Multiple choice (5 points each).

1. Give the formula for sodium acetate.
a. \( \text{Na}_2\text{CO}_3 \)  
b. \( \text{NaHCO}_3 \)
c. \( \text{NaC}_2\text{H}_3\text{O}_2 \)  
d. \( \text{NaC}_6\text{H}_6\text{O}_6 \)  
e. \( \text{NaHCl} \)  
f. \( \text{NaAsO}_4 \)  
g. \( \text{C}_3\text{H}_6\text{O}_2 \)  
h. \( \text{NaHCO}_2 \)  
i. \( \text{Na}_3\text{PO}_4 \)

2. What best describes the major result from Milikan’s oil drop experiment?
a. the structure of the atom  
b. The mass of the proton  
c. The mass of the neutron  
d. The mass of the electron  
e. The charge of the electron  
f. d and e  
g. a, b and c.

3. What was the major conclusion of Rutherford’s gold foil experiment?
a. The mass of the electron  
b. The nature of light  
c. The existence of the nucleus  
d. The charge of the electron  
e. The mass of the electron.  
f. The mass of the proton  
g. d, e and f  
h. a and d  
i. d, e and f

4. Which of the following are strong acids?
a. \( \text{HC}_2\text{H}_3\text{O}_2 \)  
b. sodium carbonate  
c. Sodium hydroxide  
d. Perchloric acid.  
e. hydroflourus acid  
f. hydrobromic acid  
g. Ammonia  
h. e and f  
i. d and f
Use the answers below to answer the next set of questions.

f. Na₂CO₃  g. Na₂SO₄  h. Na₃PO₄  i. NO₂⁻  j. NaHSO₃

Give the correct formula for the following:
5. Sodium perchlorate
6. Sodium carbonate
7. Sodium bisulfite
8. Sodium sulfate
9. Sodium hypochlorite

10. Of the objects below, which is the most dense?
    a. an object with a volume of 2.2 L and a mass of 12.5 kg
    b. an object with a volume 130 mL and a mass of 93 g.
    c. an object with a volume 0.00312 m³ and a mass of 4.33x10⁴ mg
    d. an object with a volume of 3.91x10⁻²⁴ nm³ and a mass of 7.93x10³ g
    e. an object with a volume of 22 dm³ and a mass of 1.29x10⁶

11. Which pair of atoms is a pair of isotopes of the same element?
    a. $^{14}_6X$ $^{14}_7X$
    b. $^{14}_6X$ $^{12}_6X$
    c. $^{17}_9X$ $^{17}_8X$
    d. $^{19}_{10}X$ $^{19}_9X$
    e. $^{14}_6X$ $^{14}_7X$
    f. $^{20}_{10}X$ $^{21}_{11}X$
    g. a, c, d, e

12. How many valence electrons are there in Ni?
    a. 2  c. 4  e. 8  g. 10
    b. 3  d. 6  f. 9  h. 11

13. Suppose that the spin quantum number $m_s$ had three possible values instead of two. How many elements would then be in the first two rows of the periodic table?
    a. 8  c. 10  e. 28  g. 15
    b. 9  d. 20  f. 4  h. 18
14. Which of the following electrons would you predict to feel the highest effective nuclear charge.
   a. The 3s electrons in Mg
   b. The 3p electrons in Al
   c. The 3p electrons in Cl
   d. The 3p electrons in P
   e. The 4s electrons in Ca.
   f. The 4s electrons in K.
   g. The 2p electrons in C

15. \([\text{Ar}]^4s^23d^{10}4p^3\) is the electron configuration for a(n) \__________\ atom.
   a. As  c. P  e. Sn
   b. V  d. Sb  f. Ge

16. Considering the following set of quantum numbers.  \(n = 4, l = 1, m_l = 1, m_s = \frac{1}{2}\).
   Which of the following orbitals could be described by these numbers?
   a. 4s  c. 5d\(_{xy}\)  e. 3d\(_{xy}\)  g. 1p\(_x\)
   b. 1s  d. 4d\(_{yz}\)  f. 4p\(_x\)  h. 4d\(_{xy}\)

17. Which of the following has the largest second ionization energy?
   a. Ca  c. Ga  e. Se  g. F  i. C
   b. K  d. Ge  f. Rb  h. Cl  j. Si

18. Which of the following elements has the most negative electron affinity?
   a. O  c. Na  e. Se  g. P  i. B

19. Which of the following are correctly listed in the order of size (smallest to largest)?
   a. K, Ca, Cu, Ga, Ge, As, Se
   b. Se, As, Ge, Ga, Cu, Ca, K
   c. Cu, Se, As, Ge, Ga, Ca, K
   d. Cu, K, Ca, Ga, Ge, As, Se
   e. Se, As, Ge, Ga, Ca, K, Cu
   f. Cl, S, P, Mg, Si, Al

20. 42 g of hexane is burned in a standard combustion reaction with 140 g of Oxygen.
    What is the total mass of the products, not including unreacted starting material?
    a. 190 g  b. 180 g  c. 161 g  d. 171 g  e. 142 g
    f. 2.1 g  g. 4.2 g  h. 5.1 g  i. 131 g  j. 111 g
21. An organic compound with molecular weight of 74 amu is analyzed and found to contain 48.6% carbon, 8.1% hydrogen, and 43.24% oxygen by mass. This compound has one carboxylic acid group. What is (are) the hybridization types for carbon in this molecule?
   a. sp²  b. sp³  c. sp³d  d. s  e. sp  f. sp² and sp³  g. sp and sp²

22. How many grams of this compound are needed to make 500mL of a 25mM solution.
   a. 0.925 g  b. 925 g  c. 0.925 kg  d. 9.25 g  e. 18.5 g

23. How many milliliters of 8 M NaOH is needed to neutralize the above solution (assume the density of NaOH solution is 1.05 kg/L)
   a. 50  b. 500  c. 5.0  d. 0.5  e. 0.48  f. 48

24. Given the data:
   \( \text{N}_2(g) + \text{O}_2(g) \rightarrow 2\text{NO}(g) \quad \Delta H = 185.2 \text{ kJ} \)
   \( 2\text{NO}(g) + \text{O}_2(g) \rightarrow 2\text{NO}_2 \quad \Delta H = -113.1 \text{ kJ} \)
   \( 2\text{N}_2\text{O}(g) \rightarrow 2\text{N}_2(g) + \text{O}_2(g) \quad \Delta H = -163.2 \text{ kJ} \)

Use Hess's law to calculate \( \Delta H \) for the reaction
   \( \text{N}_2\text{O}(g) + \text{NO}_2(g) \rightarrow 3\text{NO}(g) \quad \Delta H? \)
   a. -91.1 kJ  c. 210.3 kJ  e. -276.3 kJ  g. -210.3 kJ  i. 160.2 kJ
   b. 461.5 kJ  d. -461.5 kJ  f. 47.15 kJ  h. -138.2 kJ  j. -160.2 kJ

25. What is the heat of combustion of \( \text{C}_3\text{H}_8? \)
   a. -103.8 kJ mol⁻¹  c. 2220 kJ mol⁻¹  e. 103.8 kJ mol⁻¹
   b. -82.1 kJ mol⁻¹  d. -2220 kJ mol⁻¹  f. 82.1 kJ mol⁻¹

26. When 100 cm³ of 0.5 M sulfuric acid solution reacts with 100 cm³ of 1 M sodium hydroxide solution the temperature rises by 6.85 kelvins. Calculate the heat of reaction described by the equation (the specific heat of water is 1 cal/g°C):
   \( \text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \)
   a. -115.08 kJ mol⁻¹  c. 57.54 kJ mol⁻¹  e. -230.1 kJ mol⁻¹  g. 115.08 kJ mol⁻¹
   b. 230.1 kJ mol⁻¹  d. -57.54 kJ mol⁻¹  f. -50 kJ mol⁻¹  h. 50 kJ mol⁻¹
27. Assign oxidation numbers to the metals in each of the following compounds:
Fe(CN)_6^{4-}, PbCl_2, and Cu_2O(SO_4).

a. Fe^{2+}, Pb^+, Cu^{4+}  
   c. Fe^{4+}, Pb^{2+}, Cu^{2+}  
   e. Fe^{4+}, Pb^+, Cu^{2+}  
   g. Fe^{2+}, Pb^+, Cu^{3+}

b. Fe^{2+}, Pb^{2+}, Cu^{4+}  
   d. Fe^{2+}, Pb^{2+}, Cu^{2+}  
   f. Fe^{3+}, Pb^{2+}, Cu^{1+}  
   h. Fe^{2+}, Pb^+, Cu^{2+}

28. Consider the three sulfur-containing compounds, SF_2, SF_4, SF_6

   a. SF_2  
   b. SF_4  
   c. SF_6  

   a. sp  
   b. sp^3  
   c. sp^d  
   d. sp^3  
   e. sp^3  
   f. sp^3  
   g. sp^3  

29. Which of the following compounds is not polar?

   a. H_2S  
   b. NH_3  
   c. PH_3  
   d. CH_4  
   e. H_2O  
   f. SF_4  
   g. b and c  
   h. a, c and f

30. A system produces 65 kJ of heat and also does 30 kJ of work on the surroundings.
What is the change in internal energy of the system?

   a. -95 kJ  
   b. 95 kJ  
   c. -65 kJ  
   d. 65 kJ  
   e. -35 kJ  
   f. 35 kJ  
   g. -30 kJ  
   h. 30 kJ

31. What is the energy, in Joules, of a photon with a wavelength of 400 nm?

   a. 7.50 x 10^{14}  
   b. 7.50 x 10^{-16}  
   c. 4.97 x 10^{-14}  
   d. 4.97 x 10^{-28}  
   e. 4.97 x 10^{-33}  
   f. 4.97 x 10^{-18}  
   g. 7.95 x 10^{-18}  
   h. 7.95 x 10^{-32}  
   i. 4.95 x 10^{-10}  
   j. 4.95 x 10^{-12}

32. Name the following compound:
33. How many non-cyclic isomers does \( \text{C}_4\text{H}_8 \) have?
   a. 2  c. 4  e. 6  g. 8  i. 10
   b. 3  d. 5  f. 7  h. 9  j. 11

34. Which of the following functional groups does NOT contain an oxygen atom?
   a. alcohol  c. amine  e. ester  g. b, c, e and f  i. b, c and d
   b. ether  d. aldehyde  f. amide  h. b and c  j. b, c and e

35. You have a stock solution of 8.6 M \( \text{NH}_3 \). How many milliliters of this solution should you dilute to make 80.00 mL of 0.250 M \( \text{NH}_3 \)?
   a. 2.3  c. 5.5 mL  e. 0.023  g. 55
   b. 10.4  d. 23  f. .104  h. 230

36. Which of the following will have ionic bonds?
   a. \( \text{CCl}_4 \)  c. \( \text{H}_2\text{O} \)  e. \( \text{F}_2 \)  g. \( \text{BF}_3 \)  i. b, h
   b. \( \text{RbCl} \)  d. \( \text{P}_2\text{O}_5 \)  f. \( \text{CO}_2 \)  h. \( \text{Na}_3\text{PO}_4 \)  j. b, g, h,

37. Which kinds of orbitals are involved in the bond between the C and O in carbon monoxide?
   a. sp  c. \( \text{sp}^2 \)  e. \( \text{sp}^3\text{d}^3 \)  g. s  i. a and f
b. sp²  d. sp³  f. p  h. d  j. b and f

38. What is the average bond order for both bonds in the azide ion N₃⁻?

   a. 1.0  c. 1.25  e. 1.33  g. 1.50
   b. 1.75  d. 2.0  f. 2.5  h. 3.0

39. An atom has 42 neutrons and 36 electrons and has a charge of -3. What is the correct symbol for the element?

   a. Co  c. Mo  e. Y  g. As
   b. Kr  d. Rh  f. Zn  h. C

40. A system consisting of a movable piston in a cylinder gains 800 J of heat. The piston moves up and does 450 J of work on the surroundings. What is the change in internal energy of the system?

   a. -350 J  c. -450 J  e. -800 J  g. -1250 J
   b. +350 J  d. 450 J  f. 800 J  h. 1250 J