

Part II: Answer in separate answer book provided

1.

A laboratory returns the following water analysis data:

pH 8.22 EC 290 $\mu\text{S}/\text{cm}$

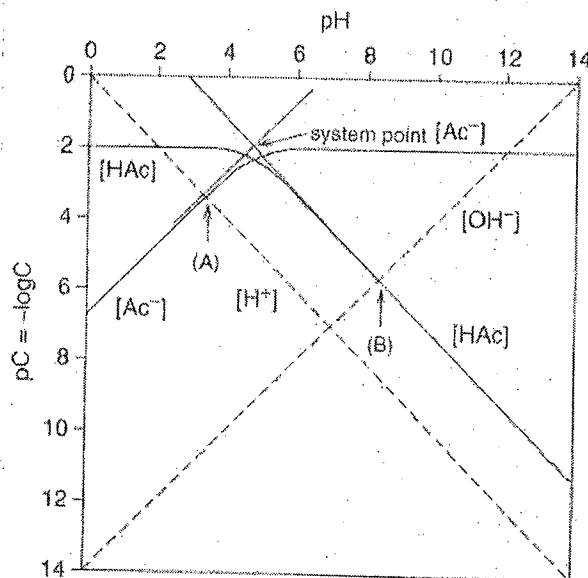
Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	SO_4^{2-}	NO_3^-
13.7	1.18	42.5	3.2	31.2	79.9	39	1.3

(mg/L)

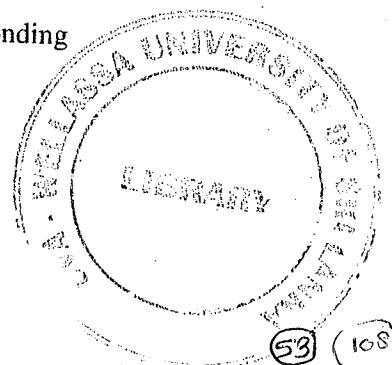
- Is this a reliable analysis? Reason your answer.
- Calculate total hardness of the water sample in mg/L CaCO_3 .
- Determine the alkalinity of the water sample.
- Estimate the TDS. After reviewing EC data comment on your answer.

2.

A chemical speciation diagram of a monoprotic acid is shown below. Answer following questions.



- Calculate the distribution of different species at pH 8 and pH 3. Which species are dominant? Show all steps in the deduction.
- Using the speciation diagram, calculate the pH of 10^{-2}M HAc solution.
- Prove that point B of the speciation diagram corresponds to 10^{-2}M NaAc.
- What is the meaning of dotted lines shown in the figure. State corresponding relationships.



3.

(a) Discuss the types of water sampling and preservation methods and their specific applications.

(b) State the meaning of following abbreviations:

(i) ICP-MS

(II) GC-MS

(III) IC

(IV) GFAAS

Briefly discuss their applications in water analysis.

(c) A 200 ml sample of water required 9.12 ml of 0.0200N H_2SO_4 for titration to the methyl orange end point, pH 4.5. What was the total alkalinity of the water sample?

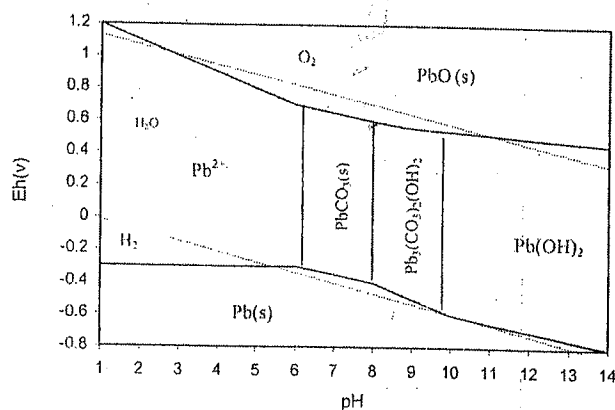
(d) Give two examples for ion selective electrodes. At 25 °C in a 2.63×10^{-4} M standard fluoride solution, a fluoride electrode reads 0.100 V vs. a reference electrode, and it reads -0.118 V in a water sample. What was the concentration of water sample? (hint: $E = E^0 - 59.2 \log \{F^-\}$).

4.

(a) Define the term Eh. How does it differs from pe?

(b) With the help of relevant Eh-pH diagram mark different water types.

(c) The diagram below illustrates some oxidation/ reduction chemistry of lead. Using this diagram answer following questions:



Water emerges as a spring from anaerobic groundwater source with a pH 4. It then flows over a limestone surface. Identifying dominant lead species describe what to be observed.

(d) Comment on the formation of acid mine drainage.

5.

(a) Define following terms.

(i) Specific surface area (II) Site density (III) Sorption

(b) State Langmuir equation identifying all terms therein. State assumptions made in the formulation of this model.

(c) Calculate the site density of arsenic sorption onto soils based on following data. Your answer should indicate the sorption density in mg/kg soil, mg/m² and $\mu\text{mol/m}^2$

Soil content used	2 g/L
Initial As(III)	50 ppb
Final As(III) in solution	27.7 ppb
Specific surface area of soil	34 m ² /g

(d) Comment on the uses of sorption processes in water industry.

