

Radical and nucleophilic substitution reactions

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab answers

These model answers use the sample times in the table. Your times may differ, but iodo must be faster than bromo, chloro slowest, and tertiary fastest of the bromo compounds.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB R3.4

Question 1 Identify the precipitates

Chloro gives **no precipitate** in the time (white AgCl would form slowly), bromo gives **cream AgBr** and iodo gives **yellow AgI**. Ionic equation: $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$.

Question 2 Effect of the halogen

The rate rises in the order **Cl < Br < I**. The C-I bond is the weakest (228 kJ mol^{-1}) and so breaks fastest, while C-Cl (346 kJ mol^{-1}) is strongest.

Question 3 Relative rates

1-iodobutane: $62 \div 9 = \mathbf{6.9}$; 2-bromobutane: $62 \div 24 = \mathbf{2.6}$; 2-bromo-2-methylpropane: $62 \div 3 = \mathbf{21}$.

Question 4 Effect of structure

Rate increases **primary < secondary < tertiary**. The tertiary compound reacts by SN1: the halide leaves to give a stable tertiary carbocation, which water then attacks.

Question 5 Controlled variables

Control **temperature, volume of silver nitrate and number of drops** (and concentration). Pre-warming ensures the reaction starts at 50°C , so times are comparable.

Question 6 Source of error

Judging when the solution first turns cloudy is subjective. Use a **black cross or lamp behind the tube** and the same observer, and repeat to average.

Question 7 Hydrolysis equation

$(\text{CH}_3)_3\text{CBr} + \text{H}_2\text{O} \rightarrow (\text{CH}_3)_3\text{COH} + \text{HBr}$, with the Br^- then precipitating with Ag^+ .