Chapter 12: Intermolecular Forces and Liquids and Solids

1. Which one of the following substances is expected to have the highest boiling point?
   A) Br_2 B) Cl_2 C) F_2 D) I_2

3. Which one of the following substances is expected to have the highest boiling point?
   A) HBr B) HCl C) HF D) HI

5. The molecular property related to the ease with which the electron density in a neutral atom or molecule can be distorted is called
   A) a dipole moment.
   B) polarizability.
   C) a dispersion force.
   D) surface tension.
   E) a van der Waals force.

7. Which one of the following substances should exhibit hydrogen bonding in the liquid state?
   A) PH_3 B) H_2 C) H_2S D) CH_4 E) NH_3

9. Which of the following substances should have the highest boiling point?
   A) CH_4 B) Cl_2 C) Kr D) CH_3Cl E) N_2

11. Which of the following liquids would have the highest viscosity at 25°C?
    A) CH_3OCH_3 B) CH_2Cl_2 C) C_2H_5OH D) CH_3Br E) $HOCH_2CH_2OH$

13. Which of the following characteristics indicates the presence of *weak* intermolecular forces in a liquid?
    A) a low heat of vaporization
    B) a high critical temperature
    C) a low vapor pressure
    D) a high boiling point
    E) None of the above.

15. Which of the following properties indicates the presence of *strong* intermolecular forces in a liquid?
    A) a low heat of vaporization
    B) a low critical temperature
    C) a low vapor pressure
    D) a low boiling point
    E) None of the above.

17. For which of the following species are the dispersion forces strongest?
A) C_4H_{10} B) C_5H_{12} C) C_6H_{14} D) C_7H_{16} E) C_8H_{18}

19. Which of the following would be expected to have the *highest* vapor pressure at room temperature?
A) ethanol, bp = 78°C
B) methanol, bp = 65°C
C) water, bp = 100°C
D) acetone, bp = 56°C

21. Given the following liquids and their boiling points, which has the *highest* vapor pressure at its normal boiling point?
A) ethanol, bp = 78°C
B) methanol, bp = 65°C
C) water, bp = 100°C
D) benzene, bp = 80°C
E) The vapor pressure of each of the liquids at its normal boiling point would be the same.

23. Arrange the following in order of <u>increasing</u> boiling point: RbCl, CH_3Cl, CH_3OH, CH_4.
A) $CH_3OH < CH_3Cl < RbCl < CH_4$
B) $CH_3OH < CH_4 < CH_3Cl < RbCl$
C) $RbCl < CH_3Cl < CH_3OH < CH_4$
D) $CH_4 < CH_3OH < CH_3Cl < RbCl$
E) $CH_4 < CH_3Cl < CH_3OH < RbCl$

25. Which one of the following substances should exhibit hydrogen bonding in the liquid state?
A) PH_3 B) He C) H_2S D) CH_4 E) CH_3OH

27. Which of the responses includes all of the following that can form hydrogen bonds with water molecules?
(1) Na^+ (2) CH_3COOH (3) C_2H_6 (4) CH_3NH_2
A) (1) and (2) B) (1) and (3) C) (2) and (3) D) (2) and (4) E) (3) and (4)

29. Which of the following substances would have the *highest* critical temperature?
A) CH_3Cl B) C_2H_6 C) F_2 D) H_2 E) CO_2

31. Which of the following is *not* true with regard to water?
    A) Water has a high heat capacity.
    B) Water has an unusually high boiling point.
    C) Water can form hydrogen bonds.
    D) Ice is more dense than liquid water.
    E) Water is a polar molecule.

33. An example of a covalent network solid is
    A) diamond.
    B) potassium.
    C) iodine.
    D) sodium chloride.
    E) None of these.

35. The structural form of the element Ge closely resembles the structure of
    A) C (diamond).
    B) N (diatomic).
    C) As (tetrahedral).
    D) S (S_8 ring).
    E) Kr (monatomic).

37. Which one of the following substances crystallizes as a covalent crystal?
    A) CaO B) SiO_2 C) CO_2 D) Pb E) $KMnO_4$

39. The number of atoms in a body-centered cubic unit cell is
    A) 1. B) 2. C) 3. D) 4. E) 8.

41. Silver metal crystallizes in a face-centered cubic lattice with L as the length of one edge of the unit cube. The center-to-center distance between nearest silver atoms is
    A) L/2. B) $2^{1/2}$ L. C) 2L. D) $L / 2^{1/2}$. E) None of the above.

43. Potassium crystallizes in a body-centered cubic lattice. How many atoms are there per unit cell?
    A) 1 B) 2 C) 4 D) 6 E) 8

45. Vanadium crystallizes in a body-centered cubic lattice, and the length of the edge of a unit cell is 305 pm. What is the density of V?
    A) 5.96 g/cm^3
    B) 2.98 g/cm^3
    C) 2.98×10^{-6} g/cm^3
    D) 5.96×10^{-30} g/cm^3
    E) 11.9 g/cm^3

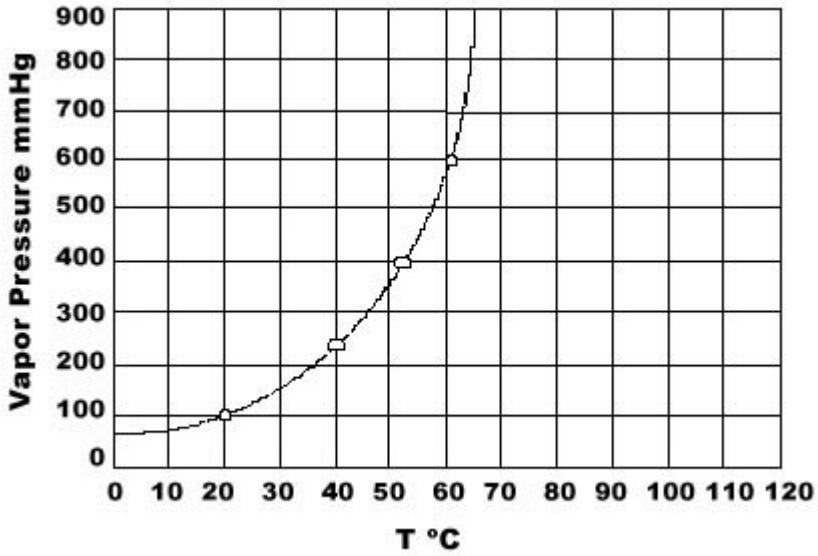
47. Platinum has a face-centered cubic crystal structure and a density of 21.5 g/cm^3. What is the radius of the platinum atom?
A) 69 pm B) 98 pm C) 139 pm D) 196 pm E) 277 pm

49. The mineral manganosite, manganese(II) oxide, crystallizes in the rock salt structure (the face-centered structure adopted by NaCl) with a density of 5.365 g/cm^3. Find the unit cell edge length of manganosite.
A) 444.5 pm B) 352.8 pm C) 280.0 pm D) 368.2 pm E) 417.9 pm

51. The triple point of iodine is at 0.12 atm and 115°C. Thus, liquid I_2
A) is more dense than I_2 (s).
B) cannot exist above 115°C.
C) is liquid at room temperature.
D) cannot have a vapor pressure less than 91 torr.

53. The heat capacity of liquid water is 4.18 J/g·°C and the heat of vaporization is 40.7 kJ/mol. How many kilojoules of heat must be provided to convert 1.00 g of liquid water at 67°C into 1.00 g of steam at 100°C?
A) 22.7 kJ B) 40.8 kJ C) 2.2 kJ D) 2,400 J E) 40.8 J

55. Use the graph of vapor pressure to determine the normal boiling point of $CHCl_3$.



A) 19°C B) 52°C C) 60°C D) 64°C E) 70°C

57. Acetic acid has a heat of fusion of 10.8 kJ/mol and a heat of vaporization of 24.3 kJ/mol. What is the expected value for the heat of sublimation of acetic acid?
A) 35.1 kJ/mol
B) –13.5 kJ/mol
C) +13.5 kJ/mol
D) –35.1 kJ/mol
E) Not enough information is given to answer the question.

59. Calculate the amount of heat that must be absorbed by 10.0 g of ice at –20°C to convert it to liquid water at 60.0°C. Given: specific heat (ice) = 2.1 J/g·°C; specific heat (water) = 4.18 J/g·°C; ΔH_{fus} = 6.0 kJ/mol.
A) 420 J B) 2,900 J C) 6,300 J D) 63 kJ E) 7.5 J

61. What mass of water would need to evaporate from your skin in order to dissipate 1.7×10^5 J of heat from your body?
$H_2O(l) \rightarrow H_2O(g)$ ΔH_{vap} = 40.7 kJ/mol
A) 7.52×10^4 g B) 418 g C) 75.2 g D) 58.4 g E) 6.92×10^6 g

63. The vapor pressure of a liquid in a closed container depends upon
A) the amount of liquid.
B) the surface area of the liquid.
C) the volume of the container.
D) the temperature.
E) None of the above.

65. Solid iodine has a vapor pressure of 1.0 mmHg at 39°C. How many *moles* of iodine will sublime into a 500. mL flask at this temperature? If the volume of the flask is doubled at constant temperature, what will happen to the *equilibrium* vapor pressure of I_2? (Assume some solid I_2 is always present in the container.)
A) 2.1×10^{-4} mol; vapor pressure increases
B) 2.0×10^{-2} mol; vapor pressure increases
C) 2.6×10^{-5} mol; no change in vapor pressure
D) 2.1×10^{-4} mol; no change in vapor pressure
E) 2.6×10^{-5} mol; vapor pressure decreases

67. Which one of the following elements would have the *lowest* melting point?
A) Kr B) Br_2 C) S_8 D) Ca E) K

69. The molar heats of sublimation and fusion of iodine are 62.3 kJ/mol and15.3 kJ/mol, respectively. Calculate the molar heat of vaporization of liquid iodine.
A) 77.6 kJ/mol
B) 47.0 kJ/mol
C) –47.0 kJ/mol
D) –77.6 kJ/mol
E) 4.07 kJ/mol

71. Use the following data to determine the molar heat of vaporization of chlorine.

T (°C)	–84.5	–71.2	–47.3
P (mmHg)	40.0	100.0	400.0

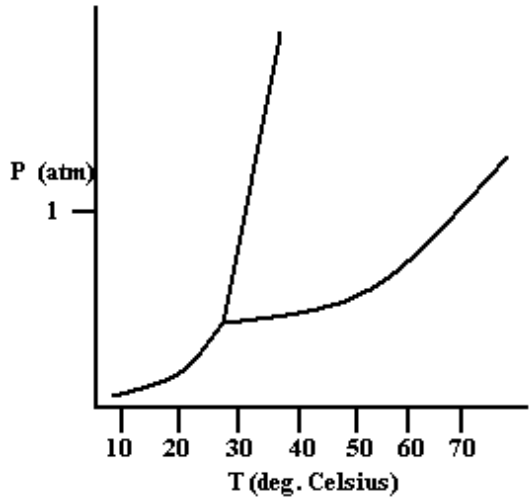
A) 34,700 J B) 21,900 J C) 317 J D) 712 J E) 9.99 kJ

73. The molar enthalpy of vaporization of boron tribromide is 30.5 kJ/mol, and its normal boiling point is 91°C. What is the vapor pressure of BBr_3 at 20°C?
A) 11.5 torr B) 311 torr C) 5.31 torr D) 143 torr E) 66.1 torr

75. The normal boiling point of methanol (CH_3OH) is 64.6°C. Given that the vapor pressure of methanol is 75.0 torr at 15.2°C, calculate the molar enthalpy of vaporization of methanol.
A) 0.383 kJ/mol
B) 3.00 kJ/mol
C) 38.0 kJ/mol
D) 27.5 kJ/mol
E) 74.7 kJ/mol

77. Find the temperature at which water boils on a day in the mountains when the barometric pressure is 593 mmHg. (Given: the heat of vaporization of water is 40.79 kJ/mol)
A) 93.1°C B) 117°C C) 41.5°C D) 97.0°C E) 68.1°C

79. Based on the phase diagram shown below, how will the melting point of the substance change if the pressure is increased above 1 atm?



A) The melting point will decrease.
B) The melting point will remain the same.
C) The melting point will increase.
D) The substance will not melt at pressures of 1 atm and above; instead, the solid sublimes to form the gas phase.