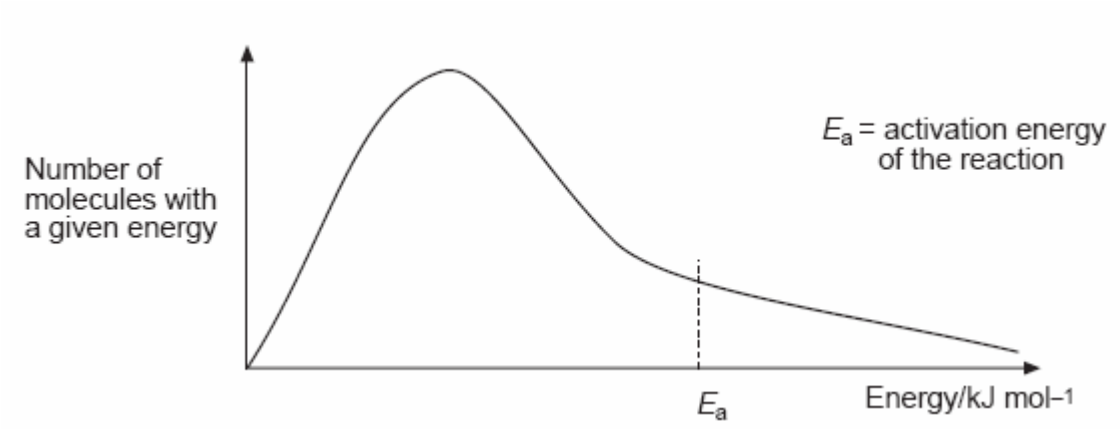
Practice exam questions for Chapter 4: Thermochemistry (Write-on version)

Question 1 (Bursary 2003 Question 6)

High temperatures increase the rate of a reaction. The solid line on the graph below represents the distribution of the kinetic energies of the molecules in a sample of gas at 500 °C.



a i What is meant by **activation energy?** A

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ii Draw a second line to show how the distribution will change if the temperature is increased. A

iii Explain, in terms of the graph, how increasing the temperature increases the rate of the reaction. M E

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Question 2 (Bursary 2003 Question 6)

Shorter covalent bonds are stronger than longer covalent bonds as illustrated by the following bond enthalpies.

E_{C-H} = 413 kJ mol^{-1}

E_{C-Br} = 285 kJ mol^{-1}

E_{H-Br} = 366 kJ mol^{-1}

a Circle the value below that is more likely to be the bond enthalpy for C-Cl. A

346 kJ mol^{-1} 243 kJ mol^{-1}

b Justify your choice. M E

c Bromine reacts with methane as shown below.

$CH_4(g) + Br_2(g) \rightarrow CH_3Br(g) + HBr(g)$ $\Delta_r H = -45$ kJ mol^{-1}

Use this equation and the bond enthalpies given above to calculate the bond enthalpy for Br-Br. A M E

Question 3 (Bursary 2000 Question 11)

a Write the equation for the vaporisation of SO_3. A

b Vaporisation of 0.235 mol of liquid sulfur trioxide requires 10.0 kJ.

Calculate the enthalpy of vaporisation of sulfur trioxide, $\Delta_{vap}H°(SO_3, l)$. A M

c Samples of SO_2 gas and SO_3 gas are at a temperature of 25 °C.

For the statements below, circle the words in brackets that make each statement correct.

i The average kinetic energy of the SO_2 molecules is (greater than / equal to / smaller than) the average kinetic energy of the SO_3 molecules. A

ii The average speed of the SO_2 molecules is (greater than / equal to / smaller than) the average speed of the SO_3 molecules at the same temperature. A

iii Justify your answer. M E

d The contact process for the preparation of sulfuric acid begins with the conversion of sulfur to sulfur dioxide, followed by oxidation of the sulfur dioxide to sulfur trioxide.

Reaction 1: $S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta_f H°(SO_2, g) = -297 \text{ kJ mol}^{-1}$

Reaction 2: $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ $\Delta_r H° = -191 \text{ kJ mol}^{-1}$

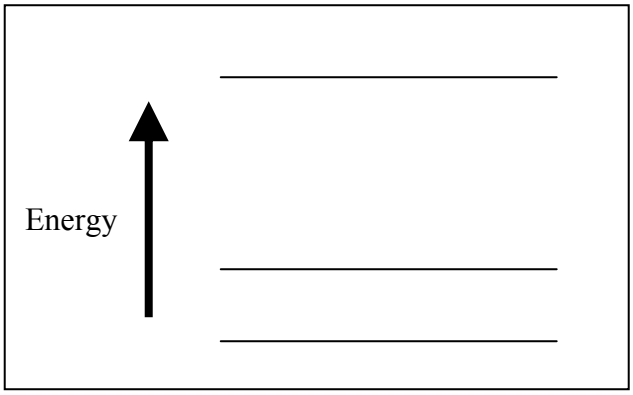
i Circle the correct word below. Reaction 1 above is: A

exothermic endothermic

ii Use the information above to calculate $\Delta_f H°(SO_3, g)$. A M

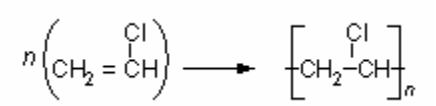
e Using the information given above, as well as your answer to **b**, place the following four species on the three lines of the energy diagram to the right. A M

$S(s)$ $O_2(g)$ $SO_2(g)$ $SO_3(g)$



Question 4 (Bursary 2001 Question 2)

Vinyl chloride is used to produce polyvinyl chloride as shown below.



Calculate the energy change for the chemical reaction that converts 15 moles of vinyl chloride to polyvinyl chloride. A M E

Bond energy:	C=C	620 kJ mol^{-1}
	C-C	347 kJ mol^{-1}
	C-H	414 kJ mol^{-1}
	C-Cl	327 kJ mol^{-1}

Question 5 (Bursary 2001 Question 5: modified)

In rocket propulsion, hydrazine, methylhydrazine and dimethylhydrazine can be burnt with oxygen to release large amounts of energy.

a Hydrazine ($H_2N–NH_2$) burns in air to form nitrogen gas and steam.
Write a balanced equation for the combustion of liquid hydrazine.

b Dimethylhydrazine burns in air to form nitrogen gas, steam and carbon dioxide.

$(CH_3)_2NNH_2(l) + 4O_2(g) \rightarrow 2CO_2(g) + N_2(g) + 4H_2O(g)$

Use the standard enthalpies of formation given below to calculate the enthalpy change per mole of dimethylhydrazine in the above reaction. A M E

	$\Delta_f H$ / kJ mol^{-1}
$H_2O(g)$	–242
$(CH_3)_2NNH_2(l)$	50
$CO_2(g)$	–394

c The enthalpy change for the burning of hydrazine is –534 kJ mol^{-1}. By carrying out the appropriate calculations, show whether burning hydrazine or dimethylhydrazine gives more heat per gram.

$M((CH_3)_2NNH_2) = 60.0$ g mol^{-1}, $M(H_2NNH_2) = 32.0$ g mol^{-1}

A M