Measuring Reaction Rates

Name: _____ **Class:** _____ **Date:** _____

Learning targets: choose measurement methods • collect and organise data • calculate average rate • compare data • evaluate reliability

A | Choosing a measurement method

1. In one sentence, define reaction rate.

_____

_____

2. Complete the table. State what each method measures (not just the instrument name).

Method	What changes or is measured?
Gas syringe	_____
Balance with gas escaping	_____
Light sensor / colorimeter	_____
Disappearing-cross test	_____

3. A reaction produces carbon dioxide. Which method would give the most useful continuous measurements: gas syringe, bubble counting, or a single stopwatch reading? Give one reason.

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_____

4. Why can counting bubbles be less reliable than measuring gas volume?

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5. Explain why measurements should be taken at regular time intervals.

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B | Collecting and interpreting gas-volume data

A student reacts calcium carbonate with excess dilute acid and records gas volume in a gas syringe. The following are example measurements.

Time (s)	0	10	20	30	40	50	60
Gas volume (cm^3)	0	16	29	38	44	47	48

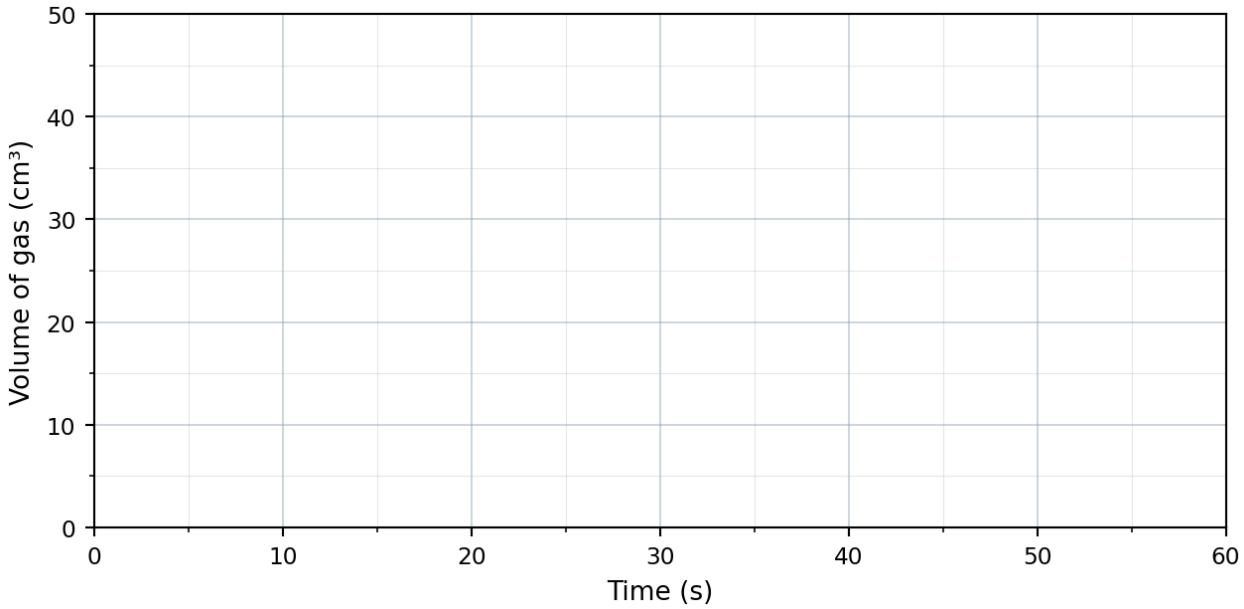
6. State the independent variable and the dependent variable for these measurements.

_____

_____

B | Gas-volume graph and calculations (continued)

7. Plot all seven points from the data table on the grid. Join the points with a smooth curve; label both axes and units.



Average rate = change in amount measured ÷ time interval. Include the correct units in every answer.

8. Calculate the average gas-production rate from 0 to 20 s.

9. Calculate the average rate from 20 to 40 s.

10. Calculate the average rate for the full 0 to 60 s.

11. During which 10 s interval was gas produced fastest? Explain how the table or your graph shows this.

12. Describe how the rate changes during the experiment. Suggest why the graph nearly levels off.

C | Comparing two experiments

A student uses identical amounts of reactants but changes one reaction condition. Both trials produce the same gas.

Time (s)	0	15	30	45	60
Trial A: gas (cm^3)	0	18	29	35	36
Trial B: gas (cm^3)	0	25	34	36	36

13. Calculate the average rate in the first 15 s for both trials.

14. Which trial is faster at the start? Support your answer with numerical evidence.

15. Both trials reach 36 cm^3. Does a faster rate always mean more product is formed in total? Explain using these data.

D | Measuring mass loss

An open flask containing an acid and a carbonate is placed on a balance. Carbon dioxide escapes. The readings are:

Time (s)	0	15	30	45	60
Mass reading (g)	128.60	128.49	128.42	128.38	128.36

16. Calculate the total mass lost during the 60 s.

17. Calculate the average rate of mass loss from 0 to 60 s, in g/s.

18. Explain why the balance reading decreases. Would the method work the same way in a completely sealed flask?

E | Reliability and repeat measurements

Five students each measure the time required to collect 30 cm^3 of gas under supposedly identical conditions.

Trial	1	2	3	4	5
Time to collect 30 cm^3 (s)	41	40	39	75	40

19. Which result is anomalous? Give a reason based on the pattern.

_____

_____

20. Calculate the mean time from the four consistent results (show working).

_____

_____

_____

21. Using your mean time, estimate the average gas-production rate up to 30 cm^3. State its units.

_____

_____

_____

22. Suggest TWO sources of measurement error and a practical way to reduce each error.

_____

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_____

F | Design a fair investigation

23. Plan how to investigate the effect of acid concentration on the rate of reaction between marble chips and dilute hydrochloric acid. Include: independent variable, dependent variable, three controlled variables, method for recording data, repeats, and one safety precaution.

Independent variable: _____

Dependent variable: _____

Three controls: _____

Data collection and repeats: _____

Safety: _____

Extension: Why might a gas syringe give a more accurate volume measurement than counting bubbles? What limitation would remain even with a syringe?