

Sample Chem 121 Final

1. A metal sample weighing 30.9232 grams was added to a graduated cylinder containing 23.20 mL of water. The volume of the water plus the sample was 24.80 mL. What is the density of the metal?

- a) 19.3 g/mL
- b) 19.33 g/mL
- c) 19.327 g/mL
- d) 2.0×10^1 g/mL
- e) 19. g/mL

2. About the year 1910 Rutherford and colleagues performed experiments by targeting a stream of alpha particles (+ charged) at a piece of gold foil and recording the deflection of the particles on a sensitive screen. Which of the following statement(s) were conclusion(s) from those experiments?

- I. most of the volume of the atom is empty space
- II. the nucleus of an atom is dense and positively charged
- III. electrons have negligible mass

- a) I only
- b) II only
- c) I and II only
- d) II and III only
- e) I, II, and III

3. Chlorine has two stable isotopes with exact masses of 34.96885 amu and 36.96590 amu. What is the relative abundance of the two isotopes?

- a) 50.00% ^{35}Cl and 50.00% ^{37}Cl
- b) 35.45% ^{35}Cl and 64.55% ^{37}Cl
- c) 64.55% ^{35}Cl and 35.45% ^{37}Cl
- d) 24.33% ^{35}Cl and 75.77% ^{37}Cl
- e) 75.77% ^{35}Cl and 24.33% ^{37}Cl

4. The chemical properties of sulfur would be most similar to

- a) P
- b) Cl
- c) Ar
- d) Se
- e) As

5. How many grams of CH_4 contain the same number of molecules as 2.50 grams O_2 ?

- a) 1.25 g
- b) 0.0781 g
- c) 0.156 g
- d) 4.70×10^{22} g
- e) 4.88×10^{-3} g

6. Which formula represents the binary compound formed by magnesium and nitrogen?

- a) MgN
- b) Mg₂N
- c) MgN₃
- d) Mg₃N₂
- e) Mg₂N₃

7. What is the correct name for FeSO₄?

- a) iron(III) sulfite
- b) iron(II) sulfite
- c) iron(II) sulfate
- d) iron(II) sulfide
- e) iron(III) sulfide

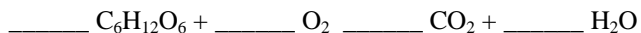
8. The formula of the compound ammonium phosphate is

- a) NH₄(PO₄)₃
- b) NH₄(PO₄)₂
- c) (NH₄)₂ PO₄
- d) (NH₄)₃PO₄
- e) (NH₄)₃ (PO₄)₂

9. Serotonin is a neurotransmitter which plays a role as neurons carry messages. The molar mass of serotonin is 176 g/mol. When a 5.31 g sample is analyzed, it was found to contain 3.62 g carbon, 0.362 g hydrogen, 0.844 g nitrogen and 0.482 g oxygen. What is the molecular formula of serotonin?

- a) C₉H₁₀N₃O
- b) C₁₁H₁₄NO
- c) C₁₀H₁₂N₂O
- d) C₉H₈N₂O₂
- e) C₁₀H₂₆NO

10. When glucose undergoes complete combustion, the products are carbon dioxide and water.



Which of the following is the most correct set of stoichiometric coefficients to balance this equation?

- a) 1, 9, 6, 6
- b) 1, 6, 6, 6
- c) 2, 12, 6, 12
- d) 2, 12, 12, 12
- e) 1, 9, 12, 12

11. Solutions of barium nitrate and ammonium sulfate are mixed. A white precipitate is observed. Write the *balanced net ionic* equation.

- a) Ba²⁺(aq) + SO₄²⁻(aq) → BaSO₄(s)
- b) 2 NH₄⁺(aq) + SO₄²⁻(aq) → (NH₄)₂SO₄(s)
- c) NH₄⁺(aq) + NO₃⁻(aq) → NH₄NO₃(s)
- d) Ba²⁺(aq) + 2 NH₄⁺(aq) + 6 H₂O(l) → Ba(NO₃)₂(s) + 20 H⁺
- e) Ba²⁺(aq) + 2 NH₄⁺(aq) + SO₄²⁻(aq) → (NH₄)₂SO₄(s) + BaSO₄(s)

12. Consider the equation: $2 \text{NaI}(\text{aq}) + \text{Cl}_2(\text{g}) \rightarrow \text{I}_2(\text{aq}) + 2 \text{NaCl}(\text{aq})$

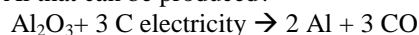
The element undergoing reduction is

- a) sodium
- b) iodide
- c) chlorine
- d) iodine
- e) water

13. The oxidation number of chlorine in KClO_3 is

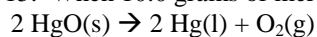
- a) +6
- b) +5
- c) -1
- d) -2
- e) +2

14. If 25.0 grams of Al_2O_3 and 75.0 grams of carbon react according to the equation below, what is the maximum number of grams of Al that can be produced?



- a) 112 grams
- b) 6.61 grams
- c) 112 grams
- d) 100.0 grams
- e) 13.2 grams

15. When 10.0 grams of mercury(II) oxide was decomposed, a student obtained 5.00 grams of mercury. What was the percent yield?



- a) 46.0%
- b) 50.0%
- c) 54.0%
- d) 33.3%
- e) 10.0%

16. What volume of 0.166 M NaOH is needed to neutralize 10.0 mL of 0.261M HNO_3 ?

- a) 0.0157 mL
- b) 1.57 mL
- c) 15.7 mL
- d) 157 mL
- e) 1.57 L

17. Equal masses of two substances, A and B, each absorb 25 Joules of energy. If the temperature of A increases by 4 degrees and the temperature of B increases by 8 degrees, one can say that

- a) the specific heat of A is double that of B.
- b) the specific heat of B is double that of A.
- c) the specific heat of B is negative.
- d) the specific heat of A is negative.
- e) the specific heat of B is triple that of A.

18. Calculate the amount of heat needed to change 25.0 g ice at -15.0°C to steam at 100°C .
(Some constants for H_2O : Heat of fusion = 333 J/g ; Heat of vaporization = 2260 J/g ;
Specific heats: Ice = $2.1\text{ J/g}\cdot\text{K}$, Water = $4.2\text{ J/g}\cdot\text{K}$, Steam $2.0\text{ J/g}\cdot\text{K}$)

- a) 75 kJ
- b) 65 kJ
- c) 48 kJ
- d) 26 kJ
- e) 11 kJ

19. When two solutions are mixed, the container "feels hot." Thus,

- a) the reaction is endothermic.
- b) the reaction is exothermic.
- c) the energy of the universe is increased.
- d) the energy of both the system and the surroundings is decreased.
- e) the energy of the system is increased

20. Calculate the standard enthalpy of reaction for the process

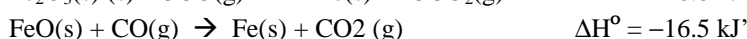
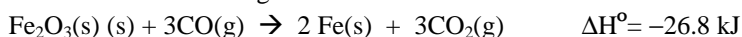


using the standard enthalpies of formation:

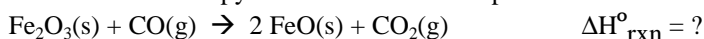
$\text{NO} = 90\text{ kJ/mol}$; $\text{N}_2\text{O} = 82.1\text{ kJ/mol}$; $\text{NO}_2 = 34\text{ kJ/mol}$

- a) 26.1 kJ
- b) -153.9 kJ
- c) -26.1 kJ
- d) 206 kJ
- e) 386 kJ

21. Given the following reactions



Calculate the enthalpy of the reaction for the process



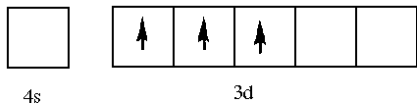
- a) +6.2 kJ
- b) -6.2 kJ
- c) -43.3 kJ
- d) +43.3 kJ
- e) 35.5 kJ

22. Which one of the following sets of quantum numbers is not allowed?

- a) $n = 3, l = 3, m_l = +1$
- b) $n = 3, l = 3, m_l = 0$
- c) $n = 3, l = 0, m_l = 0$
- d) $n = 4, l = 3, m_l = -2$
- e) $n = 4, l = 2, m_l = +2$

23. What ion has the following electron configuration

- a) Sc^{2+}
- b) V^{2+}
- c) Ca^{2+}
- d) Mn^{5+}
- e) Fe^{3+}



24. Which of the following particles has the largest radius?

- a) Ne
- b) F^-
- c) O^{2-}
- d) Na^+
- e) N^{3-}

25. Which species has more than eight electrons around the central atom?

- a) BF_3
- b) BF_4^-
- c) BrF_3
- d) PF_3
- e) OF_2

26. Which of the following compounds exhibits ionic bonding?

- a) CCl_4
- b) MgCl_2
- c) Cl_2
- d) PCl_3
- e) OF_2

27. Which is the most polar bond?

- a) O-F
- b) N-F
- c) C-F
- d) F-F
- e) Cl-F

28. The Lewis structure represented is $\text{O} \text{---} \text{N} \text{====} \text{O}$

- a) NO_2
- b) NO_2^-
- c) NO_2^+
- d) both NO_2^- and NO_2^+
- e) NO_2 , NO_2^- and NO_2^+

29. Based on the VSEPR Theory, what is the molecular shape of CF_4 ?

- a) triangular planar
- b) T-shaped
- c) linear
- d) tetrahedral
- e) angular (bent)

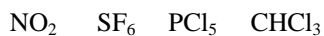
30. Based on the VSEPR Theory, what is the molecular shape of NH_3 ?

- a) triangular planar
- b) T-shaped
- c) triangular-pyramidal
- d) tetrahedral
- e) octahedral

31. What is the approximate H-C-C bond angle in $\text{H}_2\text{C}=\text{CH}_2$?

- a) 180°
- b) 120°
- c) 109.5°
- d) 90°
- e) 60°

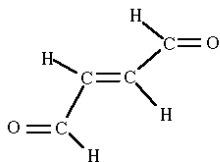
32. How many of the following molecules have a dipole moment?



- a) four
- b) three
- c) two
- d) one
- e) none of these molecule has a dipole

33. How many pi (π) bonds are in the following molecule?

- a) 2
- b) 3
- c) 9
- d) 10
- e) 11



34. What is the hybridization of the sulfur atom in SCl_4 ?

- a) sp^3
- b) sp^4
- c) sp^3d
- d) sp^3d^2
- e) sp^2d^2

35. How many grams of magnesium contain the same number of atoms as 1.00 grams of calcium?

- a) 0.411 g
- b) 0.606 g
- c) 1.65 g
- d) 1.08×10^{-24} g
- e) 9.93×10^{-23} g

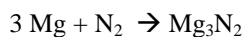
36. Which of the following compounds will form a solution with water that is a good conductor of electricity?

- a) CCl_4
- b) CO_2
- c) NaCl
- d) Cl_2
- e) CH_3OH

37. How many grams of carbon are needed to react completely with 75.2 grams of SiO_2 according to the following equation?
 $\text{SiO}_2(\text{s}) + 3 \text{C}(\text{s}) \rightarrow \text{SiC}(\text{s}) + 2 \text{CO}(\text{g})$

- a) 15.0 g
- b) 61.5 g
- c) 20.5 g
- d) 32.8 g
- e) 45.1 g

38. For the reaction of 15.0 grams of magnesium and 5.00 grams of nitrogen according to the equation below, which statement is true?



- a) Mg is limiting and 0.439 mol N_2 is in excess
- b) N_2 is limiting and 0.082 mol Mg is in excess
- c) 20.0 grams of Mg_3N_2 is produced
- d) 15.0 grams of Mg_3N_2 is produced
- e) There is no limiting reagent.

39. Which of the following particles has the lowest 1st ionization energy?

- a) F
- b) O
- c) Na
- d) Mg
- e) Ne

40. A given mass of gas in a rigid container is heated from 100 °C to 500 °C. Which of the following responses best describes what will happen to the pressure of the gas?

- a) The pressure will decrease by a factor of five.
- b) The pressure will increase by a factor of five.
- c) The pressure will increase by a factor of about two.
- d) The pressure will increase by a factor of about eight.
- e) The pressure will increase by a factor of about twenty-five.

41. An air compressor reduced a sample of helium originally at 25°C and 740 torr to 6.75 liters at 42.0 atm and 85°C. What was the original volume of the helium?

- a) 85.6 liters
- b) 35.9 liters
- c) 242 liters
- d) 319 liters
- e) 350 liters

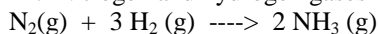
42. What volume will a mixture of 0.200 mole N₂ and 0.500 mole He occupy at 0.944 atm and 15.0 °C?

- a) 0.913 liters
- b) 5.00 liters
- c) 12.5 liters
- d) 15.7 liters
- e) 17.5 liters

43. When 7.0 grams of helium and 14.0 grams of argon were mixed in a flask the pressure was measured as 712 torr. What is the partial pressure of the helium?

- a) 593 torr
- b) 356 torr
- c) 833 torr
- d) 1070 torr
- e) 1420 torr

44. Nitrogen and hydrogen gases react to form ammonia gas:



At a certain temperature and pressure, 7.0 L of N₂ is reacted with 21.0 L of H₂. If all the N₂ and H₂ are consumed, what volume of NH₃ at the same temperature and pressure will be produced?

- a) 7.0 L
- b) 14 L
- c) 21 L
- d) 28 L
- e) 9.3 L

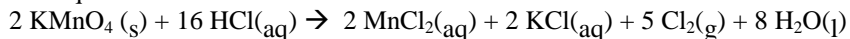
45. Which of the following gases has the greatest density at 0°C and 1 atm?

- a) N₂
- b) O₂
- c) F₂
- d) Ne
- e) CO

46. How many grams of CH_4 will react completely with 7.5 liters of O_2 measured at 150°C and 0.850 atm in a combustion reaction?

- a) 1.47 g
- b) 2.94 g
- c) 1.84 g
- d) 5.89 g
- e) 0.011 g

47. Calculate the volume of $\text{Cl}_2(\text{g})$ produced at 815 torr and 15.0°C if 6.75 grams of KMnO_4 are added to 255 mL of 0.115 M HCl .
The equation for the reaction is



- a) 0.202 L
- b) 0.470 L
- c) 0.647 L
- d) 0.942 L
- e) 2.35 L

48. Which statement about kinetic energy is true?

- a) All particles moving with the same velocity have the same kinetic energy.
- b) All particles at the same temperature have the same kinetic energy.
- c) All particles having the same kinetic energy have the same mass.
- d) As the kinetic energy of a particle is halved its velocity is also halved.
- e) As the velocity of a particle is doubled, the kinetic energy decreases by a factor of four.

49. Non-ideal behavior for a gas is most likely to be observed under conditions of

- a) standard temperature and pressure
- b) low temperature and high pressure
- c) low temperature and low pressure
- d) high temperature and high pressure
- e) high temperature and low pressure

50. Which of the following substances is more soluble in hexane (C_6H_{14}) than in water?

- a) CaCl_2
- b) CH_3OH
- c) NH_3
- d) $\text{C}_8\text{H}_{17}\text{Cl}$
- e) CH_3Cl

51. The liquids H_2O and CCl_4 are immiscible due to

- a) the strong intermolecular forces between H_2O molecules
- b) the strong intermolecular forces between CCl_4 molecules
- c) the strong dipole of the CCl_4 molecules
- d) the weak dipole of H_2O molecules
- e) the large difference in molar masses of H_2O and CCl_4

52. Which of the following would have the lowest freezing point?

- a) pure H₂O
- b) 1 *m* urea (CON₂H₄)
- c) 1 *m* KCl
- d) 1 *m* NaNO₃
- e) 1 *m* Na₂SO₄

53. Which of the following would probably have the highest melting point?

- a) LiBr
- b) LiF
- c) LiCl
- d) NaCl
- e) NaI

54. If KBr, C₂H₅OH, C₂H₆ and He are arranged in order of increasing boiling point the list is

- a) He < C₂H₅OH < C₂H₆ < KBr
- b) KBr < C₂H₆ < C₂H₅OH < He
- c) He < C₂H₆ < C₂H₅OH < KBr
- d) KBr < C₂H₆ < He < C₂H₅OH
- e) C₂H₅OH < C₂H₆ < He < KBr

55. As ice melts what bonds, if any, are broken?

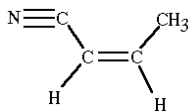
- a) one of the hydrogen and oxygen bonds within a water molecule
- b) both of the hydrogen-oxygen bonds within a water molecule
- c) hydrogen bonds between water molecules
- d) all of the above
- e) no bonds are broken

56. A chemist sets up two beakers of distilled water under the same room conditions in a laboratory. One beaker is boiling vigorously, the other beaker is boiling gently. Which of the following statements is true?

- a) The temperature of the vigorously boiling water is higher.
- b) The temperature of the gently boiling water is higher.
- c) The temperature of the water in both beakers is the same
- d) The boiling points of the water in the two beakers must be different.
- e) The temperature in the vigorously boiling water is not uniform.

57. How many sigma (σ) bonds are in the following molecule?

- a) 3
- b) 7
- c) 8
- d) 9
- e) 12



58. In the combustion of methane, CH_4 , what change in hybridization (if any) occurs to the carbon atom?

- a) sp^2 to sp^3
- b) sp^2 , to sp ,
- c) sp^3 , to sp^2
- d) sp^3 to sp
- e) no change in hybridization occurs

59. Which statement is true regarding bond order, bond length, and bond energy?

- a) As the bond order increases, the bond length increases.
- b) As the bond order increases, the bond length decreases.
- c) As the bond order increases, the bond energy decreases.
- d) As the bond energy increases, the bond length increases.
- e) As the bond energy increases, the bond order decreases.

60. How many unshared electron pairs (lone pairs) are in a molecule of SO_2 ?

- a) 2
- b) 6
- c) 7
- d) 9
- e) 12

62. When $l = 4$, what set of orbitals is designated?

- a) f
- b) p
- c) s
- d) d
- e) g

63. Which of the following most probably cannot exist?

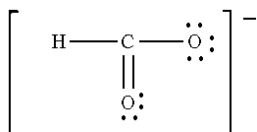
- a) BaBr_2
- b) KBr_2
- c) Br_2
- d) OBr_2
- e) FeBr_2

64. Which of the following groups of elements is arranged in order of increasing electronegativity?

- a) $\text{Si} < \text{Al} < \text{Br} < \text{Cl}$
- b) $\text{Na} < \text{K} < \text{Ca} < \text{Ba}$
- c) $\text{P} < \text{S} < \text{O} < \text{F}$
- d) $\text{K} < \text{Rb} < \text{Cs} < \text{F}$
- e) $\text{N} < \text{P} < \text{S} < \text{Cl}$

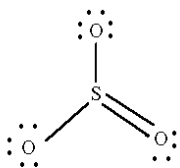
65. What is the average carbon-oxygen bond order in the formate ion ?

- a) 0
- b) 1
- c) 1.5
- d) 2
- e) 2.5



66. What is the formal charge on sulfur in the molecule, SO₃?

- a) 0
- b) 1+
- c) 1-
- d) 2+
- e) 2-



67. If the volume of a confined gas is doubled while the temperature remains constant, what change (if any) would be observed in the pressure?

- a) It would be half as large.
- b) It would double.
- c) It would be four times as large.
- d) It would be one-fourth as large.
- e) It would remain the same.

68. Which of the following has the most molecules?

- a) 1.00 L of CH₄ at 0°C and 1.00 atm
- b) 1.00 L of N₂ at 0°C and 1.00 atm
- c) 1.00 L of O₂ at 20°C and 1.00 atm
- d) 1.00 L of CO₂ at 50°C and 1.25 atm
- e) 1.00 L of CO at 0°C and 1.25 atm

69. Which of the following processes (if any) is exothermic?

- a) solid ----> gas
- b) solid ----> liquid
- c) liquid ---> solid
- d) liquid ---> gas
- e) none of these

70. The amount of solvent (grams or moles) is known for each of the following solution concentrations EXCEPT

- a) molarity
- b) molality
- c) mass %
- d) X
- e) II

ANSWER KEY FOR TEST- 111FINAL

1. a) 19.3 g/mL
2. c) I and II only
3. e) 75.77% ^{35}Cl and 24.33% ^{37}Cl
4. d) Se
5. a) 1.25 g
6. d) Mg_3N_2
7. c) iron(II) sulfate
8. d) $(\text{NH}_4)_3\text{PO}_4$
9. c) $\text{C}_{10}\text{H}_{12}\text{N}_2\text{O}$
10. b) 1, 6, 6, 6
11. a) $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
12. c) chlorine
13. b) +5
14. e) 13.2 grams

15. c) 54.0%
16. c) 15.7 mL
17. a) the specific heat of A is double that of B.
18. a) 75 kJ
19. b) the reaction is exothermic.
20. b) -153.9 kJ
21. a) +6.2 kJ
22. a) $n = 3, l = 3, m_l = +1$ and also b) $n = 3, l = 3, m_l = 0$
23. b) V^{2+}
24. e) N^{3-}
25. c) BrF_3
26. b) $MgCl_2$
27. c) C-F
28. b) NO_2^-
29. d) tetrahedral
30. c) triangular-pyramidal
31. b) 120°

32. c) two
33. b) 3
34. c) sp^3d
35. b) 0.606 g
36. c) NaCl
37. e) 45.1 g
38. b) N_2 is limiting and 0.082 mol Mg is in excess
39. c) Na
40. c) The pressure will increase by a factor of about two.
41. c) 242 liters
42. e) 17.5 liters
43. a) 593 torr
44. b) 14 L
45. c) F_2
46. a) 1.47 g
47. a) 0.202 L
48. b) All particles at the same temperature have the same kinetic energy.

49. b) low temperature and high pressure
50. d) $C_8H_{17}Cl$
51. a) the strong intermolecular forces between H_2O molecules
52. e) 1 *m* Na_2SO_4
53. b) LiF
54. c) $He < C_2H_6 < C_2H_5OH < KBr$
55. c) hydrogen bonds between water molecules
56. c) The temperature of the water in both beakers is the same
57. d) 9
58. d) sp^3 to sp
59. b) As the bond order increases, the bond length decreases.
60. b) 6
61. missing
62. e) g
63. b) KBr_2
64. c) $P < S < O < F$
65. c) 1.5

66. d) 2+
67. a) It would be half as large.
68. d) 1.00 L of CO₂ at 50° C and 1.25 atm
69. c) liquid ---> solid
70. a) molarity