General Chemistry II Jasperse
Solutions and Solubility. Extra Practice Problems

Viscosity, Surface Tension, Boiling Point….

1. Viscosity is a measure of a substance's _____

   a. ability to resist changes in its surface area
   b. compressibility
   c. surface tension
   d. color
   e. resistance to flow.

2. The resistance of a liquid to an increase in its surface area is _____

   a. surface tension
   b. a meniscus
   c. viscosity
   d. impossible
   e. capillary action

3. Rank the **viscosity** (1 being highest), if all are at the same 50ºC temperature.

   $CH_3CH_2OCH_3$ $CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_3$

4. Rank the **surface tension** (1 being highest), if all are at the same 50ºC temperature.

   $CH_3CH_2OCH_3$ $CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_3$

5. Rank the **vapor pressure** (1 being highest), if all are at the same 50ºC temperature.

   $CH_3CH_2OCH_3$ $CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_3$

6. Rank the **evaporation rate** (1 being highest), if all are at the same 50ºC temperature.

   $CH_3CH_2OCH_3$ $CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_3$

7. Rank the **volatility** (1 being highest), if all are at the same 50ºC temperature.

   $CH_3CH_2OCH_3$ $CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_3$

8. Rank the **boiling points**(1 being highest) of the following.

   $CH_3CH_2OCH_3$ $CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_3$

Note: The same concept applies to a bunch of different phenomena, and to a bunch of different terms. The above batch of mostly redundant problems are just a reminder of how you need to be familiar with the different terms (volatility, vapor pressure, viscosity, surface tension, etc.)

9. Rank the surface tension, 1 being highest:

$CH_3CH_2CH_2NH_2$ $CH_3CH_2CH_2CH_2CH_2NH_2$ $N(CH_3)_3$ $CH_3CH_2CH_2CH_3$

10. Rank the viscosity (1 being highest), if all are at the same 50ºC temperature.

$CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2OCH_2CH_3$ $CH_3CH_2CH_2CH_2OH$ $HOCHCH_2CH_2OH$

11. Rank the surface tension (1 being highest), if all are at the same 50ºC temperature.

$CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2OCH_2CH_3$ $CH_3CH_2CH_2CH_2OH$ $HOCHCH_2CH_2OH$

12. Rank the viscosity (1 being highest) of $HOCHCH_2CH_2OH$ at the following temperatures.

0ºC 40ºC 80ºC

13. Rank the surface tension (1 being highest) of $CH_3CH_2CH_2CH_2CH_2NH_2$ at the following temperatures.

20ºC 50ºC 80ºC

14. Rank the viscosity (1 being highest) of for the following substances at the listed temperatures.

$CH_3CH_2CH_2OCH_2CH_3$	$CH_3CH_2CH_2CH_2CH_2OH$	$CH_3CH_2CH_2CH_2CH_2OH$	$CH_3CH_2CH_2CH_2CH_2CH_3$
40ºC	0ºC	40ºC	40ºC

15. Rank the surface tension (1 being highest) of for the following substances at the listed temperatures.

$CH_3CH_2OCH_2CH_3$	$C_6H_{13}NH_2$	$C_4H_9NH_2$	$C_4H_9NH_2$
30ºC	0ºC	0ºC	30ºC

16. The highest viscosity is observed for which of the following liquid/temperature combinations?

a. C_6H_{14} at 275 K
b. C_6H_{14} at 299 K
c. C_5H_{12} at 299 K
d. HOC_4H_8OH at 299 K
e. HOC_4H_8OH at 275 K

17. Which of the following liquids would have the <u>lowest viscosity</u>, factoring in both the impact of the substance and the temperature?

    a. C_3H_7OH at 25˚C
    b. C_3H_7OH at 75˚C
    c. $MgBr_2$ at 25˚C
    d. $C_5H_{11}OH$ at 25˚C
    e. $C_5H_{11}OH$ at 75˚C

18. Predict which of the following liquid/temperature scenarios would have the **<u>HIGHEST</u>** vapor pressure and the **<u>LOWEST</u>** surface tension?

    a. C_6H_{14} at 275 K
    b. C_6H_{14} at 299 K
    c. C_5H_{12} at 299 K
    d. HOC_4H_8OH at 299 K
    e. HOC_4H_8OH at 275 K

<u>Vapor Pressure and Vapor Pressure Diagrams</u>

19. Which statement below regarding vapor pressure is not correct?
    a. The substance with the stronger intermolecular forces has the lower vapor pressure.
    b. Vapor pressure increases with increasing temperature.
    c. Seawater has a higher vapor pressure at a given temperature than pure water.
    d. Boiling occurs at the temperature when the vapor pressure equals the external pressure.

20. Which would have the <u>lowest boiling point?</u>

a. H_2O b. C_3H_8 c. NaOH d. CH_3OH e. CH_3CH_2Br

21. Rank the following in terms of <u>increasing boiling point</u>:

C_4H_9OH C_2H_5OH C_4H_{10} $CaBr_2$

    a. $C_4H_{10} < CaBr_2 < C_2H_5OH < C_4H_9OH$
    b. $CaBr_2 < C_4H_{10} < C_2H_5OH < C_4H_9OH$
    c. $C_4H_{10} < C_4H_9OH < C_2H_5OH < CaBr_2$
    d. $C_2H_5OH < C_4H_{10} < C_4H_9OH < CaBr_2$
    e. $C_4H_{10} < C_2H_5OH < C_4H_9OH < CaBr_2$

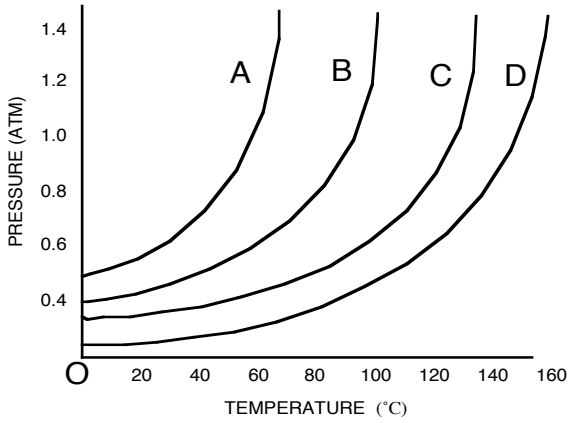
22. Which will have highest bp?

Br_2	F_2	SiH_4	CO_2
160	38	32	44

23. Which will have lowest bp?

CH_3NO_2	LiF	Cl_2	CH_3OH
61	26	70	32

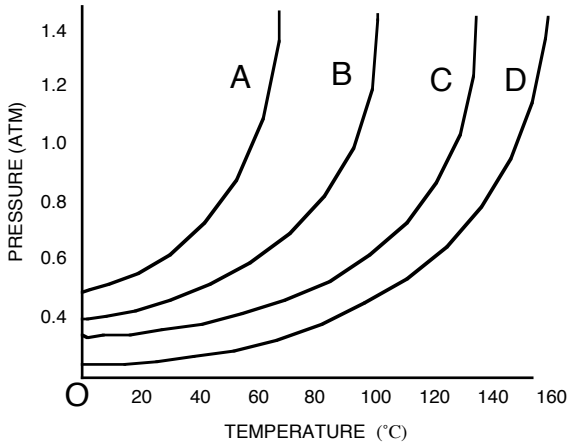
24. Which **one** of the following statements is **FALSE** for the vapor pressure/temperature diagram shown:



a. the vapor pressure for D at 120˚ is about 0.6 atm
b. substance A has the weakest intermolecular binding forces
c. the normal boiling point for A is about 60˚
d. to achieve a vapor pressure of 0.6 atm, substance D must be heated to about 60˚C

25. For the vapor pressure/temperature diagram shown, approximate the normal boiling points for:

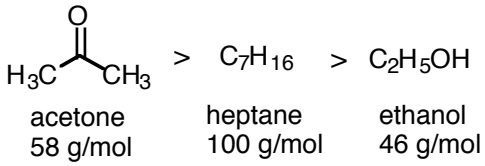
a. Substance A
b. Substance B
c. Substance C
d. Substance D



26. For the vapor pressure/temperature diagram above, approximate the vapor pressures for:

a. Substance A at 40ºC:
b. Substance B at 40ºC:
c. Substance C at 100ºC:
d. Substance D at 100ºC:

27. At room temperature, the <u>vapor pressure</u> pattern is acetone > heptane > ethanol. Which **<u>one</u>** of the following statements is **<u>FALSE</u>**:



a. a substance with higher vapor pressure is held together by weaker binding forces
b. ethanol has the <u>lowest vapor</u> pressure and strongest intermolecular force due to hydrogen bonding
c. heptane has lower vapor pressure than acetone due to London dispersion forces
d. ethanol would have a higher boiling point than heptane
e. acetone would have a higher boiling point than heptane

28. Rank the evaporation rate (1 being highest)

$CH_3CH_2CH_2CH_2CH_2OH$ $CH_3CH_2CH_2OH$ $CH_3CH_2CH_2CH_3$ $CH_3CH_2OCH_3$

29. Rank the melting points for the following, 1 being highest:

$CH_3CH_2CH_2NH_2$ LiCl $N(CH_3)_3$ $CH_3CH_2CH_2CH_2CH_2NH_2$

30. Ethyl acetate boils at 78°C. Is its vapor pressure at room temperature higher or lower than that of water?

31. Diethyl ether has higher vapor pressure than water. Which has higher bp?

Solubility Problems

32. A substance that is _____ will be insoluble in water, but a substance that is _____ will be soluble in water.

a.	hydrophobic; immiscible	d.	hydrophobic; hydrophilic
b.	immiscible; hydrophobic	e.	miscible; immiscible
c.	hydrophilic; miscible		

33. Which of the following compounds would you most appropriately call hydrophobic?

a.	CH_4	d.	HCl
b.	H_2CO	e.	NaCl
c.	CO		

34. Which of the following compounds would be most soluble in carbon tetrachloride, CCl4?

a.	H_2O	d.	C_6H_6
b.	CH_3OH	e.	HCl
c.	NH_3		

35. Indicate which of the following pairs of compounds is most likely to be miscible.

a.	H_2O and $CH_3CH_2CH_2CH_3$	d.	CCl_4 and Br_2
b.	Br_2 and HI	e.	CCl_4 and NH_3
c.	HF and CCl_4		

36. Which of the following pairs of compounds is most likely to be immiscible?

a.	Br_2 and C_6H_6	d.	CH_3OH and CH_3CH_2OH
b.	H_2O and CH_3CH_2OH	e.	H_2O and NH_3
c.	CCl_4 and H_2CO		

37. Which of the following compounds do you expect to be most soluble in water?

a.	CO_2	d.	SiO_2
b.	CCl_4	e.	NH_3
c.	O_2		

38. Which of the following substances would be the most soluble in water?

a. $CH_3CH_2CH_2CH_2NH_2$ b. $CH_3CH_2NH_2$
c. $CH_3CH_2CH_2Br$ d. $CH_3CH_2CH_2CH_3$

39. Which statement is NOT TRUE for why methanol, CH_3OH, does dissolve well in water?

    a. Solute-solvent interactions, which involve hydrogen bonding, are relatively strong
    b. The entropy change when methanol dissolves in water is favorable
    c. Solute-solvent interactions are similar in strength to original solute-solute interactions
    d. Methanol makes strong covalent bonds to water when it dissolves.

40. Which statement is TRUE for why ammonia, NH_3, does not dissolve in hexane, C_6H_{14}?

    a. there is strong charge repulsion between ammonia and hexane because hexane is ionic
    b. strong hydrogen bonding attraction between ammonia molecules would be sacrificed, and the resulting solute/solvent interactions between ammonia and hexane would be much weaker
    c. strong hydrogen bonding attraction between hexane molecules would be sacrificed
    d. ammonia in hexane would give strong ion-dipole attractions

41. In the solute/solvent pairs shown below, which would have hydrogen bonding as one of the attractive forces between solute and solvent molecules?

    a. C_8H_{16} / CH_3OH
    b. C_3H_7OH / H_2O
    c. C_6H_6 / C_8H_{16}
    d. CH_3CCl_3 / C_3H_7OH

42. Which of the following should be least soluble in heptane, C_7H_{16}?

    a. C_4H_8 b. NH_3 c. I_2 d. C_3H_7Br

43. Which relationship is true for solubility in water?

    a. C_8H_{16} > $BaBr_2$
    b. $C_{11}H_{23}OH$ > C_3H_7OH
    c. $NaNO_3$ > $CHCl_3$
    d. CH_3CCl_3 > CH_3CH_2OH

44. Which of the following statements is false?
    a. Dissolving a solid results in increasing disorder (“entropy”)
    b. Solids are generally much more soluble in cold solvent than in hot solvent.
    c. A saturated solution contains dissolved solute in equilibrium with undissolved solid
    d. For a saturated solution, the rate at which solid material dissolves equals the rate at which solid material reforms

Colligative Properties

45. For the following, how many moles of solute particles are produced when 1 mole of "formula" is dissolved? If one mole of each is placed into a liter of water, rank them in terms of how much they would depress the melting point.

	C_3H_8O	NaCl	Na_2SO_4	$Al(NO_3)_3$
Moles:				
Rank:				

46. Which would depress the vapor pressure of water more, adding 1 mole of CH_3OH or 0.5 moles of $Al(NO_3)_3$?

47. Which of the following 0.1 M aqueous solutions would have the lowest melting/freezing point?

a. C_3H_7OH b. $Fe(NO_3)_3$ c. $BaSO_4$ d. $C_6H_{12}O_6$

48. Indicate which aqueous solution has the highest vapor pressure.

a. 0.1 *M* KCl
b. 0.2 *M* Na_2CO_3
c. 0.2 *M* NaCl
d. 0.1 *M* $MgCl_2$
e. 0.2 *M* $MgCl_2$

49. Indicate which aqueous solution has the lowest vapor pressure.

a. 0.1 *M* KCl
b. 0.1 *M* Na_2CO_3
c. 0.2 *M* NaCl
d. 0.1 *M* $MgCl_2$
e. 0.2 *M* $MgCl_2$

50. Indicate which aqueous solution has the fastest evaporation rate.

a. 0.1 *M* KCl
b. 0.2 *M* Na_2CO_3
c. 0.2 *M* NaCl
d. 0.1 *M* $MgCl_2$
e. 0.2 *M* $MgCl_2$

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Answers

1. e
2. a
3. 3-2-1-4
4. 3-2-1-4
5. 2-3-4-1
6. 2-3-4-1
7. 2-3-4-1
8. 3-2-1-4
9. 2-1-3-4
10. 4-3-2-1
11. 4-3-2-1
12. 1-2-3 (0ºC > 40ºC > 80ºC)
13. 1-2-3 (20ºC > 50ºC > 80ºC)
14. 3-1-2-4
15. 4-1-2-3
16. e
17. b
18. c
19. c
20. b
21. e
22. Br_2
23. Cl_2
24. e
25. Normal Boiling points (**very** approximately):
    Substance A 60ºC Substance B 90ºC Substance C 125ºC Substance D 150ºC
26. Vapor pressures (**very** approximately):
    Substance A at 40ºC: 0.7 atm B at 40ºC: 0.5 atm C at 100ºC: 0.6 atm D at 100ºC: 0.4 atm
27. e
28. 4-3-1-2
29. 3-1-4-2
30. higher
31. water
32. d
33. a
34. d
35. d
36. c
37. e
38. b
39. d
40. b
41. b
42. b
43. c
44. b
45. How many moles solute, rank of depression:
    - Moles: 1-2-3-4
    - Depression rank: 4-3-2-1
46. 0.5 moles of $Al(NO_3)_3$
47. b
48. a
49. e
50. a