

Date: 27<sup>th</sup> November, 2018  
Time: Three hours

ES3104  
MINERALOGY  
Marks: 50

1. (a) Under the petrographic microscope, in parallel white light, a colourless non-pleochroic grain of a mineral always remains dark between cross-polars as the stage is rotated. Is it true that the mineral must be an isotropic mineral? Justify your answer. [4]  
(b) In orthoscopic observation the increase in the order of interference colour going from periphery of a grain to its centre is just the opposite of that for the same grain in conosopic observation. With the help of neat labelled diagram(s), clearly explain the reason(s) for this difference. [6]
2. With the help of neat labelled diagram(s) explain the difference in cleavages in pyroxenes and amphiboles. [10]
3. (a) Draw a neat labelled diagram showing the compositions of Ca-Mg-Fe pyroxenes at high temperature. Mark and label all the major compositions, and major composition fields. Also mention the crystal system(s) in which they crystallize. [6]  
(b) What is the major difference in structure between biotite and muscovite? [4]
4. (a) Derive the Bragg equation for the interaction between X-rays and the crystal structure. [6]  
(b) Does the equation involve true reflection of X-rays? Explain your answer. [4]
5. (a) Under what conditions would you expect olivine and quartz to coexist? [1]  
(b) What are the differences between Normal and Inverse spinel? [1]  
(c) What are the processes responsible for production of growth and retrograde zoning in garnet? [2]  
(d) Using the data given in the attached table, show that kyanite is stable over sillimanite at 12000 bars and 600°C and that andalusite is stable over sillimanite at 3000 bars and 475°C (assume  $V^T = V^{298.15}$ ). [6]

Alternative question (in lieu of Question 5d)  
only for students taking this course as Minor

- (d) Phase relations in feldspars are complicated by both structural transformations and presence of various solvi - support this statement with T-X diagrams for alkali feldspars and plagioclase feldspars. Under what conditions, plagioclase takes up K-feldspar component? [5+1 = 6]

*Sample* 27/11/18

*Brathnam*  
27-11-18

P (bars)	1
T(°C)	25 T(K) 298.2

	H(J)	S(J)	V(J/Bar)	a(CpTerm1)	b(Cp Term2)	c(Cp Term 3)	d(Cp Term4)
Andalusite Al <sub>2</sub> SiO <sub>5</sub>	-2588770	92.7	5.153	277.3	-0.006588	-1914100	-2265.6
Sillimanite Al <sub>2</sub> SiO <sub>5</sub>	-2585890	95.5	4.986	280.2	-0.0069	-1375700	-2399.4
Kyanite Al <sub>2</sub> SiO <sub>5</sub>	-2593130	83.5	4.414	279.4	-0.007124	-2055600	-2289.4

$$C_p = a + bT + cT^{-2} + dT^{-1/2}$$

*Hept* 27/11/18

*Brute Change*  
27-11-18