

BACHELOR OF SCIENCE EXAMINATION, 2019

(1st Year, 2nd Semester)

GEOLOGICAL SCIENCES

Elements of Geochemistry

Paper : CORE : 3

Time : Two hours

Full Marks : 50

Use separate Answer Script for each part.

PART - I (25 marks)

Answer *all* questions.

1. Derive Nernst-Barthelot equation. What is 'Ionic Potential (IP)' ? "Compared to Cr, K has higher IP" Accept or reject the statement. 4+1+1

Why is plagioclase more common than pure anorthite in the crustal rocks ? 2

A rock undergoes 30% change in rock mass during chemical weathering and soil formation. If the difference in concentrations of an immobile element in the host rock and in the soil is 20 ppm, what was the initial concentration of the element in the rock prior to weathering ? If another element has concentrations 200 ppm and 170 ppm in the rock and in the overlying soil respectively, comment on the behavior of the element in the weathering process. 3

Why are the green leaves depleted in $\delta^{13}\text{C}$ relative to the immediate atmosphere ? 2

(Turn Over)

(2)

2. Assume that a mass of cloud ($\delta^{18}\text{O} = -9\text{/mil}$) condenses to produce rain. The fractionation factor between the two phases ($\alpha_{\text{rain-cloud}}$) is 1.0092. What will be the $\delta^{18}\text{O}$ of the cloud after 50% of condensation. What will be the corresponding $\delta^{18}\text{O}$ of the rain water? Is it possible that $\alpha_{\text{rain-cloud}}$ has a value < 1 ? What happens to the $\alpha_{\text{rain-cloud}}$ if the temperature of condensation decreases?

$4^{1/2} + 1^{1/2}$

OR

3. Why do compounds with stronger bonds prefer heavier isotopes?

A quartz and albite vein cuts through a basic rock. Minerals in the vein are in equilibrium. Calculate the temperature of formation of the vein? Given the following:

$$1000 \ln a_{\text{qtz-w}} = 3.13 * 10^6 T^{-2} - 2.94$$

$$1000 \ln a_{\text{ab-w}} = 2.39 * 10^6 T^{-2} - 2.51$$

$\delta^{18}\text{O}$ of quartz and albite are 8/mil and 7/mil respectively.
T is in $^{\circ}\text{C}$.

3+3

4. A marine water has the molar concentrations of 3.74×10^{-4} and 5.50×10^{-5} for Ca^{2+} and $(\text{CO}_3)^{2-}$ respectively. The equilibrium constant for the calcite (CaCO_3) dissolution reaction is $K = 4.90 \times 10^{-9}$. Given the activity coefficients of 0.57 for Ca^{2+} and 0.56 for CO_3^{2-}

(5)

12. Compare between (a) S-process and R-process of nucleosynthesis, (b) homogeneous and heterogeneous accretionary model for the formation of core and mantle.

$2^{1/2} + 2^{1/2}$

—— X ——

(4)

8. Explain why large ion lithophile elements (LILE) are generally more mobile during chemical weathering than the high field strength elements (HFSE). Also explain why Ta and Nb are relatively more incompatible compared to Zr and Hf during magmatic crystallization. 3+2
9. Antarctica is considered the store house of meteorite—why? Explain with reasons the fundamental difference between the composition of solar photosphere and CI carbonaceous chondrite? “CI carbonaceous chondrites are extremely important for earth science research – justify the statement. $1\frac{1}{2}+1\frac{1}{2}+2$
10. For a suite of co-genetic igneous rocks the initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are same whereas the $^{87}\text{Rb}/^{86}\text{Sr}$ ratios are different – why? What is (are) the major problem(s) in using K-Ar geochronometer in dating minerals? 4+1
11. Do you think that $\delta^{13}\text{C}$ values of organic matter of archaeological significance can provide clues to the then local climate? Justify your answer. “Sulphide minerals formed by H_2S , derived from bacterially reduced seawater SO_4^{2-} , are characterized by much lower $\delta^{34}\text{S}$ values than that of the sea water – accept or reject the statement with reason. $2\frac{1}{2}+2\frac{1}{2}$

(3)

respectively. Is the solution saturated, undersaturated or oversaturated with respect to calcite? If the marine water behaves as ideal solution for all its chemical species what change would you expect in regard to the solubility of calcite? 6

OR

5. What is Nernst equation? Calculate the maximum Eh at which H_2O can be stable at $\text{pH} = 7$ (at 25°C). Given that $E^\circ = 1.23\text{v}$ and $P_{\text{O}_2} = 0.2$ bar. 6

PART - II (25 marks)

Answer any *five* questions.

6. Explain why the abundance of Le, Be and B are abnormally low in the solar system. Why these elements are thought to have formed during galactic nucleosynthesis? 3+2
7. Using suitable diagram compare the partition coefficients of rare earth element in hornblende and plagioclase feldspar with respect to a basaltic melt. Also, compare the expected rare earth element pattern of a rock formed from a residual melt after fractional crystallization of hornblende and plagioclase feldspar separately from such a melt. $2\frac{1}{2}+2\frac{1}{2}$

(Turn Over)