

General Science: Living Systems, Materials, Waves and Evidence

GAC023 outcome practice; check the current centre brief.

What can a pond observation actually establish?

- A pond connects organisms, water, materials and energy.
- A plant does not prove drinking-water safety.
- A concentration change does not prove destruction.

The module includes science and how the team works

- Connect biology, ecosystems, resources, chemistry and waves.
- Keep supplied practice data distinct from observations.
- Follow the current centre brief for practical and report tasks.

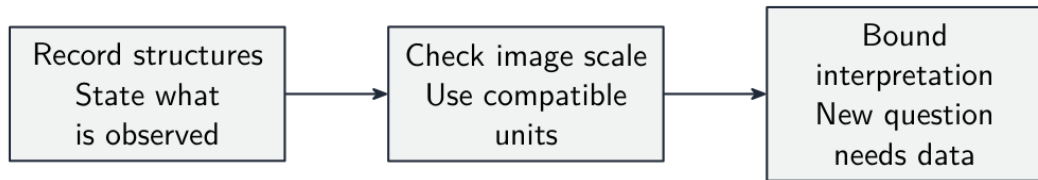
Living systems have structures, functions and change

- A cell is an organism's basic structural and functional unit.
- Prokaryotic DNA is not enclosed in a membrane-bound nucleus.
- Eukaryotic cells typically contain a nucleus and other structures.

A historical observation and a modern interpretation differ

- Hooke used “cell” for spaces in cork in 1665.
- Homeostasis regulates internal conditions within suitable limits.
- A single image cannot establish growth over time.

Record the structures, then check the scale



- State the structures actually visible.
- Use compatible units in the magnification ratio.
- A new question needs appropriate additional evidence.

Magnification is a ratio without a length unit

- Image length: 30.0 mm; stated actual length: 0.0500 mm.
- Divide image length by actual length.
- The magnification is $\times 600$.

$$M = \frac{L_{image}}{L_{actual}} = \frac{30.0 \text{ mm}}{0.0500 \text{ mm}} = 600$$

Classification uses relationships as well as visible features

- Hierarchy: kingdom, phylum, class, order, family, genus, species.
- Traits and molecular information can support relationships.
- An identification key is not an evolutionary chronology.

One family can contain different genera and species

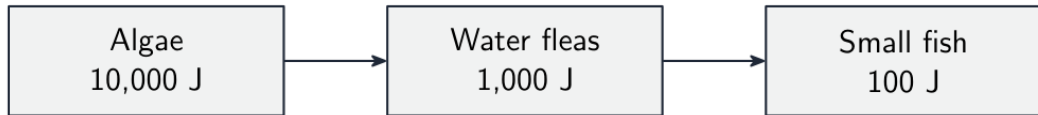


- Lion and tiger: *Panthera leo* and *Panthera tigris*.
- Domestic cat: *Felis catus*, within Felidae.
- The two-word species name needs its genus and epithet.

An ecosystem includes organisms and nonliving conditions

- Producers make organic material using an energy source.
- Consumers obtain organic material from other organisms.
- Decomposers return nutrients to available forms.

Energy transfers while matter can cycle



- The illustrated algae chain has supplied energy values.
- Energy dissipates through respiration and other pathways.
- Matter can cycle and can cross the system boundary.

The meadow record gives two different efficiencies

- Grass: 5,000 J; grasshoppers: 600 J; frogs: 60 J.
- The first transfer is 12%; the next is 10%.
- This budget does not give a population trend.

$$\eta_1 = \frac{600}{5000} \times 100\% = 12\%, \quad \eta_2 = \frac{60}{600} \times 100\% = 10\%$$

Biodiversity needs a measure suited to the question

- Species richness counts the number of species.
- Abundance distributions provide different information.
- One species count does not describe all variety.

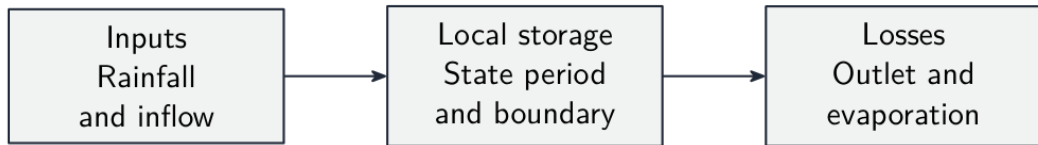
Rock changes have several possible routes

- Cooling and solidification form igneous rock.
- Deposition, compaction and cementation can form sedimentary rock.
- Heat and pressure can form metamorphic rock without melting.

Renewable does not mean unlimited

- Renewal depends on the timescale relevant to use.
- Demand can exceed replacement.
- Evaporation, precipitation, runoff and groundwater connect water stores.

A water budget needs a boundary and a period



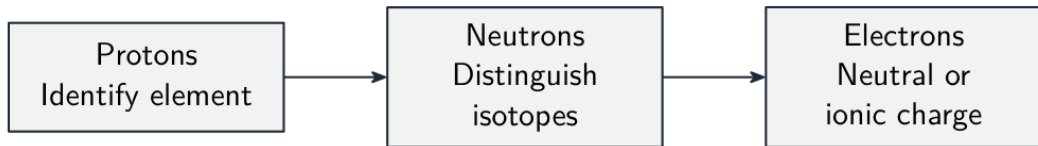
- Inputs and losses change local storage.
- The supplied budget excludes other changes by assumption.
- An extra extraction can reverse the sign of storage change.

Check both budgets before evaluating the proposal

- Without extraction, the calculated change is $+5 \text{ m}^3$.
- With an extra 12 m^3 extracted, the change is -7 m^3 .
- Neither result alone establishes long-term sustainability.

$$\Delta S = 30 - 18 - 7 = 5 \text{ m}^3, \quad \Delta S_X = 30 - 18 - 7 - 12 = -7 \text{ m}^3$$

Protons identify elements; neutrons distinguish isotopes



- Atomic number is the number of protons.
- Mass number counts protons and neutrons.
- Isotopes share proton number but differ in neutron number.

Sodium-23 keeps eleven protons when it becomes an ion

- $23 - 11$ gives 12 neutrons.
- A neutral atom has 11 electrons; Na^+ has 10.
- Sodium-24 has 13 neutrons and is still sodium.

$$N = A - Z = 23 - 11 = 12$$

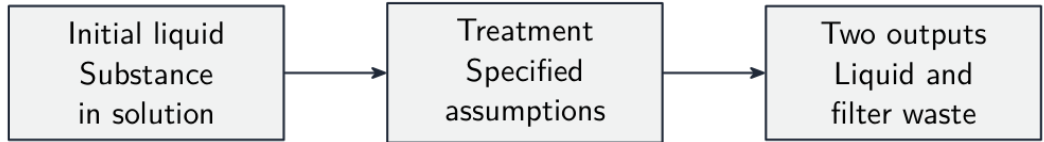
The periodic table and bond models answer different questions

- The periodic table orders elements by atomic number.
- Outer electron arrangements help explain main-group similarities.
- Ionic attraction differs from the electron-transfer process.
- Covalent bonds involve shared electron pairs.

Greenhouse effects and acid rain use different mechanisms

- Carbon-containing fuel combustion can release carbon dioxide.
- Greenhouse gases absorb and emit thermal infrared.
- Sulfur dioxide and nitrogen oxides can form acidic compounds.

Treatment has both a liquid output and a waste output



- A lower dissolved concentration is one result.
- Retained material can remain in filter waste.
- Benefits, energy use and waste handling need evaluation.

Calculate the remaining mass and check the target separately

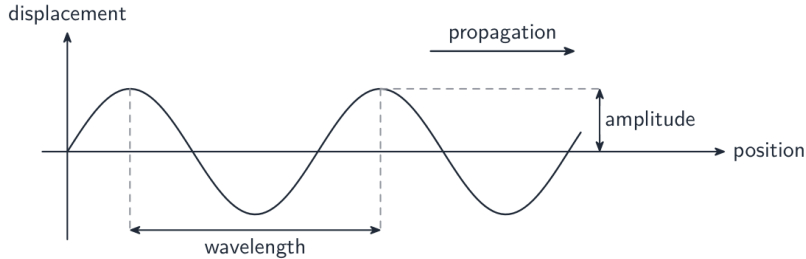
- Remaining dissolved mass: 30 mg, at unchanged volume.
- 90 mg is retained on the filter under the case assumptions.
- 3.0 mg/L still exceeds the fictional 2.0 mg/L target.

$$m = CV = 3.0 \frac{\text{mg}}{\text{L}} \times 10.0 \text{ L} = 30 \text{ mg}$$

Wave propagation differs from particle motion

- A travelling disturbance transfers energy.
- Transverse oscillation is perpendicular to propagation.
- Longitudinal oscillation is parallel to propagation.

A snapshot separates wavelength from amplitude



schematic snapshot; not a time graph

- Wavelength joins successive points in the same phase.
- Amplitude is maximum displacement from equilibrium.
- Crest-to-trough height is twice the amplitude.

Use speed equals frequency times wavelength

- Frequency: 5.0 Hz; wavelength: 0.40 m.
- The supplied wave speed is 2.0 m/s.
- Period is $1 \div \text{frequency}$, giving 0.20 s.

$$v = f\lambda = 5.0 \times 0.40 = 2.0 \frac{\text{m}}{\text{s}}, \quad T = \frac{1}{f} = 0.20 \text{ s}$$

Electromagnetic waves need no material medium

- Order: radio, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays.
- Frequency and wavelength distinguish spectrum regions.
- Electromagnetic waves share the same vacuum speed.

Two reports can describe a pond with very different evidence

- Dated, located observations let a reader check conclusions.
- Undated pictures and general claims have narrower uses.
- Team investigation includes method and evidence, not only divided writing.

Choose a question that permitted observations can address

- Compare plant coverage in two accessible, approved areas.
- Define areas, observation period and measurement rule.
- Coverage is not automatically growth rate or cause.

Sampling must not select only attractive examples

- Use the same frame size and counting rule.
- Select positions with an agreed method.
- Ten images of one patch are not ten independent patches.

Assign roles and retain a shared record

- Record observer, location, time, units and deviations.
- Check that different observers apply the same rule.
- Keep original entries and a correction trail.

The supplied coverage case compares different positions

- Area A: 20%, 30%, 40%; mean 30%.
- Area B: 40%, 50%, 60%; mean 50%.
- Each row represents a different selected position.

Percentage points are different from relative percent change

- Mean difference: $50\% - 30\% = 20$ percentage points.
- Relative increase compared with A is about 66.7%.
- Each range is 20 percentage points.

$$50\% - 30\% = 20 \text{ percentage points; } \frac{50 - 30}{30} \times 100\% \approx 66.7\%$$

Coverage data cannot invent a pollution explanation

- B has greater mean coverage in the supplied samples.
- No pollution, light, soil or time-series measurements are given.
- Coverage does not measure species richness.

Describe physical, chemical and biological features separately

- Physical: layout, slope, shade or water movement.
- Chemical: substances and quantities measured by a stated method.
- Biological: organisms, distributions and relationships.

An online claim needs its source and limits

- Check producer, date, purpose, method and relevance.
- Read the source rather than just the search preview.
- Two sites repeating one report add no independent observation.

The report should let a reader trace claims to evidence

- Keep a source log and use the required citation style.
- Separate your observations from published background.
- Show checked calculations, limitations and matching improvements.

Check yourself

- Why do extra pictures of one patch not broaden sampling?
- What is the correct unit for the mean coverage difference?
- Which missing measurements prevent a pollution claim?
- How should the team resolve a disputed entry?