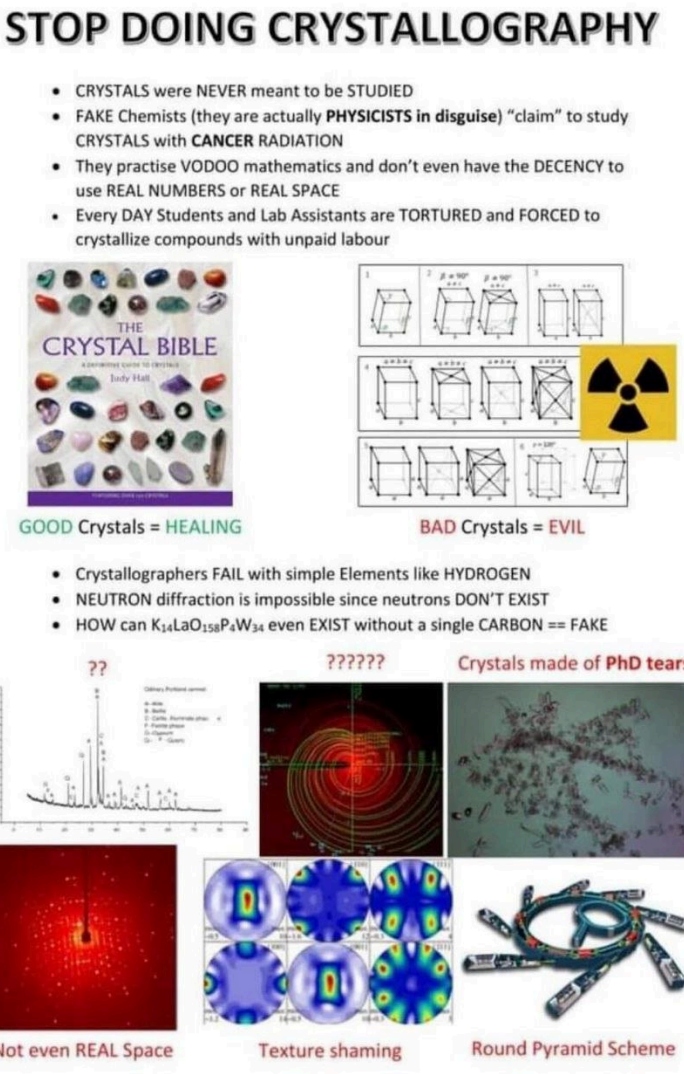
Kentuckiana Material Science KEY KEY KEY KEY

Dec 7, 2024



Team Name: _____

Participant Names: _____

Score: 125/125

Questions? Contact tanya1wu@gmail.com

Part 1: Ceramics Manufacturing [2 pts each]

1. In which of the following methods is a liquid mixture poured out of a plaster mold?
    a. Injection Molding
    b. Slip Casting
    c. Dry Pressing
    d. Throwing
2. Which of the following is not a common purpose of glazing ceramics?
    a. Creating water impermeability
    b. Glaze gives a tougher surface
    c. To prevent adherence of pollutants
    d. To simplify the ceramics manufacturing process
3. Which of the following is not an advantage of injection molding?
    a. Cheap design changes
    b. Allows for tight tolerances
    c. Time efficient
    d. Ability to reuse materials
4. What of the following is synonymous with additive manufacturing?
    a. Continuous manufacturing
    b. 3D printing
    c. Discrete manufacturing
    d. Sheet lamination
5. Which of the following is the term for vitreous ceramic of zero/low absorption after firing?
    a. Whiteware
    b. Earthenware
    c. Stoneware
    d. Chinaware
6. What is the primary reason that ceramics manufacturing releases large quantities of CO2?
    a. Gas bubbles are released from within pieces
    b. Kilns indirectly release CO2
    c. Milling and forming require large energy inputs
    d. Mining glaze materials produces environmental harm
7. Which of the following is not a problem with machining ceramics?
    a. Circles
    b. Pointy edges
    c. Holes close together

d. Corners

8. How does sintering reduce pores in ceramics?
    a. Melting particles
    b. Reducing surface energy of particles
    c. Vaporizing small amounts of the ceramic
    d. Increasing the number of particles
9. What country leads the world in ceramics manufacturing?
    a. China
    b. Russia
    c. US
    d. Canada
10. What is the primary function of the vacuum chamber in brick manufacturing?
    a. Expand clay
    b. Compresses
    c. Cools
    d. Degasses

History/General Use [1.5 pts each]

11. Which of the following locations are thought to have developed ceramics the earliest?
    a. Tanzania
    b. Iraq
    c. China
    d. Greece
12. Why was porcelain created later than earthenwares?
    a. Kilns could not reach the necessary temperatures
    b. Methods for developing denser clay haven't been discovered
    c. Treatment for bacteria in earthenware wasn't discovered
    d. Combinations of materials weren't possible before the Silk Road
13. What is a not a potential use of ceramic superconductors?
    a. Low loss electric power transmission
    b. Superconducting Quantum Interference Devices
    c. Electroceramics
    d. Plasma creation in fusion reactors
14. What is the purpose of creating ceramic matrix composites?
    a. Increase crack resistance
    b. Decrease cost
    c. Decrease shrinkage
    d. Increase control of microstructure

15. Which allotrope of carbon is most commonly added for ceramic composites?
    a. Graphite
    b. Coal
    c. Diamond
    d. Fullerene

16. What phenomenon can be seen here?
    a. Crazing
    b. Shivering
    c. Cracking
    d. Crawling
17. What is a remedy for crazing?
    a. Decrease in silica
    b. Increase in feldspar
    c. Increase in potassium
    d. Increase in boron
18. Where does the traditional blue in Chinese porcelain come from?
    a. Iron
    b. Cobalt
    c. Tin
    d. Manganese
19. Which of the following materials generally experiences the most thermal expansion?
    a. Polymers
    b. Ceramics
    c. Metals
20. What is the primary starting ingredient in Portland cement?
    a. Aluminum Oxide
    b. Calcium Carbonate
    c. Calcium Bicarbonate
    d. Calcium Oxide

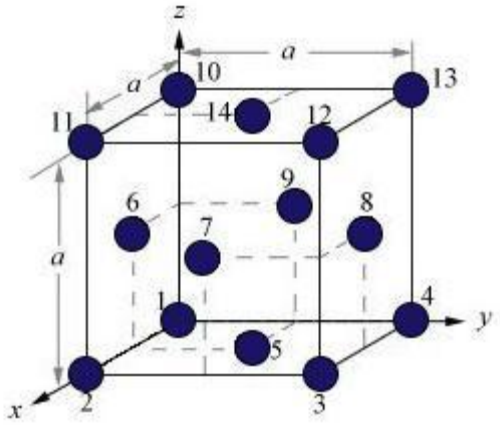
Structure [3 pts each]

21. If the cation to anion radius ratio is 0.800, what is the likely coordination number?
    a. 2

b. 3
c. 4
d. 8

22. What is the coordination number of Chlorine minus the coordination number of Sodium in NaCl?
    a. -1
    b. 0
    c. 1
    d. 2
23. What is the theoretical density of NaCl given that the ionic radii of Na+ and Cl- are 0.102 and 0.181 nm respectively, and NaCl adopts the rock crystal structure.
    a. 0.212 g/cc
    b. 0.214 g/cc
    c. 0.216 g/cc
    d. 0.218 g/cc
24. What is the oxidation number of silicon in Akermanite? Akermanite: $Ca_2MgSi_2O_7$
    a. -4
    b. -1
    c. +1
    d. +4

For questions 25 and 26 use the following image.

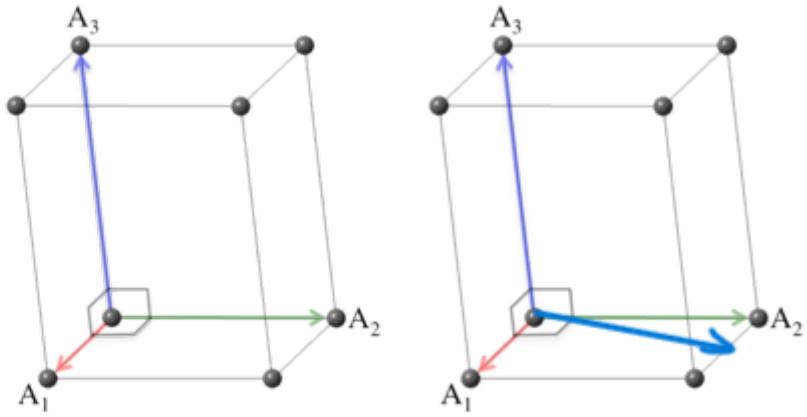


25. What is the crystal system?
    a. Tetragonal
    b. Orthorhombic
    c. Monoclinic
    d. Cubic

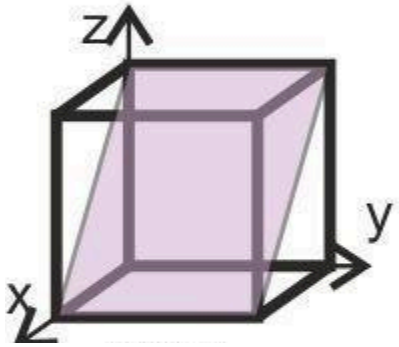
26. Which of the following points has the coordinates 0 0 1?
    e. 10
    f. 11

g. 12
h. 13

27. Draw the following vector [1, 2, 0]. The red line is the x axis, and the green line is the y axis. The reference point should be where all 3 arrows originate.



28. What is the Miller Index for the following plane?



a. 101
b. 110
c. 011
d. 111

29. For a particular hexagonal system, the Miller-Bravais indices include h = 1, k = 0, and l = -1. Find index i.

a. -1
b. 0
c. 1
d. 2

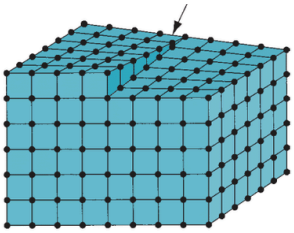
30. Calculate the linear density of Aluminum in a FCC structure in the [110] direction. The length of a unit cell is 0.405 nm.

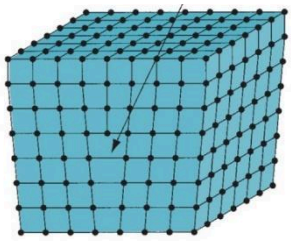
a. 2.7 nm^{-1}

b. $2.7\ g^{-1}$
c. $3.5\ nm^{-1}$
d. $3.5\ g^{-1}$

31. Calculate the planar density of Iron in a BCC structure in the [111] direction. The atomic radius of iron is 0.124 nm.
    a. $0.70*10^{19}\ m^{-2}$
    b. $0.80*10^{19}\ m^{-2}$
    c. $0.90*10^{19}\ m^{-2}$
    d. $1.00*10^{19}\ m^{-2}$
32. What is the coordination number of a cation in an octahedral position?
    a. 2
    b. 4
    c. 6
    d. 8
33. Which defect not would keep Iron Oxide stoichiometric, given that it contains an Fe^{2+} vacancy?
    a. 2 Fe^{3+} forming
    b. O^{2-} vacancy
    c. 2 Fe^{2+} forming
    d. Fe^{3+} forming
34. How would you expect the number of Frenkel defects given an absolute doubling of temperature?
    a. Halve
    b. Increase, but less than Double
    c. Double
    d. Increase, but more than double
    e. Not enough information
35. Calculate the number of Schottky defects per cubic centimeter of potassium chloride at 500C. The energy required to form each defect is 2.6 eV, and the density of KCl (at 500C) is $1.955\ g/cm^3$.
    a. $1.78 * 10^{13}$
    b. $2.40*10^{13}$
    c. $3.42*10^{13}$
    d. $5.31*10^{13}$

36. Which of the following displays a screw dislocation?

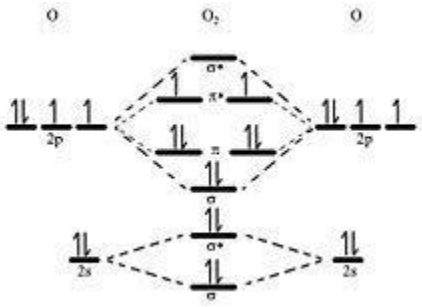
a. 

b. 

37. Which of the following is a limitation of scanning electric microscopes (sem)?
    a. Samples must be electrically conductive
    b. Samples must be etched
    c. Samples must be larger than 0.01 grams
    d. Samples cannot be photographed
38. Which of the following changes would increase the size of salt crystals?
    a. Maintaining low humidity
    b. Slower cooling
    c. Increasing impurities
    d. Supersaturating salt solution
39. What is the definition of anisotropy?
    a. Having different forms with the same chemical formula
    b. Having the same physical properties in all temperatures
    c. Having the different properties in different directions
    d. Having multiple crystals within a structure
40. A wavelength strikes a crystal at 38.3° and has a wavelength of 700 nm. What is the distance between the two layers? It is first order diffraction.
    a. 475 nm
    b. 520 nm
    c. 565 nm
    d. 570 nm

Properties [3 pts each]

41. Which of the following mechanical tests allows you to determine the effects of long term stress of a material under high temperatures?
    a. Fatigue Testing
    b. Impact Testing
    c. Creep Testing
    d. Corrosion Testing
42. If a sample has a Young's modulus of 3 GPa. If a sample fails at a strain of 0.05, what was the stress of at failure?
    a. 50 MPa
    b. 100 MPa
    c. 150 MPa
    d. 200 MPa
43. 2 identical cubes at 60C are placed into separate containers of room temperature water. If cube a has a specific heat of 0.6 J/gC, and cube b has a specific heat of 0.7 J/gC, what would be the conditions once equilibrium was reached?
    a. The temperature of both would be the same
    b. The temperature of A would be higher
    c. The temperature of B would be higher
44. What is the conversion factor between Mohs and Brinell Hardness?
    a. 50
    b. 1/50
    c. 100
    d. There is no conversion factor
45. Which of the following properties is negatively correlated with Young's Modulus?
    a. Elongation
    b. Yield Stress
    c. Failure Stress
    d. Ultimate Tensile Strength
46. Given the following molecular orbital theory diagram, what are the likely magnetic properties of the material?
    a. Attracted to magnets



47. 2 metal rods of 5 meters are at 20C. Rod A has a thermal expansion coefficient of $12*10^{-6}$ K^{-1}, and Rod B has a thermal

expansion coefficient of $10*10^{-6}$ K^{-1}. What is the difference in length of Rod A and B after the temperature is raised to 100C?

a. 0.08 mm

48. A 2mm thick sheet has a thermal conductivity of 400 W/mK. What is the heat flux through the sheet when the temperature difference across it is 150C?

a. $-3.0*10^{7}$

49. Calculate the critical angle at which total internal reflection occurs for a light ray travelling from water (n=1.333) to glass (n=1.50)

a. None

50. Calculate the resistivity of an electroceramic if a wire the diameter of 2 mm and length of 5 meters has a resistance of 0.168 Ω?

a. $1.06*10^{-7}$ Ωm