1. Diamonds are measured in carats, and 1 carat = 0.200 g. The density of diamond is 3.51 g/cm^3. What is the volume of a 5.0 carat diamond ? (10%)

2. What is the symbol of an ion with 16 protons, 18 neutrons, and 18 electrons ? (10%)

3. Which of the following sets of elements are all in the same group in the periodic table ?　(a) N, P, O　　(b) C, Si, Ge　　(c) Rb, Sn　　(d) Mg, Ca　　(10%)

4. A white powder is analyzed and found to contain 43.64% phosphorus and 56.36% oxygen by mass. The compound has a molar mass of 283.88 g/mol. What are the compound's empirical and molecular formulas ? (P: 30.97 g/mol , O: 16.00 g/mol)
(10%)

5. A 230 ml sample of a 0.275 M $CaCl_2$ solution is left on a hot plate overnight; the following morning , the solution is 1.10 M. What volume of water evaporated from the 0.275 M $CaCl_2$ solution ? (10%)

6. A sealed balloon is filled with 1.00 L of helium at 23 °C and 1.00 atm (760 torr). The balloon rises to a point in the atmosphere where the pressure is 220 torr and the temperature is -31 °C. What is the change in volume of the balloon as it ascends from 1.00 atm to a pressure of 220 torr ? (10%)

7. Consider the dissolution of $CaCl_2$:
$$CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2Cl^-(aq) \quad \Delta H = -81.5 \text{ kJ}$$
An 11.0 g sample of $CaCl_2$ is dissolved in 125 g of water, with both substances at 25.0 °C. Calculate the final temperature of the solution assuming no heat lost to the surroundings and assuming the solution has a specific heat capacity of 4.18 J/°C · g.　(Ca : 40.08 g/mol ; Cl : 35.45 g/mol) (10%)

8. In each of the following sets, which atom or ion has the smallest radius ?　(10%)
(a) Li, Na, K
(b) P, As
(c) O^+, O, O^-
(d) S, Cl, Ar
(e) Pd, Ni, Cu

9. Consider the following reaction:
$$H_2(g) + O_2(g) \rightarrow H_2O_2(g) \quad \Delta H = -153 \text{ kJ}$$
Given that the H_2 bond energy is 432 kJ/mol, the O_2 bond energy is 495 kJ/mol, and the OH bond energy is 467 kJ/mol, estimate the bond energy for the O—O single bond ? (10%)

10. Predict the molecular structure for each of the following. (10%)
(a) $XeCl_2$;　(b) ICl_3 ;　(c) TeF_4 ;　(d) PCl_5 ;　(e) $SeCl_6$