LIET 151 2nd Exam 2011. 5. 14 Dept: ID#: Name:

1. Define the following terms briefly. (each 2 pt)

① ideal gas:

② state function:

③ enthalpy:

④ uncertainty principle:

⑤ lattice energy:

⑥ Gouy balance:

2. A sample of air was compressed to a volume of 20.0 L. The temperature was 298 K and the pressure was 10.00 atm. How many moles of gas were in the sample? If the sample has been collected from air at P=1.50 atm, T=298 K, what was the original volume of the gas? (5 pts)

3. What is the density (g/L) of SF_6 gas at 700 torr and 27°C? (MM_{SF6}=146.05 g/mol) (5 pts)

4. How much does the partial pressure of N_2 gas in the atmosphere change at 30°C and 1.00 atm as the relative humidity varies from zero to 100%? (X_{N2} = 0.7808 at 0% humidity; *vp* of H_2O at 30°C=31.824 torr) (6 pts)

5. In an explosion, a compound that is a solid or a liquid decomposes very rapidly, producing large volumes of gas. The force of the explosion results from the rapid expansion of the hot gases. For example, TNT (trinitrotoluene) explodes as follows:

$2C_7H_5(NO_2)_3(s) \rightarrow 12CO\ (g) + 2C\ (s) + 5H_2\ (g) + 3N_2\ (g)$

(a) How many moles of gas are produced in the explosion of 1.5 kg of TNT? (MM_{TNT} = 227.14 g/mol) (3 pts)

(b) What volume will these gases occupy if they expand to a total pressure of 1.0 atm at 25°C? (3 pts)

6. Each of the following is placed in an ice bath until it has lost 65.0 J of energy. Compute the final temperature in each case: (each 2 pts)

(a) 60.0-g sample of H_2O originally at 32.5°C (MM_{H2O}=18.02 g/mol; C_{H2O}=75.291 J/(mol °C))

(b) 40.0-g block of Al originally at 65.0°C (MM_{Al}=26.98 g/mol; C_{Al}=24.35 J/(mol °C))

7. A 1.35-g sample of caffeine ($C_8H_{10}N_4O_2$; $MM_{caffeine}$=194.2 g/mol) is burned in a constant volume calorimeter that has a heat capacity of 7.85 kJ/°C. The temperature increases from 24.65 to 30.00°C. Determine the amount of heat released and the molar energy of combustion of caffeine. (6 pts)

8. What is the speed (in miles per hour) of a 60-kg runner whose kinetic energy is 345 J? (5 pts)

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9. A coin dealer, offered a rare silver coin, suspected that it might be a counterfeit nickel copy. The dealer heated the coin, which weighed 15.5 g, to 100.0°C in boiling water and then dropped the hot coin into 21.5 g of water at T= 15.5°C in a coffee-cup calorimeter. The temperature of the water rose to 21.5°C. Was the coin made of silver or nickel? (6 pts)
(MM_{H2O}=18.02 g/mol; C_{H2O}=75.291 J/(mol °C); C_{Ag}=25.351 J/(mol °C) ; C_{Ni}= 26.07 J/(mol °C)) (6 pts)

10. When light of frequency of 1.30 x 10^{15} s^{-1} shines on the surface of cesium metal, electrons are ejected with a maximum kinetic energy of 5.2 x 10^{-19} J. Calculate
(a) the wavelength of this light; (3 pts)

(b) the binding energy of electrons to cesium metal; (3 pts)

11. If you know that an electron has m_l = -2, what are the possible values for its other quantum numbers? (5 pts)

12. The human eye can detect as little as 2.35 x 10^{-18} J of green light of wavelength 510 nm. Calculate the minimum number of photons that can be detected by the human eye. (6 pts)

13. Make a sketch of the 1s and 2p orbitals. How would the 2s and 3p orbitals differ from the 1s and 2p orbitals? (6 pts)

14. For each pair of orbitals, determine which is more stable and explain why: (each 2pts)
(a) He 2s and He^+ 2s

(b) C 2s and C 2p

15. The ground state of ^{23}V has lower spin than that of ^{24}Cr. Construct energy level diagrams for the valence electrons that show how electron configurations account for this difference. (6 pts)

16. Show thee ground-state electron configuration of two transition metal cations; $^{29}Cu^{2+}$ and $^{24}Cr^{3+}$. (each 3 pts)

(a) Cu^{2+} [Ar] 4s ⊖ 3d ⊖ ⊖ ⊖ ⊖ ⊖

(b) Cr^{3+} [Ar] 4s ⊖ 3d ⊖ ⊖ ⊖ ⊖ ⊖

17. Pick the larger species from each of the following pairs: (each 2 pts)
(a) ^3Li or $^3Li^+$

(b) $^{53}I^-$ or $^{55}Cs^+$

(c) ^8O or $^8O^{2-}$

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R = 8.3145 J K^{-1} mol^{-1}
R = 0.08206 L atm mol^{-1} K^{-1}
h = 6.626×10^{-34} J s
c = 3.00×10^8 m s^{-1}