1. (5 pts) You can identify a metal by carefully determining its density. A 2.166 g piece of an unknown metal is 1.50 cm long, 0.550 cm wide, and 0.250 cm thick. What is a possible identity of the element?
   a. silver, 10.5 g/cm³
   b. iridium, 22.4 g/cm³
c. platinum, 21.4 g/cm$^3$
d. palladium, 12.0 g/cm$^3$
e. none of the above

2. (5pts) Fill in the numbers below for the following atoms and ions:

Nitrogen-14 ($^{14}\text{N}$) protons=________ neutrons=________ electrons=________

Helium ion ($^2\text{He}^+$) protons=________ neutrons=_______ electrons=________

3. (5pts) The products of the complete combustion of a hydrocarbon are carbon dioxide and water. Select the correct chemical equation for the combustion of pentane, C$_5$H$_{12}$.

a. C$_5$H$_{12}$(g) + 8 O$_2$(g) $\rightarrow$ 5 CO$_2$(g) + 6 H$_2$O(g)
b. C$_5$H$_{12}$(g) $\rightarrow$ 5 C(s) + 6 H$_2$(g)
c. C$_5$H$_{12}$(g) + 9 O$_2$(g) $\rightarrow$ 4 CO$_2$(g) + 5 H$_2$O(g)
d. C$_5$H$_{12}$(g) + 11 O$_2$(g) $\rightarrow$ C$_5$O$_{10}$(g) + 6 H$_2$O(g)
e. C$_5$H$_{12}$(g) + 11 O$_2$(g) $\rightarrow$ 5 CO$_2$(g) + 12 H$_2$O(g)

4. (5 pts) A certain metal oxide has the formula MO where M denotes the metal. A 39.46-g sample of the compound is strongly heated in an atmosphere of hydrogen to remove oxygen as water molecules. At the end, 31.70 g of the metal is left over. Calculate the atomic mass of M and identify the element.

5. (5) Commercially, NO is produced by the oxidation of ammonia:

$$ 4 \text{NH}_3 (g) + 5 \text{O}_2 (g) \rightarrow 4 \text{NO} (g) + 6 \text{H}_2\text{O} (g) $$

In a certain experiment 2.50 g of ammonia reacts with 2.85 g of oxygen. Which is the limiting reactant? (Show work!)
6. (5 pts) Classify the following reaction as a precipitation, an oxidation-reduction, or an acid-base reaction.

KCl(aq) + AgNO₃ (aq) → KNO₃ (aq) + AgCl(s)

a.) Type of reaction: __________________________

b.) Which ions are spectator ions?

c.) Write a balanced net ionic equation.

7. (5 pts) You have a stock solution of 14.8 M NH₃. How many mL of this solution should you dilute to make 100.0 mL of 0.100 M NH₃?

8. (5 pts) What physical phenomenon did Albert Einstein apply his theory toward regarding when electrons are ejected from the surface of a metal exposed to light of at least a certain minimum frequency?

A) Aura Effect
B) Photon Effect
C) Ritzwald Effect
D) Photoelectric Effect
E) None of the answers is correct.
9. (5 pts) Calculate the heat capacity of a sample of radiator coolant if a temperature rise from -5 °C to 142 °C requires 932 J of heat.

10. (5 pts) From the following heats of reaction:

\[
2 \text{H}_2 (g) + \text{O}_2 (g) \rightarrow 2 \text{H}_2\text{O} (g) \quad \Delta H = -483.6 \text{ kJ}
\]

\[
3 \text{O}_2 (g) \rightarrow 2 \text{O}_3 (g) \quad \Delta H = +284.6 \text{ kJ}
\]

calculate the heat of the reaction

\[
3 \text{H}_2 (g) + \text{O}_3 (g) \rightarrow 3 \text{H}_2\text{O} (g)
\]

11. (5 pts) What is the maximum number of electrons in a atom that can have the following set of quantum numbers? \(n = 4, \ell = 3, m_\ell = -2, m_s = +1/2\).

A) 0  
B) 1  
C) 2  
D) 6  
E) 10

12. (5 pts) Sketch the shape of an s orbital and a p\(_x\) orbital, labelling all axes.
13. (5 pts) Considering an hydrogen atom, if an electron transitions from the n=9 to the n=2 level, is energy absorbed or emitted? Calculate the wavelength (in nm) of the photon associated with this transition?

Answer = __________________  Wavelength is __________________

14. (5 pts) Write an abbreviated (noble gas core) electron configuration for the following:

Co$^{2+}$

Cl$^{-}$

Cd

Sr

S

15. (5pts) Place the following ions in order from smallest to largest ionic radii: P$^{3-}$, K$^+$, Na$^+$, and Cl$^-$:

a. Na$^+$ < K$^+$ < Cl$^-$ < P$^{3-}$
b. K$^+$ < Na$^+$ < Cl$^-$ < P$^{3-}$
c. Cl$^-$ < P$^{3-}$ < Na$^+$ < K$^+$
d. Cl$^-$ < P$^{3-}$ < K$^+$ < Na$^+$
e. P$^{3-}$ < Cl$^-$ < K$^+$ < Na$^+$
16. (5 pts) In the C₂H₄ molecule how many sigma (σ) bonds and how many pi (π) bonds are there? Circle correct answer:

(a) 4σ, 1π
(b) 4σ, no π
(c) 2σ, 3π
(d) 5σ, 1π
(e) 4σ, 2π

17. (5 pts) Draw a Lewis structure for the molecule PCl₅. Indicate the hybridization scheme for the central atom. Sketch the molecule and state the name of this geometry.

PCl₅:

Hybridization _______________ Name of geometry _____________________

18. (5 pts) How is the formation of the salts NaF and K₂S represented in terms of Lewis dot symbols? (write the equation showing the Lewis dot symbols on the reacting atoms and product ions)

19. (5 pts) Predict the geometries of the following species using the VSEPR method: (a) PCl₃, (b) CHCl₃
20. (5 pts) A balloon is filled with He gas to a volume of 3.22 L at 32 °C. The balloon is placed in liquid nitrogen until its temperature reaches -132 °C. Assuming the pressure remains constant, what is the volume of the cooled balloon?

a. 0.628 L  
b. 0.781 L  
c. 1.24 L  
d. 1.49 L  
e. 6.96 L