

Chemistry 1154 Fall Spring 2011 Test 3

Wednesday, March 23, 2010

Time: 1 hour 50 minutes

Name: _____

Student Number: _____

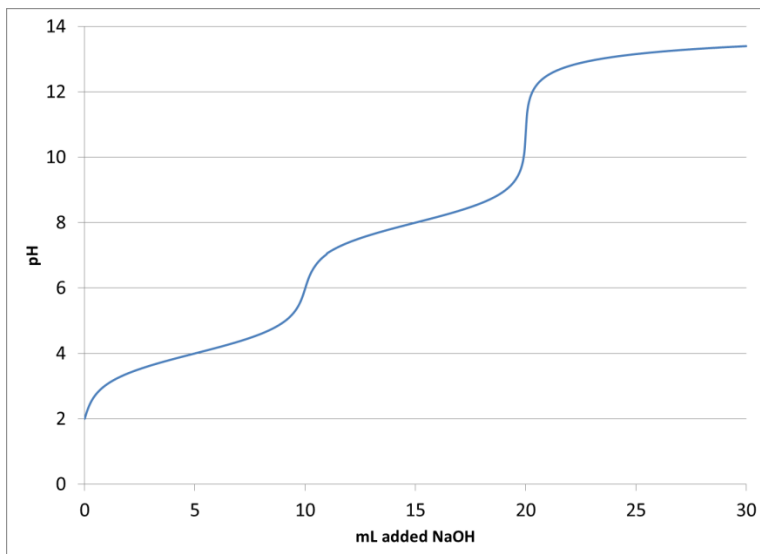
*This exam consists of **seven** pages of questions, a periodic table, and the formula sheet. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. There are **39.5** marks available. Good luck!*

1) **[4 marks total]** A 10.0-mL aliquot of 2.50×10^{-3} M HCl is to be titrated with 2.00×10^{-3} M NaOH. An indicator with $pK_{in} = 3.602$ is to be used.

a) **[3 marks]** At what volume of added base will the endpoint of the titration be reached? Give your answer in mL.

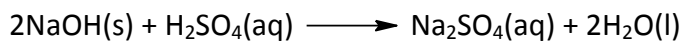
b) **[1 mark]** Is the indicator a suitable one for the titration? How do you know?

- 2) **[5 marks total]** The titration curve for a weak acid is shown below. Assume that the titration curve is complete as shown, and that all equivalence points are easily visible.



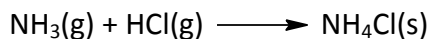
- a) **[1 mark]** How many acidic protons does the acid have?
- b) **[1 mark]** How many buffer regions are shown on the graph?
- c) **[1 mark]** What is or are the approximate pK_a value or values for the acid?
- d) **[2 marks]** Estimate the concentration of the acid.

- 3) **[4 marks]** A 1.00-gram sample of NaOH (40.0 g/mol) was added to 200. mL of 0.100 M H_2SO_4 ($S = 4.184 \text{ J/g}^\circ\text{C}$, $D = 1.00 \text{ g/mL}$) at 21.000°C .

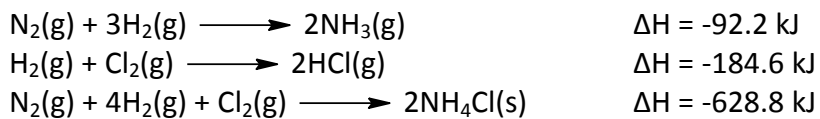


After the reaction, the temperature of the solution had increased to 23.378°C . Calculate ΔH for the reaction.

- 4) **[2 marks]** Calculate ΔH for the reaction:



Given the following data:

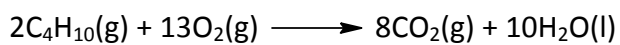


5) **[1 mark]** What is the enthalpy of formation of $\text{NH}_3(\text{g})$? Give your answer in kJ/mol.

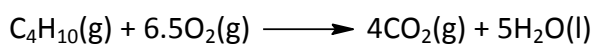
6) **[2 marks]** Given the following data:

Compound	$\Delta H^\circ_{f,298}$ (kJ/mol)
$\text{C}_4\text{H}_{10}(\text{g})$	-125.6
$\text{CO}_2(\text{g})$	-393.5
$\text{H}_2\text{O}(\text{l})$	-285.8

Calculate ΔH° for the reaction:

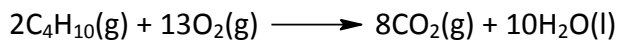


7) **[3 marks]** Given that ΔH° for the reaction

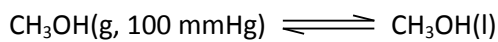


is -2877.4 kJ, how many kJ of heat would be released by the reaction of 5.80 grams of C_4H_{10} (58.0 g/mol) with 10.4 grams of O_2 (32.0 g/mol)?

- 8) **[3 marks]** A 5.8122-gram sample of C_4H_{10} (58.122 g/mol) was burned in excess oxygen in a bomb calorimeter with a heat capacity of 28.687 kJ/°C. As a result of the combustion the temperature of the bomb calorimeter increased by 10.000°C. Calculate ΔH_{298} for the reaction:



- 9) **[3 marks]** At 21.2°C, the vapour pressure of methanol (CH_3OH) is 100 mmHg. Complete the following chart for the reaction:



Your choices are positive (greater than zero), negative (less than zero), or zero.

	ΔG	ΔH	ΔS
15°C			
20°C			
25°C			

10) **[4.5 marks]** The following hypothetical process has been proposed to inflate a balloon from 2 litres to 4 litres:

- Perform the inflation against a constant external pressure of 1.50 atm.
- Add 1500 J of heat to the balloon.
- Perform the inflation at 300 K

a) **[2 marks]** Calculate q , w , ΔE , and ΔH for the process.

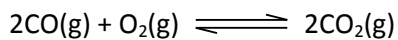
b) **[1.5 marks]** $\Delta S_{\text{sys}} = +5.76 \text{ J/K}$ for the expansion. Calculate ΔS_{surr} , ΔS_{univ} , and ΔG for the process.

c) **[1 mark]** Will the process work as proposed? How do you know?

11) **[8 marks total]** Given the following data:

Compound	$\Delta H^\circ_{f,298}$ (kJ/mol)	S°_{298} (J/mol·K)
CO(g)	-110.5	197.7
O ₂ (g)		205.1
CO ₂ (g)	-393.5	213.7

and the following reaction:



a) **[3 marks]** Calculate ΔH° , ΔS° , and $\Delta G^\circ_{350\text{ K}}$ for the reaction.

b) **[2 marks]** $\Delta G^\circ_{700\text{ K}} = -444.83$ kJ. Calculate $\Delta G_{700\text{ K}}$ for $P_{\text{CO}} = 1.0 \times 10^{-10}$ atm, $P_{\text{O}_2} = 1.0 \times 10^{-5}$ atm, and $P_{\text{CO}_2} = 1.0 \times 10^{+5}$ atm.

c) **[1 mark]** Is the reaction spontaneous at 700 K when carried out under the conditions given in (b)? How do you know?

d) **[2 marks]** Calculate $K_{p,700}$ for the reaction.