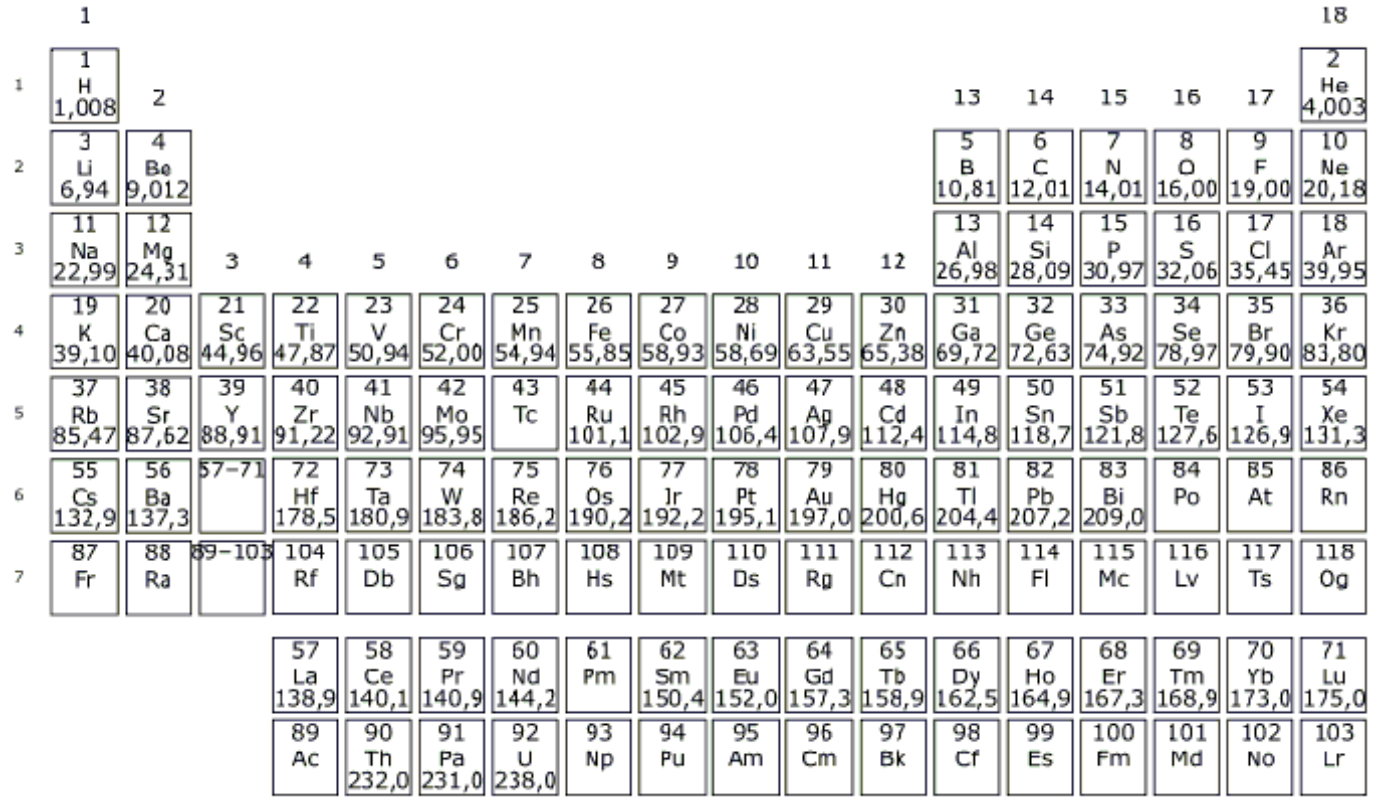
Booklet A **KIM 101E** **Final** **January 11, 2023**

Group Number	:	Surname	:	Signature
List Number	:	Name	:	
Student Number	:	e-mail	:	



$c = 2.998\times10^{8}$ m.s^{-1} $g = 9.8$ m.s^{-2} $h = 6.626\times10^{-34}$ J.s $R_H = 2.179\times10^{-18}$ J 0 °C = 273.15 K

$N_A = 6.02\times10^{23}$ 1 cal = 4.184 J 1 m = 10^9 nm = 10^{10} Å = 10^{12} pm 1 g = 10^3 mg = 10^6 µg

1 atm = 760 mmHg = 760 torr = 101325 Pa = 101.325 kPa = 1.01325 bar

$R = 0.08206$ L atm mol^{-1}K^{-1} = 0.08314 L bar mol^{-1}K^{-1} = 8.314 J mol^{-1}K^{-1} = 8.314 L kPa mol^{-1} K^{-1}

For water: $c = 4.184$ J g^{-1} K^{-1} $K_f = 1.86$ K kg mol^{-1} $K_b = 0.512$ K kg mol^{-1}

1 Newton (N) = 1 kg m s^{-2} 1 Joule (J) = 1 N m = 1 kg m^2 s^{-2} 1 Watt (W) = 1 J s^{-1}

1) When 275 mL of 0.105 M NaCl is left in an open beaker for a period of time, the volume is found to decrease to 237 mL due to the evaporation of water. What is the molarity of the final solution?

A) 0.122 M B) 0.154 M C) 0.139 M D) 0.167 M E) 0.143 M

2) What mass of $K_2Cr_2O_7$ is required to produce 5.00 L CO_2 at 75 °C and 1.07 atm pressure from excess oxalic acid, $H_2C_2O_4$?

$$Cr_2O_7^{2-}(aq) + C_2O_4^{2-}(aq) \rightarrow CO_2(g) + Cr^{3+}(aq) \quad \text{(unbalanced)}$$

A) 9.18 g B) 11.45 g C) 10.33 g D) 8.20 g E) 9.43 g

3) A soft drink contains a certain amount of citric acid ($C_6H_8O_7$, 192.13 g mol^{-1}). If 100 mL of the soft drink require 33.58 mL of 0.010 M NaOH to neutralize completely the citric acid, how many ppm of citric acid does the soft drink contain? Assume the density of the drink is 1.00 g mL^{-1}.

$$C_6H_8O_7(aq) + NaOH(aq) \rightarrow Na_3C_6H_5O_7(aq) + H_2O(l) \quad \text{(unbalanced)}$$

A) 430 ppm B) 860 ppm C) 645 ppm D) 215 ppm E) 108 ppm

4) A mixture only contains sucrose ($C_{12}H_{22}O_{11}$, 342.30 g mol^{-1}) and ethyl alcohol (C_2H_6O, 46.07 g mol^{-1}). A 1.52 g sample of this mixture is reacted with acidic aqueous potassium dichromate ($K_2Cr_2O_7$) solution. Produced 3.09 L CO2(g) is collected over water in a container at 35 °C and the container has a barometric pressure of 0.53 atm. Water has a vapor pressure of 42.20 mmHg. Calculate the mass percent of $C_{12}H_{22}O_{11}$ in the mixture.

$$C_{12}H_{22}O_{11}(aq) + Cr_2O_7^{2-}(aq) \rightarrow CO_2(g) + Cr^{3+}(aq) \quad \text{(not balanced)}$$

$$C_2H_6O(aq) + Cr_2O_7^{2-}(aq) \rightarrow CO_2(g) + Cr^{3+}(aq) \quad \text{(not balanced)}$$

A) 37% B) 25% C) 63% D) 84% E) 12%

5) If 8.35 g solid carbon dioxide (CO_2, 44.01 g mol^{-1}) was placed in a container of 4 L at 27 °C containing air under 740 mmHg pressure. What would be the total pressure (in atm) in the container after the carbon dioxide vaporizes? (Assume that the temperature is constant)

A) 1.96 atm B) 2.41 atm C) 3.14 atm D) 2.14 atm E) 1.63 atm

6) A 35 g gas mixture is composed of 0.45 moles of $N_2(g)$, 35% $O_2(g)$ by mass, and some amount of $CO_2(g)$. The mixture was in a 4.8 L container under 6 atm pressure. Then 0.45 moles of He(g) was added to the container and the temperature was raised by 20 °C. Calculate total pressure (as atm) of the final gas mixture.

A) 9.06 atm B) 6.54 atm C) 12.01 atm D) 8.41 atm E) 4.58 atm

7) When steam condenses to liquid water, 2.26 kJ of heat is released per gram. The heat from 168 g of steam is used to heat a room whose dimensions are 607 cm × 366 cm × 244 cm and filled with air. The specific heat of air at normal pressure is 1.015 J g^{-1} K^{-1} and density is 1.188 kg m^{-3}. What is the change in air temperature in the room, assuming the all the heat from the steam is absorbed by the air?

A) 17.43 °C B) 8.71 °C C) 5.81 °C D) 11.62 °C E) 7.61 °C

8) Specific heat of fusion for water is -0.334 kJ g^{-1} at 0 °C. When 31.5 g of ice completely melts in a coffee-cup calorimeter containing 0.210 kg water at 21.0 °C, what is the final temperature of the sytem at equilibrium? Assume no heat lost to the surroundings.

A) 3.92 °C B) 2.1 °C C) 14.5 °C D) 7.84 °C E) 23.5 °C

9) Determine the most stable molecular geometry and calculate the formal charge of central atom for ClO_3^- ion.

A) Trigonal Pyramidal; +2
B) Tetrahedral; -1
C) Trigonal planar; +1
D) Tetrahedral; +2
E) T-shaped; -1

10) Which of the following species has **sp^2** hybridization type?

A) PF_6^- B) COS C) $SiCl_4$ D) NO_3^- E) AsF_5

11) An unknown metal crystallizes in a face-centered cubic structure, and its density is 21.5 g cm^{-3}. The edge of the unit cell is 3.92 Å. Calculate the atomic mass of the unknown metal.

A) 63.55 g/mol B) 83.80 g/mol C) 26.98 g/mol D) 194.86 g/mol E) 106.42 g/mol

12) In which of the following compounds, hydrogen bonding **is not** an important intermolecular force?

A) HF B) CH_3OH C) CH_3NH_2 D) NH_3 E) H_2S

13) Lemon juice contain 7% citric acid, $C_6H_8O_7$, by mass. A solution of 500 mL is prepared by using enough water and lemons, which produces 90 g of juice when squezed. How many lemons should be used in order to prepare a solution contains 0.13 M citric acid?

A) 1 B) 2 C) 3 D) 4 E) 5

14) Calculate the vapor pressure depression of a solution at 35 °C made by dissolving 20.2 g of sucrose, $C_{12}H_{22}O_{11}$, in 70.1 g of water. The vapor pressure of pure water at 35 °C is 42.2 mmHg. Sucrose is non-volatile.

A) 0.30 mmHg B) 41.6 mmHg C) 1.9 mmHg D) 20.8 mmHg E) 0.63 mmHg

15) Enough amount of urea, $(NH_2)_2CO$, is dissolved in 100 g of water. The solution freezes at -0.085 °C. How many grams of urea were dissolved to make this solution?

A) 1.08 g B) 0.27 g C) 1.01 g D) 0.48 g E) 0.12 g

16) According to the following equilibrium reaction, 0.2 mol CH_4, 0.3 mol C_2H_2 and 0.4 mol H_2 are in equilibrium at 1500°C in a 4.0 L sealed flask. What is the value of K_p for this reaction at 1500°C?

$$CH_4(g) \rightleftharpoons C_2H_2(g) + H_2(g) \quad \text{(unbalanced reaction)}$$

A) 436 B) 949 C) 145 D) 635 E) 190

17) $2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g) \quad \Delta H = -197.8\ kJ \quad K_c = 35.5$

When 0.2 mol of $SO_2(g)$, 0.4 mol of $O_2(g)$ and 0.1 mol of $SO_3(g)$ are placed in a 1 L vessel, which of the following statement(s) is/are true?

I. Reaction is at the equilibrium
II. Reaction is in the forward direction
III. Concentration of $O_2(g)$ increases
IV. Decreasing the temperature increases the equilibrium constant

A) I, IV B) II, IV C) III, IV D) II E) III

18) What is the pH of 0.1 M aqueous NaF solution? $K_a = 6.6\times10^{-4}$ for HF

A) 8.09 B) 11.81 C) 3.18 D) 12.21 E) 9.82

19) HA is a weak monoprotic acid. If the pH is 5.5 for a solution of 0.1 M HA what is the pK_a value?

A) 2.1×10^{-8} B) 5.2×10^{-6} C) 1.0×10^{-10} D) 3.2×10^{-5} E) 3.7×10^{-10}

20) What is the concentration of $S^{2-}(aq)$ in a 0.5 M solution of H_2S?

$$H_2S(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + HS^-(aq) \quad K_{a,1} = 1.0 \times 10^{-7}$$
$$HS^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + S^{2-}(aq) \quad K_{a,2} = 1.0 \times 10^{-19}$$

A) 1.5×10^{-5} M
B) 2.2×10^{-4} M
C) 1.0×10^{-19} M
D) 2.3×10^{-10} M
E) 1.7×10^{-7} M

Answer Key
Testname: 11.01.2023_EN_A_CU

1) A
2) A
3) D
4) C
5) D
6) A
7) C
8) D
9) A
10) D
11) D
12) E
13) B
14) E
15) B
16) D
17) B
18) A
19) C
20) C