ENGG 201 - WINTER 2017 – MIDTERM EXAM #2

Wednesday March 22, 2017 - 19h00-21h00 (120 minutes)

a) Attempt all **four (4)** questions
b) Show all work for full marks.
c) Closed Text, Closed Notes, Schulich Calculators (only) are allowed.
d) Print your name and lecture number below, and put your ID number on each additional page in the blanks provided.

SOLUTION

Surname ______________ ______________ Section L0_

L01 (330pm TR): Dr. Sumon // L02 (1230pm TR): Dr. Kallos

STUDENT IDENTIFICATION

Each candidate must sign the Seating List confirming presence at the examination. All candidates for final examinations are required to place their University of Calgary student I.D. cards on their desks for the duration of the examination. (Students writing mid-term tests can also be asked to provide identity proof.) Students without an I.D. card who can produce an acceptable alternative I.D., e.g., one with a printed name and photograph, are allowed to write the examination.

A student without acceptable I.D. will be required to complete an Identification Form. The form indicates that there is no guarantee that the examination paper will be graded if any discrepancies in identification are discovered after verification with the student's file. **A Student who refuses to produce identification or who refuses to complete and sign the Identification Form is not permitted to write the examination.**

EXAMINATION RULES

(1) Students late in arriving will not normally be admitted after one-half hour of the examination time has passed:
(2) No candidate will be permitted to leave the examination room until one-half hour has elapsed after the opening of the examination, nor during the last 15 minutes of the examination. All candidates remaining during the last 15 minutes of the examination period must remain at their desks until their papers have been collected by an invigilator.
(3) All enquiries and requests must be addressed to supervisors only.
(4) **Candidates are strictly cautioned against:**
   (a) speaking to other candidates or communicating with them under any circumstances whatsoever;
   (b) bringing into the examination room any textbook, notebook or memoranda not authorized by the examiner;
   (c) making use of calculators and/or portable computing machines not authorized by the instructor;
   (d) leaving answer papers exposed to view;
   (e) attempting to read other student's examination papers.
   The penalty for violation of these rules is suspension or expulsion or such other penalty as may be determined.
(5) Candidates are requested to write on both sides of the pages unless the examiner has asked that the left hand page be reserved for rough drafts or calculations.
(6) Discarded matter is to be struck out and not removed by mutilation of the examination answer book.
(7) Candidates are cautioned against writing in their answer book any matter extraneous to the actual answering of the question set.
(8) The candidate is to write his/her name on each answer book as directed and is to number each book.
(9) A candidate must report to a supervisor before leaving the examination room.
(10) Answer books must be handed to the supervisor-in-charge promptly when the signal is given. Failure to comply with this regulation will be cause for rejection of an answer paper.
(11) If during the course of an examination a student becomes ill or receives word of domestic affliction, the student should report at once to the supervisor, hand in the unfinished paper and request that it be cancelled. If physical and/or emotional ill health is the cause, the student must report at once to a physician/counselor so that subsequent application for a deferred examination is supported by a completed Physician/ Counselor Statement form. Students can consult professionals at University Health Services or University Counseling Services during normal working hours or consult their physician/counselor in the community.
   Should a student write an examination, hand in the paper for marking, and later report extenuating circumstances to support a request for cancellation of the paper and for another examination, such a request will be denied.
(12) Smoking during examinations is strictly prohibited.

Question Number I *(25 Marks ~ 30 minutes)*

Assume ideal gas behavior at all conditions in Question 1.

PART A – SPHERICAL VESSELS 1, 2, and 3 (/12)

Use the data in the table below to answer Question 1 Part A. Vessels 1,2 and 3 are spherical.

Vessel Number	Component	Molar Mass (kg/kmol)	Vessel Volume (m^3)	Temperature (°C)	Pressure (kPa)	Mass (kg)
1	CH_4	16	-	0	800	5
2	N_2	28	-	27	100	-

a) Vessel 1 contains 5 kg of methane gas at 0°C and 800 kPa. Calculate the internal volume of vessel 1. (/3)

$$n = m/M = 5/16 = 0.3125 \text{ kmol}$$

$$V = \frac{nRT}{P} = \frac{(0.3125)(8.314)(273.15)}{800} = \boxed{0.8871 \text{ m}^3}$$

b) Vessel 2 contains N_2 at 27°C and 100 kPa. What is the density (kg/m^3) of N_2 in vessel 2? (/3)

$$PV = nRT = \frac{m}{M}RT$$

$$\rho = \frac{m}{V} = \frac{PM}{RT} = \frac{(100 \text{ kPa})(28 \frac{\text{kg}}{\text{kmol}})}{(8.314 \frac{\text{kPa}\cdot\text{m}^3}{\text{kmol}\cdot\text{K}})(300.15 \text{ K})}$$

$$= \boxed{1.123 \text{ kg/m}^3}$$

c) The contents of Vessel 1 and Vessel 2 are transferred to a new Vessel 3(volume = 0.8314 m³), and the resulting mixture in Vessel 3 is brought to 27°C and 6.003 MPa. Determine the number of moles of gas mixture in Vessel 3. (/3)

$V_3 = 0.8314\ m^3$
$T_3 = 300.15\ K$
$P_3 = 6.003 \times 10^3\ kPa$

$$n = \frac{Pv}{RT} = \frac{(6.003\times10^3\ kPa)(.8314\ m^3)}{(8.314\ \frac{kPa\cdot m^3}{kmol\cdot K})(300.15\ K)} = \boxed{2\ kmol}$$

d) Determine the amount of N_2 (kg) that was in vessel 2. (/3)

$$n_{tot} = n_{CH_4} + n_{N_2}$$
$$\Rightarrow 2 = 0.3125 + n_{N_2}$$
$$\Rightarrow n_{N_2} = 1.6875\ kmol = 1.6875 \times 28 = \boxed{47.25\ kg}$$

PART B – CUBE-SHAPED CONTAINER (/13)

A cube container (same length on each side) is used to store a mixture of 3 kmol of nitrogen and 5 kmol of methane at 27°C and 6.003 MPa.

a) Determine the partial pressures of nitrogen and methane in the cube container. (/2)

$n_{N_2} = 3\ kmol$
$n_{CH_4} = 5\ kmol$
$T = 300.15\ K$
$P = 6.003\times10^3\ kPa$

$y_{CH_4} = \frac{3}{8} = 0.375$
$\bar{P}_{CH_4} = 0.375 \times 6.003\ MPa = \boxed{2.251\ MPa \text{ or } 2.25\times10^3\ kPa}$

$y_{N_2} = 0.625$
$\bar{P}_{N_2} = .625 \times 6.003\ MPa = \boxed{3.752\ MPa}$

OR

$\bar{P}_{N_2} = P - \bar{P}_{CH_4} = \boxed{3.752\ MPa}$

b) Calculate the number density of the gas mixture in the cube container. (/3)

$$\rho_N = \frac{P}{KT} = \frac{6.003\times10^6\ Pa}{1.3805\times10^{-23}\ \frac{Pa\cdot m^3}{molecule\,K} \times 300.15\ K}$$
$$= \boxed{1.45\times10^{27}\ molecules/m^3}$$

c) The content of the cube container is transferred isothermally to a NEW larger cube container. The length of each side of the NEW larger cube is twice the length of the original cube. What is the new pressure? (/3)

$$\boxed{\begin{array}{c} V_1 \\ T_1 \\ P_1 \end{array}} \longrightarrow \boxed{\begin{array}{c} V_2 = 8V_1 \\ T_2 = T_1 \\ P_2 = ? \end{array}}$$

$$P_1 \cancel{V_1} = P_2 V_2 = 8 P_2 \cancel{V_1}$$

$$\Rightarrow P_2 = \frac{1}{8} P_1$$

$$= \frac{1}{8} \times 6.003 \text{ MPa}$$

$$= \boxed{0.7504 \text{ MPa}}$$

d) The content of the NEW larger cube is now heated to a temperature of 100°C. What is the new pressure? (/3)

$$\boxed{\begin{array}{c} V_2 \\ T_2 = 300.15K \\ P_2 = .7504 \text{ MPa} \end{array}} \xrightarrow{\text{Heating}} \boxed{\begin{array}{c} V_3 = V_2 \\ T_3 = 373.15K \\ P_3 = ? \end{array}}$$

$$\frac{P_2}{T_2} = \frac{P_3}{T_3} \Rightarrow P_3 = \frac{T_3}{T_2} P_2 = 1.243 \times .7504 \text{MPa}$$

$$= \boxed{0.933 \text{ MPa}}$$

e) What is the average molecular weight of gas mixture in the NEW larger cube? (/2)

$$\overline{M} = \Sigma y_i M_i = 0.325 \times 28 + 0.625 \times 16$$

$$= \boxed{20.5 \text{ kg/kmol}}$$

Question Number II *(25 Marks ~ 30 minutes)*

Nitrogen (M=14) has a critical temperature of -146.9°C, critical pressure of 3.369 MPa, and collision diameter of 3.64 Å.

a) Calculate the average speed of N_2 molecules at 500°C and 3 atm. (/3)

$$\bar{c} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8 \times 8314 \times 773.15}{\pi \times 28}}$$

$M_{N_2} = 28$ kg/kmol

$R = 8314 \frac{Pa\, m^3}{kmol\, K}$

$$\boxed{\bar{c} = 764.6 \text{ m/s}}$$

b) How far would an average N_2 molecule travel between collisions at 500°C and 3 atm? (/3)

$$\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 \rho_N} = \frac{kT}{\sqrt{2}\pi\sigma^2 P}$$

$$\lambda = \frac{1.3805 \times 10^{-23} \times 773.15}{\sqrt{2}\pi (3.64 \times 10^{-10})^2 (3 \times 101325)}$$

$$\boxed{\lambda = 5.965 \times 10^{-8} \text{ m}}$$

c) How much energy would a single nitrogen molecule gain if the temperature is raised from 100°C to 200°C at 1atm? (/3)

$$\Delta E_k = \bar{E}_{k_2} - E_{k_1}$$

$T_1 = 100°C$

$T_2 = 200°C$

$m = \frac{M}{N_A}$

$$= \frac{1}{2} m (\bar{c}_2^2 - \bar{c}_1^2)$$

$$= \frac{1}{2} \frac{28}{6.023 \times 10^{26}} \left(\frac{3R}{M} (T_2 - T_1) \right)$$

$\bar{c}^2 = \frac{3RT}{M}$

$$= 2.324 \times 10^{-26} (89.08)$$

$$\boxed{\Delta \bar{E}_k = 2.07 \times 10^{-24} \text{ kJ}}$$

d) How many nitrogen molecules would fit in a room that is 5m wide, 5 m deep and 4 m high at 25°C and 1 atm? Assume that air is 78% N_2 on a molar basis. (/4)

$$\rho_N = \frac{molec}{V} \qquad \rho_N = \frac{P}{kT} = \frac{101325\ Pa}{1.38 \times 10^{-23} \times 298.15}$$

$$\rho_N = 2.4617 \times 10^{25} \text{ (all air)}$$

$$\rho_{N(N_2)} = 0.78 \times \uparrow = 1.92 \times 10^{25}\ molec/m^3$$

$$molec = \rho_N V = (1.92 \times 10^{25})(\underbrace{5 \times 5 \times 4}_{(100\ m^3)}) = \boxed{1.92 \times 10^{27} \text{ molecules}}$$

e) The Schmidt number is defined as the ratio of the momentum diffusivity (viscosity) to mass diffusivity and can be calculated from the following formula:

$$Sc = \frac{\mu}{\rho D}$$

Where μ = viscosity, ρ = density and D = diffusivity.

Calculate the Sc for N_2 at 25°C and 1 atm assuming ideal gas behaviour. (/4)

$$Sc = \frac{\mu}{\rho D} = \frac{\frac{\cancel{M}}{\cancel{N_A \pi \sigma^2}}\sqrt{\frac{\cancel{RT}}{\pi M}}}{\frac{\cancel{PM}}{\cancel{RT}} \cdot \frac{\cancel{RT}}{\cancel{P N_A \pi \sigma^2}}\sqrt{\frac{\cancel{RT}}{\pi M}}} \qquad \rho = \frac{PM}{RT}$$

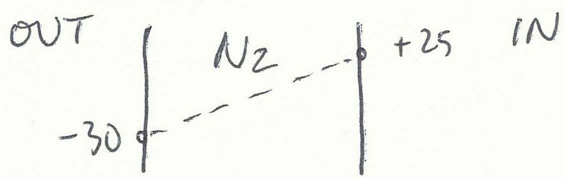
$$\boxed{Sc = 1}$$

for ideal gas.

f) How would the Sc change if the temperature were raised to 100°C and the pressure to 4 atm? (/3)

No change $\boxed{Sc = 1}$

g) Nitrogen is trapped between two window panes separated by 4 mm. Outside the window is -30°C on a cold winter day and the house inside is at 25°C. Calculate how much heat would be lost through a 1m by 1m window in a 24h period. You can assume no temperature gradient through the glass on either side of the nitrogen. (/5)



$q = ?$ in 24 h $= 24 \times 60 \times 60\,s$

$A = 1m \times 1m$

$T_{AVG} = \dfrac{-30+25}{2} = -2.5°C$

$$\frac{Q}{A} = -k\frac{dT}{dz} \longrightarrow \Delta q = -A\,\Delta t\, k\frac{dT}{dz}$$

$$k = \frac{C_v}{N_A \pi \sigma^2}\sqrt{\frac{RT}{\pi M}} = \frac{\frac{3}{2}(8.314\ kJ/kmol\,K)}{6.023\times10^{26}\pi\,(3.64\times10^{-10}m)^2}\sqrt{\frac{8314\times270.65}{\pi\times28}}$$

$k = 7.956\times10^{-6}\ kJ/msK$

$$\Delta q = -(1m^2)(7.956\times10^{-6}\ \tfrac{kJ}{msK})(24\times60\times60)\frac{-30-25}{4\times10^{-3}m}$$

$\boxed{\Delta q = 9451.5\ kJ}$

Question Number III *(25 Marks ~ 30 minutes)*

PART A /14 marks

A fixed amount (1 kmol) of ammonia is at 10 MPa and 415.6 K in a rigid container. The gas follows van der Waals (vdW) Equation of State, and the vdW parameters are given below.

Gas	Molar Mass	a	b
Ammonia (NH_3)	17 kg/kmol	4.2 atm.$(m^3/kmol)^2$	0.0374 $(m^3/kmol)$

a) Determine the molar volume of the gas at 10 MPa and 415.6 K using the ideal gas law. (/3)

$$P V_m^{IG} = RT$$

$$V_m^{IG} = \frac{RT}{P} = \frac{8.314 \frac{kPa \cdot m^3}{kmol \cdot K} \times 415.6\ K}{10 \times 10^3\ kPa} = \boxed{0.3455\ \frac{m^3}{kmol}}$$

b) Determine the molar volume of ammonia at 10 MPa and 415.6 K using the vdW Equation of State. Show two iterations. (/7)

$$V_m^3 - \left[b + \frac{RT}{P}\right] V_m^2 + \frac{a}{P} V_m^2 - \frac{ab}{P} = 0$$

Coefficients:

$$b + \frac{RT}{P} = b + V_m^{IG} = 0.0374 + 0.3455 = 0.38293\ \frac{m^3}{kmol}$$

$$\frac{a}{P} = \frac{4.2 \times 101.325\ kPa \cdot (m^3/kmol)^2}{10 \times 10^3\ kPa} = 0.04256\ \left(\frac{m^3}{kmol}\right)^2$$

$$\frac{ab}{P} = b \times \frac{a}{P} = 0.0374 \times 0.04256 = 0.001592 \left(\frac{m^3}{kmol}\right)^3$$

vdW: $$V_m^{(i+1)} = 0.38293 - \frac{0.04256}{V_m^{(i)\,2}} + \frac{0.001592}{V_m^{(i)\,2}}$$

Iteration: Initial guess: $V_m^{(0)} = V_m^{IG} = 0.3455\ m^3/kmol$

1st iteration $(i=0)$: $V_m^{(1)} = 0.2644\ m^3/kmol$

2nd " $(i=1)$: $V_m^{(2)} = \boxed{0.245\ m^3/kmol}$

... b) continued

… b) continued

c) Determine the compressibility factor of ~~methane~~ ammonia based on the molar volumes obtained in parts (a) and (b) (/2)

$$Z = \frac{V_m}{V_m^{Th}} = \frac{0.245}{0.3455} = \boxed{0.709}$$

d) Explain whether the following statement is true or false and explain why (no calculation needed): "If the temperature of the gas in the rigid container is doubled to 831.2 K, the pressure will double to 20 MPa". (/2)

False.

For ideal gas, it will be double ($P \propto T$). But,

Ammonia is $\boxed{\text{not ideal gas}}$ ($Z \neq 1$ or $a \neq 0, b \neq 0$).

$$P_1 \cancel{V_1} = \cancel{n_1} Z_1 RT$$

$$P_2 \cancel{V_2} = \cancel{n_2} Z_2 R(2T) = (Z_2)\, 2\left(\frac{P_1}{Z_1}\right)$$

$$\Rightarrow P_2 = 2P_1 * \left(\frac{Z_2}{Z_1}\right)$$ ← This is the true relationship of pressures for ammonia.

PART B /11 marks

The pressure exerted by 1 mol of a real gas in a 0.5 litre vessel at 298 K is 44.6 atm.

Gas	Molar Mass	a	b
Methane (CH_4)	M=16 kg/kmol	2.25 atm.$(L/mol)^2$	?

[L/mol = m^3/kmol]

a) Determine the van der Waals parameter b for this gas. (/4)

$$P = \frac{RT}{V_m - b} - \frac{a}{V_m^2}$$

$$\Rightarrow P + \frac{a}{V_m^2} = \frac{RT}{V_m - b}$$

$$\Rightarrow V_m - b = \frac{RT}{P + \frac{a}{V_m^2}} = \frac{0.08206 \frac{L \cdot atm}{mol \cdot K} \times 298K}{44.6\,atm + \frac{2.25\,atm \cdot (L/mol)^2}{0.5^2 (L/mol)^2}}$$

$$= 0.456\ L/mol$$

$$\Rightarrow b = V_m - 0.456 = 0.5 - 0.456 = \boxed{0.0437\ L/mol \text{ or } m^3/kmol}$$

b) Determine the critical temperature and pressure of this gas. (/4)

$$T_c = \frac{8a}{27Rb} = \frac{8 \times 2.25\ atm \cdot (L/mol)^2}{27 \times 0.08206 \frac{L \cdot atm}{mol \cdot K} \times .0437\ L/mol}$$

$$= \boxed{185.5\ K}$$

$$P_c = \frac{a}{27b^2} = \frac{2.25}{27 \times (0.0437)^2} = \boxed{43.44\ atm}$$

c) Determine the compressibility factor of this gas using the generalized compressibility chart. (ONLY if you are unable to get critical properties for this gas, use T_c=400K and P_c=4 atm) (/3)

$T_R = T/T_c = 298/185.5 = 1.61$

$P_R = P/P_c = 44.6/43.44 = 1.03$

$\boxed{Z \simeq 0.93}$

Question Number IV *(25 Marks ~ 30 minutes)*

A storage tank contains air (78% nitrogen, 21% oxygen, 1% argon on a molar basis) at 40 atm and 21.57°C. Properties of the components are shown below:

	M (kg/kmol)	**T**$_c$ (K)	**P**$_c$ (atm)	ω
Nitrogen	14	126.2	33.5	0.04
Oxygen	16	154.6	49.8	0.021
Argon	40	150.8	48	-0.004

a) Use the ideal gas law to calculate the molar volume of the gas. (/3)

$PV_M = RT \qquad V_M = \frac{RT}{P} = \frac{(0.08205)\frac{atm\,m^3}{kmol\,K} \times 294.72K}{40\ atm}$

$T = 21.57\ °C$
$= 294.72K$
$P = 40\ atm$

$\boxed{V_M = 0.6045\ m^3/kmol}$

b) Use the Law of Corresponding States and the Pitzer Curl tables to calculate the molar volume of the gas. (/8)

$T_{PC} = 0.78(126.2) + 0.21(154.6) + 0.01(150.8) = 132.41\ K$

$P_{PC} = 0.78(33.5) + 0.21(49.8) + 0.01(48) = 37.068\ atm$

$T_r = \frac{T}{T_{PC}} = \frac{294.72}{132.41} = 2.226\ (2.23) \qquad P_r = \frac{P}{P_{PC}} = \frac{40}{37.068} = 1.08$

$T_r >$ (Z^0 and Z^1 chart) → need to extrapolate

$\bar{\omega} = \sum y_i \omega_i = 0.03557$

OPTION #1 $\quad Z = 0.9765 \quad V_M = \frac{ZRT}{P} = \boxed{0.5903\ m^3/kmol}$

(OPTION #2 $\quad Z = 0.9940 \quad V_M = \frac{ZRT}{P} = \boxed{0.6009\ m^3/kmol}$

(see next pages

OPTION #1 - Use $T_r = 2.0$ (max on charts)

Z^0	$T_r = 2.0$	$P_r = 1.0$	1.08	1.2
		0.975	•	0.971

interpolate $Z^0 = 0.9734$

Z^1	$T_r = 2.0$	$P_r = 1.0$	1.08	1.2
		0.08	•	0.10

interpolate $Z^1 = 0.088$

$$Z = Z^0 + \bar{\omega} Z^1$$

$$Z = 0.9734 + 0.03557(0.088) = \boxed{0.9765 = Z}$$

OPTION #2 - Extrapolate using $T_r = 1.9$ and 2.0

Z^0

T_r \ P_r	1.0	1.08	1.20
1.9	0.968	• 1	0.962
2.0	0.975	• 2	0.971
2.23			

- Step 1 - Interpolate @ $T_r = 1.9$ to get $P_r = 1.08$

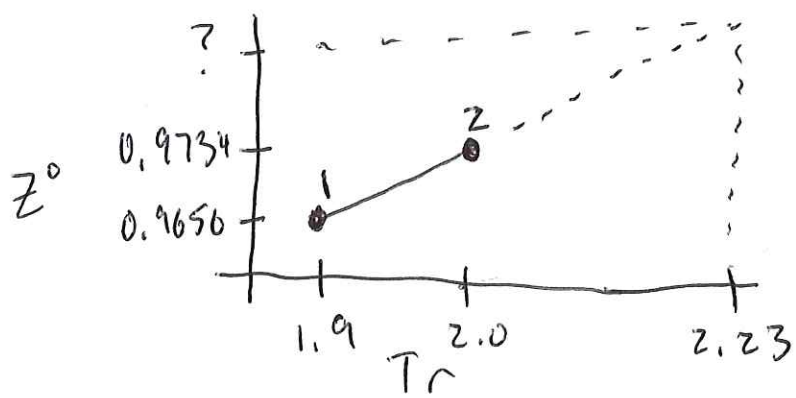
  • 1 $= 0.9656$

  - Interpolate @ $T_r = 2.0$ to get $P_r = 1.08$

  • 2 $= 0.9734$

- Step 2 - Make equation @ $P_r = 1.08$ to see effect of T_r

(could do effect of T_r @ $P_r = 1.00$ and $P_r = 1.20$ first and then extrapolate)



$y = mx + b \qquad m = \frac{\text{rise}}{\text{run}} = \frac{0.9734 - 0.9656}{2.0 - 1.9} = 0.078$

$0.9656 = 0.078(1.9) + b$

$b = 0.8174$

$y = 0.078x + 0.8174$

$Z^0 = 0.078(T_r) + 0.8174$

$T_r = 2.23 \longrightarrow \underline{Z^0 = 0.99134}$

12c

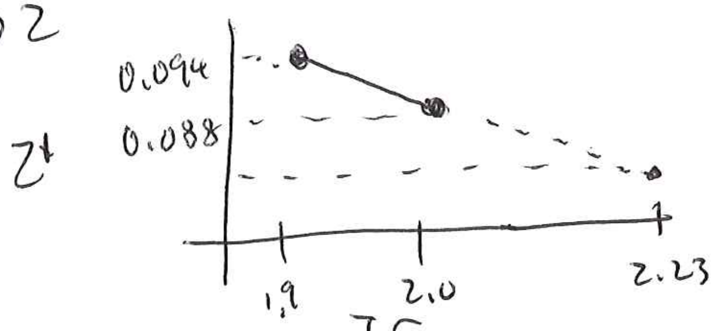
Repeat for z' (see details previous page - only answers here)

		Pr		
		1.0	1.08	1.20
	1.9	0.09	•1	0.10
Tr	2.0	0.08	•2	0.10
	2.23			

Step 1 $\rightarrow$ •1 $= 0.094$

$\rightarrow$ •2 $= 0.088$

Step 2



$z' = -0.06\,Tr + 0.208$

$z' = -0.06\,(2.23) + 0.208$

$z' = 0.0742$

$z = z^0 + \bar{\omega} z'$

$z = 0.99134 + 0.03557(0.0742)$

$\boxed{z = 0.9940}$

c) Compare your answer in b) to that obtained from the Generalized Compressibility chart. (/3)

From b) $T_r = 2.23$ $P_r = 1.08$

$Z = 0.99$ $V_m = \frac{ZRT}{P} = \boxed{0.5984\ m^3/kmol}$

(higher than OPTION #1, close to OPTION #2)

d) How much gas (kg) would be held in a cylindrical tank 2 m diameter and 4 m high? You can use your answer from b) or c). (/5)

→ Using (c) $V = \pi r^2 h = \pi (1m)^2 (4m) = 12.566\ m^3$

$V_m = \frac{V}{n} \rightarrow n = \frac{V}{V_m} = \frac{12.566}{0.5984} = 21.0\ kmol$

$\bar{M} = \sum y_i M_i = 0.78(28) + 0.21(32) + 0.01(40)$

$\bar{M} = 28.96\ kg/kmol$

$n\bar{M} = m = 21.0 \times 28.96 = \boxed{608.14\ kg}$

OR

(→ Using (b) OPTION #1 $\boxed{m = 616.48\ kg}$) $\boxed{b\#2\ \ m = 605.61\ kg}$

$n = 21.29$

e) What error (%) in your answer to d) would you have obtained if you had used the ideal gas law? (/4)

$\%\ Error = \frac{Real - Ideal}{Real} 100$

↳ d) is mass

Ideal mass

$n = \frac{12.566}{0.6045} = 20.787$

$m = \bar{M} n = 602.00\ kg$

(c) $\%\ Error = \frac{608.14 - 602}{608.14} 100 = \boxed{1.01\%}$

OR

(b#1) $\%E = \frac{616.48 - 602}{616.48} 100 = \boxed{2.35\%}$

OR

(b#2) $\%E = \frac{605.61 - 602}{605.61} 100 = \boxed{0.60\%}$

f) What non-ideal factors do the van der Waals a and b parameters represent? (/2)

a = intermolecular forces (ideal = 0)

b = size of molecules (ideal = 0)