**`Major’ Chem 1114 Lab Exercise: ACIDIMETRY REDUX**

**50 pts**

**The scenario**

A field investigator from the New York Department of Environmental Conservation (DEC) collects a 2.0 L sample of “water” from a stinking , yellow-green pool found on public land abutting a fracking operation owned by Slezoid Gas and Oil Inc. The sample has a pungent, sharp smell. The stinking pool is near a limestone shelf, which the “water” appears to be rapidly eroding. The erosion is marked by a slow dissolution of the shelf along with copious bubbling.

The sample is brought to a local testing lab where Bob, an environmental chemist first labels it ***“Original Acid X”*** . He heats a bit of the sample in beaker over a Bunsen burner. The sample quickly evolves a brown cloud of gas which dramatically clear Bob’s sinuses and makes his eyes water. Bob also discovers the acid sample can dissolve copper after accidentally spilling some on a copper pipe in his lab.

Seeing that he needs to dilute the stuff, Bob cautiously pipets a 4.00 mL volume of the fuming, noxious sample into a 500.0 mL volumetric flask, which he then fills to the mark with distilled water. He labels the diluted, unknown solution: ***“Diluted Acid X”.*** Bob plans to titrate the diluted sample with KOH, but needs to both make and standardize the base first.

He does so by measuring out ~ 18 mL stock 6 M KOH which he dilutes to 1.0 L with distilled water. He labels this ***“2o Standard KOH”.***

Bob next weighs out 2.5501 grams of ‘KHP’, a solid, monoprotic acid1 with a molecular mass of 204.0 grams/mol and places it in a 250.0 mL volumetric flask which he dilutes to mark with distilled water. He labels the KHP solution: ***“1o Standard Acid KHP.”***

The acid base reaction of KHP with KOH follows the balanced reaction:

KHP(aq) + KOH(aq) 🡪 H2O + K2P(aq)

Bob pipets three 25.00 mL volumes of the `1o standard acid’ into Erlenmeyer flasks, then adds three drops of phenolphthalein to each. He fills a buret with 2o secondary base, titrating each to end point. His recorded data is captured in Table 1.

**Table 1: Standardization of 2o Standard Base, KOH with 1o standard acid KHP**

|  |  |
| --- | --- |
| 25.00 mL 1o KHP sample # | V(ml) 2o standard base add at endpoint |
| 1 | 12.10 |
| 2 | 12.20 |
| 3 | 12.15 |

1(the P in `KHP’ stands for **“phthalate**”, an organic anion, not phosphorus)

Bob next titrates three 25.00 mL samples of the “***Diluted Acid X”*** with his freshly standardized 2o KOH in the same manner described above. Bob’s recorded data for this work is recorded in Table 2.

**Table 2: Titration of Dilute Acid X with 2o Standard Base, KOH**

|  |  |
| --- | --- |
| 25.00 mL diluted acid X sample # | V(ml) 2o standard base add at endpoint |
| 1 | 31.4 |
| 2 | 31.7 |
| 3 | 31.2 |

**Your Task**

**On the attached answer sheet provide (with work !)**

1. The concentration of the ***“1o Standard Acid KHP”***
2. The average concentration of the ***“2o Standard KOH” ± standard deviation (s)***
3. The concentration of the ***“Diluted Acid X” ± standard deviation (s)***
4. The concentration of the ***“Original Acid X” ± standard deviation (s)***
5. Deduce and write out the balanced reaction occurring to the limestone shelf.
6. Deduce the likely identity of the acid X. (Use the table below to guide your choice)
7. What is the likely identity of the brown gas ? (You will need to look up properties of acid X you identified in part 6 above.)

**Table 3: The Maximum Concentrations of Common Acids**

|  |  |
| --- | --- |
| **Acid** | **Maximum Concentration (mole/L)** |
| H2SO4 (sulfuric acid) | 18 |
| Acetic acid(HC2H3O2) | 17 |
| HNO3 (nitric acid) | 16 |
| HCl (hydrochloric acid) | 12 |
| HClO4 (perchloric acid) | 11.7 |

**ANSWER SHEET :**

**`Major’ Chem 1114 Lab Exercise: ACIDIMETRY REDUX 50 PTS**

**Due Monday 18 Nov in Lab (Show work or no credit for 1-4) Use extra sheets if needed**

Your name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. The concentration of the ***“1o Standard Acid KHP” = \_\_\_0.0500\_\_\_\_\_\_M (to nearest 0.0001)***

***(8 pts)***

***Mol KHP = 2.5501 g/204 g mol-1 =0.01250 moles***

***[KHP] = moles KHP/L = 0.01250/0.25=0.0500 M = Ca***

1. The average concentration of the ***“2o Standard KOH”= \_0.1029\_\_\_\_\_\_\_\_\_ M ± 0.0002\_\_\_\_***

***(8 pts) (to nearest 0.0001)***

***CaVa = 0.0500\*25=CbVb=> 0.0500\*25/Vb =1.2500/Vb = Cb***

***Table 1 data Cb***

|  |  |  |
| --- | --- | --- |
| 25.00 mL 1o KHP sample # | V(ml) 2o standard base add at endpoint= Vb | Cb =1.2500/Vb, M |
| 1 | 12.10 | 0.1033 |
| 2 | 12.20 | 0.1025 |
| 3 | 12.15 | 0.1029 |

**Av. Cb = 0.1029 ± 0.0004**

1. The average concentration of the ***“Diluted Acid X” =\_\_*0.1294*\_\_\_\_\_\_\_\_M ± \_\_0.0011\_\_\_\_\_\_\_***

***(8 pts) (to nearest 0.0001)***

***Now that Cb known and = 0.1029, we run calculation backwards for acid X***

***CaVa = Cx,dil \*25=CbVb =0.1029\*Vb => Cx,dil = 0.1029\*Vb/25=4.116\*10-3Vb***

***Table 2 data Cx.dil***

|  |  |  |
| --- | --- | --- |
| 25.00 mL diluted acid X sample # | V(ml) 2o standard base add at endpoint=Vb | Cx,dil = ***4.116\*10-3Vb*** |
| 1 | 31.4 | 0.1292 |
| 2 | 31.7 | 0.1305 |
| 3 | 31.2 | 0.1284 |

**Av. Cx,dil= 0.1294±0.0011**

1. The average concentration of the ***“Original Acid X”=\_\_\_\_16.1\_\_\_\_\_\_\_\_\_\_\_ M ± 0.1\_\_\_\_\_\_\_\_***

***(8 pts) (to nearest 0.1)***

***Original Acid Cx = 500\*Av. C­x,dil /4 =125\*0.1294=16.1***

1. Deduce and write out the balanced reaction occurring to the limestone shelf. (**6 pts)**

**2H+ + CaCO3(s) 🡪 H2O +CO2(g) + Ca2+**

1. Deduce the likely identity of the acid X. ***( 7 pts)* X= \_\_\_\_\_\_HNO3\_\_\_\_\_\_\_\_\_\_\_\_**
2. What is the likely identity of the brown gas ? (You will need to look up properties of acid X you

identified in part 6 above.) (***5 pts)***

***B*rown gas = \_\_\_\_NO2\_\_\_\_\_\_\_\_\_\_\_**