

Solids and Crystals Practice Problems

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) Which of the following is considered an atomic solid? 1) _____
A) N_2
B) CsCl
C) Nb
D) Br_2
E) None of these is an atomic solid.
- 2) Which of the following is considered a molecular solid? 2) _____
A) NH_4NO_3
B) Cu
C) Xe
D) I_2
E) None of these is a molecular solid.
- 3) Which of the following is considered an ionic solid? 3) _____
A) I_2
B) graphite
C) CO_2
D) $(NH_4)_2CO_3$
E) None of these is an ionic solid.
- 4) Which of the following is considered a network solid? 4) _____
A) bronze metal
B) diamond
C) silver
D) solid xenon (cubic close packed)
E) None of these is a network solid.
- 5) All sides of this unit cell are equal in length and all angles are right angles. There is an atom at each corner and one in the center. This is a: 5) _____
A) body-centered cubic cell
B) face-centered cubic cell
C) simple cubic cell
D) unit cell
E) none of these
- 6) All sides of this unit cell are equal in length and all angles are right angles. There is an atom at each corner and one at the center of each face. This is type of unit cell results from what type of crystal packing? 6) _____
A) face-centered cubic packing
B) simple cubic packing
C) cubic close packing
D) hexagonal close packing
E) plain old packing

- 7) An arrangement in which every other layer is identical (ABABABAB) is: 7) _____
 A) simple cubic
 B) not so simple cubic
 C) cubic close packing
 D) hexagonal close packed
 E) none of these
- 8) A crystal and its melt readily conduct electricity. The crystal also has a luster and is easily deformed. The crystal is likely: 8) _____
 A) a metallic crystal
 B) a molecular crystal
 C) an ionic crystal
 D) a covalent network crystal
 E) Not enough data is given.
- 9) A crystal does not conduct electricity, yet its melt and aqueous solutions do. It is hard and brittle and melts at a high temperature. What type of crystal is it? 9) _____
 A) a covalent network crystal
 B) a metallic crystal
 C) a molecular crystal
 D) an ionic crystal
 E) Not enough information is given.
- 10) A crystal does not conduct electricity, even after melting. It is hard and brittle and melts at a very high temperature. What type of crystal is it? 10) _____
 A) not enough data is given
 B) a molecular crystal
 C) a metallic crystal
 D) a covalent network crystal
 E) an ionic crystal
- 11) Choose the *INCORRECT* statement. 11) _____
 A) In a network covalent solid, covalent bonds extend throughout the crystalline solid.
 B) Fullerenes are a recently discovered allotropic form of carbons.
 C) Nanotubes are an allotropic form of carbon.
 D) Carbon in diamond is sp^3 hybridized.
 E) Carbon in graphite is sp hybridized.
- 12) A compound of iron and sulfur crystallizes in a lattice pattern described as cubic closest-packed sulfide ions with iron ions in all octahedral sites. What is its empirical formula? (use a figure of the unit cell to help you out) 12) _____
 A) FeS_2 B) Fe_3S_4 C) Fe_2S_3 D) Fe_2S E) FeS
- 13) Which of the following compounds would you predict to have the largest lattice energy: 13) _____
 NaF, NaCl, NaBr, NaI
 A) NaF
 B) NaCl
 C) NaBr
 D) NaI
 E) not enough information given

14) Which of the substances below would produce the hardest, most brittle crystals? 14) _____
 A) H₂O B) Xe **C) SiC** D) Cu E) KNO₃

15) Which of the following ionic compounds would you predict to have the highest melting point? 15) _____
A) MgO B) NaCl C) CaS D) LiBr E) NaI

16) List the following ionic compounds in order of increasing solubility: 16) _____
 RbI, CaO, KCl
A) CaO, KCl, RbI
 B) KCl, RbI, CaO
 C) RbI, KCl, CaO
 D) RbI, CaO, KCl
 E) KCl, CaO, RbI

17) Vanadium crystallizes in a body centered cubic structure and has an atomic radius of 131 pm. The edge length of a body centered cubic structure is $4r/\sqrt{3}$. How many vanadium atoms are in 1 unit cell? 17) _____
 A) 2.77 atoms **B) 2 atoms** C) 6.11 atoms D) 8.46 atoms E) 3.06 atoms

18) Vanadium crystallizes in a body centered cubic structure and has an atomic radius of 131 pm. Determine the density of vanadium, if the edge length of a bcc structure is $4r/\sqrt{3}$. 18) _____

A) 2.77 g/cm³
 B) 3.06 g/cm³
C) 6.11 g/cm³
 D) 8.46 g/cm³
 E) 12.2 g/cm³

$2 \text{ V atoms} \times \frac{\text{mol V}}{6.022 \times 10^{24} \text{ atoms}} \times \frac{50.94 \text{ g}}{\text{mol V}} = 1.69 \times 10^{-22} \text{ g}$ ← DIVIDE

$\text{VOL} = \left(\frac{4r}{\sqrt{3}}\right)^3 = \frac{64r^3}{5.196} = \frac{64(131 \text{ pm} \times \frac{10^{-12} \text{ m}}{\text{pm}} \times \frac{\text{cm}}{10^{-2} \text{ m}})^3}{5.196} = 2.77 \times 10^{-23} \text{ cm}^3$

19) Determine the radius of an Al atom (in pm) if the density of aluminum is 2.71 g/cm³. Aluminum crystallizes as a cubic close packed (face centered cubic) structure with an edge length of $2\sqrt{2}r$. 19) _____
 A) 193 pm B) 172 pm C) 96 pm **D) 143 pm** E) 227 pm

20) The "electron-sea" model for bonding in metals, does NOT do a good job explaining 20) _____
 A) electrical conductivity
 B) malleability
 C) shiny appearance
 D) ductility
E) formation of gaseous diatomic metal molecules such as Li₂

21) Which of the following would you predict to have an overlapping conduction band and valence band? 21) _____
 A) iodine crystals
 B) solid CO₂
 C) solid silicon
 D) crystalline rock salt
E) rubidium metal

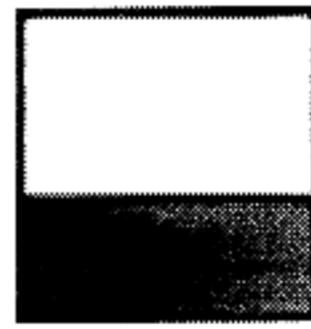
22) Which of the following band diagrams corresponds to a semiconductor?

22) _____

A)



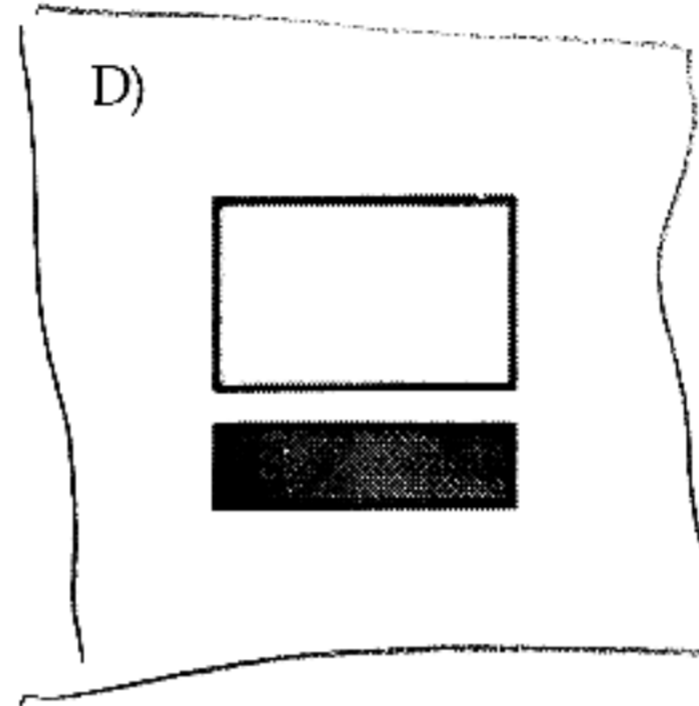
B)



C)



D)



23) Which of the following band diagrams corresponds to an electrical insulator?

23) _____

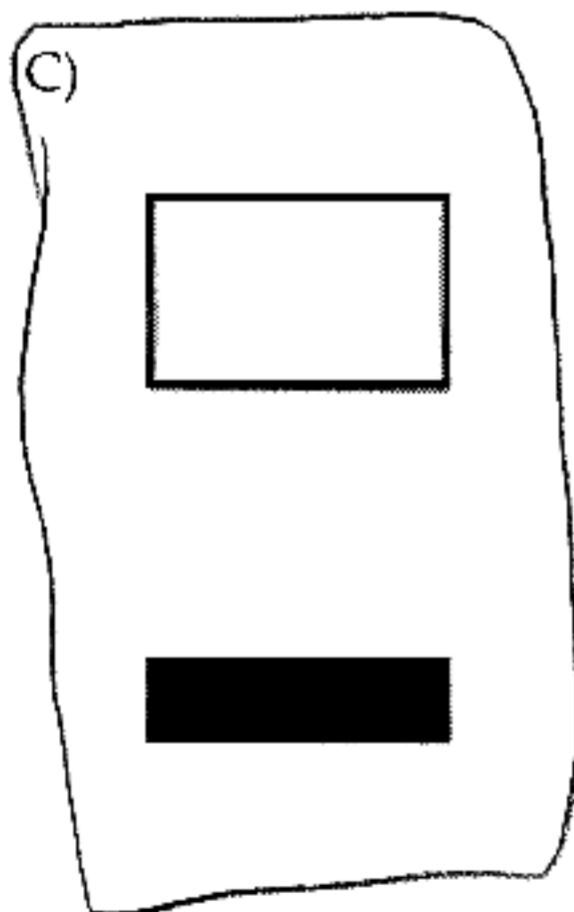
A)



B)



C)



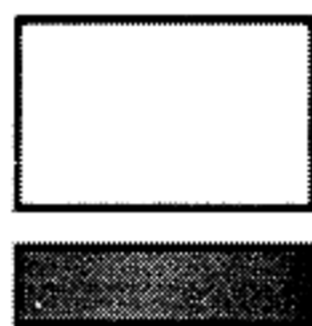
D)



- 24) Why is a material such as diamond an insulator? 24) _____
- A) There are no electrons in the valence band.
 - B) All of the electrons are in the conduction band.
 - C) Electrons cannot make the transition over the large energy gap between the valence band and the conduction band.
 - D) The bonds in diamond are too strong to allow atoms to move so no current flows.
 - E) When I get a diamond, I feel like I have a warm blanket wrapped around me.

- 25) Which of the following is FALSE? 25) _____
- A) Silicon has a small gap between its conduction band and its valence band.
 - B) Graphite has overlapping conduction and valence bands.
 - C) Elemental sulfur has a large gap between its conduction band and its valence band.
 - D) Electrical conductance requires that the solid have empty orbitals that are accessible to electrons from lower energy levels.
 - E) Aluminum has a small gap between its conduction band and its valence band.

- 26) What could you do to modify the semiconducting properties of the group 14 element below? (there may be more than one way) 26) _____



- A) Hit it with a hammer three times.
- B) It already is an intrinsic semiconductor – don't mess with it.
- C) Dope it with an electron donor from group 15 (n-type).
- D) Dope it with an electron acceptor from group 13 (p-type).
- E) There is no way to modify it.

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

- 27) The close packed arrangement abab, results in a hexagonal unit cell. 27) T
- 28) The body centered unit cell results from cubic close packing. 28) F
- 29) The electrical conductivity of semiconductors increases with temperature. 29) T
- 30) The electrical conductivity of metallic conductors increases with temperature. 30) F
- 31) The electrical resistance of superconductors is very high at low temperatures. 31) F
- 32) The electrical conductivity of superconductors is very high at low temperatures. 32) T
- 33) Band theory is well suited to describe the properties of metallic conductors, semiconductors and insulators but not superconductors. 33) T