

# THERMOCHEMISTRY

$$\Delta H_r = \underline{\Delta H_f(P_r)} - \underline{\Delta H_f(R)}$$

$$\Delta H_f[O_2(g)] = 0$$

$$\Delta H_f[\text{graphite}] = 0$$

$$\Delta H_f[Ar(s)] = 0$$

$$\Delta H_f[I_2(s)] = 0$$

$$\Delta S_r = \underline{\Delta S_f(P_r)} - \underline{\Delta S_f(R)}$$

$$\Delta S_r = S(P_r) - S(R)$$

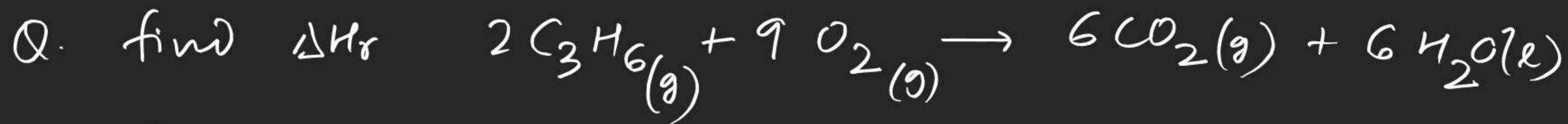


$$\Delta G = \Delta H - T \Delta S$$

$$\Delta G_r = \underline{\Delta G_f(P_r)} - \underline{\Delta G_f(R)}$$

$$\Delta G = \Delta G^\circ + RT \ln Q$$

 $\Delta H_f$  $\Delta S_f$  $\Delta G_f$



Given  $\Delta H_f [C_3H_6(g)] = -300 \text{ kJ/mol}$

-4200  $\Delta H_f [CO_2(g)] = -400 \text{ kJ/mol}$

-3900  $\Delta H_f [H_2O(l)] = -350 \text{ kJ/mol}$

$\Delta H_f = 6 \times (-400) + 6(-350) - 2(-300) = 0$

$$= -2400 - 2100 + 600$$

$$= -3900$$

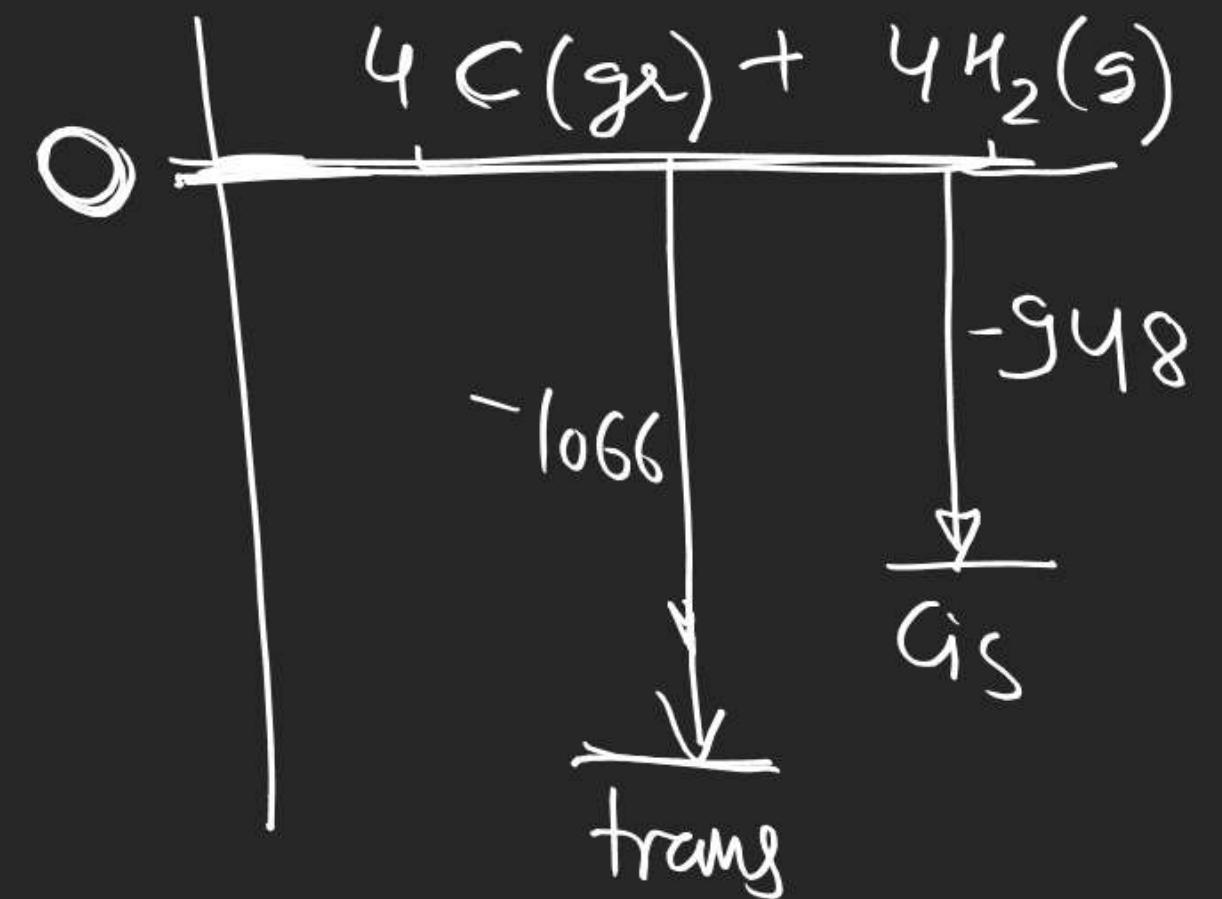
1050  
450  
-450

(11)

To compare energy of isomers or allotropes

$$\Delta H_f [ \text{cis-2-butene } (\text{C}_4\text{H}_8) ] = -948 \text{ kJ/mol}$$

$$\Delta H_f [ \text{trans-2-butene } (\text{C}_4\text{H}_8) ] = -1066 \text{ kJ/mol}$$

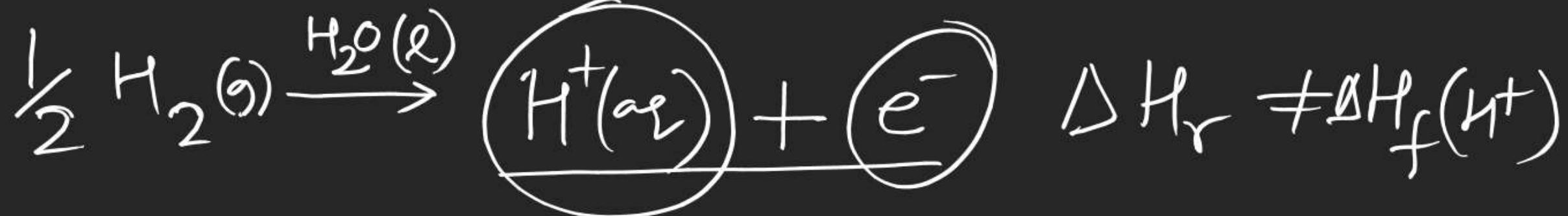


Substance with  
lower  $\Delta H_f$  has low  
energy.

$$\rightarrow \Delta H_f(\text{graphite}) = 0$$

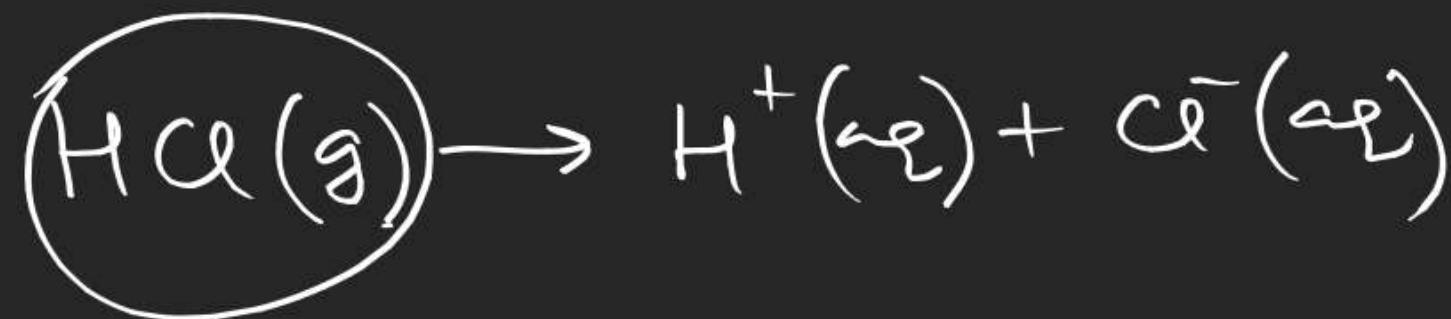
$$\Delta H_f(\text{diamond}) = 1.9 \text{ kJ/mol}$$

graphite less energy  $\rightarrow$  more stable

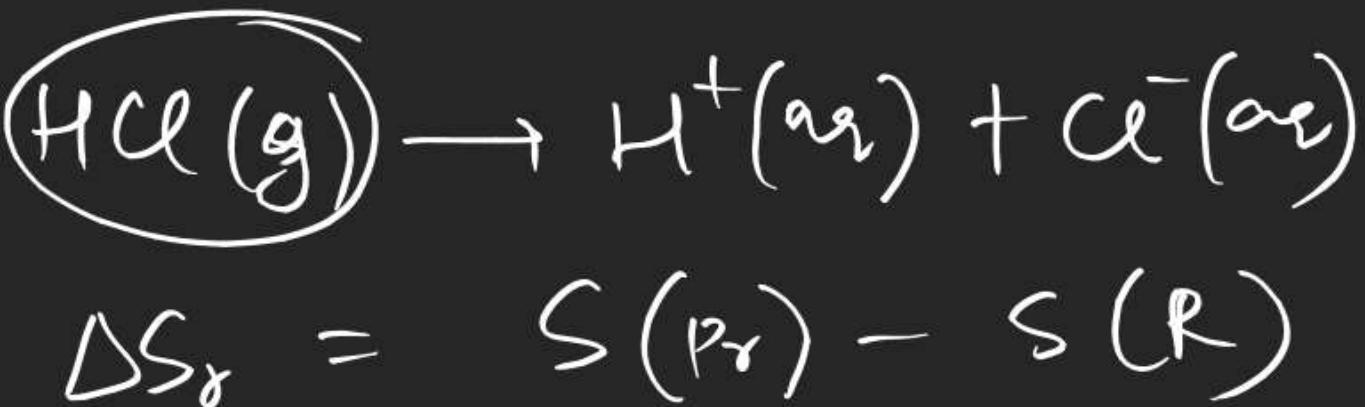
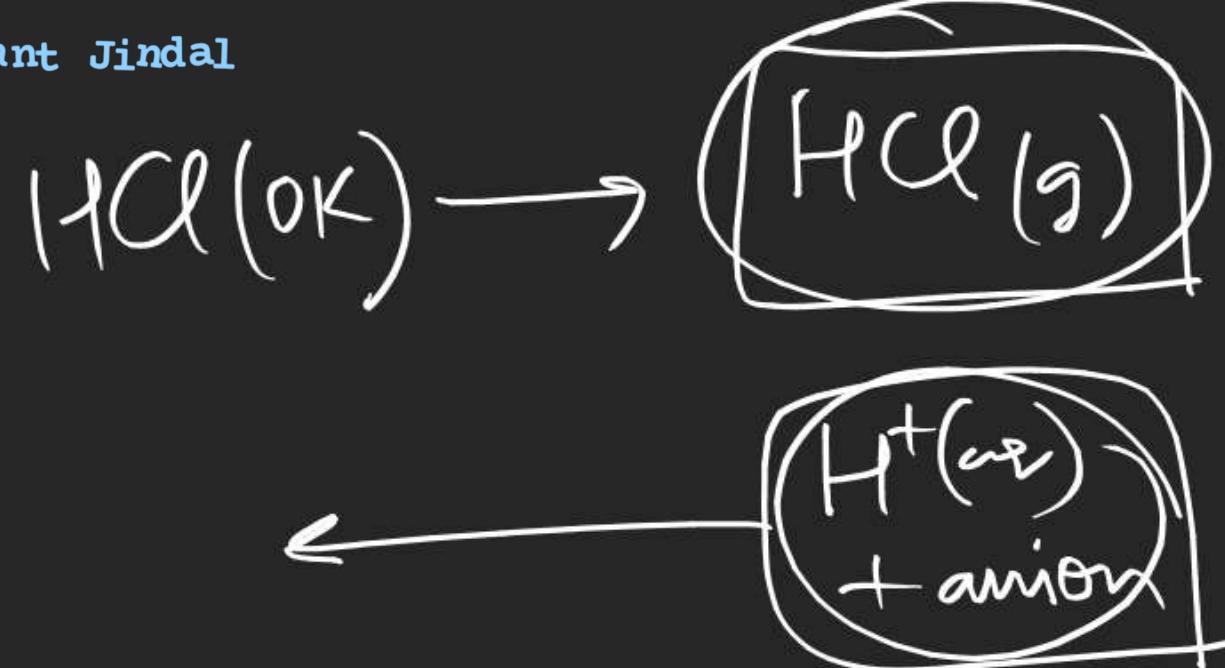


Assuming

$$\left| \begin{array}{l} \Delta H_f(\text{H}^+(\text{aq})) = 0 \\ \rightarrow \Delta S_f(\text{H}^+(\text{aq})) = 0 \\ \Delta G_f(\text{H}^+(\text{aq})) = 0 \end{array} \right.$$



$$\underline{\Delta H_r} = \underline{\Delta H_f(\text{Pr})} - \underline{\Delta H_f(\text{R})}$$

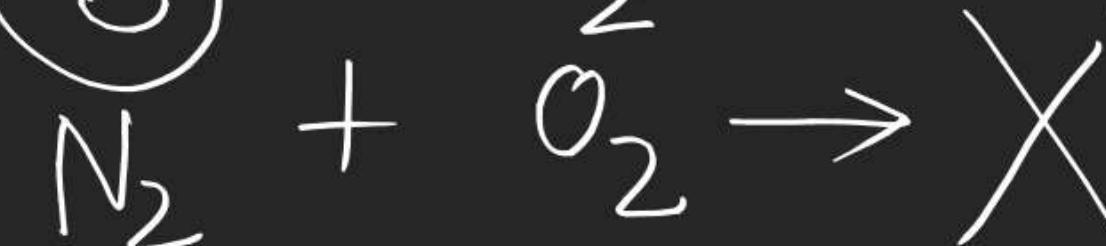
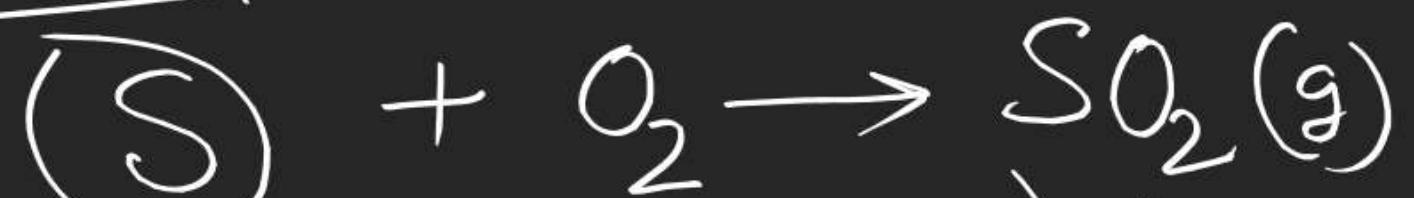
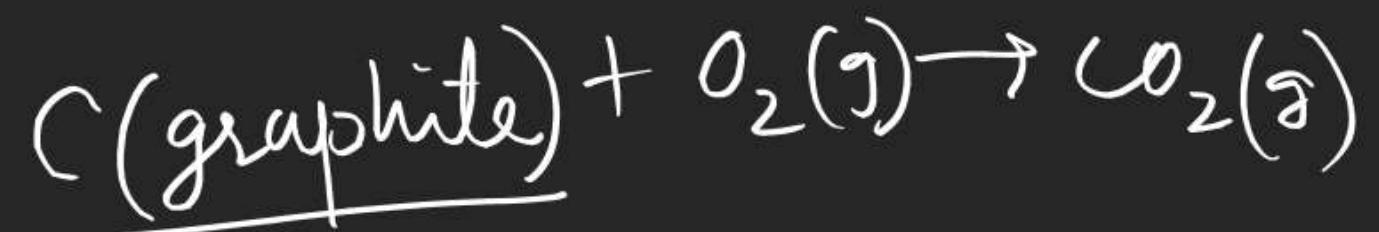
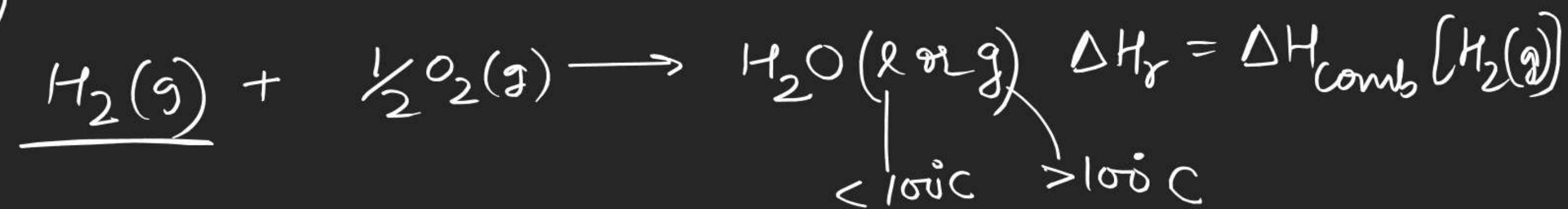


$$\Rightarrow S[\text{H}^+(\text{aq})] = 0$$

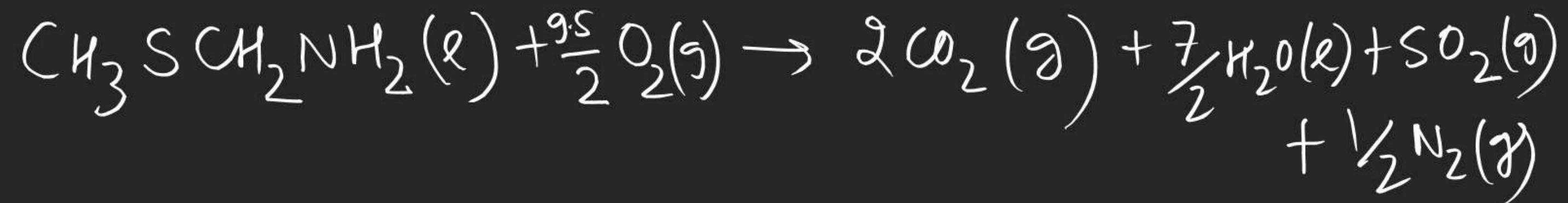
$\Rightarrow$  entropies of ions may be -ive or +ve because they are wrt  
 $\text{H}^+(\text{aq})$

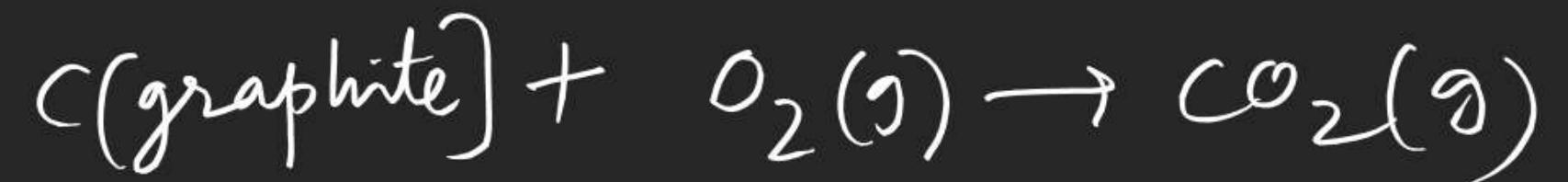
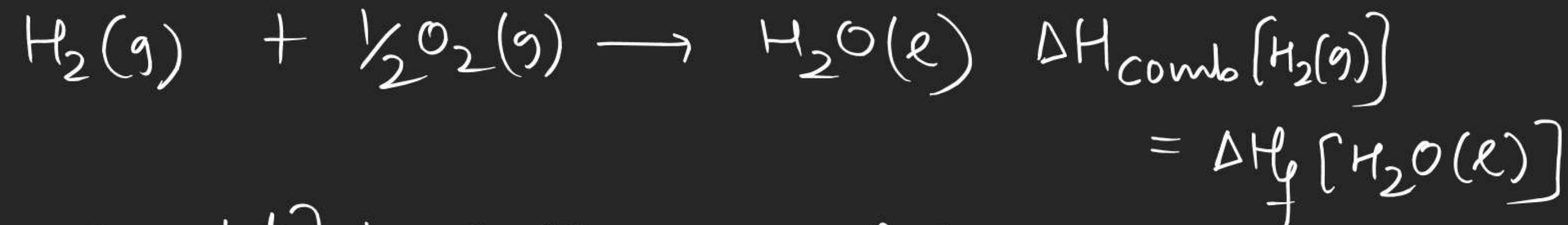
# THERMOCHEMISTRY

Enthalpy of Combustion ( $\Delta H_{\text{comb}}$ ) :- It is the enthalpy change when 1 mol substance is burnt with excess  $O_2$ .



If temperature not given  
then consider it to be room  
temp.





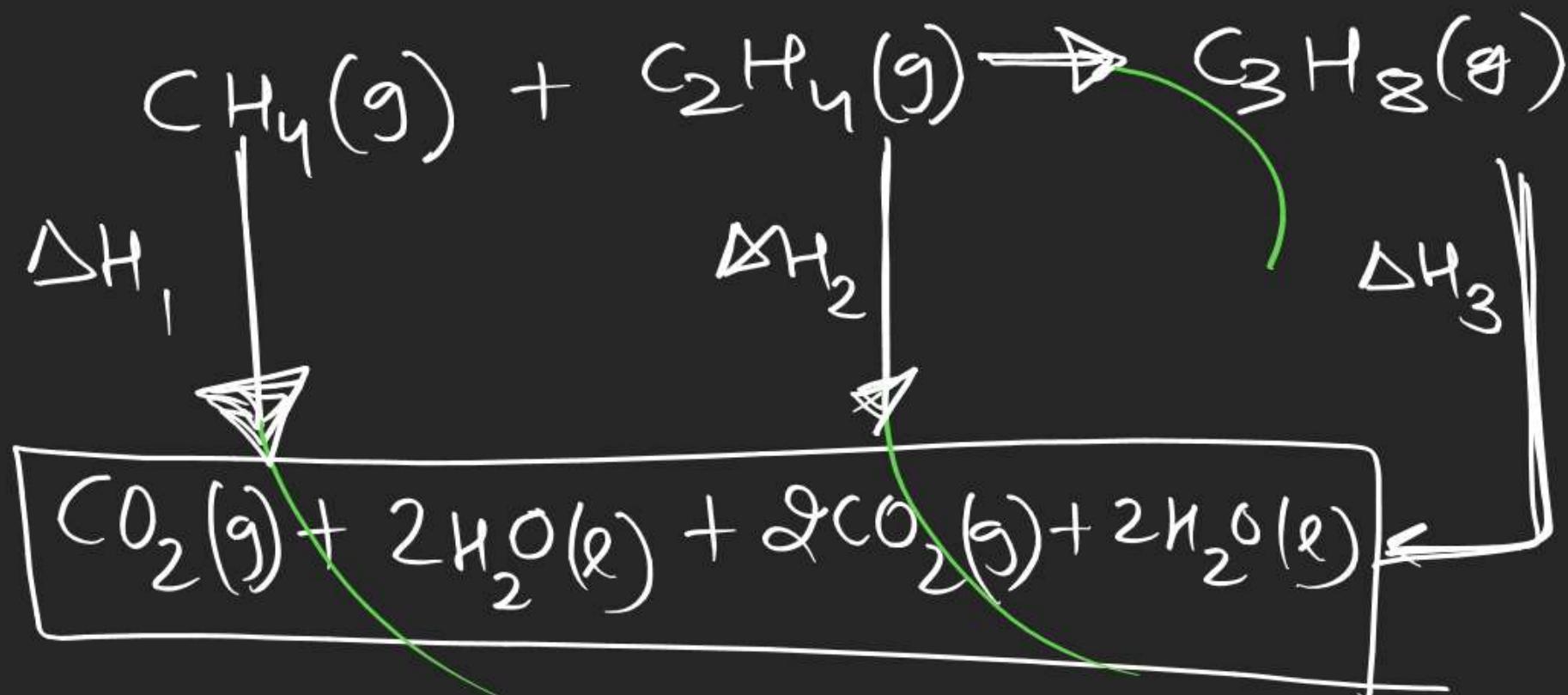
$$\Delta H_{\text{comb}} [\text{CO}_2(\text{g})] = 0$$

$$\Delta H_{\text{comb}} [\text{O}_2(\text{g})] = 0$$

$$\Delta H_{\text{comb}} [\text{Al}_2\text{O}_3(\text{s})] = 0$$

$$\Delta H_{\text{comb}} [\text{H}_2\text{O}(\text{l})] = 0$$

Application }  $\Delta H_{\text{comb}}$



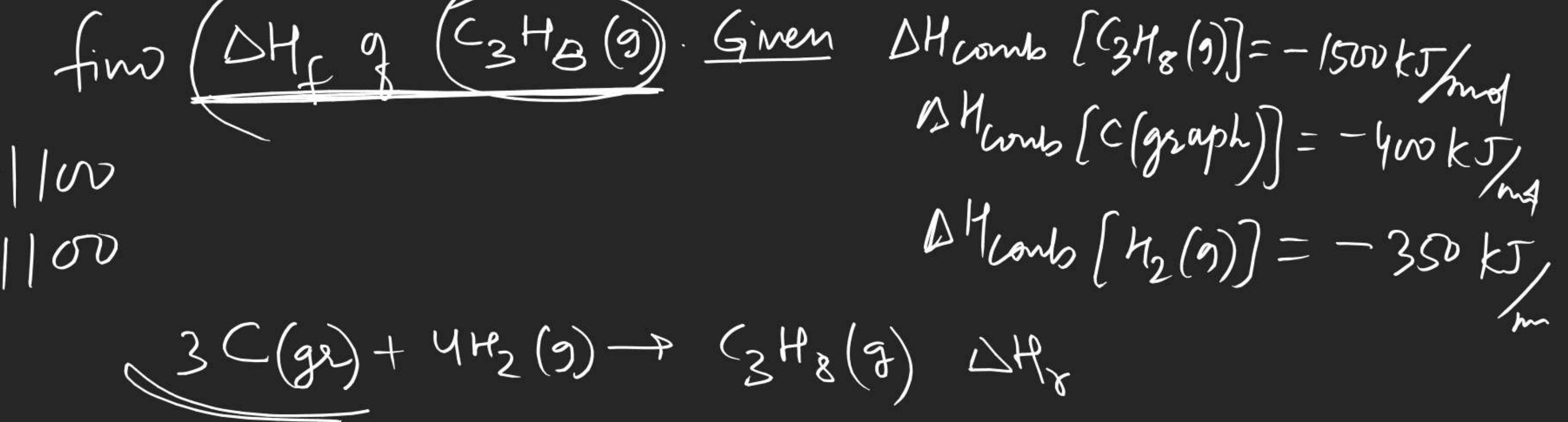
$$\Delta H_r + \Delta H_3 = \Delta H_1 + \Delta H_2$$

$$\boxed{\Delta H_r = \sum \Delta H_{\text{comb}}(R) - \sum \Delta H_{\text{comb}}(R_r)}$$

$\Delta H_{\text{comb}}(\text{CH}_4(g))$

$\Delta H_{\text{comb}}(\text{C}_2\text{H}_4(g))$

$\Delta H_{\text{comb}}(\text{C}_3\text{H}_8(g))$



$$\begin{aligned}\Delta H_f^\circ &= \Delta H_r = \frac{\Delta H_{\text{comb}}(\text{R}) - \Delta H_{\text{comb}}(\text{Pr})}{-} \\ &= \Delta H_r = -1200 - 1400 + 1500 \\ &= \Delta H_r = -1100\end{aligned}$$

O-I 1-9  
S-L 1-6

O-II TD-2

(8)

$$\Delta S_{sys} = 0$$

$$S = \text{const}$$

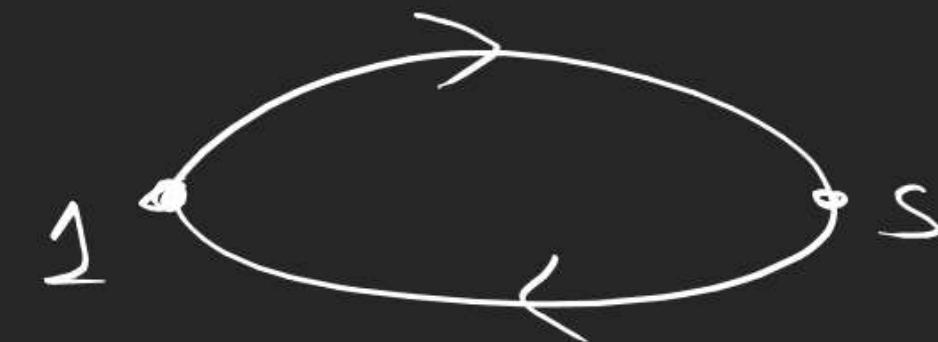
iso-entropic

(9)

(A)

$$\int \frac{dq}{T}$$

False



(B)

False       $S_{univ} \uparrow$ 

$$\Delta S = \int^2_1 \frac{q_{rev}}{T} +$$

(C)

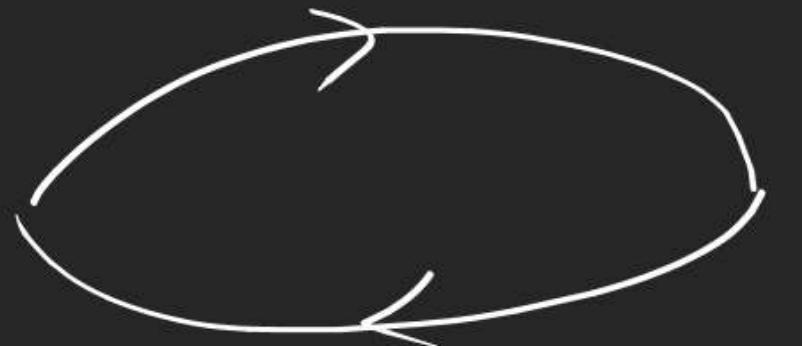
True



(D)

False

$$\Delta S_{cycle} = 0$$



$$\Delta S_{1-2} + \Delta S_{2-1} = 0$$

$$\sum \frac{q}{T} < 0$$



$$\underbrace{\int_1^2 \frac{q_{rev}}{T} + \int_2^1 \frac{q_{irr}}{T}}_{\Delta S_{cycle}} < 0 = \Delta S_{cycle}$$

(11)

$$(\Delta S_r)_{P_2} - (\Delta S_r)_{P_1} = \Delta n_g R \ln \frac{P_1}{P_2}$$

(13)



1 atm, 100 K  $\Delta G_r = 0$

$< 1 \text{ atm}, 100 \text{ K} \quad \Delta G_r < 0$

$> 1 \text{ atm}, 100 \text{ K} \quad \Delta G_r > 0$

(E)

(A)

Tone

$$S > 0$$

(B)

False

(C)

False

(D)

True.

Remaining

0-II