Principles of Collision Theory

T-Level Technical Qualification in Science · Chemistry · A11.1

Name: _____ Date: _____ Class: _____

Specification coverage

A11.1.1 Particles must collide with enough energy to break and reform bonds (activation energy).

A11.1.2 Particles must be in the correct spatial orientation.

Use both conditions when you classify a collision as successful or unsuccessful.

1. Retrieval starter

1.1 Why might two reactant particles collide without producing products? Give two possible reasons.

2. Activation energy

2.1 Define activation energy.

A11.1 Principles of Collision Theory

2.2 Particle explanation

Explain why collision energy below the activation energy does not produce the specified reaction.

Complete the table. Compare each collision energy with the activation energy.

Collision	Ea / kJ mol^{-1}	Collision energy / kJ mol^{-1}	Energy requirement met?	Reason
A	45	30		
B	45	45		
C	45	52		
D	62	58		

2.3 Explain why energy is required when bonds must break and reform during a reaction.

3. Spatial orientation

3.1 Explain what 'correct spatial orientation' means in collision theory.

3.2 A collision has more than the activation energy, but the reacting parts of the particles do not meet. Predict the outcome and explain.

4. Applying both conditions

These five scenarios are taken from the A11.1 student workbook. Decide whether each collision can be successful and justify both tests.

Scenario	Ea	Energy	Orientation	Successful?	Justification
1	45	30	Correct		
2	45	55	Incorrect		
3	45	50	Correct		
4	62	70	Correct		
5	62	61	Correct		

4.1 Decision rule

Write a two-step decision rule for deciding whether a collision is successful.

5. Error analysis

5.1 ‘Every collision produces a reaction.’ Correct the statement.

5.2 ‘If collision energy is high enough, orientation does not matter.’ Correct the statement.

5.3 ‘Correct orientation can make up for collision energy below activation energy.’ Correct the statement.

6. Unfamiliar collision challenge

6.1 Reaction X has Ea = 80 kJ mol^{-1}. A collision has 92 kJ mol^{-1} and incorrect orientation. Decide whether it is successful and justify.

6.2 Reaction Y has Ea = 35 kJ mol^{-1}. A collision has 35 kJ mol^{-1} and correct orientation. Decide whether it can be successful and justify.

7. Exam-style questions

A reaction occurs when particles P and Q collide. The activation energy is 62 kJ mol^{-1}.

7.1 [2] Collision 1 has 58 kJ mol^{-1} and the correct orientation. Explain why it is unsuccessful.

7.2 [2] Collision 2 has 70 kJ mol^{-1} but incorrect orientation. Explain why it is unsuccessful.

7. Exam-style questions continued

7.3 [2] State the two conditions required for a successful collision.

7.4 [2] Explain why many collisions between reactant particles do not form products.

8. Final knowledge check

8.1 Define activation energy.

8.2 What happens if collision energy is below activation energy?

8.3 What is correct spatial orientation?

8.4 Can sufficient energy alone guarantee reaction? Explain.

8.5 State both requirements for a successful collision.