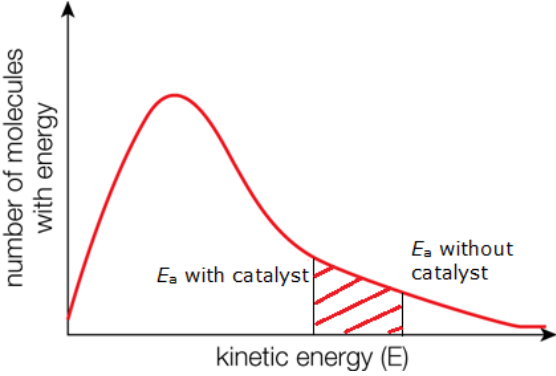
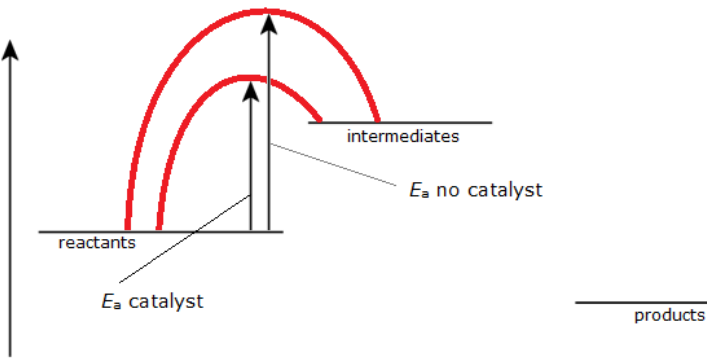


Question number	Answer	Marks	Guidance
1	C	B1	Molecules can form hydrogen bonds
2	C	B1	NH <sub>3</sub> is pyramidal so N-H bond polarities do not cancel. In all the others they do.
3	A	B1	Note it is rate not equilibrium yield that is being asked for here.
4	B	B1	There is some ozone in the troposphere. CFCs break down before they deplete ozone.
5	C	B1	A is vague but certainly untrue; B – not all absorbed; C – true in the <b>troposphere</b>
6	B	B1	A – same in each; C – all the same; D – least volatile
7	B	B1	
8	B	B1	3 is not true, a catalysts may <i>take part</i> in a reaction, provided it is unchanged at the end.
9	C	B1	1 is not true as molecules can be nucleophiles
10	A	B1	Mechanism is: Cl <sub>2</sub> → 2Cl; Cl + CH <sub>4</sub> → CH <sub>3</sub> + HCl; CH <sub>3</sub> + Cl <sub>2</sub> → CH <sub>3</sub> Cl + Cl

11 (a)	[diagram]  atom/molecule/ion/species with an <u>unpaired</u> electron	B1  B1	
11 (b) (i)	$O_3 \rightarrow O_2 + O$	B1	ALLOW 'hv' or 'hf' over arrow or on LHS of equation.
11 (b) (ii)	$O + O_2 \rightarrow O_3$	B1	
11 (c) (i)	Energy per atom = $498\,000 / 6.02 \times 10^{23}$ (= $8.27 \times 10^{-19}$ )  Frequency = $E/h$ = ans to first mark / $6.63 \times 10^{-34}$  = $1.25 \times 10^{15}$ Hz	B1  B1  B1	Must have unit for final mark (could be given as $s^{-1}$ )
11 (c) (ii)	$\lambda = c/v = 3.00 \times 10^8 / \text{ans to (i)}$  = $2.40 \times 10^{-7}$ m (or 240 nm)	B1  B1	Must have unit for second mark
11 (c) (iii)	UV of this frequency is only available in the stratosphere  ozone photolysis happens at lower energy/ lower frequency/ higher wavelength which is present in the troposphere	B1  B1	
11 (d)	propagation  one radical on each side of the equation	B1  B1	
12 (a)	<b>Level 3 (5–6 marks)</b> Candidate answers the question fully with all main points and three fine detail points  <i>The ideas are well structured providing significant clarity in the communication of the science</i>  <b>Level 2 (3–4 marks)</b> Candidate answers the question but without full detail by including all main points and at least one fine detail point.  <i>There is partial structuring of the ideas with the communication of the science generally clear</i>  <b>Level 1 (1–2 marks)</b> Candidate makes a reasonable attempt at the answer by giving three main points or two main point and one fine detail point	B1 × 6	<b>key points:</b> • mix haloalkane, $AgNO_3$ , ethanol • time for ppt to form • ppts in order iodo (fastest) bromo, chloro • $C_4H_9X + H_2O \rightarrow C_4H_9OH + HX$ (or $H^+ + X^-$ ) • $Ag^+ + X^- \rightarrow AgX$  <b>fine detail points:</b> • suitable apparatus (e.g., test tube) • equal vols of each • add $AgNO_3$ last and start timing

	<p><i>The ideas expressed are poorly structured and do not contribute to the communication of the science</i></p> <p><b>Level 0 (0 marks)</b> No response or no response worthy of credit.</p>		<ul style="list-style-type: none"> <li>chloro white ppt, bromo cream ppt, iodo yellow ppt.</li> </ul>
12 (b) (i)	<p>molecule (or bond) that has one end slightly positive (or <math>\delta^+</math>), the other slightly negative (or <math>\delta^-</math>)</p> <p>1-chlorobutane has greatest dipole</p> <p>chlorine is the most electronegative of the three halogens</p>	<p>B1</p> <p>B1</p> <p>B1</p>	
12 (b) (ii)	[mechanism]	B1	
12 (b) (iii)	breaking of C–Cl	B1	
12 (b) (iv)	greater $\delta^+$ on C attracts water more	B1	
12 (b) (v)	<p>bond strength</p> <p>C–I weakest, C–Cl strongest</p>	<p>B1</p> <p>B1</p>	
12 (c)	<p><math>\text{C}_4\text{H}_9\text{Br} + \text{NH}_3 \rightarrow \text{C}_4\text{H}_9\text{NH}_2 + \text{HBr}</math></p> <p>Amine</p>	<p>B1</p> <p>B1</p>	
13 (a) (i)	$\text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2$	B1	
13 (a) (ii)	homogeneous	B1	
13 (b) (i)	the energy with which a pair of molecules must collide in order to react	B1	
13 (b) (ii)	 <p>Labels as above Shaded part labelled as extra molecules with energy greater than <math>E_a</math></p>	<p>B1</p> <p>B1</p>	

13 (b) (iii)	 <p>upper curve, arrow and label</p> <p>lower curve, arrow and label</p>	B1 B1	<b>IGNORE</b> any curves from intermediate to products
13 (c) (i)	ozone absorbs <u>high-energy</u> UV that causes skin cancer, mutations, and so on.	B1 B1	
13 (c) (ii)	Cl breakdown of CFCs	B1 B1	