Chemistry 12 – Final Exam
December 14, 2000
FORM A

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1. For the following reaction at 1000 K, $K_p = 3.9 \times 10^{-2}$.

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

What is the value of K_c for this reaction?

A. 4.69×10^{-6}
B. 5.79×10^{-6}
C. 2.75×10^{-4}
D. 3.20
E. 324

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2. Consider the following reaction at a constant temperature for which $K_p = 2.7$.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

If 0.153 mole of CO, 0.546 mole of H_2O, 0.262 mole of CO_2 and 0.743 mole of H_2 are introduced into a 2 L vessel, which of the following statements will be true?

A. The system is at equilibrium and no change will occur.
B. The system is not at equilibrium and will proceed to the right to achieve equilibrium.
C. The system is not at equilibrium and will proceed to the left to achieve equilibrium.
D. The system is not at equilibrium and it cannot achieve equilibrium.
E. The system is at equilibrium, but the addition of a catalyst will cause the reaction to proceed to the right.

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3. At high temperature, 1.0 mole of ICl is allowed to decompose in a 2.0 L flask.

$$2ICl(g) \rightleftharpoons I_2(g) + Cl_2(g)$$

The equilibrium constant for this reaction at the temperature of interest is $K_c = 0.110$. What is the equilibrium concentration of ICl(g)?

A. 0.10 M
B. 0.20 M
C. 0.30 M
D. 0.50 M
E. 0.60 M

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4. Which one of the following aqueous solutions will have the highest vapor pressure?

A. 0.2 M NaBr
B. 0.2 M NH_4OH
C. 0.2 M $Ba(NO_3)_2$
D. 0.2 M $AlCl_3$
E. 0.2 M $C_{12}H_{22}O_{12}$ (sugar)

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5. A solution of isopropanol (C_3H_5OH) is made by dissolving 0.250 mole of isopropanol in 0.950 mole of water. What is the molality of the solution?

A. 0.0146m
B. 0.209m
C. 0.459m
D. 0.791m
E. 14.6m

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6. The normal boiling point of an aqueous solution made by dissolving 145.0 g of caffeine in 250.0 g of water is 101.55 °C. K_b of water is 0.52 °C/*m*. What is the molar mass of caffeine?

A. 10.44 g/mole
B. 580.0 g/mole
C. 123.2 g/mole
D. 335.5 g/mole
E. 194.2 g/mole

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7. For the following reaction, what will happen if the volume of the system is decreased?

$$2\,C(s) + O_2(g) \rightleftharpoons 2\,CO(g)$$

1. The equilibrium will shift to the left.
2. The equilibrium will shift to the right.
3. The mass of C(s) will increase.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 2 and 3

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8. What is the osmotic pressure of a 0.100 M solution of a nonelectrolyte at 20 °C ?

A. 1.00 atm
B. 2.41 atm
C. 0.164 atm
D. 4.82 atm
E. 1.64 atm

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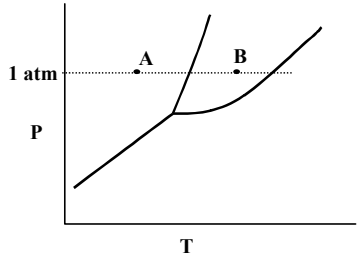
9. If a sample of CCl_4 at constant pressure of 1 atm was heated starting at point A and ending at point B, what phase transition(s) would be observed?



A. melting
B. vaporization
C. freezing
D. condensation
E. sublimation

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10. The balanced homogeneous gas-phase reaction

$$Z + R \rightleftharpoons G + Q$$

has an equilibrium constant value $K_c = 6.2 \times 10^{-4}$. At equilibrium

A. products dominate
B. reactants dominate
C. approximately equal amounts of reactants and products are present
D. only products exist
E. only reactants exist

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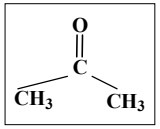
11. Which of the following intermolecular forces are present in the molecule shown?

1. London dispersion forces
2. Dipole-dipole forces
3. Hydrogen bonding



A. 1 and 2
B. 1 and 3
C. 2 and 3
D. 1 only
E. 2 only

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12. Consider a closed vessel with a pure liquid inside that is at equilibrium with its vapor. Increasing the total pressure above the liquid will cause the boiling point of the liquid to

A. increase
B. decrease
C. remain constant
D. it depends on the liquid
E. all of the above

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13. Which one of the following substances would be the most soluble in CCl_4 ?

A. CH_3CH_2OH
B. H_2O
C. NH_3
D. $C_{10}H_{22}$
E. NaCl

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14. The value of K_c for the following reaction is 0.25.

$$SO_2\,(g) + NO_2\,(g) \rightleftharpoons SO_3\,(g) + NO\,(g)$$

What is the value of K_c for the reaction shown below assuming both reactions are at the same temperature?

$$2\,SO_2\,(g) + 2\,NO_2\,(g) \rightleftharpoons 2\,SO_3 + 2\,NO\,(g)$$

A. 0.50
B. 0.062
C. 0.12
D. 0.25
E. 0.37

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15. How many kJ would it take to change 423.0 g of ice cubes at 0 ^{o}C to water at room temperature (25 ^{o}C)? $\Delta H_{melting}$ = 6.01 kJ/mol and $C_p(H_2O)$ = 4.184 J/(g ^{o}C)

A. 185.4 kJ
B. 141.2 kJ
C. 2542. kJ
D. 2456 kJ
E. 4998. kJ

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16. Given the following information, calculate the enthalpy for the combustion of acetylene:

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(\ell).$$

$2C(s) + H_2(g) \rightarrow C_2H_2(g)$ $\Delta H = +227$ kJ

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -394$ kJ

$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$ $\Delta H = -572$ kJ

A. –1301 kJ
B. –739 kJ
C. –2602 kJ
D. –1193 kJ
E. 568 kJ

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17. Which of the following statements are true?

1. All s orbitals are spherically shaped.
2. In the hydrogen atom, electrons in orbitals that have the same principal quantum number have the same energy.
3. In a p orbital, there is a high probability that the electron will be found near the nucleus.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2 are true
E. all of the statements are true

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18. How many unpaired electrons are there in the ground state electronic configuration of atomic V?

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

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19. Which of the following ionization energies is the largest (I_1 = 1st ionization energy, I_2 = 2nd ionization energy)?

A. I_1 of Li
B. I_2 of Ca
C. I_2 of Al
D. I_2 of Mg
E. I_2 of K

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20. Which of the following represents the correct ordering of lattice energies for NaCl, KCl, and CaO ?

A. NaCl > KCl > CaO
B. CaO > NaCl > KCl
C. KCl > NaCl > CaO
D. CaO > KCl > NaCl
E. NaCl > CaO > KCl

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21. How many lone (nonbonded) electron **pairs** are found in the correct Lewis structure for formaldehyde (CH_2O)? (Hint: carbon is the central atom.)

A. 0
B. 1
C. 2
D. 3
E. 4

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22. Using the information below, estimate the enthalpy of the reaction

$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

Some average Bond Enthalpies:

C–H 413 kJ/mol	C–C 348 kJ/mol
C=C 614 kJ/mol	C≡C 839 kJ/mol
H–H 436 kJ/mol	

A. –124 kJ/mol
B. +101 kJ/mol
C. –390 kJ/mol
D. –258 kJ/mol
E. +213 kJ/mol

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23. Electrons in which of the following two sets of orbitals of a multielectron atom would have the same energy?

1. n=3, ℓ=2, m_ℓ = 2, m_s = +1/2
2. n=2, ℓ=2, m_ℓ = –2, m_s = +1/2
3. n=3, ℓ=2, m_ℓ = –2, m_s = –1/2
4. n=3, ℓ=1, m_ℓ = –2, m_s = –1/2
5. n=4, ℓ=2, m_ℓ = –2, m_s = –1/2

A. 1 and 3 only
B. 2 and 3 only
C. 3 and 5 only
D. 1 and 2 only
E. 3 and 4 only

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24. An unknown liquid has a density of 2.14 g/cm^3. How many mm^3 would a 6.42 mg sample of this liquid occupy if dispensed into a 10 mm^3 UV/VIS spectrophotometer cuvette?

A. 3.00 mm^3
B. 0.300 mm^3
C. 0.0300 mm^3
D. 0.00300 mm^3
E. none of the above

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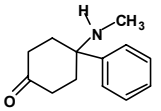
25. Identify the functional groups present in the following structure.

1. ester
2. ether
3. amine
4. ketone
5. amide



A. 1 and 5
B. 2 and 5
C. 2 and 3
D. 4 and 5
E. 3 and 4

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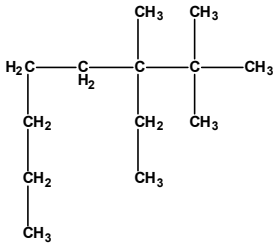
26. The correct name for the following branched alkane is



A. 3-ethyl-2,2,3-trimethyloctane
B. 2,2,3-trimethyl-3-ethyl-5-propylpentane
C. 1-propyl-3-ethyl-3,4,4,-trimethylpentane
D. 1,1,1-trimethyl-2-ethylmethylheptane
E. 6-ethyl-6,7,7-trimethyloctane

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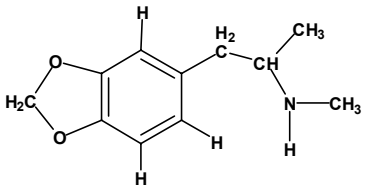
27. The percent mass of hydrogen in the following compound is



A. 5.2%
B. 7.8%
C. 8.7%
D. 7.2%
E. 8.4%

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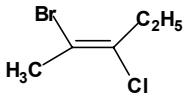
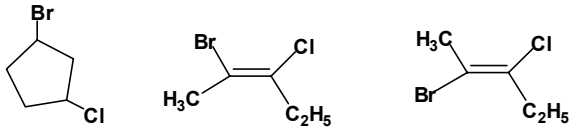
28. Which of the following is/are isomers of the structure below?





1 **2** **3**

A. 1
B. 2
C. 3
D. 1 and 2
E. 1 and 3

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29. When an aqueous solution of $Pb(C_2H_3O_2)_2(aq)$ and NaI(aq) are mixed, which of the following reactions is the correct *net ionic* equation that describes this reaction?

A. $Pb^{+2}(aq) + 2\ C_2H_3O_2^-(aq) \rightarrow Pb(C_2H_3O_2)_2(s)$

B. $2\ Na^+(aq) + 2\ C_2H_3O_2^-(aq) \rightarrow 2\ NaC_2H_3O_2(s)$

C. $Pb^+(aq) + I^-(aq) \rightarrow PbI(s)$

D. $Pb^{2+}(aq) + 2\ I^-(aq) \rightarrow PbI_2(s)$

E. $Pb^{2+}(aq) + 2\ C_2H_3O_2^-(aq) + 2\ Na^+(aq) + 2\ I^-(aq) \rightarrow 2\ Na^+(aq) + 2\ C_2H_3O_2^-(aq) + Pb^{2+}(aq) + 2\ I^-(aq)$

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30. 7.2 g of a hydrocarbon is completely combusted in oxygen and found to yield 10.8 g of water and 22.0g of carbon dioxide. The empirical formula for the hydrocarbon is

A. C_5H_6
B. C_3H_7
C. $C_{10}H_{24}$
D. CH
E. C_5H_{12}

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31. When 47.3mL of 0.107 M HCl is added to 54.7 mL of 0.213 M $Ca(OH)_2$, the resulting OH^- concentration is

A. 0.0645 M
B. 0.179 M
C. 0.114 M
D. 0.228 M
E. 0.0500 M

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32. Haloethane has a formula $C_2HBrClF_3$. It is a nonflammable, nonexplosive, and nonirritating gas used for inhalation anesthetics. If you mix 15.0 g of haloethane vapor with 23.5 g oxygen gas and the total pressure of the mixture is 855 mm Hg, what is the partial pressure of the haloethane?

A. 80.0 mm Hg
B. 775 mm Hg
C. 938 mm Hg
D. 906 mm Hg
E. 65.0 mm Hg

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33. Let us say you are asked to design an air bag for your car. What quantity of sodium azide, NaN_3, is necessary to fill a 45.5 L airbag with N_2 at 838 torr and 22.0 ^oC ?

$$2NaN_3\,(s) \longrightarrow 2Na\,(s) + 3\,N_2\,(g)$$

A. 2.05 g
B. 125 g
C. 27.5 g
D. 89.6 g
E. 136 g

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34. The density of an unknown gas is 1.23 g/L at STP. Which of these would most likely be the unknown gas?

A. Cl_2
B. O_2
C. CO
D. NH_3
E. C_2H_6

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35. Which one of the following molecules will NOT have linear molecular geometry about the central atom?

A. SCO
B. SCN^-
C. HCN
D. C_2H_2 (HCCH)
E. ClO_2^- (Chlorine is the central atom.)

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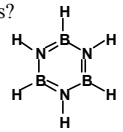
36. Borazine $B_3N_3H_6$ has been called inorganic benzene. What is the hybridization of the boron atoms?



A. sp
B. sp^2
C. sp^3
D. sp^4
E. dsp^3

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37. Which of the following molecules will have a zero dipole moment?

A. SF_4
B. BrF_5
C. ClO_2
D. C_2F_4
E. SO_2Cl (Sulfur is the central atom.)

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38. Which of the following are weak electrolytes?

1. CH_3COOH ($HC_2H_3O_2$)
2. CH_3OH
3. $C_{12}H_{22}O_{11}$ (table sugar)
4. $NaClO_4$

A. 1 and 2 are weak electrolytes
B. 1 and 3 are weak electrolytes
C. 1, 2 and 3 are weak electrolytes
D. 4 is the only weak electrolyte
E. 1 is the only weak electrolyte

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39. Which one of the following is the electron configuration for the Fe^{+2} ion?

A. [Ar] $3d^6$
B. [Ar] $4s^2\ 3d^4$
C. [Ar] $3d^8$
D. [Ar] $4s^2\ 3d^8$
E. [Ar] $4s^2\ 3d^6$

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40. Which of the following properties do greenhouse gases have?

(1) They absorb infrared radiation
(2) They block ultraviolet radiation from the sun
(3) They photodissociate to form pollutant species in the atmosphere

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Chem 12, Final Exam, December 14, 2000

Answer Key

Form A

1. D
2. B
3. C
4. E
5. E
6. E
7. D
8. B
9. A
10. B
11. A
12. A
13. D
14. B
15. A
16. C
17. D
18. C
19. E
20. B
21. C
22. A
23. A
24. A
25. E
26. A
27. B
28. D
29. D
30. E
31. B
32. A
33. D
34. C
35. E
36. B
37. D
38. E
39. A
40. A