رهواني سفيان

الشكر و الحمد لله الذي أنار لنا درب العلم و المعرفة و الذي أعاننا ووفقنا في انجاز هذا العمل المتواضع نهدي هذا العمل .

لكم أعزائي تلاميذ بكالوريا 2022 أضع بين ايديكم هاته سلسلة الرائد من التمارين حول المجال الثالث الديناميكا الحرارية تمرين تتكون من:58 تمرين





اشكر جميع أساتذة المادة على مساهماتهم ونشرهم للمواضيع والإمتحانات لتعم الفائدة .....

بالتوفيق والنجاح لجميع تلاميذ هندسة الطرائق .انتظرونا في سلسلة للمجال الرابع

شعارنا العلامة الكاملة إن شاء الله في بكالوريا 2022

التمرين رقم 1

2Kg (Adiabatique)

3Kg

(Adiabatique)

(Teq)

(1 bar)

$c_e = 4.15J / g.k$

التمرين 2 رقم

(- 1 Kg

(1 bar)

Q

1 bar

$L_{fus} = 333\ KJ / Kg$

$L_{vap} = 2257\ KJ / Kg$

c_{eau}

c_{vap}

c_{glac}

التمرين رقم 3 :

L_{vap}

500g

20 g

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$c_e = 4.15J / g.k$ C_{cal}

Lvap

. ΔHvap

التمرين رقم 4 :

(t_1 = - m_1=500g

(t_2 m_2 = 200 g

c_{glace}

c_{fer}

L_{fus} = 333 KJ / Kg

c_{eau}

التمرين رقم 5:

$C_6H_{12}O_6$ 1.8 g

التمرين رقم 6 :

10 litres

0.1 litre 1 litre 1 bar

W_{23} W_{12}

Q

ΔH ΔU P

H2

التمرين رقم 7

45 bars 1 g ( )

2 k J

c_p

ΔH ΔU

التمرين رقم 8

(2) (1) N2 ( )

(Isobare) (Isochore) (a)

(Isochore (Isobare) (b)

(Isotherme) (c)

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Etat (1)	Etat (2)
P_1 = 1 bar V_1 = 3 Litres	P_2 = 3 bar V_2 = 1 Litre

P = f(V)

التمرين رقم 9

(1 mol / l) NaOH (1 mol / l) H2SO4

1.036 g /

cm3

$KJ.mol^{-1}$ H2SO4 -1

HCl

التمرين رقم 10

100 ml

(KOH) 11, 22 g

(KOH)

(KOH)

C_{eau}

التمرين رقم 11

1mol /l NaOH 100ml

1mol /l HCl 100ml T_i = 22.5

T_f

. Q_p

ΔH_{neutr}

C_{Cal} = 200.46 $J.K^{-1}$ / Ce = 4.185 $J.K^{-1}.g^{-1}$

التمرين رقم 12

5g 200g

T_f Ti =

Lf

التمرين رقم 13

100g

C_{eau}=4185$J.kg^{-1}.K^{-1}$

L_f=3,34.105 $J.kg^{-1}$

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T(K)	.....	$T_1=T_2$

Q W

$R = 8,314 J.mol^{-1}.K^{-1}; 1atm = 1,013 \times 10^5 Pa; O = 16 g.mol^{-1}; C = 12 g.mol^{-1}$

$m_1=100g$ C_{cal} .I

$T_2=80°C$ $m_2=80g$ $T_1=25°C$

$T_{eq}= 46,5°C$

C_{cal}

$V=3\ L$ $T_{eq}=56,61°C$

V_2 $T_1=10°C$ V_1

$T_2=80,5°C$

$\rho = 1 g.mL^{-1}$; $c_{eau} = 4,185 J.g^{-1}.k^{-1}$ V_2 V_1

.II

1) $C_{(s)} + \frac{1}{2} O_{2(g)} \longrightarrow CO_{(g)}$ $\Delta H_1^\circ = -111\ kJ.mol^{-1}$

2) $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(\ )}$ $\Delta H_2^\circ = -572\ kJ.mol^{-1}$

3) $H_{2(g)} + O_{2(g)} + C_{(s)} \longrightarrow HCOOH_{(\ )}$ $\Delta H_3^\circ = -425\ kJ.mol^{-1}$

25°C ΔH_4° (1

تمارين شـــــــاملة

.I

$C_6H_{12}O_{6(s)}$

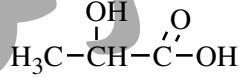
$C_6H_{12}O_{6(s)} \longrightarrow 2C_3H_6O_{3(l)}$

$\Delta H^\circ_{f(C_3H_6O_{3(\ )})}$ $\Delta H^\circ_{f(C_6H_{12}O_{6(s)})}$

$\Delta H^o_{comb}(C_6H_{12}O_6)_{(s)} = -2816 KJ/mol$

$; \Delta H^o_{comb}(C_3H_6O_3)_{(l)} = -1364 KJ/mol; C(sub) = 717 KJ/mol$

$\Delta H^\circ_{vap(C_3H_6O_{3(\ )})}$



	$C-C$	$O=O$	H - H	$C=O$
ΔH_d(KJ/mol)	348	498	436	843
	C - O	O - H	C - H	
ΔH_d(KJ/mol)	351	462	413	

B A CO m=14g .II

	A	B
V(L)	4,86	.....
P(atm)	3	$2P_1$

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$Q_{C\to A}$; $Q_{A\to B}$; $W_{B\to C}$; $W_{A\to B}$

$R = 8,314J / mol.K$; $C_P = 0,99KJ / K.mol$; $C_V = 0,84KJ / K.mol$

$1m^3 = 10^3 L$; $1atm = 1,013.10^5 Pa$

.II

$$C_2H_5\text{-}OH_{(\ )} + O_{2(g)} \longrightarrow CH_3\text{-}COOH_{(\ )} + H_2O_{(\ )} \quad ..\Delta H_r^\circ = -492,7KJ / mol$$

$\Delta H_f^\circ\left(CH_3COOH\right)_{(\ )}$

$\Delta H_f^\circ\left(H_2O\right)_{(\ )} = -286\,KJ / mol$; $\Delta H_f^\circ\left(C_2H_5OH\right)_{(\ )} = -277,6KJ / mol$

25°C **2**

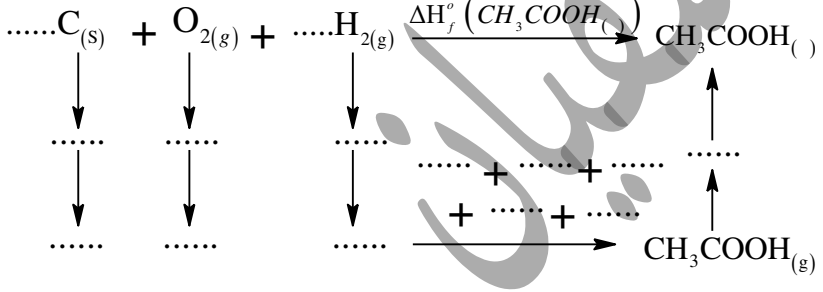
$$C_2H_5\text{-}OH_{(\ )} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(\ )} \quad ..\Delta H_{comb}^\circ = -1367KJ / mol$$

90°C

$\Delta H_{vap}^\circ\left(C_2H_5OH_{(\ )}\right) = 42,8KJ / mol$ / $T_{eb}\left(C_2H_5OH\right) = 78°C$

	$H_2O_{(\ )}$	$CO_{2(g)}$	$O_{2(g)}$	$C_2H_5OH_{(\ )}$	$C_2H_5OH_{(g)}$
$C_P\left(J.mol^{-1}.k^{-1}\right)$	**75,29**	**30,5**	**29,36**	**112,3**	**65,6**

(3



	$CO_{2(g)}$	$H_2O_{(l)}$
ΔH_f° (kJ / mol)	**- 393**	**- 286**

4) $HCOOH_{(\ )} \longrightarrow CO_{(g)} + H_2O_{(\ )}$ ΔH_4°

$\Delta H_{vap(H_2O)}^\circ = 44kJ / mol$ **110°C** **2** **2**

	$H_2O_{(l)}$	$O_{2(g)}$	$H_{2(g)}$	$H_2O_{(g)}$
$C_P\left(J.mol^{-1}.k^{-1}\right)$	**75,29**	**29,36**	**28,82**	**33,58**

(CO) $\Delta H_f^\circ(C\equiv O)$ **(2**

$\Delta H_{sub(C)}^\circ = 717kJ.mol^{-1}$; $\Delta H_{d(O=O)}^\circ = 498kJ.mol^{-1}$

m=29g **2** **.I**

$$A \xrightarrow{1} B \xrightarrow{2} C \xrightarrow{3} A$$

	A	B	C
(atm)	2	4	$P_C=P_A$
(L)	.....	$V_A=V_B$	$V_C=2V_A$
(K)	292,42	.....	$T_C=T_B$

T_B V_A

P=f(V)

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$E_{(C=O)}$ $(C=O)$

$\Delta H^{o}_{vap}\left(CH_3COOH_{(\ )}\right) = 52,1KJ/mol$; $\Delta H^{o}_{Sub}\left(C\right)_{(S)} = 717KJ/mol$

C = 250j/K $C_6H_{6(l)}$ m_1= 6g I

$T_1 = 20C^0$ m_2 = 9000g

$\Delta H^0_r(C_6H_6)_{(l)}$= - 3268KJ/mol C = 4,18j/g.K

Q_1 .1

T_2 .2

Q_2 .3

$25C^0$ II

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_1 = -393,4KJ/mol$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H_2 = -286KJ/mol$

$C_6H_{6(l)} + \frac{15}{2}O_{2(g)} \longrightarrow 6CO_{2(g)} + 3H_2O_{(l)}$ $\Delta H_3 = -3271KJ/mol$

$\Delta H^0_f(C_6H_{12})_{(l)}$ $\Delta H^0_f(C_6H_6)_{(l)}$ .1

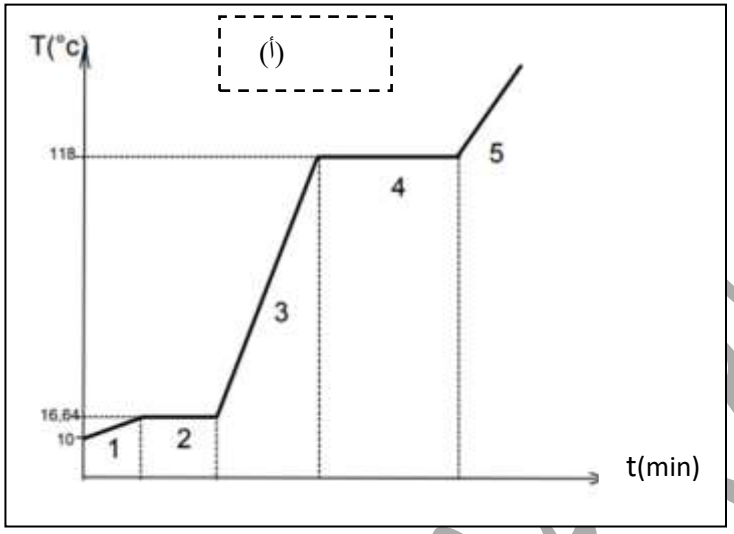
.2

R = 8,314 j/mol.k **T = 298k**

	C - C	O = O	H - H	C - O	O - H	C - H
ΔH_d(KJ/mol)	348	498	436	351	462	413

I

m = 20g



5 ، 4 ، 3 ، 2 ، 1

T_{eb} T_{fus}

L_{vap} L_{fus} .3

.4

Q_2 = 3.91KJ

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$$Q_4 = 7.90KJ$$

II

$m_1 = 300g$ L_{fus}

$m_2 = 10g$ $T_1 = 25°C$

$T_{eq} = 21.68°C$

$C_m = 2.05J / g.K$

$25°C$ ΔH^o_{comb}

1) $CH_3 - CH_2 - OH_{(\ell)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(\ell)}$ $\Delta H^o_1 = -1367kJ / mol$

2) $CH_3 - CH_2 - OH_{(\ell)} + \frac{1}{2}O_{2(g)} \longrightarrow CH_3 - CHO_{(\ell)} + H_2O_{(\ell)}$ $\Delta H^o_2 = -200,6kJ / mol$

3) $CH_3 - CHO_{(\ell)} + \frac{1}{2}O_{2(g)} \longrightarrow CH_3 - COOH_{(\ell)}$ $\Delta H^o_3 = -292,1kJ / mol$

200K $\left(\frac{1}{R}mol\right)$ .I

$T_B = 2T_A$ T_A $A \longrightarrow B$ 1

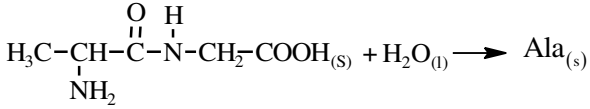
230J $B \longrightarrow C$ 2

$C \longrightarrow A$ 3

$\Delta H_{C\to A}$; $W_{C\to A}$; $W_{B\to C}$; $\Delta U_{A\to B}$

$C_V = \frac{5}{2}R$; $C_P - C_V = R$; R=8,314J/mol.K

25°C (A) 1 II

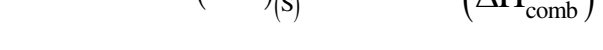


$$H_3C-\underset{\underset{NH_2}{|}}{CH}-\overset{\overset{O}{||}}{C}-\overset{\overset{H}{|}}{N}-CH_2-COOH_{(S)} + H_2O_{(l)} \longrightarrow Ala_{(s)} + Gly_{(s)} \quad \Delta H^\circ_r = -34,15kJ / mol$$

$\Delta H^o_f\left(Ala\right)_{(s)}$ 2

	$(A)_{(S)}$	$(H_2O)_{(l)}$	$(Gly)_{(S)}$
$\Delta H^o_f\,(kJ/mol)$	- 767.35	- 286	- 527,5

$(Ala)_{(S)}$ (ΔH^o_{comb})



$$H_3C-\underset{\underset{H_2N}{|}}{CH}-COOH_{(S)} + ...O_{2(g)} \longrightarrow ....CO_{2(g)} + ...H_2O_{(l)} + ...N_{2(g)} \quad \Delta H^o_{comb}$$

$\Delta H^o_f\left(CO_2\right)_{(g)} = -393kJ/mol$

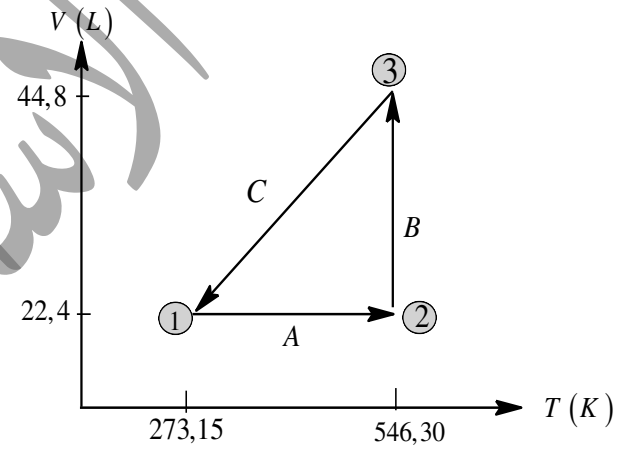
75°C

	$CO_{2(g)}$	$H_2O_{(l)}$	$O_{2(g)}$	$N_{2(g)}$	$(Ala)_{(s)}$
$C_P\,(J / mol.K)$	$32,5 + 17,05\times10^{-3}T$	75,24	$26,47 + 9,73\times10^{-3}T$	29,12	115,2

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1mol .I



-1

	$P(atm)$	$V(L)$	$T(K)$
❶	1	22,414	273,15
❷	2		546,30
❸	.	44,828	

C,B,A. -2

-3

Q W

$C_P - C_V = R, 1atm = 1,01325 \times 10^5 (Pa)$,

$C_V = 12,5J.K^{-1}.mol^{-1}, R = 8,314\ J/mol.K$

1 II

$m_1 = 150g$ (C_{cal})

$T_2 = 15°C$ $m_2 = 200g$ $T_1 = 40°C$

$T_{eq} = 27,04°C$

(C_{cal})

T_{eq} 2

$T_3 = -10\,°C$ $m_g = 45\,g$

T_f

$C_{H_2O} = 4,185J/g.K; C_g = 2,1J/g.K; L_{fus} = 335J/g$ T_f

.I

$$C_nH_{2n+1} - NH_{2(l)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(l)} + N_{2(g)}$$

n

$300g$ $200\,j/k$ $3g$

$82.6K$

n

$C_e = 4.185J/g.k$

$\Delta H_{f(CO2(g))} = -393kj/mol, \Delta H_{f(H2O(l))} = -286kj/mol, \Delta H_{f(CnH2n+1NH2(l))} = -101.5kj/mol$

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$40°C$

$N \equiv N$.

$H_{sub\,(C\,(s))} = 717kj/mol$, $H_{vap} = 31.4kj/mol$

$C-C$	$C-N$	$N-H$	$C-H$	$H-H$	
348	292	387	413	436	$H_d\,(kj/mol)$

Ar $0.5mol$ **.II**

a

b

	$1 \xrightarrow{a} 2 \xrightarrow{b} 3$		
$P(atm)$			
$V(L)$			
$T(K)$			

H U Q W

a

b

$Cp = \frac{5R}{2}$, $R = 8.314\,j/mol.k, 1atm = 1.013 \times 10^5\,Pa$

$48°C$ $150g$ **.I**

$-5°C$ $40g$

$C_nH_{2n+1}-NH_{2(l)}$	$N_{2(g)}$	$H_2O_{(l)}$	$CO_{2(g)}$	$O_{2(g)}$	
164.1	29.1	75.29	37.58	29.36	$Cp(j/mol.k)$

$c_e = 4.15\,j/g.k$, $C_g = 2.09\,j/g.k$, $L_{fus} = 334\,j/g$

$298K$ C_5H_{12} **.II**

$$C_5H_{12(l)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$$

$298K$ C_5H_{12}

$C_{(s)} \longrightarrow C_{(g)}$ $H^\circ = 717kj/mol$

$C_5H_{12(l)} \longrightarrow C_5H_{12(g)}$ $H^\circ = 26.33kj/mol$

	$H-H$	$C-H$	$C-C$
$E_{(A-B)}(Kj/mol)$			

$H_2O_{(g)} \longrightarrow H_2O_{(l)}$ $H_1^\circ = -44kj/mol$

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $H_2^\circ = -393kj/mol$

$C_{(s)} + 2O_{2(g)} + 2H_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$ $H_3^\circ = -878kj/mol$

$R = 8.314\,j/mol.k$ $298K$ U°

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.I

CO_2 $C_6H_{6(l)}$

$U = -3264.29kj/mol$ $25°C$

$R = 8.314\,j/mol.k$

$H_{f(CO2(g))} = -393kj/mol,$ $H_{f(H2O(l))} = -286kj/mol$

$H_{Liq(C6H6(l))} = -31kj/mol$

(C=C)

$H_{sub(C(s))} = 717kj/mol$

$C-C$	$C-H$	$H-H$	
348	413	436	$H_{diss}(kj/mol)$

T

$H_T = -3262.77(kj/mol)$

$C_6H_{6(l)}$	$H_2O(l)$	$CO_2(g)$	$O_2(g)$	
136	75.29	37.58	29.36	$Cp(j/mol.k)$

.II

$T_2 = 325K$ $T_1 = 300K$ $3mol$

$Cp = 30\,j/mol.K$ $P = 4bar$

W_{1-2}

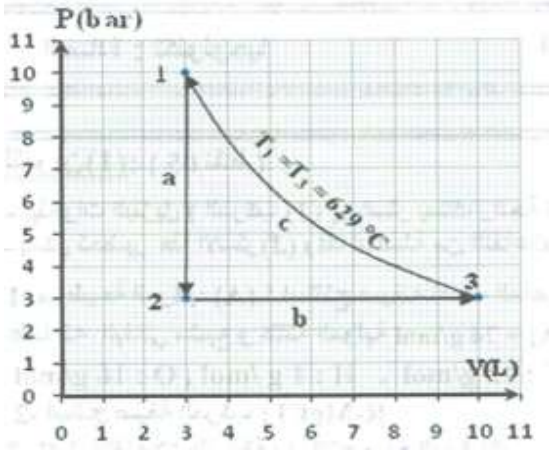
H Q

$R = 8.314\,j/mol.k,$ $1bar = 10^5\,pa$ U

C_v

.I

(c) (b) (a) $11.6g$



(P,V,T)

T_2

W

(a)

U kj

$j/mol.k$ Cv Cp

$1L = 10^{-3}\,m^3,\ 1bar = 10^5\,pa,\ M_{air} = 29g/mol$

$Cp/Cv = 1.67$ $R = 8.314\,j/mol.k$

.II

$P = 1atm$ $25°C$ $Gly_{(s)}$

$$NH_2 - CH_2 - COOH_{(s)} + \frac{9}{4}O_{2(g)} \longrightarrow 2CO_{2(g)} + \frac{5}{2}H_2O_{(l)} + \frac{1}{2}N_{2(g)} \quad H^{\circ}_{comb} = -1091\text{kj/mol}$$

$H°_{f(Gly(s))}$

$H_{f(CO2(g))} = -393kj/mol,$ $H_{f(H2O(l))} = -286kj/mol$

$Gly_{(s)}$ U

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$Gly_{(s)}$	$N_{2(g)}$	$H_2O_{(l)}$	$CO_2(g)$	$O_2(g)$	
8.5	29.1	75.29	37.58	29.36	$Cp(j/mol.k)$

$80°C$

$Gly_{(s)}$

$H°_{f(Gly(g))} = -273k/mol$

I. تفاعل إحتراق الكربون الصلب $C_{(s)}$ يتم وفقا للمعادلة التالية: $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$

تحت ضغط $1atm$ وحرارة $25°C$ ، نحرق داخل مسعر حراري سعته الحرارية C_{Cal} ويحتوي على $500g$ من الماء و $6g$ من الكربون $C_{(s)}$.

يرافق هذا الإحتراق إرتفاع درجة الحرارة ب $15°C$ وتحرير كمية من الحرارة قدرها $Q = -196.75Kj$.

أحسب السعة الحرارية للمسعر C_{Cal}.

إستنتج الأنطالبي المولي لتفاعل الإحتراق . ماذا يمثل كذلك هذا الأنطالبي؟

أحسب العمل W والتغير في الطاقة الداخلية U اللذان يرافقان هذا التفاعل.

أحسب أنطالبي تفاعل تشكل غاز $CO_{2(g)}$ عند $200°C$.

$R = 8.314\,j/mol.k,\quad 1atm = 1.013\times10^5\,pa,\quad c_e = 4.15\,j/g.k$

$C_{(s)}$	$CO_2(g)$	$O_2(g)$	المركب
8.57	37.58	29.36	$Cp(j/mol.k)$

II. 1. أكتب تفاعل تشكل الإيثانال الغازي $CH_3CHO_{(g)}$ ثم أحسب $H_{f(CH3CHO(g))}$ باستعمال أنطالبيات التفاعلات التالية:

$$CH_3CHO_{(g)} + \frac{5}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)} \qquad H_1^\circ = -1188kj/mol$$

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)} \qquad H_2^\circ = -285.9kj/mol$$

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)} \qquad H_3^\circ = -393.5kj/mol$$

2. يمكن تحضير الإيثانال الغازي $CH_3CHO_{(g)}$ إنطلاقا من تفاعل إماهة الأستلين $C_2H_{2(g)}$ حسب التفاعل التالي:

$$C_2H_{2(g)} + H_2O_{(l)} \xrightarrow{Hg2+} CH_3CHO_{(g)} \qquad H_r^\circ = ?$$

أ. احسب أنطالبي هذا التفاعل H_r° علما أن : $H_{f(C2H2(g))} = 226.7kj/mol$

ب. إستنتج طاقة الرابطة $C \equiv C$ في جزيء الأستلين $C_2H_{2(g)}$.

يعطى: $H_{vap(H2O(l))} = 40.6kj/mol$

نوع الرابطة	$O-H$	$C-H$	$C=O$	$C-C$
$E(Kj/mol)$	464	413	719.9	341.9

I.

$$6C_{(s)} + 6H_{2(g)} \longrightarrow C_6H_{12(g)}$$

$298K$ $\qquad H°_{f(C6H12(g))}$

$H_{sub(C(s))} = 717kj/mol$

C - C	C=C	C - H	H - H	
345	590	415	432	ΔH_{diss} (kj / mol)

$150°C$

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$C_{(s)}$	$C_6H_{12(g)}$	$H_{2(g)}$	
11.3	84.4	28.8	Cp(j / mol.k)

$(C_6H_{12(g)})$

$H°_{f(H2O(g))} = -242kj/mol$ $H°_{f(CO2(g))} = -393.5kj/mol$

$298K$ U

$R = 8.314\,j/mol.k$ 1Cal=4.18j

$H°_{Liq} = -11.4kcal/mol$

$H°_{f((C6H12)(l))}$

$m_1 = 250g$ $C = 120\,j/K$ .I

$m_2 = 12g$ $T_1 = 20°C$

$T_2 = -20°C$

$T_f = -15.5°C$

C_g -

c_e=4.185j/g.k , $L_{fus} = 333\,j/K$, $T_{fus} = 0°C$

$300K$ .II

$2CO_{(g)} \longrightarrow C_{(s)} + CO_{2(g)}$ $H_1 = -172kj/mol$

$MnO_{(s)} + CO_{(g)} \longrightarrow Mn_{(s)} + CO_{2(g)}$ $H_2 = -105kj/mol$

$3MnO_{(s)} + 5CO_{(g)} \longrightarrow Mn_3C_{(s)} + 4CO_{2(g)}$ $H_3 = -129kj/mol$

$300K$ $H°_{f(Mn3C(s))}$

$300K$

$3Mn_{(s)} + 2CO_{(g)} \longrightarrow Mn_3C_{(s)} + CO_{2(g)}$

.III

$H_2C{=}CH{-}\overset{\overset{O}{//}}{C}{-}H$

$25°C$

$25°C$ $H°_f(CH_2 = CH - CHO_{(l)})$

$H°_{vap}$

$15g$

$H_{f(H2O(l))} = -286kj/mol$, $H_{f(CO2(g))} = -393kj/mol$, $H_{Comb} = -1630kj/mol$

	$H-H$	$O=O$	$C=O$	$C-C$	$C-H$	$C=C$
$E(Kj/mol)$	435	498			415	620

$H_{sub(C(s))} = 717kj/mol$

$C:12g/mol$, $H:1g/mol$, $O:16g/mol$

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.I

T_1 m_1 C

T_f T_2 m_2

$T_f(°C)$	$T_2(°C)$	$T_1(°C)$	$m_2(g)$	$m_1(g)$	
20.5	88	16.5	118	125	
23.7	75	20	118	91.3	

				$J/g.K$

C_e=4.185j/g.k

.II

$25°C$ $CH_2N_{2(s)}$

$$CH_2N_{2(s)} + \frac{3}{2}O_2 \longrightarrow CO_{2(g)} + H_2O_{(l)} + N_{2(g)}$$

H°_{comb}

$\Delta H_{f(CH2N2(s))} = 58.79kj/mol$ $\Delta H_{f(CO2(g))} = -393kj/mol$ $\Delta H_{f(H2O(l))} = -286kj/mol$

$CH_2N_{2(s)}$ $20g$

$R = 8.314\,j/mol.k$ $25°C$ $(Q_p - Q_v)$

$110°C$ $80°C$

$CH_2N_{2(s)}$	$H_2O_{(g)}$	$N_{2(g)}$	$H_2O_{(l)}$	$CO_{2(g)}$	$O_{2(g)}$	
1.86	1.87	1.04	4.185	0.845	0.9175	$Cp(j/g.k)$

$N = 14$,$C = 12$, $H = 1$, $O = 16$ (g/mol) ,$T_{vap}(H_2O) = 100°C$

$C_{(s)}$ I

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

$C_{(s)}$ 6g $25°C$ 1atm

$\Delta T = 15K$ 500g C_{cal}

$Q_{comb} = -196,75KJ$

C_{cal} 1

2

ΔU W 3

$C_{H_2O} = 4,185J/mol.K$; $R = 8,314J/mol.K$; $1atm = 1,.013.10^5\,Pa$

$200°C$ $CO_{2(g)}$ 4

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	$CO_{2(g)}$	$C_{(s)}$	$O_{2(g)}$
C_P(J/mol.K)	37,1	8,57	29,4

1 II

1) $CH_3CHO_{(g)} + \frac{5}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)}$ $\Delta H_1^o = -1188KJ/mol$

2) $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H_2^o = -285,9KJ/mol$

3) $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_3^o = -393,5KJ/mol$

$CH_3CHO_{(g)}$ -أ

$\Delta H_f^o\left(CH_3CHO\right)_{(g)}$ -ب

.2

$C_2H_{2(g)} + H_2O_{(l)} \xrightarrow{Hg^{2+}} CH_3CHO_{(g)}$ $\Delta H_r^o = ?$

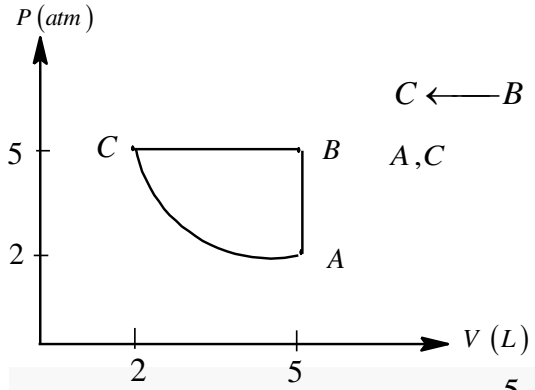
$\Delta H_f^o\left(C_2H_2\right)_{(g)} = 226,7KJ/mol$ ΔH_r^o

$C_2H_{2(g)}$ $E(C\equiv C)$

$\Delta H_{vap}^o\left(H_2O\right)_{(l)} = 44KJ/mol$

	C-H	O-H	C=O	C-C
E(KJ/mol)	413	464	719.6	341.9

0,5 mol -I



$C \longleftarrow B$ $B \longleftarrow A$ ①

A, C T ②

$A \longleftarrow C$ ③

Q W ④

ΔU

$1atm = 1,01325 \times 10^5 (Pa)$, $C_V = \frac{5}{2} \times R$, $R = 8,314\ J/mol.K$

T_1=16 °C $V_1 = 350mL$ C=209J/K -II

T_2= ? $m_2 = 280g$

T_f=17.7 °C

T_2

C_{eau}=4.185J/g.K $C_{plomb} = 0,13J/g.K$ ✓

25°C -III①

$C_3H_{6(g)} + ..O_{2(g)} \longrightarrow ..CO_{2(g)} + ..H_2O_{(l)}$ $\Delta U = -2050,7KJ.mol^{-1}$

$R=8,314J.mol^{-1}.K^{-1}$ ΔH_{Comb}°

① ΔH_{Comb}° ②

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(P₁=2atm,T₁=273K) (1) 1mol II

($\frac{V}{T} = cste$) (T₂ 298 (2)

V_2 , P_2 , V_1

$C_V = \frac{3}{2}R$ $R = 8.314\ j.mol^{-1}.K^{-1}$ W Q

ΔH ΔU

$1m^3 = 10^3L$, $1atm = 1{,}01325.10^5\ Pa$

E_{C-H} = 413kj/mol , $\Delta H^0_{d(H-H)}$ = 436 kj/mol ,$\Delta H^0_{sub(C)}$ = 716,7 kj/mol. R = 8,314 j/mol.k ,1cal = 4,185j

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(\ )} \qquad \Delta H_1^\circ = -285{,}5\ KJ.mol^{-1}$$

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)} \qquad \Delta H_2^\circ = -393{,}5\ KJ.mol^{-1}$$

$$3C_{(s)} + 3H_{2(g)} \longrightarrow C_3H_{6(g)} \qquad \Delta H_3^\circ = +19KJ.mol^{-1}$$

$\Delta H_f^\circ\left(C_3H_{6(g)}\right)$. ③

25C⁰ $C_5H_{12(g)}$ 1

$C_5H_{12(g)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$ ΔH^0_r = -3537kj/mol

25C⁰ $\Delta H^0_f\ (C_5H_{12(g)})$

25C⁰ ΔU

50C⁰

	$C_5H_{12(g)}$	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
ΔH^0_f (kj/mol)		/	-393	-286
C_P (cal/mol.k)	28,72	7,01	8,94	18

E_{C-C}

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تمارين التيرموديناميك الواردة في البكالوريا من 2009 الى 2021

01 2009 1

$298K$

$$CH_{4(g)} + 4Cl_{2(g)} \longrightarrow CCl_{4(g)} + 4HCl_{(g)}$$

$$\Delta H_r^\circ = -401.08kj/mol$$

$\Delta H_f^\circ(CH_{4(g)})$	$\Delta H_f^\circ(HCl_{4(g)})$	$\Delta H_{Vap}^\circ(CHCl_{3(l)})$	$\Delta H_{diss}^\circ(C-H)$	$\Delta H_{diss}^\circ(H-H)$	$\Delta H_{diss}^\circ(Cl-Cl)$	$\Delta H_{sub}^\circ(C)$
$-74.6kj/mol$	$-92.3kj/mol$	$30.4kj/mol$	$415kj/mol$	$432kj/mol$	$242.6kj/mol$	$716.7kj/mol$

	$CH_{4(g)}$	$Cl_{2(g)}$	$HCl_{(g)}$	$CCl_{4(g)}$
$C_p(J/K.mol)$	35,91	33,93	29,12	83,51

1 $298K$

2 $CCl_{4(g)}$

3 $C-Cl$

4 $\Delta H_f^\circ(CHCl_{3(l)})$

02 2009 2

1

$$8C_{(S)} + 9H_{2(g)} \xrightarrow{H_f(C_8H_{18(g)})} C_8H_{18(g)}$$

$$8C_{(S)} \xrightarrow{8\Delta H_{sub}^\circ(C_{(S)})} 8_{(S)} \qquad 9H_{2(g)} \xrightarrow{9\Delta H_{diss}^\circ(H-H)} 18_{(g)}$$

$$18_{(g)} \xrightarrow{7E(C-C)+18E(C-H)} C_8H_{18(g)}$$

$298K$ $\Delta H_f^\circ(C_8H_{18})_{(g)}$ -

$\Delta H_{dis}^\circ(H-H) = 436kj/mol$, $\Delta H_{Sub}^\circ(C_{(S)}) = 716.7kj/mol$

$E(C-H) = -415kj/mol$, $E(C-C) = -345kj/mol$

$C_8H_{18(g)}$ 2

$\Delta H_f^\circ(H_2O_{(g)}) = -241.83kj/mol$, $\Delta H_f^\circ(CO_{2(g)}) = -393.5kj/mol$

$298K$ ΔU 3

$R = 8.31j/mol.K$

01 2010 03

$25°C$

$$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(g)}$$

1

$3C_{(S)} + 4H_{2(g)} \longrightarrow 3C_3H_{8(g)}$ $\Delta H_1^\circ = -103.8kJ/mol$

$C_{(S)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_2^\circ = -393.5kJ/mol$

$H_{2(g)} + 1/2O_{2(g)} \longrightarrow H_2O_{(g)}$ $\Delta H_3^\circ = -241.8kJ/mol$

$700°C$ 2

$C_3H_{8(g)}$ $C-H$ 3

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	$C_3H_{8(g)}$	$H_2O_{(g)}$	$O_{2(g)}$	$CO_{2(g)}$
$C_p(J/mol.K)$	73,89	34,23	29,37	37,20

$\Delta H^{\circ}_{sub}(C_{(S)}) = 717kj/mol$ $E_{(C-C)} = -347.3kj/mol$ $\Delta H^{\circ}_{dis}(H_2) = 436kj/mol$

02 2010 04

1 $28g$ N_2 $2,445L$ $24,45L$

$25°C$

N_2

N_2

$R = 8.31j/mol.K$, N=14g/mol

2 N_2 O_2

$N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$ $\Delta H^{\circ}_1 = 180kJ$

$NO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow NO_{2(g)}$ $\Delta H^{\circ}_2 = -57kJ$

ΔH_3

$N_{2(g)} + 2O_{2(g)} \longrightarrow 2NO_{2(g)}$

3

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

$\Delta H = -92kj$ $25°C$

$500°C$ -

$C_p(N_2) = 29,10J/mol.K$

$C_p(H_2) = 28,90J/mol.K$

$C_p(NH_3) = 36,1J/mol.K$

4 $25°C$

$NH_{3(g)} + \frac{5}{4}O_{2(g)} \longrightarrow NO_{(g)} + \frac{3}{2}H_2O_{(g)}$

$\Delta H = -226.7kj$

$25°C$ ΔU -

01 2011 5

1 $25°C$

$H_{2(g)} + 1/2O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H^{\circ}_1 = -286kJ/mol$

$CO_{2(g)} + 1/2O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H^{\circ}_2 = -283kJ/mol$

$C_2H_5OH_{(l)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ $\Delta H^{\circ}_3 = -1368kJ/mol$

$25°C$

$2CO_{(g)} + 4H_{2(g)} \longrightarrow C_2H_5OH_{(l)} + H_2O_{(l)}$

$CO_{(g)}$ ΔH°_f

2 $25°C$ **3** ΔU

$R = 8.31j/mol.K$

02 2011 06

$12°C$ C_2H_4 $1g$ I

$C_2H_{4(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)}$

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1 $1g$

$1000g$ $C_{eau} = 4.19\,j/g.°C$

2 $1mol$

$C = 12g/mol$, $H = 1g/mol$

ΔH

3 ΔH_f°

$\Delta H_f^\circ(H_2O_{(l)}) = -286kJ/mol$, $\Delta H_f^\circ(C_2H_{4(g)}) = 52kJ/mol$

II

$C_2H_{4(g)} + H_2O_{(l)} \longrightarrow C_2H_4OH_{(l)}$ $\Delta H = -43kJ/mol$

-

$\Delta H_{vap}^\circ(C_2H_4OH_{(l)}) = -84.6kJ/mol$

$25°C$ III

$C_2H_{4(g)} + H_{2(g)} \xrightarrow{Ni} C_2H_{6(g)}$

$\Delta H_f^\circ(C_2H_{6(g)}) = -84.6kJ/mol$ ΔH_r 1

$25°C$ ΔU 2

$R = 8.31\,j/mol/K$

01	2012	07

$25°C$

$C_2H_5OH_{(l)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$

$\Delta H_{com} = -1368kJ/mol$

1

2 $\Delta H_f^\circ(C_2H_5OH_{(l)})$

$\Delta H_f^\circ(CO_{2(g)}) = -393kJ/mol$

$\Delta H_f^\circ(H_2O_{(l)}) = -286kJ/mol$

3 $\Delta H_{vap}^\circ = 42.63kJ/mol$

$\Delta H_f^\circ(C_2H_5OH_{(g)})$

4 $25°C$ ΔU

$R = 8.31\,j/mol/K$

5 (C-C)

$\Delta H_{sub}^\circ(C_{(s)}) = 717kJ/mol$, $E_{C-H} = -413kJ/mol$

$\Delta H_{dis}^\circ(H-H) = 436kJ/mol$, $E_{C-O} = -351kJ/mol$

$\Delta H_{dis}^\circ(O=O) = 498kJ/mol$, $E_{O-H} = -463kJ/mol$

02	2012	08

1 $\Delta H_{comb} = -3268kJ/mol$ $25°C$

$\Delta H_f^\circ(C_6H_{6(l)})$

$\Delta H_f^\circ(CO_{2(g)}) = -393kJ/mol$, $\Delta H_f^\circ(H_2O_{(l)}) = -286kJ/mol$

2 $65°C$

$C_p(C_6H_{6(l)}) = 135,17kJ/mol.K$, $C_p(O_{2(g)}) = 29.5kJ/mol.K$

$C_p(CO_{2(g)}) = 37.20kJ/mol.K$, $C_p(H_2O_{(l)}) = 75.30kJ/mol.K$

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ΔH°_{vap} **3**

$7,8g$

$\Delta H^{\circ}_{f}(C_6H_{6(g)}) = 83kJ/mol$, C=12g/mol , H=1g/mol

01 2013 09

$25°C$

1) $2NH_{3(g)} + 3/2O_{2(g)} \longrightarrow N_{2(g)} + 3H_2O_{(l)}$ ΔH_1

2) $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$ $\Delta H_2 = -92kJ$

$\Delta H^{\circ}_{f}(NH_{3(g)})$ **1**

1 ΔH_1 **2**

$\Delta H^{\circ}_{f}\left(H_2O_{(l)}\right) = -286kJ/mol$

1 $(\Delta H - \Delta U)$ **3**

$H_2O_{(l)}$

$H_2O_{(g)}$

$R = 8.31j/mol/K$

$NH_{3(g)}$ $(N-H)$ **4**

$\Delta H^{\circ}_{dis}(N \equiv N) = 945kJ/mol$

$\Delta H^{\circ}_{dis}(H-H) = 436kJ/mol$

$550°C$ **2** ΔH_2 **5**

$C_p(H_2) = 27,25 + 3,2\times10^{-3}T$ $J/K.mol$

$C_p(N_2) = 27,84 + 4,2\times10^{-3}T$ $J/K.mol$

$C_p(NH_3) = 29,72 + 2,5\times10^{-3}T$ $J/K.mol$

02 2013 10

.I

$CH_3OH_{(l)} + 3/2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$

$\Delta U = -724,76kJ/mol$ $25°C$

$R = 8.31j/mol/K$ **1**

$CH_3OH_{(l)}$ ΔH°_{f} **2**

$\Delta H^{\circ}_{f}\left(CO_{2(g)}\right) = -393kJ/mol$

$\Delta H^{\circ}_{f}\left(H_2O_{(l)}\right) = -286kJ/mol$

CH_3OH $(C-O)$ **3**

$\Delta H^{\circ}_{vap}(CH_3OH) = 35.4kJ/mol$, $E_{C-H} = -413kJ/mol$

$\Delta H^{\circ}_{sub}\left(C_{(s)}\right) = 717kJ/mol$, $E_{O-H} = -463kJ/mol$

$\Delta H^{\circ}_{dis}(H-H) = 436kJ/mol$, $\Delta H^{\circ}_{dis}(O=O) = 498kJ/mol$

$P_1 = 1atm$ $(V_1 = 24,5L)$ **1** **.II**

$25°C$ $P_2 = 10atm$

$R = 8.31j/mol.K$, $1atm = 1,013\times10^5Pa$

(W)

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ΔU

(Q)

$P = 30atm$ $V_2 = 1L$ $V_1 = 0.9L$ **2**

01 2014 11

1

$\Delta H_f^\circ(C_4H_{10(g)})$

$\Delta H_{sub}^\circ(C_{(s)}) = 717kJ/mol$

	$C-C$	$C-H$	$H-H$
$E(kJ/mol)$	**348**	**413**	**436**

$25°C$ **2**

$\Delta H_f^\circ(CO_{2(g)}) = -393kJ/mol$, $\Delta H_f^\circ(H_2O_{(l)}) = -286kJ/mol$

$25°C$ ΔU

$R = 8.31j/mol.K$

3

$\Delta H_{comb}^\circ(C_4H_{10(g)}) = -2870kJ/mol$

	$C_4H_{10(g)}$	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
$C_p(J/mol.K)$	**100,6**	**29,37**	**37,20**	**75,30**

3L **298K** **0.5mol** **4**

10L

02 2014 12

1

$$nC_{(s)} + (n+1)H_{2(g)} \longrightarrow C_nH_{2n+2(g)}$$

n $\Delta H_f^\circ(C_nH_{2n+2(g)})$

$(2n+2)$ $C-H$ $(n-1)$ $C-C$

$\Delta H_{sub}^\circ(C_{(s)}) = 717kJ/mol$

	$C-C$	$C-H$	$H-H$
$E(kJ/mol)$	**348**	**413**	**436**

$\Delta H_f^\circ(C_nH_{2n+2(g)}) = -84,6kJ/mol$

$25°C$ **2**

$H_{2(g)} + 1/2O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H_1^\circ = -285,6kJ/mol$

$CH_3 - CH_{3(g)} + 7/2O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ $\Delta H_2^\circ = -1559,8kJ/mol$

$CH_2 = CH_{2(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)}$ $\Delta H_3^\circ = -1411,3kJ/mol$

ΔH_4°

$T_0 = 25°C$ **3**

$E(O-H)$

$\Delta H_{vap}^\circ(H_2O) = 44kJ/mol$, $E_{O=O} = 498kJ/mol$

$T = 80°C$

	$H_{2(g)}$	$O_{2(g)}$	$H_2O_{(l)}$
$C_p(J/mol.K)$	**28.84**	**29,37**	**75,30**

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01 2015 13

$25°C$ $\Delta H_f^\circ\left(C_3H_{6(g)}\right)$ 1

$E_{C-H} = -413kJ/mol$, $E_{C=C} = -614kJ/mol$, $E_{C-C} = -348kJ/mol$

$\Delta H_{dis}^\circ\left(H-H\right) = 436kJ/mol$, $\Delta H_{sub}^\circ\left(C_{(s)}\right) = 717kJ/mol$

$1atm$ $25°C$ 2

ΔH_r°

$\Delta H_f^\circ\left(C_3H_{8(g)}\right) = -103,6kJ/mol$

100°C

	$H_{2(g)}$	$C_3H_{6(g)}$	$C_3H_8O_{(g)}$
$C_p(J/mol.K)$	**6,91**	**111,78**	**73.89**

$25°C$ 3

(ΔH_{comb}°)

$H_{2(g)} + 1/2O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H_1^\circ = -285,8kJ/mol$

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_2^\circ = -393,5kJ/mol$

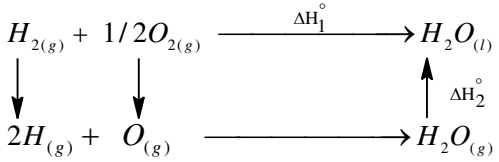
$3C_{(s)} + 3H_{2(g)} \longrightarrow 2C_3H_{6(g)}$ $\Delta H_f^\circ\left(C_3H_{6(g)}\right)$

$25°C$ (ΔU)

$R = 8.31j/mol/K$

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1



$E_{O-H} = -463kJ/mol$, $\Delta H_{dis}^\circ\left(O=O\right) = 498kJ/mol$

$\Delta H_{dis}^\circ\left(H-H\right) = 436kJ/mol$, $\Delta H_2^\circ = -44kJ/mol$

ΔH_2°

ΔH_1°

ΔH_4° ΔH_3° 2

$C_{(s)} + 1/2\,O_{2(g)} \longrightarrow CO_{(g)}$ $\Delta H_3^\circ = ?$

$C_{(\ )} + CO_{2(\ )} \longrightarrow 2CO_{(g)}$ $\Delta H_4^\circ = ?$

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_5^\circ = -393kJ/mol$

$CO_{(g)} + 1/2O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_6^\circ = -283kJ/mol$

$25°C$ 3

$C_2H_{4(g)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$ $\Delta H_r^\circ = -1396kJ/mol$

$\Delta H_f^\circ\left(C_2H_{4(g)}\right)$

$(C=C)$

$(C=C)$

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$\Delta H^{\circ}_{sub}(C_{(s)}) = 717kJ/mol$ ، $E_{C-H} = -413kJ/mol$ ، $\Delta H^{\circ}_{dis(H-H)} = 436kJ/mol$

$90°C$ C_2H_4 ΔH°_r

	$C_2H_{4(g)}$	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
$C_p(J/mol.K)$	43	29,50	37,20	75,24

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$m = 8,5g$ NH_3 .I

$(P_2, V_2 = 4L, T_2)$ $(P_1 = 6atm, V_1 = 6L, T_1)$

NH_3

T_2, P_2, T_1 1

W 2

Q_p

$R = 8.31j/mol/K$ ، $C_p(NH_{3(g)}) = 33.6J/mol/K$

$1atm = 1,013 \times 10^5 Pa$ ، H=1g/mol ، N=14g/mol

CH_3COCH_3 .II

1

$\Delta H^{\circ}_f(CH_3COCH_{3(g)})$ 2

$\Delta H^{\circ}_{sub}(C_{(s)}) = 717kJ/mol$

	$H-H$	$O=O$	$C-H$	$C-C$	$C=O$
$\Delta H^{\circ}_{dis}(kJ/mol)$	436	498	414	348	711

$25°C$ 3

$\Delta H^{\circ}_{comb} = -1821,38kJ/mol$

$\Delta H^{\circ}_f(CH_3COCH_{3(l)})$

$\Delta H^{\circ}_{vap}(CH_3COCH_3)$

$\Delta H^{\circ}_f(CO_{2(g)}) = -393kJ/mol$ ، $\Delta H^{\circ}_f(H_2O_{(l)}) = -286kJ/mol$

$25°C$ ΔU 4

$R = 8.31j/mol/K$

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$25°C$ .I

$C_3H_{8(g)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$ $\Delta H^{\circ}_r = ?$

1

$\Delta H^{\circ}_f(C_3H_{8(g)})$ 2

$\Delta H^{\circ}_{sub}(C_{(s)}) = 717kJ/mol$

	$H-H$	$C-C$	$C-H$
$\Delta H^{\circ}_{dis}(kJ/mol)$	436	348	413

ΔH°_r 3

$\Delta H^{\circ}_f(CO_{2(g)}) = -393kJ/mol$ ، $\Delta H^{\circ}_f(H_2O_{(l)}) = -286kJ/mol$

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4 $50°C$

	$C_3H_{8(g)}$	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
$C_p(J/mol.K)$	**73,51**	**29,36**	**37,45**	**75,24**

$25°C$ $(\Delta H-\Delta U)$ 5

$R=8.31\,j/mol/K$

.II $C_{Cal}=100J/K$ $m_1=100g$

$T_1=25°C$ $m_2=80g$ $T_2=80°C$

c=4,18J/g.K T_{eq} -

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1 $25°C$

$$C_6H_5COOH_{(s)} + ...O_{2(g)} \longrightarrow .....CO_{2(g)} + ... H_2O_{(l)}$$

(ΔH_r°)

$\Delta H_{comb}^\circ = -3227kJ/mol$

$\Delta H_f^\circ\left(CO_{2(g)}\right) = -393kJ/mol$

$\Delta H_f^\circ\left(H_2O_{2(l)}\right) = -286kJ/mol$

2

	$C_6H_5COOH_{(g)}$	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
$C_p(J/mol.K)$	**146,7**	**29,36**	**37,58**	**75,29**

ΔH_{fus}° 3

$\Delta H_f^\circ(C_6H_5-COOH_{(l)}) = -362.4kJ/mol$

4 24,4g (Q)

H=1g/mol , C=12g/mol , O=16g/mol

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.I $C_4H_{8(g)}$ 1 $25°C$ 1atm

1 1

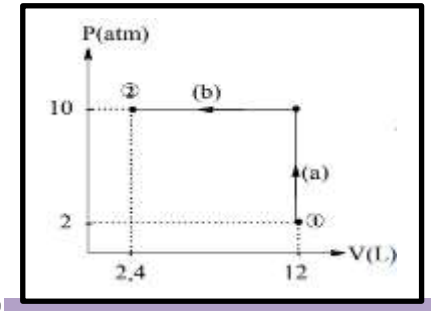
1 2

	$C_4H_{8(g)}$	$H_2O_{(l)}$	$CO_{2(g)}$
$\Delta H_f(kJ/mol)$	**-0.4**	**-286**	**-393**

1 3

	$H-H$	$C=C$	$C-H$	$C-C$
$\Delta H_{dis}^\circ(kJ/mol)$	436	612	413	348

.II P=f(V) 1 2



(b) (a) 1

W 2

$1atm=1{,}013\times10^5 Pa$

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.I

$MgO_{(s)} + 2(H_3O^+,Cl^-)_{(aq)} \longrightarrow (Mg^{2+},2Cl^-)_{(aq)} + 3H_2O_{(l)}$ $\Delta H_1^\circ = ?$

HCl $V_1 = 100ml$ $C = 100J/K$

$m = 1.5g$ $T_1 = 25°C$ 0,744mol/L

$T_f = 35.5°C$ MgO

$m_{sol} = m_{H_2O}$ c_{sol}=4,185J/g.K

Q_r **1**

ΔH_1° **2**

M_{Mg}=24.3g/mol , M_O=16g/mol , ρ_{H_2O}=1g/ml

3

$Mg_{(s)} + 1/2O_{2(g)} \longrightarrow MgO_{(s)}$ $\Delta H_f^\circ(MgO_{(s)})$

$Mg_{(s)} + 2(H_3O^+,Cl^-)_{(aq)} \longrightarrow (Mg^{2+},2Cl^-)_{(aq)} + H_{2(g)} + 2H_2O_{(l)}$ $\Delta H_2^\circ = -461,95kJ/mol$

$H_{2(g)} + 1/2O_{2(g)} \longrightarrow H_2O_{(g)}$ $\Delta H_3^\circ = -242kJ/mol$

$H_2O_{(g)} \longrightarrow H_2O_{(l)}$ $\Delta H_4^\circ = -44kJ/mol$

Ne 0,5mol **.II**

a **2** **1** -

b **3** **2** -

$m_{eau} = 400g$ $(C_{Cal} = 130,8J/K)$

$T_i = 20°C$

$C_2H_5\text{-}NH_2$ 2,25g

$T_f = 68.2°C$

$C_2H_5\text{-}NH_{2(g)} + 15/4O_{2(g)} \longrightarrow 2CO_{2(g)} + 7/2H_2O_{(l)} + 1/2N_{2(g)}$

(Q_1) **1**

(Q_2) **2**

c_{eau}=4,18J/g.K

H=1g/mol , C=12g/mol , N=14g/mol

ΔH_{comb}° **3**

$\Delta H_f^\circ(C_2H_5\text{-}NH_{2(g)})$ **4**

$\Delta H_f^\circ(CO_{2(g)}) = -393kJ/mol$

$\Delta H^\circ(H_2O_{2(\ )}) = -286kJ/mol$

(N-H) 5

$\Delta H_{sub}^\circ(C_{(s)}) = 717kJ/mol$

	$H-H$	$N \equiv N$	$C-H$	$C-C$	$C-N$
$\Delta H_{dis}^\circ(kJ/mol)$	436	945	414	348	292

6

Al=27g/mol $C_{Al} = 24.35J/mol.K$

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	$(1) \xrightarrow{a} (2) \xrightarrow{b} (3)$		
	1	**2**	**3**
(Pa)	$P_1 = 10^5$	$P_2 = ?$	$P_3 = 2\times10^5$
(L)	$V_1 = 12$	$V_2 = 18$	$V_3 = ?$
(K)	$T_1 = ?$	$T_2 = 433$	$T_3 = 866$

1

b **a** Q W **2**

$R = 8.31 j/mol.K$, $C_p = 20,78 j/mol.K$, $C_p - C_v = R$

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.I

$25°C$ (A)

$$C_nH_{2n+2}O_{(l)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$$

1

(A) **2**

$\Delta H^\circ_{comb}(C_nH_{2n+2}O_{(l)}) = -1368 kJ/mol$, $\Delta H^\circ_f(C_nH_{2n+2}O_{(l)}) = -277 kJ/mol$

$\Delta H^\circ_f(CO_{2(g)}) = -393 kJ/mol$, $\Delta H^\circ_f(H_2O_{2(l)}) = -286 kJ/mol$

(A) **3**

$\Delta H^\circ_{vap}(C_nH_{2n+2}O_{(l)}) = 43,5 kJ/mol$

(A) $(O-H)$ **4**

$\Delta H^\circ_{sub}(C_{(s)}) = 717 kJ/mol$

	$H-H$	$C-O$	$C-H$	$C-C$	$O=O$
$E(kJ/mol)$	**436**	**351**	**413**	**348**	**498**

.II

$m_1 = 50g$ C_{Cal}

$T_2 = 30°C$ $m_2 = 100g$ $T_1 = 20°C$

$T_{eq} = 25,7°C$

$c_{eau} = 4,18 J/g.K$ C_{Cal}

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$(m = 3g)$ **1**

$20,56°C$ $25°C$ V=1L $C_{Cal} = 155 j/K$

Q_{comb}

ΔH_{comb}

$c_{H_2O} = 4,18 J/g.K$, $\rho_{H_2O} = 1 g/ml$

H=1g/mol , C=12g/mol , O=16g/mol

2

$$1) C_6H_{12}O_{6(s)} + 3O_{2(g)} \longrightarrow C_2H_5OH_{(l)} + 4CO_{2(g)} + 3H_2O_{(l)} \quad \Delta H^\circ_1$$

$25°C$ **1**

$$2) C_6H_{12}O_{6(s)} + O_{2(g)} \longrightarrow 2C_3H_4O_{3(l)} + 2H_2O_{(l)} \quad \Delta H^\circ_2 = -471 kJ/mol$$

$$3) C_3H_4O_{3(l)} + 5/2O_{2(g)} \longrightarrow 3CO_{2(g)} + 2H_2O_{(l)} \quad \Delta H^\circ_3 = -1165 kJ/mol$$

$$4) C_2H_5OH_{(l)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)} \quad \Delta H^\circ_{comb}$$

$55°C$ **1**

	$C_6H_{12}O_{6(s)}$	$O_{2(g)}$	$C_2H_5OH_{(l)}$	$CO_{2(g)}$	$H_2O_{(l)}$
$C_p(J/K.mol)$	14,185+0,693T	**29.36**	**111.46**	**37.45**	**75.29**

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$\Delta H^{\circ}_{comb}\left(C_3H_6O_{(l)}\right)$

$\Delta H^{\circ}_{f}\left(CO_{2(g)}\right)=-393,5kJ/mol$, $\Delta H^{\circ}_{f}\left(H_2O_{2(l)}\right)=-286kJ/mol$

$25°C$ ΔU

$R=8,314J/mol.K$

$C_3H_6O_{(l)}$ 1,45g $C_3H_6O_{(l)}$ **3**

$\Delta T=18,1K$ $m_{eau}=600g$

c_{eau} =4,18J/g.K

Q

$\Delta H^{\circ}_{comb}\left(C_3H_6O_{(l)}\right)$

H=1g/mol , C=12g/mol , O=16g/mol

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.I $300ml$ $T_1=20°C$ $200ml$

$T_f=50°C$ $T_2=75°C$

1

c_{eau} =4,18J/g.K , $\rho_{H_2O}=1g.ml^{-1}$

$T_{eq}=37°C$ $500ml$ **2**

$T_2=75°C$ V_2 $T_1=20°C$ V_1

V_2 V_1

.II (N=O) $\Delta H^{\circ}_{f}(NO_{(g)})$ **1**

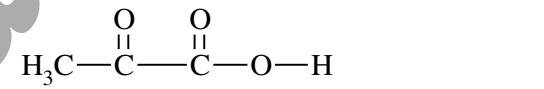
	$N\equiv N$	$O=O$	$N=O$
$\Delta H^{\circ}_{d}(kJ/mol)$	945	498	631

$\Delta H^{\circ}_{f}\left(C_3H_4O_{3(l)}\right)$ **3**

$\Delta H^{\circ}_{f}\left(H_2O_{2(l)}\right)=-286kJ/mol$, $\Delta H^{\circ}_{f}\left(C_6H_{12}O_{6(s)}\right)=-1273kJ/mol$

$\Delta H^{\circ}_{d}(C=O)$ $(C=O)$ **4**

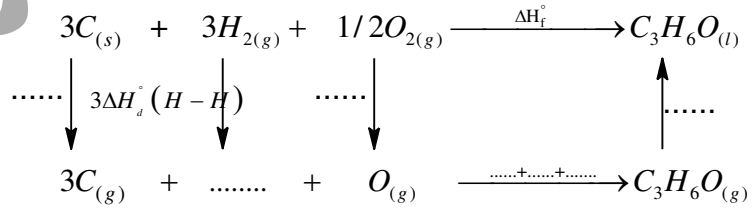
$\Delta H^{\circ}_{sub}\left(C_{(s)}\right)=717kJ/mol$, $\Delta H_{vap}\left(C_3H_4O_3\right)=52.4kJ/mol$



	$H-H$	$O=O$	$C-H$	$C-C$	$C-O$	$O-H$
$\Delta H^{\circ}_{d}(kJ/mol)$	436	498	413	348	351	463

01 2018 23

$C_3H_6O_{(l)}$ **1**



$\Delta H^{\circ}_{f}\left(C_3H_6O_{(l)}\right)$

$\Delta H^{\circ}_{sub}\left(C_{(s)}\right)=717kJ/mol$, $\Delta H_{vap}(C_3H_6O)=29.7kJ/mol$

	$H-H$	$O=O$	$C-H$	$C-C$	$C=O$
$\Delta H^{\circ}_{d}(kJ/mol)$	437	498	410	347	749

$25°C$ $C_3H_6O_{(l)}$ **2**

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$25°C$ 2

$2NH_{3(g)} + 5/2O_{2(g)} \longrightarrow 2NO_{(g)} + 3H_2O_{(l)}$ $\Delta H_r^\circ = -46kJ/mol$

$\Delta H_f^\circ(H_2O_{(l)})$

$\Delta H_f^\circ(NH_{3(g)}) = -46kJ/mol$

$90°C$ ΔH_r° 3

	$NH_{3(g)}$	$O_{2(g)}$	$NO_{(g)}$	$H_2O_{(l)}$
$C_p(J/K.mol)$	35.06	29.37	29.84	75.24

$V_{NH_3} = 0.1mol.L^{-1}.s^{-1}$ 4

V_{H_2O}. V_{O_2}

01 2019 25

723g $C_3H_{8(g)}$ 1,32g 1

$\Delta T = 22K$

c_{eau} =4,18J/g.K

Q

$\Delta H_{comb}^\circ(C_3H_{8(g)})$

H=1g/mol , C=12g/mol

$C_3H_{8(g)}$

$\Delta H_f^\circ(C_3H_{8(g)})$

$\Delta H_f^\circ(CO_{2(g)}) = -393kJ/mol$, $\Delta H_f^\circ(H_2O_{2(l)}) = -286kJ/mol$

$\Delta H_f^\circ(C_3H_{8(g)})$ 2

$\Delta H_{sub}^\circ(C_{(s)}) = 717kJ/mol$ $25°C$

	$H-H$	$C-H$	$C-C$
$\Delta H_d^\circ(kJ/mol)$	436	413	347

3

$C_3H_7Cl_{(l)} + H_{2(g)} \longrightarrow C_3H_{8(g)} + HCl_{(g)}$ $\Delta H_1^\circ = -52kJ/mol$

$C_3H_{6(g)} + HCl_{(g)} \longrightarrow C_3H_7Cl_{(l)}$ $\Delta H_1^\circ = -72kJ/mol$

ΔH_3°

$C_3H_{6(g)} + H_{2(g)} \longrightarrow C_3H_{8(g)}$ $\Delta H_3^\circ = ?$

$\Delta H_f^\circ(C_3H_7Cl_{(l)})$

$\Delta H_f^\circ(HCl_{(g)}) = -92kJ/mol$

$(\Delta H_{d(C-Cl)}^\circ)$ C-Cl

$\Delta H_{vap}^\circ(C_3H_7Cl_{(l)}) = 27kJ/mol$, $\Delta H_{d(Cl-Cl)}^\circ = 242kJ/mol$

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1atm $25°C$ $Gly_{(s)}$ 1

$NH_2-CH_2-COOH_{(s)} + ...O_{2(g)} \longrightarrow .....CO_{2(g)} + ... H_2O_{(l)} + ...N_{2(g)}$ ΔH_{comb}°

$Gly_{(s)}$

$25°C$ ΔH_{comb}°

	$Gly_{(s)}$	$H_2O_{(l)}$	$CO_{2(g)}$
$\Delta H_f(kJ/mol)$	-527.5	-286	-393

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.I 1

$m_1 = 200g$

$T_2 = 45°C$ $m_2 = 300g$ $T_1 = 24°C$

$T_f = 35,5°C$

C_{Cal} -

c_{eau} =4,18J/g.K

$m_4 = 500g$ $CH_{4(g)}$ m_3 2

$\Delta T = 34K$

$H_2O_{(l)}$ $CO_{2(g)}$

Q

$CH_{4(g)}$ m_3

H=1g/mol , C=12g/mol , $\Delta H_{comb(CH_{4(g)})} = -890,7kJ/mol$

$Q = -881kJ$ $1atm$ $298K$ **.II** 1

$25°C$ 7,5g

H=1g/mol , C=12g/mol , O=16g/mol , N=14g/mol

60°C $\left(\Delta H^{\circ}_{comb}\right)$ 2

	$Gly_{(s)}$	$O_{2(g)}$	$N_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
$C_p(J/K.mol)$	**99.20**	29.37	29.12	37.45	75.29

3

$NH_2-CH_2-COOH_{(s)} \longrightarrow NH_2-CH_2-COOH_{(g)}$ $\Delta H^{\circ}_{sub(Gly)} = 147kJ/mol$

$\Delta H^{\circ}_f\left(Gly_{(g)}\right)$ -

4

$2C_{(s)} + 5/2H_{2(g)} + 1/2N_2 + O_{2(g)} \xrightarrow{\Delta H_f(Gly)_{(g)}} H_2N-CH_2-\overset{\overset{O}{\|}}{C}-O-H_{(g)}$

$\Delta H^{\circ}_d(C-N)$ $(C-N)$ -

$\Delta H^{\circ}_{sub}\left(C_{(s)}\right) = 717kJ/mol$

	$H-H$	$O=O$	$C-H$	$C-C$	$C=O$
$\Delta H^{\circ}_d(kJ/mol)$	436	498	413	348	810
	$O-H$	$C-O$	$N\equiv N$	$N-H$	
$\Delta H^{\circ}_d(kJ/mol)$	463	351	940	391	

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$C_3H_3N_{(l)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)} + N_{2(g)}$ $\Delta H^{\circ}_1 = ...kJ/mol$

ΔH°_1

$\Delta H^{\circ}_f\left(CO_{2(g)}\right) = -393,5kJ/mol$, $\Delta H^{\circ}_f\left(H_2O_{2(l)}\right) = -286kJ/mol$

$R = 8.31j/mol.K$

2

$C_2H_{2(g)} + HCN_{(g)} \longrightarrow C_3H_3N_{(g)}$ $\Delta H^{\circ}_2 = ...kJ/mol$

$298°K$ ΔH°_2 -

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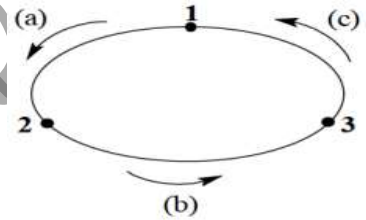
$$C_2H_{2(g)} + 5/2O_{2(g)} \longrightarrow 2CO_{2(g)} + H_2O_{(l)} \qquad \Delta H_3^\circ = -1300kJ/mol$$

$$HCN_{(g)} + 5/4O_{2(g)} \longrightarrow CO_{2(g)} + 1/2H_2O_{(l)} + 1/2N_{2(g)} \qquad \Delta H_4^\circ = -671,1kJ/mol$$

$$\Delta H_{vap}^\circ(C_3H_3N_{(l)}) = 32,64kJ/mol$$

	02	2021	28

$(P_1 = 1,97atm\ ,\ V_1 = 14L)$ 1mol



	2	1	P=Cste	(a)
V_1	3	2	T=Cste	(b)
	1	3	V=Cste	(c)

$T_1, T_2, T_3, V_2, V_3, P_2, P_3$ 1

P=f(V) 2

V_1 P_1 $W_{1\to2}, W_{2\to3}$ 3

$W_{1\to2}, W_{2\to3}, W_{3\to1}, Q_{1\to2}, Q_{2\to3}, Q_{3\to1}$

$\ln 2 = 0,69$, 1L.atm=101,3J , $R=0,082L.atm.K^{-1}$, $\gamma = \frac{C_p}{C_v} = 1,4$

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