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Subject: How Far, How Fast?

Code: 2813/01

Session: June

Year: 2002

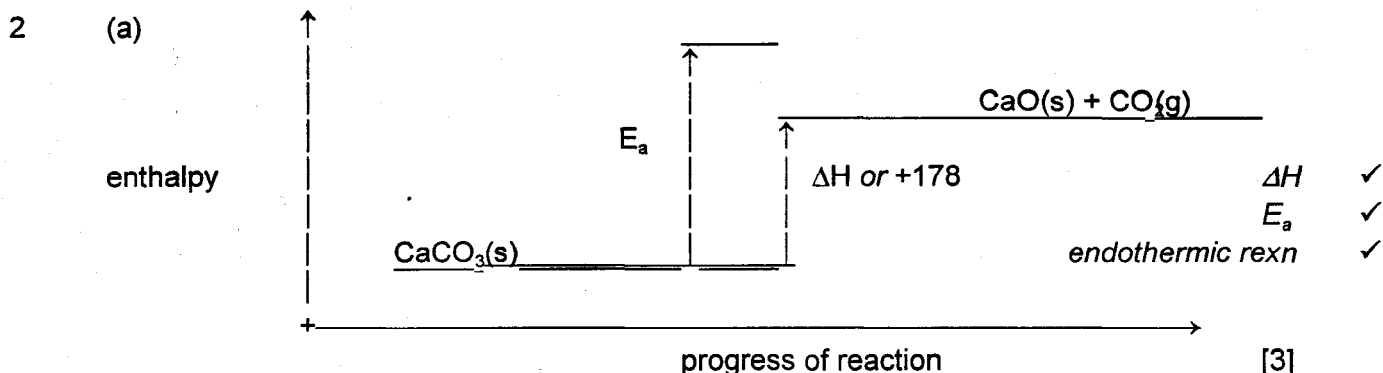
Final Mark Scheme

MAXIMUM MARK	45
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Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	;	= separates marking points
	NOT	= answers which are not worthy of credit
	()	= words which are not essential to gain credit
	<u> </u>	= (underlining) key words which must be used to gain credit
	ecf	= error carried forward
AW	= alternative wording	
ora	= or reverse argument	

- 1 (a) $E = -(31.9-18.0) \times 4.18 \times 100$ ✓
 $E = (-)5810 \text{ J}$ ✓ [3] [2]
 (allow 2905 for [1] mark, also allow 5.81 J for [1])
- (b) $2.0 \times 50/1000 = 0.1 \text{ moles}$ ✓ [1]
- (c) $-5810/(0.1 \times 1000) = -58.1 \text{ kJ mol}^{-1}$ ✓(sign, u/c) ✓ecf [4] [2]
 (allow ecf for (ans to (a))/(ans to (b) x 1000), allow sign mark even if value is wrong)
- Total: 5



- (marks for E_a and ΔH are for label + arrow. Allow double-headed arrows or lines. Last mark is for products being higher than reactants. If arrow is single-headed its direction must be consistent with height of products (i.e. in the exo or endothermic direction))
- (b) (high T) speeds up reaction or (gives energy to) overcome activation energy ✓
 or provides energy to break bonds or reaction has a big E_a .
 and (gives the energy needed to carry out the) **endothermic** reaction ✓
 or reaction takes in heat
- [2]
- (c) $\Delta H = 82 - 178 = -96 \text{ kJ mol}^{-1}$ ✓(sign) ✓ [2]
 (allow [1] only for +96 or 96 or ± 260 , sign mark is conditional on 96 being correct)

Total: 7

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- 3 (a) (i) reaction 3.1: $413 - 432 = -19$ (kJ mol⁻¹) ✓
 reaction 3.2: $243 - 327 = -84$ (kJ mol⁻¹) ✓ [2]
 (if both signs are wrong, i.e. +19 and +84, penalise once only, and award [1])

(ii) reaction 3.2 is faster, because weaker bonds are being broken or lower likely E_{act} or less energy needed ✓ [1]

- (b) for reaction 3.3: a comparison of $E(C-Cl)$ with either $E(C-H)$ or $E(H-Cl)$ or a calculation, e.g. $\Delta H = 413 - 327 = +86$ ✓ [1]
 (the reaction is) is too endothermic (to take place) or it has a highly positive ΔH ✓ [1]
 or too high an E_a or too much energy is needed Total: 5

- 4 (a) $C_8H_{18} + 12.5 O_2 \longrightarrow 8 CO_2 + 9 H_2O$ (or doubled) ✓ [1]

(b) (i) + (ii) ✓✓✓✓ [4]

fuel	ΔH_c per mole of alkane burned (kJ mol ⁻¹)	ΔH_c per mole of CO ₂ produced (kJ)	moles of CO ₂ produced per kJ of heat given out
methane	-890	-890	$1.1 - 1.15 \times 10^{-3}$ (a) ecf
octane	-5479	-684 to -685 ecf from incorrectly balanced equation	$1.4 - 1.5 \times 10^{-3}$ (b) ecf (needs a calc. - not just a ratio)

(iii) ratio (= $1.124/1.462$) = 0.7 – 0.8 ✓ecf, i.e. any (a)/(b) [1]
 (allow a whole number fraction)

- (c) (i) unburned h/c low-level ozone or smog or greenhouse gas or carcinogenic NOT ozone depletion, smoke, pollution, sootiness etc
 CO poisonous/toxic (to animals - ignore refs to trees etc) or reacts with haemoglobin
 (mention of greenhouse gas or acid rain or ozone depletion **negates** any valid CO effect mentioned)
 NO smog or acid rain or bad for lungs or causes respiratory problems or irritant NOT poisonous. (Ignore ozone depletion) ✓✓✓ [3]

(ii) from the combination of N₂ and O₂ (from the air) (or equation) ✓ [1]

(iii) $NO + CO \longrightarrow \frac{1}{2}N_2 + CO_2$ (or double) ✓ [1]

(iv) Pt or Pd or Rh or all (any other metal negates the mark) ✓ [1]

(v) in a different phase/state (to the reactants) or a solid reacting with gases ✓ [1]

(vi) rate of reaction is increased the hotter it is or more molecules with $E > E_a$ or more energy available to break bonds or more energy available to overcome activation (barrier) or increased collision rate ✓ [1]

Total: 14

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- 5 (a) pressure increases the rate of reaction ✓
because the molecules are pushed closer together *or* become more concentrated
or collide more often *or* more collisions
(NOT because they are travelling faster *or* have more energy – mention of either
of these **negates** any correct comment) ✓ [2]
- (b) (i) (increasing T will) increase yield *or* drive equilibrium over to right ✓
or favour the forward reaction ✓ [2]
because it's an endothermic reaction *or* ΔH is positive ✓
- (ii) (increasing P will) decrease yield *or* drive equilibrium over to left ✓
or favour the backward reaction ✓ [2]
because there are more (gas) moles on the right than the left. ✓
- (c) *either* each reaction requires different conditions of temperature *or* pressure
or the reaction use different catalysts (N.B. not just unspecified "different conditions") ✓ [1]

Total: 7

- 6 acid = contains H^+ *or* proton donor *or* $\rightarrow H^+$ in an equation *or* an electron pair acceptor ✓

4 main reactions: $HCl(aq) + \text{metal (from Ca to Fe in reactivity)}$
 $HCl(aq) + \text{(insoluble) metal oxide}$
 $HCl(aq) + \text{soluble metal hydroxide } *or* \text{ ammonia}$
 $HCl(aq) + \text{carbonate (any one - allow hydrogencarbonate too)}$
also allow: $HCl(aq) + \text{an alcohol} + ZnCl_2$, giving a chloroalkane

an example of each to include the name *or* correct formula of reactant (can be read into an
equation) **and** a description of the observation ✓✓✓

[if none of these 3 marks has been awarded there are 2 ways in which a **salvage mark** may be given for stating 3
correct reagents but no observations *or* for stating the 3 general (word) equations for acid reactions]

observations: **metal** dissolves *or* H_2 evolved *or* gas evolved/produced/formed *or* fizzes
(in words, not to be read from $H_2(g)$ in the equation)

carbonate dissolves *or* CO_2 evolved *or* gas evolved *or* fizzes
(in words, not to be read from $CO_2(g)$ in the equation)

metal oxide dissolves

soluble hydroxide heats up *or* changes the colour of an indicator

(for any metal that gives coloured salts, allow the correct colour of the solution as an observation)

also allow: solution (of alcohol) turns cloudy

balanced chemical equations (any two from the five reaction types above) ✓✓

[for reactive metals, e.g. Na, allow [1] for balanced equation, but not the observation mark]

ionic equations (any two) [these must not include any spectator ions] ✓✓

[8] max [6]

QWC (two informative sentences) ✓

[1]

Total: 7