InkBiology

ANSWER BOOK

# Handling data: units, scales, rates and uncertainty

Scientific method and quantitative biology · Unit B00

AQA MS 0.1–0.5, 1.1, 1.3, 2.2, 3.1, 3.5, 3.6 · OCR A Module 1.1.3–1.1.4; mathematical requirements
Edexcel A Mathematical skills appendix; core practical analysis
CAIE Papers 3 and 5; mathematical requirements

6 questions · 19 marks

NAVY EDITION


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## SECTION A · Short, 1 to 2 marks

**A1** **B1** resolution is the smallest change an instrument can register, such as 1 mm on a metre rule or 0.01 g on a two-decimal-place balance. **B1** a single reading off a scale is taken as half the smallest division, so plus or minus 0.5 mm. [2]

## SECTION B · Standard, 3 to 5 marks

**B1** **M1** change in mass = 4.60 - 5.00 = -0.40 g, and because the two masses were subtracted the absolute uncertainties add to give plus or minus 0.02 g. **A1** percentage change = -0.40 ÷ 5.00 × 100 = -8.00 per cent, the sign showing that the chip lost mass. **M1** percentage uncertainty in the change = 0.02 ÷ 0.40 × 100 = 5.0 per cent, and in the initial mass = 0.01 ÷ 5.00 × 100 = 0.20 per cent. **A1** the two were divided, so the percentage uncertainties add: about 5.2 per cent. [4]

**B2** **B1** a population that multiplies repeatedly spans several factors of ten, so on a linear axis the early counts lie flattened against the baseline where nothing can be read from them. **B1** on a logarithmic axis equal distances represent equal multiplications, so the steps 1, 10, 100 and 1000 are evenly spaced and every hour is as readable as every other. **B1** each hour multiplies the population by the same factor and therefore adds the same amount to the logarithm, so constant growth plots as a straight line. **B1** a straight line is therefore evidence that the growth factor never changed over that period, which is what exponential growth means, and a rise of 3 on the axis is a multiplication of the population by 1000. [4]

**B3** **B1** an answer carries the same number of significant figures as the least precise measurement that went into it, and the volume of 24 $cm^3$ carries only two. **B1** significant figures record how finely the instrument measured, so writing more digits claims a precision the syringe never had. **B1** decimal places depend only on the unit chosen: 24 $cm^3$ written as 0.024 $dm^3$ has three decimal places and still two significant figures, because changing the unit cannot improve the measurement. [3]

**B4** **M1** the rate is the gradient of the tangent, which is the rise divided by the run, with both values read off the axes rather than counted in squares of paper. **M1** rise = 20.0 - 2.0 = 18.0 $cm^3$ and run = 30 - 0 = 30 s. **A1** initial rate = 18.0 ÷ 30 = 0.60 $cm^3\ s^{-1}$. [3]

**B5** **B1** the percentage change rests on the difference between two similar masses, and subtracting keeps the whole of both absolute uncertainties while leaving only a small value behind. **B1** so the percentage uncertainty in that small difference is large even though each individual weighing was good to a fraction of one per cent. **B1** leaving the chips immersed for longer, or using a solution further from the potato's own water potential, produces a larger change in mass and shrinks the percentage uncertainty without changing the balance. [3]