Factors Affecting Reaction Rate

CHEMISTRY WORKSHEET • Use collision theory to explain changes in rate

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

Instructions: Answer in the spaces provided. Give a particle-collision explanation where asked. Show working and include units for calculations.

A • Temperature

1. Complete the statement: reacting particles must _____, have sufficient _____ and, where required, a suitable _____.

2. State how increasing temperature usually affects reaction rate.

3. Explain the effect using kinetic energy, activation energy and successful collisions.

4. Two identical acid–metal reactions are carried out at 20°C and 40°C. Which should be faster initially? Explain.

5. Why does refrigerating food often slow the chemical reactions involved in spoilage?

B • Concentration

6. What is meant by the concentration of a solution?

7. Explain why a more concentrated acid may react faster with marble chips of the same mass and size.

In otherwise identical trials, the volume of CO_2 collected during the first 20 s was measured:

Acid concentration (mol/L)	0.50	1.00	1.50	2.00
CO_2 volume in first 20 s (cm^3)	12	22	31	38

8. Calculate the average gas-production rate (cm^3/s) for the 0.50 mol/L and 2.00 mol/L trials. Show working.

9. Which trial has the greatest average rate over the first 20 s?

10. Name two variables that should be controlled to make this a fair comparison.

C • Surface area

11. What does “exposed surface area” mean for a solid reactant?

12. Rank the following from fastest to slowest initial reaction with excess acid: (A) one 5 g marble chunk; (B) 5 g small marble chips; (C) 5 g marble powder.

13. Explain the order using the number of collisions at the solid surface.

14. If all 5 g of marble reacts completely with excess acid, should the different forms produce the same final volume of CO_2 under the same conditions? Explain.

15. Sketch a large solid piece and the same amount broken into many tiny pieces. Show where acid particles can reach each solid.

One large piece	Many small pieces

D • Pressure and gaseous reactions

16. A gas mixture is compressed into a smaller volume at constant temperature. What happens to the number of reacting particles per unit volume?

17. Explain how compression usually changes collision frequency and reaction rate for gaseous reactants.

18. Identical amounts of two reactive gases are placed in (A) a 1.0 L vessel and (B) a 0.50 L vessel at the same temperature. Which usually reacts faster initially? Why?

19. Would increasing pressure normally have an equally strong effect on a reaction between two solid lumps? Explain.

20. Evaluate this claim: “Any increase in total gas pressure must make a gaseous chemical reaction faster.” Give a reason or counterexample.

E • Predicting reaction-rate changes

21. For each change, predict whether the initial rate will increase (↑), decrease (↓), or show no expected direct change (=). Give a brief collision-theory reason.

Change made (other conditions unchanged)	↑ / ↓ / =	Reason
Warm the reaction mixture from 20°C to 35°C	_____	_____
Dilute an acid solution	_____	_____
Crush a solid into powder (same mass)	_____	_____
Compress a mixture of reacting gases at constant temperature	_____	_____
Expand a sealed reacting gas mixture at constant temperature	_____	_____
Cool a reaction mixture	_____	_____
Change only the colour of the reaction vessel	_____	_____

22. Choose ONE of the changes above and explain it in more detail using successful collisions.

23. A student increases both temperature and acid concentration; the reaction becomes faster. Can they conclude that temperature alone caused the increase? Explain.

F • Planning a fair experiment

A student compares the effect of marble surface area using 5.0 g of calcium carbonate and 50 cm^3 of excess hydrochloric acid. CO_2 is collected with a gas syringe.

24. Identify the independent variable.

25. State the dependent variable, how it is measured and how a rate can be calculated.

26. List THREE variables that must be controlled.

27. Outline a method that allows a fair comparison between different marble sizes.

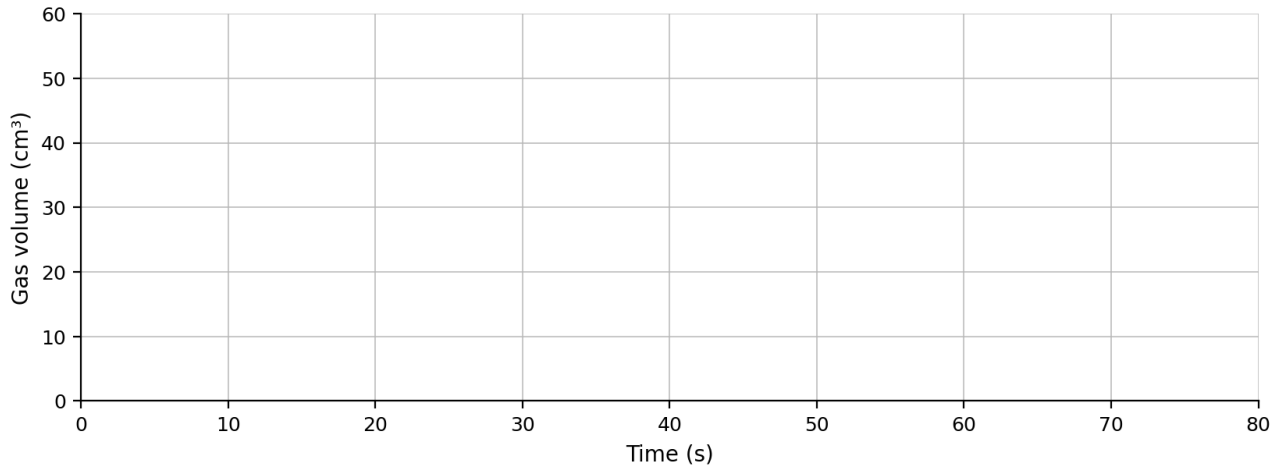
28. Give ONE laboratory risk and an appropriate safety precaution.

G • Experimental data and graph interpretation

Two reactions use the same amounts of reactants and the same apparatus. Only temperature is changed. The volume of gas is measured over time.

Time (s)	0	10	20	30	40	50	60	80
20°C: CO_2 (cm^3)	0	11	21	30	39	47	54	60
40°C: CO_2 (cm^3)	0	23	41	52	58	60	60	60

29. Plot BOTH sets of data on the same axes. Join each set of points with a smooth curve and include a key.



30. Calculate the average rate for each temperature over the first 20 s. Show working and units.

31. Approximately how many times faster is the 40°C trial over the first 20 s?

32. Explain why the 40°C curve becomes horizontal sooner.

33. Why is the final gas volume the same for both trials even though the initial rates differ?

34. Explain one limitation of using averages over 10–20 s intervals to describe how rate changes during the reaction.