

Big investigation: how tall is the school?

CURRICULUM ALIGNMENT

MEA.MSR.4b

find, interpret and deduce measures experimentally with increasing precision.

NUM.FRC.4b

investigate proportionality and ratios of quantities (sets).

DAT.DAT.4b

critically analyse and evaluate findings; and communicate inferences, conclusions and implications from the findings.

WHAT THIS LESSON TEACHES

You can find how tall the school is by comparing shadows. A stick of known height and the school cast shadows in the same ratio as their real heights, so $\text{school height} = (\text{stick height} \div \text{stick shadow}) \times \text{school shadow}$.

→ A 1 m stick casts a 0.6 m shadow at the same moment the school casts a 6 m shadow, so the school is about 10 m tall.

→ $\text{building height} = (\text{stick height} \div \text{stick shadow}) \times \text{building shadow}$

MODEL THIS ON THE BOARD

STICK AND SCHOOL SHADOWS

- ① A 1 m stick casts a 0.6 m shadow. At the same moment the school casts a 6 m shadow.
- ② Work out the scale: $\text{stick height} \div \text{stick shadow} = 1 \div 0.6$.
- ③ Multiply that scale by the school shadow: $(1 \div 0.6) \times 6 = 10$.
- ④ The school is about **10** m tall.

LESSON ARC

Open from the yard with the puzzle: how do you measure a height you can never reach? Sketch the two same-shaped shadow triangles on the board and walk the shadow-and-stick numbers (1 m stick, 0.6 m shadow, 6 m building shadow, $\times 10$). Pupils rule a four-column estimate table in their copy, then go outside to measure real shadows together and run the formula. Groups then estimate one feature two ways, checking the estimates agree within 10%.

TEACHING MOVES

1. **Getting Started.** Point at the actual roofline from the yard or window and take three hands-up guesses in metres — no call-outs. Hold the puzzle open: do NOT mention shadows yet. Let 'how do you measure what you can't reach?' sit unanswered.
2. **Watch and Notice.** Sketch the two triangles side by side — short stick with short shadow, tall building with long shadow — and stress they are the same shape because the sun is in the same place. Pause and make the class verify the $\times 10$ on the board before moving on. Keep the brick and storey cross-checks deliberately brief; Method 1 is the anchor.
3. **Set Up Your Estimate Table in Your Copy.** Rule the four headings on the board — Feature, Method used, Estimate (m), How sure (1–5) — and have pupils copy with at least five rows. Glance only for headings and ruled lines as you walk; no marking. This frame travels outside with them.
4. **Try It Together.** Budget a minute for the out-and-back walk. Outside, stand the metre stick vertical, chalk and tape its shadow, then immediately chalk and tape the school's shadow — same moment, so use two pupils marking at once. Have pupils call out each number before you divide: $(1 \text{ m} \div \text{stick shadow}) \times \text{building shadow}$. If it's cloudy, switch to a shared brick-count instead.

5. **Class Challenge.** Send groups to fixed unreachable features — flagpole, tall wall, hoop, tree. Keep it brisk: each group does their main feature two different ways, then quick single-method estimates of two more. As you circulate, push for a genuinely different second strategy so the two estimates are a real cross-check, not the same sum twice.
6. **What Did We Notice?.** Ask which estimate they trust most and why two agreeing methods beat one. Revoice a strong answer: 'one estimate is a guess, two that agree is evidence.' Catch the 'longest shadow means tallest' idea — shadow length depends on the sun's height, which is why both shadows must be measured at the same moment.

COMMON MISCONCEPTIONS

⚠ Pupils measure the school's shadow a few minutes after the stick's, then can't see why their answer is off — 'we measured both, didn't we?'

Outside, deliberately re-measure the stick shadow a few minutes later so the class sees it has visibly changed length. Drive home that both shadows must be chalked at the same moment, because the sun keeps moving.

⚠ Pupils set up the ratio upside down — dividing the shadow by the stick height, or multiplying when they should divide.

Anchor them to the triangle sketch: the stick is shorter than its shadow here, so $1 \div 0.6$ is more than 1, and the building must end up taller than its shadow. Have them sanity-check the answer against the picture before trusting the number.

⚠ Pupils treat 'agreement within 10%' as 'the numbers must match exactly' and panic when 9.8 m and 10 m don't.

Put 9.8 and 10 on the board and show they're only 0.2 m apart — well within a metre. Tell them estimates that land this close are a success, not a failure; matching to the centimetre would actually be suspicious.

DIFFERENTIATION

EMERGING

- Give these pupils the stick-shadow role and let them call out the two measured shadow lengths while you do the division aloud — they own the data, not the calculation.
- Pre-fill their copy table's Method column with 'shadow' so they only record the feature, estimate and confidence number.

DEVELOPING

- Ask them to predict the building height from the shadows BEFORE you divide, then check how close their guess was to the worked answer.
- Challenge them to find a feature where the shadow method is awkward (a thin flagpole) and explain which method suits it better.

PROFICIENT

- Pose: the sun moved and your stick shadow grew from 0.6 m to 0.9 m between the two measurements — by how much would that throw off a 10 m answer? Ask them to work it through in their copy.
- Have them invent a fourth method for a feature with no shadow at all (an indoor height, say) and justify why it would still give a trustworthy estimate.

✓ **Cross-curricular:** Tie to Geography — the same shadow-ratio idea is how surveyors and early astronomers estimated the height of mountains and the size of the Earth.

ANSWER KEY

a) **Method 1 — shadow + 1 m stick:** $\text{school shadow} \div \text{stick shadow} \times 1 =$ (answers depend on the pupils' own measurements)

b) **Method 2 — count bricks:**
 $\text{brick count} \times \text{brick height (cm)} \div 100 =$ (answers depend on the pupils' own measurements)

c) **Method 3 — count storeys:** $\text{storeys} \times \approx 3 \text{ m per storey} =$ (answers depend on the pupils' own measurements)

d) **Compare: are two estimates within 10% of each other? (Y/N):** pupils' own answer

e) Which estimate do you trust most? Why?: pupils' own answer

Q1: 8 m

Q2: 10 m

Q3: 5 m

Q4: 12 m

a) Always : That equal-ratio rule is exactly how the shadow method works.

b) Always : Heights scale by the same factor as the shadows.

c) Never : 140×7 cm equals 980 cm which is 9.8 m, not 10 m.

d) Never : Clear shadows are needed and they only form in sunlight.

EXTENSION SHEET · STRETCH ANSWERS

S1: 32.5

S2: 23.5

S3: 17

S4: 17

S5: 18