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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 5421

CHM2 Foundation Physical and Inorganic Chemistry

Mark Scheme

2008 examination - June series

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CHM2

Question 1

(a)	(i)	$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$	1	Accept multiples
		$TiCl_4 + 2H_2 \rightarrow Ti + 4HCl$	1	Accept multiples Not [H] Penalise CL, NA, h once
(a)	(ii)	Hydrogen/it is explosive/ HCl is an acid/forms an acid/ hydrogen stored under high pressure/ HCl corrosive/ HCl toxic/ HCl reacts with metal	1	*Not flammable or dangerous alone* *Not HCl produced*
(b)		Titanium carbide forms/TiC forms/ Ti goes brittle	1	Not Ti reacts with C
(c)	(i)	$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ Or $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$	1	Accept multiples *Not equations from Fe_3O_4 or FeO* Accept in range 1000-2000^{0}C Do not accept heat
		High temperature/ 1500^{0}C	1	
(c)	(ii)	Limestone/calcium carbonate	1	Must have name *Penalise contradiction of name and formula*
		$CaCO_3 \rightarrow CaO + CO_2$	1	
		$CaO + SiO_2 \rightarrow CaSiO_3$	1	Allow $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$ For 2 marks Allow multiples
(c)	(iii)	roads/ breezeblocks/ concrete slabs/ cement/ tarmac/ ballast for railway sleepers/ insulation blocks/ hard core/ aggregate	1	*Not just building materials/ blocks/ bricks*
(d)	(i)	$Al^{3+} + 3e^- \rightarrow Al$	1	Accept multiples
		$2O^{2-} \rightarrow O_2 + 4e^-$	1	*Not O*
(d)	(ii)	Lowers melting point/ solvent/ dissolves bauxite/ reduces temperature	1	*Not lowers mp of Al* Lowers mp of Al_2O_3 is OK Ignore temps if quoted *Not conductor/ catalyst*
(e)		Saves <u>energy</u>/ saves <u>electricity</u>	1	*Ignore cost /mining/ melting* Can have <u>comparison</u> answers w.r.t electrolysis

Question 2

(a)	Enthalpy <u>change</u> when 1 mole of substance	1	Accept heat energy change
			Not in air
	Completely burns or reacts in oxygen/ burns in XS oxygen	1	
			298K and 100kPa
	Under standard conditions	1	Accept 1 bar *Not 1 atm*
(b)	<u>Enthalpy change is independent of the route taken</u>	1	Accept heat energy change
(c)	(ΔH_f)= $\Sigma\Delta H$reactants - $\Sigma\Delta H$ products	1	If+ 108 give 3 ticks. If wrong work back *Ignore units even if wrong* –108 = 1 mark
	= (-394 x 4) + (-286 x 3) – (- 2542)	1	
	= -2434 - - 2542		
	= (+) 108 (kJmol^{-1})	1	
	allow ΔH_c C_4H_6 = $\Sigma\Delta H$*prodts*- $\Sigma\Delta H$reactts or good cycle as alternative to mark 1		*If AE for mark 2 mark on for mark 3*
(d)	ΔH/-240 = ΣBonds broken–Σbonds made	1	
	-240 = (6 x 412) + 2 C=C + 348 + (2 x 436) – [(3 x 348) + (10 x 412)]	1	Allow -240 = 2C=C + 872 – (696 + 1648)
	-240 = 3692 + 2C=C -5164		If 616 give 3 ticks If 1232 give 2 ticks *Ignore units* Last mark is for ÷2 –616 = max 1
	2 C=C = 1232		
	C=C = 616 (kjmol^{-1})	1	

Question 3

(a)		Gains/ receives./ accepts/ takes electrons	1	*Not pairs of electrons*
(b)	(i)	$H_2SO_4 + 2H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ or $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$	1	allow multiples
(b)	(ii)	$2Br^- \rightarrow Br_2 + 2e^-$	1	allow multiples
(b)	(iii)	$H_2SO_4 + 2H^+ + 2Br^- \rightarrow SO_2 + Br_2 + 2H_2O$ or $SO_4^{2-} + 4H^+ + 2Br^- \rightarrow SO_2 + Br_2 + 2H_2O$	1	allow multiples *penalise BR, br, h once in b(i), (ii) and (iii)* allow equation with 2HBr accept equation with NaBr and spectator sodium ions on RHS
(b)	(iv)	Reducing agent/ electron donor/ reduces sulphuric acid/ reduces H_2SO_4	1	Not electron proton donor ie contradictions
(c)	(i)	Cl^- or F^- or chloride or fluoride	1	*Not chlorine* *Not Cl* *Not fluorine* *Not F* *Not Chlorine ion* *Not fluorine ion*
(c)	(ii)	$Cl^- + H_2SO_4 \rightarrow HCl + HSO_4^-$ or $F^- + H_2SO_4 \rightarrow HF + HSO_4^-$ or $NaCl + H_2SO_4 \rightarrow HCl + NaHSO_4$ or $NaF + H_2SO_4 \rightarrow HF + NaHSO_4$ or $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$ or $2NaF + H_2SO_4 \rightarrow 2HF + Na_2SO_4$ etc	1	Allow multiples
(c)	(iii)	Acid/ proton donor	1	
(d)		Oxidising agent/ electron acceptor/ Oxidises NaBr/ oxidises Br^-	1	*Not electron pair acceptor*
(e)	(i)	Cl^- or or chloride	1	*Not chlorine* *Not Cl* *Not Chlorine ion*
(e)	(ii)	$Ag^+ + Cl^- \rightarrow AgCl$ $AgNO_3 + Cl^- \rightarrow AgCl + NO_3^-$	1	Accept multiples
(e)	(iii)	F^- or fluoride	1	*Not fluorine* *Not F* *Not fluorine ion*

Question 4

(a)		Rate of forward reaction = rate of backward reaction	1	Accept speed of F reaction = speed of B reaction Accept rate of both rxns is same *Not speeds are constant*
(b)	(i)	Reaction is endothermic	1	*If exo CE = 0*
		System moves to absorb heat/ oppose or counter change/ decrease temp	1	
(b)	(ii)	Cost (of energy) is high/ expensive/ amount of energy is high Or safety factor with a reason	1	*Not dangerous*
(c)		Decrease	1	If trend wrong CE = 0 *If blank mark on*
		2 moles on left and 4 moles on right/ more moles on right/ goes to side with more moles	1	*If no's they must be correct*
		System opposes change/ increases pressure	1	
(d)		Changes/ speeds up/ increases the rate of both the forward and backward reactions	1	Look for rate/ speed and change/ increase rate
		equally	1	Dependant on first mark

Question 5

(a)	Activation energy is the <u>minimum</u> energy needed	1	Accept lowest amount
	for a reaction to occur or start / successful collision	1	
(b)	**Q** = most probable/ likely/ common/ abundant energy of molecules or modal energy	1	*<u>Not</u> energy most molecules have*
	Area under curve represents (<u>total) number/ amount of molecules</u>	1	*Penalise atoms once*
	Curve starts at the origin since all molecules have some energy/ no molecules have no energy (Do not allow 'if there are no molecules there will be no energy')	1	
	(very) few/ small no of molecules have high energy/ energy greater than E_a	1	
(c)	Curve becomes flatter /lower	1	can get these 2 marks from a diagram if both curves drawn *ignore wider/ spread out*
	and shifts to right	1	
	Area does not change	1	
	E_a does not change	1	
	Q is higher / increases/ to the right	1	'Many' dependant on second mark
	(Increasing temp increases rate since there are) <u>many</u>	1	
	more molecules/collisions with E >E_a / more successful collisions/ more molecules with enough energy to react	1	
(d)	Catalyst lowers activation energy More molecules have E> E_a / more successful collisions allow alternative route /forms intermediate/ surface	2	Allow any 2 of 3 points