CHEMISTRY 110 EXAM 4
May 2, 2011
FORM A

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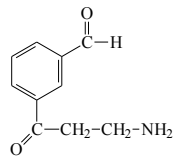
1. Which of the functional groups are present in the following structure?



   A. amine and ether
   B. carboxylic acid and ketone
   C. amine, aldehyde, and carboxylic acid
   D. amine, ketone, and aldehyde
   E. ether, aldehyde, and ketone

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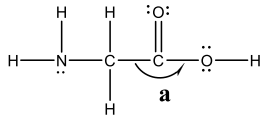
2. What is the approximate bond angle **(a)** in this molecular structure?



   A. 90°
   B. 109.5°
   C. 120°
   D. 180°
   E. 60°

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3. In which of the following molecules is the central atom surrounded by four electron domains?

   I CO_2 II SO_3 III $CHCl_3$ IV SeF_2

   A. only choice I
   B. only choice II
   C. choices I and II
   D. choices III and IV
   E. choices I, II and III

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4. What is the molecular weight of a gas if 3.5 g of the gas occupies 2.1 L at STP?

   A. 41 g/mol
   B. 5.5×10^3 g/mol
   C. 37 g/mol
   D. 4.6×10^2 g/mol
   E. 2.7×10^{-2} g/mol

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5. What species is oxidized in the following chemical reaction?

$$Cu\,(s) + 2AgNO_3\,(aq) \rightarrow 2Ag\,(s) + Cu(NO_3)_2\,(aq)$$

A. Cu (s)
B. Ag^+ (aq)
C. Ag (s)
D. Cu^{+2} (aq)
E. NO_3^- (aq)

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6. What is the standard enthalpy of formation of one mole of strontium carbonate, $SrCO_3$ (s)?

$Sr\,(s) + \frac{1}{2}\,O_2\,(g) \rightarrow SrO\,(s)$ $\quad \Delta H° = -592$ kJ

$SrCO_3\,(s) \rightarrow SrO\,(s) + CO_2\,(g)$ $\quad \Delta H° = +234$ kJ

$C\,(graphite) + O_2\,(g) \rightarrow CO_2\,(g)$ $\quad \Delta H° = -394$ kJ

A. −1812 kJ
B. −1220 kJ
C. −752 kJ
D. +36 kJ
E. +752 kJ

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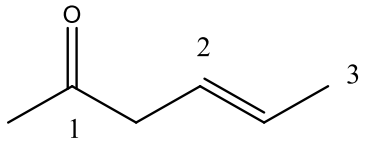
7. For the molecule, pick the choice with the correct hybridization for carbon atoms 1, 2 and 3.



	1	2	3
A	sp	sp^2	sp^3
B	sp^2	sp^3	sp^2
C	sp^2	sp^2	sp^3
D	sp^2	sp	sp^3
E	sp	sp	sp^2

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8. The C−Cl bond dissociation energy in CF_3Cl is 339 kJ/mol. What is the maximum wavelength of photons that can rupture this bond?

A. 45 nm
B. 353 nm
C. 137 nm
D. 275 nm
E. 742 nm

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9. Using the bond energy data tabulated below, estimate the enthalpy of formation (per mole) of NH_3 (g).

Bond	Average bond energy (kJ/mol)
N≡N (N_2)	941
H−H	436
N−H	391

The correct answer is closest to

A. −422 kJ/mol
B. −49 kJ/mol
C. 49 kJ/mol
D. 204 kJ/mol
E. 422 kJ/mol

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10. Given the following reaction at equilibrium at 300.0 K:

$$NH_4HS\ (s) \leftrightarrows NH_3\ (g) + H_2S\ (g)$$

What is the value of K_p if the partial pressures of NH_3 and H_2S are $P_{NH3} = P_{H2S} = 0.111$ atm?

A. 1.23×10^{-2}
B. 4.99×10^{-4}
C. 1.11×10^{-1}
D. 8.12×10^{-2}
E. Not enough information is given to calculate K_p

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11. K_c for the reaction below equals 125 at a particular temperature.

$$F_2(g) + Cl_2(g) \leftrightarrows 2\ FCl(g)$$

What is the value of K_c for the reaction given below?

$$1/2\ F_2(g) + 1/2\ Cl_2(g) \leftrightarrows FCl(g)$$

A. $K_c = 0.0894$
B. $K_c = 11.2$
C. $K_c = 0.0160$
D. $K_c = 62.5$
E. $K_c = 125$

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12. A student measures the following in the process of collecting nitrogen gas by water displacement at STP:

Vapor pressure of water at 0 °C: 4.58 mm Hg
Volume of gas collected: 100 mL

Assuming ideal gas behavior, which of the following is the number of moles of N_2 the student collected?

A. 0.00444 moles N_2
B. 0.00429 moles N_2
C. 0.00393 moles N_2
D. 3.85×10^{-3} moles N_2
E. 2.68×10^{-5} moles N_2

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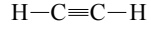
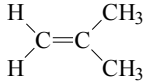
13. Which of the following compounds can have a geometrical isomer?

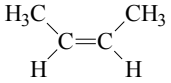
I



II



III



A. I only
B. II only
C. III only
D. I and II only
E. II and III only

14. Which of the following ions has the electron configuration [Ar] $3d^6$?

I. Ni^{2+}
II. Co^{3+}
III. Fe^{2+}

A. I only
B. II only
C. III only
D. II and III
E. I, II, and III

15. For which one of the following equations is $\Delta H°_{rxn}$ equal to $\Delta H°_f$ for the product?

A. $N_2\,(g) + 2F_2\,(g) \rightarrow N_2F_4\,(g)$
B. $CH_4\,(g) + 2Cl_2\,(g) \rightarrow CH_2Cl_2\,(l) + 2HCl\,(g)$
C. $N_2\,(g) + O_3\,(g) \rightarrow N_2O_3\,(g)$
D. $2CO\,(g) + O_2(g) \rightarrow 2CO_2\,(g)$
E. $C\,(diamond) + 2Cl_2\,(g) \rightarrow CCl_4\,(l)$

16. What is the concentration of HCl if 17.5 mL are needed to neutralize 29.6 mL of 0.250 M $Ca(OH)_2$?

A. 0.157 M
B. 0.314 M
C. 0.423 M
D. 0.846 M
E. 1.69 M

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17. Consider the following reaction:

$6\ CO_2\ (g) + 6\ H_2O\ (l) \leftrightarrows C_6H_{12}O_6\ (s) + 6\ O_2\ (g) \qquad \Delta H^o = 2816\ kJ$

Which one of the following statements about this equilibrium is **false**?

A. Decreasing the total pressure by increasing the volume at constant temperature will have no effect on the equilibrium.
B. Increasing the CO_2 pressure will cause the reaction to shift to the right.
C. Increasing the temperature will cause the reaction to shift to the right.
D. Removing some of the $C_6H_{12}O_6$ will shift the reaction to the right.
E. Adding catalyst will have no effect on equilibrium.

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18. Which one of the following equilibriums is least affected by a change in the volume of the system?

A. $2\ C\ (s) + O_2\ (g) \leftrightarrows 2\ CO\ (g)$
B. $H_2\ (g) + S\ (l) \leftrightarrows H_2S\ (g)$
C. $2\ NO_2\ (g) \leftrightarrows N_2O_4\ (g)$
D. $H_2O\ (l) \leftrightarrows H_2O\ (g)$
E. $2\ NO\ (g) + Cl_2\ (g) \leftrightarrows 2\ NOCl\ (g)$

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19. Which of the following has the highest melting point?

A. LiCl
B. NaBr
C. MgO
D. SrS
E. KI

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20. Rank the C-O bond lengths in the following molecules, from shortest to longest.

A. $CO = CO_2 < CO_3^{2-}$
B. $CO_2 < CO < CO_3^{2-}$
C. $CO_3^{2-} < CO_2 < CO$
D. $CO < CO_2 = CO_3^{2-}$
E. $CO < CO_2 < CO_3^{2-}$

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21. Which of the following has the largest **second** ionization energy?

A. Mg
B. Na
C. Ga
D. Ge
E. S

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22. Assuming Bohr model behavior, what is the *longest* wavelength of light that can be used to ionize a hydrogen atom in its ground state?

    A. 328 nm
    B. 555 nm
    C. 91.2 nm
    D. 912 nm
    E. 906 nm

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23. Which one of these molecules has the strongest intermolecular forces?

    A. CH_3Br
    B. CH_3Cl
    C. $CHCl_3$
    D. CH_3I
    E. CH_3F

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24. Caffeine ($C_8H_{10}N_4O_2$) is a stimulant found in coffee and tea. If a solution of caffeine in chloroform ($CHCl_3$) as a solvent has a concentration of 0.0750 m, calculate percent caffeine by mass.

    A. 4.19%
    B. 7.78%
    C. 3.20%
    D. 1.44%
    E. 0.59%

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25. How would the solubility of CO_2 gas in aqueous solution be affected by increasing the partial pressure of CO_2 above the solution at constant T?

    A. The solubility of the CO_2 gas would increase.
    B. The solubility of the CO_2 gas would decrease.
    C. It would have no effect on the solubility of the CO_2 gas.
    D. Need the total pressure to answer.
    E. Need the temperature of the solution to answer.

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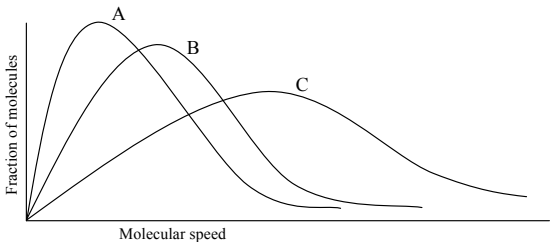
26. The plot shows the distribution of speeds of different gases at the same temperature. If each of these gases was in a 1 L box at STP, which one would have the greatest density?



A. A
B. B
C. C
D. They would all have the same density.
E. It is impossible to tell from this information.

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27. When Na_2S (aq) and $ZnSO_4$ (aq) are mixed and a reaction occurs, what are the spectator ions?

A. Na^+ (aq) and Zn^{2+} (aq)
B. S^{2-} (aq) and Zn^{2+} (aq)
C. Zn^{2+} (aq) and SO_4^{2-} (aq)
D. Na^+ (aq) and S^{2-} (aq)
E. Na^+ (aq) and SO_4^{2-} (aq)

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28. One mole of aluminum and one mole of manganese oxide are placed in a reaction vessel, and the following reaction occurs

$$2\ Al\ (s) + 3\ MnO\ (s) \rightarrow Al_2O_3\ (s) + 3\ Mn\ (s)$$

Which of the following statements is **true**?

A. 1.0 mole of Mn will be produced.
B. 2.0 mole of Al_2O_3 will be produced.
C. 1.0 mole of Al will be left over.
D. 2.0 mole of MnO will be left over.
E. Al is the limiting reactant.

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29. Rank these systems in order of increasing electrostatic potential energy.

I an electron that is 2.8 nm from a +2 charge
II an electron that is 2.8 nm from a –2 charge
III an electron that is 2.8 nm from a proton

A. I < III < II
B. I = II < III
C. II < III < I
D. I = II = III
E. III < II = I

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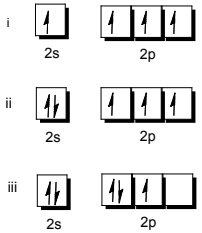
30. Which of the following electron configurations is possible for valence electrons of nitrogen (ground state or excited state)?



A. i only
B. ii only
C. i and ii
D. ii and iii
E. all three are correct

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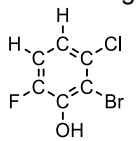
31. Which bond in the following molecule is the most polar?



A. C—H
B. C—Cl
C. C—Br
D. C—O
E. C—F

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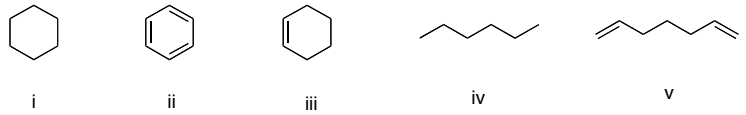
32. Which of the following organic molecules can be classified as an alkene?



A. i and iv
B. ii only
C. ii and v
D. iii and v
E. ii, iii, and v

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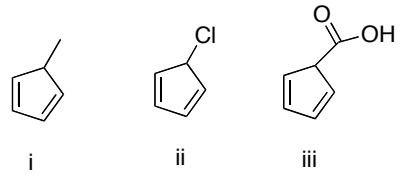
33. Which of the following molecules are polar?



A. i only
B. ii only
C. i and ii
D. ii and iii
E. all three are polar

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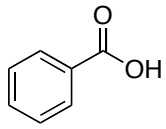
34. Arrange the following in order of decreasing melting point.

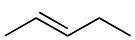
CaO Ar H_2O

A. CaO > H_2O > Ar
B. CaO > Ar > H_2O
C. H_2O > CaO > Ar
D. H_2O > Ar > CaO
E. Ar > H_2O > CaO

35. Which one of the following will have delocalized π bonding?



i


ii

iii

A. i only
B. i and ii
C. i and iii
D. ii and iii
E. all three

36. What is the correct order of the freezing points for the following aqueous solutions starting with the highest?

I. 0.010 m $BaCl_2$
II. 0.010 m $C_6H_{12}O_6$
III. 0.020 m KBr

A. III > II > I
B. III > I > II
C. I > III > II
D. II > I > III
E. I > II > III

37. Detonation of nitroglycerin proceeds as follows:

$4\ C_3H_5N_3O_9\ (l) \rightarrow 12\ CO_2\ (g) + 6\ N_2\ (g) + O_2\ (g) + 10\ H_2O\ (g)$

When 5.00×10^{-3} L of nitroglycerin (density = 1.592 g/mL) is detonated, how many total moles of gas are produced?

A. 0.138 mole
B. 0.253 mole
C. 0.00460 mole
D. 2.53×10^{-4} mole
E. 6.55×10^{-4} mole

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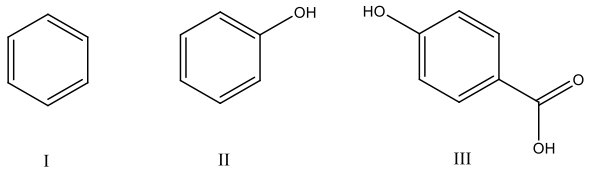
38. Rank these compounds in order of increasing viscosity starting with the least viscous.



I II III

A. I < II < III
B. II < I < III
C. III < I < II
D. II < III < I
E. III < II < I

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39. At a particular temperature, for the reaction below $K_c = 4$.

$$N_2\,(g) + O_2\,(g) \leftrightarrows 2\,NO\,(g)$$

If we mix 1 mol of N_2 and 1 mol of O_2 in a 2 L container what will the concentration of NO be once equilibrium is reached at the given temperature?

A. 0.25 M
B. 0.33 M
C. 0.50 M
D. 0.67 M
E. 1.0 M

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40. When a student mixes 50 mL of 1.0 M HCl and 50 mL of 1.0 M NaOH in a coffee-cup calorimeter, the temperature of the resultant solution increases from 21.0 °C to 27.5 °C. Calculate the enthalpy change for the reaction in kJ per mol of HCl, assuming that the calorimeter loses only a negligible quantity of heat. The total volume of the solution is 100 mL, its density is 1.0 g/mL, and its specific heat is 4.18 J/g-K.

A. 2.7 kJ/mol
B. −2.7 kJ/mol
C. 54.4 kJ/mol
D. −54.4. kJ/mol
E. −108 kJ/mol

End of Exam

CHEM 110 Spring 2011
Final Exam Answer Key
5/2/2011

Form A

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