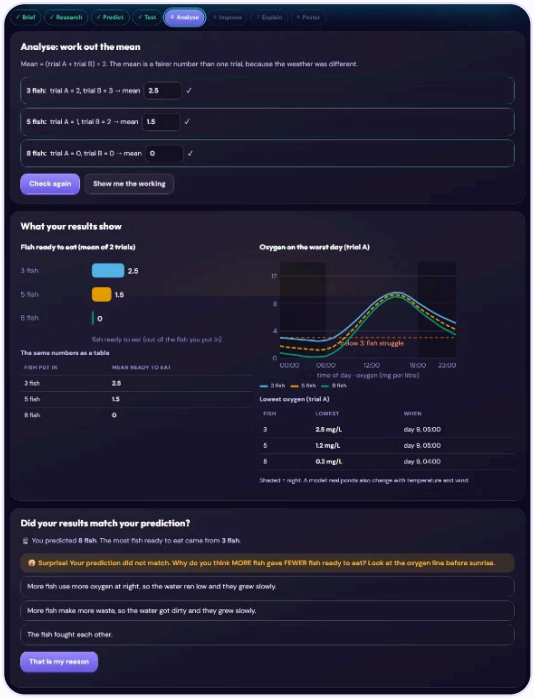
4 Test
Each number of fish twice, on a model of the paddy (10 days in a few seconds).

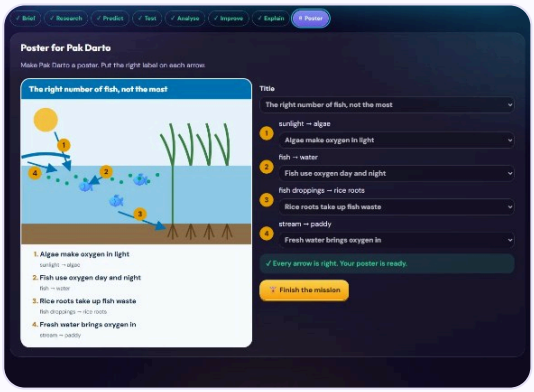
5 Analyse
Work out the means, read the bar chart and the oxygen line before sunrise.

6 Improve
ONE change that could help: rice, or fresh stream water.

7 Explain
Advice built from their own trials as evidence, with a reason.

8 Poster
Label the paddy poster for Pak Darto.





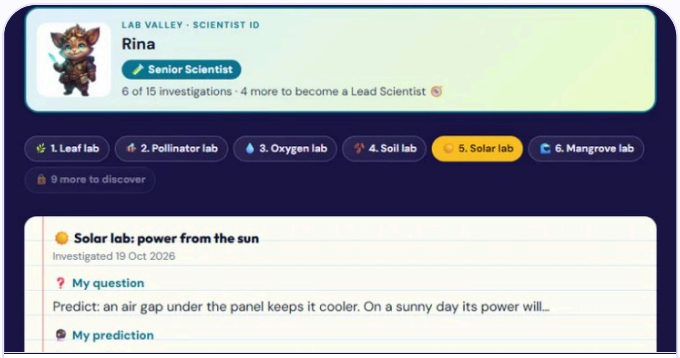
⚠ Watch for
Students who think more fish always means more food. With rice growing, 5 fish give the most fish per day: 8 fish run short of oxygen before sunrise and grow slowly.

✅ Check
Why did 8 fish give less food per day than 5, and which one change helped most?

NEW ON 19 OCTOBER 2026 · THE SCIENTIST'S RECORD

A notebook, a rank and a field station.

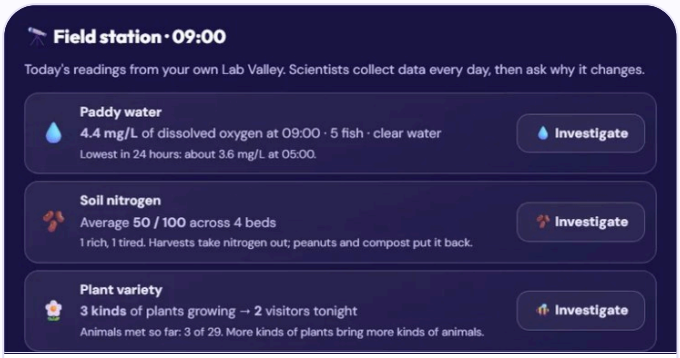
Every finished lab now becomes a page in the student's own lab notebook. A scientist rank grows with the labs they finish, two pieces of scientist gear open on the way, and a field station shows today's readings from their own valley. None of it gives points.



My lab notebook

On the lab bench, and "See my page" on the finish card. Each page: the date, ❓ **My question**, 🔮 **My prediction**, 📊 **My tests** (each set-up with its result, as a table and a chart; the Soil lab lists the nitrogen-cycle steps), 💡 **What I found out** and a stamp: "Explained like a scientist" or "Worth another look".

The same on any device. **Only the student sees it**; in My classes you see which labs they finished. Labs finished before 19 October say "Do it again and this page fills in".



Field station

A button on the Lab Valley card and the lab bench. Today's readings from the student's own valley, from the same models as the labs; nothing is stored.

💧 **Paddy water**: oxygen now and the lowest in 24 hours. 🫘 **Soil nitrogen**: the average of their beds. 🪴 **Plant variety**: visitors tonight. Then, as zones open: 🗼 **weather** at 1000 m, 🌼 **solar** watts, 🌿 **mangrove** waves.

Investigate beside a reading opens the lab that explains it, once that lab is open in the student's chain.

Scientist rank · labs finished

🔎 **Lab Visitor**	0	🥼 **Junior Researcher**	1
🔬 **Field Scientist**	3	🧫 **Senior Scientist**	6
🧭 **Lead Scientist**	10	🏅 **Chief Scientist**	15



Scientist gear for the Character Studio: Lab Safety Goggles at the first lab, the Young Scientist's Lab Coat at three. Never in the daily chest; never locked again.

Using them in class

1 Exit ticket: show your notebook page

At the end of a lab lesson, each student opens **My lab notebook** and shows you the page: their prediction, their tests and what they found out. A "Worth another look" stamp means: run it again with a partner.

2 Starter: today's reading

Open the field station on the projector with your own student view. "Oxygen in the paddy was lowest at 05:00. Why then?" Take predictions, then press **Investigate** to open the lab that explains it.

3 Fair test check

The **My tests** table lists every set-up a student tried. Ask: which ONE thing did you change each time, and what stayed the same?

4 Praise finishing

The rank counts investigations finished, never right answers. Name the effort ("you are a Field Scientist now"), not a score. Nothing here goes into grades.

SAFE AND SIMPLE

Real science, on the student's own island.

🛒 Free, no adverts

Nothing to buy. Seeds and gifts are earned by practising.

🤐 No chat

No chat, comments or posts. The Lab Valley is private to each student.

📘 Not part of grades

Nothing from the labs goes into report cards or school assessments.

👀 Who sees what

Teachers: which labs each student finished. Leaders: counts only. The notebook: only the student.



The live guide for teachers

Every lab for your band, with screens (Teachers Hub sign-in)

teachershub.eduversal.org

See the valley

Pictures, videos and every Sparkuna guide

sparkuna.com/tour

Also for teachers: **A Guide for Teachers** and **STEAM Integration** on sparkuna.com/tour. Notes on a lab? Send them to Eduversal: corrections go live for every school.

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