Multiple Choice

1) The number of $CaSO_4$ moles contained in 340.38 g of $CaSO_4$ are:

A) 2.2 B) 2.5 C) 2.7 D) 2.9

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2) The mass (in g) of iron "Fe" present in 43.0 g of ferrous sulfate "$FeSO_4$" is:

A) 11.7 B) 13.5 C) 14.2 D) 15.8

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3) A compound of boron "B" and hydrogen "H" contains 82.13% boron by mass has the empirical formula:

A) B_3H_7 B) B_2H_3 C) BH_3 D) BH_4

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4) The molality (*m*) of an aqueous solution that contains 20.0% sodium acetate "CH_3COONa" by mass is:

A) 3.5 B) 3.0 C) 2.5 D) 2.0

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5) When the following chemical formula is balanced:

$$C_2H_5OH(\ell) + O_2(g) \longrightarrow CO_2(g) + H_2O(\ell)$$

the sum of all coefficients is:

A) 12 B) 10 C) 9 D) 7

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6) When 125.0 g of vanadium pentaoxide "V_2O_5" are allowed to react with 150.0 g of calcium "Ca" according to:

$$V_2O_5(s) + 5Ca(\ell) \longrightarrow 5Ca(s) + 2V(\ell)$$

the theoretical yield (in g) of vanadium "V" is:

A) 80.0 B) 77.0 C) 72.0 D) 70.0

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7) A mixture of 2.7 mol O_2 gas, 3.3 mol N_2 gas and 3.0 mol CO_2 gas has a total pressure of 2.0 atm at 25^oC. What is the partial pressure (in mmHg) of the O_2 gas in this gas mixtureK?

A) 439 B) 456 C) 475 D) 488

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8) The pressure (in atm) exerted by 9.6×10^3 g of oxygen gas "O_2" stored in a 100.0 L gas cylinder at 31.6^oC is:

A) 65.0 B) 68.0 C) 72.0 D) 75.0

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9) Regarding the Van der Waals constants ("a" and "b") which appear in the Real Gas Equation, which statement is true?

i) The constant "a" accounts for the attractive forces between the gas molecules.
ii) The constant "a" accounts for the volume occupied by the gas molecules.
iii) The constant "b" accounts for the attractive forces between the gas molecules.
iv) The constant "b" accounts for the volume occupied by the gas molecules.

A) (i) only B) (ii) and (iv) **C) (i) and (iv)** D) (ii) only

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10) A glass containing 200.0 g of water at 20.0°C was placed into a refrigerator. The water lost 12.552 kJ as it cooled to a constant temperature. Knowing that the specific heat of water is 4.184 J/g °C, calculate the final temperature of this water.

A) 4.0 **B) 5.0** C) 6.0 D) 7.0

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11) Glycine "$C_2H_5O_2N$" is a biological energy source. The combustion of glycine is:

$4C_2H_5O_2N(s) + 9O_2(g) \longrightarrow 8CO_2(g) + 10H_2O(\ell)$ $\Delta H^o_{rxn} = -3858$ kJ

Given: $\Delta H^o_f[CO_2(g)] = -393.5$ kJ/mol, $\Delta H^o_f[H_2O(\ell)] = -285.8$ kJ/mol

Calculate (in kJ/mol) $\Delta H^o_f[C_2H_5O_2N(s)]$.

A) –645 B) –632 C) –585 **D) –537**

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12) Given:

$2C_8H_{18}(\ell) + 25O_2(g) \longrightarrow 16CO_2(g) + 18H_2O(\ell)$ $\Delta H^o_{rxn} = -11020$ kJ

What is ΔH^o_{rxn} (in kJ/mol) for:

$$8CO_2(g) + 9H_2O(\ell) \longrightarrow C_8H_{18}(\ell) + 12\tfrac{1}{2}O_2(g)$$

A) +5510 B) –5510 C) +11020 D) +22040

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13) A gas is allowed to expand from 2.0 L volume to 22.0 L volume against an external pressure of 0.50 atm. If the gas at the same time absorbs 1200.25 J of heat from the surrounding. Calculate (in J) ΔE of this gas system.

A) –2213.5 B) +2213.5 **C) +187** D) +373

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14) At 30.0°C, the vapor pressure of pure benzene "C_6H_6" is 120.0 torr and that of pure toluene "C_7H_8" is 40.0 torr. What is the vapor pressure (in torr) of an ideal solution that is formed from 1.0 mol of benzene and 3.0 mol of toluene at 30.0°C?

A) 80.0 **B) 60.0** C) 90.0 D) 70.0

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15) Given:
K_f (water) = 1.86°C/m and K_b (water) = 0.52°C/m. What is the freezing point (in °C) of an aqueous solution of a nonvolatile-nonelectrolyte solute that boils at 102.8°C?

A) −7.0 B) −8.0 C) −9.0 **D) −10.0**

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16) The osmotic pressure of an 0.01 M aqueous solution of $CaCl_2$ (an electrolyte nonvolatile solute) is found to be 0.602 atm at 25°C. What is the Van't Hoff factor "I" of this solution?

A) 2.46 B) 2.63 C) 2.75 D) 2.86

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17) The reaction $A + 2B \longrightarrow$ Product is found to follow the rate law:

$$\text{Rate} = k\,[A]^2\,[B]$$

Predict by what factor the rate of the reaction will increase when the concentration of "A" is tripled and the concentration of "B" is doubled, while the temperature remains constant.

A) 9 B) 12 **C) 18** D) 24

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18) For a first order reaction it took 462 s for the reaction to be 75% complete. What is the half life "$t_{1/2}$" period (in s) of this reaction?

A) 287 B) 265 C) 252 **D) 231**

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19) For a first order reaction, regarding its half life period "$t_{1/2}$", which statement is true?

A) $t_{1/2}$ increases with increasing temperature.
B) $t_{1/2}$ decreases with increasing temperature.
C) $t_{1/2}$ is always constant and never changes by changing temperature.
D) $t_{1/2}$ changes only by changing the concentration of the reactant.

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20) The forward reaction of an equilibrium process has: ΔH_{rxn} = −80.0 kJ/mol and its activation energy "E_a" = 48.0 kJ/mol, therefore, the reverse reaction for this process is:

A) Exothermic having E_a = 128.0 kJ/mol.
B) Exothermic having E_a = 32.0 kJ/mol.
C) Endothermic having E_a = 128.0 kJ/mol.
D) Endothermic having E_a = 32.0 kJ/mol.

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21) The correct equilibrium constant expression for the following reaction:

$$Fe_2O_3(s) + 3H_2(g) \rightleftharpoons 2Fe(s) + 3H_2O(g)$$

is:

A) $K_c = \frac{[Fe_2O_3][H_2]^3}{[Fe]^2[H_2O]^3}$ B) $K_c = \frac{[Fe]^2[H_2O]^3}{[Fe_2O_3][H_2]2}$

C) $K_c = \frac{[H_2]^3}{[H_2O]^3}$ **D) $K_c = \frac{[H_2O]^3}{[H_2]^3}$**

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22) For the following reactions occurring at 250.0°C, arrange them in order of increasing tendency to proceed to completion:

(least ⟶ greatest tendency)

i) $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$ $K_p = 1.7\times10^{-2}$

ii) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ $K_p = 1.5\times10^{3}$

iii) $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ $K_p = 1.3\times10^{-5}$

iv) $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$ $K_p = 5.5\times10^{-5}$

A) iii < iv < i < ii B) ii < i < iv < iii

C) iv < iii < ii < i D) iv < iii < i < ii

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23) Given the following equilibrium:

$CCl_4(g) + \frac{1}{2}O_2(g) \rightleftharpoons COCl_2(g) + Cl_2(g)$ $K_c = 4.4\times10^{9}$ at 100°C

calculate K_c at 700°C for the following manipulated equilibrium:

$$2COCl_2(g) + 2Cl_2(g) \rightleftharpoons 2CCl_4(\ell) + O_2(g)$$

A) 1.14×10^{-10} B) 1.94×10^{19} C) 5.17×10^{-20} D) 2.35×10^{-18}

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24) An equilibrium mixture for the reaction:

$$2H_2S(aq) \rightleftharpoons 2H_2(g) + S_2(g)$$

on analysis was found to contain:

1.0 mol H_2S, 4.0 mol H_2 and 0.8 mol S_2 in a 4.0 L vessel. Calculate K_c for this reaction:

A) 4.6 B) 3.2 C) 1.6 D) 0.8

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25) 1.0 mol of A and 1.8 mol of B were initially placed into a 5.0 L reaction vessel and the following reaction was allowed to achieve equilibrium:

$$A(g) + 2B(g) \rightleftharpoons C(g)$$

After the reaction reached equilibrium 1.0 mol of B was found. Calculate the value of K_c for this reaction

A) 3.33 B) 6.67 C) 12.86 D) 16.67

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26) $K_c = 0.083$ at 900.0°C for the following equilibrium:

$$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$$

What is the value of K_p at 900.0°C for this equilibrium?

A) 8.0 B) 9.0 C) 10.0 D) 11.0

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27) For the following equilibrium occurring at 25°C, $K_p = 3\times10^{24}$:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Calculate K_c for this reaction at 25°C.

A) 2.25×10^{20} B) 5.25×10^{21} **C) 7.34×10^{25}** D) 1.23×10^{23}

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28) For the following equilibrium:

$$2X(s) + Y(g) \rightleftharpoons 2Z(g) \qquad K_c = 128 \text{ at } 400.0^oC$$

Determine the concentration (in mol/L) of Z in equilibrium with 0.4 mol of X and 0.5 mol of Y inside a 1.0 L reaction vessel.

A) 3.2 **B) 8.0** C) 4.8 D) 2.0

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29) For the reaction:

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g) \qquad K_c = 24.0 \text{ at } 25^oC$$

The following system was prepared by injecting: 0.1 mol PCl_3, 0.15 mol Cl_2 and 0.6 mol PCl_5 into a 1.0 L reaction vessel at 25°C. Which response is correct?
The reaction:

A) is at equilibrium.
B) will consume PCl_3 and Cl_2 until equilibrium is reached.
C) will form more PCl_3 and Cl_2 until equilibrium is reached.
D) will form more PCl_5 until equilibrium is reached.

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30) Consider the following equilibrium:

$$2NO(g) + Br_2(g) \rightleftharpoons 2NOBr(g) \qquad \Delta H_{rxn} = -30 \text{ kJ}$$

Which of the following changes will cause the concentration of the NOBr to increase:

A) Increase the temperature and decrease the total pressure by increasing the container volume.
B) Decrease the temperature and decrease the total pressure by increasing the container volume.
C) Increase the temperature and increase the total pressure by compressing the gas mixture into a smaller volume.
D) Decrease the temperature and increase the total pressure by compressing the gas mixture into a smaller volume.

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31) The formula of the hydronium ion is:

A) H_3O^+ B) OH^- C) H_3O^- D) H_2O

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32) Identify the conjugated acid of HPO_4^{--}:

A) H_3PO_3 B) $H_2PO_4^-$ C) H_3PO_4 D) PO_4^{---}

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33) Identify the conjugated base of NH^{--}:

A) NH_4^+ B) NH_3 C) NH_2^- D) N^{---}

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34) For the base, NO_2^- , $K_b = 2.2\times10^{-11}$ at 25°C, therefore, K_a for the acid HNO_2 at 25°C is:

A) 2.2×10^{-3} B) 11.8×10^{-4} C) 4.5×10^{-4} D) 11.8×10^{-5}

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35) The pH value of the 0.20 M phenoxide ion solution (phenoxide ion $C_6H_5O^-$ is a weak base having $K_b = 7.7\times10^{-5}$) is:

A) 11.59 B) 9.89 C) 4.11 D) 2.41

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36) The concentration (in mol/L) of the aqueous HCl (strong acid) solution having pH = 2.3, is:

A) 3.0×10^{-3} B) 4.0×10^{-3} C) 5.0×10^{-3} D) 6.0×10^{-3}

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37) Which of the following weak monoprotic acids has the strongest conjugated base:

A) CH_3COOH ($K_a = 1.8\times10^{-5}$) B) C_6H_5COOH ($K_a = 6.5\times10^{-5}$)
C) HOCl ($K_a = 3.2\times10^{-8}$) D) HCN ($K_a = 4.9\times10^{-10}$)

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38) In which one of the following acetic acid "CH_3COOH" (a weak monoprotic acid) aqueous solutions will acetic acid has the greatest degree of ionization:

A) 0.1M CH_3COOH, alone.
B) 0.1M CH_3COOH together with 0.05 M HCl.
C) 0.1M CH_3COOH together with 0.1 M HCl.
D) 0.1M CH_3COOH together with 0.1 M CH_3COONa.

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39) Which one of the following mixtures is suitable for making a buffer solution with an optimum pH of 9.25?

A) HOCl/NaOCl (K_a[HOCl] = 3.2×10^{-8})
B) C_6H_5COOH/C_6H_5COONa (K_a[C_6H_5COOH] = 6.5×10^{-5})
C) NH_3/NH_4Cl (K_b[NH_3] = 1.8×10^{-5})
D) HCNO/NaCNO (K_a[HCNO] = 2.0×10^{-4})

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40) Calculate the pH value of a buffer prepared by dissolving 0.55 mol sodium acetate "CH_3COONa" and 0.3 mol acetic acid "CH_3COOH" in enough water to obtain exactly 1.0 L solution (knowing that K_a [CH_3COOH] = 1.8×10^{-5}):

A) 4.0 B) 4.5 C) 5.0 D) 5.5