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CHM 151 Exam 2 Spring 2007 100 Pts Name: Key
Multiple Choice

1. A balloon contains 1.0 L of gas at sea level, where the pressure is 1.0 atm. What will the volume be when the pressure is 0.80 atm, the temperature remaining constant?
   a. 1.3 L
   b. 0.80 L
   c. 0.20 L
   d. 1.0 L
   e. 1.8 L

$P_1 = 1.0\,atm$ $V_1 = 1.0\,L$ $T_1 = const$

$P_1V_1 = P_2V_2$

$V_2 = 1.25$

2. The volume of a sample of gas measured at 25.0°C and 1.00 atm pressure is 10.0 L. What must the final temperature be in order for the gas to have a final volume of 7.5 L at 1.00 atm pressure?
   a. -55°C
   b. -50°C
   c. -45°C
   d. -35°C
   e. 19°C

$P_1V_1T_2 = P_2V_2T_1$

$T_2 = \frac{P_2V_2T_1}{P_1V_1} = \frac{(7.5\,L)(25.0+273)\,K}{10.0\,L} = 223.5\,K$

$223.5 - 273 = -49.5\,^{\circ}C$

3. The temperature of a gas in a sealed container changes from 20.0°C to 40.0°C. If the volume remains constant, the pressure will change from 740 mmHg to
   a. 693 mmHg.
   b. 1480 mmHg.
   c. 370 mmHg.
   d. 791 mmHg.
   e. 760 mmHg.

T_1 T_2

$P_1V_1T_2 = P_2V_2T_1$

$P_2 = \frac{P_1T_2}{T_1} = \frac{(40.0+273\,K)(740\,mmHg)}{(20.0+273\,K)}$

4. How many moles are in a gas sample occupying 0.500 L at 170 mmHg and 25°C?
   a. 0.00458
   b. 0.00500
   c. 2.18
   d. 3.48
   e. 3.85

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(170\,mmHg)(0.500\,L)}{62.4\,L\cdot torr}\,\frac{mol\,K}{(25+273)\,K}$

5. Which of the following gases would occupy the largest volume at 25°C and 1.00 atm pressure?
   a. 100 g CH_4
   b. 100 g N_2O
   c. 100 g O_2
   d. 100 g CO_2
   e. All of the gases would have the same volume at STP.

smallest molar mass gives most moles

6. At 25°C and 1.00 atm pressure, it is found that 2.24 L of gas weighs 3.11 g. Its relative molecular mass is
   a. 3.11 g.
   b. 28.5 g.
   c. 31.1 g.
   d. 33.9 g.
   e. 37.1 g.

molar mass = 2 ÷ mol

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(1.00\,atm)(2.24\,L)}{0.0821\,L\cdot atm}\,\frac{mol\cdot K}{(25+273)\,K}$

$n = 0.0916\,mol$

$\text{molar mass} = \frac{3.11\,g}{0.0916\,mole} = 33.97\,g/mole$

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7. The partial pressures of CH_4, N_2, and O_2 in a sample of gas were found to be 155, 435, and 122 mmHg respectively. Calculate the mole fraction of methane.
   a. 0.171
   b. 0.198
   c. 0.204
   d. 0.218
   e. 0.611

$$\frac{155}{(155+435+122)}$$

8. The density of ethane, C_2H_6, (MW = 30.1 g/mol) at 25°C and 1.10 atm pressure is
   a. 1.15 g/L.
   b. 1.20 g/L.
   c. 1.25 g/L.
   d. 1.30 g/L.
   e. 1.35 g/L.

density = g/L

C_2H_6 molar mass = 30.079 g/mol

use 1 mol

$$PV = nRT$$

$$V = \frac{(1\,\text{mol})(0.0821\,\text{L}\cdot\text{atm})(298\,\text{K})}{\text{mol}\cdot\text{K}} \Big/ 1.10\,\text{atm}$$

$V = 22.24\,\text{L}$

$$D = \frac{30.079}{22.24\,\text{L}} = 1.35\,\text{g/L}$$

9. What is the partial pressure of oxygen in a container that contains 2.0 mol of oxygen, 3.0 mol of nitrogen, and 1.0 mol of carbon dioxide when the total pressure is 900 mmHg?
   a. 100 mmHg
   b. 200 mmHg
   c. 300 mmHg
   d. 400 mmHg
   e. 600 mmHg

$$\frac{2.0}{(2.0+3.0+1.0)}\,(900\,\text{mm Hg}) = 300\,\text{mm Hg}$$

10. If a sample of nitrogen gas in a sealed container of fixed volume is heated from 25°C to 250°C, the value of which of the following quantities will remain constant?
   a. the average intensity of a molecular collision with the walls of the container
   b. the pressure of the gas
   c. the average speed of the molecules
   d. the average kinetic energy of the molecules
   e. the density of the nitrogen

11. Real gases deviate from ideal behavior because of the actual volume of the gas molecules and
   a. attractive forces between the molecules.
   b. ionization energies.
   c. molecular vibrations.
   d. pressures within the chemical bonds.
   e. the molecules all having different velocities.

12. The behavior of $PH_3(g)$ is most likely to approach ideal behavior at
   a. 10 atm and 100°C.
   b. 1.0 atm and 0°C.
   c. 0.10 atm and -100°C.
   d. 1.0 atm and 100°C.
   e. 0.10 atm and 100°C.

low P & high T

13. All of the following are weak acids except
   a. H_2CO_3.
   b. H_2SO_3.
   c. HNO_2.
   d. HCl.
   e. H_3PO_4.

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14. The net ionic equation for the reaction of nitric acid (strong Acid) with lithium hydroxide (strong Base) is
    a. $HNO_3(aq) + LiOH(aq) \longrightarrow LiNO_3(aq) + H_2O(l)$.
    b. $HNO_3(aq) + LiOH(aq) \longrightarrow Li^+(aq) + NO_3^-(aq) + H_2O(l)$.
    c. $HNO_2(aq) + Li^+(aq) + OH^-(aq) \longrightarrow Li^+(aq) + NO_2^-(aq) + H_2O(l)$.
    d. $H^+(aq) + NO_2^-(aq) + Li^+(aq) + OH^-(aq) \longrightarrow Li^+(aq) + NO_2^-(aq) + H_2O(l)$.
    e. $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$.

15. What is the molecular mass of $Al(BrO_3)_3$?
    a. 155
    b. 177
    c. 251
    d. 411
    e. 555

16. Chlorine was passed over 1.10 g of heated titanium and 3.54 g of a chloride of Ti was obtained. What is the empirical formula of the chloride?
    a. TiCl
    b. Ti_2Cl_3
    c. $TiCl_2$
    d. $TiCl_3$
    e. $TiCl_4$

    $Ti: \frac{1.10\,g}{47.88\,g/mol} = 0.02297 \div 0.02297 = 1$

    $Cl: \frac{2.44\,g}{35.45\,g/mol} = 0.0688 \div 0.02297 = 3$

17. How many moles of sulfate ions are there in a 0.1-liter solution of 0.02-molar $Al_2(SO_4)_3$?
    a. 0.002
    b. 0.004
    c. 0.006
    d. 0.024
    e. 0.06

    one $Al_2(SO_4)_3$ gives 3 SO_4^{2-} ions so

    $\frac{0.1\,L}{} \left| \frac{0.02\,mol\,Al_2(SO_4)_3}{L} \right| \frac{3\,SO_4^{2-}}{1\,Al_2(SO_4)_3} =$

18. What volume of 0.200-molar Na_2CO_3 (FW = 106) solution contains 53.0 g Na_2CO_3?
    a. 0.200 L
    b. 0.400 L
    c. 0.500 L
    d. 1.60 L
    e. 2.50 L

    $\frac{53.0\,g}{} \left| \frac{mol}{106\,g} \right| \frac{L}{0.200\,mol} = 2.50\,L$

19. Calculate the molarity of a solution that contains 50.0 g of NaOH in 750.0 mL of solution.
    a. 0.60 M
    b. 0.80 M
    c. 1.07 M
    d. 1.25 M
    e. 1.67 M

    $\frac{50.0\,g}{} \left| \frac{mol}{40.0\,g} \right| \frac{}{0.750\,L} = \frac{mol}{L}$

20. 250.0 mL of 3.00-M HCl are added to 400.0 mL of 6.00 M HCl. Assuming that the volumes are additive, the final concentration is
    a. 4.15 M.
    b. 4.50 M.
    c. 4.85 M.
    d. 5.15 M.
    e. 9.00 M.

    $\left(\frac{250.0\,mL}{} \left| \frac{3.00\,mol}{1000\,mL} \right. + \frac{400.0\,mL}{} \left| \frac{6.00\,mol}{1000\,mL} \right. \right) \div 0.650\,L$

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21. What volume of acid must you use to prepare 100 mL of 0.50 M HCl from 2.00 M HCl?

a. 25.0 mL
b. 50.0 mL
c. 100 mL
d. 200 mL
e. 400 mL

22. What mass of calcium carbonate, $CaCO_3$, is required to react with 100 mL of 2.00 *M* HCl solution?

100.09 g/mol

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

a) 5.00 g
b) 10.0 g
c) 15.0 g
d) 20.0 g
e) 23.0 g

23. If 40.0 mL of H_2SO_4 solution reacts with 0.212 gram of Na_2CO_3, what is the molarity of the H_2SO_4 solution?

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

a) 0.500 *M*
b) 0.100 *M*
c) 0.200 *M*
d) 0.400 *M*
e) 0.0500 *M*

24. What volume of 0.385 molar nitric acid, HNO_3, is required to react with 48.0 mL of 0.0770 *M* calcium hydroxide, $Ca(OH)_2$, according to the following equation?

$$2HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3) + 2H_2O$$

a) 24.8 mL
b) 9.62 mL
c) 38.4 mL
d) 19.2 mL
e) 45.0 mL

25. What is the molarity of a barium hydroxide solution if 18.62 mL of this $Ba(OH)_2$ solution requires 35.84 mL of 0.2419 *M* HCl for titration to the equivalence point?

$$2HCl + Ba(OH)_2 \rightarrow BaCl_2 + 2H_2O$$

a) 0.4656 *M*
b) 0.2328 *M*
c) 0.1164 *M*
d) 0.3492 *M*
e) 0.6984 *M*