

12. Metals exhibit high conductivity in the solid state due to their mobile surface electrons. In ionic compounds in the solid state, the electrons are tightly bonded to the individual ions, which have stable (“octet”) electron configurations. However, when melted, the ions are mobile and readily attracted to charged electrodes or terminals inserted into the melted compounds. The ability of charged ions to migrate through a distance creates electrical conductivity in the melted state. The correct answer is the ionic compound, LiCl, answer (C).

The correct answer is (C).

[LO 2.24 SP 1.1, 6.2, 7.1]

13. In “hydrogen bonding,” as now spelled out in the revised AP Chemistry curriculum, the hydrogen atoms in molecular compound are strongly attracted to the highly electronegative fluorine, oxygen or nitrogen atoms in an adjacent molecule. The only molecular substance above in which this combination of atoms exists is Glycerol, $C_3H_5(OH)_3$. Hydrogen must be in a polar bond with the elements F, O, or N to be able to form H-bonding with an adjacent molecule.

The correct answer is (B).

[LO 2.32 SP 1.1, 6.2, 7.1]

14. Vaporization involves molecules moving from the liquid phase to the gaseous phase. Evaporation is one form of vaporization (boiling is another). Excitation is the process in which electrons absorb incoming energy and move to higher energy levels in an atom. Sublimation is the process in which a solid moves directly from the solid into the gas state (like dry ice). This process accounts for the shrinkage of ice cubes and snowmen.

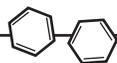
The correct answer is (B).

[LO 3.1 SP 1.5, 7.1] [LO 2.32 SP 1.1, 6.2, 7.1]

15. Approximating the temperature on the graph at 25°C , the liquid which would be expected to have the highest equilibrium vapor pressure at room temperature is CHCl_3 . The vapor pressure at room temperature is approximately 200 Torr for CHCl_3 , but the value of the other liquids on the graph, at this temperature, are visibly lower. CCl_4 , with an additional chlorine, has more surface (valence) electrons (also referred to as “polarizable “electrons”). H_2O is a polar molecule, which exhibits strong “hydrogen bonding,” resulting in the lowest evaporation rate of these three at room temperature.

The correct answer is (A).

[LO 2.16 SP 6.2] [LO 2.32 SP 1.1, 6.2, 7.1]



16. In answer (A), both are metallic substances, each contributing one valence electron to the delocalized “sea of electrons” holding the atoms together, much like a blanket, in the solid form. Rb metal has a larger radius, resulting in a lower surface charge density per atom, so atoms of Rb would require a lower energy to separate or melt. The same reasoning would apply to answer (D), where atoms of Fe would have a smaller radius and each atom would contribute two valence electrons to the sea of electrons in contrast to Cs metal, with one valence electron and a larger radius. In answer (C), both compounds are molecular compounds made up of neutral molecules. The larger molecule, CS_2 , would have more surface area in contact with neighboring CS_2 molecules, resulting in more opportunity for instantaneous attractions to arise between molecules. These stronger inter-molecular forces would result in lower evaporation rates and require higher melting points. In answer (B), with LiCl , an ionic crystal, one is comparing the stronger forces of attraction between oppositely charged ions to the weak attractive forces between neutral, non-polar molecules. The LiCl will require greater heat to separate the ions.

The correct answer is (B).

[LO 2.28 SP 1.1, 6.2, 7.1]

17. Answer (B) ignores the fact that H_2O molecules have more valence electrons than CH_4 , (Bunsen burner gas). Answer (C) is incorrect because it is not true. Water molecules exhibit hydrogen bonding between one another, an extreme type of dipole-dipole attractions, but CH_4 are non-polar molecules that do not exhibit dipole-dipole attractions. Answer (D) is also false because “hydrogen bonding” does NOT exist between CH_4 molecules: the CH_4 molecule does not contain any of the F, O, or N atoms needed for “hydrogen bonding.” However with the polar H_2O molecules, the dipole-dipole attractions between the H_2O molecules are significantly stronger than the attractions between H_2O and the non-polar CH_4 molecules. Therefore CH_4 will not be appreciably soluble in (solvated by) water molecules.

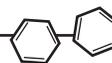
The correct answer is (A).

[LO 2.15 SP 1.4, 6.2]

18. Covalent network solids typically consist of C, Si or Ge atoms, each with four valence electrons. These atoms have high ionization energies, which do not lead to mobile surface electrons found in metallic elements. These mobile surface electrons found in metallic substances readily allow a mechanism for transmitting heat to neighboring atoms, as well as the “pushing” of electrons across the surface, resulting in electrical conductivity and the ability to deform the metal and draw it into wires (ductility). Network covalent crystal will therefore not exhibit any of these characteristics. The strongly bonded network structure, however, will result in the extreme hardness and high melting points that we do find in networks like diamond (C atoms) and quartz (Si atoms).

The correct answer is (C).

[LO 2.22 SP 4.2] [LO 2.30 SP 1.1, 6.2, 7.1]



19. Copper wire is made up of solid Cu atoms. With relatively low ionization energy, and a shiny surface, copper is classified as a metallic substance.

The correct answer is (B).

[LO 2.2 SP 4.2]

20. Carbon dioxide, also known as dry ice, is made up of neutral, non-metallic CO_2 molecules with a O-C-O bond angle of 180° . The dipole moments cancel out, so the molecules are non-polar.

The correct answer is (D).

[LO 2.2 SP 4.2]

21. Benzene liquid, C_6H_6 , is similar to CO_2 discussed in question 20 above. It is made up of neutral molecules, but exists in a symmetrical, hexagonal shape. Because the molecular structure IS symmetrical, the molecule is non-polar and the electrons are not as polarizable as those in CO_2 .

The correct answer is (D).

[LO 2.2 SP 4.2]

22. Lithium nitrate is made up of positive Li ions and negative NO_3 ions. Both are univalent, resulting in the formula, LiNO_3 . All ionic compounds are solids at room temperature, so solid LiNO_3 is therefore classified as an ionic solid. None of the other substances listed as potential answers consists of positive and negative ions.

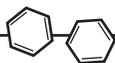
The correct answer is (A).

[LO 2.2 SP 4.2]

23. Powdered graphite, often written as $\text{C}_{(\text{gr})}$, is made up of carbon atoms with strong bonds in two dimensions and weak bonds between layers. These different forces results in great strength within planes of carbon atoms but weak forces between the planes. This behavior can occur with carbon, silicon or germanium atoms and, in this form, is referred to as planar covalent.

The correct answer is (C).

[LO 2.2 SP 4.2]



24. Inexpensive, sealed hand-boilers work on the principle that the boiling point of a liquid varies as the atmosphere pressure varies. This is because the boiling point of a liquid is defined as the temperature at which the vapor pressure cancels out the atmospheric (ambient) pressure. If the liquid is placed in a hand boiler device, often a narrow glass container, and then the device is hooked to a vacuum pump, the pressure over the liquid can be reduced to a very low pressure, and the device can be sealed off. Now with very little additional heat, like that which can be supplied by a human hand, the vapor pressure rises and is capable of canceling out the low pressure above it. The liquid then begins to boil. This means that answers (C) and (D) are false. The correct answer is (B). Any liquid has an array of boiling points, depending upon the pressure over it. This means that answer (A) is false necessitating a common standard. This results in the term “normal boiling point,” the temperature at which a liquid boils when the atmospheric pressure is 1 atmosphere (760 Torr).

The correct answer is (B).

[LO 2.16 SP 6.2]

25. Liquified ammonia consists of NH_3 molecules, which contain N–H bonds and one non-bonded pair of electron on the nitrogen atoms, resulting in a polar molecule. The polarity of the molecules leads to dipole – dipole attractions between the molecules, so answer (B) is false, because these forces DO exist between NH_3 molecules. Because the NH_3 are neutral and polar, we have appreciable instantaneous London Dispersion forces between the molecules, making answer (C) false as well. In highly polar bonds in “hydrogen bonding,” as now spelled out in the revised AP Chemistry curriculum, the hydrogen atoms in a molecular compound are strongly attracted to the highly electronegative fluorine, oxygen or nitrogen atoms in an adjacent molecule. Therefore NH_3 molecules will exhibit “hydrogen bonding,” making answer (D) false. The sharing of electrons between nitrogen and hydrogen atoms is covalent bonding, not ionic bonding.

The correct answer is (A).

[LO 2.32 SP 1.1, 6.2, 7.1]