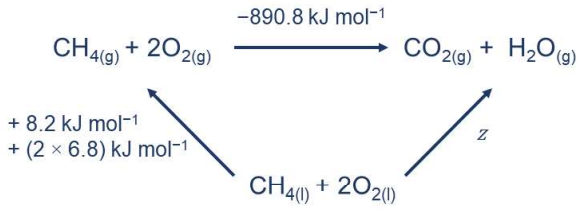
1.	This question is about rocket fuel	Mark
(a)	$H_2 + ½O_2 \rightarrow H_2O$ *State symbols not required* *Accept any multiple with correct stoichiometry e.g., $2H_2 + O_2 \rightarrow 2H_2O$*	☑
(b)	+494 kJ mol^{-1} If the equation used is $H_2 + ½O_2 \rightarrow H_2O$: $\Delta_r H = \sum$bonds broken(reactants) − $\sum$bonds formed (products) −241 kJ mol^{-1} = [(432 + y) − (2 × 460)] kJ mol^{-1} y = [−241 − 432 + (2 × 460)] kJ mol^{-1} y = +247 kJ mol^{-1} (for ½ mole of O_2) 1 mole of O=O is 2y = +494 kJ mol^{-1} If the equation used is $2H_2 + O_2 \rightarrow 2H_2O$: $\Delta_r H = \sum$bonds broken(reactants) − $\sum$bonds formed (products) [2 × −241] kJ mol^{-1} = [(2 × 432) + y − (4 × 460)] kJ mol^{-1} y = [(2 × −241) − (2 × 432) + (4 × 460)] kJ mol^{-1} y = +494 kJ mol^{-1}	☑
(c) (i)	35.2 mol 1 dm^3 = 1000 cm^3 Density (ρ) = mass (m) / volume (v) m(H_2) = ρv m(H_2) = 0.071 g cm^{-3} × 1000 cm^3 = 71 g n(H_2)= m/M_r = 71 g / 2.016 g mol^{-1} = 35.2 mol	☑
(ii)	8480 kJ Energy released = 35.2 mol × +241 kJ mol^{-1} = 8480 kJ	☑
(d) (i)	$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$	☑
(ii)	Oxidation state of H in reactant: 0; Oxidation state of C in reactant: +4 Oxidation state of H in product: +1; Oxidation state of C in product: −4 *All four oxidation states must be correct for the mark. + sign is not needed.*	☑
(e)	−869.0 kJ  z = [+8.2 + (2 × 6.8) + −890.8] kJ mol^{-1} = −869.0 kJ mol^{-1}, therefore −869.0 kJ. *No penalty if final answer in kJ mol^{-1}. No marks if value given in wrong units.*	☑
	Total out of 7	**7**