1 Morning class week 5 day 3: boiling points

Table 1: boiling points[1] of various compounds and elements

compound	boiling point	compound	boiling point	compound	boiling point
He	4	Ar	87	Kr	120
Ne	27	Xe	165	F	85
Cl	239	Br	332	Se	958
Te	1261	O	90	I	457
S	600	N	77	P	553
Cl	239	Br	332	water	370
As	887	Sb	1860	Si	3500
Ge	3100	C	5100	acetone	330
aluminum sulfate	2800	barium chloride	1800	cadmium nitrate	400
sodium chloride	1100	CO_2	200	Mg chloride	1400
aluminum chloride	500	barium fluoride	2600	sodium fluoride	2000
Mg fluoride	2500	Mg oxide	4200	sodium oxide	2300
aluminum oxide	3300	hexane	342	decane	447
ethanol	352	methane	110	propane	230
n-butane	280	iso-butane	260	HF	293
HCl	188	HBr	207	HI	238
ammonia	240	PH_3	180	BiH_3	290
SbH_3	250	H_2S	213	H_2Se	230
AsH_3	210	cyanogen	250	SnH_4	220
CF_4	140	CCl_4	350	SiH_4	150
CF_2Cl_2	240	CF_3Cl	190	CCl_3F	297
GeH_4	180	CS_2	319	CSe_2	400
methanol	340	acetaldehyde	293	acetic acid	390
ethylene glycol	470	formaldehyde	250	acetonitrile	350

[1] Boiling points are given for 1 atm pressure and are given in degrees Kelvin.

1. *You will be asked to rationalize the listed sets of observed boiling points. The best way to do these questions is to,* **first, without looking** *at the table, make your best effort to rank the compounds in the list from lowest to highest boiling point. Second step should be looking up the real boiling points. The last step should be spent reconciling any differences.*

   (a) Please look up the boiling points of He, Ne, Ar, Kr, and Xe in the provided table. Please rationalize the observed trend.

   (b) Please rationalize the boiling points of HF, HCl, HBr, and HI.

   (c) Please rationalize the boiling points of fluorine, chlorine, bromine, and iodine.

   (d) Please rationalize the boiling points of nitrogen and carbon.

   (e) Please rationalize the boiling points of water, H_2S, and H_2Se.

   (f) Please rationalize the boiling points of ammonia, PH_3, AsH_3 and BiH_3.

(g) Please re-examine the last two problems. Rationalize why water has the highest b.p. in its series but BiH_3 has the highest value in its series.

(h) Rationalize the boiling points of oxygen, carbon dioxide, and aluminum oxide.

(i) Please rationalize the boiling points of methane (CH_4), ethane (C_2H_6), and propane ($CH_3CH_2CH_3$).

(j) Please draw Lewis structures for the two different butanes, normal butane, $CH_3CH_2CH_2CH_3$ and iso-butane, $CH(CH_3)_3$. Do they have the same molecular masses? Which of these two should have the lower boiling point. Why?

(k) Before starting on the next list, please answer the following requests. What kind of bonding do MgF_2, Na_2O, MgO, and NaF all have? Please recall ionic energy is a Coulombic energy.

$$E_{pot} = C\frac{q_+q_-}{r},$$

where r is the distance between the cation and the anion. Please make a table where you place the four compounds in one column, where you calculate the values of q_+q_- in a second column, and where you state the relative ranking of interatomic distances r in the third column.

Now examine the boiling points of magnesium fluoride, magnesium oxide, sodium oxide, and sodium fluoride.Please rationalize the order of their boiling points.

(l) Please rationalize the boiling points of ethanol (CH_3CH_2OH), acetonitrile (H_3CCN), propane ($CH_3CH_2CH_3$), and acetaldehyde (CH_3CHO). Are the molecular masses of these three compounds similar?

(m) Please rationalize the boiling points of formaldehye (CH_2O), acetone (CH_3COCH_3) and acetaldehyde. Are the molecular masses of these three compounds similar?

(n) Please rationalize the boiling points of methane, Si, and SiH_4.

(o) Please rationalize the boiling points of methane, ethane, formaldehyde, actaldehyde, acetonitrile, and acetic acid(CH_3COOH)

(p) Please rationalize the boiling point of water, methanol and ethanol.

(q) Please rationalize the boiling points of butane, acetone, acetic acid (CH_3COOH) and ethylene glycol ($HOCH_2CH_2OH$). Are the molecular masses of these five compounds similar?

(r) Please rationalize the boiling points of acetonitrile and cyanogen (N≡C-C≡N).

(s) Please rationalize the boiling points of CCl_4, sodium chloride, and barium chloride.

2. *Two liquids are miscibile if they form a common solution. For example, oil and vinegar are not miscible.*

(a) Are hexane ($CH_3CH_2CH_2CH_2CH_2CH_3$) and octane ($CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$) miscible?

(b) Are water and ammonia miscible?

(c) In which of the three solvents is liquid bromine more soluble: carbon disulfide, ethyl alcohol, or hexane?

(d) Water and acetonitrile are miscible. Why?