



Sun Catchers & Leaf Bubbles

KINDERGARTEN SCIENCE • NGSS K-LS1-1

Little Explorer:

Date:

My Leaf Type:

Task Statement: Observe leaves submerged in warm water under direct sunlight using magnifying hand lenses to detect oxygen bubbles, compare green leaves placed in sunlight versus total darkness, and draw a 3-part 'Sun Kitchen' sequence illustrating how sun, water, and air help plants grow green and share fresh air.

Step 1: The Underwater Breath Hunt



Cup A: In Bright Sunshine

Look with your hand lens! Did you see bubbles?

[Shiny Bubbles!]

[Many Pearls]

[Rising Up]

[Draw leaf covered in shiny air bubbles]



Cup B: In the Dark Closet

Did the sleeping leaf make any bubbles?

[No Bubbles]

[Still & Quiet]

[Asleep]

[Draw quiet leaf with no bubbles]

Step 2: The Sun Kitchen Story (Draw & Trace)

1. Catch the Sun

Green leaves soak up warm sunlight rays!

[Draw Sun + Leaf]

2. Drink Water

Roots sip cool water from the ground!

[Draw Roots Drinking]

3. Fresh Air Gift

Leaf breathes out sweet clean oxygen!

[Draw Clean Air Flow]

Step 3: Kinesthetic Earth Breathing Game

Classroom Motion: (1) Hold hands high like solar panels to catch sunlight! (2) Wiggle toes like roots drinking deep water! (3) Take a deep breath and gently blow out clean fresh air for all animal friends!



Kindergarten Observational Assessment Rubric

NGSS K-LS1-1 ALIGNMENT

Teacher / Evaluator: _____ • Student: _____

Teacher Conference & Demonstration Checklist

Teacher Prompts during the Underwater Leaf Observation:

- “Point with your finger to the bubbles on the leaf in Cup A. What are those made of?” (Fresh air / oxygen)
- “Why didn’t the leaf in the dark closet make bubbles?” (The kitchen is closed without light!)
- “Who breathes the clean air that green plants share with the world?” (People, birds, and animals)

Observational Standards Rubric (Kindergarten Inquiry)

Inquiry Skill	Mastered (3)	Developing (2)	Emerging (1)
Bubble Observation Sensory detection	Identifies and describes tiny oxygen bubbles on the sunlit leaf; confirms absence in dark cup.	Spots bubbles on the leaf with teacher guidance; notes sun cup is brighter.	Unable to locate bubbles; confuses the sunny and dark test cups.
Sun Kitchen Sequencing 3-Part growth cycle	Correctly illustrates sun capture, water drinking, and fresh air release in chronological order.	Draws sun, water, and leaf, but confuses the cause-and-effect sequence.	Draws unrelated images; requires direct step-by-step assistance.
Basic Needs Understanding K-LS1-1 Living Things	Verbally explains that plants need light and water to make food and make fresh air for animals.	States that plants like the sun, but unsure why leaves make bubbles underwater.	Does not recognize sunlight as a requirement for plant life or clean air.
Kinesthetic Roleplay Physical modeling	Enthusiastically models solar leaf hands, drinking root toes, and gentle air exhalation.	Participates in the breathing game with peer cues and teacher modeling.	Reluctant or unable to connect physical movements to plant functions.

Teacher Notes & Mastery Stamp

Individual Observations & Accommodations:

Status: ☐ Meeting Standards ☐ Approaching ☐ Needs Support

Teacher Signature: _____



Inside the Leaf Factory: Light & Oxygen Lab

GRADE 3 SCIENCE • NGSS 3-LS1-1 / 4-LS1-1 / 5-LS1-1

Investigator: _____

Date: _____

Plant Specimen: _____

Task Statement: Conduct a controlled fair test using sunlight-blocking leaf stencils and aquatic plant bubble counts at varying light distances, diagram the chemical inputs (sunlight, water, carbon dioxide) and outputs (sugar, oxygen), and construct a Claim-Evidence-Reasoning (CER) explanation detailing how light intensity controls the rate of oxygen production.

Part 1: The Leaf Factory Blueprint (Inputs & Outputs)

Scientific Diagram (The Working Leaf)

[Draw leaf showing inputs entering & outputs leaving]

Required Labels: ① Sunlight ② Carbon Dioxide ③ Water ④ Glucose (Sugar) ⑤ Oxygen

Factory Roles:

Chlorophyll: Green solar panels that trap radiant light.

Stomata: Tiny trapdoors on leaf undersides taking in air.

Veins: Pipelines bringing water from roots up to leaves.

Black Stencil Discovery:

What happened to the leaf area covered by dark foil?

Part 2: Light Distance vs. Oxygen Bubble Production

Count oxygen bubbles streaming from the cut stem of an aquatic plant for 2 minutes per trial.

Light Distance	Trial 1 (Count)	Trial 2 (Count)	Average Bubbles / 2 Min
Close (10 cm) - Bright Light	_____ bubbles	_____ bubbles	_____ bubbles
Medium (30 cm) - Moderate Light	_____ bubbles	_____ bubbles	_____ bubbles
Far (60 cm) - Dim Light	_____ bubbles	_____ bubbles	_____ bubbles

Part 3: Fair-Test Variable Identification

Changed (Independent):

Lamp distance from plant (Light intensity)

Measured (Dependent):

Number of oxygen bubbles released

Kept Same (Controlled):

Water volume, plant piece, room temperature



Grade 3 Scientific CER & Assessment Rubric

NGSS STANDARDS ALIGNMENT: 3-LS1-1 & 5-LS1-1

Evaluator: Teacher / Peer Assessment • Total Score: ____ / 16 Points

Scientific CER: Light Energy and Fresh Air

Guiding Question: How does changing the amount of light affect how quickly a plant makes oxygen?

1. Claim (One direct sentence answering the guiding question):

2. Evidence (Compare numerical bubble averages from 10 cm vs. 60 cm):

3. Reasoning (Explain scientifically using the words *chlorophyll* and *solar energy*):

Standards-Based Assessment Rubric (NGSS 3-LS1-1 & 5-LS1-1)

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Emerging (1)
Leaf Model & Labeling	Accurately diagrams all 3 inputs and both outputs; clearly explains function of stomata and chlorophyll.	Diagram includes all 5 labels correctly positioned with minor functional omissions.	Missing 2 labels; misidentifies inputs (e.g., puts oxygen as an input).	Incomplete diagram; demonstrates little grasp of plant input/output cycle.
Fair-Test Data Collection	Conducts multiple trials at all 3 distances; records precise bubble counts and computes accurate averages.	Records bubble counts for all distances; computes averages with minor math errors.	Skips trials or only tests 1–2 distances; incomplete data logging.	Fails to record systematic bubble data; demonstrates off-task testing.
Variable Control	Clearly distinguishes independent variable (distance) from constants (temperature, plant size, dissolved air).	Correctly identifies what was changed versus measured with guidance.	Confuses controlled variables with independent light intensity.	Unable to identify experimental variables or experimental controls.
CER Scientific Conclusion	Synthesizes quantitative metrics into an airtight claim backed by solar photon energy conversion reasoning.	Claim directly answers question with supporting bubble count data and basic reasoning.	Claim stated but lacks specific numbers from the data table; weak reasoning.	Inaccurate claim or simply restates the prompt without evidence.

Grading Scale: 15–16: Advanced | 12–14: Proficient | 8–11: Developing | <8: Intervention

Teacher Signature: _____



Photonic Energetics: Floating Leaf Disk Assay

MIDDLE LEVEL (6–8) • NGSS MS-LS1-6 / MS-LS1-7

Lead Investigator: _____

Lab Group #: _____

Date: _____

Task Statement: Quantify the rate of photosynthetic oxygen production using the floating leaf disk assay to determine the median effective time (ET_{50}) across varying light intensities and bicarbonate concentrations, model the balanced chemical reaction ($6CO_2 + 6H_2O + \text{photons} \rightarrow C_6H_{12}O_6 + 6O_2$), and evaluate the planetary feedback loop between cellular respiration and atmospheric oxygen balance.

1. Scientific Hypothesis & Physiological Mechanism

Assay Mechanism: Vacuum infiltration removes air from spongy mesophyll spaces, replacing it with 0.2% $NaHCO_3$ solution. Disks sink. As photolysis occurs, $O_2(g)$ accumulates in lacunae, restoring buoyancy until disks float.

Formal Hypothesis: If sunken leaf disks are exposed to high photon flux density (I_{high}), then the rate of floatation will _____, resulting in a lower ET_{50} because:

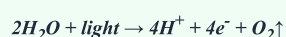
2. Quantitative Infiltration Assay Data Log ($n = 10$ Disks per Cohort)

Experimental Condition	1m	2m	3m	4m	5m	6m	7m	8m	10m	12m	ET_{50} (Min)
Cohort A: Direct Light + CO_2											_____ min
Cohort B: Dim Light + CO_2											_____ min
Cohort C: Direct Light (No CO_2 / H_2O only)											_____ min

3. Biochemical Pathway Analysis

Light-Dependent Phase (Thylakoid):

Photons excite electrons in Photosystem II. Photolysis splits water, yielding protons, electrons, and gaseous oxygen:



Light-Independent Phase (Stroma / Calvin Cycle):

Enzyme RuBisCO catalyzes carbon fixation of dissolved CO_2 into phosphoglycerate, consuming ATP/NADPH to build glucose:





Middle School Quantitative Assessment

Rubric

NGSS ALIGNMENT: MS-LS1-6 & MS-LS1-7

Student / Group: _____ • Evaluation Date: _____

Quantitative Post-Lab Analysis Prompts

1. ET_{50} Calculation & Photonic Velocity: How does median float time (ET_{50}) quantitatively represent photosynthetic rate? Calculate the reciprocal rate index ($1/ET_{50}$) for Cohort A vs. Cohort B:

2. The Negative Control (Cohort C): Explain why leaf disks submerged in boiled or bicarbonate-free water fail to float even under intense illumination:

3. Global Planetary Feedback (MS-LS1-6): Construct an argument detailing how large-scale terrestrial and marine deforestation disrupts atmospheric carbon-oxygen homeostasis:

Standards-Based Evaluation Rubric (4-Point Analytic Scale)

Performance Indicator	4 - Advanced	3 - Proficient	2 - Basic	1 - Below Standard
Experimental Execution & Infiltration SEP: Planning & Carrying Out	Flawless syringe aspiration without tissue bruising; maintains rigorous timing and controls light heating artifacts.	Aspirates disks successfully; minor timing delays; tracks all 3 cohorts completely.	Bruises leaf disks during aspiration; inconsistent light distance or missing control cohort.	Incomplete infiltration; disks fail to sink initially; uncollected data.
Quantitative Analysis & ET_{50} Math / Rate Processing	Accurately determines median effective time (ET_{50}) and reciprocal rate ($1/ET_{50}$); analyzes rate kinetics thoroughly.	Calculates ET_{50} for cohorts with minor rounding errors; interprets general rate trends.	Records raw float counts but struggles to determine ET_{50} or graph rate progression.	Data table incomplete; mathematical rate calculations omitted or erroneous.
Biochemical Content Knowledge MS-LS1-7 Matter & Energy	Thoroughly explains photolysis, electron transport, ATP generation, and carbon fixation via RuBisCO in the stroma.	Accurately models balanced equation and explains that light splits water to release oxygen gas.	Identifies basic equation but claims oxygen comes from carbon dioxide rather than water.	Significant misconceptions; confuses photosynthesis with cellular respiration.
Planetary Systems Modeling MS-LS1-6 Earth Carbon-Oxygen	Synthesizes lab findings into global biospheric cycles; models carbon sinks, ocean acidification, and atmospheric balance.	Explains how plant photosynthesis directly supports animal respiration and regulates atmospheric carbon.	Mentions plants make air for animals, but lacks systems perspective on global carbon cycling.	Fails to connect microscopic leaf processes to global atmospheric dynamics.

Total Score: ____ / 16 Points | **Proficiency:** [] Exceeding [] Meeting [] Approaching

Evaluator Signature: _____