CHEM 331
Physical Chemistry
Revision 1.0

First Derivatives of U, H, A and G

Internal Energy U	Enthalpy H	Helmholtz A	Gibbs G
$\left(\frac{\partial U}{\partial T}\right)_P = C_P - PV\alpha$	$\left(\frac{\partial H}{\partial T}\right)_P = C_P$	$\left(\frac{\partial A}{\partial T}\right)_P = -S - PV\alpha$	$\left(\frac{\partial G}{\partial T}\right)_P = -S$
$\left(\frac{\partial U}{\partial T}\right)_V = C_V$	$\left(\frac{\partial H}{\partial T}\right)_V = C_V + \frac{V\alpha}{\varkappa}$	$\left(\frac{\partial A}{\partial T}\right)_V = -S$	$\left(\frac{\partial G}{\partial T}\right)_V = -S + \frac{V\alpha}{\varkappa}$
$\left(\frac{\partial U}{\partial T}\right)_S = \frac{PC_V\varkappa}{\alpha T}$ $= \frac{PV\alpha}{\gamma-1}$	$\left(\frac{\partial H}{\partial T}\right)_S = \frac{C_P}{\alpha T}$	$\left(\frac{\partial A}{\partial T}\right)_S = -S + \frac{PV\alpha}{\gamma-1}$ $= -S + \frac{PC_V\varkappa}{T}$	$\left(\frac{\partial G}{\partial T}\right)_S = -s + \frac{c_p}{\alpha T}$ $= -s + \frac{V\gamma\alpha}{(\gamma-1)\varkappa}$
$\left(\frac{\partial U}{\partial P}\right)_T = -V\alpha T + V\varkappa P$	$\left(\frac{\partial H}{\partial P}\right)_T = V(1 - \alpha T)$ $= C_P\,\mu_{JT}$	$\left(\frac{\partial A}{\partial P}\right)_T = PV\varkappa$	$\left(\frac{\partial G}{\partial P}\right)_T = V$
$\left(\frac{\partial U}{\partial P}\right)_V = \frac{C_V\varkappa}{\alpha}$ $= \frac{V\alpha T}{\gamma-1}$	$\left(\frac{\partial H}{\partial P}\right)_V = V + \frac{C_V\varkappa}{\alpha}$	$\left(\frac{\partial A}{\partial P}\right)_V = -\frac{S\varkappa}{\alpha}$	$\left(\frac{\partial G}{\partial P}\right)_V = -\frac{S\varkappa}{\alpha} + V$
$\left(\frac{\partial U}{\partial P}\right)_S = \frac{PV\varkappa}{\gamma}$	$\left(\frac{\partial H}{\partial P}\right)_S = V$	$\left(\frac{\partial A}{\partial P}\right)_S = -\frac{SV\alpha T}{C_P} + \frac{PV\varkappa}{\gamma}$ $= -\frac{S\varkappa(\gamma-1)}{\gamma\alpha} + \frac{PV\varkappa}{\gamma}$	$\left(\frac{\partial G}{\partial P}\right)_S = -\frac{SV\alpha T}{C_P} + V$ $= -\frac{S(\gamma-1)\varkappa}{\gamma\alpha} + V$
$\left(\frac{\partial U}{\partial V}\right)_T = \frac{\alpha T}{\varkappa} - P$	$\left(\frac{\partial H}{\partial V}\right)_T = \frac{\alpha T}{\varkappa} - \frac{1}{\varkappa}$	$\left(\frac{\partial A}{\partial V}\right)_T = -P$	$\left(\frac{\partial G}{\partial V}\right)_T = -\frac{1}{\varkappa}$
$\left(\frac{\partial U}{\partial V}\right)_P = \frac{C_P}{V\alpha} - P$ $= \frac{\gamma\alpha T}{(\gamma-1)\varkappa} - P$	$\left(\frac{\partial H}{\partial V}\right)_P = \frac{C_P}{V\alpha}$	$\left(\frac{\partial A}{\partial V}\right)_P = -\frac{S}{V\alpha} - P$	$\left(\frac{\partial G}{\partial V}\right)_P = -\frac{S}{V\alpha}$
$\left(\frac{\partial U}{\partial V}\right)_S = -P$	$\left(\frac{\partial H}{\partial V}\right)_S = -\frac{\gamma}{\varkappa}$	$\left(\frac{\partial A}{\partial V}\right)_S = \frac{S\alpha T}{C_V\varkappa} - P$ $= \frac{S(\gamma-1)}{V\alpha} - P$	$\left(\frac{\partial G}{\partial V}\right)_S = \frac{S\alpha T}{C_V\varkappa} - \frac{\gamma}{\varkappa}$ $= \frac{S(\gamma-1)}{V\alpha} - \frac{\gamma}{\varkappa}$
$\left(\frac{\partial U}{\partial S}\right)_T = T - \frac{P\varkappa}{\alpha}$	$\left(\frac{\partial H}{\partial S}\right)_T = T - \frac{1}{\alpha}$	$\left(\frac{\partial A}{\partial S}\right)_T = -\frac{P\varkappa}{\alpha}$	$\left(\frac{\partial G}{\partial S}\right)_T = \frac{1}{\alpha}$
$\left(\frac{\partial U}{\partial S}\right)_P = T - \frac{PV\alpha T}{C_P}$ $= T - \frac{(\gamma-1)P\varkappa}{\gamma\alpha}$	$\left(\frac{\partial H}{\partial S}\right)_P = T$	$\left(\frac{\partial A}{\partial S}\right)_P = -\frac{ST}{C_P} - \frac{PV\alpha T}{C_P}$ $= -\frac{ST}{C_P} - \frac{P\varkappa(\gamma-1)}{\gamma\alpha}$	$\left(\frac{\partial G}{\partial S}\right)_P = -\frac{ST}{C_P}$
$\left(\frac{\partial U}{\partial S}\right)_V = T$	$\left(\frac{\partial H}{\partial S}\right)_V = T + \frac{\gamma-1}{\alpha}$	$\left(\frac{\partial A}{\partial S}\right)_V = -\frac{ST}{C_V}$	$\left(\frac{\partial G}{\partial S}\right)_V = -\frac{ST}{C_V} + \frac{V\alpha T}{C_V\varkappa}$ $= -\frac{ST}{C_V} + \frac{V(\gamma-1)}{C_V\alpha}$