

GEO2-1205 Tentamen: MINERALS**17 October 2006**

Name _____ Student nummer _____

**YOU MUST ANSWER ALL PARTS OF QUESTIONS 1-4
FOR QUESTION 5 CHOOSE ONLY ONE PART, EITHER A,B,C OR D.**

QUESTION 1

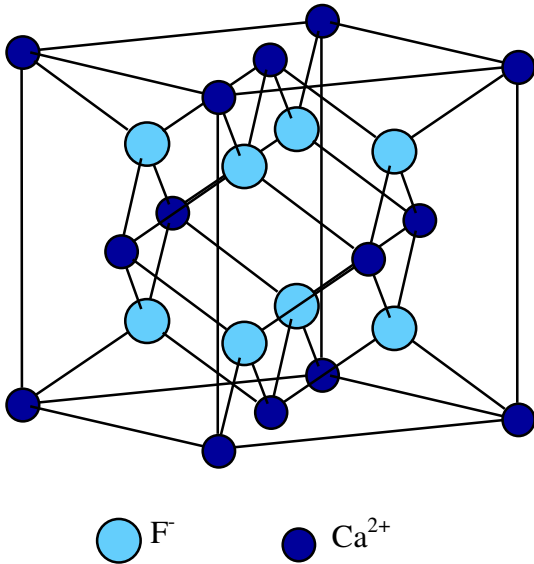
- a) Why do we use x-ray diffraction and not an optical microscope to determine the structure of a mineral?
- b) List the differences between a *mineral*, a *crystalline solid* and an *amorphous solid* in the following table. Give an example of a solid material for each category:

Mineral	Crystalline solid	Amorphous solid
Example:	Example:	Example:

- c) Which part of a crystal structure is influenced by both rotational and translational symmetry?

QUESTION 2

The following crystal structure represents a close packed mineral



a) What type of close packing does this structure represent, HCP or CCP?

b) How many layers of close packed atoms are there before the structure repeats?

c) How are the tetrahedral sites filled in this structure?

c) Which mineral is this structure named after?

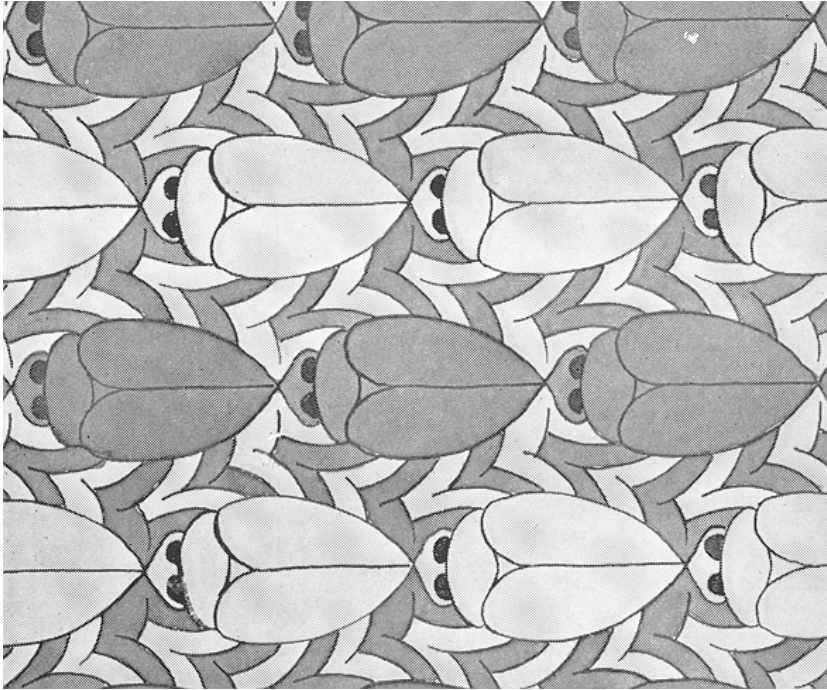
d) What is the structural difference between the structure given above and that of sphalerite (ZnS)?

e) Another cation could substitute for Ca²⁺ in the structure shown above. Which two properties of the cation would be most critical in controlling its incorporation into this structure?

f) Silicate minerals are not close packed. Which group of silicates is the closest to being close packed?

g) Give an *optical property* of a silicate mineral that indicates approximately how close its constituent atoms are packed together

QUESTION 3



**Look at the Escher pattern above and answer the following questions.
Draw on the diagram above to give your answers for parts a) and b)**

- a) Show the 2D symmetry elements using the official symbols for rotation axes, mirror planes and glide planes on the diagram.
- b) Draw the boundary of the unit cell
- c) What is the plane group? *Use Appendix A at the end of this exam paper to help you.*

- d) What is the multiplicity of the motif?
- e) Explain the difference between a special and a general position in the motif.

QUESTION 5

IMPORTANT: FOR THE FOLLOWING QUESTION CHOOSE ONLY ONE PART - EITHER A, B, C OR D

5A OPTION A

a) Name an example of an island silicate and give its chemical formula

What is the Si:O ratio in an island silicate mineral?

b) Why do island silicate minerals not show cleavage? Give the main crystallographic and structural controls in your answer.

c) Where in the Earth would you expect to find abundant island silicate minerals?

d) What is a *solid solution*? In your answer give the most important structural and chemical controls on this process.

5B OPTION B

a) How many bridging oxygens are present per $[\text{SiO}_4]^{4-}$ tetrahedron in

(i) a single chain silicate? _____

(ii) a double chain silicate? _____

b) Pyroxene is a single chain silicate mineral which has two types: orthopyroxene (opx) and clinopyroxene (cpx)

Which crystal systems do ortho- and clinopyroxene fall into:

OPX Crystal system: _____ Conditions: a ____ b ____ c ____ α ____ β ____ γ ____

CPX Crystal system: _____ Conditions: a ____ b ____ c ____ α ____ β ____ γ ____

c) What is *cleavage*? How many cleavages are present in pyroxene?

d) Under what specific conditions do the amphibole minerals crystallize, as can be predicted from their chemical composition?

5D OPTION D

- a) How are the tetrahedra linked in a framework silicate mineral?
- b) Which *cations* play an important role in the framework silicates and why?
- c) Silica (SiO_2) has a number of polymorphs that exist under different pressure and temperature conditions. Which phase is most stable at standard pressure and temperature conditions?

Give the properties of the mineral that you just described in hand specimen and describe the general structural and chemical reasons for these properties:

Colour:

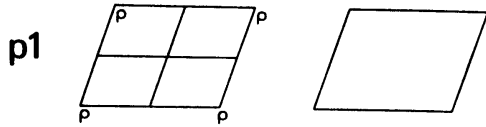
Cleavage:

Crystal shape and hence crystal system:

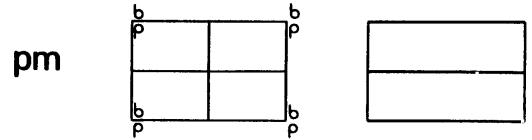
- d) Anorthite ($\text{CaAl}_2\text{Si}_2\text{O}_8$), Albite ($\text{NaAlSi}_3\text{O}_8$) and Sanidine (KAlSi_3O_8) are all types of feldspar that are used on a ternary composition diagram to show the solid solutions that are possible. Which two of these compositions do not show solid solution?

Appendix A: Two dimensional plane groups

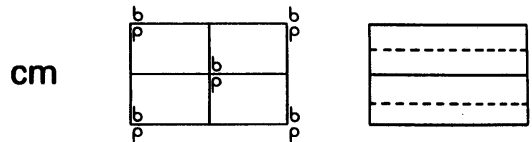
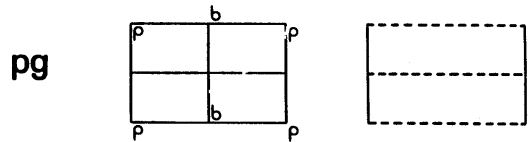
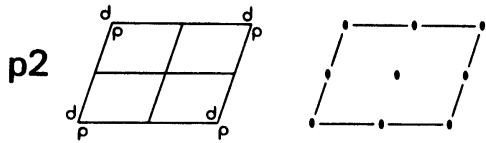
1 Oblique



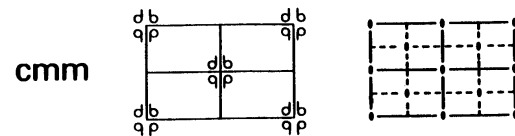
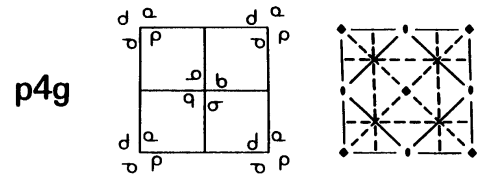
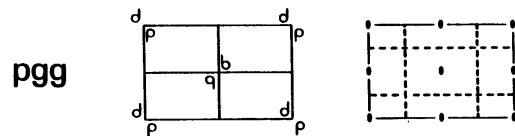
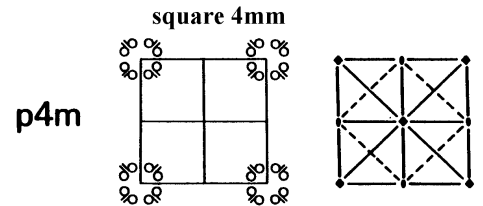
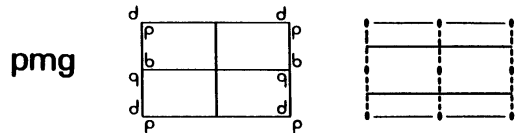
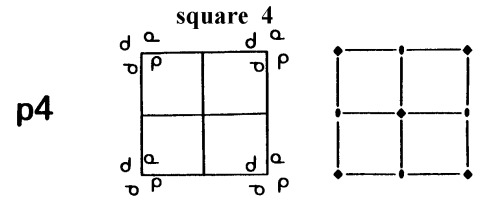
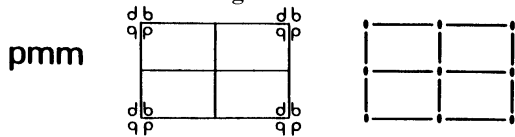
Rectangular m

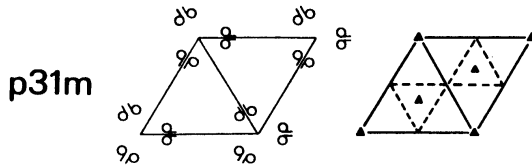
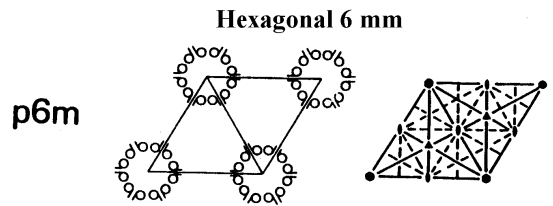
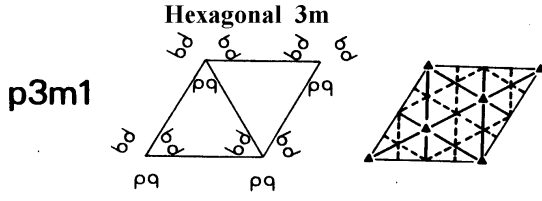
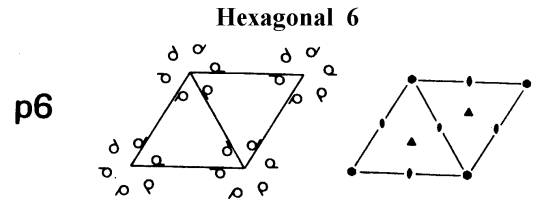
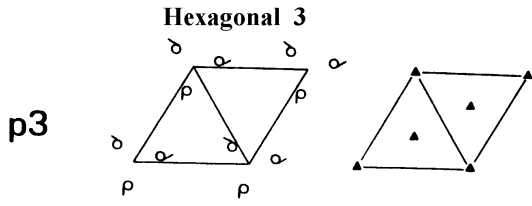


2 Oblique



Rectangular mm





EXTRA PAPER FOR ANSWERS

