Solutions Manual for Basic Principles and Calculations in Chemical Engineering, 8th Edition by **Himmelblau** **ISBN** 0132346605 9780132346603

ExamNo.6 (Open Book, 2 hours)

PROBLEM 1 (**20%**)

A high pressure line canies natural gas (all methane) at 1.0,000 kPa and 40°C. How would you calculate the volume of the gas under these conditions that is equivalent to 0.03 m^3 of CH at standard conditions using an equation of state? Select one equation other than van der Waal's equation, and list it on your solution page. Give a list of steps to complete the calculations. Include all the proper equations, and include a list of data involved, but you do not have to obtain a solution for the volume.

PROBLEM 2 (20%)

From the following data estimate the vapor pressure of sulfur dioxide at 100°C.

Temperature (°C)	–10	6.3	32.1	55.5
Vapor pressure (atm)	1	2	5	10

PROBLEM 3 (20%)

o%

dry air

o

o

Dry atmospheric air at the ambient conditions of 90°F and 29.42 in. Hg absolute passes through a small blower and is bubbled up through water so that the air leaving the water is saturated. The temperature of the water is constant at 80°F, and because of the back pressure in the system, the pressure in the vapor space in the top of the bottle is 2.7 in. H_2O greater than atmospheric pressure. The bottle is weighted after the air is blown for 2 hours, 13 minutes, 47 seconds, and the decrease in weight was found to be 8.73 lb. What was the hourly rate of flow of air at ambient conditions in ft^3?

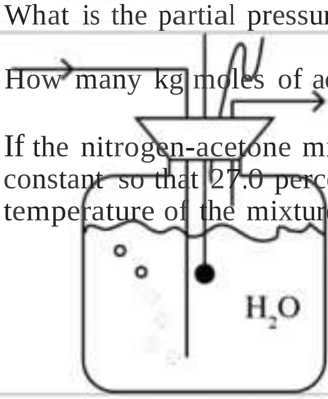
PROBLEM 4 (20%)

A vessel with a volume of 2.83 m^3 contains a mixture of nitrogen and acetone at 44.0°C and 100.0 kPa. The dew point of the mixture is 20.0°C and the relative saturation of the acetone in the mixture is 58.39%. The vapor pressure of acetone at 44.0°C is 65.35 kPa and it is 24.62 kPa at 20.0°C.

a. What is the partial pressure of acetone vapor in the original mixture, in kPa?

b. How many kg moles of acetone does the original mixture contain?

c. If the nitrogen-acetone mixture is cooled with the volume remaining at 2.83 m^3 constant so that 27.0 percent of the acetone condenses, what is the final temperature of the mixture in °C?



Solutions Chapter 2

2.1.1

(a)	N/mm or nm (nanometer)
(b)	°C/M/s
(c)	100 kPa
(d)	273.15 K
(e)	1.50m, 45 kg
()	25O€
(g)	J/s
(h)	250N

2.2.1

a. Basis: I mi

]ySso n as+an[in_jy

1m (1 mi | (1 [I n) | (1 in | [1oo cm. [in1@mi]

b. Basis: 1 f/s

1]6 [748 g!pi .a7n7]

sh»mRl in

2.2.2

a. 0.04 g | 60 minl(12 in)^3 | 1 lb, = lb, (X)] | i i | 1 ft^3 | 1i g = 1 '@@)

b. 2L[00 s[24 hi]Id / s | 1 hr | 1 day | 28.32L = [6]x]Q' A / day

c. 6(n cm) | If | (i) | yr | [1 day/'hr | 2.2 lb, / (yr(s)lb, (f)/(12 in)\(2.54 cm)[365 days[24 hr[3600s] | 1 kg

! !! | 0.3048 m / 12 inl | If = 1. I4 10. m / (kg) (s)

2.2.3 a Basis: 60.0 mile/hr

6me[g2son]_ I r −[%s f]
hr 1 mile 3600 sec sec

b. Basis: 50.0 lb,/(in)

50.0/lbm |454 g 1 kg l(in)2 (100 cm)2 =-13.52x 10·8
(in) 1lb '1000 g1(2.54 cm) (1 m) m2

c. Basis: 6.20 cm/(hr)

6.20 cm 1 1 m 10^9nm l(hr)^2 =4.79 nm
(hr) '100 cm I m |(3600 sec) sec

2.2.4 20 hp|0.7457 kW _ 14.91 1w
1 hp

|No], not enough power even at 100% efficiency; 68 kW = 91.2 hp.

2.2.5

1hr [220O gal[1ooo mile _ [419o.s ga1]
525 mile 1 hr

1 hr 2000 gal 1000 mile 4210 gal
475 mile 1 hr = (20 gal)

None: 20 gal more are needed.

2.2.6 Let t, be the time for A to paint one house; tp for B
A does a house in 5 hours, or 1 house/5 hr. B does one house in 3 hours, or 1 house/3 hr.

1 house |tA hr + 1 house |tB hr − 1 house
5hr 3hr

Also t, =t% so that $\frac{3}{15}$ 1, + $\frac{5}{15}$ t, =1 or $\frac{8}{15}$ 1 ,=1

, − $\frac{\ }{8}$ nr=ı, =1875 hr or [112 5 mi]

2.2.7 (a) mass, because masses arc balanced
(b) weight, because the force exerted on the mass pushes a spring

2.2.8

20.0g | 1lb, | 0.3048m/ | 3600s | 1 (lb,6s) | 1(hr)
(m)(s) | 453.6g | If | 1hr | 32.174(lb,_(fb)) | (3600)'s

=h 1.16x ⊄+ (b,(hp / f?

2.2.9

L.0 Btu | 24 hrs | IR | 1in | (100 cm) | 1.8°F | 2.54 cm
(ho<<) (°FJ / ft | 1 day | (12 in)2 | (2.54 cm²) | 1 m² | 1°C | m

252cal | 12 in | 4.184J | 1kJ _1490 10'. kJ
I Btu | 1ft | 1cal | 1000J (day)(m)(°C/cm)

2.2.10 Basis: 1 lb HO

a. W-'%e-!! b [[3j' (X8), -o Se
2 2 s /32174-01b,)

b. Let A= area of the pipe and v= water velocity. The flow rate is

q=Av=l(1tD²)(v)

[@2i)1 __f_ [3n] 60s [7.48 g! [9.37 gal/in]
4 (12in) S 1min 1ft

2.2.11

PE= 75 gal | 8.33 lbm | 32.2 ft | !()Cl] | 60 S | s'-lb, | Btu =4818 Btu/hr
min | gal | sec° | 'n] | hr | 32.2 lb,-1 | 778 f-lb,

Pump Work = 2 hp | 2545 Btu / hp-hr = 5090 Btu/hr

Rate of energy input for heating = PW−PE =5090 - 4818 = 272 Btu/hr

2.2.12 The object has a mass of21.3 kg (within a precision of± .1kg). The weight is the force used to support the mass.

2.2.13 In American Engineering System

Power = FV

= 800 lbr | 300 ft / 1 | min = 240 (bu/ mm ~727%,

In SI

Power = 4000 N | 1 .5 m | 1 (watt)(s) / 1 | s | 1(N)(m)

=- [@oo@watts

2.2.14

KE = $\frac{1}{2}mv^2$

=

gpawW ks]. W, [goon"! 1 Ba

[[0454 kg] s |[32 2 lb,I I '778 2(6(1)

lb, sec

- [ii1B

2.2.15 Basis: 10 tons at 6 ft/s

r-'me1[20O01,[/6f)² |(s²Mb,)—[1,2co@u.]

2 2| s /322OOb,) " T

2.2.16 Basis: 1 mRNA

InRNA] 3r ribonucleotides] I active ribosome 1200 amino acids protein

—i nRNA | 264 ribonucleotides | min-active ribosome | x amino acids =

13.6 protein molecules fonned per min per nRNA

2.3.1

a,. A is in g/cm°

as. B is in g/(cm)(°C)

a. Since the exponent of e must be dimensionless
C is in atm'

b₁ Log[@o±rem[yo, -[%((. " ;]
cm' f 454g f

b₂ B = 0.00086 gl(30.48) cm 1l lbm = 0-0298 lbm
(em("C) 3 3

b₃ f 1454g'18"R (ft(R)

C _0.000953] 1atm = q.0000648 '
atm '14.7 lb,/in lb,/in

2.3.2 Introduce the units. The net units are the same on both sides of the equation.

$(ft)(ft)\left(\frac{ft}{s^2}\right)^{1/2} = \frac{ft^3}{s}$

2.3.3

No. q=0.6@2m\@2]9.8m/10'm]5O10'(kg(m)] I [g?) 1/2
kg)(

The net units on the right hand side of the equation are

$m^2\left[\frac{m^3}{s^4}\right]^{1/2} = \frac{m^3}{s}$

Consequently, the formula will not yield 80.8 m/s, presumably in the formula the g should be g. for use in the AE system.

144 i° 231b, + 73 in gas/0.703 H,0] In l+7 lbf in

ΛD=

= 7-

2.3.4 Q=O61S ⁄(2 P)/p assume hole is open to atmosphere

1f in 1gas 12in]3391 f H,0

= 3,579 1b,/f

0.7031 162.4 lbH,O ftHO lb

P 1l⁄NH,O 4 T

$$s = \pi\left(\frac{1}{(4)12}\right)^2 = 3.41\times10^{-4}\,ft^2$$

Q = (3600)(0.61)(3.41 x 10~)J(2)(3579)gJ 43.87 = 154 ~

2.3.5

a. $Z = 1 + \rho B + \rho^2 C + \rho^3 D$

	Units
B	cm/g mol
C	(cm/g mol
D	(cm/g mol)

b. $Z = 1 + \rho^* B^* + (\rho^*)^2 C^* + (\rho^*)^3 D^*$

	Units
B	f/lb,
C	(e/1 _ 2
D	(ft/1b,

If B is the original coefficient, B* is obtained by multiplying B by conversion factors. Let MW is the molecular weight of the compound.

B* ft³/lb,, as] gmol . 1 ft / 30.48 cm j[: ma / MW g t / I lb, %ii] / MW

1 ; j - lb,, ; j gmol , '' j 30.48 cm [!= j MWg j e I lb, j e $\frac{.57\times10^{-4}}{MW}$

$D\left(\frac{ft^3}{lb_m}\right)^3 = D\ \frac{4.096\times10^{-6}}{MW}$