

IB Chemistry HL - R2.2

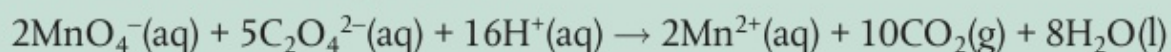
How fast? The rate of chemical change

Exercises + Practice questions

Official answers appended at the end

Exercise

Q1. Consider the following reaction.



Describe three different ways in which you could measure the rate of this reaction.

Q2. Which units are used to express the rate of a reaction?

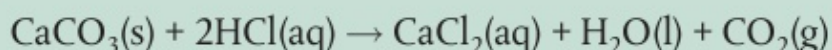
A $\text{mol dm}^{-3} \text{ time}$

B $\text{mol}^{-1} \text{ dm}^3 \text{ time}^{-1}$

C $\text{mol dm}^{-3} \text{ time}^{-1}$

D mol time^{-1}

Q3. The reaction between calcium carbonate and hydrochloric acid is carried out in an open flask. Measurements are made to determine the rate of the reaction.



(a) Suggest three different types of data that could be collected to measure the rate of this reaction.

(b) Explain how you would expect the rate of the reaction to change with time and why.

Q4. The following data were collected for the reaction
 $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$ at 390°C .

$[\text{H}_2\text{O}_2] / \text{mol dm}^{-3}$	Time / s	$[\text{H}_2\text{O}_2] / \text{mol dm}^{-3}$	Time / s
0.200	0	0.070	120
0.153	20	0.063	140
0.124	40	0.058	160
0.104	60	0.053	180
0.090	80	0.049	200
0.079	100		

Draw a graph of concentration against time and determine the reaction rate after 60 s and after 120 s.

Exercise

- Q5.** Which statement is correct for a collision between reactant particles that leads to reaction?
- A** Colliding particles must have different energy.
 - B** Colliding particles must have the same energy.
 - C** Colliding particles must have kinetic energy greater than the average kinetic energy.
 - D** Colliding particles must have kinetic energy greater than the activation energy.

Q6. Which of the following determine whether a reaction will occur?

- I. the orientation of the molecules
- II. the energy of the molecules
- III. the volume of the container

A I and II **B** I and III **C** II only **D** I, II and III

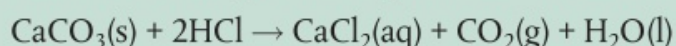
Q7. If we compare two reactions, one which requires the simultaneous collision of three molecules and the other which requires a collision between two molecules, which reaction would you expect to be faster? Explain why.

Exercise

- Q8.** Which of the following statements is correct?
- A** A catalyst increases the rate of the forward reaction only.
 - B** A catalyst increases the rate of the forward and backward reactions.
 - C** A catalyst increases the yield of product formed.
 - D** A catalyst increases the activation energy of a reaction.
- Q9.** Which statements are correct for the effects of catalyst and temperature on the rate of reaction?

	Adding a catalyst	Increasing the temperature
A	collision frequency increases	collision frequency increases
B	activation energy decreases	collision frequency increases
C	collision frequency increases	activation energy increases
D	activation energy increases	activation energy decreases

- Q10.** In the reaction between marble (calcium carbonate) and hydrochloric acid, which set of conditions would give the highest rate of reaction?



- A** marble chips and $1.0 \text{ mol dm}^{-3} \text{ HCl}$
 - B** marble powder and $1.0 \text{ mol dm}^{-3} \text{ HCl}$
 - C** marble chips and $0.1 \text{ mol dm}^{-3} \text{ HCl}$
 - D** marble powder and $0.1 \text{ mol dm}^{-3} \text{ HCl}$
- Q11.** A sugar cube cannot be ignited with a match, but a sugar cube coated in ashes will ignite. Suggest a reason for this observation.
- Q12.** Catalytic converters are now used in most cars to convert some components of exhaust gases into less environmentally damaging molecules. One of these reactions converts carbon monoxide and nitrogen monoxide into carbon dioxide and nitrogen. The catalyst usually consists of metals such as platinum or rhodium.
- (a)** Write an equation for this reaction.
 - (b)** Explain why it is important to reduce the concentrations of carbon monoxide and nitrogen monoxide released into the atmosphere.
 - (c)** Why do you think the converter sometimes consists of small ceramic beads coated with the catalyst?
 - (d)** Suggest why the converter usually does not work effectively until the car engine has warmed up.
 - (e)** Discuss whether the use of catalytic converters in cars solves the problem of car pollution.