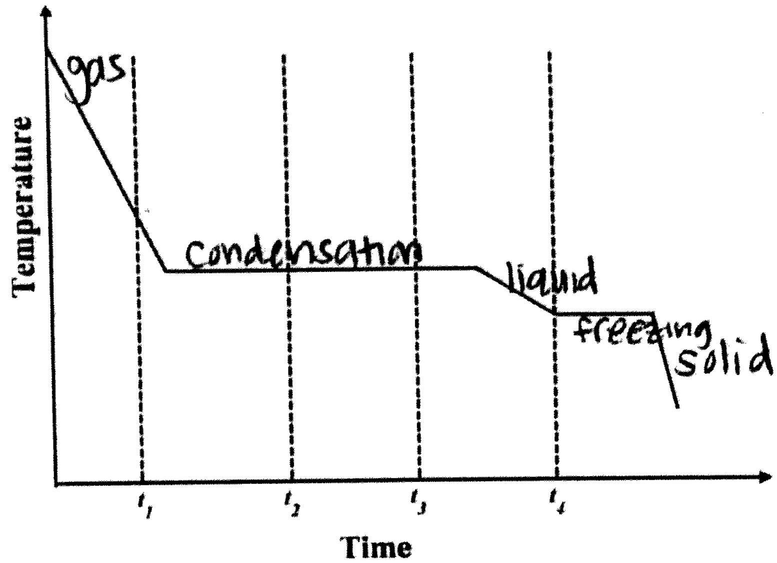
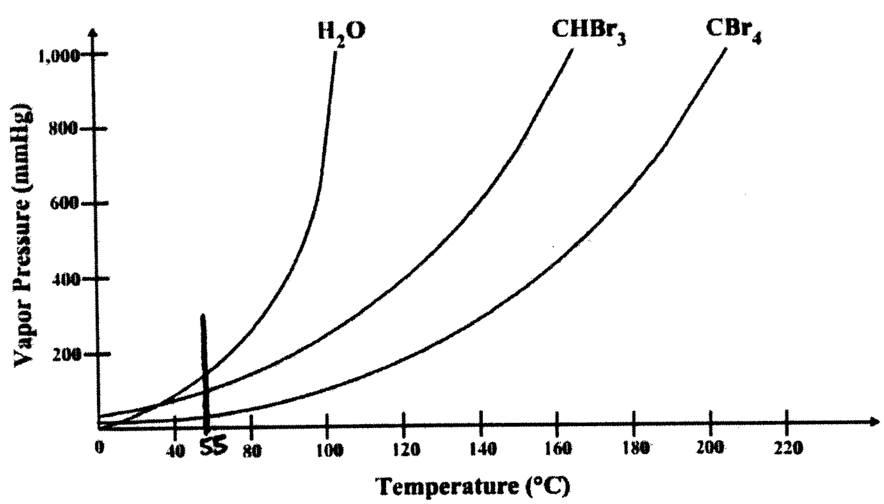
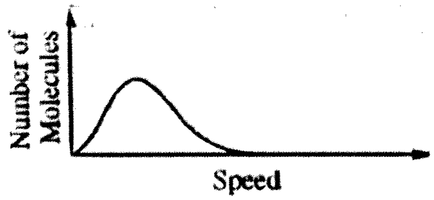
Gases & States of Matter Study Guide Part 2



1. The cooling curve above shows how the temperature of a sample varies with time as the sample goes through phase changes. The sample starts as a gas, and heat is removed at a constant rate. At which time does the sample contain the most liquid?
   (a) t_2
   (b) t_3
   (c) t_4 - start of freezing, most of sample is still liquid
   (d) t_5

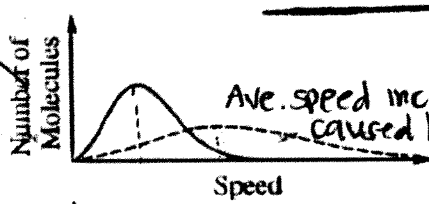


2. Which liquid above would be expected to have the highest equilibrium vapor pressure at 55°C? most gas
   (a) H_2O
   (b) $CHBr_3$
   (c) CBr_4
   (d) All three would have the same vapor pressure at 55°C.

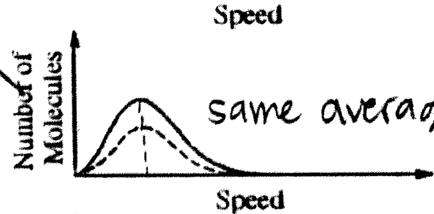


3. The graph above shows the speed distribution of molecules in a sample of gas at a certain temperature. Which of the following graphs shows the speed distribution of the same molecules at a lower temperature (as a dashed curve)?

decrease T = slower speed = decrease average speed
"cool 'em down, slow 'em down"

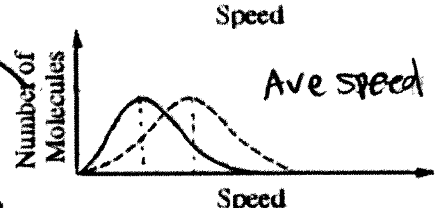
(A) 

Ave. speed incr. caused by increase T

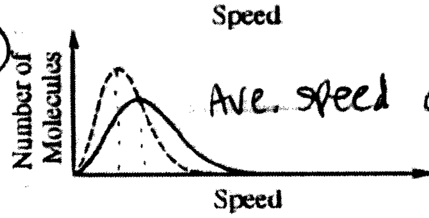
(B) 

same average speed

☆ For a given amount of gas, the higher T curve is more flat and wider

(C) 

Ave speed incr.

(D) 

Ave. speed decreased.

4. A molecular solid coexists with its liquid phase at its melting point. The solid-liquid mixture is heated, but the temperature does not change while the solid is melting. The best explanation for this phenomenon is that the heat absorbed by the mixture
   (a) is lost to the surroundings very quickly
   (b) is used in overcoming the intermolecular attractions in the solid
   (c) is used in breaking the bonds within the molecules of the solid
   (d) causes evaporation of the liquid, which has a cooling effect

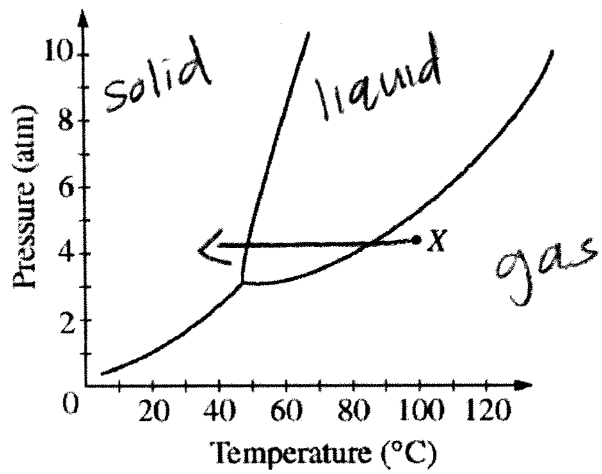
covalent bonds are not broken when molecular solid melts

5. Which of the following pairs of substances has the greatest difference in melting points at 1 atm?

greatest difference in attractions

   (a) Sr versus Ba metal vs. metal
   (b) SO_2 versus SO_3 molecular vs. molecular
   (c) KCl versus $CaCl_2$ ionic vs. ionic
   (d) NaCl versus C_3H_8 ionic vs. molecular

6. A certain crystalline substance that has a low melting point does not conduct electricity in solution or when melted. This substance is likely to be
   (a) a covalent network solid - very high melting pt.
   (b) a metallic solid - very high MP & conducts electricity
   (c) an ionic solid - high melting pt & conducts electricity when melted.
   (d) a molecular solid



7. Shown above is the phase diagram of a pure substance. The substance under the conditions corresponding to point X on the diagram is cooled to 40°C while the pressure remains constant. As the substance cools, the phase of the substance changes from
   (a) gas to liquid to solid
   (b) gas to solid to liquid
   (c) liquid to solid to gas
   (d) liquid to gas to solid

8. Under which of the following conditions of temperature and pressure will H_2 gas be expected to behave most like an ideal gas? ideal = no attractions = High T & low P
   (a) 50 K and 0.10 atm
   (b) 50 K and 5.0 atm
   (c) 500 K and 0.10 atm
   (d) 500 K and 50 atm

9. A 2 L sample of N_2(g) and a 1 L sample of Ar(g), each originally at 1 atm and 0°C, are combined in a 1 L tank. If the temperature is held constant, what is the total pressure of the gases in the tank?
   (a) 2 atm
   (b) 3 atm
   (c) 4 atm
   (d) 5 atm

P_{N_2} doubles since V is halved, thus $P_{N_2} = 2$ atm
P_{Ar} stays same since V stays same, thus $P_{Ar} = 1$ at
$P_T = P_{N_2} + P_{Ar} = 2$ atm $+ 1$ atm $= 3$ atm

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1. a)

$$\frac{24.5\text{ g } N_2}{} \Big| \frac{1\text{ mol } N_2}{28.02\text{ g } N_2} = 0.874\text{ mol } N_2$$

$$\frac{28.0\text{ g } O_2}{} \Big| \frac{1\text{ mol } O_2}{32\text{ g } O_2} = 0.875\text{ mol } O_2$$

$$n_T = 0.874\text{ mol} + 0.875\text{ mol} = 1.749\text{ mol total}$$

$$PV = nRT$$

$$P_T = \frac{n_T RT}{V} = \frac{(1.749\text{ mol})(0.0821\ \frac{L\cdot atm}{mol\cdot K})(298\text{ K})}{5.00\text{ L}}$$

$$\boxed{P_T = 8.56\text{ atm}}$$

b) i) mol fraction $N_2 = \frac{\text{mol } N_2}{\text{total mol}} = \frac{0.874\text{ mol } N_2}{1.749\text{ mol total}} = \boxed{0.500}$

ii) $P_{N_2} = \frac{n_{N_2} RT}{V} = \frac{(0.874\text{ mol } N_2)(0.0821\ \frac{L\cdot atm}{mol\cdot K})(280\text{ K})}{5.00\text{ L}}$

$$\boxed{P_{N_2} = 4.02\text{ atm}}$$

c) N_2 has a smaller mass than O_2, thus N_2 effuses faster. ∴ There would be less N_2 than O_2 remaining in the cylinder, thus the ratio $\frac{N_2}{O_2}$ would decrease.

d) $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

e) $\frac{0.176 \text{ mol NO}}{} \left| \frac{2 \text{ mol } NO_2}{2 \text{ mol NO}} \right. = \underline{0.176 \text{ mol } NO_2}$ ∴ NO = limiting reactant

$\frac{0.176 \text{ mol } O_2}{} \left| \frac{2 \text{ mol } NO_2}{1 \text{ mol } O_2} \right. = 0.352 \text{ mol } NO_2$

$n_{NO_2} = 0.176$ mol produced

n_{O_2}: $\frac{0.176 \text{ mol NO}}{} \left| \frac{1 \text{ mol } O_2}{2 \text{ mol NO}} \right. = 0.0880 \text{ mol } O_2$ used

n_{O_2} remaining in cylinder after rxn = 0.176 mol O_2 starting
− 0.0880 mol O_2 used

0.088 mol O_2 left over

$n_T = 0.176 \text{ mol } NO_2 + 0.088 \text{ mol } O_2 = 0.264$ mol total

$$P_T = \frac{n_T RT}{V} = \frac{(0.264 \text{ mol})(0.0821 \frac{L \cdot atm}{mol \cdot K})(298 K)}{5.00 \text{ L}}$$

$P_T = 1.29$ atm

2. a) $P_T = P_{H_2O} + P_{O_2}$

$762.6 \text{ torr} = 21.6 \text{ torr} + P_{O_2}$

$\boxed{P_{O_2} = 741.0 \text{ torr}}$

b) $741.0 \text{ torr} \times \dfrac{1 \text{ atm}}{760 \text{ torr}} = 0.9750 \text{ atm} = P_{O_2}$

$PV = nRT$

$n = \dfrac{PV}{RT} = \dfrac{(0.9750 \text{ atm})(0.1824 \text{ L})}{(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(296.4 \text{ K})} = \boxed{7.31 \times 10^{-3} \text{ mol } O_2}$

c) $7.31 \times 10^{-3} \text{ mol } O_2 \times \dfrac{2 \text{ mol } H_2O_2}{1 \text{ mol } O_2} \times \dfrac{34.02 \text{ g } H_2O_2}{1 \text{ mol } H_2O_2} = \boxed{0.497 \text{ g } H_2O_2}$

d) $\% \, H_2O_2 = \dfrac{\text{mass } H_2O_2}{\text{mass } H_2O_2 \text{ soln}} \times 100 = \dfrac{0.497 \text{ g } H_2O_2}{6.951 \text{ g soln}} \times 100 = \boxed{7.15 \%}$

3. a) The London dispersion forces in H_2S are stronger than those in H_2O. H_2S has more electrons than H_2O. Thus, H_2S is more polarizable and has stronger LDF's than H_2O.

b) the dipole-dipole forces in H_2O are stronger than those in H_2S. The H-O bond is much more polar than the H-S bond. Thus, the H_2O molecule is more polar than the H_2S molecule.
∴ Dipole-dipole forces are stronger in H_2O.

4. a) i) NH_3 has H-bonding and London Dispersion forces.
NF_3 has Dipole-dipole and London Dispersion forces.

ii) The intermolecular forces in NH_3 are much stronger than in NF_3. The strong H-bonds in NH_3 require much more E to separate the molecules, resulting in NH_3 having the higher boiling pt.

b) i) Ionic bonding in both KCl and NaCl

ii) Na^+ is smaller in size than the K^+ ion, causing the attraction between Na^+ and Cl^- to be stronger than between K^+ and Cl^-. Thus, more E is needed to break the attractions in NaCl, resulting in NaCl having the higher melting point.