

LECTURE TEST 1
September 23, 2004

Please **read** each of the questions **carefully**. *Answer all portions of each question.* **Ionic radii** and **electronegativity** values are given on the last page. Partial credit makes a difference, do not leave blanks! Points given in (). Use the back of the sheet if more space is required. **GOOD LUCK!** .

1. Mineralogy is the study of minerals - the materials that compose our Planet Earth. The definition of a mineral includes specific criteria that must be meant in order for a material to be classified as a mineral. List these five criteria. (10)

- (a)
- (b)
- (c)
- (d)
- (e)

Given the above definition, would you consider calcite in sea shells to be a mineral? Why or why not?

2. The physical and chemical properties of a mineral result, in part, from the type(s) of bonding. (1) **Fill in the major bond types**, exclusive of H bonding (row of BOND). (2) For each of the properties, describe the characteristic that each principle bond type imparts. (16)

BOND	.....	.....	.....	.....
Bond Strength (strong-weak)	.....	.....	.....	.....
bonding mechanism	.....	.....	.....	.....

3. What bond type produces the hardest minerals? (2)_____

4. What bond type produces the weakest minerals?(2) _____

5. What bond type conducts electricity? Why? (3)
6. If you can scratch kyanite (a mineral) parallel to the 'c' crystallographic axes, but you can not scratch it parallel to the 'a' crystallographic axes, which direction has the strongest bonds? (3)
7. What is the bond strength of the following bonds? (8)

Ti^{4+} in octahedral coordination with oxygen in biotite? _____

Fe^{+2} in tetrahedral coordination with oxygen in staurolite? _____

Si^{4+} in tetrahedral coordination with oxygen in olivine? _____

Which bond is stronger? _____

8. What is the coordination number when radius ratio (RR) = 1? (5) _____
Describe the resulting packing of spheres.

9. Minerals can be grouped into 32 crystal classes based on their translation-free = (_____) symmetry elements. For these symmetry operations, one _____ is left unchanged in the crystal, therefore we also call these crystal classes _____ groups.

What are these *elements* and the *operations* required to produce these classes? (19)

Operation	Element
.	
.	

10. In 3D crystals, two additional symmetry elements are produced by adding translation to the above. What are these *elements* and the *operations* required to produce them? (5)

Element	Operation(s)
.	
.	

Combining the 14 lattices with the 32 point groups, results in 230 _____.

11. What is a unit cell? (3)

12. Many sulfide minerals display a metallic luster. Why is this? (3)

13. Is five-fold symmetry possible in a mineral? Why? or Why not? (3)

14. Color is one of the most visible but least diagnostic properties of a mineral. (15)

We see color because of light that is _____

When can we use color as a diagnostic property? _____

Color is produced by four different mechanisms. List and briefly describe these.

- (a)
- (b)
- (c)
- (d)

15. When the following cations are coordinated with $O^{2-} = 1.40$, what is the resulting shape of the coordination polyhedra and what is the coordination number? (Show your work) (10)

<u>Ion</u>	<u>Coordn. Polyhedra</u>	<u>Coordn. Number</u>
Ba^{2+}
Si^{4+}
Al^{3+}
Mg^{2+}

Which coordination polyhedra is the most likely to share faces? _____

Which is the least likely to share faces? _____

Why?

16. The 32 crystal classes can be grouped into six crystal systems. (18pts)

(a) What is a crystallographic axis?

(b) Fill in the table below. Name the six crystal systems. Describe them by giving the relative lengths of each axis and the angles between the axes. If the crystallographic axes are coincident with any symmetry elements, give the relationship between symmetry elements and crystal axes for each crystal system (for the most symmetric class) in the column xl axes to Rotn axes.

Name	XL System	Axes Length	Angles b/t Axes	xl axes to Rotn Axes

(c) One system has an a subsystem. Describe the subsystem and how it differs from the system.

17. Determine the bond type(s) of the following compounds. Show your work. For those compounds that are mixtures of ionic and covalent, what is the percent ionic character of the bond(s)?

- | | |
|-----------------------------------|----------------------|
| Mg_2SiO_6 | Au-Au in gold..... |
| Te-As in enargite | $CaCO_3$ |
| Al(OH) | CuS_2 |
| Graphite (C), within layers | between layers |

18. The most stable configuration between cations in two adjacent polyhedra in a crystal structure is:(3) (Circle the correct answer)

face-sharing edge-sharing corner-sharing

Why?

19. Why does Ba^{2+} have a cubic coordination whereas B^{+4} has tetrahedral coordination? (3)

BONUS: 6 points possible.

BONUS: Whyt does naming hurricanes after men make no sense?

BONUS: Why are Pauling's Rules important to Mineralogy?

BONUS: Name three people who were important to the development of the science of crystallography. State their contributions. (6)