NAME :

Quiz 20

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(a) Using the Euler relation and the differential form of the first law of thermodynamics, show that [3]

$$\mathrm{d}\mu = -s\mathrm{d}T + v\mathrm{d}p. \tag{1}$$

(b) How are $\mathrm{d}\mu_{\text{liquid}}$ and $\mathrm{d}\mu_{\text{vapour}}$ related along the curve of phase coexistence? Show that this implies that if we define $\ell = T(s_{\text{vapour}} - s_{\text{liquid}})$ as the *latent heat*, then: [3]

$$\frac{\mathrm{d}p}{\mathrm{d}T} = \frac{\ell}{T(v_{\text{vapour}} - v_{\text{liquid}})}, \tag{2}$$

(c) Now, we will try to find an approximate equation for the phase coexistence curve $p(T)$. Assuming (reasonably) that $v_{\text{liquid}} \ll v_{\text{vapour}}$, that ℓ is a constant, and that the vapour can be approximated by an ideal gas, show that

$$\frac{\mathrm{d}p}{\mathrm{d}T} = \frac{p\ell}{k_B T^2}. \tag{3}$$

Solve this equation to find $p(T)$. [4]