Materials Science and Engineering Department
MSE 200-002, Exam #4, Spring 2009

ID number ________________________________ *First letter of your last name:* ____

*Name:*____

No notes, books, or information stored in calculator memories may be used. Cheating will be punished severely. All of your work must be written on these pages and turned in. Mark your answer on this paper first, and then copy onto the answer sheet at the end of the test. **Use #2 pencil to mark the answer sheet.**

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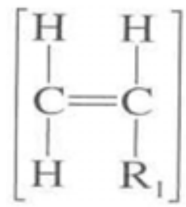
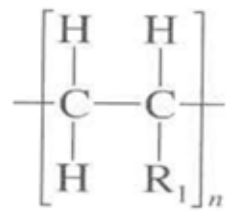
Multiple choices (3 points each):

__C__ 1. Shown on the right is



A. an ethylene molecule
B. an ethylene monomer
C. a vinyl molecule
D. a vinyl monomer

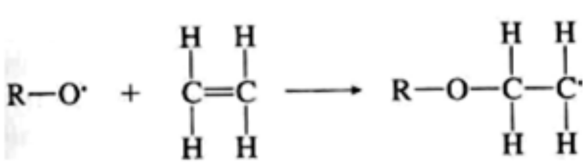
__B__ 2. Shown on the right is



A. polyethylene
B. a vinyl polymer
C. a vinylidene polymer

__B__ 3. Polymerization involves the following 3 steps
A. Radical generation, monomer reaction, and polymer molecule growth
B. Initiation, propagation, and termination
C. Catalyst reaction, monomer reaction, and entanglement
D. None of the above

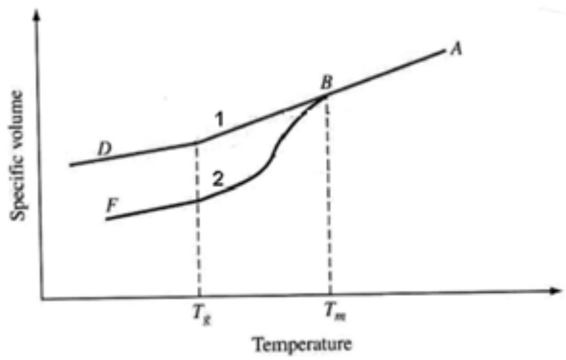
__A__ 4.  represents
A. A reaction to produce free radicals
B. Initiation of polymerization
C. Dissociation of hydroxide
D. Propagation

__B__ 5.  represents
A. A reaction to produce free radicals
B. Initiation of polymerization
C. Dissociation of hydroxide
D. Propagation

__B__ 6. **ABBABABBAAAAABA** represents
A. A homopolymer

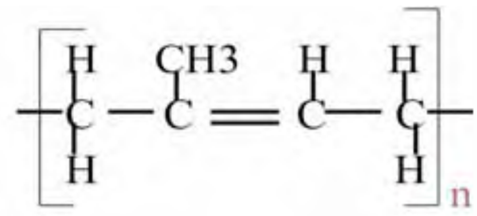
B. A random polymer
C. An alternating polymer
D. A block polymer
E. A graft polymer

__A__ 7. In the right figure, T_m represents the



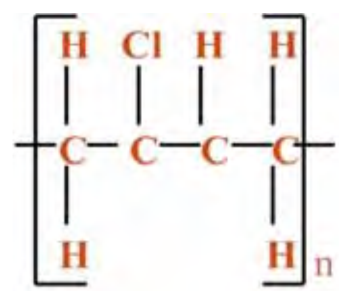
A. melting temperature of a partly crystalline polymer
B. melting temperature of noncrystalline polymer
C. glass transition temperature of a partly crystalline polymer
D. glass transition temperature of noncrystalline polymer

__A__ 8. The formula on the right represents the



A. natural rubber
B. styrene-Butadiene rubber
C. nitrile rubber
D. polychloroprene rubber
E. silicone rubber

__D__ 9. The formula on the right represents the



A. natural rubber
B. styrene-Butadiene rubber
C. nitrile rubber
D. polychloroprene rubber
E. silicone rubber

__D__ 10. Vulcanization of rubber

A. increase tensile strength
B. increase stiffness
C. cross-links rubber molecules
D. all of the above

__A__ 11. The figure on the right represents

A. elastic deformation
B. elastic or plastic deformation
C. plastic deformation

__B__ 12. Below the glass transition temperature, Tg, a thermoplastic polymer

A. can deform plastically
B. can only deform elastically
C. will be brittle

D. will melt

__B__ 13. A thermoset polymer

A. can deform plastically above the glass transition temperature
B. can only deform elastically
C. will melt above the melting temperature
D. none of the above

__B__ 14. Above the melting temperature, Tm, a partially crystalline thermoplastic polymer

A. will melt partially
B. will melt totally
C. none of the above

__D__ 15. The following can strengthen a thermoplastic except

A. increasing molecular weight
B. adding side groups
C. increasing crystallinity
D. mixing with a plasticizer

__C__ 16. A copolymer consists of 15 wt% of PVA and 85% PVC. Determine the mole fraction of PVC. The mass of a PVA mer is 86 g/mol. The mass of a PVC mer is 62.5 g/mol.

A. 0.113 B. 0.174 C. 0.887 D. 1.36

__D__ 17. Determine the mole fraction of PVA in a PVA+PVC copolymer, which has a molecular weight of 10520 g/mol and a degree of polymerization of 160. The mass of a PVC mer is 62.5 g/mol. The mass of a PVA mer is 86 g/mol.

A. 0.113 B. 0.174 C. 0.86 D. 0.14

__C__ 18. Determine the mole fraction of PVC in a PVA+PVC copolymer, which has a molecular weight of 10520 g/mol and a degree of polymerization of 160. The mass of a PVC mer is 62.5 g/mol. The mass of a PVA mer is 86 g/mol.

A. 0.113 B. 0.174 C. 0.86 D. 0.14

__C__ 19. A stress of 1100 psi is applied to an elastic rubber at a constant strain. After 40 days at 20℃, the stress decreases to 700 psi. What is the stress after 60 days at the same temperature?

A. 300 psi B. 500 psi C. 559 psi D. 437 psi

__A__ 20. An ABS copolymer consists of 25 wt% of polyacrylonitrile, 30 wt% polybutadiene, and 45 wt% polystyrene. The mass of acrylonitrile mer is M_a = 53 g/mol; the mass of butadiene mer is M_b = 54 g/mol; the mass of styrene mer is M_s = 104 g/mol. The mole fraction of polyacrylonitrile is

A. 0.322 B. 0.384 C. 0.294 D. 0.423

__B__ 21. An ABS copolymer consists of 25 wt% of polyacrylonitrile, 30 wt% polybutadiene, and 45 wt% polystyrene. The mass of acrylonitrile mer is M_a = 53 g/mol; the mass of butadiene mer is M_b = 54 g/mol; the mass of styrene mer is M_s = 104 g/mol. The mole fraction of polybutadiene is

A. 0.322 B. 0.384 C. 0.294 D. 0.423

__A__ 22. A stress of 100 MPa is applied to an elastomer at 27 °C, and after 25 days the stress is reduced to 75 MPa. At 50 °C, the stress is reduced from 110 MPa to 40 MPa. Calculate the activation energy. ($\sigma = \sigma_0 e^{-t/\tau}$), ($1/\tau = Ce^{-Q/RT}$), R=8.314 J/(mol K).

A. 122 kJ/mol   B. 235 kJ/ml   C. 98 kJ/mol   D. 148 kJ/mol.

__A__ 23. A tensile stress of 50 MPa is applied to an elastomer at 27 °C, and after 5 minutes the stress is reduced to 25 MPa. Calculate the relaxation time. ($\sigma = \sigma_0 e^{-t/\tau}$), ($1/\tau = Ce^{-Q/RT}$), R=8.314 J/(mol K).

A. 7.21 minutes   B. 2.0 minutes   C. 5.0 minutes

__C__ 24. A tensile stress of 50 MPa is applied to an elastomer at 27 °C, and after 5 minutes the stress is reduced to 25 MPa. Calculate the load after 30 minutes. ($\sigma = \sigma_0 e^{-t/\tau}$), ($1/\tau = Ce^{-Q/RT}$), R=8.314 J/(mol K).

A. 72.2 MPa   B. 3.2 MPa   C. 0.78 MPa

__B__ 25. An elastomer can be made stiffer (the modulus can be increased) by

A. heating it above the Tg
A. increasing the amount of cross-linking
B. decreasing the amount of cross-linking
C. none of the above

__D__ 26. Ceramics typically are

A. brittle
B. chemically stable
C. high melting temperature
D. all of the above

__C__ 27. A ceramic compound has a coordinate of 4, the ratio r_{cation}/r_{anion} is

A. $r_{cation}/r_{anion} \geq 0.732$
B. $0.414 \leq r_{cation}/r_{anion} < 0.732$
C. $0.225 \leq r_{cation}/r_{anion} < 0.414$
D. $0.155 \leq r_{cation}/r_{anion} < 0.225$
E. $r_{cation}/r_{anion} \leq 0.225$

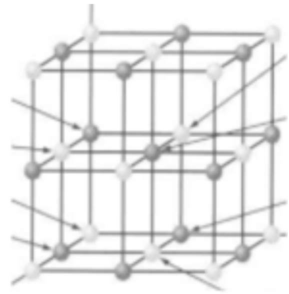
__D__ 28. A ceramic compound has a coordinate of 3, the ratio r_{cation}/r_{anion} is

A. $r_{cation}/r_{anion} \geq 0.732$
B. $0.414 \leq r_{cation}/r_{anion} < 0.732$
C. $0.225 \leq r_{cation}/r_{anion} < 0.414$
D. $0.155 \leq r_{cation}/r_{anion} < 0.225$
E. $r_{cation}/r_{anion} \leq 0.225$

__A__ 29. In the ZrO_2, the electronegativity difference is 2.3. The % ionic character of Zr-O bond is

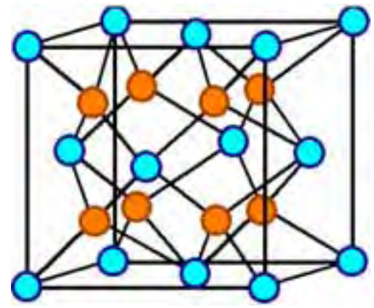
A. 73%,   B. 27%   C. 32%   D. 68%

__B__ 30. The figure on the right represents this crystal structure



A. CsCl
B. NaCl
C. CaF_2
D. ZnS

__C__ 31. The figure on the right represents this crystal structure



A. CsCl
B. NaCl
C. CaF_2
D. ZnS

__B__ 32. Ceramics typically have
A. high tensile strength
B. high compressive strength
C. high ductility
D. high toughness

__E__ 33. A covalently bonded ceramics under compressive load may
A. fracture in brittle mode if it is a single crystal
B. deform in plastic mode if it is a single crystal
C. fracture in brittle mode if it is polycrystalline
D. fracture in plastic mode if it is polycrystalline
E. Both A and C
F. Both B and D

__F__ 34. A inonically bonded ceramics under compressive load may
A. fracture in brittle mode if it is a single crystal
B. deform in plastic mode if it is a single crystal
C. fracture in brittle mode if it is polycrystalline
D. fracture in plastic mode if it is polycrystalline
E. Both A and C
F. Both B and D

__C__ 35. A large ceramic part
A. is weaker than a small ceramic part
B. has the same strength as a small ceramic part
C. is likely weaker than a small ceramic part
D. likely has the same strength as a small ceramic part

__E__ 36. The toughness of a ceramic materials can be described as $K_{IC} = Y\sigma_f\sqrt{\pi a}$, where Y is the geometry factor, *a* is the crack length
A. K_{IC} changes with the geometry factor Y

B. K_{IC} changes with applied stress
C. K_{IC} changes with crack length
D. All of above
E. None of the above

__D__ 37. In the CsCl compound, the ionic radii of Cs+ and Cl- are 0.170 nm and 0.181 nm, respectively, the coordination number should be

A. 3, B. 4, C. 6, D. 8

__C__ 38. In the NaCl compound, the ionic radii of Na+ and Cl- are 0.102 nm and 0.181 nm, respectively, the coordination number should be

A. 3, B. 4, C. 6, D. 8

__A__ 39. In the CsCl compound, the ionic radii of Cs+ and Cl- are 0.170 nm and 0.181 nm, respectively. Calculate the packing factor

A. 0.68, B. 0.74, C. 0.63, D. 0.48

__B__ 40. In the NaCl compound, the ionic radii of Na+ and Cl- are 0.102 nm and 0.181 nm, respectively, and their atomic masses are 22.99 g/mol and 35.45 g/mol, respectively. Avogadro's constant Na = 6.023×10^{23} mol^{-1}. Calculate its density in g/cm^3:

A. 3.42, B. 2.14, C. 2.68, D. 4.82

__D__ 41. In the Zinc blende (ZnS) compound, the ionic radii of Zn^{2+} and S^{2-} are 0.060 nm and 0.174 nm, respectively, and their atomic masses are 65.37 g/mol and 32.06 g/mol, respectively. Avogadro's constant Na = 6.023×10^{23} mol^{-1}. Calculate its density in g/cm^3:

A. 3.42, B. 2.14, C. 2.96, D. 4.12

__A__ 42. A Kevlar-epoxy composite contains 60% by volume Kevlar. The densities of Kevlar and epoxy are 1.48 g/cm^3 and 1.20 g/cm^3, respectively. The weight% of Kevlar is

A. 64.9%, B. 35.1%, C. 60.0%, D. 40.0 %

__C__ 43. A glass-epoxy composite contains 60% by volume glass fiber. The Young's modulus of glass fiber and epoxy are 10.5 GPa and 0.45 GPa, respectively. The strengths of glass fiber and epoxy are 350 MPa and 9 MPa, respectively. Calculate the strength of the composite:

A. 289 MPa, B. 350 MPa, C. 214 MPa D. 9 MPa

__C__ 44. The coordination of the cation in an ionic ceramic structure depends on

A. the density
B. the charges on the ions
C. the ratio of the cation to the anion radii
D. none of the above

__A__45. Larger ceramic parts are usually weaker because than smaller parts because larger parts

A. have higher probability of having a larger crack
B. are heavier and harder to handle
C. have rougher surfaces
D. have lower density

Equation sheet

$\sigma = \sigma_0 e^{-t/\tau}$, $1/\tau = Ce^{-Q/RT}$

Avogadro's constant Na = 6.023×10^{23} mol^{-1}.

R=8.314 J/(mol K)

$$K_{IC} = Y\sigma_f \sqrt{\pi a}$$

$$\frac{1}{E_c} = \frac{V_f}{E_f} + \frac{V_m}{E_m}$$

$$\% = \left[1 - e^{-\frac{(X_A - X_B)^2}{4}}\right] x100\%$$