

Exercise walk-through

3.2

Measurement, recording and uncertainty

Pearson Edexcel · International A-Level · Physics

Exercises 2.1·2.2

2.1 Distinguish accuracy from precision. Explain why a zero error can give precise but inaccurate results. [3]

accuracy

precision

2.2 A micrometer sleeve reads 3.5 mm and thimble division 18 aligns with the reference. Its resolution is 0.01 mm and closed-jaw reading is +0.02 mm. Find indicated and corrected values, then the basic single-reading absolute uncertainty. [3]

sleeve: 3.5 mm
thimble: division 18
resolution: 0.01 mm
zero error: +0.02 mm

Exercises 2.1·2.2

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accuracy

precision

2.1 Accuracy concerns closeness to the true value. Precision concerns clustering of repeated values. A fixed zero offset can shift all closely clustered results away from the true value.

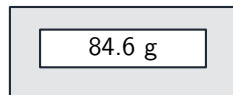
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sleeve: 3.5 mm
thimble: division 18
resolution: 0.01 mm
zero error: +0.02 mm

2.2 $d_{ind} = 3.5 + 18 \times 0.01 = 3.68$ mm. Subtract the positive zero error: $d = 3.68 - 0.02 = 3.66$ mm. Half resolution gives $\Delta d = 0.005$ mm, before considering other method uncertainties.

Exercises 2.3·3.1

2.3 A balance reads 84.6 g with 0.1 g resolution. Calculate absolute and percentage uncertainty using this specification's single-reading convention. [3]



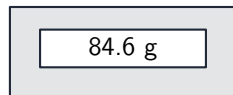
resolution 0.1 g

3.1 Repeated times are 6.12, 6.24, 6.18, 6.20 s. Calculate the mean, half range and percentage uncertainty. A student reports 6.18500 ± 0.005 s. Give two criticisms. [5]

time / s			
6.12	6.24	6.18	6.20

Exercises 2.3·3.1

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resolution 0.1 g

2.3 Half resolution: $\Delta m = 0.1/2 = 0.05$ g. Percentage = $(\Delta m/m) \times 100\%$. $0.05/84.6 \times 100 = 0.059\%$.

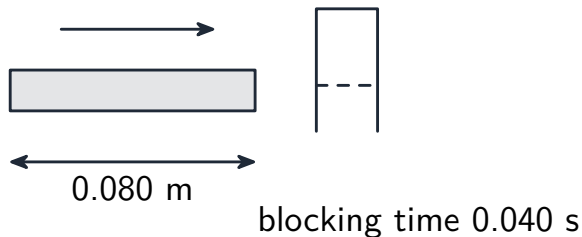
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time / s			
6.12	6.24	6.18	6.20

3.1 Mean $\bar{t} = (6.12 + 6.24 + 6.18 + 6.20)/4 = 6.185$ s. Half range $\Delta t = (6.24 - 6.12)/2 = 0.06$ s. Percentage = $0.06/6.185 \times 100 = 0.97\%$. The quoted mean has unjustified extra digits for the readings; 0.005 s uses half resolution but ignores the much larger repeat spread. Report about (6.19 ± 0.06) s.

Exercise 3.2

3.2 A light gate records a car blocking time of 0.040 s. Its interrupting length is 0.080 m. Find the passage speed. Explain why this alone does not give acceleration, and describe an additional measurement route. [4]



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0.080 m

blocking time 0.040 s

3.2 $v = l/t = 0.080/0.040 = 2.0 \text{ m s}^{-1}$. One speed is not a change in speed per time. Use two gates to find two passage speeds and measure the elapsed time between the corresponding speed positions/events, then $a = \Delta v / \Delta t$ for the stated mean acceleration.

Exercise 3.3

3.3 A group gets five closely clustered wire diameters with one micrometer. Another group using a different micrometer obtains a consistently larger mean. Explain which quality the first group shows and which wider check is being made. Suggest a cause, a check and why deleting the larger mean is unsuitable. [5]

group A
micrometer A

group B
micrometer B

same wire

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group A micrometer A

group B micrometer B

same wire

3.3 Within-group clustering demonstrates precision/repeatability under the same method. Comparison across operators/apparatus examines reproducibility. A micrometer zero offset or different contact pressure could cause the discrepancy. Check both zeros/calibration or use a controlled ratchet technique on the same positions. A difference is evidence to investigate, not a reason to discard the inconvenient group without justification.