

Quantitative Chemistry Capstone and Competition Synthesis

g11_u09_w36

Purpose and boundary

Use original fictional paper-model cards only. No experiment, chemical handling, device operation, research participation, or real-world decision is requested.

Targets: I can select a model, show units, test a result against evidence, and state a limitation. **Vocabulary:** constraint, model, residual, uncertainty, limiting factor, synthesis. **Prerequisites:** moles, energy, equilibrium, calibration, uncertainty, evidence claims.

All values are fictional. Use $F = 96\,485\text{ C mol}^{-1}\text{ e}^{-}$ and $M_{\text{Cu}} = 63.55\text{ g mol}^{-1}$ only where stated.

For the gas card, use $R = 0.08206\text{ L atm mol}^{-1}\text{ K}^{-1}$.

1. A fictional gas card has $n = 0.500\text{ mol}$, $T = 300.\text{ K}$, $P = 1.00\text{ atm}$. Find V .

2. State one model assumption behind item 1.

3. A calibration card gives $S = 2.00C + 0.10$ and $S = 1.10$. Find C .

4. State one calibration-range limit for item 3.

5. An equilibrium card has $K = [B]/[A] = 3.00$, $[A] = 0.40\text{ M}$, $[B] = 0.60\text{ M}$. Find Q and modeled direction.

6. Explain why item 5 does not give a real-system rate.

7. A charge card gives $Q = 1930\text{ C}$ for $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$. Find modeled mass Cu.

8. State one boundary on interpreting item 7 as a real product result.

9. A route card has $m_{\text{desired}} = 45.0$, $m_{\text{reactants}} = 75.0$, $m_{\text{actual}} = 36.0$, $m_{\text{theoretical}} = 45.0\text{ g}$. Find atom economy and percent yield.

10. Explain why two metrics in item 9 do not create an overall ranking.

11. Three fictional values are 4.9, 5.1, 5.0 units. Find mean and half-range.
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12. A second card reports 5.6 ± 0.2 units. Compare simple intervals.
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13. Why is item 12 not causal proof?
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14. A source card lists 100 cases but no sampling rule. Identify one limitation.
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15. A multivariable card has residuals $+0.1, -0.2, +0.5$. Which has largest magnitude and what model question follows?
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16. A phase-card point crosses a liquid-gas boundary. Name the model change and one operational limit.
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17. Write a one-sentence claim with data, condition, comparison, and limitation.
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18. Name one next fictional measurement/model check that would reduce ambiguity in any capstone card.
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19. Explain why a correct calculation can still support an incomplete conclusion.
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20. Write a two-sentence capstone synthesis using two different model cards and a limitation.
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