ENGG 201– Pure Component Examples – Chapter 4

Fall 1990 (Mid-Term)-b

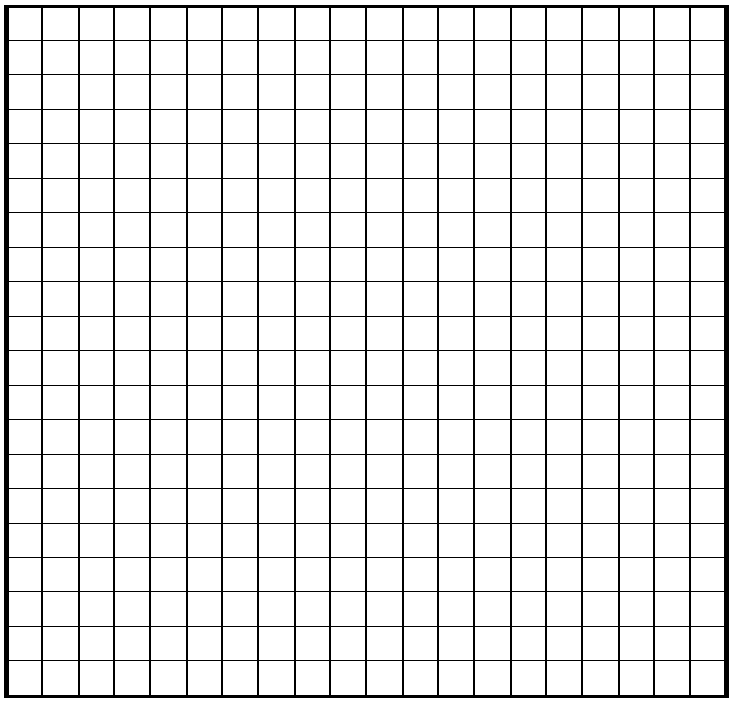
Ammonia (NH_3, M = 17.03 g/mol) is a compound that finds important applications in the fertilizer and refrigeration industries. Its triple-point temperature and pressure are 195.4 K and 6.08 kPa, respectively. Additional *P-V-T* data for NH_3 in the vapor-liquid region are provided below:

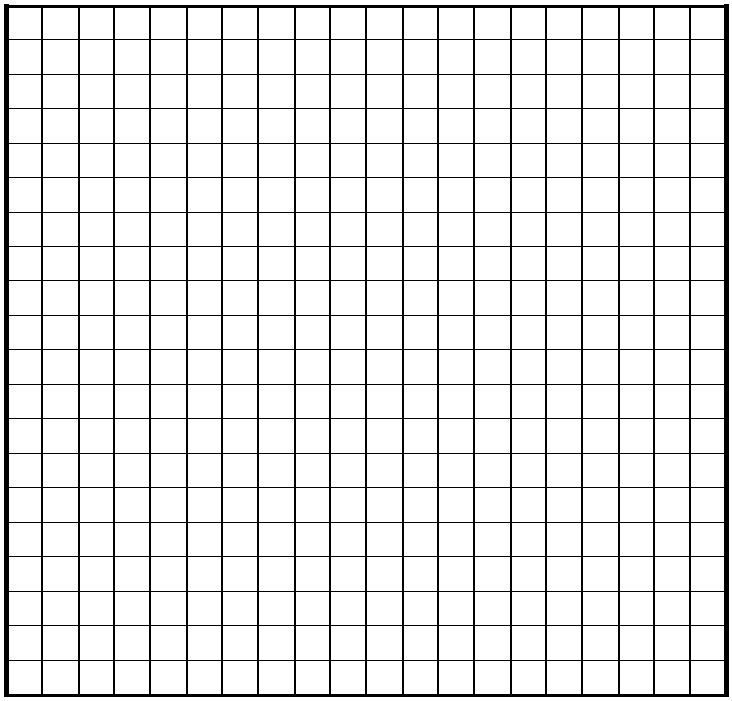
		V (cm^3/g)	
T (K)	P, MPa	liquid	vapor
350.0	3.87	1.95	31.73
370.0	5.89	2.15	19.02
390.0	8.61	2.50	10.72
405.6	11.30	4.25	4.25

Ten grams of NH_3 is brought to the following sets of conditions. In each case, state whether the NH_3 is a liquid, a vapor, a gas, a solid, or more than one phase. If there is more than one phase, calculate the mass of each phase.

(a) T = 370.0 K; P = 10.0 MPa.
(b) T = 370.0 K; P = 4.0 MPa.
(c) T = 420.0 K; P = 8.0 MPa.
(d) T = 380.0 K; P = 5.89 MPa.
(e) T = 360.0 K; P = 5.89 MPa.
(f) T = 180.0 K; P = 5.89 MPa.
(g) T = 370.0 K; volume = 300 cm^3.
(h) T =370.0 K; volume = 21 cm^3.
(i) P = 5.89 MPa; volume = 100 cm^3.

Ans. (a) L, (b) V, (c) G, (d) V, (e) L, (f) S, (g) V, (h) L, (i) L (5.4g) & V (4.6g).





Fall 1993 (Mid-Term)-a

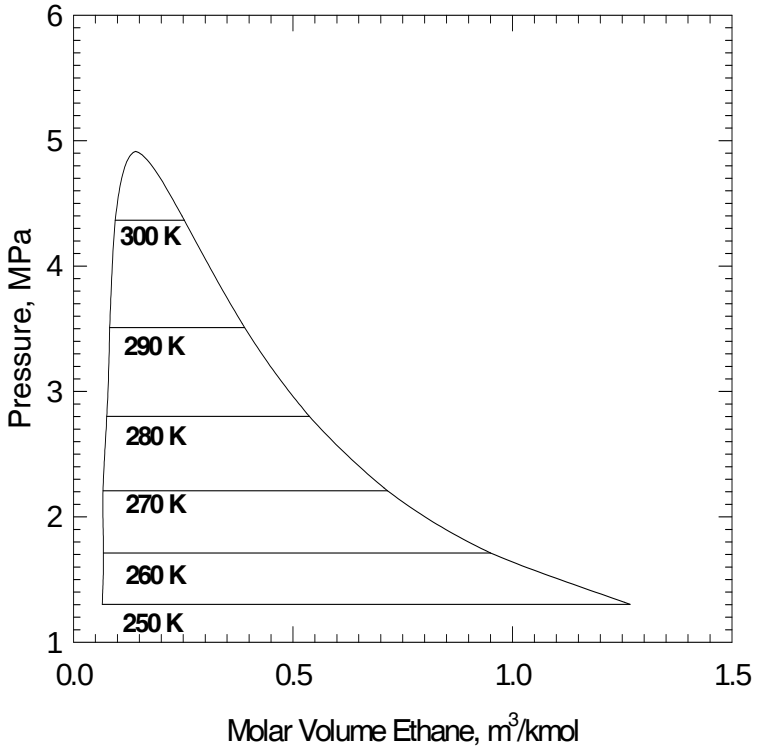
The *P*-*V* diagram, covering the vapour and liquid phase regions, of ethane (C_2H_6; M = 30.1 kg/kmol) is shown below. The critical properties are: P_c =4.9MPa, T_c =305.4K, and V_c =0.14m^3/kmol.

(a) Identify the state(s) of C_2H_6 at each of the following conditions.
  (i) T=270K, P = 4MPa
  (ii) P=2MPa, V = 1.0m^3/kmol.
  (iii) T=280K, V=0.4m^3/kmol.
  (iv) T = 260K, V=1.1m^3/kmol.
  (v) T = 320K, P = 3MPa.

(b) What is the density (in kg/m^3) of C_2H_6 at its critical conditions?

(c) (i)Give the dew point and bubble point pressures and the vapour pressure of C_2H_6 at 280K.
  (ii) What is the ratio of the densities of the co-existing liquid and vapour phases at 280K?

(d) (i) Find the mass of the vapour phase in a 100-Litre bottle filled with 3.01 kg of C_2H_6 at 260K.
  (ii) What is the volume of the liquid phase in the bottle in Part (d)(i)?



Ans. *(a)(i)L, (ii)V,(iii)L+V,(iv)V,(v)G, (b) 215kg/m^3, (c)(i)280K, 2.8MPa,, (ii)7, (d)(i)3.01kg, (ii)0.*

Fall 1991 (Mid-Term)-a

The *P-V* diagram for a new industrial material (M = 49 kg/kmol) is provided below. The critical properties of this material are (approximately): T_c = 52°C, P_c = 11.5 MPa, and V_c = 0.34 m^3/kmol. Use the *P-V* diagram to answer the following questions:

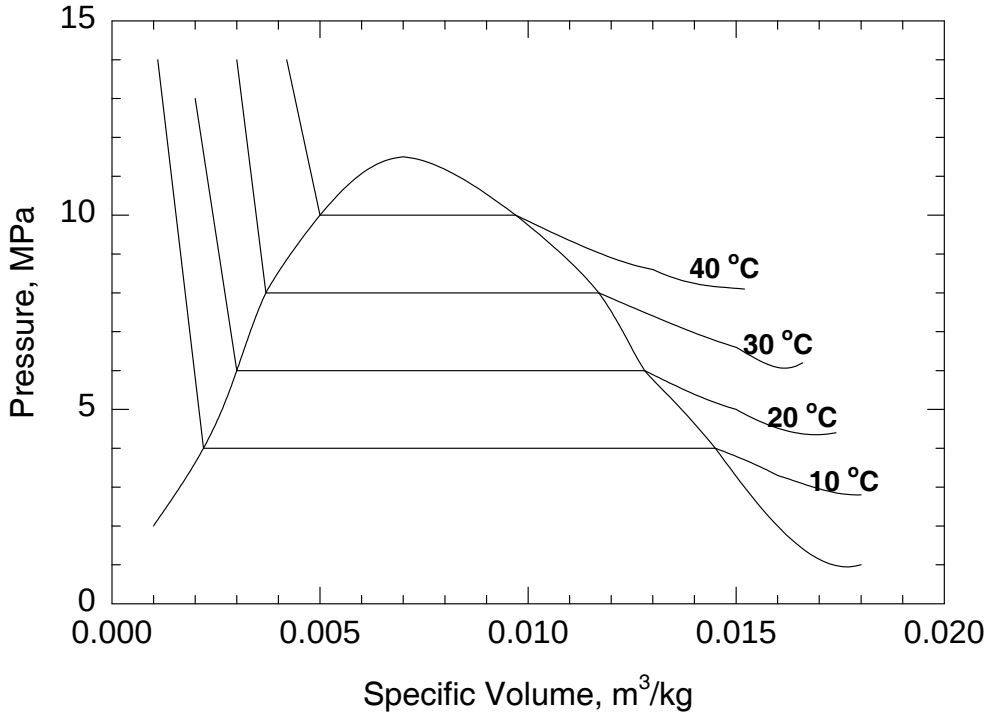
(a) What is the state of the material at each of the following conditions?
- (i) T = 30°C, V = 0.015 m^3/kg
- (ii) P = 5 MPa, V = 0.010 m^3/kg
- (iii) P = 10 MPa, T = 15°C
- (iv) V = 0.010 m^3/kg, P = 15 MPa

(b) What is the density of the material (in kg/m^3) at its critical conditions?

(c) What is the vapour pressure at 25°C?

(d) What is the density and mass of the liquid phase in a 1 kg sample which occupies a volume of 0.006m^3 at 10°C?

(e) What are the density and the volume occupied by the vapour phase in Part (d)?



Ans. (a) (i)V, (ii)L+V, (iii)L, (iv)G, (b) 144.12kg/m^3, (c) 7MPa, (d) 500kg/m^3, 0.71kg, (e) 69kg/m^3, 4.2liter