Sch4u

Science, Physics

SCH4U UNIT 3: Thermochemistry Assignment May 2, 2011 1. Upon the addition of potassium nitrate to liquid water, the beaker feels cold. Explain, using appropriate terms: system, surroundings, heat, temperature, endothermic or exothermic. The endothermic process whereby the system of KNO3 crystals dissolving in the water absorb energy from the surroundings and the measured temperature of the surroundings (beaker, air) drops. 2. The phase change from a gas to a liquid is called condensation. Is the enthalpy change, g â†’ l, exothermic or endothermic? Explain. The enthalpy change is exothermic. Recall that energy is always released when new bonds form. Here, the phase change involves the formation of intermolecular attractions releasing energy as the particles adopt lower-energy conformations. The strength of the intermolecular attractions between molecules, and the amount of energy released when attractions form (or the amount of energy required to overcome these attractive forces) depends on the molecular properties of the substance. Generally, the more polar a molecule is, the stronger the attractive forces between molecules are. 3. Identify the type of molar enthalpy for each reaction below: a) MgCl2 (s) â†’ Mg2+ (aq) + 2 Cl- (aq) Î” Hsol b) CH3COOH (aq) + NaOH (aq) â†’ CH3COONa (aq) + H2O (l) Î” Hneut c) H2O (l) â†’ H2O (s) Î” Hfr 4. There are three modes of molecular motion associated with energy. Identify the mode(s) of molecular motion available to helium gas (He) and compare to those of nitrogen gas (N2). Which gas has the higher molar heat capacity? Explain. Three kinds of motion are associated with energy: translational, rotational, and vibrational. Helium, He, is a monatomic gas which only has translational motion as there is no bond about which to rotate and no bond on which to

vibrate. Nitogen, N2 , is a diatomic gas which can divert heat energy into rotational and vibrational motion. Therefore, for the same temperature increase, Nitrogen gas requires more heat energy than Helium. The molar heat capacity of N2 (29. 1 J/mol·°C) is higher than that of He (20. 8 J/mol·°C). 5. Temperature does not reflect the total thermal energy of a system. Explain using a comparative example. A cup of hot chocolate at 85°C has a higher temperature than a bathtub at 75°C. However, the bathtub of water has many more water molecules that can store thermal energy compared to the small cup of hot chocolate. 6. a) Consider the process: H2O (s) â†’ H2O (l) â†’ H2O (g). When the temperature holds constant at 100 ËšC, what is the heat energy used for? Heat energy supplied is used to overcome the strong dipole-dipole intermolecular attractive forces (Hydrogen Bonding) holding liquid molecules together. 7. Calculate the enthalpy change for the reaction: HCl (g) + NaNO2 (s) â†’ HNO2 (g) + NaCl (s) âˆ†HËš = ? Use the following thermochemical equations: 2 NaCl + H2O â†’ 2 HCl + Na2O âˆ†HËš = +507 kJ NO + NO2 + Na2O â†’ 2 NaNO2 âˆ†HËš = - 427 kJ NO + NO2 â†’ N2O + O2 âˆ†HËš = - 43 kJ 2 HNO2 â†’ N2O + O2 + H2O âˆ†HËš = + 34 kJ Eq’n #1 : Rev, x ½ Î” H = -253. 5 kJ Eq’n #2 : Rev, x ½ Î” H = + 213. 5 kJ Eq’n #3 : x ½ Î” H = - 21. 5 kJ Eq’n #4 : Rev, x ½ Î” H = - 17 kJ Î” H = - 78. 5 kJ 8. Using standard heat of formation values (âˆ†HfËš)(, calculate the molar enthalpy of combustion of propane. (Assume the production of liquid water.) C3H8 (g) + 5 O2 (g) â†’ 3 CO2 (g) + 4 H2O (l) Î” H = [3(-393. 5) + 4 (-285. 8)] — [-104. 7 + 5(0)] = -2219 kJ n = m/M 1mol = 1134 mol = 50 000g / 44. 11 g/mol -2219 kJ x kJ = 1134 mol x = - 2. 515 x 106 kJ 9. (Use bond energy values to estimate the enthalpy change (âˆ†HËš) for the combustion of

ethanol. C2H5OH (l) + 3 O2 (g) â†’ 2 CO2 (g) + 3 H2O (l) Bonds broken: 4 700. 1 kJ Bonds Formed: 5 976 kJ 5 x C-H = 5 (414) = 2070 4 x C= O = 4 (804)= 3216 1 x C-C = 1 (347) = 347 6 x O-H = 6 (460) = 2760 1 x C-O = 1 (327) = 327 1 x O-H = 1 (460) = 460 3 x O= O = 3(498. 7) = 1496. 1 Î” H = âˆ‘ bond E of bonds broken - âˆ‘ bond E of bonds formed = 4 700. 1 kJ — 5 976 kJ = -1275. 9 kJ Combustion of 1 mol ethanol: -1275. 9 kJ/mol Combustion of 5 mol ethanol: -6379. 5 kJ 10. Aluminum chloride reacts readily with chlorine gas to produce aluminum chloride. The reaction is highly exothermic. 2Al (s) + 3Cl2 (g) â†’ 2AlCl3 (s) âˆ†HËš = -1408 kJ What is the enthalpy change when 100 kg of Al reacts completely with excess Cl2? n = m/M = 100 000 g/ 26. 98 g/mol = 3706 mol Al 2 mol Al = 3706 mol Al -1408 kJ x kJ x = -2 609 024 kJ = -2. 609 x 106 kJ 11. Sketch Energy Diagrams for: a) an exothermic reaction, and b) an endothermic reaction. a) an exothermic reaction, b) an endothermic reaction, Ea products reactant _ _ _ _ _ _ Ea E E reactants _ _ _ _ _ _ _ _ + Î” H - Î” H products Reaction pathway Reaction pathway 12. Read Chapter 5. 6 “ The Energy Debate". Read Figure 5 descriptions for a) and b). Go to a reliable news website and update your understandings of Japan’s current nuclear challenges. http://www. cbc. ca/news/world/story/2011/04/30/nuclear-japan-resignation. html