CAMBRIDGE INTERNATIONAL AS & A LEVEL CHEMISTRY · 9701

CHEMISTRY



MARK SCHEME

8 REACTION KINETICS

SCORE	PERCENTAGE
/	%

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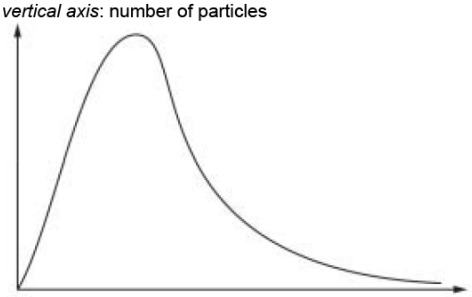
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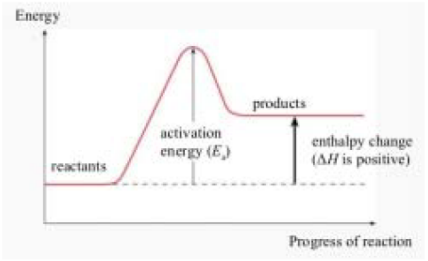
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Paper 1 Multiple Choice Answers: Reaction Kinetics

Question	Paper	Q. No.	Answer
410	9701_m21_qp_12	10	C
411	9701_s21_qp_12	11	C
412	9701_s17_qp_11	11	B
413	9701_w17_qp_11	7	D
414	9701_w17_qp_12	10	D
415	9701_m22_qp_12	15	A
416	9701_m22_qp_12	16	B
417	9701_m21_qp_12	11	D
418	9701_s21_qp_11	5	B
419	9701_s21_qp_13	12	B
420	9701_s20_qp_11	6	C
421	9701_m19_qp_12	1	B
422	9701_s19_qp_11	1	B
423	9701_s17_qp_13	11	B
424	9701_s16_qp_12	1	D
425	9701_w16_qp_11	1	C
426	9701_w16_qp_12	1	D
427	9701_s15_qp_12	11	B
428	9701_w15_qp_12	11	C
429	9701_s21_qp_11	11	C
430	9701_s21_qp_12	7	D
431	9701_w21_qp_11	11	D
432	9701_w21_qp_13	11	D
433	9701_w20_qp_11	11	C
434	9701_s19_qp_12	1	B
435	9701_s19_qp_12	11	B
436	9701_w19_qp_11	1	C
437	9701_w19_qp_12	1	D
438	9701_s18_qp_11	4	C
439	9701_s18_qp_12	11	B
440	9701_s18_qp_13	11	D
441	9701_w18_qp_11	11	C
442	9701_w18_qp_12	10	A
443	9701_w18_qp_12	11	A
444	9701_s17_qp_12	11	C
445	9701_w17_qp_11	10	C
446	9701_w17_qp_12	11	A
447	9701_s16_qp_11	11	C
448	9701_w16_qp_11	11	C
449	9701_w16_qp_12	2	C
450	9701_s15_qp_11	1	D
451	9701_s15_qp_13	1	C

32. 9701_m21_ms_22 Q: 1

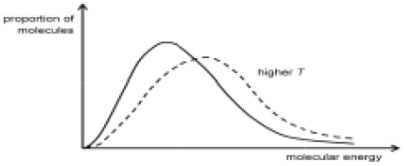
Question	Answer	Marks
(a)(i)	*vertical axis*: number of particles  *horizontal axis:* (kinetic / particle) energy **M1:** shape of curve correct **M2:** labelled axes	**2**
(a)(ii)	Labelled line (**T2**) with lower peak to right of original	**1**
(b)(i)	Any two from: • no VdW forces present / no forces of attraction between particles • (ideal gas) particles have no / negligible volume (compared to container) • collisions between (ideal gas) particles / walls of container are perfectly elastic • (ideal gas) particles behave as rigid spheres	**2**
(b)(ii)	**M1:** moles of krypton = 2.00 ÷ 83.8 (= 0.0239 mol) **M2:** conversion of value into consistent units for $pV = nRT$ **M3:** $p = \frac{M1 \times 8.31 \times 393}{5.00 \times 10^{-3}} = 15600$ Pa	**3**

Question	Answer	Marks
(b)(iii)	**M1:** low pressure **AND** high temperature **M2:** Either of: • volume of particles is negligible (compared to volume of container) • VdW forces are insignificant (owing to high kinetic energy of particles)	**2**
(c)(i)	 **M1:** end higher than start **AND** 'hill' for E_a **M2:** E_a **AND** ΔH labelled	**2**
(c)(ii)	• rate increases • (increase in temperature means) more particles have energy ⩾ activation energy • frequency of successful collisions increases	**2**

33. 9701_s17_ms_22 Q: 3

(a)	(+) 103	**1**
(b)(i)	general shape of the curve and peak are displaced to right of original and starts at origin	**1**
	the peak is lower and curve crosses once only finishing **above** original	**1**
(b)(ii)	rate increases AND correct explanation in terms of 'more collisions'	**1**
	at higher T area above *E*a is greater / more molecules with $E \geqslant E$a	**1**
	higher frequency of successful collisions OR more successful collisions per unit time / higher chance of successful collisions per unit time / higher proportion of successful collisions per unit time	**1**
(b)(iii)	increases (%) decomposition (of HBr)	**1**
	(increasing T) shifts equilibrium to the right / in the forward direction / endothermic direction / towards $H_2 + Br_2$	**1**
	to oppose the change or oppose the increase in temperature OR to absorb (additional) energy / heat OR to decrease the temperature	**1**
(b)(iv)	H-I bond strength less than H-Br OR less energy needed to break H-I *ora*	**1**
	I (atom) is big(ger) (than Br) OR I (atom) has more shielding (than Br) *ora*	**1**
	Br (atom) has greater (%) orbital / outer shell overlap OR attraction (of nucleus in iodine) for shared (pair of) electrons is weak(er) OR attraction (of nucleus in iodine) for bonding pair (or electrons) is weak(er) *ora*	**1**
(c)(i)	H_2 = 0.015 (mol)	**1**
	HC*l* = 0.27 (mol)	**1**
(c)(ii)	HC*l* = 9/10 AND xH_2 = 1/20 AND Cl_2 = 1/20 OR HC*l* = 0.9(0) AND H_2 = 0.05 AND Cl_2 = 0.05	**1**
(d)(i)	$(K_p =) \frac{pH_2 \times pCl_2}{pHCl^2}$	**1**
(d)(ii)	equal number of moles (of gas) on either side (of equation) / (total) pressure cancels	**1**
(d)(iii)	4.649×10^{-3}	**1**
	Total:	**18**

34. 9701_w17_ms_21 Q: 1

(a)(i)	energy needed / required to break a mole of (covalent) bonds	1
	(All) in the gaseous state	1
(a)(ii)	–92 = {944 + 3(436)} – 6E(N–H)	1
	E(N–H) = (+)390.7 / 390.67 / 391	1
(b)(i)	general shape of the curve and peak are displaced to right of original line and starts at origin	1
	the peak is lower and curve crosses once only finishing **above** original line	1
		
(b)(ii)	rate increases AND explanation in terms of collisions	1
	(at higher T) area above E_a is greater OR (at higher T) more molecules with $E \geqslant E_a$	1
	higher frequency of successful collisions OR more successful collisions per unit time / higher chance of successful collisions per unit time / higher proportion of successful collisions per unit time	1
(b)(iii)	reduces yield (of ammonia).	1
	(increasing *T*) shifts equilibrium (reaction) to the left / in the reverse direction / towards N_2 and H_2 / towards reactants / in endothermic direction	1
	to oppose the change OR oppose the increase in temperature OR to absorb the (additional) heat / energy OR decrease the temperature	1
(c)(i)	N_2 = 0.850 (mol)	1
	H_2 = 2.55 (mol)	1
(c)(ii)	n_{TOTAL} = 3.7 mol	1
	mol fraction of NH_3 = 0.3 / 3.7	1
	$pNH_3 = 2 \times 10^7 \times (0.3 / 3.7) = 1.62 \times 10^6$	1
(d)(i)	$K_p = \frac{pNH_3^2}{pN_2 \times pH_2^3}$	1
(d)(ii)	$K_p = 1.(00) \times 10^{-16}$	1
	Pa^{-2}	1
(d)(iii)	(yield of ammonia) increases	1
	(value of K_p) stays the same	1

35. 9701_S15_ms_21 Q: 2

(a) (i)	Straight line drawn horizontally from same intercept	[1]
(ii)	T_1 because it shows greatest deviation/furthest from ideal	[1]
(iii)	reducing T (reduces KE of particles) so intermolecular forces of attraction become more significant	[1]
(iv)	greatest deviation is at high pressure increasing pressure decreases volume so volume of particles becomes more significant ora	[1] [1]
(b)	Mass of air = 100×0.00118 = 0.118 g Mass of flask = 47.930 – 0.118 = **47.812** g Mass of **Y** = 47.989 – 47.812 = **0.177** g $pV = nRT = \frac{m}{M_r} RT$ $M_r = \frac{mRT}{pV} = \frac{0.177 \times 8.31 \times 299}{1 \times 10^5 \times 100 \times 10^{-6}}$ = **44.0** (43.979 to 2 or more sf)	[1] [1] [1] [1]
(c) (i)	strong <u>triple</u> bond	[1]
(ii)	high temperature (needed for reaction between N_2 and O_2)	[1]
(iii)	$2NO + 2CO \rightarrow N_2 + 2CO_2$ **OR** $2NO + C \rightarrow N_2 + CO_2$	[1]
(iv)	$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$	[1]
(v)	$NO + ½O_2 \rightarrow NO_2$ $NO_2 + SO_2 \rightarrow NO + SO_3$ **OR** $NO_2 + SO_2 + H_2O \rightarrow NO + H2SO_4$	[1] [1]

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