

Captains Tryouts 2017-2018

Materials Science



Exploring the World of Science

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Instructions:

1. Write all answers on the Answer Sheet. Do not write on this Test Packet.
2. This test has a total of 110 points.
3. Tiebreakers are, in order: 5, 10, 11, 16, 18, 24, 31, 35, 44, 46, 48. Answers for each question are compared, moving down the list until the tie is broken.

Multiple Choice – 2 points per question.

1. Which of the following is not a polymer?
 - A. Natural resin
 - B. Glass
 - C. Proteins
 - D. Plastic grocery bags
2. Monomers in a branched chain forming continuously have _____ active sites at any one time.
 - A. 0
 - B. 1
 - C. 2
 - D. 3
3. Polymeric entanglement is
 - A. the method by which synthetic polymers are formed, by adding monomers one at a time.
 - B. a cross-linking process.
 - C. how natural rubber is produced.
 - D. chemical attractions between different parts of a chain located near each other.
4. Branched polymers form by replacement of a/an _____ by a/an _____.
 - A. nitrogen; side chain
 - B. hydrogen; side chain
 - C. side chain; monomer
 - D. monomer; oligomer
5. The process by which monomers combine by releasing H₂O is
 - A. polymerization
 - B. condensation
 - C. hydrogenation
 - D. esterization
6. In general, polymer formation is
 - A. exothermic
 - B. endothermic
 - C. heterothermic
 - D. gastrothermic
7. A polymer that has no one-dimensional orientation is known as a/an
 - A. entanglement polymer
 - B. paraffin
 - C. cross-linked polymer
 - D. network polymer
8. IUPAC organic nomenclature allows for only one prefix, but multiple suffixes.
 - A. True
 - B. False
9. Aromatic compounds are all derivatives of which basic compound?
 - A. Acetate
 - B. Benzene
 - C. Leucine
 - D. Glycerol
10. Which of the following happens to a plastic that is heated above its glass transition point?
 - A. It becomes more viscous
 - B. It becomes more resistant to shear stress
 - C. It becomes more elastic
 - D. It becomes a liquid

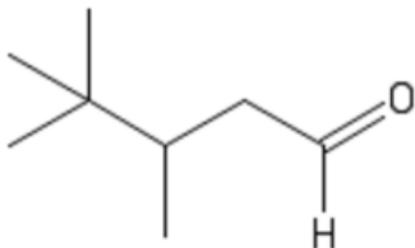
11. Thermoset polymers can have all of the following properties except
 - A. cross-links
 - B. a melting point
 - C. viscoelasticity
 - D. shear strength
12. Elastomers have which of the following properties?
 - A. High tensile strength and viscoelasticity
 - B. Low tensile strength and zero shear strength
 - C. Low tensile strength and high elasticity
 - D. High elasticity and zero shear strength
13. Thermosetting refers to the process of
 - A. Forming cross-links
 - B. Melting a polymer
 - C. Burning a polymer
 - D. Destroying the waste products of polymerization
14. In general, thermosets are less likely to _____ than thermoplastics.
 - A. burn
 - B. decompose
 - C. stretch
 - D. be toxic
15. A polymer always has a nonzero viscosity
 - A. True
 - B. False
16. The “melting point” of a polymer refers to the temperature at which it
 - A. decomposes into monomers
 - B. crystallizes
 - C. becomes amorphous
 - D. melts, of course
17. An extrusion tube’s channel depth typically continually decreases in the
 - A. feeding zone
 - B. extrusion zone
 - C. melting zone
 - D. decompression zone
18. Injection molds can be used with
 - A. Thermosets
 - B. Thermoplastics
 - C. Elastomers
 - D. All of the above
 - E. None of the above
19. Which of the following plastics production techniques produces a piece in thin films?
 - A. Vulcanization
 - B. Injection molding
 - C. Solution casting
 - D. Extrusion
20. The technique mentioned in the previous question is most commonly used for which of the following?
 - A. Industrial parts
 - B. Household appliances
 - C. Medical devices
 - D. Golf club handles

21. A catalyst is required for
 - A. Addition polymerization
 - B. Condensation polymerization
 - C. Copolymerization
 - D. Desiccation
22. A graft copolymer consists of
 - A. Two different monomers in an alternating chain
 - B. Two sections of different monomers joined together, where each section reacts independently
 - C. A linear chain of identical monomers
 - D. A branched chain with the side chains being of a different type of monomer than the main chain.
23. A copolymer can be formed with all monomers having the same chemical formula.
 - A. True
 - B. False
24. Paraffin wax is used as an additive for which of the following?
 - A. Flame retardation
 - B. Anti-ozone cracking
 - C. Dyeing
 - D. Plasticization
25. Which of the following is not used as an adhesive?
 - A. Polyurethane
 - B. Epoxy
 - C. Cyanoacrylate
 - D. Polymethacrylate
26. Which of the following polymers is found in natural rubber?
 - A. Polyurethane
 - B. Polypropylene
 - C. Polyvinyl chloride
 - D. Polyisoprene
27. Around which of the following points is the stress-strain curve of a thermoplastic most likely to slope downward (i.e. where is strain not a mathematical function of stress)?
 - A. Tensile strength
 - B. Yield strength
 - C. Young's modulus
 - D. Region of elastic deformation
28. Thermoplastics typically have a breaking point with a stress _____ their yield strength.
 - A. less than
 - B. slightly greater than
 - C. much greater than
 - D. equal to
29. The slope of the stress-strain curve of an elastomer rarely/never decreases.
 - A. True
 - B. False
30. Young's modulus is independent of cross-sectional area.
 - A. True
 - B. False
31. For viscoelastic materials, strain is dependent on
 - A. Stress and load time
 - B. Only stress
 - C. Only load time
 - D. Neither stress nor load time

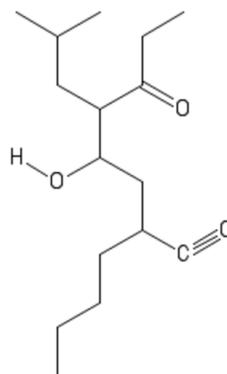
32. Under isotropic conditions, Poisson's ratio can never be greater than
- 0
 - 0.5
 - 1
 - 2.72
33. In general, polymers with a _____ number of monomers per unit volume, and a _____ polarizability have a larger refractive index.
- high; low
 - low; low
 - high; high
 - low; high
34. The formation of disulfide bonds is associated with which of the following processes?
- Copolymerization
 - Propagation
 - Vulcanization
 - Hydrogenation
35. Polymers with a high refractive index are most useful in which of the following applications?
- Reflecting telescopes
 - Light-emitting diodes
 - Charge-coupled devices
 - Enteroscopy
36. Which of the following types of polymers is used in lasers?
- Polyvinyl chloride
 - Polyethylene terephthalate
 - Low-density polyethylene
 - Polymethyl methacrylate
37. Which of the following polymers is most often used to produce films or sheets?
- Polyisoprene
 - Polyurethane
 - Cyanoacrylate
 - Polyethylene
38. Which of the following types of polymers does not form by addition polymerization?
- Polyethylene
 - Polystyrene
 - Polyvinyl chloride
 - Polyethylene terephthalate
39. Which of the following are the most commonly used plasticizers?
- Aliphatics
 - Terephthalates
 - Phthalates
 - Terphenyls
40. Which of the following polymers contains the most oxygen atoms per monomer?
- Polyethylene
 - Polyethylene terephthalate
 - Polystyrene
 - Polycarbonate
41. Which of the following polymers is the most common polymeric foam?
- Polyethylene
 - Polyurethane
 - Polybutylene
 - Polymethacrylate

Organic Nomenclature – Give the name of the molecule based on the image provided, 3 points per question.

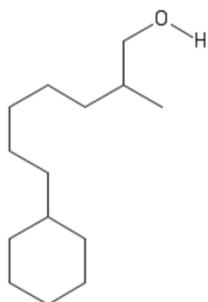
42.



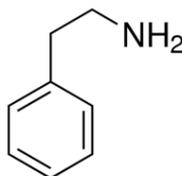
44.



43.



45.



Lab, sort of – 14 points

46. A 1000 mm cube of PVC is compressed in one direction over time. Using the data below, construct a line graph approximating Poisson's ratio for each 5 minute time interval, with appropriately labeled axes and a title. (10 pts)
47. What is the approximate average value of Poisson's ratio from 0 minutes to 50 minutes? (2 pts)
48. Explain the continued change in strain from 50 minutes to 60 minutes. (4 pts)

| Time (min) | Stress (MPa) | Axial length (mm) | Non-axial lengths (mm) |
|------------|--------------|-------------------|------------------------|
| 0 | 0 | 1000.00 | 1000.00 |
| 5 | 2 | 999.50 | 1000.19 |
| 10 | 4 | 998.69 | 1000.49 |
| 15 | 6 | 997.67 | 1000.87 |
| 20 | 8 | 996.44 | 1001.35 |
| 25 | 10 | 994.97 | 1001.92 |
| 30 | 12 | 993.13 | 1002.65 |
| 35 | 14 | 990.90 | 1003.56 |
| 40 | 16 | 988.19 | 1004.69 |
| 45 | 18 | 984.89 | 1006.11 |
| 50 | 20 | 980.98 | 1007.83 |
| 55 | 20 | 976.12 | 1009.98 |
| 60 | 20 | 970.37 | 1012.52 |