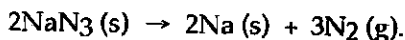


MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) Automobile air bags use the decomposition of sodium azide as their source of gas for rapid inflation:



What mass (g) of NaN_3 is required to provide 40.0 L of N_2 at 25.0°C and 763 torr?

- A) 1.64
- B) 107
- C) 160
- D) 1.09
- E) 71.1

$$n = \frac{PV}{RT}$$

$$= \frac{1.004(40)}{0.0821(298)}$$

$$n = 1.64$$

- 2) According to kinetic-molecular theory, in which of the following gases will the average molecular speed of the molecules be the highest at 200°C ?

- A) H_2O
- B) HCl
- C) SF_6
- D) Cl_2

E) None. The molecules of all gases have the same average speed at any given temperature.

- 3) Which of the following liquids will have the highest freezing point?

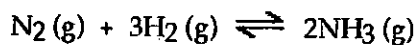
- A) aqueous $\text{Fe}(\text{NO}_3)_3$ (0.030 m)
- B) aqueous glucose (0.050 m)
- C) aqueous NaI (0.030 m)
- D) aqueous NaI (0.010 m)
- E) pure H_2O

- 4) When NaCl dissolves in water, aqueous Na^+ and Cl^- ions result. The force of attraction that exists between Na^+ and H_2O is called a(n) _____ interaction.

- A) London dispersion force
- B) hydrogen bonding
- C) ion-dipole
- D) dipole-dipole
- E) ion-ion

Enter All Answers in the Scantron Sheets

5) The equilibrium constant for the gas phase reaction



is $K_{\text{eq}} = 4.34 \times 10^{-3}$ at 300°C . At equilibrium, _____

- A) only products are present
- B) reactants are favoured
- C) products are favoured
- D) only reactants are present
- E) roughly equal amounts of products and reactants are present

6) Which one of the following derivatives of ethane has the highest boiling point?

- A) C_2F_6
- B) C_2Br_6
- C) C_2Cl_6
- D) C_2I_6
- E) C_2H_6

7) George is making spaghetti for dinner. He places 4.01 kg of water in a pan and brings it to a boil. Before adding the pasta, he adds 58 g of table salt (NaCl) to the water and again brings it to a boil. The temperature of the salty, boiling water is _____ $^\circ\text{C}$.

Assume a pressure of 1.00 atm and negligible evaporation of water. K_b for water is $0.52^\circ\text{C}/m$.

- A) 100.00
- B) 99.74
- C) 99.87
- D) 100.13
- E) 100.25

$$\Delta T =$$

$$T_2 - T_1 = 0.52(m)$$

$$0.57(0.247)$$

$$\text{NaCl} = 58.44$$

$$\frac{58g}{58.44}$$

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

$$n = \frac{m}{M}$$

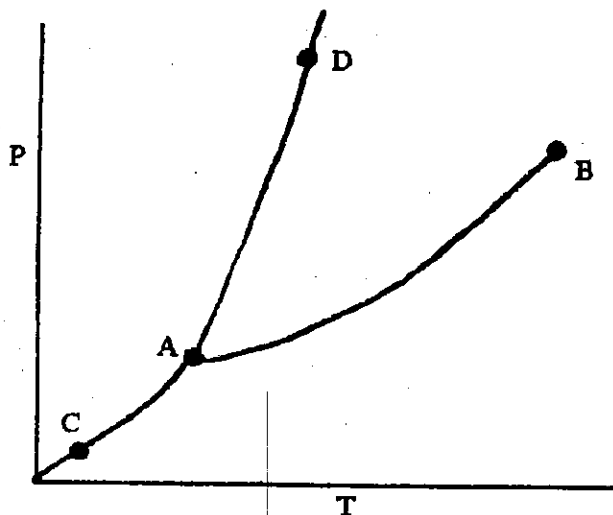
$$T_2 - 100 = 0.129$$

$$T_2 = 100.13$$

$$\frac{0.99}{4.01}$$

$$= 0.247$$

Enter All Answers in the Scantron Sheets



- 8) On the phase diagram shown above, the connecting segment _____ corresponds to the conditions of temperature and pressure under which the solid and the gas of the substance are in equilibrium.
- A) CD
 - B) AC
 - C) BC
 - D) AD
 - E) AB

- 9) A mixture of Xe, Kr, and Ar has a total pressure of 6.70 atm. What is the mole fraction of Kr if the partial pressures of Xe and Ar are 1.60 atm and 2.80 atm, respectively.

- A) 0.256
- B) 0.570
- C) 0.343
- D) 0.481
- E) 0.174

$$n = \frac{PV}{RT} = \frac{6.70(5)}{24.5}$$

$$= 1.37$$

$$6.70 = 1.60 + 2.80 + x$$

$$x = 6.70 - 1.60 - 2.80 = 2.30$$

$$= \frac{2.30}{6.70}$$

$$= 0.343$$

- 10) How high a liquid will rise up a narrow tube as a result of capillary action depends on _____.
- A) the magnitudes of cohesive forces in the liquid and adhesive forces between the liquid and the tube, and gravity
 - ~~B) gravity alone~~
 - C) only the magnitude of adhesive forces between the liquid and the tube
 - ~~D) the viscosity of the liquid~~
 - ~~E) only the magnitude of cohesive forces in the liquid~~

Enter All Answers in the Scantron Sheets

11) Calculate the enthalpy change associated with the conversion of 25.0 grams of ice at -4.00°C to water vapor at 110.0°C . The specific heats of ice, water, and steam are $2.09 \text{ J/g}\cdot\text{K}$, $4.18 \text{ J/g}\cdot\text{K}$, and $1.84 \text{ J/g}\cdot\text{K}$, respectively. For H_2O , $\Delta H_{\text{fus}} = 6.01 \text{ kJ/mol}$ and $\Delta H_{\text{vap}} = 40.67 \text{ kJ/mol}$.

- A) $1.11 \times 10^4 \text{ kJ}$
- B) $1.12 \times 10^4 \text{ kJ}$
- C) $1.00 \times 10^5 \text{ kJ}$
- D) 64.8 kJ
- E) 75.9 kJ

$$\Delta H_{\text{rxn}} = 1.39(40.67) - 1.39(6.01)$$

$$= 56.5 - 8.35$$

12) Diethyl ether is a volatile organic compound. The vapor pressure of diethyl ether is 401 mm Hg at 18°C and the $\Delta H_{\text{vap}} = 26.0 \text{ kJ/mol}$. Calculate the vapor pressure of diethyl ether at 25°C .

- A) 500 mm Hg 0.658
- B) 401 mm Hg 0.746
- C) 605 mm Hg 0.786
- D) 598 mm Hg 0.787
- E) 516 mm Hg 0.679

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{-26000}{8.314} \left(\frac{1}{298} - \frac{1}{291}\right)$$

$$0.528$$

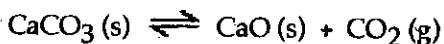
$$\ln\left(\frac{P_2}{401}\right) = \frac{-3127}{298} + \frac{3127}{291}$$

$$\ln\left(\frac{P_2}{401}\right) = 0.252$$

$$\ln P_2 - \ln 401 = 0.252$$

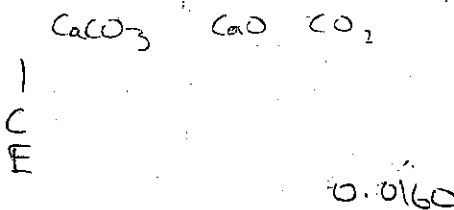
$$\ln P_2 = 6.25$$

13) Given the following reaction at equilibrium at 450.0°C :



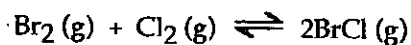
If $p_{\text{CO}_2} = 0.0160 \text{ atm}$, $K_c =$ _____

- A) 0.0821
- B) 7.23
- C) 723
- D) 0.0160
- E) 2.70×10^{-4}



Enter All Answers in the Scantron Sheets

14) At 400 K, the equilibrium constant for the reaction



is $K_p = 7.0$. A closed vessel at 400 K is charged with 1.00 atm of $\text{Br}_2(\text{g})$, 1.00 atm of $\text{Cl}_2(\text{g})$, and 2.00 atm of $\text{BrCl}(\text{g})$. Determine which of the statements below is true.

- A) The equilibrium partial pressure of $\text{BrCl}(\text{g})$ will be greater than 2.00 atm.
- B) At equilibrium, the total pressure in the vessel will be less than the initial total pressure.
- C) The reaction will go to completion since there are equal amounts of Br_2 and Cl_2 .
- D) The equilibrium partial pressure of Br_2 will be greater than 1.00 atm.
- E) The equilibrium partial pressures of Br_2 , Cl_2 , and BrCl will be the same as the initial values.

15) Which one of the following statements regarding K_w is false?

- A) $\text{p}K_w$ is 14.00 at 25°C
- B) The value of K_w shows that water is a weak acid.
- C) The value of K_w is always 1.0×10^{-14} .
- D) K_w is known as the ion product of water.
- E) K_w changes with temperature.

16) What fraction of the volume of each corner atom is actually within the volume of a face-centered cubic unit cell?

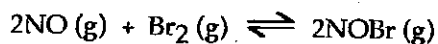
- A) 1
- B) $\frac{1}{2}$
- C) $\frac{1}{4}$
- D) $\frac{1}{8}$
- E) $\frac{1}{16}$

Enter All Answers in the Scantron Sheets

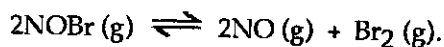
17) A 25.0 mL sample of 0.723 M HClO₄ is titrated with a 0.27 M KOH solution. The H₃O⁺ ion concentration after the addition of 80.0 mL of KOH is _____ M.

- A) 1 × 10⁻⁷
- B) 0.7
- C) 0.4
- D) 3 × 10⁻²
- E) 3 × 10⁻¹³

18) At 1000.0 K, the equilibrium constant for the reaction



is $K_p = 0.013$. Calculate K_p for the following reaction (at 1000.0 K),



- A) 1.6 × 10⁻⁴
- B) 0.013
- C) 39
- D) 77
- E) 0.026

$$0.013 = \frac{[2]^2}{[3]^2 [5]}$$

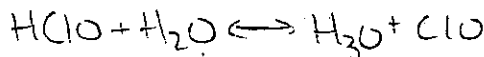
0.0888

11.25

$$\frac{0.0888}{11.25} = \frac{0.013}{x}$$

19) The K_a of hypochlorous acid (HClO) is 3.0×10^{-8} at 25.0°C. What is the % ionization of hypochlorous acid in a 0.015 M aqueous solution of HClO at 25.0°C?

- A) 0.0021
- B) 1.4 × 10⁻³
- C) 4.5 × 10⁻⁸
- D) 0.14
- E) 2.1 × 10⁻⁵



20) Calculate the molality of a 25.4% (by mass) aqueous solution of phosphoric acid (H₃PO₄).

- A) 25.4 m
- B) 3.47 m
- C) 2.59 m
- D) 4.45 m
- E) The density of the solution is needed to solve the problem.

25.4 g

97.97 g
100

Enter All Answers in the Scantron Sheets

mol
L

21) The K_a of acetic acid is 1.76×10^{-5} . The pH of a buffer prepared by combining 50.0 mL of 1.00 M potassium acetate and 50.0 mL of 1.00 M acetic acid is _____.

- A) 2.383
- B) 4.754
- C) 3.406
- D) 0.851
- E) 1.705

$$\text{pH} = 4.75 + \log()$$

22) The density of NH_3 gas in a 4.32 L container at 837 torr and 45.0°C is _____ g/L.

- A) 0.182
- B) 0.719
- C) 0.432
- D) 4.22×10^{-2}
- E) 3.10

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P = \frac{d \cdot M}{RT}$$

$$\frac{1.10 \text{ atm} (17.018)}{6.0821 (318)} = d$$

$$\frac{PM}{RT} = d = 0.717$$

23) The predominant intermolecular force in liquid $(\text{CH}_3)_2\text{NH}$ is _____.

- A) dipole-dipole forces
- B) hydrogen bonding
- C) London dispersion forces
- D) ionic bonding
- E) ion-dipole forces

24) The aqueous solubility of nitrogen gas at 25°C and 1 atm pressure is 6.8×10^{-4} mol/L. If the partial pressure of nitrogen gas in air is 0.76 atm, what is the concentration of dissolved nitrogen at 25°C ?

- A) 4.9×10^{-4} M
- B) 6.8×10^{-4} M
- C) 5.2×10^{-4} M
- D) 3.8×10^{-4} M
- E) 1.1×10^{-5} M

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$\frac{P}{RT} = 0.03106 \frac{\text{mol}}{\text{L}} \cdot \frac{1}{V} \cdot \frac{\text{atm} \cdot \text{mol} \cdot \text{K}}{\text{L} \cdot \text{atm} \cdot \text{K}}$$

$$PV = nRT$$

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