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OCR

RECOGNISING ACHIEVEMENT

How far, How fast?

Mark Scheme 2613/01
June 2001

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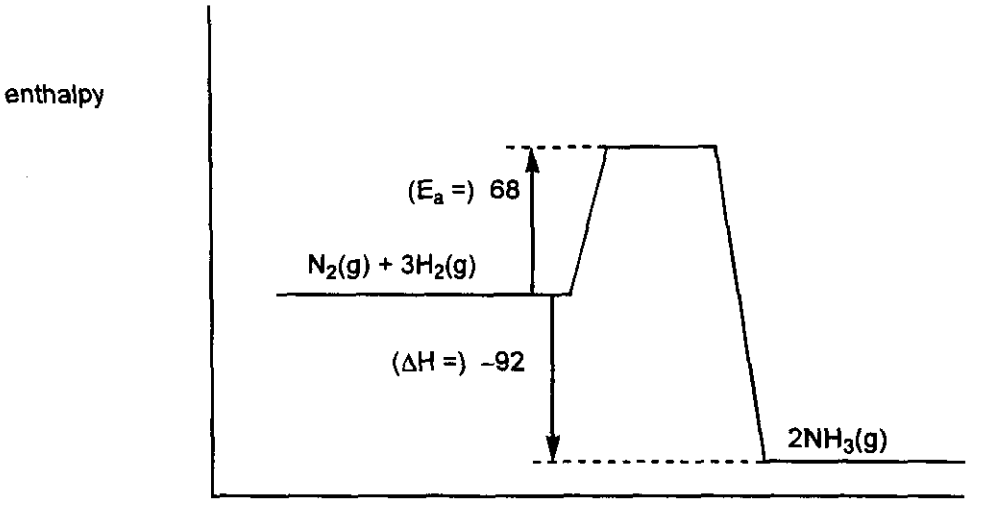
	ora = or reverse argument

Question	Expected Answers	Marks
1 (a) (i)	the enthalpy change when 1 mole (in words) of compound/substance ✓ [N.B. NOT element in its standard state, and NOT 1 mol of elements, if a compound is being made] (is formed from its) elements under standard conditions *or* at 100 kPa and a stated temperature *or* at room temperature and pressure ✓	[2]
(ii)	$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ *balanced for 1 mole of water* ✓ *state symbols (u/c -anything on left, but has to be H_2O**(l)** on RHS)* ✓	[2]
(b)	$x - 75 - 2(286) = -394$ [x = 75 + 572 - 394] *(x 2)* ✓ *(correct +/- signs)* ✓ x = (+)**253** (kJ mol^{-1}) ✓ecf *correct ans ⇒ [3] marks.* *Award [2] for any of the following: -33, +103, -253, -891, +1041* *Award [1] for any of the following: +33, -183, -605, +755, -1041*	[3]
(c)(i)	 *look for:* *ΔH shown as exothermic or – 92 kJ mol^{-1}* ✓ *E_{act} or 68 kJ mol^{-1} from reactants to trans. state* ✓ *product labelled correctly **after** transition state* ✓	[3]
(ii)	92 + 68 =**160** (kJ mol^{-1}) ✓ (no ecf)	[1]
		total 11

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Question	Expected Answers	Marks
2 (a)	$C_6H_6(l) + 7\frac{1}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$ (or 15/2) *Correct formulae and state symbols* ✓ *balanced for 1 mole of C_6H_6* ✓	[2]
(b)	x - 3267 = 3(-1301) *(x 3)* ✓ *(correct +/- signs)* ✓	
	x = **-636** (kJ mol^{-1}) ✓ecf	
	correct ans ⇒ [3] marks. *Award [2] for any of the following: +636, +1966, ±7170, +665* *Award [1] for any of the following: -1966, ±4568, -665* * ***If no other mark has been awarded***, *you could award [1] for 3 x (-)1301*	[3]
(c) (i)	(rate) increases ✓ more molecules have E > E_a *or* enough energy to react (at higher T) ✓ collision rate increases (with T) *or* there are more (effective) collisions ✓ *N.B. there is no mark for "molecules go faster/have more energy"*	[3]
(ii)	(rate) increases ✓ (because they are closer together) molecules collide more often *or* more collisions *or* more molecules in contact with the catalyst ✓ *N.B. no mark for molecules go faster/have more energy*	[2]
(d) *	it's a catalyst *or* it speeds up the reaction ✓ by lowering E_{act} *or* providing alternative route with lower energy *or* adsorbs/forms (temporary) bonds with the reagents ✓ *N.B. no mark for "provides surface" or "extra surface area"*	[2] total 12

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Question	Expected Answers	Marks
3 (a)	• forward rate = reverse rate (***not*** *concentration of reactants and products are equal)* • can be approached from either direction *or* reversible reaction *or* (constant) change from reactants to products and vice versa • no change in overall macroscopic properties (*or* one specified property, e.g. colour/concentration) *or* appears to have stopped • takes place in a closed system *(any two bullet points)* ✓✓	[2]
(b)	a change in conditions *or* a disturbance will cause a shift in the (position of) equilibrium ✓ in the direction that minimises/opposes/reduces/attempts to balance out/ the effect of the change ✓ * *N.B. do not accept "cancels" or "equals" or "balances" or "restores" without the "attempt"*	[2]
(c)	solution would turn yellow (allow yellow-green) ✓ *(do not allow this mark if candidate says it goes yellow and then back to green again!)* (increasing/added $[H^+]$ pushes) the equilibrium to left hand side *or* equilibrium shifts to form more HIn ecf ✓ *ecf: if candidate states that the colour goes blue, then the first mark is lost, but the second can be awarded for stating that the eqm. goes to the* ***right***	[2]
(d)	(colour goes from yellow to) green u/c ✓ then to blue (allow blue-green) ✓ *(do not allow this mark if candidate says it goes blue and then back to green again!)* *N.B. allow e.c.f. for* ***both*** *these marks as follows:* * *if candidate has said in (c) that colour goes blue, then these two marks are for (blue to) green [1]; and yellow(-green) [1] (don't allow "blue" in both!)* * OH^- reacts with/removes H^+ (*or* equation) *or* is a proton acceptor *or* neutralises the acid ✓ *N.B. not just "OH^- is a base"* shifting the equilibrium to the right hand side *or* equilibrium shifts to form more In^- ecf ✓ *(the word "equilibrium" need only appear once in parts (c) and (d). If it is omitted from* ***both*** *(c) and (d), deduct [1] only. If it is omitted from only* ***one*** *part, allow full marks (as long as the chemistry is correct!))*	[4] total 10

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Question	Expected Answers	Marks
2 (a)	$C_6H_6(l) + 7\frac{1}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$ (or 15/2) *Correct formulae and state symbols* ✓ *balanced for 1 mole of C_6H_6* ✓	[2]
(b)	x - 3267 = 3(-1301) *(x 3)* ✓ *(correct +/- signs)* ✓	
	x = **-636** (kJ mol^{-1}) ✓ecf	
	correct ans ⇒ [3] marks.	
	Award [2] for any of the following: +636, +1966, ±7170, +665	[3]
	Award [1] for any of the following: -1966, ±4568, -665	
*	***If no other mark has been awarded**, you could award [1] for 3 x (-)1301*	
(c) (i)	(rate) increases ✓	
	more molecules have E > E_a *or* enough energy to react (at higher T) ✓	
	collision rate increases (with T)	
	or there are more (effective) collisions ✓	
	N.B. there is no mark for "molecules go faster/have more energy"	[3]
(ii)	(rate) increases ✓	
	(because they are closer together) molecules collide more often	
	or more collisions *or* more molecules in contact with the catalyst ✓	[2]
	N.B. no mark for molecules go faster/have more energy	
(d)	it's a catalyst *or* it speeds up the reaction ✓	
*	by lowering E_{act} *or* providing alternative route with lower energy	
	or adsorbs/forms (temporary) bonds with the reagents ✓	
	N.B. no mark for "provides surface" or "extra surface area"	[2]
		total 12

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Question	Expected Answers	Marks
3 (a)	• forward rate = reverse rate (***not*** *concentration of reactants and products are equal)* • can be approached from either direction *or* reversible reaction *or* (constant) change from reactants to products and vice versa • no change in overall macroscopic properties (*or* one specified property, e.g. colour/concentration) *or* appears to have stopped • takes place in a closed system *(any two bullet points)* ✓✓	[2]
(b)	a change in conditions *or* a disturbance will cause a shift in the (position of) equilibrium ✓ in the direction that minimises/opposes/reduces/attempts to balance out/ the effect of the change ✓ * *N.B. do not accept "cancels" or "equals" or "balances" or "restores" without the "attempt"*	[2]
(c)	solution would turn yellow (allow yellow-green) ✓ *(do not allow this mark if candidate says it goes yellow and then back to green again!)* (increasing/added $[H^+]$ pushes) the equilibrium to left hand side *or* equilibrium shifts to form more HIn ecf ✓ *ecf: if candidate states that the colour goes blue, then the first mark is lost, but the second can be awarded for stating that the eqm. goes to the* ***right***	[2]
(d)	(colour goes from yellow to) green u/c ✓ then to blue (allow blue-green) ✓ *(do not allow this mark if candidate says it goes blue and then back to green again!)* *N.B. allow e.c.f. for* ***both*** *these marks as follows:* * *if candidate has said in (c) that colour goes blue, then these two marks are for (blue to) green [1]; and yellow(-green) [1] (don't allow "blue" in both!)* * OH^- reacts with/removes H^+ (*or* equation) *or* is a proton acceptor *or* neutralises the acid ✓ *N.B. not just "OH^- is a base"* shifting the equilibrium to the right hand side *or* equilibrium shifts to form more In^- ecf ✓ *(the word "equilibrium" need only appear once in parts (c) and (d). If it is omitted from* ***both*** *(c) and (d), deduct [1] only. If it is omitted from only* ***one*** *part, allow full marks (as long as the chemistry is correct!))*	[4] total 10

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Question	Expected Answers	Marks
4 (a)	a strong acid is completely ionised/dissociated (to $H^+(aq)$) *or* gives 1 mol of $H^+(aq)$ for each 1 mol of HA ✓ a weak acid is incompletely ionised/dissociated (NOT unionised) *or* gives less than 1 mol of $H^+(aq)$ for each 1 mol of HA ✓ *N.B. if neither of the above two marks can be awarded, you can award [1] for the statement that "strong acids donate protons/H+ more readily than weak acids*	[2] [1]
(b) (i)	$CaCO_3 + 2HA \longrightarrow CaA_2 + H_2O + CO_2$ ✓ *or* $CaCO_3 + 2H^+ \longrightarrow Ca^{2+} + H_2O + CO_2$ *or* $CO_3^{2-} + 2H^+ \longrightarrow H_2O + CO_2$	
(ii)	• (average) energy/speed/movement of molecules/particles increases with temperature • more (molecules) have $E > E_a$ (at higher T) *or* have enough energy to react *N.B. do not allow this point if candidate has stated that the E_a decreases with temperature* • activation energy is the minimum energy molecules need in order to react • collision rate *or* number of collisions increases (with T) *(any three bullet points)*✓✓✓ *N.B. the first two bullet points could be read into two labelled Boltzmann distribution curves, showing E_a*	[3] total 6

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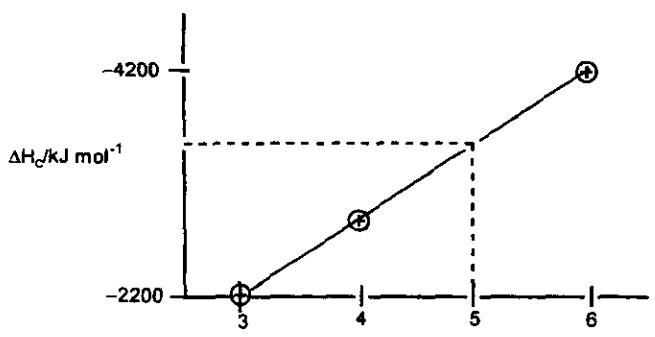
Question	Expected Answers	Marks
5 (a) (i)	the energy/enthalpy/heat required to break ✓ 1 mole of bonds *or* a bond per molecule in 1 mole ✓ *N.B. do not allow "(energy needed to break the bonds in) 1 mole of compound"*	[2]
(ii)	¼CH_4(g) ⟶ ¼C + H *(i.e. balanced for 1 mol of H)* ✓✓✓ *If the above three marks cannot be awarded (this is more than likely!), allow the following:* Any equation with CH_4(g) on the left hand side ✓ Any equation showing the breaking of a CH bond, e.g. C + 4H *or* CH_3 + H on the right hand side ✓	[3]
(b)	total BE on left = 2(C-C) + 8(C-H) + 5(O=O) = +6488 kJ ✓ total BE on right = 6(C=O) + 8(O-H) = +8542 kJ ✓ *N.B. if neither of these two marks can be awarded, you could award [1] if **all** of the correct multipliers (2, 8, 5, 6, 8) have been used.* ΔH = 6488-8542 = **-2054** (kJ mol^{-1}) ✓ecf *([3] for correct ans)* *(ecf: award the mark for correctly taking **their** total BE on right from **their** total BE on left. **Not** vice versa. If you cannot clearly see which is BE on right and which is BE on left, don't award this mark)*	[3]
(c) (i)	*either:* average bond energies are not applicable to particular bonds *or:* ΔH_c is for H_2O**(l)**, whereas bond energies are for gases ✓ *N.B. ignore any ref. to changes in conditions/temperature etc.*	[1]
(ii) *	 *plotting of points **and** a straight line* ✓	[1]
(iii)	−3450 to −3550 (kJ mol^{-1}) (ignore absence of sign, but do not allow +)✓ (allow e.c.f. - correct interpretation of incorrect graph)	[1]
(iv)	Successive members/molecules/compounds/formulae increase by a regular/fixed/the same amount (of C and/or H) *or* by a CH_2 group ✓	[1] **12 max 11**

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Question	Expected Answers	Marks
6 (a)	• mention of **two** of the following *as pollutants*, or *as products of combustion* or *as being present in exhaust gases*: carbon monoxide, nitrogen monoxide, nitrogen dioxide, unburned hydrocarbons (ignore any ref. to sulphur compounds) • heterogeneous (catalysis) (***not*** *heterolytic!*) • needs a high temperature • (reactants) adsorbed onto the catalyst's surface • weakly/temporarily bonded to the catalyst • bonds in reactants are weakened • (products easily) desorbed after reaction *or* lost/released from surface • description of how one of the pollutants undergoes transformation into harmless products, e.g. $CO + NO \longrightarrow CO_2 + \frac{1}{2}N_2$ (*or* $2CO + O_2 \longrightarrow 2CO_2$ *or* $2NO \longrightarrow N_2 + O_2$ *or* h/c + $O_2 \longrightarrow CO_2 + H_2O$) (*or* in words - equation does not need to be balanced) *any five bullet points* ✓✓✓✓✓ *Q of WC:* Look for two things here; the overall account must read clearly, and make sense grammatically (ignore spellings), and in addition at least **one** of the following words should be used correctly in a suitable context: heterogeneous, catalyst, adsorption, desorption., oxidation, reduction *Indicate this mark as* Q✓	[6]
(b)	• Haber process converts nitrogen/N_2 (from the air hence cheap and plentiful) into ammonia/NH_3 *or* in an (unbalance) equation *ammonia is used* • as a refrigerant *and to make* • fertilisers • such as ammonia itself, ammonium sulphate *or* other ammonium salt *or* urea etc. • which are needed for more crops/food),. *and nitric acid, which is used to make* • explosives *or* a named N-containing explosive, • polyamides/nylon, • dyes etc. *any 4 bullet points* ✓✓✓✓	[4] total 10

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