

Name _____

1. In a polymer the backbone and the cross-links differ because of the type of bonding. What are those bonds called?
2. What is the difference between a thermoset and a thermoplastic? Give one example of each.
3. When asked for the melting point of plastics one is faced with a tough question, why?
4. Suggest at least one method that could be used to determine if the plastic material delivered for Zoob production is the right stuff.
5. As you increase in molecular weight of a polymer you would expect what change in the modulus.
6. As you increase the degree of cross-linking in rubber you would expect what change in the modulus.
7. Explain the difference between fracture toughness and fatigue.
8. For isolation of a machine from vibrations due to truck traffic, would you use a material with a high or a low loss coefficient and why?
9. An airplane propeller must sustain constant loading as it rotates. However, fracture toughness cannot be neglected because of the possibility of impact with a bird or other object while in flight. If the propeller is assumed to act like a brittle plate -- $\frac{K_{IC}^{1/2}}{\rho} = C$ Select several possible candidate materials for building an airplane propeller from the given chart for light fracture resistant materials.

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10. When corrosion of a chrome-plated part begins – like the bumper on an old car – the plating often appears to be peeling off the metal. Explain this process in terms of a loss of material at the anode. Describe the differences in the process that would occur if you galvanize the bumper versus chrome plating the bumper.

11. What are the three primary and 2 secondary bonds we discussed in class? Give one example of each.

12. At what temperature does Pb. Melt?
Sn. Melt?
A mixture of 62% Sn and 38% Pb?

13. Discuss the process that 17-4 stainless steel undergoes to create a precipitate in hardening. Heat treat for this material requires 1 hr at 1000°F. What happens during this hour to make the material a LOT harder and a LOT stronger?

14. For many applications in electronics and for some sensors, very pure metals are used. Please comment on appropriate strengthening mechanisms that can be employed with these materials.

15. Comment on:
I was talking with my boyfriend about rustproofing the inside of my steel frame, and he said, "why don't you just fill it with foam insulation? It's light and would fill the tubes so that water and oxygen can't get in..." Sounds like an idea to me, but I thought I'd ask here first to see if anyone's tried something like this. I did a search on the list archives and couldn't find anything on rust proofing that didn't have to do specifically with chains. (from the icebike listserv)
Please give her some advice?
Will this work?
Why or Why Not?
Should she ditch the guy?

16. As the proud owner of two 1972 Dodge Darts discuss the existence of large cracks on the dashboard. Can you suggest at least two reasons why the black dash board cover cracked in 1975 and the white dash did not crack until 1982!

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The questions may be answered using your book and your notes. If you choose to do so, you will need to turn in the rest of your test before continuing.

12. For a spoke on a bicycle wheel it is necessary to select a material with high strength to weight ratio. What is the slope of the line that should be used for selecting equivalent materials on the density versus modulus diagram? How is shape accommodated for a problem such as a bicycle spoke.

13. You make the shaft of a canoe paddle out of any of the materials listed at the end of the quiz. Assume that any of the materials can be made as a hollow tube except wood. Rank order the choice of materials for the handle, assuming that the length and shape are specified for a beam in bending.

Back to closed book stuff

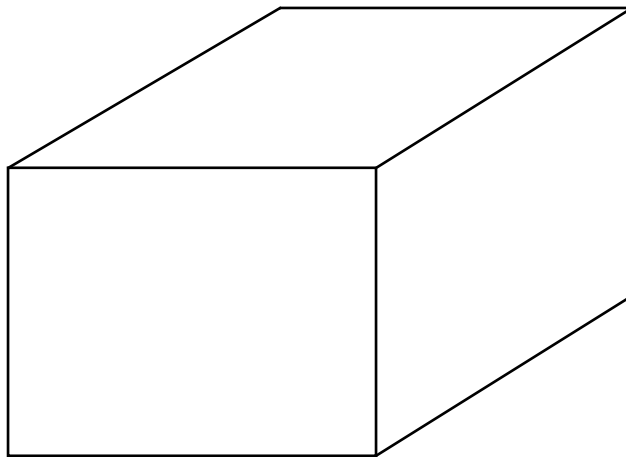
14. Draw a stress strain curve for a **brittle** material, on the curve label the yield strength, the modulus and the ultimate tensile strength. Comment on the absence or presence of any of these quantities.

15. Draw a stress strain curve for a **ductile** material **WITH** a clear yield strength and label the modulus, the yield strength, the ultimate tensile strength and the breaking strength. Comment on the absence or presence of any of these quantities and the need to carefully define the values.

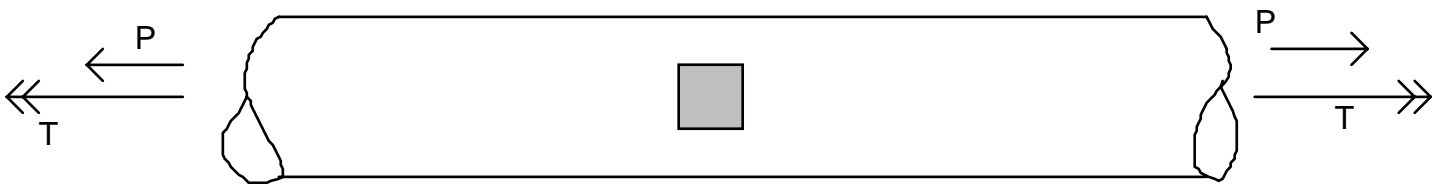
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16. Draw a stress strain curve for a **ductile** material **WITHOUT** a clear yield strength and label the modulus, the yield strength, the ultimate tensile strength and the breaking strength. Comment on the absence or presence of any of these quantities and the need to carefully define the values.

17. Draw on the figure of a cube, the applied shear stress and the tensile stress in the x direction.



18. In the associated figure a torque (T) **and** a tensile stress (P) are applied to the circular rod. Draw the stress element at zero degrees (the dark box shown) and 45 degrees and show the applied stress. This is a qualitative drawing, but you should probably show Mohr's circle to make sure that no miscommunication occurs!



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19. Refer to the Fe-C phase diagram.
 - (a) Why is the solubility of carbon in iron higher at 1130°C than at 723°C?
 - (b) What are the solubility limits of carbon in iron at these two temperatures?

20. Wood has two bubbles on the stiffness versus density diagram from the text – how is this different or similar to the “uni-ply” and “laminates” bubbles for Carbon Fiber Reinforced Plastics (CFRP), Kevlar Fiber Reinforced Plastics (KFRP), Glass Fiber Reinforced Plastics (GFRP)? Note that each of these designations shows up two times in the engineering composites bubble.

21. The shear modulus (G) of aluminum is about 27 GPa. If a T4 hardening is performed followed by an H16 temper in a 6061 alloy, estimate the shear modulus of the material.

22. Discuss the process that aluminum undergoes to create a precipitate in hardening (such as the T6 alloy). Suggest at least two reasons an engineer who is not a material specialist should know about precipitation hardened alloys.

23. Define fracture toughness. Why should fracture toughness be considered when designing a travel mug?

24. Discuss the types of criteria that should be considered when selecting a material for use in a chisel. What issues other than cost are primary in the material selection?

25. A 7178-T6 aluminum alloy has a higher _____ than the 7178 alloy in the wrought condition. a) ductility b) yield c) modulus d) none of the above

26. On the Fe-C phase diagram γ is a FCC crystal that is stable at high temperatures. When γ is quenched (cooled quickly) a different structure is obtained at room temperature that is called Martensite. Is this structure shown on the attached Fe-C phase diagram? Indicate the Greek letter that represents Martensite or explain why it is not on the phase diagram.

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27. At 800°C an alloy of 0.45% C in Fe is at equilibrium. The α phase has(choose one)

0.0123% C in Fe

0.53% C in Fe

0.45% C in Fe

28. At 800°C an alloy of 0.45% C in Fe is at equilibrium. For a 100 gram sample the α phase is (choose one)

84.5 grams

15.5 grams

53.0 grams

45.0 grams

29. An airplane propeller must sustain constant loading as it rotates. However, fracture toughness cannot be neglected because of the possibility of impact with a bird or other

object while in flight. If the propeller is assumed to act like a brittle plate -- $\frac{K_{IC}^{1/2}}{\rho} = C$

Select several possible candidate materials for building an airplane propeller from the given chart for light fracture resistant materials.

30. Aluminum as a pure material has very high formability. Explain why this is different for some of the precipitation hardened alloys? What changes in the material?

31. On the Fe-C phase diagram γ is a FCC crystal that is stable at high temperatures. When γ is quenched (cooled quickly) a different structure is obtained at room temperature that is called Martensite. Is this structure shown on the attached Fe-C phase diagram? Indicate the Greek letter that represents Martensite or explain why it is not on the phase diagram.

32. At 1450°F an alloy of 0.20% C in Fe is at equilibrium. The α phase has(choose one)

0.02% C in Fe

0.52% C in Fe

0.20% C in Fe

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33. At 1450°F an alloy of 0.45% C in Fe is at equilibrium. For a 100 gram sample the α phase is (choose one)
- 64.0 grams
 - 36.0 grams
 - 53.0 grams
 - 47.0 grams
34. In the Al-Si phase diagram describe the composition of the material when 10% by wt of silicon is added to Al and it is at equilibrium at 300 °C.
35. From the Al-Si phase diagram find the Greek letter that represents the precipitate that forms in a precipitation hardened alloy. Write that Greek letter here
- ⇒ _____
36. At 577°C an alloy of 0.10% Si in Al is at equilibrium. The α phase has _____% Si.
37. At 577°C an alloy of 0.10% Si in Al is at equilibrium. For a 100 gram sample the α phase is _____ grams.
38. As wood becomes scarcer and old growth wood becomes unavailable, the modulus of wood used in many applications decreases. Suggest a modification of the standard wood floor joist using composite materials to stiffen the beam.
39. It is possible to make a canoe paddle handle out of either aluminum or wood. If strength is the design parameter, write out the type of equation that would show how you include shape into your material selection. The exponent for a bar in bending is $2/3$ in the numerator and 1 in the denominator.
40. Name three strengthening mechanisms and write a short description of each.
41. What are the three primary and 2 secondary bonds we discussed in class. Give one example of each.

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42. How is the elastic modulus of a metal related to the graph of U , the interatomic potential, and r the interatomic spacing.
43. On the Fe-C phase diagram γ is a FCC crystal that is stable at high temperatures. When γ is quenched (cooled quickly) a different structure is obtained at room temperature that is called Martensite. Is this structure shown on the phase diagram?
44. Draw a stress strain curve for a linear, perfectly elastic material and for a ductile material with significant plastic deformation. Mark the yield strength, the modulus and the ultimate strength
45. Mark on a figure the plastic strain in a stress strain curve. Also mark the yield strength, the ultimate strength and the modulus.
46. At 1400°F (the left hand scale on the phase diagram), the equilibrium constitution for a 0.6 Wt% Carbon Iron Alloy has:
An overall composition of:
Number of phases:
Composition of each phase:
Proportion of each phase:
47. At what temperature does:
a) 2.0 Wt. % Carbon Iron Alloy melt?
b) 4.3 Wt. % Carbon Iron Alloy melt?
c) 0.8 Wt. % Carbon Iron Alloy form austenite, A FCC cubic structure?
48. At 1600°F (the left had temperature scale), the equilibrium constitution for a 0.8 Wt% Carbon Iron Alloy has:
The overall composition
Number of phases
Composition of each phase
Proportion of each phase

Name _____

Low density wood

Density 0.24-0.49 Mg/m³
Price 0.788-12.61 USD/kg
Compressive strength 14.8-46.6 MPa
Elastic Limit 16.2-45.1 MPa
Endurance limit 8-24.6 MPa
Fracture Toughness 0.6-3.6 MPa m^{0.5}
Young's Modulus 3.7-14.3 Gpa

Tough Steels

Density 7.8-7.9 Mg/m³
Price 0.394-0.709 USD/kg
Failure strength 335-1155 MPa
Elastic Limit 335-1155 MPa
Endurance limit 281-606 MPa
Fracture Toughness 27-92 MPa m^{0.5}
Young's Modulus 200-215 GPa

Brass

Density 7.8 – 8.8 Mg/m³
Price 1.57-2.21 USD/kg
Compressive strength 70-500 Mpa
Elastic Limit 70-500 MPa
Endurance limit 105-300 MPa
Fracture Toughness 30-86 MPa m^{0.5}
Young's Modulus 90-120 GPa

Titanium

Density 4.36-4.84 Mg/m³
Price 23.64-63.04 USD/kg
Compressive strength 130-1395 Mpa
Elastic Limit 172-1245 MPa
Endurance limit 175-705 MPa
Fracture Toughness 14-120 MPa m^{0.5}
Young's Modulus 90-137 GPa

Epoxy-Glass Fiber Composite

Density 1.5-2.0 Mg/m³
Price 2.05-111.03 USD/kg
Compressive strength 240-880 MPa
Elastic Limit 150-1100 MPa
Endurance limit 128-765 MPa
Fracture Toughness 6-40 MPa m^{0.5}
Young's Modulus 15-45 GPa