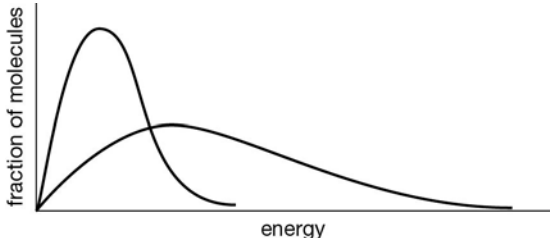


Question number	Answer	Marks	Guidance
1 (a)	minimum energy for a reaction to occur	1 1	You could say for a successful collision.
1 (b)	few molecules / particles have the required activation energy	1	
1 (c)	molecules are closer together therefore they collide more often	1 1	Because there are more particles in a given volume.
1 (d)	Many more molecules have energy greater than the activation energy	1 1	
1 (e)	speeds up a reaction but is chemically unchanged at the end	1	You need to explain in full what a catalyst is (2 marks) although there is only one mark available.
1 (f)	increases the surface area	1	
2 (a)		2	You must not refer to fraction of moles on the y-axis.
2 (b)	the curve should be higher and displaced to the left (see above) it should start at the origin and cross the other curve only once and not cross the x-axis	1 1	
2 (c)	particles have energy $< E_a$	1	
2 (d)	increase concentration	1	Or increase the pressure.
2 (e)	Many more molecules have $E > E_a$	1 1	You must not say KE increases with T.
2 (f)	lowers E_a	1	

	provides an alternative route	1	
3 (a)	<u>Number / proportion / percentage / fraction of molecules</u>	1	Ignore "particles"
3 (b)	None OR no effect OR no change	1	
3 (c)	X	1	
3 (d)	Answers in either order M1 collision OR collide M2 collision / molecules / particles with the activation energy OR with $E \geq E_{act}$ OR with <u>sufficient / enough</u> energy OR with the <u>minimum</u> energy OR with the correct orientation	2	Mark independently Ignore "correct" amount of energy
3 (e)	A small increase in temperature results in <u>many more / much higher proportion of / a lot more / significantly more molecules / particles / collisions with $E \geq E_{act}$ / energy greater than the activation energy / sufficient energy / enough energy / minimum energy to react</u> (compared with a small increase in concentration)	1	Not just "more molecules with $E \geq E_{act}$ " The answer must convey that the increase is significant Accept reference to "atoms", "molecules", "particles" Ignore "species"
4 (a)	M1 On the <u>energy axis</u> E_{mp} at the maximum of <u>the original peak</u> M2 The peak of their new curve <u>is displaced to the left and higher than the original</u> M3 All of the following are required • The new curve starts at the origin and should begin to separate from the original almost immediately • <u>and</u> the new curve crosses the original curve <u>once</u> • <u>and</u> an attempt has been made to draw the new curve correctly towards the energy axis <u>below the original curve</u> but not to touch the original curve or the axis	3	M1 The limits for the horizontal position of E_{mp} are defined as above the word "the" in the sentence below the graph.
4 (b)	The rate of reaction decreases as the temperature decreases because M1 <u>A decrease in the number / proportion of molecules with $E \geq E_a$</u> OR fewer molecules have $E \geq E_a$ OR fewer molecules have <u>sufficient / enough</u> energy	2	In M1 Ignore "molecules have less energy". Ignore "less energetic collisions". Ignore "molecules do not gain activation energy".

	<p><u>to react / decompose</u></p> <p>M2 <u>Fewer effective / productive / successful collisions in a given time / given period</u> OR <u>fewer frequent effective / productive / successful collisions</u> OR <u>lower rate of effective / productive / successful collisions</u></p>		<p>Ignore "fewer collisions".</p> <p>Credit "particles" for "molecules" but NOT "atoms".</p> <p>Ignore "chance of collision"; this alone does not gain M2</p>
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