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- 1) Which one of the following substances is expected to have the lowest melting point?
- A) BrI
 - B) CsI
 - C) LiI
 - D) NaI
 - E) RbI
- 2) 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
- 3) Arrange the following substances in order of increasing boiling point: $\text{CH}_3\text{CH}_2\text{OH}$, $\text{HOCH}_2\text{CH}_2\text{OH}$, $\text{CH}_3\text{CH}_2\text{Cl}$, and $\text{ClCH}_2\text{CH}_2\text{OH}$
- A) $\text{CH}_3\text{CH}_2\text{OH} < \text{HOCH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{Cl} < \text{ClCH}_2\text{CH}_2\text{OH}$
 - B) $\text{CH}_3\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_2\text{OH} < \text{ClCH}_2\text{CH}_2\text{OH} < \text{HOCH}_2\text{CH}_2\text{OH}$
 - C) $\text{CH}_3\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{Cl} < \text{HOCH}_2\text{CH}_2\text{OH} < \text{ClCH}_2\text{CH}_2\text{OH}$
 - D) $\text{CH}_3\text{CH}_2\text{Cl} < \text{ClCH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{OH} < \text{HOCH}_2\text{CH}_2\text{OH}$
 - E) $\text{CH}_3\text{CH}_2\text{OH} < \text{ClCH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{Cl} < \text{HOCH}_2\text{CH}_2\text{OH}$
- 4) Each of the following substances is a liquid at -50°C . Place these liquids in order of *increasing* vapor pressure: dimethyl ether (CH_3OCH_3), propane (C_3H_8), and ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) .

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- A) ethanol < propane < dimethyl ether
 - B) ethanol < dimethyl ether < propane
 - C) propane < dimethyl ether < ethanol
 - D) dimethyl ether < ethanol < propane
 - E) propane < ethanol < dimethyl ether
- 5) The boiling points of chloromethane (CH_3Cl) and dichloromethane (CH_2Cl_2) are -24°C and $40.^\circ\text{C}$ respectively. The boiling point of trichloromethane (CHCl_3) is predicted to be:
- A) $< -24^\circ\text{C}$
 - B) $> 40.^\circ\text{C}$
 - C) $> -24^\circ\text{C}$ and $< 40.^\circ\text{C}$
 - D) -24°C
 - E) $40.^\circ\text{C}$
- 6) Arrange the following in order of increasing melting point: NaCl , H_2O , CH_4 , $\text{C}_6\text{H}_4(\text{OH})_2$.
- A) $\text{NaCl} < \text{H}_2\text{O} < \text{CH}_4 < \text{C}_6\text{H}_4(\text{OH})_2$
 - B) $\text{CH}_4 < \text{H}_2\text{O} < \text{NaCl} < \text{C}_6\text{H}_4(\text{OH})_2$
 - C) $\text{CH}_4 < \text{H}_2\text{O} < \text{C}_6\text{H}_4(\text{OH})_2 < \text{NaCl}$
 - D) $\text{CH}_4 < \text{C}_6\text{H}_4(\text{OH})_2 < \text{H}_2\text{O} < \text{NaCl}$
 - E) $\text{CH}_4 < \text{NaCl} < \text{C}_6\text{H}_4(\text{OH})_2 < \text{H}_2\text{O}$
- 7) Palladium crystallizes in a face-centered cubic unit cell. Its density is 12.0 g/cm^3 at 27°C . Calculate the atomic radius of Pd.
- A) 154 pm
 - B) 138 pm
 - C) $1.95 \times 10^{-8} \text{ nm}$
 - D) 0.109 nm
 - E) $1.95 \times 10^{-8} \text{ cm}$

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- 8) 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) $5.96 \times 10^{-30} \text{ g/cm}^3$
B) $2.98 \times 10^{-6} \text{ g/cm}^3$
C) 2.98 g/cm^3
D) 5.96 g/cm^3
E) 11.9 g/cm^3
- 9) Potassium bromide, KBr, crystallizes like NaCl in a face-centered lattice. The ionic radii of K^+ and Br^- ions are 133 pm and 195 pm, respectively. Assuming that all Br^- ions are positioned in the face and corners of the unit cell, while the K^+ ions are positioned along the edge alternating between anions, calculate the length of a unit cell edge.
- A) 230 pm
B) 328 pm
C) 523 pm
D) 656 pm
E) 780 pm
- 10) The atomic planes in a graphite crystal are separated by 335 pm. At what angle would you find the first-order ($n = 1$) diffraction of 0.154 nm X-rays from a graphite crystal?
- A) 0.232°
B) 2.63°
C) 13.3°
D) 27.4°
E) 66.8°
- 11) 3.59 g of water was introduced into an evacuated 1.50 L flask at 30°C . What mass of water will evaporate? (Vapor pressure of water at 30°C is 31.82 mmHg.)

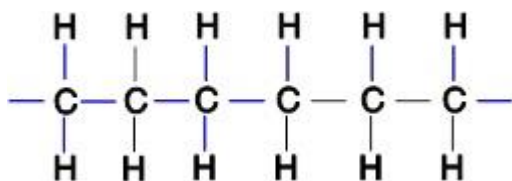
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- A) $2.52 \times 10^{-3} \text{ g}$
B) 0.04187 g
C) 0.0455g
D) 0.4187 g
E) 0.455 g
- 11)** Octane is a liquid component of gasoline. Given the following vapor pressures of octane at various temperatures, estimate the boiling point of octane in Leadville, Colorado, where the atmospheric pressure is 496 mmHg.
400 mmHg @ 104°C, 500 mmHg @ 111°C, 600 mmHg @ 117°C, 700 mmHg @ 122°C, 760 mmHg @ 125°C
A) 125°C
B) 120°C
C) 115°C
D) 110°C
E) 105°C
- 13)** 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) 34,700J
B) 21,900J
C) 9.99 kJ
D) 712 J
E) 317 J
- 14)** 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 BBr₃ at 20°C?

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- A) 11.5 torr
- B) 311 torr
- C) 5.31 torr
- D) 143 torr
- E) 66.1 torr

- 15) Polyethylene plastic consists of long chains of carbon atoms, each of which is also bonded to hydrogens as shown below:



Water forms beads when placed on a polyethylene surface. Why?

- A) Water is nonpolar and polyethylene is nonpolar. Therefore there is very little interaction between these compounds. Accordingly, water beads are expected.
- B) Water is highly polar and polyethylene is nonpolar. Therefore there is very little interaction between these compounds. Accordingly, water beads are expected.
- C) Water is highly polar and polyethylene is polar. Therefore there is very little interaction between these compounds. Accordingly, water beads are expected.
- D) Water is highly polar and polyethylene is ionic. Therefore there is very little interaction between these compounds. Accordingly, water beads are expected.
- E) None of the above explains this example.