

SAMPLE  
CHM 101 FINAL EXAM

1. Which of the following metric relationships is incorrect?
  - a. 1 microliter =  $10^{-6}$  liters
  - b. 1 megagram =  $10^6$  grams
  - c. 1 millimeter =  $10^3$  meters
  - d. 1 kilogram =  $10^3$  grams
  - e. 100 centimeters = 1 meter
  
2. A piece of indium with a mass of 16.6 g is submerged in 46.3 cm<sup>3</sup> of water in a graduated cylinder. The water level increases to 48.6 cm<sup>3</sup>. The correct value for the density of indium from these data is:
  - a. 7.217 g/cm<sup>3</sup>
  - b. 7.2 g/cm<sup>3</sup>
  - c. 0.14 g/cm<sup>3</sup>
  - d. 0.138 g/cm<sup>3</sup>
  - e. More than 0.1 g/cm<sup>3</sup> away from any of these values
  
3. How many significant figures are there in the number 10085?
  - a. 13
  - b. 5
  - c. 7
  - d. 0
  - e. 4
  
4. 100 seconds contain this many nanoseconds.
  - a.  $1 \times 10^7$
  - b.  $1 \times 10^{11}$
  - c.  $1 \times 10^{10}$
  - d.  $1 \times 10^{12}$
  - e.  $1 \times 10^8$
  
5. The degree of agreement among several measurements of the same quantity is called \_\_\_\_\_. It reflects the reproducibility of a given type of measurement.
  - a. Accuracy
  - b. Error
  - c. Precision
  - d. Significance
  - e. Certainty
  
6. The density of gasoline is 0.7025 g/mL at 20°C. When gasoline is added to water:
  - a. It Will Float On Top.
  - b. It Will Sink To The Bottom
  - c. It Will Mix So You Can't See It
  - d. The Mixture Will Improve The Running Of The Motor
  - e. None Of These Things Will Happen

7. Perform the following arithmetic and express the answer to the proper number of significant figures:

$$\frac{(8.300 + 0.20) \times 9340.1}{0.6270}$$

- a.  $12.7 \times 10^4$
- b.  $1.3 \times 10^5$
- c.  $1.27 \times 10^5$
- d.  $1.26 \times 10^5$
- e. None of the above

8. Which one of the following statements about atomic structure is false?

- a. The electrons occupy a very large volume compared to the nucleus
- b. Almost all of the mass of the atom is concentrated in the nucleus
- c. The protons and neutrons in the nucleus are very tightly packed
- d. The number of protons and neutrons is always the same in the neutral atom

9.  ${}_{20}^{40}\text{Ca}^{2+}$  has

- a. 20 protons, 20 neutrons, and 18 electrons
- b. 22 protons, 20 neutrons, and 20 electrons
- c. 20 protons, 22 neutrons, and 18 electrons
- d. 22 protons, 18 neutrons, and 18 electrons
- e. 20 protons, 20 neutrons, and 22 electrons

10. Which of the following has 45 neutrons, 35 protons, and 36 electrons?

- a.  ${}_{35}^{80}\text{Hg}$
- b.  ${}_{45}^{103}\text{Rh}^{-}$
- c.  ${}_{35}^{80}\text{Br}^{-}$
- d.  ${}_{35}^{71}\text{Lu}^{-}$
- e.  ${}_{35}^{81}\text{Tl}^{-}$

11. Which of the following statements is (are) true?

- a.  ${}_{8}^{18}\text{O}$  and  ${}_{9}^{19}\text{F}$  have the same number of neutrons
- b.  ${}_{6}^{14}\text{C}$  and  ${}_{7}^{14}\text{N}$  are isotopes of each other because their mass numbers are the same
- c.  ${}_{8}^{18}\text{O}^{2-}$  has the same number of electrons as  ${}_{10}^{20}\text{Ne}$
- d. a and b
- e. a and c

12. Which of the following are incorrectly paired?

- a. Copper, Co
- b. Silver, Ag
- c. Iron, Fe
- d. Lead, Pb
- e. Sodium, Na

13. All of the following are characteristics of nonmetals *except*:

- a. poor conductors of electricity
- b. often bond to each other by forming covalent bonds
- c. tend to form negative ions in chemical reactions with metals
- d. appear in the upper left-hand corner of the periodic table
- e. do not have a shiny (lustrous) appearance

14. The formula for calcium bisulfate is

- a.  $\text{Ca}(\text{SO}_4)_2$
- b.  $\text{CaS}_2$
- c.  $\text{Ca}(\text{HSO}_4)_2$
- d.  $\text{Ca}_2\text{HSO}_4$
- e.  $\text{Ca}_2\text{S}$

15. Which of the following is incorrectly named?

- a.  $\text{Pb}(\text{NO}_3)_2$ , lead(II) nitrate
- b.  $\text{NH}_4\text{ClO}_4$ , ammonium perchlorate
- c.  $\text{PO}_4^{3-}$ , phosphate ion
- d.  $\text{Mg}(\text{OH})_2$ , magnesium hydroxide
- e.  $\text{NO}^{3-}$ , nitrite ion

16. Gallium consists of two isotopes of masses 68.95 amu and 70.95 amu with abundances of 60.16% and 39.84%, respectively. What is the average atomic mass of gallium?

- a. 69.95
- b. 70.15
- c. 71.95
- d. 69.75
- e. 69.55

17. A sample of ammonia has a mass of 56.6 g. How many molecules are in this sample?

- a. 3.32 molecules
- b.  $17.03 \times 10^{24}$  molecules
- c.  $6.78 \times 10^{23}$  molecules
- d.  $2.00 \times 10^{24}$  molecules
- e.  $1.78 \times 10^{24}$  molecules

18. Nitric acid contains what percent hydrogen by mass?

- a. 20.0%
- b. 10.0%
- c. 4.50%
- d. 1.60%
- e. 3.45%

19. Suppose the reaction  $\text{Ca}_3(\text{PO}_4)_2 + 3\text{H}_2\text{SO}_4 \rightarrow 3\text{CaSO}_4 + 2\text{H}_3\text{PO}_4$  is carried out starting with 103 g of  $\text{Ca}_3(\text{PO}_4)_2$  and 75.0 g of  $\text{H}_2\text{SO}_4$ . How much phosphoric acid will be produced?

- a. 74.9 g
- b. 50.0 g
- c. 112 g
- d. 32.5 g
- e. 97.6 g

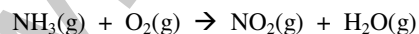
20. Phenol is a compound that contains 76.57% carbon, 6.43% hydrogen, and 17.0% oxygen. The empirical formula of phenol is

- a. CHO
- b.  $\text{CH}_2\text{O}$
- c.  $\text{C}_3\text{H}_3\text{O}$
- d.  $\text{C}_2\text{HO}$
- e.  $\text{C}_6\text{H}_6\text{O}$

21. The empirical formula of a group of compounds is  $\text{CHCl}$ . Lindane, a powerful insecticide, is a member of this group. The molar mass of lindane is 290.8. How many atoms of carbon does a molecule of lindane contain?

- a. 2
- b. 3
- c. 4
- d. 6
- e. 8

22. What is the coefficient for oxygen when the following equation is balanced?



- a. 3
- b. 6
- c. 7
- d. 12
- e. 14

23. A 6.32-g sample of potassium chlorate was decomposed according to the following equation:  $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$ . How many moles of oxygen are formed?

- a. 1.65 g
- b. 0.051 moles
- c. 0.0344 moles
- d. 0.0774 moles
- e. none of these

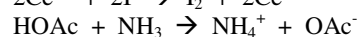
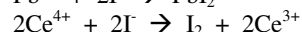
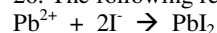
24. How many grams of NaCl are contained in 350 mL of a 0.250 M solution of sodium chloride?

- a. 41.7 g
- b. 5.11 g
- c. 14.6 g
- d. 87.5 g
- e. none of these

25. The net ionic equation for the reaction of calcium bromide and sodium phosphate contains which of the following species?

- a.  $\text{Ca}^{2+}(\text{aq})$
- b.  $\text{PO}_4^{3-}(\text{aq})$
- c.  $2\text{Ca}_3(\text{PO}_4)_2(\text{s})$
- d.  $6\text{NaBr}(\text{aq})$
- e.  $3\text{Ca}^{2+}(\text{aq})$

26. The following reactions:



Are examples of

- a. acid-base reactions
- b. unbalanced reactions
- c. precipitation, acid-base, and redox reactions, respectively
- d. redox, acid-base, and precipitation reactions, respectively
- e. precipitation, redox, and acid-base reactions, respectively

27. How many of the following salts are expected to be insoluble in water?

|                  |                     |
|------------------|---------------------|
| sodium sulfide   | barium nitrate      |
| ammonium sulfate | potassium phosphate |

- a. none
- b. 1
- c. 2
- d. 3
- e. 4

28. A student weighs out 0.568 g of KHP (molar mass = 204 g/mol) and titrates to the equivalence point with 36.78 mL of a stock NaOH solution. What is the concentration of the stock NaOH solution? KHP is an acid with one acidic proton.

- a. 0.100 M
- b. 3.15 M
- c. 0.943 M
- d. 0.0757 M
- e. none of these

29. In the reaction  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ ,  $\text{N}_2$  is

- a. oxidized
- b. reduced
- c. the electron donor
- d. the reducing agent
- e. two of these

30. Balance the following oxidation-reduction reaction using the half-reaction method:



In the balanced equation, the coefficient of  $\text{Fe}^{2+}$  is

- a. 1
- b. 2
- c. 3
- d. 4
- e. none of these

31. Use the ideal gas law to predict the relationship between  $n$  and  $T$  if pressure and volume are held constant.

- a.  $n \propto T$
- b.  $n \propto 1/T$
- c.  $n/T = \text{constant}$
- d.  $PT = nRV$
- e.  $PV/T = R$

32. It is found that 250.0 mL of gas at STP has a mass of 1.00 g. What is the molar mass?

- a. 89.6 g/mol
- b. 28.0 g/mol
- c. 14.0 g/mol
- d. 22.4 g/mol
- e. none of these

33. What volume of  $\text{H}_2\text{O}(\text{g})$  measured at STP is produced by the combustion of 4.00 g of natural gas ( $\text{CH}_4$ ) according to the following equation?



- a. 5.60 L
- b. 11.2 L
- c. 22.4 L
- d. 33.6 L
- e. 44.8 L

34. At  $1000^\circ\text{C}$  and 10.0 torr, the density of a certain element in the gaseous state is  $2.9 \times 10^{-3}$  g/L. The element is:

- a. Ne
- b. He
- c. Na
- d. Ar
- e. Hg

35. Calculate the root mean square velocity for the  $O_2$  molecules in a sample of  $O_2$  gas at  $25.0^\circ C$ .

- a.  $2.32 \times 10^5 m/s$
- b.  $658 \times 10^2 m/s$
- c.  $482 m/s$
- d.  $853 m/s$
- e.  $97.5 m/s$

36. Calculate the ratio of the effusion rates of  $N_2$  and  $N_2O$ .

- a. 0.637
- b. 1.57
- c. 1.25
- d. 0.798
- e. 1.61

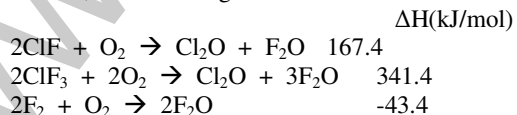
37. A gas absorbs  $0.0 J$  of heat and then performs  $15.2 J$  of work. The change in internal energy of the gas is

- a.  $-24.8 J$
- b.  $14.8 J$
- c.  $55.2 J$
- d.  $-15.2 J$
- e. none of these

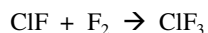
38. Which one of the following statements is *false*?

- a. The change in internal energy,  $\Delta E$ , for a process is equal to the amount of heat absorbed at constant volume,  $q_v$ .
- b. The change in enthalpy,  $\Delta H$ , for a process is equal to the amount of heat absorbed at constant pressure,  $q_p$ .
- c. A bomb calorimeter measures  $\Delta H$  directly.
- d. If  $q_p$  for a process is negative, the process is exothermic.
- e. The freezing of water is an example of an exothermic reaction.

39. At  $25^\circ C$ , the following heats of reaction are known:

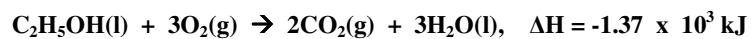


At the same temperature, calculate  $\Delta H$  for the reaction:



- a.  $-217.5 kJ/mol$
- b.  $-130.2 kJ/mol$
- c.  $+217.5 kJ/mol$
- d.  $-108.7 kJ/mol$
- e. none of these

40. Consider the reaction



When a 15.1 g sample of ethyl alcohol (molar mass = 46.1 g/mol) is burned, how much energy is released as heat?

- a. 0.449 kJ
- b.  $2.25 \times 10^3$  kJ
- c.  $4.49 \times 10^2$  kJ
- d.  $1.02 \times 10^3$  kJ
- e. 196 kJ

41. Which of the following is true?

- a. When a gas is compressed,  $w$  is negative.
- b. Temperature is an extensive property.
- c. Hess's law is a notable exception to the first law of thermodynamics.
- d. The melting of ice is an exothermic process.
- e. The change in enthalpy is the same as heat at constant pressure.

42. Which form of electromagnetic radiation has the longest wavelengths?
- Gamma Rays
  - Microwaves
  - Radio Waves
  - Infrared Radiation
  - X-Rays
43. How many f orbitals have the value  $n=3$ ?
- 0
  - 3
  - 5
  - 7
  - 1
44. How many electrons in an atom can have the quantum numbers  $n = 3, l = 2$ ?
- 2
  - 5
  - 10
  - 18
  - 6
45. What is the electron configuration of calcium?
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
  - $1s^2 2s^2 2p^6 2d^{10}$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$
  - $1s^2 2s^3 2p^6 3s^3 3p^3 4s^2$
  - $1s^2 2s^3 2p^5 3s^4 3p^5 4s^1$
46. An element has the electron configuration  $[\text{Kr}]4d^{10}5s^25p^2$ . The element is a(n)
- nonmetal
  - transition element
  - metal
  - lanthanide
  - actinide
47. How many unpaired electrons are there in an atom of sulfur in its ground state?
- 0
  - 1
  - 2
  - 3
  - 4
48. Consider the following orderings.
- $\text{Al} < \text{Si} < \text{P} < \text{S}$
  - $\text{Be} < \text{Mg} < \text{Ca} < \text{Sr}$
  - $\text{I} < \text{Br} < \text{Cl} < \text{F}$
  - $\text{Na}^+ < \text{Mg}^{2+} < \text{Al}^{3+} < \text{Si}^{4+}$

Which of these give(s) a correct trend in size?

- I
- II
- III
- IV
- II, IV

49. Which of the following statements is true?

- a. The first ionization potential of H is greater than that of He
- b. The ionic radius of  $\text{Fe}^+$  is larger than that of  $\text{Fe}^{3+}$
- c. The ionization energy of  $\text{S}^{2-}$  is greater than that of  $\text{Cl}^-$
- d. The atomic radius of Li is larger than that of Cs
- e. All are false

50. Which of the following bonds is least polar?

- a. C-O
- b. H-C
- c. S-Cl
- d. Br-Br
- e. They are all nonpolar

51. In which pair do both compounds exhibit predominantly ionic bonding?

- a.  $\text{PCl}_5$  and HF
- b.  $\text{Na}_2\text{SO}_3$  and  $\text{BH}_3$
- c. KI and  $\text{O}_3$
- d. NaF and  $\text{H}_2\text{O}$
- e. RbCl and CaO

52. Which of the following molecules does not have a dipole moment?

- a. HCl
- b. CO
- c.  $\text{NCl}_3$
- d.  $\text{BCl}_3$
- e. All have a dipole moment

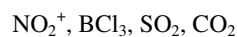
53. Which of the following types of molecules has a dipole moment (when polar bonds are present)?

- a. Linear Molecules With Two Identical Bonds
- b. Tetrahedral Molecules (Four Identical Bonds Equally Spaced)
- c. Trigonal Pyramid Molecules (Three Identical Bonds)
- d. Trigonal Planar Molecules (Three Identical Bonds Equally Spaced)
- e. None Has A Dipole Moment

54. Which of the following has a Lewis structure most like that of  $\text{CO}_3^{2-}$ ?

- a.  $\text{CO}_2$
- b.  $\text{SO}_3^{2-}$
- c.  $\text{NO}_3^-$
- d.  $\text{O}_3$
- e.  $\text{NO}_2$

55. How many of the following molecules or ions are linear?



- a. 0
- b. 1
- c. 2
- d. 3
- e. 4

56. Which of the following species has a trigonal bipyramidal structure?

- a.  $\text{NH}_3$
- b.  $\text{IF}_5$
- c.  $\text{I}_3^-$
- d.  $\text{PCl}_5$
- e. None of these

57. The bond angle in  $\text{H}_2\text{Se}$  is about:

- a.  $120^\circ$
- b.  $60^\circ$
- c.  $180^\circ$
- d.  $109^\circ$
- e.  $90^\circ$

58. Which ion is planar?

- a.  $\text{NH}_4^+$
- b.  $\text{CO}_3^{2-}$
- c.  $\text{SO}_3^{2-}$
- d.  $\text{ClO}_3^-$
- e. All are planar

59. Which of the following molecules contains an  $\text{sp}^2\text{-sp}^2$  sigma bond?

- a.  $\text{CH}_4$
- b.  $\text{C}_2\text{H}_2$
- c.  $\text{C}_2\text{H}_4$
- d.  $\text{C}_2\text{H}_6$
- e. None of these

60. The hybridization of sulfur in the sulfate anion,  $\text{SO}_4^{2-}$ , is:

- a.  $\text{sp}^3$
- b.  $\text{sp}^2$
- c.  $\text{sp}$
- d.  $\text{sp}^3$
- e. not hybridized

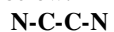
61. The bond order in the NO molecule is

- a. 1
- b. 1.5
- c. 2
- d. 2.5
- e. 3

62. Which of the following has the shortest bond length?

- a.  $\text{O}_2^{2-}$
- b.  $\text{O}_2$
- c.  $\text{O}_2^-$
- d.  $\text{O}_2^+$

63. Consider the skeletal structure shown below:



Draw the Lewis structure and answer the following:

How many of the atoms are sp hybridized?

- a. 0
- b. 1
- c. 2
- d. 3
- e. 4

64. How many pi bonds does the molecule contain?

- a. 0
- b. 2
- c. 4
- d. 6
- e. 7

# KEY

|       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|
| 1. c  | 2. b  | 3. b  | 4. b  | 5. c  | 6. a  |
| 7. c  | 8. d  | 9. a  | 10. c | 11. e | 12. a |
| 13. d | 14. c | 15. e | 16. d | 17. d | 18. d |
| 19. b | 20. e | 21. d | 22. c | 23. d | 24. b |
| 25. e | 26. e | 27. a | 28. d | 29. b | 30. b |
| 31. b | 32. a | 33. b | 34. c | 35. c | 36. c |
| 37. d | 38. c | 39. d | 40. c | 41. e | 42. c |
| 43. a | 44. c | 45. a | 46. c | 47. c | 48. b |
| 49. b | 50. d | 51. e | 52. d | 53. c | 54. c |
| 55. c | 56. d | 57. d | 58. b | 59. c | 60. a |
| 61. d | 62. d | 63. e | 64. c |       |       |