MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) An ideal gas differs from a real gas in that the molecules of an ideal gas __________.
   A) have no kinetic energy
   B) have appreciable molecular volumes
   C) have a molecular weight of zero
   D) have an average molecular mass
   E) have no attraction for one another

2) The critical temperature and pressure of CS₂ are 279°C and 78 atm, respectively. At temperatures above 279°C, CS₂ can only occur as a __________.
   A) liquid and gas
   B) supercritical fluid
   C) liquid
   D) gas
   E) solid

3) The vapor pressure of any substance at its normal boiling point is
   A) 1 atm
   B) 1 torr
   C) equal to atmospheric pressure
   D) 1 Pa
   E) equal to the vapor pressure of water

4) Standard temperature and pressure (STP), in the context of gases, refers to __________.
   A) 298 K and 1 atm
   B) 298 K and 1 torr
   C) 273 K and 1 pascal
   D) 273 K and 1 torr
   E) 273 K and 1 atm

5) On a phase diagram, the critical temperature is __________.
   A) the temperature at which all three states are in equilibrium
   B) the temperature above which a gas cannot be liquefied
   C) the temperature required to cause sublimation of a solid
   D) the temperature below which a gas cannot be liquefied
   E) the temperature required to melt a solid
6) Which one of the following substances will have hydrogen bonding as one of its intermolecular forces?

A) 
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 H      O
 / \
 H- C- C
    / \ 
   H   H
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B) 
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 H   H
 / \ 
 H- C- N
    / \ 
   H   H
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C) 
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 H   
 /  
 H- C-H
    / 
   F
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D) 
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 O   
 / 
 H- C-H
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E) 
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 O   
 / 
 H3C-C-CF3
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7) What intermolecular force is responsible for the fact that ice is less dense than liquid water?
   A) ion-dipole forces
   B) hydrogen bonding
   C) dipole-dipole forces
   D) ionic bonding
   E) London dispersion forces

8) The molar volume of a gas at STP is _______ L.
   A) 62.36
   B) 14.7
   C) 0.08206
   D) 22.4
   E) 1.00
9) Of the following, ________ is a valid statement of Charles’ law.
   A) \( PV = \) constant
   B) \( \frac{P}{T} = \) constant
   C) \( V = \) constant \( \times n \)
   D) \( \frac{V}{T} = \) constant
   E) \( V = \) constant \( \times P \)

9) ________

10) The phase diagram of a substance is given above. This substance is a ________ at 25°C and 1.0 atm.
   A) gas
   B) crystal
   C) supercritical fluid
   D) solid
   E) liquid

10) ________

11) The average kinetic energy of the particles of a gas is directly proportional to ________.
   A) the rms speed
   B) the particle mass
   C) the square of the rms speed
   D) the square of the particle mass
   E) the square root of the rms speed

11) ________

12) Which one of the following derivatives of ethane has the highest boiling point?
   A) \( \text{C}_2\text{F}_6 \)
   B) \( \text{C}_2\text{Br}_6 \)
   C) \( \text{C}_2\text{I}_6 \)
   D) \( \text{C}_2\text{Cl}_6 \)
   E) \( \text{C}_2\text{H}_6 \)
13) The pressure exerted by a column of liquid is equal to the product of the height of the column times the gravitational constant times the density of the liquid, \( P = gh \delta \). How high a column of methanol \((d = 0.79 \text{ g/mL})\) would be supported by a pressure that supports a 713 mm column of mercury \((d = 13.6 \text{ g/mL})\)?

A) 41 mm
B) 1.2 \times 10^4 \text{ mm}
C) 713 mm
D) 9.7 \times 10^3 \text{ mm}
E) 17 mm

14) ________ are particularly polarizable.

A) Small polar molecules
B) Small nonpolar molecules
C) Large nonpolar molecules
D) Large polar molecules
E) Large molecules, regardless of their polarity.

15) Molecular compounds of low molecular weight tend to be gases at room temperature. Which of the following is most likely not a gas at room temperature?

A) CH₄  B) Cl₂  C) HCl  D) H₂  E) LiCl

16) Which of the following is not part of the kinetic–molecular theory?

A) Atoms are neither created nor destroyed by ordinary chemical reactions.
B) The volume occupied by all of the gas molecules in a container is negligible compared to the volume of the container.
C) Attractive and repulsive forces between gas molecules are negligible.
D) Gases consist of molecules in continuous, random motion.
E) Collisions between gas molecules do not result in the loss of energy.

17) Hydrogen bonding is a special case of ________.

A) ion–dipole attraction
B) London–dispersion forces
C) dipole–dipole attractions
D) none of the above
E) ion–ion interactions
18) The phase changes B → C and D → E are not associated with temperature increases because the heat energy is used up to
   A) increase distances between molecules
   B) break intramolecular bonds
   C) rearrange atoms within molecules
   D) increase the density of the sample
   E) increase the velocity of molecules

19) Of the following, ___________ is a correct statement of Boyle's law.
   A) \( \frac{V}{p} = \) constant
   B) \( \frac{V}{T} = \) constant
   C) \( PV = \) constant
   D) \( \frac{n}{p} = \) constant
   E) \( \frac{p}{V} = \) constant

20) Which statement about ideal behavior of gases is false?
   A) Low pressures and high temperatures typically cause deviations from the ideal gas behavior.
   B) All particles in the ideal gas behave independently of each other.
   C) At low densities all gases have similar physical properties.
   D) Gas ideality assumes that there are no interactions between gas particles.
   E) Volume of 2.00 moles of oxygen gas, \( O_2 \), is assumed to be the same as that of 2.00 moles of carbon dioxide gas, \( CO_2 \), as long as the temperature and pressure conditions are the same.
21) Which one of the following is a valid statement of Avogadro's law?  
   A) \( \frac{P}{T} \) = constant  
   B) \( V = \text{constant} \times P \)  
   C) \( PV = \text{constant} \)  
   D) \( \frac{V}{T} = \text{constant} \)  
   E) \( V = \text{constant} \times n \)  

22) A real gas will behave most like an ideal gas under conditions of _________.  
   A) low temperature and low pressure  
   B) STP  
   C) high temperature and low pressure  
   D) high temperature and high pressure  
   E) low temperature and high pressure

23) Together, liquids and solids constitute ________ phases of matter.  
   A) the compressible  
   B) all of the  
   C) the disordered  
   D) the condensed  
   E) the fluid

24) In general, the vapor pressure of a substance increases as ________ increases.  
   A) molecular weight  
   B) surface tension  
   C) hydrogen bonding  
   D) temperature  
   E) viscosity
1. **EVALUATE THE FOLLOWING TWO PROBLEMS.**

The reaction in a safety air bag is as follows:

\[ 2 \text{NaN}_3 (s) \rightarrow 2 \text{Na} (s) + 3 \text{N}_2 (g) \]

If the airbag has a volume of 40 L and is to be filled with nitrogen gas at a pressure of 1.15 atm at a temperature of 26.0 °C, how many grams of NaN\(_3\) needs to be decomposed?

**Or**

Hydrogen gas is produced when zinc reacts with sulfuric acid:

\[ \text{Zn} (s) + \text{H}_2\text{SO}_4 (aq) \rightarrow \text{H}_2 (g) + \text{ZnSO}_4 (aq) \]

If 169 mL of H\(_2\) is collected over water 24°C and a barometric pressure of 738 torr, how many grams of Zn have been consumed.
2. The fluorocarbon compound C$_2$Cl$_2$F$_3$ has a normal boiling point of 47.6 °C. The specific heat of C$_2$Cl$_2$F$_3$ (l) and C$_2$Cl$_2$F$_3$ (g) are 0.91 J/g K and 0.67 J/g K respectively. The heat of vaporization for the compound is 27.49 kJ/mol. Calculate the heat required to convert 25.0 g of C$_2$Cl$_2$F$_3$ from a liquid at 5.00 °C to a gas at 82.00 °C.