

## Essay Questions

1986



Oxyacids, such as those above, contain an atom bonded to one or more oxygen atoms; one or more of these oxygen atoms may also be bonded to hydrogen.

- Discuss the factors that are often used to predict correctly the strengths of the oxyacids listed above.
- Arrange the examples above in the order of increasing acid strength.

1990

Give a brief explanation for each of the following.

- For the diprotic acid  $\text{H}_2\text{S}$ , the first dissociation constant is larger than the second dissociation constant by about  $10^5$  ( $K_1 = 10^5 K_2$ ).
- In water,  $\text{NaOH}$  is a base but  $\text{HOCl}$  is an acid.
- $\text{HCl}$  and  $\text{HI}$  are equally strong acids in water but, in pure acetic acid,  $\text{HI}$  is a stronger acid than  $\text{HCl}$ .
- When each is dissolved in water,  $\text{HCl}$  is a much stronger acid than  $\text{HF}$ .

1994

A chemical reaction occurs when 100. milliliters of 0.200Molar  $\text{HCl}$  is added dropwise to 100. milliliters of 0.100-molar  $\text{Na}_3\text{PO}_4$  solution.

- Write the two net ionic equations for the formation of the major products.
- Identify the species that acts as both a Brønsted acid and as a Brønsted base in the equation in (a). Draw the Lewis electron-dot diagram for this species.
- Sketch a graph using the axes provided, showing the shape of the titration curve that results when 100. milliliters of the  $\text{HCl}$  solution is added slowly from a buret to the  $\text{Na}_3\text{PO}_4$  solution. Account for the shape of the curve.

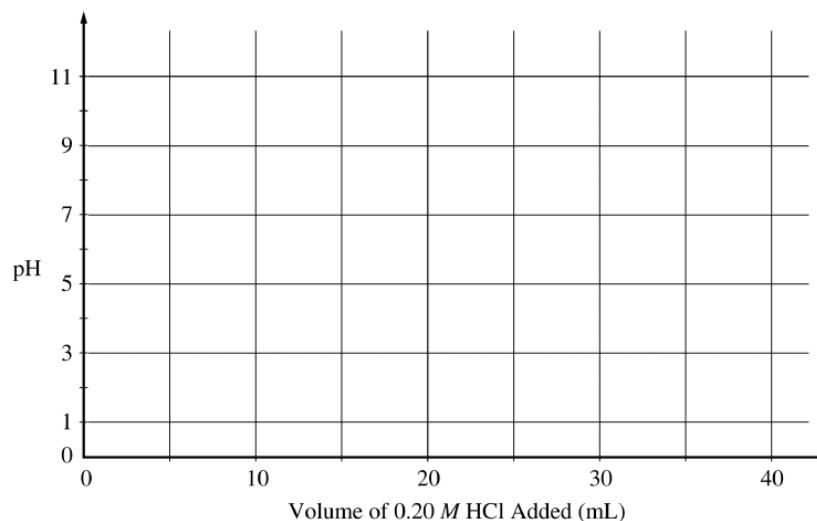


- Write the equation for the reaction that occurs if a few additional milliliters of the  $\text{HCl}$  solution are added to the solution resulting from the titration in (c).

2000

A volume of 30.0 mL of 0.10 M  $\text{NH}_3(aq)$  is titrated with 0.20 M  $\text{HCl}(aq)$ . The value of the base-dissociation constant,  $K_b$ , for  $\text{NH}_3$  in water is  $1.8 \times 10^{-5}$  at 25°C.

- (a) Write the net-ionic equation for the reaction of  $\text{NH}_3(aq)$  with  $\text{HCl}(aq)$ .
- (b) Using the axes provided below, sketch the titration curve that results when a total of 40.0 mL of 0.20 M  $\text{HCl}(aq)$  is added dropwise to the 30.0 mL volume of 0.10 M  $\text{NH}_3(aq)$ .



- (c) From the table below, select the most appropriate indicator for the titration. Justify your choice.

Indicator	$\text{p}K_a$
Methyl Red	5.5
Bromothymol Blue	7.1
Phenolphthalein	8.7

- (d) If equal volumes of 0.10 M  $\text{NH}_3(aq)$  and 0.10 M  $\text{NH}_4\text{Cl}(aq)$  are mixed, is the resulting solution acidic, neutral, or basic? Explain.

## Problems

1987

The percentage by weight of nitric acid,  $\text{HNO}_3$ , in a sample of concentrated nitric acid is to be determined.

- (a) Initially a NaOH solution was standardized by titration with a sample of potassium hydrogen phthalate,  $\text{KHC}_8\text{H}_4\text{O}_4$ , a monoprotic acid often used as a primary standard. A sample of pure  $\text{KHC}_8\text{H}_4\text{O}_4$  weighing 1.518 grams was dissolved in water and titrated with the NaOH solution. To reach the equivalence point, 26.90 milliliters of base was required. Calculate the molarity of the NaOH solution. (Molecular weight:  $\text{KHC}_8\text{H}_4\text{O}_4 = 204.2$ )
- (b) A 10.00 milliliter sample of the concentrated nitric acid was diluted with water to a total volume of 500.00 milliliters. Then 25.00 milliliters of the diluted acid solution was titrated with the standardized NaOH solution prepared in part (a). The equivalence point was reached after 28.35 milliliters of the base had been added. Calculate the molarity of the concentrated nitric acid.
- (c) The density of the concentrated nitric acid used in this experiment was determined to be 1.42 grams per milliliter. Determine the percentage by weight of  $\text{HNO}_3$  in the original sample of concentrated nitric acid.

1996

Concentrated sulfuric acid (18.4-molar  $\text{H}_2\text{SO}_4$ ) has a density of 1.84 grams per milliliter. After dilution with water to 5.20-molar, the solution has a density of 1.38 grams per milliliter and can be used as an electrolyte in lead storage batteries for automobiles.

- (a) Calculate the volume of concentrated acid required to prepare 1.00 liter of 5.20-molar  $\text{H}_2\text{SO}_4$ .
- (b) Determine the mass percent of  $\text{H}_2\text{SO}_4$  in the original concentrated solution.
- (c) Calculate the volume of 5.20-molar  $\text{H}_2\text{SO}_4$  that can be completely neutralized with 10.5 grams of sodium bicarbonate  $\text{NaHCO}_3$ .
- (d) What is the molality of the 5.20-molar  $\text{H}_2\text{SO}_4$ ?