MULTIPLE CHOICE. Answer each of the following questions by filling in the bubble for the corresponding answer on the bubble sheet. There is only one correct answer for each question. Answers on the bubble sheet are considered final. Use pencil only. (1 mark each)

1) At STP how many liters of NH_3 can be produced from the reaction of 6.00 mol of N_2 with 6.00 mol of H_2?

$$N_2(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g)$$

6.00 mol 6.00 mol

AT STP 1 mol GAS = 22.7 L

A) 272 L
B) 204 L
(C) 90.8 L
D) 136 L

H_2 IS LIMITING REAGENT

$$\text{mol } NH_3 = 6 \text{ mol } H_2 \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} = 4.00 \text{ mol } NH_3$$

$V_{NH_3} = 4.00 \text{ mol} \times 22.7 \text{ L} = 90.8 \text{ L}$

2) A 0.286-g sample of gas occupies 125 mL at 0.800 bar and 25 °C. What is the molar mass of the gas?

A) 5.95 g mol^{-1}
B) 44.1 g mol^{-1}
(C) 70.8 g mol^{-1}
D) 59.5 g mol^{-1}

$V = 0.125 \text{ L}$ $T = 298 \text{ K}$ $PV = nRT$

$$n = \frac{PV}{RT} = \frac{(0.800 \text{ bar})(0.125 \text{ L})}{(0.08314 \text{ L bar mol}^{-1} \text{ K}^{-1})(298 \text{ K})} = 4.04 \times 10^{-3} \text{ mol}$$

$$\text{mole} = \frac{\text{MASS}}{\text{MOLAR MASS}} \qquad 4.04 \times 10^{-3} = \frac{.286 \text{ g}}{\text{MOLAR MASS}}$$

molar MASS = 70.8 g mol^{-1}

3) You are given two flasks of equal volume. One contains H_2 at 0°C and 1.01 bar while the other contains CO_2 at 0°C and 2.02 bar. Which of the following quantities will be the same for both flasks?

A) number of molecules present
B) density
(C) average molecular kinetic energy
D) average molecular speed

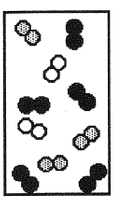
ACCORDING TO KINETIC MOLECULAR THEORY GASES AT SAME TEMPERATURE WILL HAVE SAME AVERAGE KINETIC ENERGY.

4) Which of the following gases has the **lowest** average speed at 25 °C?

(A) H_2S
B) NH_3
C) CH_4
D) O_2

THE GREATER THE MOLAR MASS THE LOWER THE AVERAGE VELOCITY.

In the diagram below, nitrogen molecules are represented by unshaded spheres, oxygen molecules by gray spheres, and chlorine molecules by black spheres.



$\#N_2 = 2$ $\#O_2 = 5$ $\#Cl_2 = 5$ TOTAL = 10

5) If the total pressure in the container is 1.20 bar, what is the partial pressure of nitrogen?

A) 0.600 bar
B) 0.360 bar
C) 0.120 bar
(D) 0.240 bar

$$P_{N_2} = X_{N_2} P_{TOTAL} = \left(\frac{2}{10}\right)(1.20 \text{ bar}) = 0.240 \text{ bar}$$

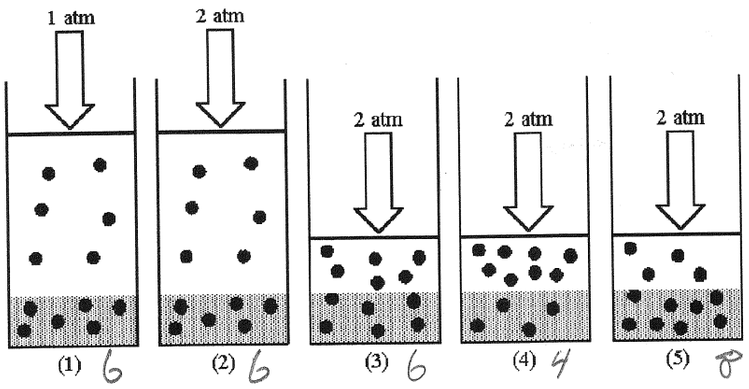
6) To make a 2.00 *m* solution, one could take 2.00 moles of solute and add

A) enough solvent to make 1.00 kg of solution.
B) enough solvent to make 1.00 L of solution.
C) 1.00 L of solvent.
(D) 1.00 kg of solvent.

$$\text{molality} = \frac{\text{mole SOLUTE}}{\text{kg SOLVENT}}$$

2 m IS EQUIVALENT TO 2 mol SOLUTE FOR EVERY 1 kg SOLVENT

7) Drawing (1) shows a system in which an equilibrium exists between dissolved and undissolved gas particles at P = 1 bar. According to Henry's law, if the pressure is increased to 2 bar and equilibrium is restored, which drawing (2)–(5) best represents the equilibrium at 2 bar?



WHEN PRESSURE INCREASES THE SOLUBILITY OF GAS INCREASES, INITIAL DRAWING HAS 6 mol OF GAS DISSOLVED. DRAWING 5 IS ONLY OPTION THAT HAS MORE MOLES OF GAS DISSOLVED

A) drawing (2)
B) drawing (3)
C) drawing (4)
D) drawing (5)

8) Which of the following solutions will have the **lowest** freezing point?

A) 0.0100 *m* Li_2SO_4
B) 0.035 *m* $CH_3CH_2CH_2OH$
C) 0.0100 *m* NaCl
D) 0.015 *m* $MgCl_2$

LOWEST FREEZING POINT IS SOLUTION WITH GREATEST NUMBER OF SOLUTE PARTICLES. CONSIDER EFFECT OF IONIC SOLUTES AND VANT HOFF FACTOR, i

MULTIPLY MOLALITY BY i TO DETERMINE GREATEST NUMBER OF MOLES OF SOLUTE PARTICLES.

9) When 0.500 g of vitamin K is dissolved in 10.0 g of camphor (K_f = 40.0 °C m^{-1}), the freezing point of the solution is 4.43 °C lower than that of pure camphor. Assuming vitamin K is a nonelectrolyte in camphor, calculate its molar mass.

A) 451 g mol^{-1}
B) 0.451 g mol^{-1}
C) 2.22 × 10^{-3} g mol^{-1}
D) 55.4 g mol^{-1}

$\Delta T_F = 4.43$

$\Delta T_F = K_f m$

$4.43\,^{\circ}C = (40.0\,^{\circ}C\,m^{-1})\,m$

$m = 0.111\ mol\ kg^{-1}$

$m = \frac{mol}{kg}$

$0.111\ mol\ kg^{-1} = \frac{mol}{0.0100\ kg}$

$mol = 1.11 \times 10^{-3}$

$mol = \frac{mass}{molar\ mass}$

$1.11 \times 10^{-3} = \frac{0.500\ g}{molar\ mass}$

$molar\ mass = 4.51 \times 10^{2}\ g\ mol^{-1}$

10) A solution is made by dissolving 13.0 g of sucrose ($C_{12}H_{22}O_{11}$, molar mass = 342.30 g mol^{-1}) in 117 g of water, producing a solution with a volume of 125 mL at 20 °C. What is the expected osmotic pressure at 20 °C?

A) 5.13 bar
B) 5.13 × 10^3 bar
C) 7.40 bar
D) 0.505 bar

$V = 0.125\ L$

$T = 293\ K$

$moles = \frac{13.0\ g}{342.30\ g\ mol^{-1}} = 0.038\ mol$

$M = \frac{0.038\ mol}{0.125\ L} = 0.304\ mol\ L^{-1}$

$\Pi = MRT$

$= (0.304)(0.08314)(293)$

$= 7.40\ bar$

11) Given the reaction at a certain temperature: 2 AB(*g*) ⇌ A_2(*g*) + B_2(*g*). At equilibrium, the partial pressure of AB is 1.8 × 10^{-3} bar, and the partial pressures for A_2 and B_2 are 0.10 bar each. Find K_p at that temperature.

A) 3.1 × 10^3
B) 1.8 × 10^{-1}
C) 5.6 × 10^1
D) 3.2 × 10^{-4}

$K_p = \frac{P_{A_2} P_{B_2}}{P_{AB}^2} = \frac{(0.10\ bar)(0.10\ bar)}{(1.8 \times 10^{-3}\ bar)^2} = 3.1 \times 10^{3}$

12) What is the equilibrium equation for the following reaction?

$$2\ H_2O\ (l) \rightleftharpoons H_3O^+\ (aq) + OH^-\ (aq)$$

A) $K_c = \frac{[H_2O]^2}{[H_3O^+]\,[OH^-]}$

B) $K_c = [H_3O^+]\,[OH^-]$

C) $K_c = \frac{1}{[H_3O^+]\,[OH^-]}$

D) $K_c = \frac{[H_3O^+]\,[OH^-]}{[H_2O]^2}$

13) Cyclohexane (C_6H_{12}) undergoes a molecular rearrangement in the presence of $AlCl_3$ to form methylcyclopentane (MCP) according to the equation:

$$C_6H_{12} \rightleftharpoons MCP$$

If $K_c = 0.143$ at 25°C for this reaction, predict the direction the reaction will shift if the initial concentrations of C_6H_{12} and MCP are 0.200 mol L^{-1} and 0.100 mol L^{-1}, respectively. The system

$Q = \frac{[MCP]}{[C_6H_{12}]} = \frac{0.100\ mol\ L^{-1}}{0.200\ mol\ L^{-1}} = 0.5 > K_c$

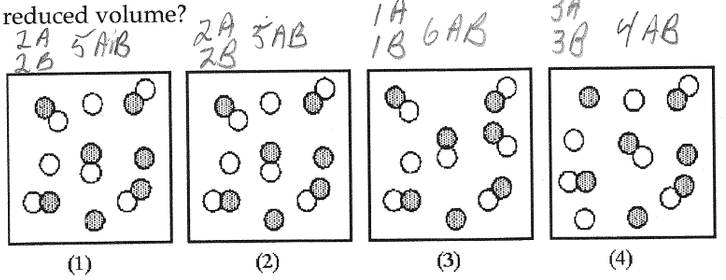
A) will shift right.
B) is already at equilibrium.
C) is not at equilibrium and will remain in an unequilibrated state.
(D) will shift left.

14) The decomposition of nitrosyl bromide is exothermic: 2 NOBr(g) ⇌ 2 NO(g) + Br2(g). Which of the following changes in reaction condition will shift the reaction to the left?

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g) + HEAT$

A) add more NOBr RIGHT
B) increase the container volume RIGHT
C) decrease the temperature RIGHT
(D) None of these

15) Picture (1) represents the equilibrium mixture for the gas-phase reaction A (g) + B (g) ⇌ 2 AB (g) at 298 K. If the volume of the equilibrium mixture is decreased, which picture (2)-(4) represents the equilibrium at the reduced volume?



SINCE THERE ARE EQUAL NUMBERS OF MOLES OF GAS ON BOTH SIDES A CHANGE IN VOLUME SHOULD NOT AFFECT THE EQUILIBRIUM MIXTURE.

(A) picture (2)
B) picture (3)
C) picture (4)
D) None of these