How Fast? - Rates

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Rates, Equilibria & Further Organic Chemistry
Sub Topic	How Fast? - Rates
Booklet	Mark Scheme 1

Time Allowed: **46 minutes**

Score: **/38**

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	Reject	Mark
1	D		1

Question Number	Correct Answer	Reject	Mark
2	D		1

Question Number	Correct Answer	Reject	Mark
3	A		1

Question Number	Correct Answer	Reject	Mark
4	C		1

Question Number	Correct Answer	Reject	Mark
5	C		**(1)**

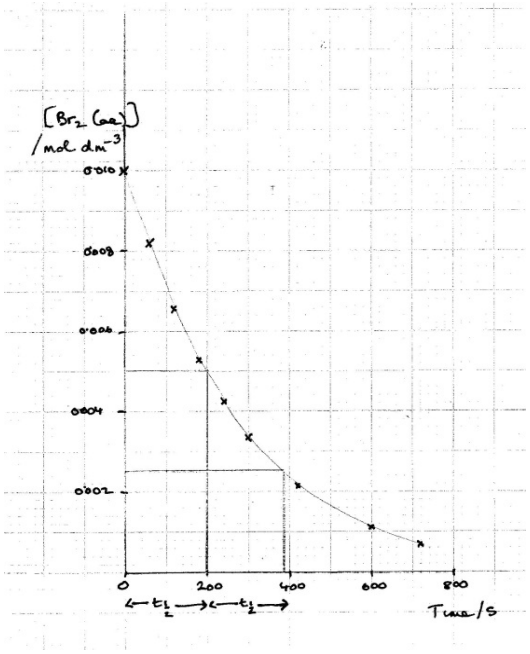
Question Number	Correct Answer	Reject	Mark
6	C		**1**

Question Number	Correct Answer	Reject	Mark
7	D		**1**

Question Number	Correct Answer	Reject	Mark
8	B		**1**

Question Number	Acceptable Answers	Reject	Mark
9a	TWO of Bromine / Br_2 by colorimetry **(1)** Carbon dioxide / CO_2 by (measurement of) gas **volume** / **mass** change **(1)** ALLOW Hydrogen ions / H^+ and / or bromide ions / Br^- By electrical conductivity **(1)** ALLOW Hydrogen ions / H^+ by pH measurement **(1)**	Dilatometry Sampling methods Br / Br^- Calorimetry Just 'gas syringe' 'measure amount of gas' 'use balance' Br_2 or bromine HCOOH	2

Question Number	Acceptable Answers	Reject	Mark
9b(i)	 Suitable scale so the points cover more than half of grid in both directions **and** axes labelled Horizontal axis labelled time /s ALLOW (s) Vertical axis labelled [Br_2] / mol dm^{-3} ALLOW mol / dm^3 [Br_2] x 10^{-3} /mol dm^{-3} **(1)** Correct plotting of **all** points with smooth curve through all points ALLOW Minor wobbles **(1)**	Non uniform scale scores 0 Br_2 for [Br_2] Straight lines between points	2

Question Number	Acceptable Answers	Reject	Mark
9b(ii)	 Any two half lives **shown on graph** **IGNORE** Third half life even if not 195 ± 15 s **(1)** Each half life 195 ± 15 s must approximately match values from graph This may be shown on the graph **(1)** Third mark is stand alone: Half life is (approximately) constant (so first order) **(1)** ALLOW Lines showing tangents at two different concentrations **(1)** Values of gradients of both tangents **(1)** Gradient (rate) is directly proportional to concentration **(1)**	200 and 400	3

Question Number	Acceptable Answers	Reject	Mark
9b(iii)	**Concentration** of methanoic acid does not change (significantly) during course of reaction (as it is so much greater than concentration of bromine)	Methanoic acid is not involved in the rds Just 'it is in excess'	1

Question Number	Acceptable Answers	Reject	Mark
9b(iv)	Rate/ r/ R = $k[Br_2]^{(1)}[HCOOH]^{(1)}$ Formulae must be correct ALLOW Upper case K for k	Omission of Rate/ r/ R Br / CHOOH /HCOH Lack of square brackets	1

Question Number	Acceptable Answers	Reject	Mark
9b(v)	$k = \frac{4.54 \times 10^{-5}}{0.01 \times 0.5}$ $= 9.08 \times 10^{-3}$ / 0.00908 **(1)** Mark units independently but must match rate equation in 16(b)(iv) $dm^3\ mol^{-1}\ s^{-1}$ (in any order) **(1)** TE on rate equation IGNORE SF NOTE If first order then units are s^{-1}		2

(Total for Question 9 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
10(a)	**The first two marks can be scored from a diagram or a written account** Suitable reaction vessel e.g. side arm conical flask / flask with delivery tubing attached via bung / side arm boiling/test tube / boiling/test tube with delivery tubing attached via bung **(1)** Method of gas collection e.g. gas syringe / upturned measuring cylinder/burette over water **Allow** this as a label on a poorly drawn diagram **(1)** Measure volume collected at time intervals / time taken to collect fixed volume **Allow** mention of volume and time **Allow** amount of gas and time **Ignore** measure time taken for reaction to go to completion **(1)** **OR** A suitable open reaction vessel (but plugged with cotton wool) **(1)** Use of balance **(1)** Measure the mass at various time intervals / at a fixed time on a balance **Allow** mention of mass (loss) and time **(1)** **Ignore** heating	Diagram of apparatus that will not work eg delivery tube starting in solution or apparatus not sealed for first mark only Measure rate at which gas is produced	**3**

Question Number	Acceptable Answers	Mark
10(b)(i)	Any linked pair of responses. In each pair, the 2nd mark is dependent on the 1st mark being awarded. **EITHER** Reaction is endothermic /energy taken in / temperature **falls** **Allow** just "lower temperature" **Ignore** room temperature falls **(1)** Decreases rate of reaction **(1)** **OR** There is loss of product/gas before the apparatus is sealed **(1)** This is **greater** because the reaction is at a higher concentration (of A) **(1)** **OR** Active sites/surface (area) on catalyst full/blocked/saturated **(1)** Because the reaction is at a higher concentration (of A)/ decreases rate of reaction **(1)** **Ignore** references to experimental error **Ignore** comparisons of concentrations of A and B **Ignore** any reference to side-reactions	**2**

Question Number	Acceptable Answers	Mark
10(b) (ii)	0 order **(1)** As increase/change in concentration does not affect the rate /rate is independent of [A] **Allow** graph is a horizontal line / has zero gradient **(1)** **Ignore** graph is a straight line **Ignore** just 'there is no change in the rate' / 'rate is constant' / gradient remains constant	**2**

Question Number	Acceptable Answers	Mark
10(c)(i)	**EITHER** increases reliability improves validity (of the data obtained) / confirms the initial result / to check for anomalous results **Ignore** References to average/precision/accuracy **OR** to determine order w.r.t B and/or X / to determine order w.r.t reactants / substances / to find overall order / to see the effect of B and/or X on the rate/ to see the effect of reactants/ substances on the rate/ to determine rate equation / to calculate *k* **Allow** to find out which species are in the rate determining step	**1**

Question Number	Acceptable Answers	Mark
10(c)(ii)	2nd order w.r.t B **(1)** (Compare expt 1 & 2 when [X] is constant), as [B] triples so rate increases by a factor of 9 **(1)** First order w.r.t X **(1)** **EITHER (using experiments 1 and 3 or 1 and 4)** as [**B**] quadruples so rate should increase by a factor of 16 but increases by a factor of 32 / additional increase of x 2 due to doubling of [X] (hence first order w.r.t X) **OR (using experiments 2 and 3 or 2 and 4)** as [B] x4/3 (1.333) so rate should increase by a factor of 16/9 (1.778) but increases by 3.556 / additional increase of x2 due to doubling of [X] (hence first order w.r.t X) **Allow** these explanations shown as equations If C used instead of X, allow both marks for order and explanation **(1)** **Allow** TE on order w.r.t A and B	**4**

Question Number	Acceptable Answers	Mark
10(c)(iii)	Rate=k[B]^2[X] / Rate=k[A]^0[B]^2[X] **Allow** r/R for rate and *K* for *k* **Allow** TE from b(ii) and c(ii)	**1**

Question Number	Acceptable Answers	Mark
10(c)(iv)	k = rate/[B]^2[X] = 0.08/(0.1x0.1x0.2) = 40 **(1)** dm^{6}mol^{-2}s^{-1} **Allow** units in any order **(1)** **Allow** use of data from experiments 1, 2 & 4 **Allow** TE from c(iii)	**2**

Question Number	Acceptable Answers	Mark
10(d)	**Correct feature – two from** Mechanism does involve (formation of) a transition state **Allow** mechanism does involve the (formation of) an intermediate **Allow** transition/intermediate step **(1)** Second order overall / S_N2 /both halogenoalkane and hydroxide ions involves in slow step/rds/1st Step **(1)** Correct curly arrow from C-Br bond to Br **(1)** Transition state has a negative charge / correct charge Or Charges on all species are correct **(1)** **Ignore** references to stereochemistry **Ignore** references to final product correct/ lone pairs correct **Incorrect features – two from** Curly arrow should go from OH^- to carbon (attached to Br as it represents movement of a lone pair of electrons) / OH^- should give electrons rather than accept them **Allow** the arrow between C and O should be in the opposite direction **(1)** Bonds to OH and Br should be partial bonds /dotted lines (in transition state as insufficient electrons for (five) complete bonds) / carbon can only form four full bonds **(1)** **Allow** Dipole/partial charges on C-Br not shown **(1)** **Ignore** Mechanism should be 1 step not 2 steps for S_N2 **Ignore** there should be a curly arrow from C-Br bond to Br in the transition state	**4**

Total for Question 10 = 19 marks