Answer the following questions on the answer sheet.
Give your answer to 3 significant figures except for question 17.

1) Which of the following compounds have dipole moments (are polar)?

O_2 H_2O CO_2 CH_3OCH_3 CH_3F

2) Which of the following compounds have dipole moments (are polar)?
CH_2F_2 NH_3 SO_3 SO_2 PF_5

3) Which of the following compounds have will "hydrogen bond" to another similar molecule?

H_3PO_4 SO_2 CH_4 CH_3COOH H_2O

4) Which of the following compounds have will "hydrogen bond" to another similar molecule?
CO_2 CH_3OCH_3 HF CH_2F_2 NH_3

5) Arrange the following in order of increasing London forces. SiH_4 , CH_4 , GeH_4 , SnH_4

6) Arrange the following in order of increasing London forces. HCOOH, C_2H_5COOH, $C_6H_{13}COOH$, CH_4COOH

7) Calculate the vapor pressure of ethanol at 57.8 °C. The boiling point of ethanol is 78.3 °C and its molar enthalpy of vaporization is 39.26 kJ mol^{-1}. R = 8.314 J mol^{-1} K^{-1}

8–9) What is the classification of each of the following solids? (ionic solid, covalent solid, metallic solid or molecular solid)

$H_2O(s)$, NaCl , gold , $CaCl_2$, $CH_4(s)$

10) – 11) What are the strongest types of forces or bonds responsible for forming the solid phase for each of the following? (ionic attractions, covalent bonds, metallic bonding, "hydrogen bonding", dipole–dipole attraction, London forces)

diamond , iron , teflon , solid Ar , HCl(s)

12) – 13) What is the van't Hoff factor for each of the following? (If it does not dissociate: i = 1.)

HNO_3 , NH_3 , $HClO_2$, Na_2SO_4 , NaCl

14) Calculate the total molality for a solution made up to be 5.77 g in NaCl in 380.7 g of water.

15) Calculate the freezing point depression for a solution made up to be 4.73 g in $CaCl_2$ in 335.2 g of water. (K_f = 1.86 °C kg mol^{-1})

16) Calculate the osmotic pressure for a solution of water containing 37.4 g of CH_3COOH in 2.539 L of water solution at 25 °C. R = 0.08206 L atm mol^{-1} K^{-1}

17) What is the vapor pressure of water over a solution that contains 19.50 g of ethanol (C_2H_5OH) in 214.9 g of water if at the measurement temperature the vapor pressure would be 49.43 torr for pure water? Give your answer to **4 significant figures**.

18) What is the molar mass of a non–electrolyte compound if when 5.0333 g of it are dissolved in 66.7 g of water, it will lower the freezing point by 3.19 °C? (K_f = 1.86 °C kg mol^{-1})

19) What is the principal reason that the boiling point of HF is much greater than HCl

20) What is the principal reason that the melting point of H_2O is much greater than H_2S

NAME_____

For question 1 through 4 circle the correct answer.

1) O_2 polar non–polar
   H_2O polar non–polar
   CO_2 polar non–polar
   CH_3OCH_3 polar non–polar
   CH_3F polar non–polar

2) CH_2F_2 polar non–polar
   NH_3 polar non–polar
   SO_3 polar non–polar
   SO_2 polar non–polar
   PF_5 polar non–polar

3) H_3PO_4 hydrogen bonded not hydrogen bonded
   SO_2 hydrogen bonded not hydrogen bonded
   CH_4 hydrogen bonded not hydrogen bonded
   CH_3COOH hydrogen bonded not hydrogen bonded
   H_2O hydrogen bonded not hydrogen bonded

4) CO_2 hydrogen bonded not hydrogen bonded
   CH_3OCH_3 hydrogen bonded not hydrogen bonded
   HF hydrogen bonded not hydrogen bonded
   CH_2F_2 hydrogen bonded not hydrogen bonded
   NH_3 hydrogen bonded not hydrogen bonded

5) _____ < _____ < _____ < _____

6) _____ < _____ < _____ < _____

7) _____ _____ units!

8–9)
   $H_2O(s)$ =_____

   NaCl =_____

   gold =_____

   $CaCl_2$ =_____

   $CH_4(s)$ =_____

NAME_____

10–11)

diamond = _____

iron = _____

teflon = _____

solid Ar = _____

HCl(s) = _____

12–13)

HNO_3 *i* = _____

NH_3 *i* = _____

$HClO_2$ *i* = _____

Na_2SO_4 *i* = _____

NaCl *i* = _____

14) _____ _____ units!

15) _____ _____ units!

16) _____ _____ units!

17) _____ _____ units!

18) _____ _____ units!

19) _____

20) _____

KEY

1) O_2 **non–polar**
   H_2O **polar**
   CO_2 **non–polar**
   CH_3OCH_3 **polar**
   CH_3F **polar**

2) CH_2F_2 **polar**
   NH_3 **polar**
   SO_3 **non–polar**
   SO_2 **polar**
   PF_5 **non–polar**

3) H_3PO_4 **yes**
   SO_2 **no**
   CH_4 **no**
   CH_3COOH **yes**
   H_2O **yes**

4) CO_2 **no**
   CH_3OCH_3 **no**
   HF **yes**
   CH_2F_2 **no**
   NH_3 **yes**

5) CH_4 , SiH_4 , GeH_4 , SnH_4

6) HCOOH , CH_4COOH , C2H5COOH , $C_6H_{13}COOH$

7) 0.435 atm

8–9)
   $H_2O(s)$ = molecular solid
   NaCl = ionic solid
   gold = metal
   $CaCl_2$ = ionic solid
   $CH_4(s)$ = molecular solid

KEY

10–11)
diamond = covalent bond throughout
iron = metallic bond
teflon = covalent bond throughout
solid Ar = London forces
HCl(s) = dipole–diple forces

12–13)
HNO_3 = 2
NH_3 = 1
$HClO_2$ = 1
Na_2SO_4 = 3
NaCl = 2

14) 0.519mol kg^{-1}

15) 0.710 °C (or K)

16) 6.00atm

17) 47.74 torr

18) 44.0 g mol^{-1}

19) "hydrogen bonding"

20) "hydrogen bonding"