

**San José State University**  
**Chemical and Materials Engineering**  
**MatE 115 Structure and Properties of Solids**  
**Fall 2009**

<b>Instructor:</b>	Dr. Gleixner
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<b>Office Hours:</b>	Mon 9:30-11:30, Tu 9-10, 1:30-2:30, and Th 9-10
<b>Class Days/Time:</b>	Tu and Th 3-4:15 pm in Clark Hall 202
<b>Prerequisites:</b>	For undergraduates only: 2.0 average for Phys 71 or Phys 51 and Phys 52, Math 32 and Math 133A, Chem 1A, Chem 1B; MatE 25 (with a grade of "C"); graduate students require instructor consent. Corequisite: Engr 10

### **Course Description**

Bonding and crystal structure; the space lattice and unit cell calculations; crystalline anisotropy; point, line and surface defects; phase equilibria and interpretation of phase diagrams; thermal activation and the vacancy mechanism of mass transport in solids.

### **Course Goals**

This class provides the foundation for your future education and career in materials science. Critical to how a materials scientist think is classifying how materials are similar and different at an atomic and microstructural levels. Through this course, you will obtain the framework and nomenclature for classifying materials through crystal structures and crystallography. You will go on in future classes to understand how these structures influence properties and how you can change the structure and properties through processing.

The other primary goal of this course is to get you acclimated to the Chemical and Materials Engineering department at SJSU and to a future career in materials engineering. Hopefully, you will leave the course feeling engaged in our department's community and excited for what you will learn and do in this field.

### **Textbooks**

Required: Allen and Thomas, The Structure of Materials (MIT Series in Materials Science and Engineering).

Highly Recommended: Abbaschian, Abbaschian, and Reed-Hill, Physical Metallurgy Principles, 4<sup>th</sup> edition, PWS-Kent Publishing. (You will use this text in MatE 154 and it is optional for MatE 152.)

### **Class Blackboard Site**

This course will conduct all of its communications outside of class using Blackboard Learning System. All of the online resources including solutions to in class work, homework, and exams will be on Blackboard. To access the class site at Blackboard you must be enrolled in the course. Go to the <http://www.sjsu.edu/ecampus/students/>. The username, password, and login are on the right. On the left, there is a tutorial you haven't used Blackboard before.

### **Classroom Protocol**

Silence all cell phones during the class period (you are rolling your eyes here...but let's count how many times they go off during the semester). Please arrive on time for class. I will collect all homework and assignments at the very start of class. If you are late to class, you will be marked down 10% on the assignment. Please hold all assignments to pass in to the end (it is very disruptive when you walk up and hand it to me during the floe of the class).

### **Dropping and Adding**

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's [Catalog Policies](http://info.sjsu.edu/static/catalog/policies.html) section at <http://info.sjsu.edu/static/catalog/policies.html>. Add/drop deadlines can be found on the [current academic calendar](http://www.sjsu.edu/academic_programs/calendars/academic_calendar/) web page located at [http://www.sjsu.edu/academic\\_programs/calendars/academic\\_calendar/](http://www.sjsu.edu/academic_programs/calendars/academic_calendar/). The [Late Drop Policy](http://www.sjsu.edu/aars/policies/latedrops/policy/) is available at <http://www.sjsu.edu/aars/policies/latedrops/policy/>. Students should be aware of the current deadlines and penalties for dropping classes.

Information about the latest changes and news is available at the [Advising Hub](http://www.sjsu.edu/advising/) at <http://www.sjsu.edu/advising/>.

### **Assignments and Grading Policy**

Course Element:	%
Homework	10%
In-class Activities	5%
Blackboard Discussions	5%
Reading Assignments	5%
Grand Challenges Project	15%
Crystal Structure Project	15%
Midterm	20%
Final Exam	25%
Total	100 %

Total Course Score	Letter Grade
97-100	A+
93-96	A
90-92	A-
87-89	B+
83-86	B
80-82	B-
77-79	C+
73-76	C
70-72	C-
60-69	D
< 60	F

### **In Class Activities**

You will be actively involved in doing things during the class period. The general flow of each class period is that we will review what you worked on at home and the reading assignment, go over any questions that work sparked, work on harder applications of that material, and then wrap-up with any lingering questions. This flow can be very effective at ensuring you understand the material. However, it only works if come to class prepared! Do the reading and review last class's notes so that you can actively participate and get all your questions answered.

### **Homework and Reading Exercises**

Homework must be submitted by the start of class period. If you are late to class or miss class, you can pass it in at the end of class or by the close of the day (5pm) for 10% off. If you have a legitimate, verifiable excuse such as travel for work or illness with a doctor's note, let me know and an alternative deadline will be agreed upon between us.

You are encouraged to work together on the assignments. However, you must pass in individual homework solutions. You are required to list the names of the students you worked with below your name in the upper right hand corner of your packet. Groups can be no larger than 3 students. If similar solutions are passed in by multiple students but they do not state they worked together, all the students will receive a 0 on that assignment.

You must have actively participated in solving everything you pass in and have a full understanding of the solution you submitted. Copying partial or complete answers from other students is unacceptable. *You will receive a 0 on the assignment and be reported to the University if you copy any portion of the homework or if you allow your homework to be copied. It is also a violation of the University academic honesty code to allow your work to be copied. You will receive a 0 on the assignment and be reported to the University if you allow your work to be copied.*

Test questions will target material learned through the homework. If you do not fully understand the solutions you pass in, you not only risk getting a 0 on that assignment but you will not be able to answer the related questions during the tests. This will significantly affect your overall grade! **Come to office hours if you are having trouble doing the homework yourself.**

There will be a number of reading assignments throughout the semester. **They are most likely going to be due on Tuesdays every week. They are not listed on the course schedule so watch Blackboard for the assignments.** These assignments have a dual purpose of helping you gain the crucial information from the assigned textbook reading while teaching you some general skills to read more effectively.

### **Blackboard Discussions**

We will be using the Blackboard discussion board to continue to learn and apply the material outside of class. All students are expected to participate in the discussions. To participate, you can post questions, answer other postings, or refer students to related links and applications you found. Full participation would be a minimum of five thoughtful postings over the course of the semester.

### **Grand Challenges in Materials Project**

The National Academy of Engineering has identified 14 Grand Challenges in Engineering. These are listed at <http://www.engineeringchallenges.org/cms/8996.aspx> As you look at the list, you will see that a number of them are very dependent on research in materials science and engineering. You will be participating in a group project to create a

- Project Preference “Form” on Blackboard

- Individual 1 page summary of Grand Challenge on Blackboard (15%)

- Individual maximum 3 page summary of technical paper on Blackboard (25%)

- Group oral presentation (60%)

### **Turnitin.com**

All project writing assignments must be uploaded to turnitin.com. Our course site info is class ID: **2822013**, enrollment password: **materials**

### **Crystal Structure Project**

Groups of students will be assigned two materials by me. Your group needs to prepare something (presentation, YouTube video, physical model, poster...) that explains what the two materials are used for and goes into the detail of the symmetry and crystal nomenclature to classify the two structures. Your project should highlight all the terminology we learn in the class and emphasize the similarities and differences between the materials.

### **Examinations & Quizzes**

There will be a midterm and a comprehensive final exam. Both tests will be open book, open notes. However, you will not have access to any electronic devices (other than a calculator) and you will not have access to the Blackboard site. You must bring a

calculator to the examinations. To study for the tests, you should review the readings, course lecture notes, homework, and learning objectives well in advance of the test date.

## **University Policies**

### **Academic integrity**

Students should know that the University's [Academic Integrity Policy](http://sa.sjsu.edu/judicial_affairs/faculty_and_staff/academic_integrity/index.html) is available at [http://sa.sjsu.edu/judicial\\_affairs/faculty\\_and\\_staff/academic\\_integrity/index.html](http://sa.sjsu.edu/judicial_affairs/faculty_and_staff/academic_integrity/index.html). Your own commitment to learning, as evidenced by your enrollment at San Jose State University and the University's integrity policy, require you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The [Student Conduct and Ethical Development website](http://www.sa.sjsu.edu/judicial_affairs/index.html) is available at [http://www.sa.sjsu.edu/judicial\\_affairs/index.html](http://www.sa.sjsu.edu/judicial_affairs/index.html).

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include in your assignment any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy F06-1 requires approval of instructors.

### **Campus Policy in Compliance with the American Disabilities Act**

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the [Disability Resource Center](http://www.drc.sjsu.edu/) (DRC) at <http://www.drc.sjsu.edu/> to establish a record of their disability.

### **Student Technology Resources**

Computer labs for student use are available in the Academic Success Center located on the 1<sup>st</sup> floor of Clark Hall and on the 2<sup>nd</sup> floor of the Student Union. Additional computer labs may be available in your department/college. Computers are also available in the Martin Luther King Library.

### **Engineering Student Success Center**

Davidson College of Engineering Student Success Center (ESSC) assists undergraduate students in increasing their level of academic success and knowledge. In part, this is accomplished by helping students understand university requirements, policies, and procedures as well as by fostering a community of support. For more info, drop by E344 or see <http://www.engr.sjsu.edu/students/essc>

### **SJSU Writing Center**

The SJSU Writing Center is located in Room 126 in Clark Hall. It is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the seven SJSU colleges. Our writing specialists have met a rigorous GPA

requirement, and they are well trained to assist all students at all levels within all disciplines to become better writers. The [Writing Center website](http://www.sjsu.edu/writingcenter/about/staff/) is located at <http://www.sjsu.edu/writingcenter/about/staff/>. They offer **free** drop-in and by appointment writing sessions as well as workshops and online tutorials.

### **King Library**

Most of all of you know of the library, but do you know of all it's hidden resources. You can reserve the small study rooms (great for group study work): <http://www.sjlibrary.org/services/rooms/>

There are a lot of tutorials online that are helpful on things like citing & writing, evaluating information, and search tips. Click on the side bar of this link: [http://www.sjlibrary.org/services/literacy/info\\_comp/students.htm](http://www.sjlibrary.org/services/literacy/info_comp/students.htm)

Also, you can make an appointment with the engineering librarian to get help on searching and referencing. Their contact info is here: [http://www.sjlibrary.org/about/contacts/sjsu\\_specialists.htm](http://www.sjlibrary.org/about/contacts/sjsu_specialists.htm)

### **Career Center**

Be sure to register for the Career Center <http://careercenter.sjsu.edu/>. They have **free** workshops on resumes, interviewing, etc. You can make an appointment for a specialist to work on your resume with you. They have large internship and full time job fairs and an online job database.

### **Learning Assistance Resource Center**

The Learning Assistance Resource Center (LARC) is located in Room 600 in the Student Services Center. It is designed to assist students in the development of their full academic potential and to motivate them to become self-directed learners. The center provides **free** support services, such as skills assessment, individual or group tutorials, subject advising, learning assistance, summer academic preparation and basic skills development. The [LARC website](http://www.sjsu.edu/larc/) is located at <http://www.sjsu.edu/larc/>.

### **Peer Mentor Center**

The Peer Mentor Center is located on the 1<sup>st</sup> floor of Clark Hall in the Academic Success Center. The Peer Mentor Center is staffed with Peer Mentors who excel in helping students manage university life, tackling problems that range from academic challenges to interpersonal struggles. On the road to graduation, Peer Mentors are navigators, offering “roadside assistance” to peers who feel a bit lost or simply need help mapping out the locations of campus resources. Peer Mentor services are **free** and available on a drop –in basis, no reservation required. The [Peer Mentor Center website](http://www.sjsu.edu/muse/peermentor/) is located at <http://www.sjsu.edu/muse/peermentor/>

### **Student Health Center**

The health center is free to all students for drop in or by appointment care. You can have an regular check-up or go with a specific question. (They do not handle emergencies. For emergencies, call 911 or campus police). They also have a number of

health and wellness workshops. For hours and info, see: <http://www.sjsu.edu/studenthealth/>

### **Counseling Services**

There is a free counseling service for students that takes both drop in and appointments. They handle the spectrum from depression, homesickness, stress, and academic study skills. Check out their services at: <http://www.sa.sjsu.edu/counseling/index.html>

### **Associates Students Site**

The Associated students site (<http://as.sjsu.edu/> ) hosts a range of resources including child care, recreation facilities, print shop, and transportation passes.

### **Student Clubs**

SJSU has over 300 recognized student clubs. You can find an online directory of them here <http://www.sjsu.edu/getinvolved/> Also, the College of Engineering lists all their student clubs here <http://www.engr.sjsu.edu/students/organizations>

### **Budget Info**

Please note that the facts in this section are completely accurate. However, the interpretation is my opinion and is not the official stance of SJSU or the CSU.

As you have noticed with your tuition bill, there have been dramatic changes in the CSU over the summer. SJSU has had a \$42 million dollar cut in the amount of support the campus receives from the state. That is 36% of the total state support the campus receives. This, simply put, is a lot of money and a very deep cut. It is unprecedented both in size and in the rapid timescale in which it was implemented.

The majority of the shortfall is being made up in two ways. First, as you know, students have a 30% fee increase from last year. This is following a steady stream of fee increases since 2003 that total 150%. The fee increase this year will result in increased revenue for the campus of \$18 million. Second, faculty and staff have been furloughed. This is a 9% pay cut with a reduction of work days during the academic year. This results in a one time savings to the campus of \$19 million dollars. The rest of the budget shortfall is being made up through general cuts in operations. The plan is to meet the future years' diminished budgets with a smaller campus: less students, classes, faculty, and staff.

It is important to note that the budget problems the CSU are having this year are not just due to a reduced state budget. There has been a dramatic shift, in just the short period of this summer, of who is funding public higher education in California. Over the last decade, the CSU system has consistently received about 3.4% of the state general budget. However, this year we will receive only 1.8%. That is, the CA state budget was dramatically reduced by the economy and on top of that, the CSU system got an even smaller percentage. With the shrinking budget, the Governor and legislature chose to meet other pressing needs by cutting the CSU more. I acknowledge that this must have been a very tough decision and that there are a lot of valuable services the state budget funds. However, the decision may have lasting consequences for the CSU. Over the last

couple decades, the CSU budget was balanced with about 67% state support and 33% student fees. The primary reasoning behind this funding rationale was that access to quality education to all was important to California's economy and society. Over this summer, the balance on SJSU's campus shifted to 53% student fees and 47% state fees. As far as we know, this is not temporary. The CSU system has not been promised an increase in funding or even a return to the original percentage of the state budget. The SJSU campus will be moving forward to enhance our campus budget through increased research grants and innovative campaigns for alumni and industry support.

So, what can you do. If you do not agree in the shifting balance of how public education in CA is funded, I encourage you to email your legislators and the Governor. [http://www.legislature.ca.gov/legislators\\_and\\_districts/legislators/your\\_legislator.html](http://www.legislature.ca.gov/legislators_and_districts/legislators/your_legislator.html)  
<http://gov.ca.gov/interact#contact>

I am sure the tuition increases were a significant hardship. This year has brought an increase in federal financial aid (<http://www.sjsu.edu/faso/>) as well as an increase to on-campus federal work study programs (<http://www.sjsu.edu/faso/typesofaid/federalworkstudy/>). I encourage you to investigate both of those. Also, SJSU has free counseling services that include stress management (<http://sa.sjsu.edu/counseling/index.html>).

Most importantly, I encourage you to not get caught in the trap of fixating on the negative. Revel in the fact that you are an important part of a great institution and are getting a great education. Be proud of how far you have come, what you are achieving, and where it will take you. I encourage you to get involved in the SJSU community. Utilize all the great resources the campus has to offer and truly excel in your education. Go on to do great things in society and prove that public education is a vital part of California's economy and society.

## **Furlough Details**

The faculty and staff furlough days will impact your life here on campus, though every effort is being made to minimize that. Staff and administration furlough days are set by the University and are posted here. <http://www.sjsu.edu/hr/furlough/index.htm> Offices run by staff such as the registrar and the bursar will be closed those days. Campus police are not furloughed; the campus will have its normal protection on all days. Except for the overlap with the faculty furlough days discussed next, classes will be held on the staff furlough days.

Faculty are required to take nine furlough days. On those days, the faculty will not be on campus and in theory will not be working. You will not have class on those furlough days. The campus has set 3 of these faculty furlough days: Tu 9/22, M 10/19, and F 11/13. In addition, each faculty selects 6 other furlough days. Mine are M 8/31, W 9/9, W 10/14, Tu 11/24, F 12/4, and M 12/21.

This class will be cancelled for you on Tu 9/22 and Tu 11/24. In replace of class, I encourage (though not require) you to attend the College's Silicon Valley Leaders Symposium. These speakers are passionate, knowledgeable of their field, and very motivating. <http://www.engr.sjsu.edu/about/svls>

## Course Schedule

Date	Lecture	Readings & Assignments	LOs
1: 8/25, 27	Review of crystallography	<i>A&amp;T: Ch 1; A,A&amp;R-H: Ch 1.1-1.8</i>	1-7
2: 9/1, 3	2D Crystallography	<i>A&amp;T: Ch 3.1.1-3.1.4</i> <b>Th: Post preferences for Grand Challenges</b>	8, 9
3: 9/8, 10	2D Nets & Plane Groups	<i>A&amp;T: Ch 3.1.5- 3.1.7</i> <b>Th: HW 1</b>	10-12
4: 9/15, 17	<b>Tu: No Class, Campus Furlough Day</b> 3D Symmetry	<i>A&amp;T: Ch 3.2.1</i> <b>Th: 1 page summary of Grand Challenge</b>	13
5: 9/22, 24	Miller Indices & Stereographic Projections	<i>A&amp;T: Ch 3.2.2</i> <i>A,A&amp;R-H: 1.11 -1.18</i> <b>Th: HW 2</b>	14-18
6: 9/29, 10/1	3D Crystallography	<i>A&amp;T: Ch 3.2.3-2.2.5</i>	19-21
7: 10/6, 8	3D Crystallography and Space Lattices	<i>A&amp;T: Ch 3.2.6</i> <i>A,A&amp;R-H: Ch 1.11-1.14</i> <b>Th: Crystallography Project Presentations</b>	22-26
8: 10/13, 15	Point Defects	<i>A&amp;T: Ch 3.4, 5.1; A,A&amp;R-H: Ch , 9.1-9.5</i> <b>Th: HW 3</b>	27-32
9: 10/ 20, 22	<b>Tu: Midterm</b> Point Defects	<b>Tu: Midterm</b>	33-37
10: 10/27, 29	Dislocations	<i>A&amp;T: Ch 5.2; A,A&amp;R-H: Ch 4 &amp; 5</i>	38-50
11: 11/3, 5	Grain Boundaries & Microstructure	<i>A&amp;T: Ch 5.3, Ch 6; A,A&amp;R-H: Ch 6</i> <b>Th: HW 4</b>	51-60
12: 11/10, 12	Phases, Compounds, & Phase Diagrams	<i>A,A&amp;R-H: Ch 10</i> <b>Th: 3 page summary technical paper for Grand Challenge</b>	61-64
13: 11/17, 19	Phase Diagrams	<i>A,A&amp;R-H: Ch 11</i> <b>Th: HW 5</b>	65-69
14: 11/24, 26	<b>No Class Tu &amp; Th Furlough Day &amp; Thanksgiving</b>		
15: 12/2, 4	<b>Grand Challenge Projects Presentations</b>		
16: 12/8	Review	<b>Tu: HW 6</b>	
<b>Cumulative Final: Th Dec 10<sup>th</sup>, 2:45-5:00 pm</b>			

## MatE 115 Learning Objectives

Students who complete all of the course assignments, including attending lectures, preparing homework problems, reading assignments, and completing student projects, should be able to...

### Crystallography and Symmetry

1. Define a basis set (motif).
2. Describe the relationship between lattice points, bases and unit cells.
3. Sketch crystallographic coordinates, directions and planes for any crystal system.
4. Calculate linear density, areal density, atomic packing factor and volume density for any crystal system.
5. Calculate coordination number, number of nearest neighbors and nearest neighbor distances for any crystal system.
6. Calculate lattice parameter from nearest neighbor distance.
7. Describe stacking sequences and stacking faults.
8. Describe symmetry operations both in concept and using International and Schoenflies notation.
9. Identify the 10 2D plane point groups
10. Recognize the 17 plane groups
11. Identify the 5 2D plane nets
12. Generate 2D patterns using the plane groups and determine the plane group of a 2D pattern.
13. Identify 3D symmetry operations (inversion, rotoinversion, rotoreflection, and screw) in patterns and crystal structures.
14. Utilize correct Miller index notation (both 3-index and 4-index notation).
15. Create and read standard stereographic projections
16. Find the angle between two directions or the angle between direction and plane in a unit cell of any Bravais lattice.
17. Find planes of a zone or the zone axis of a set of planes of a zone.
18. Identify the planes or directions in a family.
19. Utilize 32 3D point groups to create 3D patterns.
20. Utilize proper International and Schoenflies notation to determine the point group from a pattern and crystal structure.
21. Distinguish between the 14 Bravais lattices.
22. Generate 3D patterns using the 230 space groups and determine the space group of a certain crystal structures.
23. Utilize standard nomenclature to describe common compound structures such as CsCl, NaCl, BaTiO<sub>2</sub>.
24. Define polymorphism (allotropism) and enantiomorphism.
25. Derive the Wyckoff positions of a plane group.

26. Demonstrate the atomic positions in a unit cell of an elemental solid or compound using the space group and Wyckoff site descriptions.

**Point Defects**

27. Identify point, line, areal and volume defects.
28. Identify and distinguish among vacancies, interstitials, substitutional impurities, and Frenkel and Schottky defects in elemental and ionic solids.
29. Utilize Kroger-Vink notation to identify defects in ionic solids.
30. Describe the origin of vacancies in elemental solids.
31. Use the mixing entropy to derive the equilibrium fraction of vacancies.
32. Calculate the concentration of vacancies in elemental solids, as a function of activation energy and temperature.
33. Calculate number of octahedral and tetrahedral sites in simple cubic, body centered cubic, face centered cubic and hexagonal unit cells.
34. Calculate the radius of an atom for “perfect fit” within a given interstitial site.
35. Identify the requirements a solute must meet before it can occupy an interstitial site.
36. Describe the charge neutrality requirement for filling of interstitial sites in ionic solids.
37. Explain the Hume-Rothery Rules as they pertain to solid solubility.

**Line Defects**

38. Explain the origin of dislocations in solids.
39. Describe edge and screw dislocations.
40. Demonstrate knowledge of relationship among Burger’s vector, dislocation line and direction of dislocation motion.
41. Determine slip directions, slip planes and slip systems.
42. Write vector notation for dislocations.
43. Explain partial dislocations.
44. Illustrate dislocation climb.
45. Explain dislocation interactions with point defects.
46. Analyze stress state around an edge or screw dislocation.
47. Analyze the force on a dislocation.
48. Determine the strain energy due to dislocations.
49. Find the resolved shear stress on a slip system.
50. Calculate the critical resolved shear stress.

**Grain boundaries**

51. Identify twist and tilt boundaries.
52. Utilize relationship between dislocation spacing and low angle tilt boundary angle.
53. Explain the factors which influence grain boundary energy.
54. Utilize and explain the relationship between grain boundary energy and dihedral angle between grain boundaries.
55. Explain the factors that influence interphase interfaces.

56. Describe the relationship between grain boundaries and mechanical properties using the Hall-Petch equation.

57. Define coincidence site and explain how such sites relate to twist boundaries.

**Microstructure**

58. Explain the difference between crystal structure and microstructure.

59. Describe how to measure the texture of a sample.

60. Utilize the microstructure to predict the deformation and processing done on a sample.

**Phase Diagrams**

61. Express a binary solution composition in atomic or weight percent.

62. Define total solid solubility and solubility limit.

63. Explain substitutional solid solutions.

64. Explain the effect of temperature on substitutional solid solubility.

65. Distinguish between and identify components, phases and constituents.

66. Distinguish between and calculate phase composition and weight fraction of a phase.

67. Utilize the lever rule and the tie line.

68. Explain the following transformations: polymorphic, eutectic, peritectic, monotectic, eutectoid, peritectoid, solid state precipitation.

69. Identify congruent points and explain them.