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# Thinking like a scientist







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Thinking like a scientist

# A number needs a unit



THE IDEA

A measurement is more than a number. “The table is 120” is incomplete. A quantity needs a value and a unit: 120 cm.

Standard units let another class compare results. Symbols also need definitions: m can mean mass in an equation or metre after a length.

CHECK YOUR THINKING

### What makes a length measurement usable?

A. A number, a unit and a clear description of what was measured.

B. A number with many decimal places.

**A. Precision cannot repair an undefined quantity or a missing unit.**

A RELATED EXAMPLE

## Keep the useful details

A model answers a particular question. To compare parachute descent, a first model keeps canopy area and load. It might ignore fabric colour. Assumptions simplify the system. If wind changes the results, the model needs that extra detail.

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# Observation or explanation?



THE IDEA

Separate what you see from what you infer. A leaf has holes: that is an observation. “An insect ate it” is a possible explanation.

Look for evidence that distinguishes this from tearing or disease. A single photograph may not show the cause.

CHECK YOUR THINKING

### Which is an observation?

A There are three holes in the leaf.

B An insect must have eaten it.

**A. An observation reports evidence; an explanation proposes a cause.**

A RELATED EXAMPLE

## Check the scale

Ten trays use 150 mL each. First multiply 10 × 150. Then convert millilitres to litres. A classmate reports 150 L. Explain the unit error before giving your own estimate.

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# Make a fair comparison



THE IDEA

Change one cause; match the rest. To test light, compare similar seedlings with the same water, soil and temperature.

Measure growth in several plants, not just one. Repeats reveal variation; controls help identify a cause.

CHECK YOUR THINKING

### Which comparison isolates light best?

A Different plants given different water and light.

B Matched plants differing mainly in light exposure.

**B. Several changed conditions make the cause of a difference unclear.**

LOOK AGAIN

## A shaded plant is also colder. What conclusion becomes uncertain?

With both light and temperature changed, you cannot attribute a growth difference to light alone. Match temperature and repeat with several plants.

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# Estimate a water need



THE IDEA

Start with assumptions, then calculate. Suppose each of 25 seedlings needs about 40 mL per day. Total = 25 × 40 = 1000 mL, or 1 L.

This estimates a daily need, not an exact biological rule. Hotter weather or different plants may change it.

CHECK YOUR THINKING

**What is the estimated need for two similar days?**

A 2000 L.

B 2 L.

**B. 1000 mL is 1 L; two days at that rate need about 2 L.**

LOOK AGAIN

## Which assumption would you check before ordering a month's supply?

Check actual water use over several days and under different weather. An estimate of 40 mL per plant per day may not hold for a whole month.

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# When trials disagree

### Time for three trials




THE IDEA

Variation is evidence to examine. Three trials give 18, 20 and 22 seconds. Their mean is 20 seconds, but the spread still matters.

An unusual reading should be investigated, not deleted just because it disagrees. Record conditions and repeat the test.

CHECK YOUR THINKING

**Which report is most transparent?**

A Report only the reading closest to the prediction.

B List the trials, mean and conditions.

**B. Keeping the variation visible allows others to judge the claim.**

LOOK AGAIN

## What would make a fourth reading of 60 seconds worth investigating?

Record the fourth reading and check the setup, timing and conditions before interpreting it. A surprising measurement is a reason to investigate.

ONE LAST CHALLENGE

# Does clarity establish that the water is safe to drink?

A sand filter removes visible dirt from a water sample. The filtered water looks clear.



THE REVEAL

## No. The observation only establishes that visible dirt was reduced.

Dissolved substances and microorganisms may remain. Appearance alone cannot test for them.

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