

**Subject: How Far, How Fast?**

**Code: 2813/01**

**Session: January**

**Year: 2002**

**Final Mark Scheme**

<b>MAXIMUM MARK</b>	<b>60</b>
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<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/	= 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) (i) the enthalpy change when **1 mole** of compound/substance is formed from its **elements** under **standard conditions** (of temperature and pressure) ✓ ✓ [2]
- (ii) temperature of 298K (or 25 °C) ✓  
pressure of 1 atmos (or 100 kPa or 101 kPa) ✓ [2]
- (b) (i) a reaction that gives out heat/energy to its surrounds or in which the reactants react with a decrease in internal enthalpy/energy. [NOT temperature rise] ✓ [1]
- (ii) e.g. combustion/burning of fuels (*or* stated fuel, e.g. alkanes) *or* respiration *or* metabolism *or* (unbalanced) equation representing this. [NOT just ‘burning’ on its own] ✓ [1]
- (c) (i)  $\Delta H = 4(-242) - 2(+51) - 9$  (✓ for x2 and x4)  
 $= -968 - 102 - 9$  (✓ for the correct signs)  
 $= -1079 \text{ kJ mol}^{-1}$  (✓ for the answer) *ecf*  
*(see separate list of alternatives)* [3]
- (ii) Because the products are **gases** (if products are identified, both must be correct) [NOT low activation energy] ✓ [1]
- Total: [10]

2	(a)	at a high temperature (accept any stated temperature above 0°C)	✓	
				[1]
	(b)	photosynthesis requires (only) <b>light.</b> <i>or</i> 'energy from the sun' [NOT heat, or heat from the sun]	✓	
				[1]
	(c)	(i)		
		6(O-H) + 6(C=O)	✓	
		= 6 x 464 + 6 x 750		
ecf		= 7284 (kJ mol <sup>-1</sup> )	✓	
				[2]
		(ii)		
		3(O=O) + 4(C-H) + 2(C-C) + 2(C-O) + 2(O-H) + C=O	✓	
		= 3 x 498 + 4 x 413 + 2 x 347 + 2 x 358 + 2 x 464 + 750		
ecf		= 6234 (kJ mol <sup>-1</sup> )	✓	
		<i>(see separate list of alternatives allow [1] if only C-C is omitted)</i>		
				[2]
	(iii)	ΔH = 7284 - 6234		
		= + 1050 kJ mol <sup>-1</sup>	<i>ecf</i> (i.e. (i)-(ii))	✓
				[1] ecf
	(d)	diagram	✓	
		[to include: C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> + 3O <sub>2</sub> as product		
		<i>and</i> ΔH <i>or</i> '+1050', drawn to be consistent with answer to part (iii) above]		[1]
				Total: [8]

- 3 (a) (i) distribution curve ( $T_1$ ):  
 starts at (0,0) and goes to a maximum ✓  
 right hand side tails off to x-axis exponentially ✓  
 [it can *reach* the axis, but not cross it]  
 [2]
- (ii) second curve ( $T_2$ ):  
 starts at (0,0) and has its maximum at a lower ordinate value ✓  
 and to the right of the  $T_1$  maximum ✓  
 [2]
- (b) the (minimum) energy that molecules/particles need to have in order to react  
*or* energy required for effective collisions  
*or* minimum energy needed for a reaction to occur  
*or* energy needed to break bonds [NOT the energy needed to start a reaction] ✓  
 [1]
- (c) *at higher temperature*  
 more molecules have  $E > E_a$  [NOT just 'more molecules have higher energy'] ✓  
 ∴ greater chance of reacting on collision (*or* more **successful** collisions) ✓  
 [NOT just 'more collisions']  
 ∴ faster reaction *or* increased rate ✓u/c  
 (*or* accept the converse arguments at a lower temperature)  
 [3]
- (d) (i)  $\boxed{\text{B}} < \boxed{\text{C}} < \boxed{\text{D}} < \boxed{\text{A}}$   
 smallest  $E_{\text{act}}$  largest  $E_{\text{act}}$  ✓✓ (all correct: [2])  
 (*either*  $C < D < B < A$  *or*  $C < D < A < B$ , i.e. one in wrong place: [1])  
 [2]
- (ii) no bonds broken in B  $\Rightarrow$  low  $E_{\text{act}}$  ✓  
 the others go in order of bond energies ✓ [2]  
 (*or* write – e.g. A has the greatest bond energy)  
 Total: [12]

- 4 (a) a catalyst speeds up a reaction (without being used up). ✓  
it offers a different route ✓  
of lower activation energy ✓ [3]
- (b) heterogeneous ✓ [1]
- (c) needs to happen in a closed system  
no change in macroscopic properties  
forward and backward reactions continue to proceed  
but at the same **rate** as each other [NOT same *extent*]  
any two ✓✓ [2]
- (d) (i) (*When a system in dynamic equilibrium is subjected to a change in conditions...*)  
the (position of) **equilibrium** [NOT reaction] will shift (*or* be restored) ✓  
in the direction that minimises the effect of the change  
*or* opposes the change [NOT negates or cancels the change] ✓ [2]
- (ii) pressure  
equilibrium shifts to the left ✓  
because 9 moles of gas on LHS and 10 moles of gas on RHS  
*or* less particles on left hand side of equation ✓u/c
- temperature  
equilibrium shifts to the left hand side ✓  
because reaction is exothermic *or*  $\Delta H$  is negative ✓u/c [4]
- (e) To speed up reaction. ✓  
*or* To obtain a reasonable yield at reasonable rate. [1]
- Total: [13]

5	(a) (i)	ammonia is acting as a base/alkali/proton acceptor [NOT ammonia reacts with/absorbs protons]	✓	[1]
	(ii)	$M_r$ for $(\text{NH}_4)_2\text{SO}_4 = 132.1$ $2 \times 17 \longrightarrow 132.1$ $\therefore 100 \longrightarrow 132.1 \times 100/34$ $= \quad \mathbf{388-390 \text{ g}}$	✓ ✓ ✓ecf	(mark for 2 x 17) [3]
	(iii)	fertiliser	✓	[1]
	(b)	<b>Gas/CO<sub>2</sub> is evolved/given off or reaction fizzes.</b> [this mark is NEGATED if a change of colour is mentioned]	✓	
		$\text{MgCO}_3 + 2\text{HNO}_3 \longrightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$	correct formulae of reagents ✓ equation balanced ✓	[3] Total: [8]
6		CFCs affect the <b>ozone</b> layer C-Cl bond breaks with UV <i>or</i> energy from sunlight giving Cl <b>radicals</b> <i>or</i> Cl• <i>or</i> Cl <b>atoms</b> (the Cl can be read into an equation, but ‘radical’/‘atom’ has to be in words) homogeneous catalysis	✓ ✓ ✓ ✓ ✓	
		<b>word</b> explanation of how Cl acts as a homogeneous catalysis (e.g. it is regenerated) ✓		
		mention of chain reaction hence one Cl breaks down many O <sub>3</sub> $\text{Cl} + \text{O}_3 \longrightarrow \text{ClO} + \text{O}_2$ $\text{ClO} + \text{O} \longrightarrow \text{Cl} + \text{O}_2$ [ignore $\text{O}_3 \longrightarrow \text{O}_2 + \text{O}$ ]	✓ ✓ ✓ ✓	
		<i>or</i> $\text{ClO} + \text{O}_3 \longrightarrow \text{Cl} + 2\text{O}_2$	✓	
		10 points: any 8 score Q of w C (at least one sensible sentence):	✓	[9] Total: [9]