> *restart*;

make g a symbolic function of pressure and temperature:

> $g := G(P, T);\ S := -(diff(g, T));\ V := diff(g, P);$

$$g := G(P, T)$$
$$S := -\frac{\partial}{\partial T} G(P, T)$$
$$V := \frac{\partial}{\partial P} G(P, T) \qquad \textbf{(1)}$$

in my notation below dxdyz is the derivative of x with respect to y at constant z given that we know s and v only as a function of P and T our main problem is to express the derivatives in terms of the four derivatives of s and v that we can evaluate, i.e.,

> $dsdpt := diff(S, P);\ dsdtp := diff(S, T);\ dvdpt := diff(V, P);\ dvdtp := diff(V, T);$

$$dsdpt := -\frac{\partial^2}{\partial P \partial T} G(P, T)$$
$$dsdtp := -\frac{\partial^2}{\partial T^2} G(P, T)$$
$$dvdpt := \frac{\partial^2}{\partial P^2} G(P, T)$$
$$dvdtp := \frac{\partial^2}{\partial P \partial T} G(P, T) \qquad \textbf{(2)}$$

to avoid having to recognize the inverse of these derivatives we can also assign them here:

> $dpdst := 1/dsdpt;\ dtdsp := 1/dsdtp;\ dpdvt := 1/dvdpt;\ dtdvp := 1/dvdtp;$

$$dpdst := -\frac{1}{\frac{\partial^2}{\partial P \partial T} G(P, T)}$$
$$dtdsp := -\frac{1}{\frac{\partial^2}{\partial T^2} G(P, T)}$$
$$dpdvt := \frac{1}{\frac{\partial^2}{\partial P^2} G(P, T)}$$
$$dtdvp := \frac{1}{\frac{\partial^2}{\partial P \partial T} G(P, T)} \qquad \textbf{(3)}$$

with the above partial derivatives we can now evaluate any thermodynamic partial derivative from equations 4.43-4.46, e.g., isobaric expansivity (1/V*diff(V,T)) is:

> alpha := 1/V*diff(V, T);

$$\alpha := \frac{\frac{\partial^2}{\partial P \partial T} G(P, T)}{\frac{\partial}{\partial P} G(P, T)} \quad (4)$$

or in problem 4.5 we have:

> v_phi := sqrt(Ks/rho);
> Ks := -V*dpdvs;

$$v\_phi := \sqrt{\frac{Ks}{\rho}}$$

$$Ks := -\left(\frac{\partial}{\partial P} G(P, T)\right) dpdvs \quad (5)$$

a somewhat ill-advised strategy for expressing Ks in terms of G would be to first invert d[dvs and then use rule 4.42 ($(\partial f/\partial x)_z = (\partial f/\partial x)_y - (\partial f/\partial y)_x (\partial y/\partial z)_x (\partial z/\partial x)_y$) mapping v->f, p->x and s->z to expand dvdps

> $dpdvs = \frac{1}{dvdps}$;

$$dpdvs = \frac{1}{dvdps} \quad (6)$$

> #dvdps := ...
> v_phi;

$$\sqrt{-\frac{\left(\frac{\partial}{\partial P} G(P, T)\right) dpdvs}{\rho}} \quad (7)$$