№ 5_Дәріс

Ван-дер-Ваальс теңдеуін талдау

$$\left(p+\frac{a}{V^2}\right)(V-b)=RT$$

$$pV+\frac{aV}{V^2}-pb-\frac{ab}{V^2}=RT$$

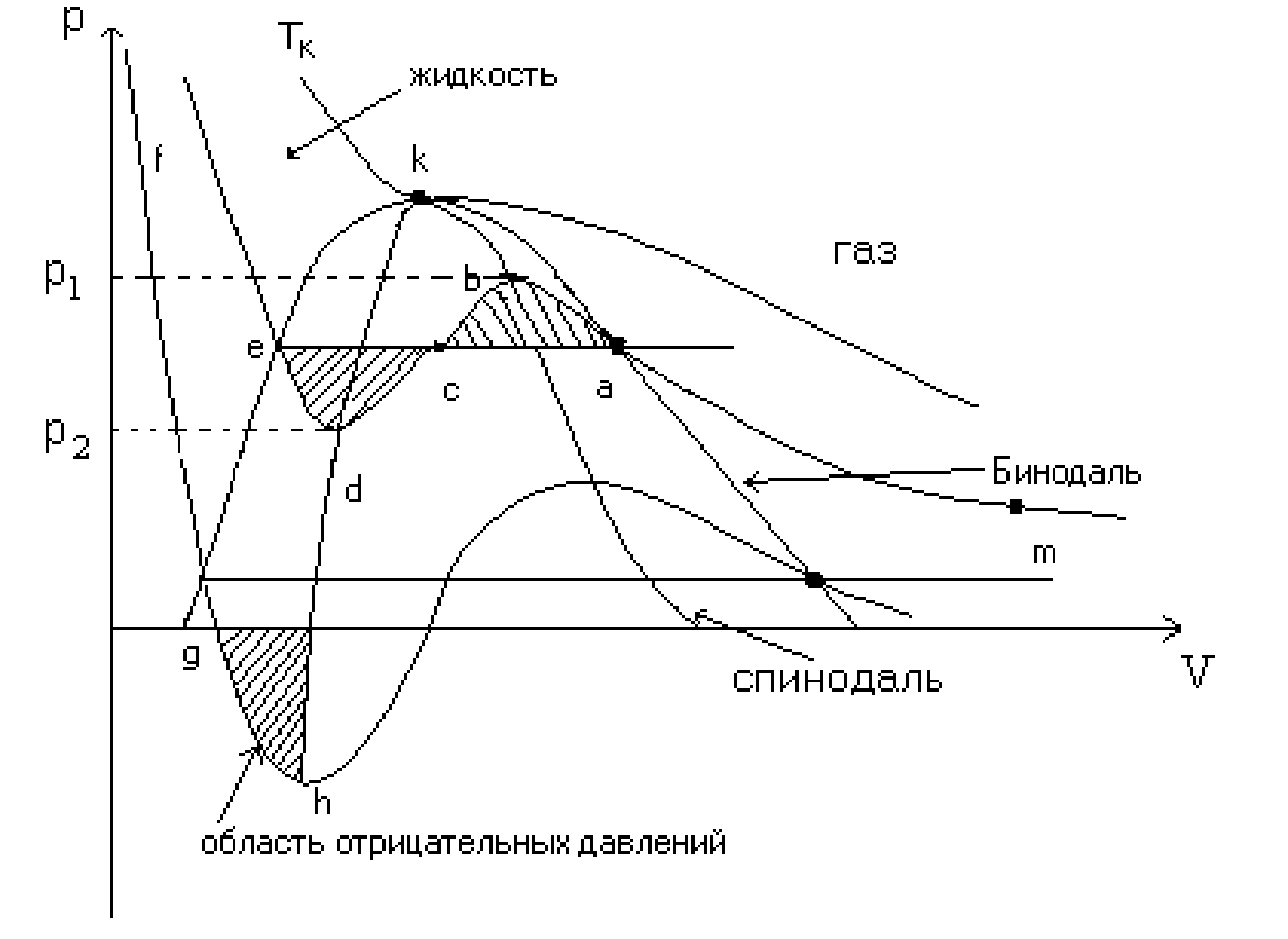
$$pV^3+aV-pbV^2-ab=RTV^2$$

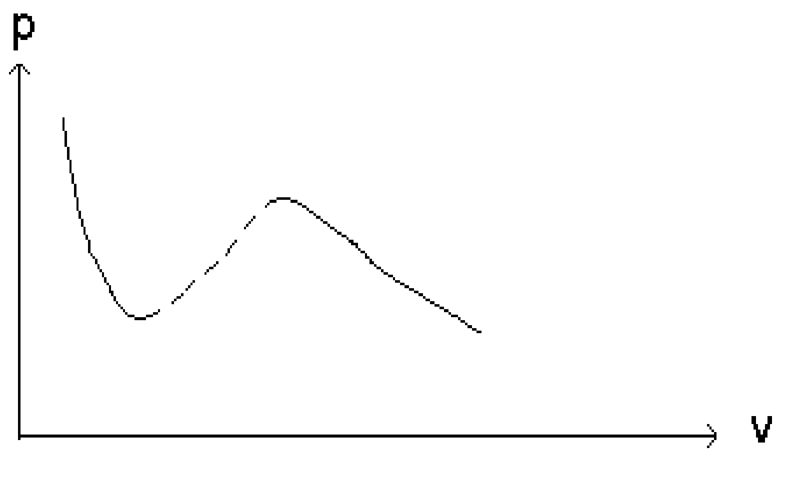
$$pV^3-(pb+RT)V^2+aV-ab=0$$

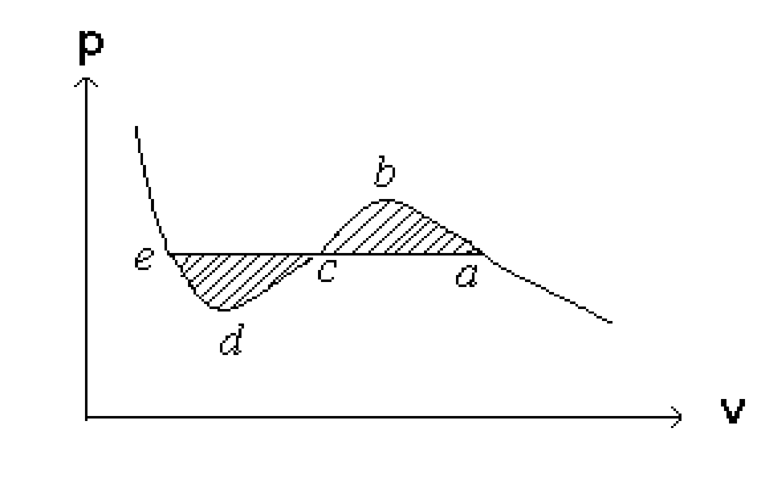
$T<T_k$ $T>T_k$

$$\left(\frac{\partial p}{\partial V}\right)_T > 0$$

$$\left(\frac{\partial p}{\partial V}\right)_T = 0$$





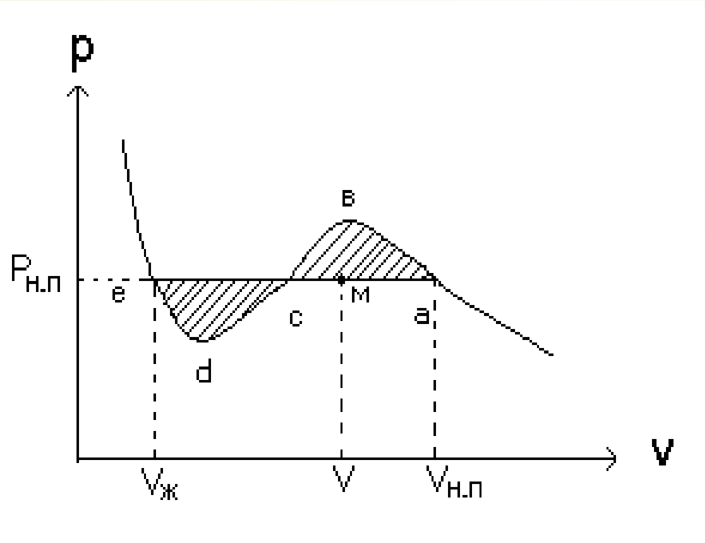


$$\delta Q = dU + pdV, \qquad \delta Q = TdS, \qquad TdS = dU + pdV$$

$$\oint TdS = \oint dU + \oint pdV \qquad T\oint dS = \oint dU + \oint pdV$$

$$\oint dU = 0 \qquad \oint dS = 0 \qquad \oint pdV = 0$$

$$\oint_{edce} pdV = \oint_{cbac} pdV$$



$$V = xV_{ж} + (1-x)V_{нп}$$

$$x\underbrace{\left(V_{нп} - V_{ж}\right)}_{ae} = \underbrace{V_{нп} - V}_{ma}$$

$$\underset{\substack{\downarrow \\ жидk}}{x} = \frac{ma}{ea} \qquad \underset{\substack{\downarrow \\ пар}}{1-x} = \frac{em}{ea}$$

$$p = \frac{RT}{V-b} - \frac{a}{V^2}$$

$$< p >= \frac{1}{V_{нп} - V_{ж}} \int_{V_{ж}}^{V_{нп}} p\,dV = \frac{1}{V_{нп} - V_{ж}} \int_{V_{ж}}^{V_{нп}} \left(\frac{RT}{V-b} - \frac{a}{V^2}\right) dV = p_{нп}$$

$$p_{нп} = \frac{1}{V_{нп} - V_{ж}} \left[RT \ln\left(\frac{V_{нп} - b}{V_{ж} - b}\right) - a\left(\frac{1}{V_{ж}} - \frac{1}{V_{нп}}\right)\right]$$

$(p_{нп}V_{нп})_{расч} > (p_{нп}V_{нп})_{эксп}, \quad (p_{нп})_{расч} > (p_{нп})_{эксп}$

$$\frac{dp}{dT} = \frac{q_{12}}{T(\upsilon_2 - \upsilon_1)}$$

1) будың меншікті көлемі сұйықтықтың меншікті көлемінен әлдеқайда көп, $\upsilon_2 >> \upsilon_1$, сондықтан сұйықтықтың меншікті көлемі υ_1 ескерілмейді;

2) буды идеалды газ ретінде қарастыруға болады, сондықтан

$$\upsilon_2 = \frac{R_0 T}{p} \qquad R_0 = \frac{R}{M}$$

3) будың пайда болу жылуы температураға байланысты емес (немесе аздап тәуелді), сондықтан оны қабылдауға болады

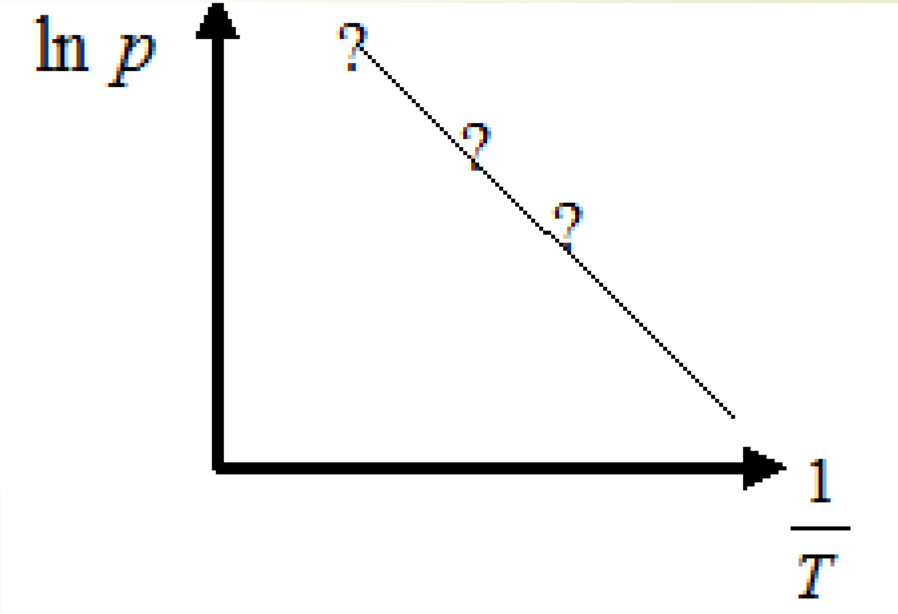
$$q_{12} = const$$

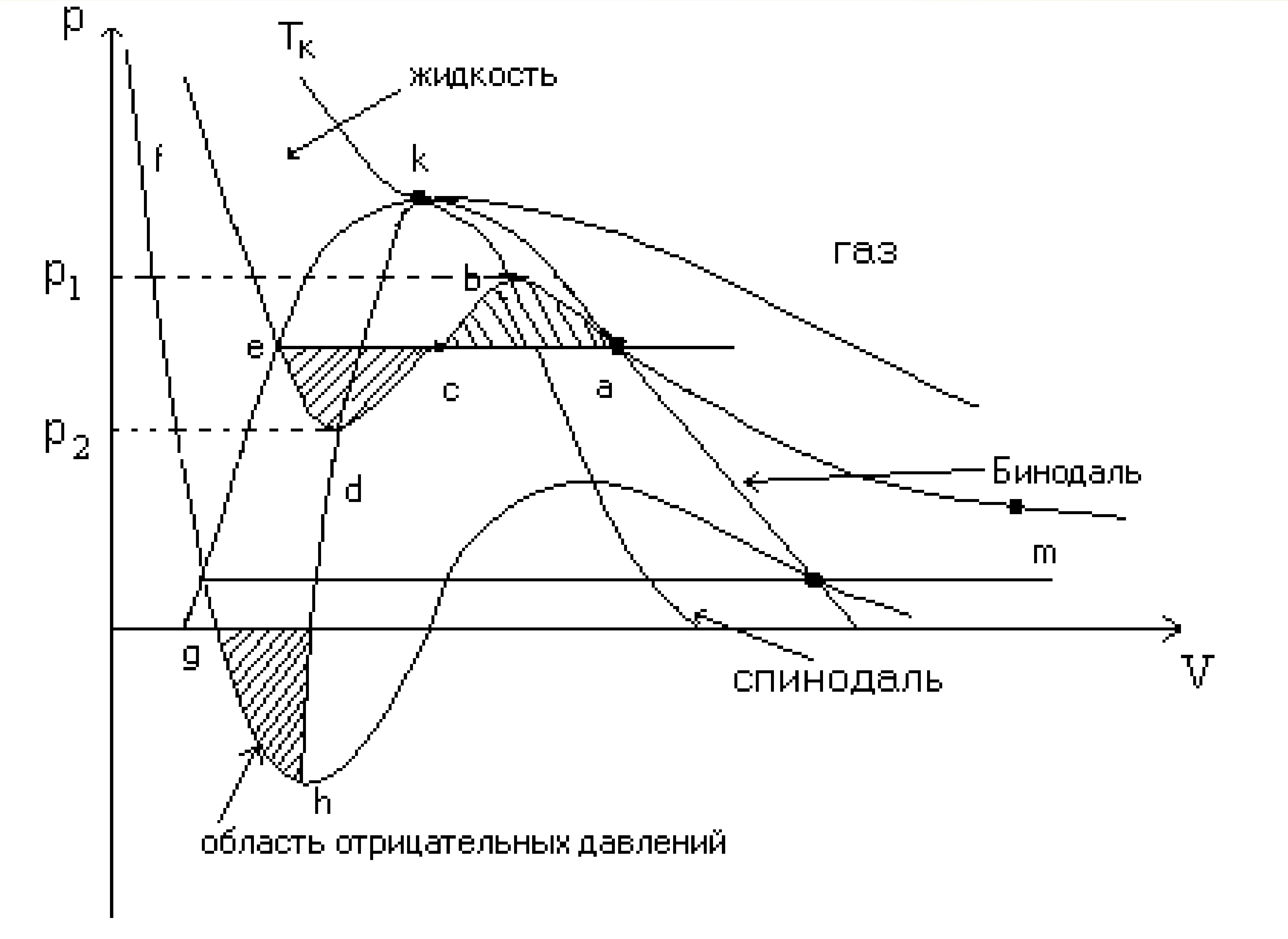
$$\frac{dp}{dT} = \frac{q_{12}\,p}{R_0 T^2}$$

$$\ln p = -\frac{q_{12}}{R_0 T} + C$$

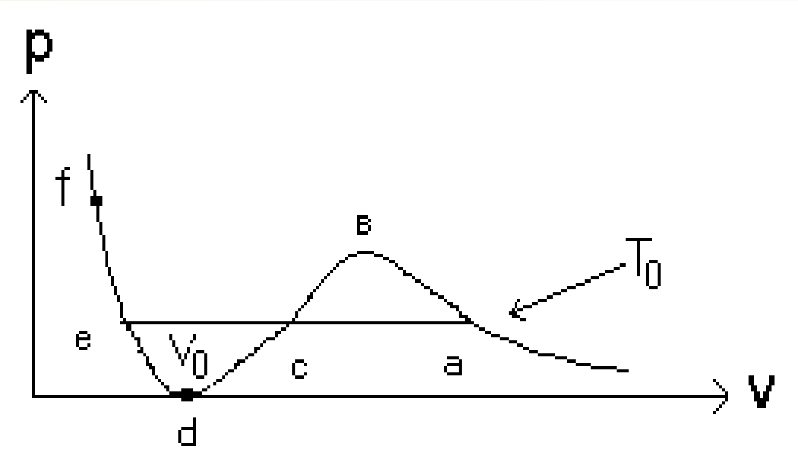
$$T_{нк} \qquad p_{нп} = 1{,}01325 \cdot 10^5\ Па = p_0$$

$$\ln p = \ln p_0 + \frac{q_{12}}{R_0}\left(\frac{1}{T_{нк}} - \frac{1}{T}\right)$$





p
$T_к$
жидкость
f
k
газ
p_1
b
e
c
a
p_2
d
Бинодаль
m
g
спинодаль
V
h
область отрицательных давлений



$$\left(p+\frac{a}{V^2}\right)(V-b)=RT$$

$$p=\frac{RT}{V-b}-\frac{a}{V^2}$$

$$\left(\frac{\partial p}{\partial V}\right)_T=-\frac{RT}{(V-b)^2}+\frac{2a}{V^3}$$

$$p=p_{mep}-p_i$$

$$p_i>p_{mep} \qquad p<0 \qquad T<T_0$$

$$T=T_0 \qquad p=0$$

$$\left(\frac{\partial p}{\partial V}\right)_T=0$$

$$\begin{cases}\dfrac{RT_0}{V_0-b}-\dfrac{a}{V_0^2}=0\\ -\dfrac{RT_0}{(V_0-b)^2}+\dfrac{2a}{V_0^3}=0\end{cases}$$

$$V_0-b=\frac{V_0}{2}\Rightarrow \qquad V_0=2b$$

$$\frac{RT_0}{2b-b} - \frac{a}{4b^2} = 0$$

$$\frac{RT_0}{b} = \frac{a}{4b^2}$$

$$T_0 = \frac{a}{4Rb}$$

$$V_0 = 2b \qquad T_0 = \frac{a}{4Rb}$$

$$T_K = \frac{8a}{27Rb} \qquad T_0 = \frac{27}{32} T_K$$