

## TOPIC H PROBLEMS

1) Classify each of the following substances as molecular, ionic, or metallic, and explain your answers. (There are no network covalent substances in this list.) Base your answers on the chemical formulas and the positions of the elements in the periodic table: you should not need to look up any additional information.

- a) Cl<sub>2</sub>S      b) K<sub>2</sub>S      c) H<sub>2</sub>SO<sub>4</sub>      d) Fe      e) He

2) Each of the following substances is a solid at room temperature. What would you expect to be the most important type of attractive force between individual formula units in each of these substances? Base your answers on the chemical formulas and the positions of the elements in the periodic table: you should not need to look up any additional information.

- a) CBr<sub>4</sub>      b) CaBr<sub>2</sub>      c) Ca      d) C

3) For each of the following molecular substances, list all of the intermolecular forces that play a significant role in determining the physical properties of the substance. *Reminder: the three types of intermolecular forces are London dispersion forces, dipole-dipole attraction, and hydrogen bonding.)*

- a) NH<sub>3</sub>      b) N<sub>2</sub>      c) NF<sub>3</sub>      d) CH<sub>4</sub>      e) CH<sub>2</sub>O

4) From each of the following pairs of compounds, select the compound that should have the higher boiling point, and explain your choice.

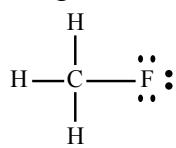
- a) CO and BeO      b) NaF and MgO

5) HCl is a strong electrolyte (as you already know!). Its melting point and boiling point are -114°C and -85°C, respectively.

a) What state (solid/liquid/gas) is HCl in at room temperature?

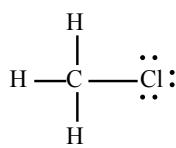
b) A student concludes that HCl is an ionic compound, based on the fact that it ionizes completely in aqueous solution. Would you agree with this conclusion? If not, what sort of compound is HCl? Be sure to discuss the melting and boiling points in your answer.

6) Using your knowledge of intermolecular forces, explain the trend in boiling points in the following series of compounds.



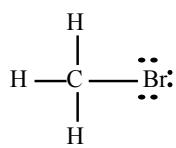
fluoromethane

(boiling point = -78°C)



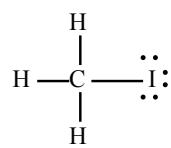
chloromethane

(boiling point = -24°C)



bromomethane

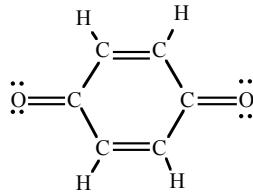
(boiling point = 4°C)



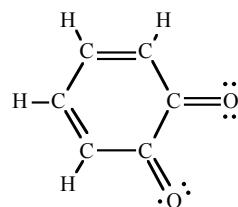
iodomethane

(boiling point = 42°C)

7) One of the compounds below boils at 70°C, while the other boils at 116°C. Which is which? Explain your reasoning.

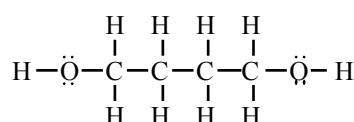


compound 1

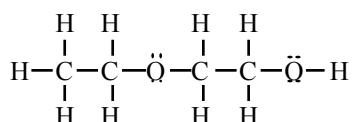


compound 2

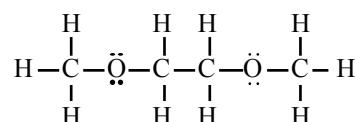
8) The following three compounds are isomers (they have the same chemical formula), but they have quite different boiling points: one boils at 82°C, one at 135°C, and one at 235°C. Match each substance with the correct boiling point, and explain your reasoning.



compound 1

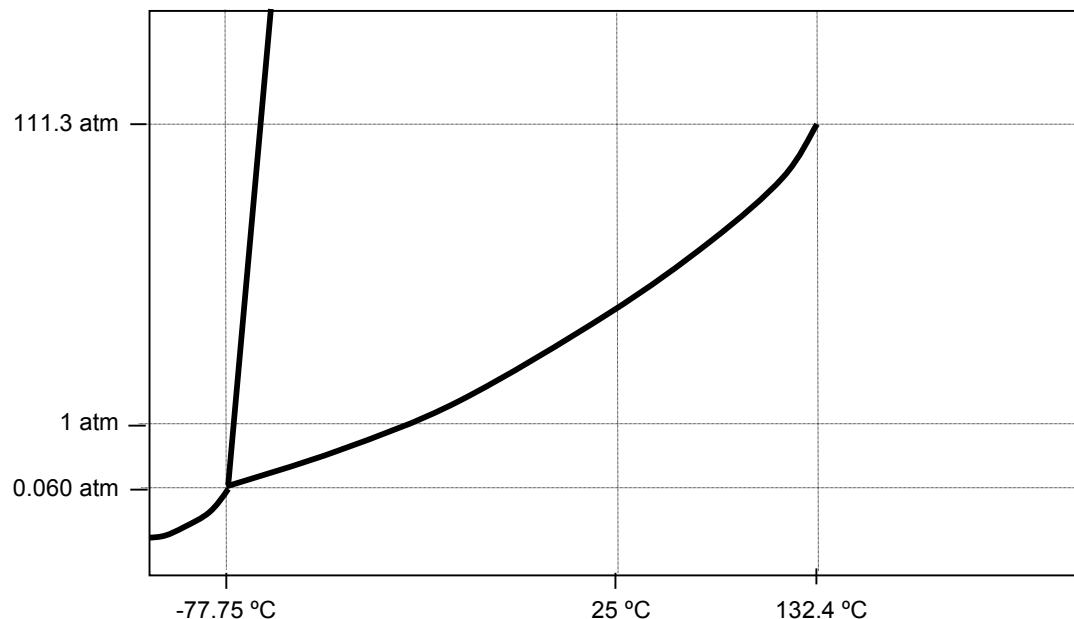


compound 2



compound 3

9) The phase diagram for ammonia is shown below (not drawn to scale).



- What state is ammonia in at 25°C and 1 atm?
- What state is ammonia in at -80°C and 10 atm?
- What are the temperature and pressure at the triple point of ammonia?
- What are the temperature and pressure at the critical point of ammonia?

e) If you heat ammonia from -100°C to 150°C at a pressure of 5 atm, what states will you observe?

f) If you heat ammonia from -100°C to 150°C at a pressure of 0.01 atm, what states will you observe?

g) A container holds ammonia at -77.70°C and a pressure of 0.010 atm. If the pressure is increased to 150 atm without changing the temperature, what states will you observe?

h) If you increase the temperature of ammonia from 125°C to 175°C at a pressure of 200 atm, what states will you observe?