

1.3 Use scientific units and notation to check a measurement claim

Name: _____ Class: _____ Date: _____

Total: 24 marks**KEY WORDS** units 单位 • precision 精密度 • accuracy 准确度

Objective

Use scientific units and notation to check a measurement claim. This is original GAC013-aligned practice, not an official assessment. All supplied case data and review records are fictional; explicitly cited historical context is factual. The case data are invented for learning; they are not findings about a real school, country or population. Use the supplied evidence and do not invent missing observations.

1 Key knowledge and worked examples

■ **Key knowledge: a quantity needs its definition, unit and sensible reported precision**

Units 单位 identify the scale used for a physical quantity. Conversions preserve the quantity while changing its numerical representation. Average speed is distance travelled divided by elapsed time. **Precision** 精密度 concerns closeness of repeated measurements, while **accuracy** 准确度 concerns closeness to a suitable reference or true value. Close repeats do not prove accuracy. Report digits supported by the measurements and avoid claiming uncertainty that was not established.

■ **Source A: text or task brief**

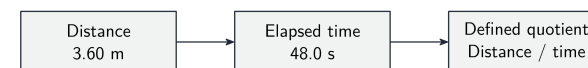
Fictional trolley record: total travelled distance 3.60 m; elapsed time 48.0 s. The written task assumes these supplied values and asks for average speed. Three repeated timer readings for a separate fixed event are 10.1 s, 10.1 s and 10.2 s. A suitable independent reference measures that event as 12.0 s.

A separate paper square has side length 10.0 cm. Use $1\text{ m} = 100\text{ cm}$ and $1\text{ m}^2 = 10,000\text{ cm}^2$. No uncertainty budget or acceleration measurements are supplied.

■ **Source B: response or review record**

Student notes: “Average speed = time divided by distance = 13.3 m/s. Ten centimetres is 0.010 m, so the square area is 0.010 m². The three timer readings are close, therefore accurate. Every calculated result should show eight decimal places. The trolley’s average speed proves it travelled at a constant speed.”

■ **Worked example: write the equation before the conversion and substitution**



Known: distance 3.60 m and elapsed time 48.0 s. Why divide distance by time? Average speed is the distance travelled per unit time.

$$v_{\text{avg}} = \frac{d}{t}$$

$$v_{\text{avg}} = \frac{3.60\text{ m}}{48.0\text{ s}} = 0.0750\frac{\text{m}}{\text{s}}$$

This is an average for the whole interval. It does not state the speed at every moment.

2 Practice

2.1 State the equation for average speed and its SI unit. [2]

2.2 Convert 10.0 cm to metres and calculate the square’s area in m². [2]

2.3 Calculate the trolley’s average speed with a suitable number of significant figures. [3]

2.4 Explain what the repeated timer readings show about precision and accuracy. [3]

3 Exam-style questions

3.1 Evaluate the student notes with six corrections or limits. [6]

3.2 Write an 80–110-word corrected measurement note explaining the result and its limits. [8]

Solutions

2.1

: average speed = travelled distance / elapsed time, $v_{\text{avg}} = d/t$.: metre per second, written m/s or as a stacked fraction.

2.2

: $10.0/100 = 0.100$ m.: area = side² = $(0.100 \text{ m})^2 = 0.0100 \text{ m}^2$. The student's area happens to have the right numerical size but their stated side length does not support it.

2.3

: $v_{\text{avg}} = d/t$.: $v_{\text{avg}} = 3.60/48.0 = 0.0750$ m/s.: three significant figures match the supplied values; leading zeros are not significant.

2.4

: readings are close, indicating good repeat precision for this record.: they differ substantially from the supplied 12.0 s reference.: therefore close repeats do not establish accuracy; a systematic timing problem should be investigated.

3.1

each: speed uses distance/time, not the reverse; inverted quotient has units s/m, not m/s; 10.0 cm is 0.100 m; area conversion squares the length factor; precision differs from accuracy; average speed does not establish constant speed. Accept justified reporting precision instead of one of the distinct unit corrections.

3.2

Local analytic rubric, 8 ×: state distance/time definition; give 0.0750 m/s; use appropriate precision; correct length conversion; square the conversion for area; distinguish close repeats from accuracy; use independent reference; avoid constant-speed or invented-uncertainty claim; coherent truthful 80–110 word response. Example: “Average speed is travelled distance divided by elapsed time. The trolley's supplied values give 0.0750 metres per second, reported to three significant figures. This interval average does not prove constant speed. A side of 10.0 centimetres equals 0.100 metres, so its square area is 0.0100 square metres. Length and area need different conversion factors. The repeated timer readings are close together, but they disagree with the supplied 12.0-second reference. They therefore show repeat precision without establishing accuracy. We should investigate the timing procedure rather than add unsupported decimal places or invent an uncertainty range.”