InkChemistry

ANSWER BOOK

Measurement, uncertainty and significant figures in chemistry

Working in the laboratory · Unit C00

AQA MS 1.1, MS 1.3; 8 (practical skills) · OCR A 1.1.3, 1.1.4

15 questions · 47 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 MU-Q11

B1 the temperature rise is not affected by the faulty thermometer. **B1** the rise is the difference of two readings, and the same 1.5 °C offset in each reading cancels when one is subtracted from the other. [2]

A2 MU-Q15

B1 judging the exact drop at which the indicator changes colour. **B1** reading the meniscus slightly differently from one reading to the next. [2]

SECTION B · Standard, 3 to 5 marks

B1 MU-Q2

M1 titre = 23.70 - 1.20 = 22.50 cm³. **M1** the titre is the difference of two readings, so its uncertainty is 2 × 0.05 = ±0.10 cm³. **M1** percentage uncertainty = 0.10 ÷ 22.50 × 100; error carried forward from an undoubled ±0.05 cm³. **A1** percentage uncertainty = 0.44%; allow 0.444%. [4]

B2 MU-Q12

B1 random errors make readings scatter unpredictably on both sides of the true value, whereas systematic errors shift every reading the same way. **B1** random errors reduce precision, whereas systematic errors reduce accuracy. **B1** the effect of random errors is reduced by repeating and taking a mean, whereas systematic errors are not reduced by repeating. **B1** a random error is judging the end point a drop early or late; a systematic error is a burette rinsed with water, which dilutes the titrant every time. [4]

B3 MU-Q14

B1 the eye is level with the meniscus, to avoid a parallax error. **B1** the reading is taken at the bottom of the meniscus. **B1** it is recorded to two decimal places, to the nearest 0.05 cm³, so the last figure is 0 or 5. **B1** 24.7 cm³ is wrong, because it has only one decimal place; it should be written 24.70 cm³. [4]

B4 MU-Q18

B1 the end point was overshot, with extra drops added after the indicator had changed colour. **B1** an air bubble in the burette tip escaped during the titration and was counted as titre; allow a misread burette reading. **B1** the titre lies far outside the agreement of the concordant titres, so it comes from a fault in that run, not from the true end point. **B1** including it would pull the mean away from the value the concordant titres agree on, making the result less accurate. [4]

B5 MU-Q1

B1 the burette reading is uncertain by ±0.05 cm³, half of the 0.10 cm³ division, because the scale is read by eye. **B1** the balance reading is uncertain by ±0.01 g, one in the last digit of the display; allow ±0.005 g only where the question states it. **B1** the thermometer reading is uncertain by ±0.5 °C, half of the 1 °C division. [3]

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B6 MU-Q3 — **M1** volume = 22.40 ÷ 1000 = 0.02240 dm^3, converting cm^3 to dm^3. **M1** amount = concentration × volume = 0.125 × 0.02240. **A1** 2.80×10^{-3} mol, in standard form to three significant figures; reject 2.8×10^{0} from an unconverted volume. [3]

B7 MU-Q4 — **M1** mass transferred = 14.73 - 12.28 = 2.45 g. **M1** the mass comes from two readings, each ±0.01 g, so its uncertainty is ±0.02 g. **A1** percentage uncertainty = 0.02 ÷ 2.45 × 100 = 0.82%; allow 0.41% only from a stated ±0.005 g a reading. [3]

B8 MU-Q6 — **M1** temperature rise = 27.5 - 21.0 = 6.5 °C. **M1** the rise comes from two readings, so its uncertainty is ±1.0 °C. **A1** percentage uncertainty = 1.0 ÷ 6.5 × 100 = 15%. [3]

B9 MU-Q7 — **B1** a systematic error shifts every reading in the same direction by a similar amount. **B1** water left in the burette dilutes the acid every time, so every titre is too large. **B1** repeats all carry the same error, so they agree with each other and the mean is still too large; the error is removed only by fixing its cause. [3]

B10 MU-Q8 — **B1** the absolute uncertainty of the titre is ±0.10 cm^3 whatever its size, because it comes from the burette. **B1** on 10 cm^3 that is a percentage uncertainty of 1.0%, but on 25 cm^3 it is 0.4%. **B1** the larger titre therefore has the smaller percentage uncertainty, so the calculated result is known more precisely. [3]

B11 MU-Q9 — **B1** a result cannot be more precise than the least precise data used to calculate it. **B1** the mass and the pipette volume have three significant figures, fewer than the four of the titre. **B1** the answer is 0.0828 mol dm^{-3}; reject 0.08275 and reject 0.083. [3]

B12 MU-Q10 — **B1** the mass is uncertain by ±0.02 g from two readings, which is 0.02 ÷ 0.12 × 100 = 17% of the mass. **B1** use a larger mass of magnesium, scaling up the acid and the gas collection to match, so the same ±0.02 g is a smaller fraction of the mass. **B1** use a balance with a finer resolution, such as one reading to 0.001 g, so a mass by difference is uncertain by ±0.002 g; ignore 'repeat and take a mean'. [3]

B13 MU-Q19 — **M1** pipette: (0.06 ÷ 25.0) × 100 = 0.24%. **M1** the titre is the difference between two burette readings, so its uncertainty is 2 × 0.05 = ±0.10 cm^3. **A1** titre: (0.10 ÷ 20.00) × 100 = 0.50%, which is larger than 0.24%; the burette contributes about twice the uncertainty of the pipette. [3]

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