A Chemistry
Unit 4 (Chapter 10) Problem Practice Sheet Answers
Gas laws

1. $PV = nRT$

rearrange to:

$$\frac{n}{V} = \frac{P}{RT}$$

since $\frac{moles}{L} \times \frac{grams}{mole} = \frac{g}{L}$ or density

multiplying each side by the GMW gives the following:

$$D = \frac{P(GMW)}{RT} = \frac{\left(\frac{745\ mmHg}{760\ mmHg}\right)(64.0g)}{\left(0.0821\ L \cdot atm/mol \cdot K\right)(295\ K)}$$

$$D = 2.59\ g/L$$

2.

$$\overset{10.0g}{Zn} + 2HCl \longrightarrow ZnCl_2 + \overset{x}{H_2}$$

$$\frac{10.0g\ Zn}{1} \times \frac{1\ mol\ Zn}{65\ g\ Zn} \times \frac{1\ mol\ H_2}{1\ mol\ Zn} \times \frac{22.4\ L\ H_2}{1\ mol\ H_2} = 3.45\ L\ of\ H_2\ @\ STP$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{(3.45L)(760)}{273} = \frac{V_2(912)}{300.} \qquad V_2 = 3.16\ L\ H_2$$

(3) Alloy + Acid $\longrightarrow$ NO_2

0.869 g @ 27°C

a) $PV = nRT$

$$P = \frac{nRT}{V} = \frac{\left(\frac{0.869\,g}{46\,g/mol}\right)\left(\frac{.0821\ L\cdot atm}{mol\cdot K}\right)(300\ K)}{.480\ L}$$

$P = .969$ atm

(4) A gas behaves ideally when we assume the attractive forces to be 0 and when the individual molecules have no volume. When the attractive forces between molecules become significant, the volume decreases slightly. Manipulating the equation $PV=nRT$ to solve for GMW yields:

$$PV = \left(\frac{g}{GMW}\right) RT$$

$$GMW = \frac{gRT}{PV}$$

It is obvious that when V decreases, GMW will increase. If the particles were not behaving ideally, the volume would be less than it should be and the GMW greater than the real value.

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Answer:

(a) 1. mass of flask + cap (foil)
2. mass of flask + cap + liquid
3. temp. of boiling water
4. barometric pressure
5. volume of flask

(b) 1. Measure mass of empty flask w/cap
2. Pour about 3 mL of volatile liquid into flask.
3. Replace cap and place flask into boiling water.
4. Record temperature and barometric pressure.
5. When all the liquid has evaporated remove flask and allow to cool, wipe if necessary.
6. Weigh flask w/cap and condensed liquid.
7. Fill the flask completely with water and measure the volume by pouring the water into a graduated cylinder.

(c) 1. calculated mass of condensed liquid (i.e. the mass of the vapor)
2. volume of vapor at STP
3. moles of vapor (from PV=nRT)
4. molecular weight of vapor = mass/mol

(d) If non-volatile impurities were present it would make the calculated mass of condensed liquid larger than expected but not change the volume significantly. Therefore, the calculated molecular weight (in grams/mol) would be too large.

6. $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $\quad \frac{(1.00\,atm)(2.0\,L)}{373K} = \frac{V_2 (2.00\,atm)}{473K}$

$V_2 = 1.27 = 1.3L$

7. $PV = nRT$

$n = \frac{PV}{RT} = \frac{(2.0\,atm)(1.12L)}{\left(.0821 \frac{L \cdot atm}{mol\,K}\right)(1092\,K)} = .025$ moles

8. $\frac{10.0\,g}{5.6\,L} \times \frac{22.4\,L}{1\,mole} = \frac{40.\,g}{1\,mole}$

9. $P_1 V_1 = P_2 V_2$

$(400.\,mm)(200.\,mL) = P_2\,(300.\,mL)$

$P_2 = 267\ mmHg$

$P_T = P_1 + P_2$

$= 267 + 250$

$P_T = 517\ mm\ Hg$

10. Real gases deviate from ideal behavior because they have significant individual volume and forces of attraction between molecules under certain conditions. Those conditions are low temperature and high pressure.

11. $$\left(P + \frac{an^2}{V^2}\right)\left(V - nb\right) = nRT$$

$\frac{an^2}{V^2}$: correction for attractive forces

nb: correction for volume of particles

a is a constant for each gas. As MW↑, "a"↑

b is the Van der Waals constant different for each gas (L/mol) as MW↑, b↑

12. CH_4 (the lightest)

13. H_2 (non-polar and the smallest)

14. $P_T = P_{O_2} + P_{H_2O}$

$676\ mmHg = P_{O_2} + 30\ mm\ Hg$

$646\ mm\ Hg = P_{O_2}$

15. at Constant temperature, volume doubles:
a) no, not if T is constant
* b) true - fewer collisions because particles travel further before reaching the wall.
c) no, distance increases
d) no, since volume ↑, m/v will ↓

16. at Constant Temperature
a) no - only average K.E.
b) no - same T = same average K.E, regardless of substance
c) no - same
* d) true

17. 1 L $H_2(g)$ and 1 L $O_2(g)$ at STP.
a) no $H_2 = \frac{1L}{1} \times \frac{1 mole}{22.4L} \times \frac{2g}{1 mole}$ $O_2 = \frac{1L}{1} \times \frac{1 mole}{22.4L} \times \frac{32g}{1 mol}$

* b.) yes Same T = Same Average K.E.
÷c.) yes equal volumes at same conditions (gases) have equal moles.
equal moles = equal molecules
d.) no equal T = same Av. K.E.