AP Chem - unit 7
wkst - Unit 7 Review - Key

1) ANS: D

Reread the question, this question scored really low, but was supposed to be easy. It focuses on the VAPOR above the solution and the mole fraction of ONE of the constituents. Dalton's Law applies, there is a total pressure of 100 mmHg, where 75 mm Hg is due to benzene and 25 mm Hg is due to toluene. Therefore, the mole fraction of benzene is 75/100 or 0.75 or 3/4 if the answers were presented as actual fractions.

DIF: Hard   OBJ: 2.4   NAT: 1.4 | 6.4   TOP: States of Matter
KEY: vapor pressure | mole fraction   NOT: 39% answered correctly

2) ANS: C

P to Q shows the liquid cooling to a supercooled state. Most likely the liquid was not stirred during the cooling. Once it is stirred, or a seed crystal is added, the temperature rises as the heat of crystallization is released (points Q to R) and the freezing point is reached. Note that the temperature (KE_{ave}) remains constant throughout the freezing process from points R to S.

So, solid must be present from points Q to S.

DIF: Medium   OBJ: 5.7   NAT: 4.2 | 5.1   TOP: States of Matter
KEY: phase change | cooling curve | lab   NOT: 57% answered correctly

3) ANS: C

Phase changes involve overcoming IMFs. The temperature remains constant (therefore KE remains constant) during a phase change. The only plateau on the graph occurs between points R and S.

Again, it is important to note that point Q represents a supercooling moment, most likely due to the liquid not being stirred as it cooled. Adding a seed crystal or stirring or scraping the glass container will usually start the crystallization process and the heat of crystallization is released and the substance warms back up to its melting point.

DIF: Medium   OBJ: 2.11   NAT: 6.2 | 6.4   TOP: States of Matter
KEY: cooling curve | IMFs | supercooling   NOT: 57% answered correctly

4) ANS: C

On mountaintops, the atmospheric pressure is less. The "pull" of gravity originates at the center of earth and acts on the gases in the atmosphere. The further away from the source of our gravitational pull, the less tightly the atmospheric gases are held, the lower the density of air, thus the lower the atmospheric pressure. Water boils when its vapor pressure is equal to atmospheric pressure. If the atmospheric pressure is less, less thermal energy must be added to a sample of water to raise its VP to a (lesser) atmospheric pressure. Since the water is actually boiling at a lower temperature, food must be boiled longer to compensate!

DIF: Hard   OBJ: 5.6   NAT: 2.2 | 2.3   TOP: States of Matter
KEY: pressure changes with altitude | states of matter | boiling point | vapor pressure
NOT: 39% answered correctly

5) ANS: A

When a nonvolatile (code for very covalent molecule that does not vaporize at normal temperatures) solute is added to a pure solvent, it disrupts the solvent's IMFs. That causes the solvent's vapor pressure to drop, and ideal character to be diminished. (No longer on the AP exam, but nice to know for college: Adding a nonvolatile solute to a pure solvent also causes the solution's BP to increase, FP to decrease.)

DIF: Medium   OBJ: 2.16   NAT: 6.2   TOP: Solutions
KEY: colligative properties | vapor pressure | IMFs   NOT: 53% answered correctly

6) ANS: D

London dispersion forces, van der Waals forces and induced dipole-induced dipole ALL MEAN THE SAME THING! They are the weakest intermolecular forces (IMFs) and result from the temporary polarization of a molecule or collection of molecules. I_2 has a completely nonpolar bond with an electronegativity difference equal to zero, and thus forms completely nonpolar molecules. Therefore there should be NO attraction between iodine molecules, yet at room temperature iodine is a solid. Why? Electrons are in constant motion and "pile up" on one side of a molecule creating a temporary negative pole, this induces polarization in neighboring molecules and thus very weak attractive London dispersion forces are created.

The larger the molecule, the greater the polarizability, the more likely this will happen. A consequence for I_2 solid is that it sublimes when slightly heated. A bit of thermal energy overcomes the LDFs and I_2 goes from solid to gas.
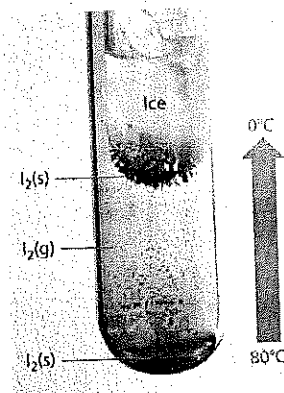
DIF: Medium   OBJ: 2.32   NAT: 1.1 | 6.2 | 7.1 TOP: IMFs
KEY: IMFs | LDFs | iodine molecules   NOT: 57% answered correctly

7) ANS: C

HF is exhibiting a special case of the dipole-dipole IMF referred to as hydrogen bonding [don't confuse it with bonded hydrogens]. F is smaller and more electronegative than Br, therefore the H's of adjacent H–F molecules are more strongly attracted to F than Br, thus more *energy* is required to overcome the attractive forces *between* HF molecules and separate them. "Boiling or vaporizing" is an extreme case of separation! **Remember, only F, O, and N can form hydrogen bonds AND the H involved in a hydrogen bond must be attached to the F, O or N!**

DIF: Easy   OBJ: 5.9   NAT: 6.4   TOP: IMFs
KEY: IMFs | dipole-dipole | hydrogen bond   NOT: 72% answered correctly
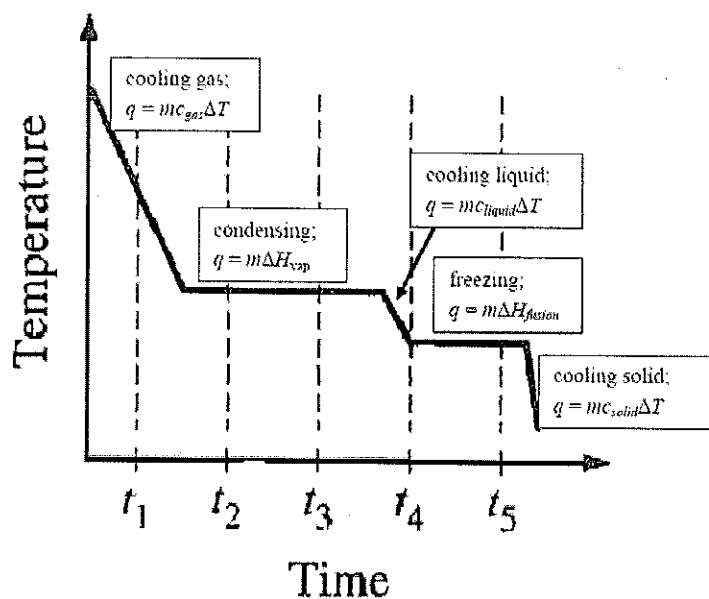
8) ANS: D

This energy overcomes the electrostatic attractions between closely spaced oppositely charged ions. You can also link this to melting points, boiling points, etc. using Coulomb's Law.

DIF: Medium   OBJ: 2.24   NAT: 1.1 | 6.2 | 7.1 TOP: Periodicity
KEY: lattice energy   NOT: 48% answered correctly

9) ANS: C

Realize the "slants" represent temperature changes during which the entire sample is in a single phase. The "plateaus" represent a single temperature during which a phase change is taking place and the two phases are in *equilibrium*.

So, the "most liquid" will be present during t_4 since that time involves the cooling of the liquid (a "slant") whereas t_1 represents a time when the gas is cooling. Additionally, t_2 and t_3 represent times when an equilibrium mixture of gas and liquid are present at constant temperature (CP⇌BP) and t_5 represents a time when an equilibrium mixture of liquid and solid are present at constant temperature (FP⇌MP).

| cooling gas; $q = mc_{gas}\Delta T$ |
| condensing; $q = m\Delta H_{vap}$ |
| cooling liquid; $q = mc_{liquid}\Delta T$ |
| freezing; $q = m\Delta H_{fusion}$ |
| cooling solid; $q = mc_{solid}\Delta T$ |

Time

DIF: Medium   OBJ: 3.11   NAT: 1.5 | 4.4   TOP: States of Matter
KEY: phase change | IMFs | heat of vaporization   NOT: 57% answered correctly

10) ANS: A

These gases are all super duper nonpolar therefore, those with the most electrons are most polarizable, thus have the strongest LDFs and the converse is also true. So, pick puny little hydrogen molecules with only 2 itty bitty electrons.

DIF: Medium   OBJ: 2.11   NAT: 6.2 | 6.4   TOP: IMFs
KEY: LDF | London forces | dispersion forces   NOT: 41% answered correctly

11) ANS: B

It's the old "breaking bonds to melt" routine which is a tip off for "network covalent" solids typically containing C as diamond or graphite OR silicon. Sand or SiO_2 is a classic when diamond or graphite are not answer choices!

DIF: Easy   OBJ: 2.30   NAT: 1.1 | 6.2 | 7.1   TOP: States of Matter | IMFs
KEY: covalent network | melting point | molecular solid

12)
ANS: B
Vaporization involves molecules gathering enough energy to move to the gas phase, evaporation is a form of vaporization as is boiling. Condensation is when water vapor from the air, strikes a cooler surface, loses energy and condenses. Think about the cold mirror in the bathroom in the morning and the condensation that occurs as you take a hot shower. Sublimation is when solid matter moves directly to the gas phase like when solid carbon dioxide or solid iodine are gently heated.

DIF: Medium   OBJ: 3.1 | 2.32   NAT: 1.5 | 7.1 | 1.1 | 6.2
TOP: States of Matter | IMFs   KEY: sublimation | vaporization | condensation

13)
ANS: D
VP is dependent upon the average KE of the molecules, so if the temperature is the same, then the VP is the same for both samples of acetone. Again, I'd call this easy, but you may think it's a trick question.

DIF: Hard   OBJ: 2.16   NAT: 6.2   TOP: Solutions
KEY: VP | colligative properties | states of matter   NOT: 23% answered correctly

14) E

15) E

16) B

17) A $\Delta T_B = K_b \cdot m \cdot i$ K_b = molal Bpt constant
                                                      m = concentration, All same
                                                      i = Van't Hoff factor ← what effects
                                                      K_2SO_4 = 3) NH_4NO_3 = 2 $C_{12}H_{22}O_{11}$ = 1
                                                      HCl = 2 $MgSO_4$ = 2

18) C $\left(\dfrac{6.00 \text{ moles } H_2SO_4}{1 L}\right)\left(\dfrac{.05 L}{1}\right)\left(\dfrac{98.1 g \, H_2SO_4}{1 \text{ mole } H_2SO_4}\right)$ = 29.4 g H_2SO_4

19) A CH_3OH is covalent while all others are Ionic compounds

20) C

21) C

22) e

23) E

24) E

25) D $(10.0 \text{ mL})(6.00 \text{ M}) = ? \text{ mL} (.500 \text{ M})$

                    $? \text{ mL} = 120 \text{ mL}$ this is total Volume!
                    Already have 10. mL

26) B

27) A   Smallest

28) C

29) b

30) B   Biggest

31) A

32) D

33) B   Vapor pressure will decrease

34) D

35) C

36) A

37) E

38) A $\left(\dfrac{39.0\,KJ}{1\,mole}\right)\left(\dfrac{15.8g\ CH_3OH}{1}\right)\left(\dfrac{1\,mole\ CH_3OH}{32.04\,g\ CH_3OH}\right) =$

39) D

40) B

41) C

42) C

43) B

44) A

45) C & E

46) D

47) E, greatest molar mass

48) e

49) A

50) A

51) D $molal = \dfrac{moles\ Solute}{Kg\ Solvent}$ $\left(\dfrac{2.21g\ KBr}{1}\right)\left(\dfrac{1\,mole\,KBr}{119.00g\,KBr}\right) = .0186\ \underset{KBr}{\overset{mole}{}}$

$$\dfrac{.0186\ mole\ KBr}{.897\ Kg\ H_2O} = .0207$$

52) b   Al(NO$_3$)$_3$ for every Al(NO$_3$)$_3$ that breaks up
         you get 3NO$_3^-$ ions. ∴

$$3(.9) = 2.70$$

53) c

54) b

55) E $\Delta T = i K_f m$ i ∴   glucose (1)(.6) = .6
                                                  Sucrose (1)(6) = .6
                                                  FeI$_3$ (4)(.24) = .96
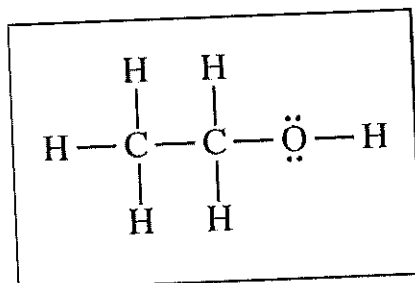   KF   (2)(.51) = 1

FR_____

1)

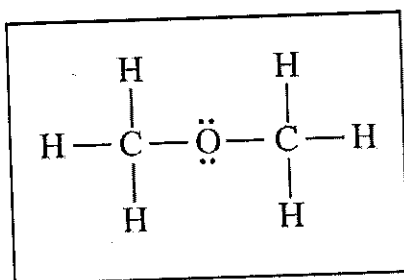(a) NH$_3$ exhibits hydrogen bonding (H attached to nitrogen, attracted to N in adjacent molecule) between molecules which creates a larger IMF than CH$_4$ which doesn't exhibit H-bonding, only weak London dispersion forces). More energy is required to overcome this higher IMF in NH$_3$ and, therefore, has a higher boiling point.

(b) Both ethane's and hexane's IMF consist mainly of weak London dispersion forces. The greater number of electrons in hexane (50 vs. ethane's 18) creates a greater IMF, enough to make it a liquid at 25°C but for ethane, the fewer electrons make a smaller IMF and that is not strong enough to cause ethane to condense.

(c) Si forms strong network covalent bonds (4 per atom) to create a high melting solid. The non-polar molecules of Cl$_2$ (covalent bond, Cl–Cl) do not form strong IMF, only weak London dispersion forces and that makes it easy to melt at a low temperature.

(d) Magnesium oxide is a Mg^{2+}O^{2-} ionic compound while sodium fluoride is a Na$^+$F$^-$ ionic compound. The larger ionic charge creates a stronger Coulombic attraction between the anion and cation in MgO and a higher temperature is required to overcome it and melt it.

2.) A)

H—C—C—Ö—H with H, H on top and H, H on bottom (Box X, ethanol structure)

Box X

1 point is earned for a correct Lewis diagram.

H—C—Ö—C—H with H on top of each C and H on bottom of each C (Box Y, dimethyl ether structure)

Box Y

1 point is earned for a correct Lewis diagram.

B)

Compound 2 is in Box X. Compound 2 (X) would have intermolecular hydrogen bonding. Compound 1 (Y) would have weaker dipole-dipole and London dispersion forces (LDFs). Because compound 2 has stronger intermolecular forces (IMFs) it has a higher boiling point. Also, compound 2 is capable of forming more hydrogen bonds with H_2O than compound 1 is, causing the solubility difference noted in the table.	2 points are earned for identification of compound 2 **and** a rationale that references the types of IMFs in each compound while explaining relative boiling points and/or solubilities.

2) continue

c)

Dichloromethane has a greater solubility in water than carbon tetrachloride has. Account for this observation in terms of the intermolecular forces between each of the solutes and water.

CH_2Cl_2 is polar, whereas CCl_4 is not. Therefore, CH_2Cl_2 interacts with H_2O via dipole-dipole forces, while CCl_4 only interacts with water via dipole/induced dipole forces or LDFs, which would be weaker. As a result, CH_2Cl_2 has a greater solubility.	2 points are earned for a rationale that references the types of IMFs between each compound and water.

In terms of intermolecular forces, explain why dichloromethane has a higher vapor pressure than carbon tetrachloride.

d)

Because CH_2Cl_2 has the higher vapor pressure, the combination of LDFs and dipole-dipole forces in CH_2Cl_2 must be weaker than the strong LDFs in CCl_4.	2 points are earned (1 point for referencing the type(s) of IMFs in each of the two compounds).