Chemistry 20B Exam 1, Spring 2020

"We would like to thank all students for their understanding, as we navigate this unprecedented situation. In addition, the university would like to remind students about their obligations under the UCLA Student Conduct Code: https://www.deanofstudents.ucla.edu/Individual-Student-Code"

INSTRUCTIONS:

Due: Friday May 1 at 11:59pm on Gradescope as a scanned pdf Remember to use the "Assign Pages" feature when submitting to Gradescope The exam is open book, open note and collaborative
Please start each problem on a new page
Please write your name, UID and problem number on each page For questions please email myself or the TAs. We will try to respond quickly. I will email out any announcements and post them on CCLE and Questionsly

(i) BE SURE TO SHOW ALL YOUR REASONING AND CALCULATIONS. CORRECT ANSWERS WITHOUT PROPER ARGUMENTS WILL BE MARKED WRONG
(ii) BE CAREFUL WITH UNITS: NEVER GIVE A NUMERICAL ANSWER WITHOUT UNITS
(iii) PLEASE CROSS OUT ANY WORK YOU DO NOT WANT US TO GRADE

1. A constant force of 100 N is used to extend 1 gram of wire a distance of 0.1 meters. Given

$$w = \int F dl$$

that the work associated with extension can be calculated as and that the wire warms up by 2 K during the extension process, calculate the change in internal energy of the wire during the extension. The specific heat of the wire is $0.5 \frac{J}{gK}$.

2. Calculate the work done when 10 g of zinc reacts with sulfuric acid to produce zinc sulfate and hydrogen gas in (i) a closed vessel of fixed volume, and (ii) an open beaker at 27℃. You can neglect the volume of the solid and aqueous components.

$$Zn_{(s)} + H_2SO^4_{(aq)} \rightarrow ZnSO^4_{(aq)} + H^2_{(g)}$$

3. (i) Given the below standard enthalpies of formation determine the standard enthalpy of the

$$HN^3_{(\ell)} + NO_{(g)} \rightarrow H_2O^2_{(\ell)} + N^2_{(g)}$$

reaction . (ii) Is this reaction exothermic or $HN^3_{(\ell)}$

endothermic? (iii) Determine how much you need to warm 1 L of water by 5 K if all of the heat is transferred from the reaction to the water. Remember to balance the chemical

$$4.2^{J}_{gK}$$

equation. The specific heat of water is .

$$mol\Delta H^o_f(NO_{(g)}) = 264^{k\,J}$$

$$\Delta H^o_f(H_2O^2_{(\ell)}) = -187.78^{k\,J}$$

$$mol\Delta H^o_f(HN^3_{(\ell)}) = 90.25^{k\,J\,mol}$$

4. 5 kg of ice at a temperature of -20°C is added to an insulated container filled with 100 L of water at 70°C (a hot tub). Determine the equilibrium temperature of the system given that

$$4.2^{J}_{gK} 2.1^{J}_{gK}$$

the specific heat of water is , the specific heat of ice is and the standard 333^{J}_{g}

enthalpy of fusion for water is .

5. (i) If n moles of a monatomic ideal gas are expanded reversibly and isothermally from an

$$(P_i, T_i, V_i) \quad (P_f, T_f, V^f)$$

initial state to a final state , determine the heat, work and internal

energy change associated with this process. (ii) If instead, the monatomic ideal gas follows a different path—a reversible isochoric process, followed by a reversible isobaric expansion —between the same initial and final states, determine the heat, work and internal energy change associated with this process. (iii) Compare your values for parts (i) and (ii), and indicate the direction of both heat and work exchange.

6. (i) Which has stronger intermolecular forces, CO or KF? Explain your reasoning considering only each molecule interacting with another of itself. (ii) Sketch a plot of the potential

energy versus separation distance for CO and KF (PLEASE PLOT BOTH MOLECULES ON THE SAME GRAPH). Indicate the appropriate axes and indicate the relative depths and relative positions of the minima. (iii) Given the information below, construct a P—T phase diagram for CO. Determine the equilibrium phases at the following (P, T) $(0.15atm, 50K)$ $(0.15atm, 68K)$ $(1atm, 68K)$

points (a) , (b) , and (c) . (iv) 20 moles of $CO_{(g)}$ are held inside a 1 m^3 spherical container at 300 K. Calculate the force exerted on the surface of the container assuming CO is an ideal gas. (v) If the container is allowed to expand to achieve mechanical equilibrium with its surroundings at a pressure of 1 atm, what will be it's final volume assuming it holds an ideal gas?

	Temperature (K)	Pressure (atm)
Triple Point	68	0.15
Critical Point	133	35
Normal Boiling Point	82	1
Normal Melting Point	68	1