

Exam Study Questions
Chemistry 20L
Fall 2005

The exam will be held in CS50 – the lecture hall.

During the exam you will be allowed to use a calculator, your lab notebook, your lecture guides and any hand-written materials that you want. The lab manual, textbooks, and other printed materials including printed copies of the study questions and/or answers will not be allowed during the exam.

The final exam will cover ALL the topics discussed in lectures and in the laboratory; the emphasis will be on the material not examined on the midterm.

Review the pre-lab study questions even if they were not assigned. You should be able to answer all these questions now.

Review the sidebar questions in the experiments.

Review the experimental procedures.

Review the study questions posted on VOH for the first exam.

The following questions (or modifications of them) have been taken from previous 20L exams.

1. Sketch the titration curves for each of the following systems. Calculate and indicate on each sketch, the equivalence point volume, the initial pH of the solution, and at least one other pH on the titration curve. Also be sure to indicate the approximate pH of the equivalence point if this is not the second point that you choose.

(a) 10.00 mL of 0.0500 N HNO₃ (beaker) titrated with 0.100 N NaOH (buret)

(b) 10.00 mL of 0.0500 N benzoic acid ($K_a = 6.46 \times 10^{-5}$) (beaker) titrated with 0.100 N NaOH (buret).

2. A Chemistry 20L student determined the sodium tripolyphosphate (Na₅P₃O₁₀) in a detergent by ashing a sample and then titrating the acid in the ash with NaOH assuming the following reaction:



(a) Based on the following data, calculate the percent STTP in the detergent.

Molecular weight of STTP = 371 g

Weight of sample	2.000 ± 0.0002 g
Concentration of standard NaOH	0.500 ± 0.001 M
Volume of standard NaOH to titrate the ashed sample	19.41 ± 0.03 mL

(b) Presuming that the sample was completely ashed and dissolved, and that there were no other sources of acid in the ash to react with the NaOH, calculate the percent inherent error in the phosphate determination.

3. Define the following terms being careful to identify any differences or relationships between them.

- (a) End point and equivalence point
- (b) Volumetric and non-volumetric glassware
- (c) Phase diagram and phase change
- (d) Normality and molarity
- (e) Absorbance and transmittance
- (f) Accuracy and precision

4. "Acid base indicators are usually weak acids, which can exist in solution as either the undissociated acid or the conjugate base. The two species have different colors. As the pH of the titration changes, the predominant form of the indicator changes from one form to the other." *(Chemistry Experiments for Physical Science and Engineering Majors, pp58)*

(a) In Assignment 4 you recorded the pH ranges for the color changes for four indicators. Based on that data, complete the following table.

SA = strong acid, SB = strong base; WA = weak acid, WB= weak base

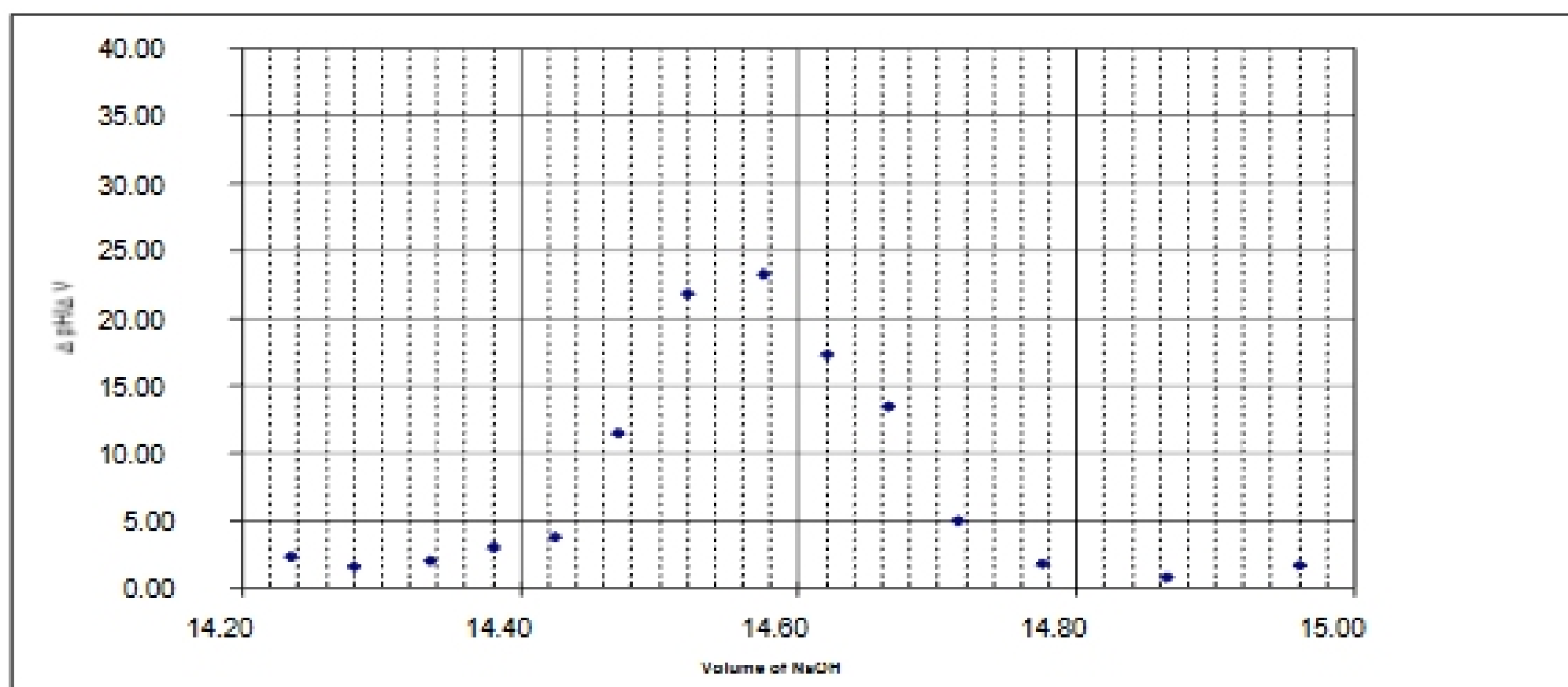
Indicator	pH range of color change	color of undissociated indicator	color of conjugate base	Appropriate indicator for titration of 0.1000 M reagents of acid and base (Explain below)		
				SA-SB	WA-SB	WB-SA
Bromocresol green						
Phenolphthalein						
Methyl red						
Methyl orange						

Give your reasoning for choice of titration.

(b) Calculate the pH of a 1.85×10^{-2} M solution of $\text{Ba}(\text{OH})_2$.

5. A 10.00-mL sample of an unknown acid was titrated with 0.1015 M NaOH. The titration data is shown below along with the Excel plot of the first derivative ($\Delta\text{pH}/\Delta V$ vs volume base) graph in the vicinity of the equivalence point.

Vol NaOH	pH	Vol NaOH	pH
0.07	2.59	14.36	6.47
3.02	4.03	14.40	6.59
5.98	4.46	14.45	6.78
9.13	4.82	14.49	7.24
12.22	5.29	14.55	8.55
12.49	5.39	14.60	9.71
13.00	5.53	14.64	10.40
13.90	5.92	14.69	11.07
13.98	5.99	14.74	11.32
14.10	6.09	14.81	11.44
14.14	6.14	14.92	11.53
14.22	6.21	15.00	11.66
14.25	6.28	15.49	11.97
14.31	6.37		



- What is the equivalence point volume?
- What is the concentration of the acid?
- What is the pK of the acid?