Soquids M/C Questions

58. On a mountaintop, it is observed that water boils at 90°C, not at 100°C as at sea level. This phenomenon occurs because on the mountaintop the
A) equilibrium water vapor pressure is higher due to the higher atmospheric pressure
B) equilibrium water vapor pressure is lower due to the higher atmospheric pressure
C) equilibrium water vapor pressure equals the atmospheric pressure at a lower temperature
D) water molecules have a higher average kinetic energy due to the lower atmospheric pressure
E) water contains a greater concentration of dissolved Gas

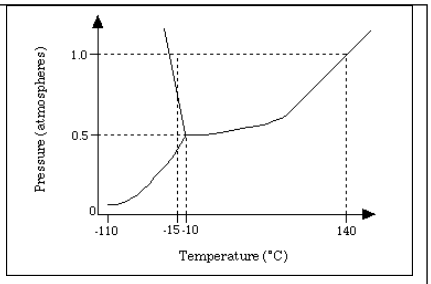
68. In which of the following processes are covalent bonds broken?
A) $I_2(s) \rightarrow I_2(g)$
B) $CO_2(s) \rightarrow CO_2(g)$
C) NaCl(s) --> NaCl(l)
D) C(diamond) --> C(g)
E) Fe(s) --> Fe(l)

27. The critical temperature of a substance is the
(A) temperature at which the vapor pressure of the liquid is equal to the external pressure
(B) temperature at which the vapor pressure of the liquid is equal to 760 mm Hg
(C) temperature at which the solid, liquid, and vapor phases are all in equilibrium
(D) Temperature at which liquid and vapor phases are in equilibrium at I atmosphere
(E) lowest temperature above which a substance cnnot be liquified at any applied pressure

54. Which of the following statements is always true about the phase diagram of any one-component system?
(A) The slope of the curve representing equilibrium between the vapor and liquid phases is positive.
(B) The slope of the curve representing equilibrium between the liquid and solid phases is negative.
(C) The slope of the curve representing equilibrium between the liquid and solid phases is positive.
(D) the temperature at the triple point is greater than the normal freezing point.
(E) The pressure at the triple point is greater than 1 atmosphere.

21. Which of the following is true at the triple point of a pure substance?
(A) The vapor pressure of the solid phase always equal the vapor pressure of the liquid phase.
(B) The temperature is always 0.01 K lower that the normal melting point.
(C) The liquid and gas phases of the substance always have the same density and are therefore indistinguishable.
(D) the solid phase always melts if the pressure increases at constant temperature.
(E) The liquid phase always vaporizes if the pressure increases at constant temperature.

49. Use the following diagram for 49-51.



49. The normal boiling point of the substanced represented by the phase diagram above is

(A) -15 °C

(B) -10 °C

(C) 140 °C

(D) greater than 140 °C

(E) not determinable from the diagram

50. The phase diagram above provides sufficient information for determining the

(A) Entrop. change on vaporization

(B) conditions necessary for sublimation

(C) deviations from ideal gas behavior of the gas phase

(D) latent heat of vaporization

(E) latent heat of fusion

51. For the substance represented in the diagram, which of the phases is most dense and which is least dense at - 15 °C.

	Most Dense	Least Dense
(A)	Solid	Gas
(B)	Solid	Liquid
(C)	Liquid	Solid
(D)	Liquid	Gas
(E)	The diagram gives no information about densities.	

26. Which of the following actions would be likely to change the boiling point of a sample of a pure liquid in an open container?

I. Placing it in a smaller container

II. Increasing the number of moles of the liquid in the container

III. Moving the container and liquid to a higher altitude

(A) I only

(B) II only

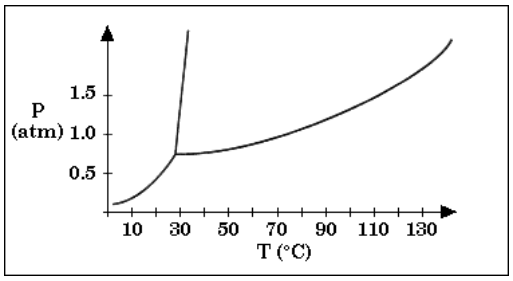
(C) III only

(D) II and III only

(E) I, II, and III

5. Questions 5-7 refer to the phase diagram below of a pure substance.

(A) Sublimation



(B) Condensation
(C) Solvation
(D) Fusion
(E) Freezing

5. If the temperature increases from 10° C to 60° C at a constant pressure of 0.4 atmosphcre, which of the processes occurs?

6. If the temperature decreases from 110° C to 40° C at a constant pressure of 1.1 atmospheres, which of the processes occurs?

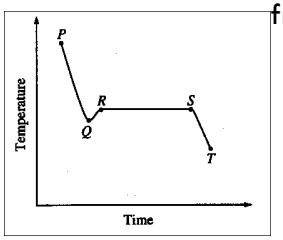
7. If the pressure increases from 0.5 to 1.5 atmospheres at a constant temperature of 50° C, which of the processes occurs?

13. Questions 13-16 refer to the following descriptions of bonding in different types of solids.

(A) Lattice of positive and negative ions held together by electrostatic forces.
(B) Closely packed lattice with delocalized electrons throughout
(C) Strong single covalent bonds with weak intermolecular forces.
(D) Strong multiple covalent bonds (including bonds.) with weak intermolecular forces
(E) Macromolecules held together with strong polar bonds.

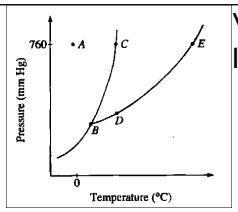
13. Cesium chloride, CsCl (s)
15. Carbon dioxide, CO2(s)
16. Methane, CH4(s)

25. The cooling curve for a pure substance as it changes from a liquid to a solid is shown right. The solid and the liquid coexist at



(A) point Q only
(B) point R only
(C) all points on the curve between Q and S
(D) all points on the curve between R and T
(E) no point on the curve

39. The phase diagram for a pure substance is shown above. Which point on the diagram corresponds to the equilibrium between the solid and liquid phases at the normal melting point?



(A) A
(B) B
(C) C
(D) D
(E) E

Soquids F/R

1977 D

The state of aggregation of solids can be described as belonging to the following four types:

(1) ionic (3) covalent network

(2) metallic (4) molecular

For each of these types of solids, indicate the kinds of particles that occupy the lattice points and identify forces among these particles. How could each type of solid be identified in the laboratory?

Answer:

1978 D

The freezing point and electrical conductivities of three aqueous solutions are given below.

Solution (0.010 molal)	Freezing Point	Electrical Conductivity
sucrose	-0.0186°C	almost zero
formic acid	-0.0213°C	low
sodium formate	-0.0361°C	high

Explain the relationship between the freezing point and electrical conductivity for each of the solutions above. Account for the differences in the freezing points among the three solutions.

Answer:

1984 C

Give a scientific explanation for the following observations. Use equations or diagrams if they are relevant.

(a) It takes longer to cook an egg until it is hard-boiled in Denver (altitude 1 mile above sea level) than it does in New York City (near sea level).

(b) Burn coal containing a significant amount of sulfur leads to ôacid rain.ö

(c) Perspiring is a mechanism for cooling the body.

(d) The addition of antifreeze to water in a radiator decreases the likelihood that the liquid in the radiator will either freeze or boil.

1987 D

In 1884 the Swedish chemist Svante Arrhenius proposed that salts dissociate into two or more separate, independent, ionic fragments when they dissolve in water.

(a) Give one piece of experimental evidence that more than 1 mole of particles is formed when 1 mole of a salt dissolves in water.

(b) Give one piece of experimental evidence that the particles formed when a salt dissolves in water are charged.

(c) Explain why the heat of neutralization is always the same when 1 mole of any monoprotic strong acid reacts with enough strong base to form a neutral solution.

(d) Explain why hydrogen chloride, HCl, dissociated when it dissolves in water but not when it dissolves in benzene.

1988 D

The normal boiling and freezing points of argon are 87.3 K and 84.0 K, respectively. The triple point is at 82.7 K and 0.68 atmosphere.

(a) Use the data above to draw a phase diagram for argon. Label the axes and label the regions in which the solid, liquid and gas phases are stable. On the phase diagram, show the position of the normal boiling point.

(b) Describe any changes that can be observed in a sample of solid argon when the temperature is increased from 40 K to 160 K at a constant pressure of 0.50 atmosphere.

(c) Describe any changes that can be observed in a sample of liquid argon when the pressure is reduced from 10 atmospheres to 1 atmosphere at a constant temperature of 100 K, which is well below the critical temperature.

(d) Does the liquid phase of argon have a density greater than, equal to, or less than the density of the solid phase? Explain your answer, using information given in the introduction to this question.

Answer:

1989 D

Consider three unlabeled bottles, each contain small pieces of one of the following metals.

- Magnesium
- Sodium
- Silver

The following reagents are used for identifying the metals.

- Pure water
- A solution of 1.0 molar HCl
- A solution of concentrated HNO_3

(a) Which metal can be easily identified because it is much softer than the other two? Describe a chemical test that distinguishes this metal from the other two, using only one of the reagents above. Write a balanced chemical equation for the reaction that occurs.

(b) One of the other two metals reacts readily with the HCl solution. Identify the metal and write the balanced chemical equation for the reaction that occurs when this metal is added to the HCl solution. Use the table of standard reduction potentials (attached) to account for the fact that this metal reacts with HCl while the other does not.

(c) The one remaining metal reacts with the concentrated HNO_3 solution. Write a balanced chemical equation for the reaction that occurs.

(d) The solution obtained in (c) is diluted and a few drops of 1 M HCl is added. Describe what would be observed. Write a balanced chemical equation for the reaction that occurs.

Answer:

1994 D

For each of the following, use appropriate chemical principles to explain the observation.

(a) Sodium chloride may be spread on an icy sidewalk in order to melt the ice; equimolar amounts of calcium chloride are even more effective.

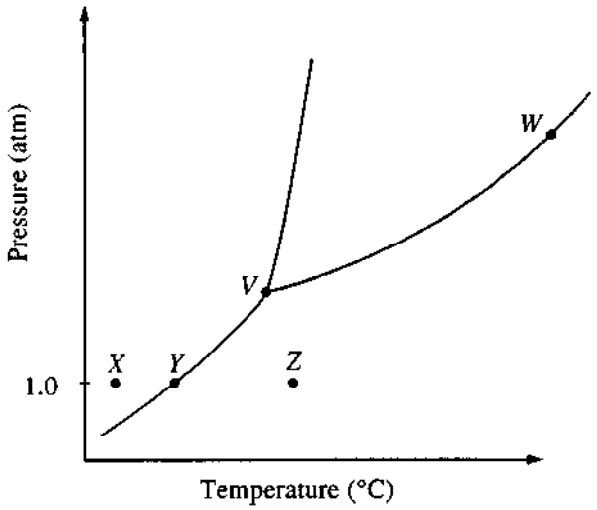
(b) At room temperature, NH_3 is a gas and H_2O is a liquid, even though NH_3 has a molar mass of 17 grams and H_2O has a molar mass of 18 grams.

(c) C (graphite) is used as a lubricant, whereas C (diamond) is used as an abrasive.

(d) Pouring vinegar onto the white residue inside a kettle used for boiling water results in a fizzing/bubbling phenomenon.

Answer:

1995 D



The phase diagram for a pure substance is shown above. Use this diagram and your knowledge about changes of phase to answer the following questions.

(a) What does point *V* represent? What characteristics are specific to the system only at point *V*?.

(b) What does each point on the curve between *V* and *W* represent?

(c) Describe the changes that the system undergoes as the temperature slowly increases from *X* to *Y* to *Z* at 1.0 atmosphere.

(d) In a solid-liquid mixture of this substance, will the solid float or sink? Explain.

Answer:

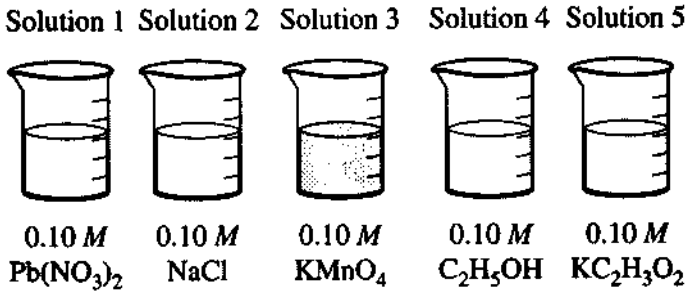
1998 D

Answer each of the following using appropriate chemical principles.

(a) Why does it take longer to cook an egg in boiling water at high altitude than it does at sea level?

Answer

2001 D Required



Answer the questions below that relate to the five aqueous solutions at 25°C shown above.

(a) Which solution has the highest boiling point? Explain.

(b) Which solution has the highest pH? Explain.

(c) Identify a pair of the solutions that would produce a precipitate when mixed together. Write the formula of the precipitate.

(d) Which solution could be used to oxidize the $Cl^{-}_{(aq)}$ ion? Identify the product of the oxidation.

(e) Which solution would be the least effective conductor of electricity? Explain.

2003 D Required

For each of the following, use appropriate chemical principles to explain the observations. Include chemical equations as appropriate.

(a) In areas affected by acid rain, statues and structures made of limestone (calcium carbonate) often show signs of considerable deterioration.

(b) When table salt (NaCl) and sugar ($C_{12}H_{22}O_{11}$) are dissolved in water, it is observed that

(i) both solution have higher boiling points than pure water, and

(ii) the boiling point of 0.10 *M* $NaCl_{(aq)}$ is higher than that of 0.10 *M* $C_{12}H_{22}O_{11(aq)}$.

(c) Methane gas does not behave as an ideal gas at low temperatures and high pressures.

(d) Water droplets form on the outside of a beaker containing an ice bath.

Answer:

1973 D

Discuss briefly the relationship between the dipole moment of a molecule and the polar character of the bonds within it. With this as the basis, account for the difference between the dipole moments of CH_2F_2 and CF_4.

Answer:

1974 D

The possible structures for the compound dinitrogen oxide are NNO and NON. By experimentation it has been found that the molecule of dinitrogen oxide has a non-zero dipole moment and that ions of mass 44, 30, 28, 16, and 14 are obtained in the mass spectrometer. Which of the structures is supported by these data? Show how the data are consistent with this structure.

Answer:

1974 D

The boiling points of the following compounds increase in the order in which they are listed below:

$$CH_4 < H_2S < NH_3$$

Discuss the theoretical considerations involved and use them to account for this order.

Answer:

1978 D

State precisely what is meant by each of the following four terms. Then distinguish clearly between each of the two terms in part (a) and between each of the two terms in part (b), using chemical equations or examples where helpful.

(a) Bond polarity and molecular polarity (dipole moment)

Answer:

1979 D

Butane, chloroethane, acetone, and 1-propanol all have approximately the same molecular weights. Data on their boiling points and solubilities in water are listed in the table below.

Compound	Formula	Boiling Pt.(°C)	Solubility in water
Butane	$CH_3CH_2CH_2CH_3$	0	insoluble
Chloroethane	CH_3CH_2Cl	12	insoluble
Acetone	$CH_3C(=O)CH_3$	56	completely miscible
1-Propanol	$CH_3CH_2CH_2OH$	97	completely miscible

On the basis of dipole moments (molecular polarities) and/or hydrogen bonding, explain in a qualitative way the differences in the

(a) boiling points of butane and chloroethane.

(b) water solubilities of chloroethane and acetone.

(c) water solubilities of butane and 1-propanol.

(d) boiling points of acetone and 1-propanol.

Answer:

1988 D

Using principles of chemical bonding and/or intermolecular forces, explain each of the following.

(a) Xenon has a higher boiling point than neon has.

(b) Solid copper is an excellent conductor of electricity, but solid copper chloride is not.

(c) SiO_2 melts at a very high temperature, while CO_2 is a gas at room temperature, even though Si and C are in the same chemical family.

(d) Molecules of NF_3 are polar, but those of BF_3 are not.

Answer:

1989 D

The melting points of the alkali metals decrease from Li to Cs. In contrast, the melting points of the halogens increase from F_2 to I_2.

(a) Using bonding principles, account for the decrease in the melting points of the alkali metals.

(b) Using bonding principles, account for the decrease in the melting points of the halogens.

(c) What is the expected trend in the melting points of the compounds LiF, NaCl, KBr, and CsI? Explain this trend using bonding principles.

Answer:

1992 D

Explain each of the following in terms of atomic and molecular structures and/or intermolecular forces.

(a) Solid K conducts an electric current, whereas solid KNO_3 does not.

(b) $SbCl_3$ has measurable dipole moment, whereas $SbCl_5$ does not.

(c) The normal boiling point of CCl_4 is 77ºC, whereas that of CBr_4 is 190ºC.

(d) $NaI_{(s)}$ is very soluble in water, whereas $I_{2(s)}$ has a solubility of only 0.03 gram per 100 grams of water.

Answer:

2001 D

Account for each of the following observations about pairs of substances. In your answers, use appropriate principles of chemical bonding and/or intermolecular forces. In each part, your answer must include references to both substances.

(a) Even though NH_3 and CH_4 have similar molecular masses, NH_3 has a much higher normal boiling point (-33°C) than CH_4 (-164°C).

(b) At 25°C and 1.0 atm, ethane (C_2H_6) is a gas and hexane (C_6H_{14}) is a liquid.

(c) Si melts at a much higher temperature (1,410°C) than Cl_2 (-101°C).

(d) MgO melts at a much higher temperature (2,852°C) than NaF (993°C).

Answer: