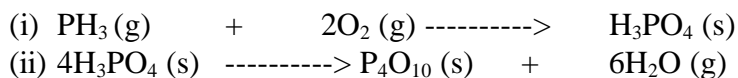
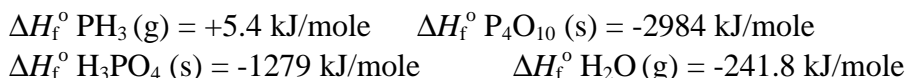


For full credit, please show all work clearly.

(1.) The following equations describe a formation (i) and a decomposition (ii) of phosphoric acid:

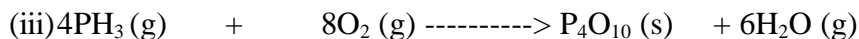


(a) Please use some of the following data to calculate ΔH° for (i). (5 points)



(b) Please use some of the data above to calculate ΔH° for equation (ii). (5 points)

(c) Now, please calculate ΔH° for equation (iii), shown below (5 points)



(d) Please represent (i), (ii), and (iii) together on an energy level diagram. (5 points)

(e) For reaction (iii), 6.800 g of $\text{PH}_3(\text{g})$ is combined with 12.00 g of O_2 ; which is the limiting reactant? What is the theoretical yield of P_4O_{10} ? (5 points)

(f) Please assign the principal intermolecular force which is operating in the molecules below: (5 points)



(g) Is PH_3 a polar or non-polar molecule? Will it dissolve appreciably in water? (2 pts)

(h) Will NH_3 be more soluble or less (in water)? Please explain. (3 points)

(i) Phosphoric acid (9.80 g) dissolves in $\text{C}_2\text{H}_5\text{OH}$ (50.0 g) at 19°C . Please calculate the vapor pressure of this solution, given that the vapor pressure of the solvent is 40.0 torr at 19°C . (5 points)

(j) What is the osmotic pressure, in torr, at 19°C , of a 0.0500 M solution of phosphoric acid in $\text{C}_2\text{H}_5\text{OH}$? Why is the osmotic pressure of a 0.0500 M solution in ethylene glycol, $\text{C}_2\text{H}_6\text{O}_2$, the same at 19°C ? (5 points)

(Please assume $R = 0.0821 \text{ Latm/mole/K}$)

(2.) (a) Please calculate the wavelength (in nm) of the photon emitted as the electron falls from the $n=7$ level to $n=4$ in the hydrogen atom? (5 points)

(b) What is the energy of this photon, in J? (5 points)

(c) What is the energy of this photon, in kJ/mole? (5 points)

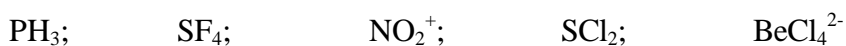
(d) What region of the electromagnetic spectrum is this radiation in? (5 points)

(Please assume: $c=3.00 \times 10^8 \text{ m/s}$; Rydberg constant= 109678 cm^{-1} ; $h=6.626 \times 10^{-34} \text{ Js}$; and Avogadro's # = $6.022 \times 10^{23} \text{ things/mole}$)

(3.) Equimolar amounts of the gases N_2O_3 and N_2O are combined in a vessel of volume 882.6 mL at 298 K, and the vessel is sealed. The gases react together very slowly, but completely, to produce 12.00 g of NO (g). (Please assume $R = 0.0821 \text{ Latm/mole/K}$)

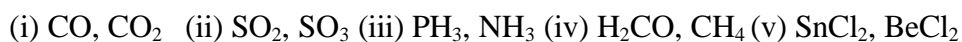
- Please write the balanced equation. (5 points)
- What are the names of all these gases? (3 points)
- How many moles of NO are produced? (2 points)
- What is the pressure in the vessel after the reaction is complete? (5 points)
- What was the pressure in the vessel before any N_2O_3 and N_2O reacted? (5 points)
- After the reaction, 1.401 g of Ar (g) is introduced, and the vessel resealed; this gas does not react with NO. What is the new pressure in the vessel, at 298 K? (5 pts)
- The vessel is then heated to 337 K; what is the pressure at this temperature? (3 pts)
- What are the mole fractions, "X", of NO and Ar? (2 points)
- A small valve on the vessel is then opened and the gases allowed to escape:
what is the rate of effusion of NO relative to Ar? (3 points)
What is the name of the relevant "gas law" here? (2 points)

- (4.) (a) Please draw a Lewis structure for the nitrate ion, and show possible resonance structures. What is the hybridization at N? What is the shape of nitrate? (5 pts)
- (b) Please draw Lewis structures for the following molecules, and ions:



Please give the hybridization at the central atom in each, the molecular (or ionic) shape, and the direction of a dipole moment, if there is one. (30 points)

- (c) Please encircle the molecule which possesses a permanent dipole moment from each pair below: (5 points)



- (5.) (a) What is the molarity of 96.0% sulfuric acid, H_2SO_4 , given that its density is 1.84 g/mL? (5 points)
- (b) What is the molality of the above solution? (5 points)
- (c) A person is making tea, and dissolves 34.23 g of sugar in 152.0 g of water before the water boils. The boiling point of the water is then observed to be 100.33 °C. Please calculate the molecular mass, M_m , for the sugar, given that $K_b = 0.51 \text{ }^\circ\text{C/m}$ for water, and that the water itself would have boiled at 100.00 °C. (5 points)
- (d) Based on the experiment above, is $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ a reasonable molecular formula for the sugar? What is the empirical formula of the glucose molecule, $\text{C}_6\text{H}_{12}\text{O}_6$? (4 points)
- (e) What is the freezing point of the sugar solution prepared above? Please assume that $K_f = 1.86 \text{ }^\circ\text{C/m}$ for water. (3 points)
- (f) At 20.0 °C, the vapor pressure of ethyl acetate is 72.8 torr. What is the barometric pressure (in torr) on a day in Monroe, LA, when the boiling point of ethyl acetate is 77.0 °C? Please assume that for ethyl acetate, $\Delta H_{\text{vap}} = +35.8 \text{ kJ/mole}$. (8 points) (Please assume $R = 8.314 \text{ J/mole/K}$)

- (6.) (a) Nitrate ion reacts with metallic tin in aqueous acidic solution to produce stannous ion and ammonium ion. Please determine the balanced redox reaction. (5 points)
- (b) Suppose you wish to separate and collect the stannous ion by precipitation. Name three ions you could introduce to effect precipitation of a stannous salt. (3 points)
- (c) Please write a net ionic reaction for the precipitation with one of your ions above (2 points)
- (d) Please draw the Aufbau diagram for the element tin. (2 points)
- (e) Please encircle and identify the core and valence electrons on the diagram immediately above. (2 points)
- (f) Please write the short-hand electronic configuration for lead (Pb)? (2 points)
- (g) Is the lead atom larger or smaller than that of tin? (2 points)
- (h) Gold and silver both “borrow;” please write their short-hand electronic configurations. (2 points)
- (7.) Please correlate identity with melting point by writing the best matching letter in the space given below, using each letter once only: (5 points)

melting point (°C)	identity
_____ 1495	(A) aluminum
_____ 63.3	(B) potassium
_____ 3550	(C) neon
_____ 660	(D) carbon
_____ -248.7	(E) cobalt

Please encircle the one with the lower boiling point from each pair below: (5 points)

- (a) Ne, He (b) H₂O, H₂S (c) Cl₂, Br₂ (d) HCl, HBr (e) SO₂, O₃