



Materials Science

Directions:

You may use ONE nonprogrammable calculator and ONE 3-ring binder for this test.

This test is designed for two people and a 50 minute time period. Your team should be able to complete all questions on this test.

A periodic table is provided on the last page. It is necessary for some of the questions. Use it.

Good Luck!

1. What is the deformation after elastic deformation and before necking called?
2. Which of the three-dimensional Bravais lattices is the least symmetrical?
3. What is the coordination number of the diamond cubic crystal structure?
4. Material 1 has a higher Young's Modulus and a lower Bulk Modulus than Material 2. What can be determined about the Poisson's ratio of the materials?
5. What is the term for a eutectic-like point that involves three solid phases?
6. Which two metals are the main components of modern brass?
7. What type of material are inorganic, nonmetallic solids mainly composed of ionic and covalent bonds?
8. What is the surface area to volume ratio of BCC structure in terms of R (atomic radius)?
9. What are the two monoclinic Bravais lattices?
10. If a reaction is in thermal equilibrium, what can we determine about the Gibbs free energy?
11. Describe silicon's band gap. What property of silicon tells us this?
12. What unit is toughness measured in? Use SI units.

13. How can the toughness of a material be determined from its stress-strain curve?
14. What is the term for the force between two permanent dipoles (which is a form of the Van der Waals force)?
15. What is the numerical definition of the annealing point of a glass?
16. What is the specific strength of a material?
17. Which component of an optical microscope captures light and focuses it onto the specimen?
18. Fill in the blanks: Antifluorite crystal structure can be best described as the anions in a _____ structure with the cations filling the _____ holes.
19. What is the direct opposite of thixotropy?
20. What is the term for different crystal structures of the same element?
21. What is the approximate ratio between the shear modulus and young's modulus of metals?
22. Explain what the hardness rating 130HV5/5 means.
23. Explain why a one-component system cannot have a quadruple point.

For questions 24-30, indicate which material treatment processes are described by the definitions provided.

24. The process of converting rubber into more durable materials by the addition of sulfur or other curatives or accelerators.

25. This process molds reinforced plastics. This process often involves an autoclave and results in higher fiber concentration and provides better adhesion between layers of this sandwich construction.

26. Based on atomic diffusion, creates objects from powders.

27. Used to manufacture materials with a resin and a matrix. In this process, reinforced fibers are pulled in through a resin. The material is then pulled into a tool that cuts and shapes the material using a press. In this step the resin undergoes polymerization.

28. Involves rapid cooling to obtain material properties.

29. Increasing temperature above the critical state and then letting the metal cool to room temperature in still air to increase ductility.

30. This process prevents chocolate from crumbling (instead of snapping) and assures that the best form of chocolate is sold to you

31. For the following five attributes, indicate if they affect the creep rate of the material, and if they do, if they affect it directly or inversely.

A. Temperature _____

B. Grain size _____

C. Elastic Modulus _____

D. Applied Stress _____

E. Molecular weight _____

32. What molecule eventually forms when the coating applied to a metal through galvanization is oxidized?

33. What is the electron configuration of a phosphorous ion with a -2 charge?

34. Rank the following materials from greatest Young's Modulus to least: Tin, Graphite, PVC, rubber

35. Indicate whether the following materials are polymers, ceramics, metals, or composites.

A. Titanium

B. Laminate

C. Polyethylene terephthalate

D. Wood

E. Alumina

36. Which of the following has the highest melting point: Butane (C_4H_{10}), Ethanol (C_2H_6O), or Octane (C_8H_{18})?

Use the following chart for questions 37-38.

	Type of Material	Young's Modulus (GPa)	Fracture Toughness (MPa*sqrt(m))	Melting Point (K)
Material A	Metal	15	20	3410
Material B	Polymer	.31	21	520
Material C	Metal	182	34	2210

37. Which of the materials would most likely not undergo creep under temperatures of 1200 K?

38. Which of the materials would be best for a bungee cord? Why?

39. Zinc has the HCP structure and a specific gravity of 7.14. What is its atomic radius?

40. What are the lattice parameters of Zinc?

41. Rubidium has a specific gravity of 1.532 and an atomic radius 2.47 \AA . What is its crystal structure?

42. What is the planar density of Rubidium on the (011) plane?

43. A rope has a Young's Modulus of 32 MPa and a diameter of 4.5 cm. 70 cm of the rope is hung from a hook and has a 30 kg mass attached to the bottom. How much will the rope deform?

44. In the scenario presented in the last question, the rope's diameter decreased by 83.2 \mu m . What is Poisson's ratio for the rope?

45. X-ray irradiation with a wavelength of 4.31 \AA hits a material and reflects and an angle of 55.12° . What is the distance between the layers of atoms?

46. Potassium has an ionic radius of 133 pm ; Bromine has an ionic radius of 195 pm . In potassium bromide, which holes in the crystal lattice will the cation fill? What is the crystal structure of potassium bromide?

47. What is the density of potassium bromide?

48. To determine the shear modulus of a rubber, a 5 cm x 5 cm x 2 cm piece was prepared for experimenting. It was then subjected to various shear stresses parallel to its largest face. The table of the shear stresses applied and the resultant transverse displacements to the right was created from this experiment.

Shear Stress (kPa)	Transverse Displacement (mm)
100	1.575
150	2.362
200	3.151
250	3.937
300	4.724

What is the Shear Modulus of this material? _____

