

Take-Home Portion of Exam 2
CHEM 120
Fall 2009

Name: _____

Instructions:

Answer the questions in the space provided. You may use the back of any page for your work, if needed. If you need yet more space, you may insert additional pages, but you must do it so that they immediately follow the question in the order that you want me to read them. Do not attach them at the end of the entire packet. All final numerical answers and all essay-type questions must be hand-written in complete sentences, unless otherwise indicated. If a question requires a graph or spreadsheet output, tape the item in the provided space; do not use staples.

You may not consult with anyone, except the instructor, about specific questions regarding this exam. You may ask other faculty members general questions about topics and methods on this exam, but not about any specific question on the exam. You may not work on this portion of the exam with any one else.

Write your answers neatly and legibly in ink. Answers in pencil will be accepted, but you will not be able to appeal any apparent grading errors (except simple addition errors).

Give a brief description of what you are doing in each numerical problem. This description should give the reader an idea of what you are doing and some justification for your approach. You do not need to justify simple mathematical manipulations.

Problem	Possible Points	Points Received
1	28	
2	23	
3	15	
Total	66	

1a. (13 Points) A chemist needs to determine the amount of the dye cresol red (chemical formula: $\text{NaC}_{21}\text{H}_{17}\text{SO}_5$, formula weight 404.4 g/mole) in a product produced by her company for quality control purposes. So, she constructs a calibration curve for the colorimetric determination of cresol red in the product by preparing solutions with known concentrations of cresol red. Her data are shown below. Reproduce her calibration curve including a best fit line through the data. Tape your graph in the space provided and write the slope and intercept from your best fit line at 95% confidence in the blanks provided at the bottom of this page.

[Cresol Red] (M)	Absorbance
3.202×10^{-6}	0.179
6.401×10^{-6}	0.297
1.452×10^{-5}	0.585
1.927×10^{-5}	0.775
2.881×10^{-5}	1.115

Table 1. Absorbance as a function of cresol red concentration.

Figure 1. Calibration curve for the colorimetric determination of cresol red

Slope = _____

Intercept = _____

b. (11 Points) A 1.557-g sample of the product is dissolved in water and filtered to remove water-insoluble components and then diluted to 100.0 ml. This solution is serially diluted first by taking 2.000 ml of the solution and diluting to 50.00 ml and then taking 1.000 ml of the newly prepared dilute solution and diluting to 25.00 ml. The final dilute solution has an absorbance reading of 0.475. Determine the % cresol red by mass in the original sample.

c. (4 Points) If the % cresol red by mass in the product is supposed to be 25.3%, what can the chemist conclude about the purity of the product? Is there anything else she must do before she can draw any conclusions about the product's purity? If so, what?

2. It is possible to analyze samples containing both tin and bismuth by first dissolving the sample in sulfuric acid, which converts the metals to Sn^{2+} and Bi^{3+} . One then titrates the resulting solution with MnO_4^- to give Sn^{4+} and Mn^{2+} (note that Bi^{3+} does not react with MnO_4^- under these conditions).

a. (5 Points) Write the balanced chemical equation for the reaction that takes place between Sn^{2+} and MnO_4^- in this acidic solution.

b. (18 Points) A 0.427-g sample that contains both tin and bismuth metal is treated, as described above, and diluted to 100.0 ml in a volumetric flask. Four 25.00-ml aliquots are removed from the flask and titrated with a 0.01006 M KMnO_4 solution. The table below summarizes the results for the four titrations; in each case the volume of KMnO_4 is the volume required to reach the equivalence point in the titration. What is the average % Sn by mass in the sample at 95% confidence, based on these four measurements? Don't forget to apply a Q test (at 90% confidence) to any suspect datum. If you did not get an answer to part a, assume the stoichiometric ratio between Sn^{2+} and MnO_4^- is 5:2. Show your work on the next page and write your answer in the space provided

Titration #	Volume KMnO_4 (ml)
1	15.72
2	15.61
3	15.63
4	15.62

Average % Sn by mass in the sample: _____

3. (15 Points) A 20.00-g ingot of gallium initially at 20.00 °C is placed into 100.00 g H₂O initially at 75.00 °C. What is the final temperature, assuming that no heat is exchanged with the surroundings? Some potentially useful data concerning gallium and water are shown below.

	H ₂ O	Ga
Melting Point (°C)	0.00	29.78
ΔH_{fus}^0 (kJ·mole ⁻¹)	+6.008	+5.57
Boiling Point (°C)	100.00	
ΔH_{vap}^0 (kJ/mole)	+40.656	
Heat capacity of solid (J·K ⁻¹ ·mole ⁻¹)		26.09
Heat capacity of liquid (J·K ⁻¹ ·mole ⁻¹)	75.291	28.45
Heat capacity of gas (J·K ⁻¹ ·mole ⁻¹)	35.58	