Science: data representation and defensible extrapolation

Original skill preparation; versioned source scope

ACT Science: Data Representation and Defensible Extrapolation

- Read tables and graphs, with units, and describe a **trend 趋势**.
- Calculate a **rate of change 变化率** between measurements.
- Estimate between measured points by **interpolation 插值**.
- Recognise **extrapolation 外推** beyond the data and judge whether the **evidence 证据** supports it.

Reading representations

- Read the title, axis labels, units and key before the numbers.
- A table gives exact measured values; a graph shows the pattern.
- Describe two things separately: the value (rising, falling) and the rate (speeding up, slowing down).

Rates of change

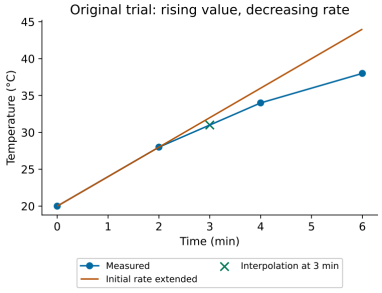
- A rising temperature can have a falling rate of increase: the curve flattens.
- Average rates over intervals do not give the exact rate at every instant.

$$\text{average rate} = \frac{\text{change in quantity}}{\text{change in time}}$$

Interpolation and extrapolation

- Interpolation estimates between measured points, usually with a straight line between them.
- Extrapolation extends beyond the measured range. It depends on an assumption that the pattern continues.
- Extending the starting rate of a flattening curve overestimates later values.

Figure: Interpolation and extrapolation



- The temperature keeps rising but more slowly, so extending the starting rate overestimates
- Read the axes and units first.

Practice research summary

- Original hypothetical research summary — A cooling sleeve
- A laboratory team tests sleeves intended to reduce a small sensor's temperature during operation.
- All sensors start at 22°C.
- Temperature is measured after ten minutes of use with the same power setting, room conditions and measuring instrument.

Worked example: rates from the time series

- $\frac{28-22}{2}=3$, $\frac{32-28}{2}=2$, $\frac{34-32}{2}=1$ °C per minute.
- The temperature rises throughout, while the rate of rise falls.
- These are average rates for each interval, not exact rates at each moment.

Worked example: estimating and extending

- Interpolation at 3 minutes: halfway between 28 and 32, so about $28 + \frac{1}{2}(4) = 30$ °C.
- Extending the first rate to 6 minutes: $22 + 3 \times 6 = 40$ °C, but the measurement was 34 °C. The first-slope model overestimates.
- A value at 12 minutes would be an extrapolation beyond the 0–6 minute data. It needs a stated model and more measurements; the rising curve could level off.

Common errors

- Describing the temperature when the question asks about the rate.
- Reading an extrapolated value as if it were measured.
- Extending a starting rate along a flattening curve.

Common errors (2)

- Ignoring units on the axes.
- Treating interval averages as exact instantaneous rates.

Key terms

- **trend**: The general direction of change in data.
- **rate of change**: How fast a quantity changes, per unit of time or another variable.
- **interpolation**: Estimating a value between measured points.
- **extrapolation**: Estimating a value beyond the measured range.

Check yourself

- Values are 10, 16, 20 at 0, 3, 6 seconds. Find each average rate.
- Is estimating the value at 4.5 seconds interpolation or extrapolation?
- Why is a prediction at 20 seconds less certain?