**Multiple Choice**

1. The number of BaCl2 molecules present in 34.6 g of BaCl2 compound is:

**D** A) 3.0×1022 B) 3.0×1023 C) 2.0×1021 D) 1.0×1023

1. The percent by mass of phosphorous "P" in the phosphate rock Ca10F2(PO4)6 is:

**B** A) 19.85 B) 18.42 C) 17.63 D) 16.25

1. 11.2 g of iron "Fe" is heated in excess oxygen to give 16.0 g of iron oxide having the emperical formula:

**C** A) FeO B) Fe3O4 C) Fe2O3 D) FeO2

1. The mass in gram of table sugar "C12H22O11" in 300 mL of 0.15 M solution of table sugar is:

**D** A) 12.5 B) 13.8 C) 14.3 D) 15.4

1. The gas which has a density of 1.0 g/L at a pressure of 1.5 atm and 20oC is most likely:

**A** A) CH4 B) N2 C) O2 D) CO2

1. The pair of gas mixture that could be most easily separated by gaseous effusion is:

**C** A) O2 and Ar B) O2 and Kr C) He and Ne D) CO2 and Xe

1. One of the following statements is incorrect:

A) At the same temperature, the average kinetic energy of H2 molecules and that of O2 molecules are equal.

B) Real gas molecules exert no intermolecular forces on each other

**B** C) Deviations from ideal gas law are greater at low temperature and high pressure.

D) The average molecular speed at 25oC of Ar is greater than that of Kr.

1. The specific heat of silver "Ag" is 0.24 J/g oC, therefore the molecular heat capacity of silver in J/mol oC is:

**A** A) 25.9 B) 27.3 C) 28.5 D) 30.8

1. The heat of combustion of vaniline "C8H8O3" is –25.4 kJ/g. In a bomb calorimeter that has a total heat capacity of 6350.0 J/oC (for the calorimeter and the water) 1.25 g of vaniline was combusted, consequently, the temperature rise (in oC) should be:

**D** A) 3.5 B) 4.5 C) 4.5 D) 5.0

1. The symbol [HNO3(*l*)] refers to one of the following reactions occurring at 25oC:

A) H(g) + N(g) + 3O(g) → HNO3(*l*)

B) 1/2 H2(g) + 1/2 N2(g) + 3/2 O2(g) → HNO3(*l*)

**B** C) H2(g) + N2(g) + 3O2(g) → 2HNO3(g)

D) H2(g) + N2(g) + 3O2(g) → 2HNO3(*l*)

1. The solubility of gas in water usually increases with

A) Increasing the partial pressure of the gas and increasing the temperature.

B) Decreasing the partial pressure of the gas and increasing the temperature.

**D** C) Decreasing the partial pressure of the gas and decreasing the temperature.

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1. The molar mass of a certain protein is 25000 g/mol. The osmotic pressure (in torr) at 27oC of an aqueous solution prepared from 1.34 g of this protein (a nonelectrolyte) in enough water to make 100.0 mL of solution is:

**A** A) 10 B) 11 C) 12 D) 14

1. The reaction A + 2B → products, was found to follow the rate law:

rate = k[A]2 [B]

Predict by what factor the rate of this reaction will increase when the concentration of A is tripled and the concentration of B is also tripled.

**D** A) 8 B) 12 C) 18 D) 27

1. The reaction 2A + B → products, was found to follow the rate law?

rate = k[A] [B]3

The units for the rate constant are:

**B** A) mol3 L-3 s-1 B) mol-3 L3 s-1 C) mol-4 L4 s-1 D) mol4 L-4 s-1

1. For a chemical reaction at equilibrium:

A) The activation energy for the forward reaction and that for the reverse reaction must be equal.

B) The activation energy for the endothermic reaction is always greater than that for the exothermic reaction.

C) The activation energy for the exothermic reaction is always greater than that for the endothermic reaction.

**B** D) The activation energy has nothing to do with the enthalpy of the reaction.

1. Solid phosphorous pentachloride "PCl5" decomposes to liquid phosphorous trichloride "PCl3" and chlorine gas according to the following equilibrium reaction:

PCl5(s) ⇌ PCl3(*l*) + Cl2(g)

At a certain temperature and when the reaction reached equilibrium: 0.4 mol of PCl5, 0.6 mol of PCl3 and 0.6 mol of Cl2 are present inside the 500 mL closed reaction vessel. Therefore, the Kc value is:

**C** A) 1.80 B) 1.44 C) 1.2 D) 1.5

1. Consider the following equilibrium reaction:

CH4(g) + H2O(g) ⇌ CO(g) + 3H2(g)

At 1500oC when Kc = 6.4 an equilibrium mixture of these gases was found to have [CO] = 0.30 M, [H2] = 0.8 M and [CH4] = 0.4 M. Therefore, the equilibrium concentration of H2O(g) in this mixture was:

**A** A) 0.06 M B) 1.0 M C) 0.024 M D) 0.2 M

1. At 773oC, the equilibrium reaction:

CO(g) + 2 H2(g) ⇌ CH3OH(g)

has Kc = 0.4, therefore, Kp for this reaction at 773oC is:

**B** A) 9.93×10-5 B) 5.42×10-5 C) 2950 D) 1611

1. Using the following equilibria:

2CH4(g) ⇌ C2H6(g) + H2(g) Kc = 9.5×10-13

CH4(g) + H2O(g) ⇌ CH3OH(g) + H2(g) Kc = 2.8×10-21

Consequently, for the following equilibrium:

2CH3OH(g) + H2(g) ⇌ C2H6(g) + 2H2O(g)

the Kc value is:

**D** A) 2.66×10-33 B) 7.45×10-54 C) 3.39×108 D) 1.21×1029

1. At high temperature, 2.0 mol of HBr gas was placed in a 4.0 L closed and empty reaction vessel where it decomposed according to the following equilibrium reaction:

2HBr(g) ⇌ H2(g) + Br2(g)

At equilibrium, the concentration of Br2 was measured to be 0.12 M. Therefore, the Kc value for this equilibrium at this temperature is:

**C** A) 818×10-3 B) 4.65×10-3 C) 0.213 D) 0.554

1. At 450oC, hydrogen iodide HI(g) decomposes according to the following equilibrium having Kc = 0.015625.

2HI(g) ⇌ H2(g) + I2(g)

A 0.66 mol of HI sample was injected into a 2.0 L reaction vessel and held at 450oC till equilibrium was reached. At equilibrium, the concentration of HI was:

**D** A) 0.297 B) 0.152 C) 0.508 D) 0.264

1. For the following equilibrium reaction:

2SO2(g) + O2(g) ⇌ 2SO3(g) Ho = –198 kJ

Which one of the following factors would cause the equilibrium constant to increase:

1. Compress the gas mixture into a smaller volume to increase the total pressure.
2. Increase the container volume to reduce the total pressure.
3. Remove the SO3 produced.

**D** D) Decrease the reaction temperature.

1. In which one of the following solutions will acetic acid CH3COOH (a weak acid) have the greatest degree of ionization?

A) 0.1 M CH3COOH plus 0.1 M CH3COONa

B) 0.1 M CH3COOH plus 0.2 M CH3COONa

C) 0.1 M CH3COOH plus 0.3 M CH3COONa

**D** D) 0.1 M CH3COOH

1. Formic acid HCOOH is a weak monoprotic acid that has Ka = 1.7×10-4. The pH value of 0.50 M formic acid solution is:

**B** A) 3.77 B) 2.04 C) 4.03 D) 4.63

1. Ammonia (NH4OH) is a weak base that has Kb = 1.8×10-5. The pH value of a 0.25 M ammonia solution is:

**C** A) 2.67 B) 4.74 C) 11.33 D) 9.45

1. Which of the following sets forms a conjugated acid/base pair?

1) NH4+/NH3 2) H2CO3/CO3-- 3) H3PO4/H2PO4- 4) NH3/NH2-

**B** A) All of them B) 1 and 3 only C) 3 and 4 only D) 1, 3 and 4 only

1. Knowing that Kb for the weak base (NO2-) is 2.2×10-11. Calculate the hydrogen ion concentration [H+] of a 0.50 M nitrous acid (HNO2) solution.

**A** A) 1.5×10-2 M B) 3.3×10-6 M C) 4.7×10-6 M D) 4.5×10-4 M

1. Which of the following sets cannot form a buffer solution?
2. HNO3/NaNO3 (strong acid and its salt)
3. HCN/NaCN (weak acid and its salt)
4. NH4OH/NH4Cl (weak base and its salt)
5. HCl/NaCl (strong acid and its salt)

**D** A) 2, 3 B) 1, 3 C) 2, 4 D) 1, 4

1. The pH value of 1.2 M C2H5NH2 (ethylamine, a weak base) solution is 12.41. Calculate the Kb value for ethylamine.

**C** A) 1.3×10-25 B) 3.2×10-13 C) 5.5×10-4 D) 1.2×10-9

1. Calculate the pH of a buffer solution which contains 0.25 M benzoic acid C6H5COOH and 0.15 M sodium benzoate C6H5COONa. Given Ka = 6.5×10-5.

**B** A) 4.19 B) 3.97 C) 6.5 D) 4.83