Q	Part	Sub Part	Marking Guidance	Mark	Comments
6	(a)		$\Delta H = \Sigma\Delta H_f$(products) – $\Sigma\Delta H_f$(reactants)	1	
			= –201 – 242 –(–394)	1	
			= –49 kJ mol^{-1}	1	+49 kJ mol^{-1} = 1 mark units not required, wrong units lose 1 mark
6	(b)		$\Delta S = \Sigma S$(products) – ΣS(reactants)	1	
			=238 + 189 –(214 + 3x131)	1	
			= –180 J K^{-1} mol^{-1}	1	+180 = 1 mark units not required, wrong units lose 1 mark
6	(c)		$\Delta G = \Delta H - T\Delta S$	1	If use G not ΔG penalise M1 but not M2 and M3
			(ΔS is negative so) at high temp $-T\Delta S$ (is positive and) greater than ΔH / large	1	Do not award M2 or M3 if positive ΔS value used
			So $\Delta G > 0$	1	Independent mark unless positive ΔS value used
			(Limiting condition $\Delta G = 0$ so) $T = \Delta H/\Delta S$	1	
			= 272 K	1	Allow 297-298 if used given values. Do not award M5 if T –ve or if M4 should give T -ve
			Reaction is too slow at this temperature/to speed up the reaction	1	

6	(d)		$CH_3OH + 3/2O_2 \rightarrow CO_2 + 2H_2O$	1	Allow multiples. Ignore state symbols. Do not allow equation for wrong compound but mark on provided number of moles increases or stays the same. If no equation or equation that gives a decrease in the number of moles, CE = 0
			2.5 mol give 3 mol (gases)	1	Allow statement 'increase in number of moles/molecules' If numerical values given, they must match the equation in M1 Ignore the effect of incorrect state symbols on the number of moles of particles unless used correctly
			Therefore ΔS is positive/entropy increases	1	If correct deduction from wrong equation is ΔS =0 or ΔS very small must say ΔH –ve
			(combustion exothermic so ΔH –ve so $\Delta H - T\Delta S$) and hence ΔG always negative (less than zero)	1	Allow *G* instead of ΔG Can score 3 out of 4 marks if equation wrong but leads to increase or no change in number of moles M4 dependent on M3 Note, if equation wrong AND there is an incorrect deduction about the change in number of moles, CE = 0

6	(e)		CO_2 /CO/CH_4 may be produced during H_2 manufacture/building the plant/transport/operating the plant	1	