Name

1. (5 points) One of the most important molecules in biochemical systems is adenosine triphosphate, ATP. ATP has a molecular formula of $C_{10}H_{12}N_5O_{13}P_{3(s)}$. Write the equation for the standard enthalpy of formation for 1 mole of adenosine triphosphate. (elemental P is $P_{4(s,\ wwhite)}$)

2. (5 points) The optic nerve needs a minimum of 2.00 x 10^{-17} J of energy to trigger a series of impulses that eventually reach the brain for the eye to detect visible light.
   How many photons of yellow-orange light with a λ = 589 nm are emitted from a low-pressure sodium lamp in a parking lot?

3. Styrene is an organic liquid that easily combusts in the presence of oxygen. The $\Delta H°_{rxn}$ for the following reaction is —4395.0kJ. Using the standard heats of formation listed on the formula page, calculate the heat of formation ($\Delta H°_f$) for styrene,$C_8H_{8(l)}$?

4. (10 points) Given below are several electron configurations that might be correct for the nitrogen atom. Indicate whether each of these representations are the ground state, the excited state, or un-allowed (forbidden) state. Using Hund's rule, the Pauli principle, and aufbau (building up), BRIEFLY explain your choices. [Some might violate more than one rule.]

	1s	2s	2p	3s			
a)	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow$ $\uparrow$ $\downarrow$	__			
b)	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow$ $\uparrow$ $\uparrow$	__	ES	GS	FS
c)	$\uparrow\downarrow$	$\uparrow\uparrow$	$\uparrow$ $\uparrow$ $\uparrow$	__	ES	GS	FS
d)	$\uparrow\downarrow$	$\uparrow$	$\uparrow$ $\uparrow$ $\uparrow$	$\uparrow$	ES	GS	FS
e)	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow$ $\uparrow$ __	__	ES	GS	FS

Write your explanations here.

a)

b)

c)

d)

e)

5. (8 points total) The combustion of 0.1584 g benzoic acid increases the temperature of a bomb calorimeter by 2.54°C.
   a. (4 points) Calculate the heat capacity of the calorimeter. The energy released by the combustion of benzoic acid is —26.42 kJ per gram.
   b. (4 points) A 0.2130 g sample of the vanillin is burned in the same calorimeter, and the temperature increases by 3.25°C. What is the energy of combustion of vanillin in kJ/g? Show positive and negative signs clearly in answers for clarity.

6. (10 points) A sample of gold metal must absorb radiation with a minimum frequency of $1.2619 \times 10^{15}\ s^{-1}$ before it can emit an electron from its surface via the photoelectric effect.

   a. (2 points) What is the minimum energy required to produce this effect? (ϕ, PE)
   b. (8 points) If the surface of the gold sample is irradiated with light of wavelength 106 nm, what is the maximum possible velocity of the emitted electrons? Mass of an electron is 9.10938×10^{-31} kg

7. **(5points)** What is the ΔH_{RXN} at constant pressure for the reaction of interest?

   Reaction of interest: $ClF_{(g)} + F_{2(g)} \rightarrow ClF_{3(g)}$
   Pathway reactions:
   Equation 1: $2ClF_{3(g)} + 2\ O_{2(g)} \rightarrow Cl_2O_{(g)} + 3F_2O_{(g)}$ ΔHrxn = 341.4 kJ/mol
   Equation 2: $F_{2(g)} + 1/2\ O_{2(g)} \rightarrow F_2O_{(g)}$ ΔHrxn = –21.8 kJ/mol
   Equation 3: $2\ ClF_{(g)} + O_{2(g)} \rightarrow Cl_2O(g + F_2O_{(g)}$ ΔHrxn = + 167.4 kJ/mol

8. [4 points] An electron in the hydrogen atom can undergo only set transitions. Calculate the wavelength for an electron transitioning from n =10 to n =2. Based on n_f, is this visible, infrared, or ultraviolet light? Explain your choice.

9. **(4 points**) Suppose you were marooned on a tropical island and had to make a primitive barometer using sea water (density = 1.10 g/mL). What height would the water reach in your barometer when a mercury barometer would reach 77.5 cm? d (Hg) = 13.6g/mL

10. (6 points) A 50.0-g sample of water at 100.00°C was placed in an insulated cup. Then 25.3-g of zinc at 25.00°C was added to the water. The temperature of the water dropped to 96.68°C. What is the specific heat of the zinc?

11. (4 points) An incandescent light bulb is filled with 6.00×10^{-5} mol of argon. The bulb has a volume of 800.0 mL. What is the pressure of the argon in the light bulb at 75°C?

12. (10 points) A quantity of Neon gas originally at 5.25 atm in a 2.00-L container at 26.0°C is transferred to a 12.5 L container at 20°C. A quantity of He originally at 5.25 atm and 26.0°C in a 5.00-L container is transferred to the same container (12.5L) containing the neon.

    a. (3 points) What is the pressure of the neon in the new container?
    b. (3 points) What new pressure of the He gas?
    c. (2 points) What is the total pressure of the new container?
    d. (2points) What are the mole fractions of He and Ne in the new container?

13. (6 points) At a given temperature and pressure, it takes 4.85 minutes for a 1.5 L sample of helium effuse through a membrane. How long does it take for 1.5 L of fluorine effuse under the same conditions? Rate = distance/time. Assume that the membranes are 3.0 nm long

14. (5 points) State which of the following sets of quantum numbers would be possible and which would not. Using one or two sentences (not <,>, =,≥, or any with slashes-use your words) explain what is wrong with the quantum numbers that are not possible. Note: missing the spin quantum number is not an error.

    a. n =5, l = 9, ml = –1

    b. n = 18, l =0, ml = 0

    c. n =9, l = 2, ml = –3

    d. [–5, 0, 1]

    e. [2,–1, 0]

15. (6points) Fill in the blanks with the correct response:

    a. The number of orbitals with the quantum numbers [3,1,1] ____________________

    b. When n = 5, the angular momentum quantum number***, l***, can be what value(s) ____________________

    a) Of, the 3s, the 5fy^3, and the 9d$_{xy}$ orbitals, the orbital with the smallest number of radial nodes. ____________________.

    c. Which color of visible light has the lowest energy? ____________________

    d. The sub shell with the quantum numbers [7,3] is ____________________

    e. Which value of n has the first appearance of the d orbitals? ____________________

16. **(6 points)** A 23.5-mL volume of hydrochloric acid reacts completely with a solid sample of $MgCO_3$. The volume of CO_2 formed is 154 mL at 25.98°C and 731.6 mmHg. What is the molarity of the acid solution?

$$2HCl_{(aq)} + MgCO_{3(s)} \rightarrow CO_{2(g)} + H_2O_{(l)} + MgCl_{2(aq)}$$

17. **(8 points)** A sample of nitrogen gas is at STP. The volume of the container is decreased while keeping the temperature constant. Use kinetic-molecular theory to explain whether each of the following would increase, decrease, or remain constant and WHY.

    a. the average KE

    b. the average speed

    c. the frequency of the collisions

    d. the frequency of collisions per unit area

    e. The pressure of the gas

18. (6 points) Give the electron configuration for the following elements or ions. [You can give noble gas core]:

    a. Sb

    b. Polonium

    c. Nickel (III) ion

    d. Cr^{2+}

    e. Se

    f. Iron(II)

    g. Atom: $[Ar]4s^1 3d^{10}$

    h. Cl

    i. Co^{2+}

19. **Extra credit (8 points)** Calculate the amount of heat needed to convert 10.00 g of ice at – 24.05 ºC to water at 28.22 ºC. (figure out how many steps first and be sure to use correct specific heats) $C_{(ice)}$ = 2.06 J/g°C, $\Delta H_{(fus)}$ for H_2O is 334.J/g, $C_{(H2O)}$ = 4.184 J/g°C,

20. **Extra credit (5 points)** Goldie Locks was visiting her old friends, The Bears. She decided to take a bath in their tub. Tub. The tub holds 80.95 gallons of water. The water is 110.5°F. This water is too hot! How many gallons of cold water (40.0°F) does she need to add to cool the tub water to a nice toasty 102.1°F, which is just right? (All you need to solve this problem is here!)