AP® Chemistry
2001 Sample Student Responses

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8A

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8. 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).

(a) NH_3 has a much higher boiling pt compared to CH_4 because CH_4 has only London Dispersion Forces while NH_3, which is polar, has dipole-dipole forces & even more specifically - hydrogen bonding - which is stronger than regular dipple dipole since NH_3's intermolecular forces are bigger than those of CH_4, the NH_3 bonds take more KE to break them & thus have a higher boiling pt.

(b) Both have only LDF but since C_6HM is a more complex molecule, it has more e^- & thus more polarization opportunities. Because of this C_6H_{14} has more chances of inducing dipole forces & thus the intermolecular forces between C_6H_{14} molecules are higher & require more KE to break. Thus, @ 25°C, there is enough KE to make C_2H_6 into a gas while C_6H_{14} is a liquid.

(c) Si has a covalent network bonding structure while Cl_2 has only LDF forces covalent network is a very rigid bonding structure and is hard to break compared to the easily broken LDF Cl_2 bonds. Thus Si melts at higher temp than Cl_2

(d) Coulombs law states that the higher the atoms charge the stronger the bond between the atoms. Mg has a +2 charge & O has a −2 charge which are greater than the +1 & −1 charges of Na & F respectively. Thus, breaking the ionic

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ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

bond between NaF is easier than the bond between Mg & O & thus MgO melts at a higher temp than NaF

8B

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8. Account for each of the following observations about pairs of substanc
principles of chemical bonding and/or intermolecular forces. In each p
to <u>both</u> 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).

a. NH_3 has a higher boiling point than CH_4 because NH_3 has an unbonded electron pair which allows the NH_3 to form hydrogen bonds which are much stronger intermolecular forces than the London forces which CH_4 forms, the stronger the intermolecular forces are, the higher the boiling point is.

b. C_2H_6 is a much smaller molecule than C_6H_{14} Because C_6H_{14} is so much larger, its instantaneous dipoles are much stronger than those of C_2H_6. Since neither can form hydrogen bonds or dipole-dipole forces (they are non polar and have no F, O, or N) the strongest force is the London forces created by instantaneous dipoles, since the intermolecular forces in C_6H_{14} are much stronger, it is far more likely to condense into a liquid

c. Si melts at a much higher temperature because it forms bonds with 2 other silicon molecules each to complete its octet, while Cl_2 only form in pairs. Since Si have so many more bonds, it takes a much larger temperature to liquify it.

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d. MgO and NaF are both ionic, however MgO is formed from Mg^{2+} and O^{2-} ions which have a difference in charge of 4, while Na^{+} & F^{-} (the ions that form NaF) have only a 1 difference of 2 charge. because the strength of the bonds are based on the difference in charge, the MgO takes far more heat to melt.

8C

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8. 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 <u>both</u> 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).

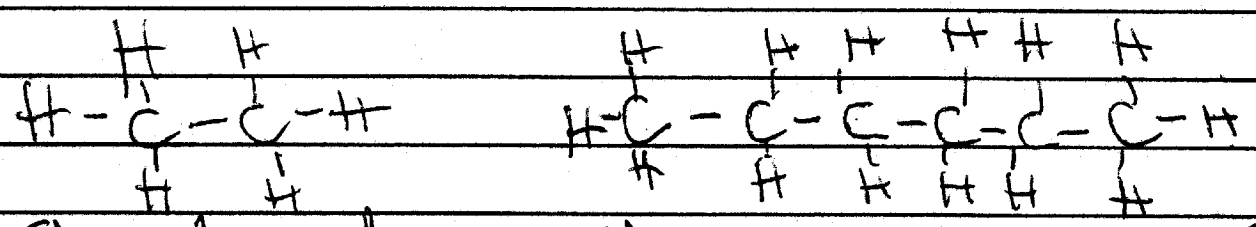
(b) At 25°C and 1.0 atm, ethane (C_2H_6) is a gas and hexane (C_6H_{14}) is a liquid.

(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).

a) NH_3 has a much higher bp due to H-bonding. That CH_4 doesn't have. H-bonding is much stronger than the dispersion forces that CH_4 has.

b)



They both have the same forces but C_6H_{14} has a much greater molar mass. This increases the melting point.

c) Si tends to forms ~~mo~~ molecular crystals which creates a very large melting point. Cl_2 has only weak dispersion forces that can be ~~o~~ overcome more easily than Si

d) MgO and NaF are both ionic compounds. NaF has a greater difference in electronegativity.