Kinetics

Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Kinetics
Booklet	Mark Scheme

Time Allowed: **53 minutes**

Score: **/44**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Mark
1	A	**(1)**
	Incorrect answers B – peak is too far to the right and line touches x axis C – peak is too far to the right D – lines touches x axis	

Question Number	Correct Answer	Mark
2	C	**(1)**
	Incorrect answers A – activation energy does not decrease B- activation energy does not decrease and particles do not collide with more energy D - particles do not collide with more energy	

Question Number	Correct Answer	Mark
3	D	**(1)**
	Incorrect answers A – doubling the size of particles will decrease the rate and so will decreasing the temperature B - doubling the size of particles will decrease the rate C – decreasing the temperature will decrease the rate	

Question Number	Correct Answer	Mark
4	A	**(1)**
	Incorrect answers B – is not the activation energy C – is not the activation energy D - is not the activation energy	

Question Number	Correct Answer	Reject	Mark
5	B		1

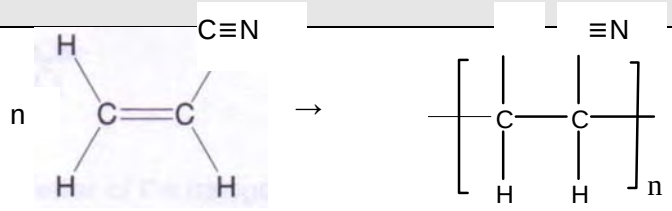
Question Number	Correct Answer	Reject	Mark
6	C		1

Question Number	Correct Answer	Reject	Mark
7	B		1

Question Number	Correct Answer	Reject	Mark
8	C		1

Question Number	Correct Answer	Reject	Mark
9 (a)	D		1

Question Number	Correct Answer	Reject	Mark
9 (b)	C		1

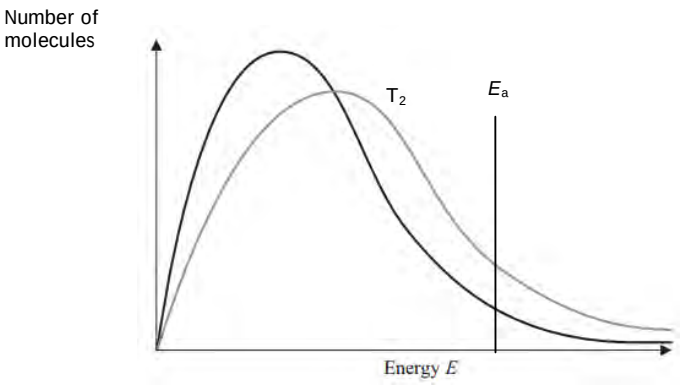
Question Number	Acceptable Answers	Reject	Mark
10 (a)	 ALLOW CN for C≡N throughout IGNORE 'connectivity' to the C≡N / CN group **First mark – M1:** Two "n" in the equation and a correct formula (molecular or structural or displayed) for propenenitrile on LHS of the equation LHS "n" must be to left of the monomer RHS "n" must be a **subscript** IGNORE Any square or round brackets around monomer on LHS **(1)** **Second mark – M2:** One correct **displayed** repeat unit (with or without a bracket or "n" shown in the equation) **(1)** **Third mark – M3:** Continuation bond at each end of the repeat unit (with or without a bracket or "n" shown in the equation) **(1)** **NOTE** M3 is awarded for the two continuation bonds, even if the repeat unit given is incorrect Polymer containing a C=C scores max **(1)** **Additional comment** Mark the three scoring points independently	No M2 mark if **more than one** repeat unit shown	**3**

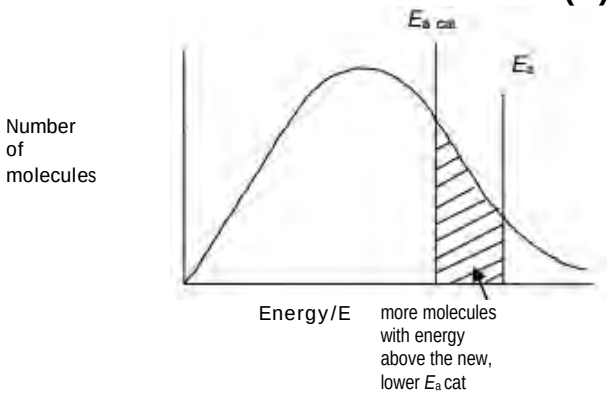
Question Number	Acceptable Answers	Reject	Mark
10 (b)	(It is an) addition reaction OR An addition polymer is made OR All the reactants are made into the desired / required product OR Only one product (is made) OR No waste products / no by-products ALLOW No 'side' products	**Just** 'all the product is useful' **Just** 'all the reactants become products' 'No product wasted'	**1**

Question Number	Acceptable Answers	Reject	Mark
10 *(c)(i)	**First mark – M1:** (Position of equilibrium shifts/'favours') to the left OR to the reactants OR to the backward reaction/direction OR to the reverse reaction/direction OR towards C_3H_6 / NH_3 / O_2 ALLOW decreases yield of products / decreases yield of CH_2CHCN / decreases yield of H_2O **(1)** **Second mark – M2:** **This mark is dependent on the correct change in THE position of equilibrium** **(i.e. (0) overall for question if states that eq'm shifts to the RIGHT)** (Forward) reaction is exothermic OR (Forward) reaction gives out heat OR Backward reaction is endothermic / takes in heat OR Reverse reaction is endothermic / takes in heat IGNORE References to just "decreasing the temperature" / "opposes the increase in temperature" **(1)** **Additional comment** JUST a statement that it "moves in / favours the endothermic direction" can get M1 ONLY IF M2 has already been awarded (as it is then clear that the candidate realises that from right to left **is** the endothermic direction).		**2**

Question Number	Acceptable Answers	Reject	Mark
10 *(c)(ii)	**First mark – M1:** (Position of equilibrium shifts/'favours') to the left OR to the reactants OR to the backward reaction/direction OR to the reverse reaction/direction OR towards C_3H_6 / NH_3 / O_2 ALLOW decreases yield of products / decreases yield of CH_2CHCN / decreases yield of H_2O **(1)** **Second mark – M2:** **This mark is dependent on the correct change in THE position of equilibrium** **(i.e. (0) overall for question if states that eq'm shifts to the RIGHT)** Right-hand side has more moles/molecules (of gas) OR Products have more moles/molecules (of gas) OR Left-hand side has fewer moles/molecules (of gas) OR Reactants have fewer moles/molecules (of gas) **NOTE:** 2nd mark awarded if mentions: **3½** moles/molecules (of gas) on LHS **and** **4** moles/molecules (of gas) on RHS **(1)**	References to ATOMS/PARTICLES, if chooses to refer to these, (instead of molecules) no 2nd mark	**2**

Question Number	Acceptable Answers	Reject	Mark
10 (d)(i)	(*y*-axis:) Fraction of molecules / number of molecules ALLOW Proportion of molecules ALLOW 'particles' instead of molecules for the label on the *y*-axis **and** (*x*-axis:) Energy / *E* / kinetic energy NOTE: **BOTH** graphs' axes (on p14 and p15 of script) need to be labelled correctly for this mark	'**atoms**' instead of molecules/particles	**1**

Question Number	Acceptable Answers	Reject	Mark
***10 (d)(ii)**	**First mark – M1:** Correct drawing of Maxwell-Boltzmann distribution at T_2 clearly identified NOTE As long as it is clear which curve the candidate has drawn, if it is correctly drawn award this mark, even if their curve is not actually labelled "T_2" **NOTE** **Peak** of candidate's curve (at the higher temperature) should be clearly **lower and** to the **right** of that at the lower temperature **(1)** **Second mark – M2:** Suitable E_a shown on graph **(1)** **Third mark – M3:** (At higher temperature) more molecules/more collisions / more particles have **energy greater than the activation energy** NOTE: Must refer to activation energy / E_a for M3 IGNORE 'more frequent collisions' **(1)**  Only M1 can be awarded if **two** E_a values drawn on graph for this part	E_a shown at peak or to the left of peak "More **atoms**"	**3**

Question Number	Acceptable Answers	Reject	Mark
10 *(d)(iii)	**First mark – M1:** E_a for the **catalysed reaction** shown to the **left** of E_a for the **un-catalysed reaction** NOTE Do not penalise again the actual position of either E_a if M2 was not awarded in Q22(d)(ii) for the same reason **(1)** **Second mark – M2:** **EITHER** (With catalyst) more molecules / more collisions / more particles have energy greater than the (new, lower) activation energy **OR** Diagram labelled as shown below NOTE If a shaded area is shown between the two E_a lines, even if it is unlabelled, award M2 NOTE ALLOW alternatives for **M2** such as "More molecules have enough energy to react (with the catalyst)" OR "More molecules are able to react at lower energies (with the catalyst)" [Unlike in Q22(d)(i), E_a doesn't HAVE to be mentioned.] **(1)**  IGNORE **Just** a statement that "a catalyst provides an alternative reaction route/pathway of lower activation energy"	Two curves shown (no M1) "More **atoms**"	**2**

(Total for Question 10 = 14 marks)

Question Number	Acceptable Answers	Reject	Mark
11 *(a)	**These marks are independent** The outer electrons are further from the nucleus / the electron being removed is further from the nucleus/ larger atomic radius (in calcium) ALLOW Ca has one more shell/ more shells (of electrons) **(1)** More shielding (in calcium) **(1)** OR Reverse argument for magnesium ALLOW Discussion based on trend going down group without specifying Mg and Ca IGNORE repulsion between shells	Larger ionic radius (in Ca) Just "Calcium is larger" Reference to molecules, delocalised electrons Just "Ca has more energy levels" Two more shells Any reference to polarising power of ions	2

Question Number	Acceptable Answers	Reject	Mark
11 (b)	Electrons are promoted/ jump / become excited to higher energy level **(1)** Electron(s) return/ fall back to lower energy level ALLOW to ground state **(1)** Release of (visible) light (energy) upon return / energy is released in visible spectrum ALLOW release of photons upon return **(1)**		3

Question Number	Acceptable Answers	Reject	Mark
11 (c)(i)	$CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$ Ignore state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
11 (c)(ii)	**Observation mark:** (Calcium nitrate) produces a **brown**/ **red-brown gas** ALLOW NO_2 for gas Fumes for gas OR (Potassium nitrate) does not produce a **brown** gas IGNORE Oxygen is given off / Gas given off relights a glowing splint **(1)** **Second mark (can also be an observation):** (Only calcium nitrate) produces the oxide OR (Only potassium nitrate) produces the nitrite OR calcium nitrate is less stable to heat OR potassium nitrate decomposes at a higher temperature/takes longer to produce oxygen **(1)** ALLOW "Calcium nitrate produces a white solid **and** potassium nitrate produces a yellow solid" as an alternative for either mark NOTE Reject comparisons with one correct and one incorrect statement (this applies to both marks)	Flame colours Reference to other incorrect products.	2

Question Number	Acceptable Answers	Reject	Mark
11 (d)(i)	Hydrogen (gas) / H_2 If name and formula are given both must be correct		1

Question Number	Acceptable Answers	Reject	Mark
11 (d)(ii)	White ppt/white solid/goes milky/goes cloudy/ white suspension **(1)** $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ **(1)** ALLOW Alternative answer White precipitate forms which dissolves with excess carbon dioxide **(1)** $Ca(OH)_2 + 2CO_2 \rightarrow Ca(HCO_3)_2$ **(1)**	White solution / any solution produced	2

Question Number	Acceptable Answers	Reject	Mark
11 (d)(iii)	(One of): $Sr(OH)_2$/$Ba(OH)_2$/$Ra(OH)_2$ OR (One of):Strontium/Barium/Radium hydroxide If name and formula given then both must be correct	SrOH/ BaOH/ RaOH Just Sr/ Ba/ Ra $Mg(OH)_2$/MgOH/ magnesium hydroxide/ $Be(OH)_2$/BeOH/ beryllium hydroxide	1

Question Number	Acceptable Answers	Reject	Mark
11 (e)(i)	White ppt/solid ALLOW White crystals **(1)** ($BaSO_4$ is insoluble but) $MgSO_4$ is (very) soluble / $MgSO_4$ gives a colourless solution/ $MgSO_4$ gives no precipitate ALLOW $BaSO_4$ does not dissolve TE on first mark if it stated that a precipitate formed even if colour is wrong/ missing **(1)**	White ppt of $BaCl_2$ / $MgCl_2$ Extra observations eg effervescence Magnesium is soluble / barium is insoluble A precipitate of magnesium sulfate forms and then dissolves Just "$MgSO_4$ is more soluble / less insoluble" Reference to solubility of chlorides There would be no reaction	2

Question Number	Acceptable Answers	Reject	Mark
11 (e)(ii)	Barium sulfate is not absorbed/ is insoluble IGNORE Comments on X-rays Barium sulfate is not digested Barium sulfate is unreactive/ does not react with stomach acids References to toxicity.	Just 'Barium'	1

Question Number	Acceptable Answers	Reject	Mark
11 (f)	**First mark:** (Increase) concentration of **HCl** **(1)** **Second mark** More particles/ moles of (HCl) in the same volume OR more (frequent/ successful) collisions Allow second mark only if factor is concentration **(1)** --- Any two from three of the following for third and fourth marks: Reduce particle size / use powder (instead of lumps)/ use finely divided (solid) **(1)** (Increases) surface area **(1)** more (frequent/ successful) collisions **(1)** ALLOW Reverse arguments	Increase concentration of $CaCO_3$/HCl **and** $CaCO_3$ /reactants Increase kinetic energy of particles Increase kinetic energy of particles	4

Question Number	Acceptable Answers	Reject	Mark
11(g)	Pressure only affects gaseous reactions/ there are no gaseous reactants (or products) /there is no significant volume change/ liquids are incompressible ALLOW pressure doesn't affect solids/ solutions Note: there are many possible correct ways of expressing the idea that pressure only affects rate of reactions involving gases. IGNORE Number of moles in reaction doesn't change		1

TOTAL FOR Q11 = 20 MARKS