Problem 1:

(3) a) Thermodynamics

+ applies to arbitrary systems
- purely empirical
- only describes macroscopic quantities

Statistical physics:

+ derives things from microscopic model
+ quantities on all scales can be studied
- hardly anything can actually be solved

b) The value of an extensive state variable changes proportional to the system size. The value of (1) an intensive state variable does not depend on system size.

Examples: extensive: $V, N, S, U, \vec{M}$ (2)
intensive: $p, \mu, T, \vec{H}$

c) An equation of state is a relationship between (2) state variables in addition to the fundamental relations provided by thermodynamics.
Equations of state have to be derived from (1) a microscopic picture.

Problem 2:

a)

1.5 (1)(i) $\int_a^x (2xb + x^2)dx + \int_b^y x^2 dy = \cancel{bx^2} - ba^2 + \frac{1}{3}x^3 - \frac{1}{3}a^3 + x^2y - \cancel{x^2b}$

1.5 (1)(ii) $\int_b^y a^2 dy + \int_a^x (2xy + x^2)dx = \cancel{a^2y} - a^2b + \frac{1}{3}x^3 - \frac{1}{3}a^3 + x^2y - \cancel{a^2y}$

1.5 (2)(i) $\int_a^x b(x-2b)dx - \int_b^y x^2 dy = \frac{1}{2}bx^2 - \frac{1}{2}ba^2 - 2b^2x + 2b^2a - x^2y + x^2b$

$= \frac{3}{2}bx^2 - \frac{1}{2}ba^2 - 2b^2x + 2b^2a - x^2y$

1.5 (2)(ii) $-\int_b^y a^2 dy + \int_a^x y(x-2y)dx = -ya^2 + ba^2 + \frac{1}{2}yx^2 - \frac{1}{2}ya^2 - 2y^2x + 2y^2a$

$= -\frac{3}{2}ya^2 + ba^2 + \frac{1}{2}yx^2 - 2y^2x + 2y^2a$

2 b) Since the integral of du_2 along two different paths depends on the path taken du_2 cannot be exact. For the two paths considered, the integral of du_1 is independent of the path. Thus, du_1 could be an exact differential.

2 c) $\frac{\partial}{\partial y}(2xy + x^2) = 2x$

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \| \quad \Rightarrow du_1$ is exact

$\frac{\partial}{\partial x} x^2 = 2x$