

MRT 453-1 Water Quality Data Management

**Instructions to candidates**

Duration: Two (02) hours

Number of questions: Four (04)

Answer all questions. Use the Visual MINTEQ software to generate the answers

Mark allocation: 100

1.
    - 1.1 Calculate the pH in 0.02 M  $\text{Na}_2\text{CO}_3$  and 0.02 ppm  $\text{NaHCO}_3$  at  $25^\circ\text{C}$  using the “Calculated from mass balance” option
    - 1.2 Calculate the pH in 0.02 M  $\text{Na}_2\text{CO}_3$  and 0.02 ppm  $\text{NaHCO}_3$  at  $25^\circ\text{C}$  using the “Calculated from mass and charge balance” option
    - 1.3 Compare the “Number of Iterations” used in “Calculated from mass balance” and “Calculated from mass and charge balance”
    - 1.4 In a 0.02 M  $\text{CaSO}_4$  solution pH is 7 at  $25^\circ\text{C}$ . State the possible speciation in concentration and activity scale
    - 1.5 In a 0.01 ppm  $\text{K}_2\text{SO}_4$  solution pH is 7.8 at  $24.5^\circ\text{C}$ . State the possible speciation in Concentration and activity scale
- (25 Mark)

2.
  - 2.1 A solution is containing 2 M  $\text{NaCl}$ . Add Sufficient  $\text{CaCO}_3(\text{s})$  powder to saturate solution. State the following parameters at  $20^\circ\text{C}$  if equilibrium with atmospheric  $\text{CO}_2$  is assumed?

- i. pH
- ii. Total dissolved  $\text{Ca}^{2+}$
- iii. Carbonate alkalinity

- 2.2 The chemistry of a tap water sample is given in the table. The pH is 8.68 at  $25^\circ\text{C}$ .

- i. Calculate the ionic strength of the sample
- ii. Predict ten (10) most possible mineral phases to be present in this sample
- iii. State the “Percentage of total concentration” of following ions
  - a.  $\text{HOCl}(\text{aq})$
  - b.  $\text{H}_3\text{SiO}_4^-$
  - c.  $\text{CaHPO}_4^-$
  - d.  $\text{Fe}(\text{OH})_4^-$
  - e.  $\text{NaHPO}_4$



Cation/Anoin	Concentration (mg/L)
H <sub>4</sub> SiO <sub>4</sub>	5.17
Ca <sup>2+</sup>	2.8
Mg <sup>2+</sup>	3.54
Na <sup>+</sup>	3.14
K <sup>+</sup>	4.0
SO <sub>4</sub> <sup>2-</sup>	4.7
Cl <sup>1-</sup>	2.5
CO <sub>3</sub> <sup>2-</sup>	7.78
NO <sub>3</sub> <sup>-</sup>	0.6
PO <sub>4</sub> <sup>3-</sup>	0.2
F <sup>-</sup>	0.88
Fe <sup>3+</sup>	0.05
Mn <sup>3+</sup>	0.04
OCl <sup>-</sup>	2.0

(25 Mark)

3.

3.1. To a 200 mL 2 M NaH<sub>2</sub>PO<sub>4</sub> solution, 60 mg of calcite powder is added. Assume a temperature of 23°C and that the system is equilibrated with atmospheric CO<sub>2</sub>.

- i. Will the calcite be completely dissolved or will some of it remain precipitated? If it is completely dissolved, state the "Total dissolved Calcite" amount or if some portion remain precipitated, state the precipitated "equilibrium amount of calcite".
- ii. What is the total dissolved Ca concentration at equilibrium?

3.2. Following ions are present in a water sample at 27°C. Using the chemistry of this water sample, answer the following questions.

Cation/Anoin	Concentration (mg/L)
Ca <sup>2+</sup>	1.5
Na <sup>+</sup>	2.14
SO <sub>4</sub> <sup>2-</sup>	3.7
Cl <sup>-</sup>	1.5
CO <sub>3</sub> <sup>2-</sup>	6.78
H <sub>4</sub> SiO <sub>4</sub>	5.17

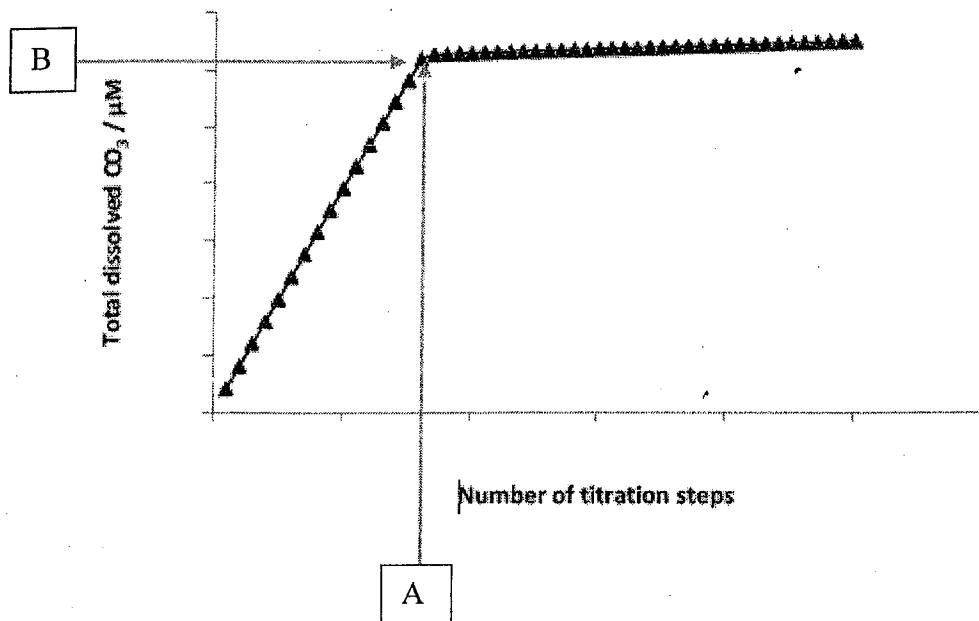
- i. Calculate the pH using "mass balance" option
- ii. Calculate the pH using "mass and charge balance" option
- iii. Calculate the "ionic strength" at both above instances
- iv. State 05 possible mineral phases from which the solution is saturated with.

(25 Mark)

4.

To a solution consisting of 50 mL 0.002 M  $\text{CaCl}_2$ , 0.001 M  $\text{Na}_2\text{CO}_3$  is added in 0.1-mL increments. The experiment was carried out in a sealed container with no gas exchange with the atmosphere, at 20°C. The initial concentration of  $\text{CO}_3^{2-}$  can be considered negligible.

- i. How many mL is required to add before  $\text{CaCO}_3(\text{s})$  is being precipitated
- ii. Generate the graph using MS Excel for development of  $\text{CO}_3^{2-}$  as a function of the  $\text{Na}_2\text{CO}_3$  addition and find out the values for A and B in the graph.



(25 Mark)

