Problem Set #4

CHEM101A: General College Chemistry

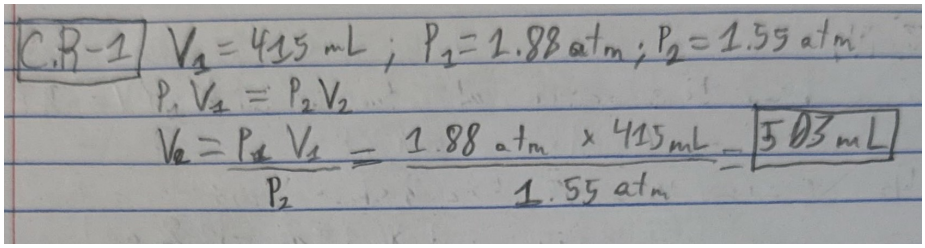
Donald Aingworth IV

September 12, 2025

1 Topic C Problem R-1

A container holds 415 mL of air at a pressure of 1.88 atm. If you want to reduce the pressure to 1.55 atm without changing the temperature, to what volume must you expand the air?

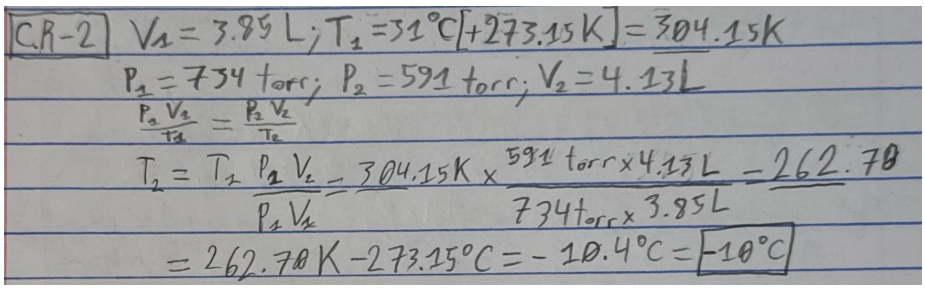
1.1 Solution



2 Topic C Problem R-2

A balloon is filled with 3.85 L of oxygen at 31°C and a pressure of 734 torr. The balloon is then taken to the top of a mountain, where the pressure is 591 torr. The volume of the oxygen is found to be 4.13 L. What is the temperature of the oxygen? Give your answer in °C.

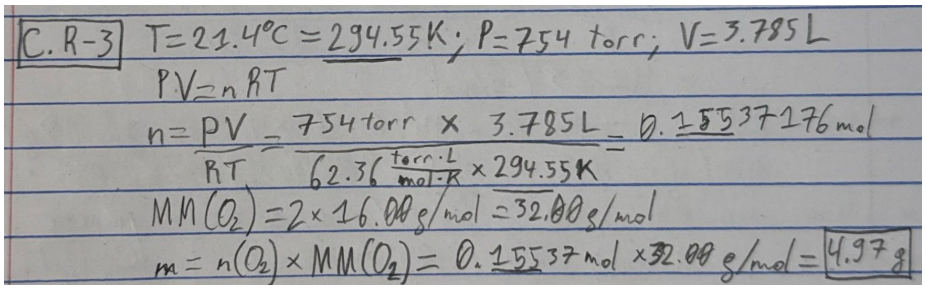
2.1 Solution



3 Topic C Problem R-3

A container is filled with gaseous O_2 at 21.4°C (70.5°F) and a pressure of 754 torr. If the volume of the container is one gallon (3785 mL), what is the mass of the O_2?

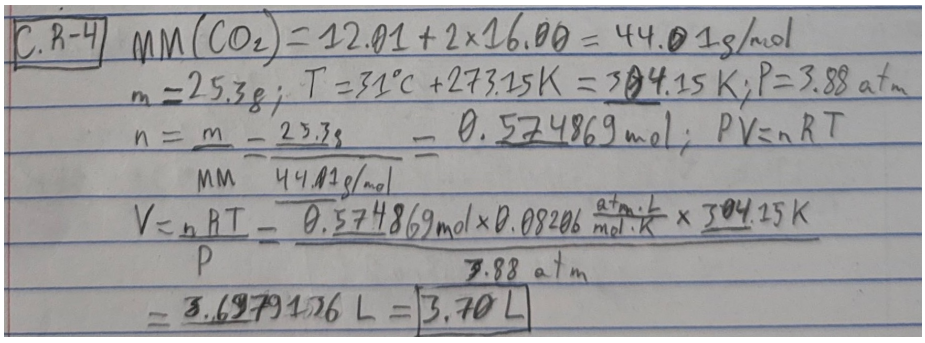
3.1 Solution



4 Topic C Problem R-4

A container is filled with 25.3 g of gaseous CO_2 at 31°C. If the carbon dioxide exerts a pressure of 3.88 atm, what is the volume of the container?

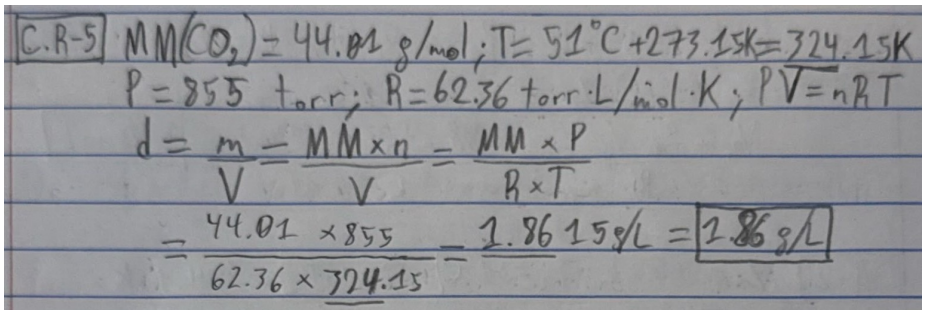
4.1 Solution



5 Topic C Problem R-5

What is the density of gaseous carbon dioxide at 51°C and a pressure of 855 torr?

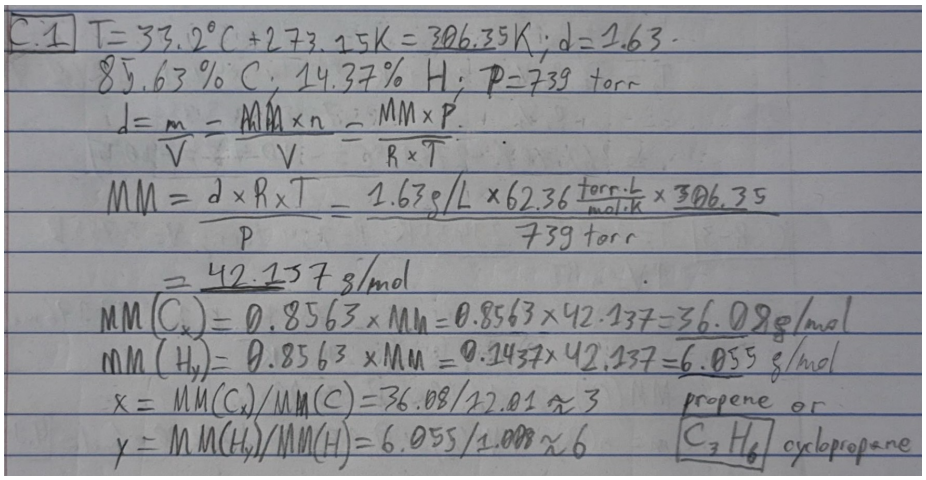
5.1 Solution



6 Topic C Problem 1

A gaseous compound has the following composition: 85.63% carbon, 14.37% hydrogen. The density of this compound is 1.63 g/L at 33.2°C and a pressure of 739 torr. What is the molecular formula of the compound?

6.1 Solution



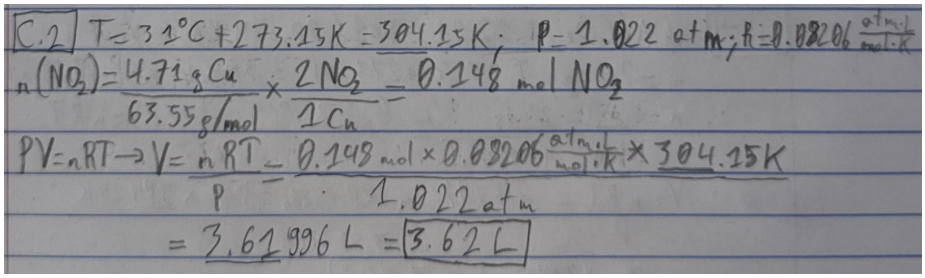
7 Topic C Problem 2

Copper reacts with nitric acid as shown below:

$$\mathrm{Cu(s) + 4\,HNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2\,NO_2(g) + 2\,H_2O\,(l)} \qquad (1)$$

If 4.71 g of copper reacts with excess 3 M nitric acid, what volume of nitrogen dioxide will be formed at 31°C and 1.022 atm?

7.1 Solution



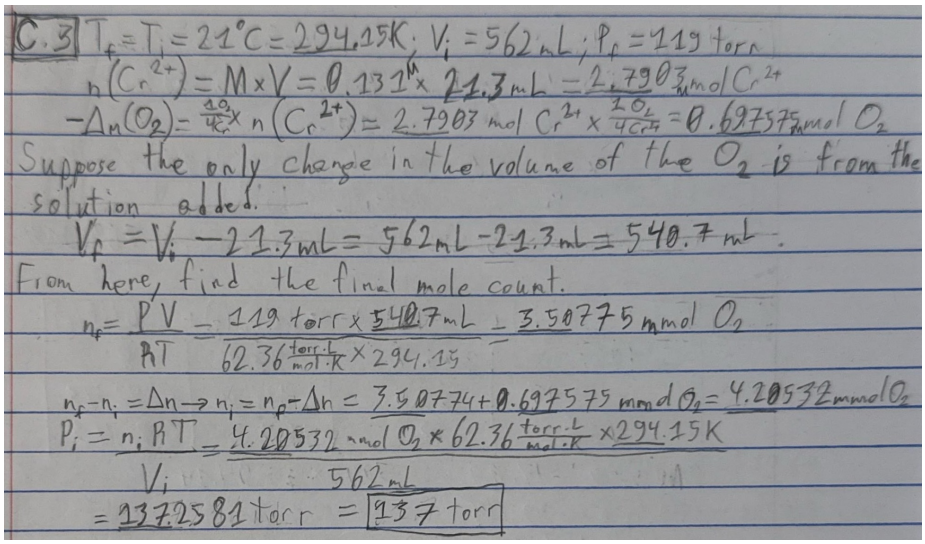
8 Topic C Problem 3

Consider the following reaction:

$$4\,Cr_2{}^{+}(aq) + O_2(g) + 4\,H^{+}(aq) \longrightarrow 4\,Cr_3{}^{+}(aq) + 2\,H_2O\,(l) \qquad (2)$$

A container that holds 562 mL of gaseous oxygen at 21°C is prepared. Then, 21.3 mL of a solution that contains 0.131 M Cr^{2+} ions is added to the container. After the reaction, the pressure of the oxygen in the container is found to be 119 torr and the temperature is still 21°C. What was the pressure of oxygen in the container before the Cr^{2+} solution was added? (You can assume that H^{+} is present in excess.)

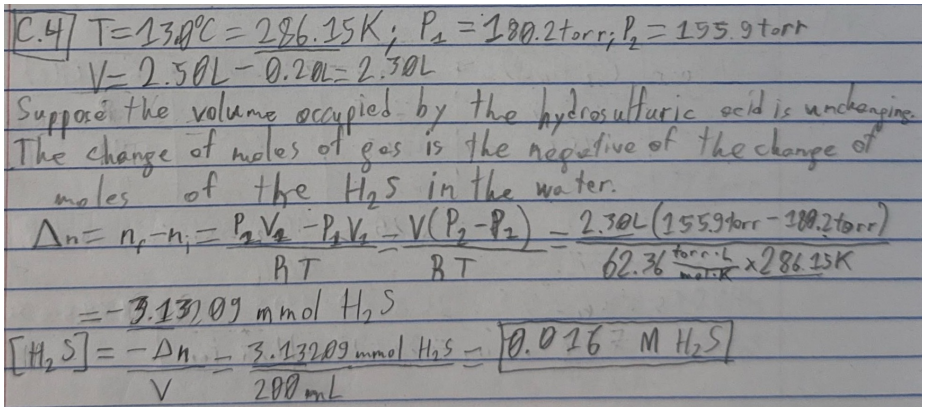
8.1 Solution



9 Topic C Problem 4

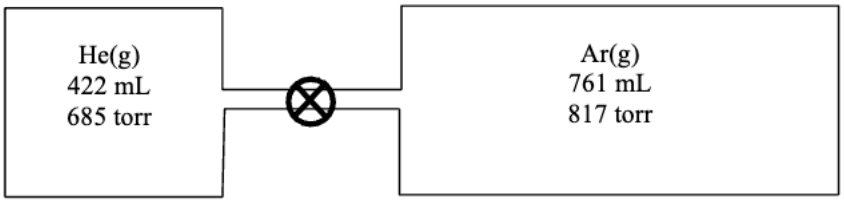
A chemist puts 200.0 mL of water into a 2.50 L container, and adds enough gaseous H_2S to give a pressure of 180.2 torr at a temperature of 13.0°C. Some of the H_2S then dissolves in the water, causing the pressure in the container to drop to 155.9 torr. The temperature remains constant throughout this experiment. What is the molar concentration of H_2S in the water at the end of the experiment?

9.1 Solution



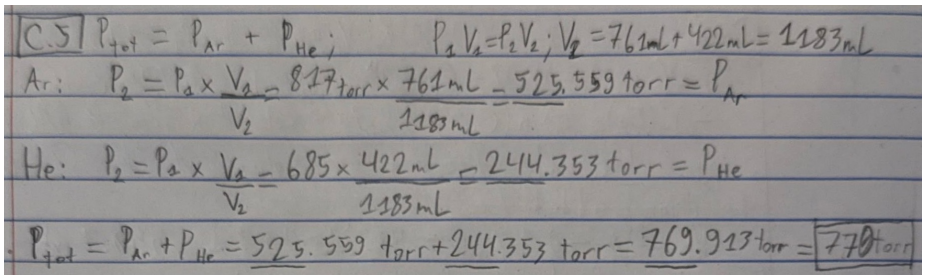
10 Topic C Problem 5

Consider the apparatus pictured below, which consists of two containers separated by a valve.



Assuming that the two gases are the same temperature and that the temperature does not change, what will be the total final pressure in the system after the valve is opened and the gases mix completely?

10.1 Solution

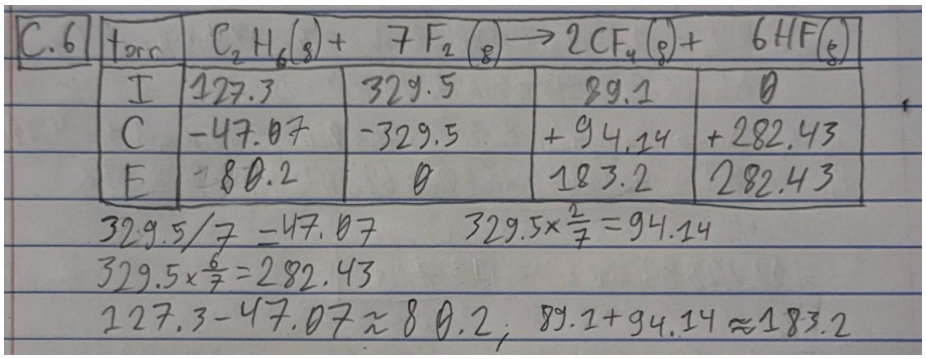


11 Topic C Problem 6

Complete the following ICE table. All of the reactants and products for this reaction are gases, and the temperature and volume are constant during the reaction.

torr	$C_2H_6 +$	$7\,F_2$	$\rightarrow 2\,CF_4 +$	$6\,HF$
Initial pressure (torr)	127.3	329.5	89.1	0
Change (torr)				
Ending pressure (torr)				

11.1 Solution



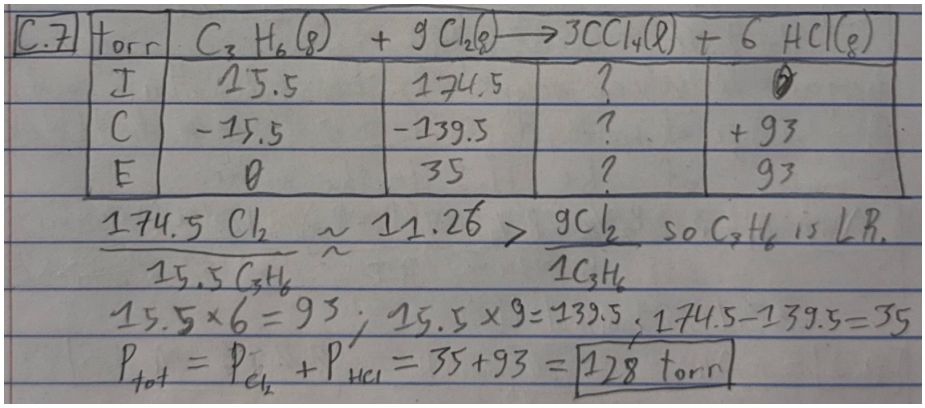
12 Topic C Problem 7

At 30°C, propylene (C3H6) reacts with chlorine as follows:

$$C_3H_6(g) + 9\,Cl_2(g) \longrightarrow 3\,CCl_4(l) + 6\,HCl(g) \tag{3}$$

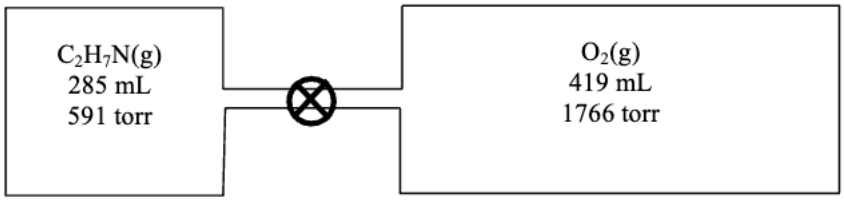
A mixture containing 15.5 torr of C3H6 and 174.5 torr of Cl2 is allowed to react at 30°C. What will be the total gas pressure in the container when the reaction is complete? You may assume that the volume and temperature are constant.

12.1 Solution



13 Topic C Problem 8

Consider the apparatus pictured below, which consists of two containers separated by a valve.



The valve is opened and the gases react as follows (note that the temperature is high enough that the water is produced as a gas):

$$4\,C_2H_7N\,(g) + 15\,O_2(g) \longrightarrow 8\,CO_2(g) + 14\,H_2O\,(g) + 2\,N_2(g) \qquad (4)$$

What will be the total pressure in the apparatus when the reaction has gone to completion? Assume that the temperature does not change.

13.1 Solution

C.8 ICE table. For initial values, use $P_1V_1 = P_2V_2$

torr	$4\,C_2H_7N(g)$	$+\,15\,O_2(g)$	$\rightarrow 8\,CO_2(g)$	$+\,14\,H_2O(g)$	$+\,2N_2(g)$
I	239.25	1051.07	0	0	0
C	−239.25	−897.20	+478.51	+837.39	+119.63
E	0	153.87	478.51	837.39	119.63

$V_2 = 285\,mL + 419\,mL = 704\,mL$

C_2H_7N: $P_2 = P_1 \times \frac{V_1}{V_2} = 591 \times \frac{285\,mL}{704\,mL} = 239.25$ torr

O_2: $P_2 = P_1 \times \frac{V_1}{V_2} = 1766 \times \frac{419\,mL}{704\,mL} = 1051.07$ torr

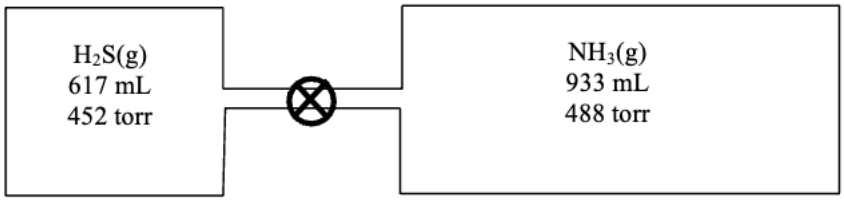
$239.25 \times \frac{15}{4} = 897.20$; $1051.07 - 897.20 = 153.87$

$239.25 \times \frac{8}{4} = 478.51$; $239.25 \times \frac{14}{4} = 837.39$; $239.25 \times \frac{1}{4} = 119.63$

$P_{total} = \sum P_i = 153.87 + 478.51 + 837.39 + 119.63 = 1589.39$ torr $\approx$ 1589 torr

14 Topic C Problem 9

Consider the apparatus pictured below, which consists of two containers separated by a valve.



The valve is opened and the gases react as follows:

$$H_2S(g) + 2\,NH_3(g) \longrightarrow (NH_4)_2S(s) \tag{5}$$

What will be the total pressure in the apparatus when the reaction has gone to completion? Assume that the temperature does not change.

14.1 Solution

C.9 Find pressures after opening valve, before rxn ($P_1V_1 = P_2V_2$)

$V_2 = 617\,mL + 933\,mL = 1550\,mL$

H_2S: $P_2 = P_1 \times \frac{V_1}{V_2} = 452\,torr \times \frac{617\,mL}{1550\,mL} = 179.925\,torr$

NH_3: $P_2 = P_1 \times \frac{V_1}{V_2} = 488\,torr \times \frac{933\,mL}{1550\,mL} = 293.745\,torr$

Now use an ICE table. Only one gas will remain, the non-LR.

torr	$H_2S(g)$	$+\,2NH_3(g)$	$\rightarrow (NH_4)_2S(s)$
I	179.925	293.745	?
C	−146.872	−293.745	?
E	33.053	0	?

$\frac{293.745\,NH_3}{179.925\,H_2S} < \frac{2\,NH_3}{1\,H_2S}$

H_2S is LR

$179.925 - \frac{1\,H_2S}{2\,NH_3} \times 293.745 = 33.053\,torr$

$P_{tot} = P_{H_2S} + P_{NH_3} = 33.053\,torr + 0\,torr = 33.053\,torr = \boxed{33\,torr}$

Contents