Name _______________________________ (Print last name in CAPS)

SECTION ____________________________ (same as your lab section)

1. Read each question carefully before answering.

2. Mark the choice that best answers the question or completes the statement.

3. Use the scantron provided. Use a no. 2 pencil and clearly mark your choice. If you change an answer, completely erase your previous mark.

4. Answer each question. There is no penalty for guessing. However, multiple answers are graded as incorrect, and blank answers are graded as incorrect.

5. On the scantron, fill in your last name, first name and initial. Blacken the corresponding letters.

6. Fill in your ID, the department=CHEM, Course no. = 101, and Section= your lab section. Blacken the corresponding letters and numbers.

7. If you want your score posted by a portion of your ID# mark A under the option column. They will be posted on the bulletin board where you got your seat assignment.

8. Use the test for scratch paper.

9. Mark your answers on the test so you can check them with the key when it is posted.

10. ***Turning in a blank scantron results in a grade of zero. ***

11. Turn in both the scantron and the exam, have your ID and your calculator ready to be checked.

12. Work at a steady pace and you will have ample time to finish.

13. The keys will be posted on my class web page as soon as possible. You may check your grade at the class web site. Your password is the middle 5 numbers of your student ID followed by the first letter of your last name in CAPS. Be patient and give the webmaster time to enter all of this information.

There are 35 questions for 125 points. Good Luck!
Possibly Useful Information

1 cal = 4.184 J

\[ M = \frac{\text{mol solute}}{\text{L soln}} \]

\[ M_1 V_1 = M_2 V_2 \]

\[ q = \text{mass} \times \text{sp ht} \times \Delta T \]

\[ \left( \frac{W}{W} \right) \% = \frac{\text{mass solute}}{\text{total mass}} \times 100 \]

\[ d = \text{mass/vol} \]

Volume = \( \ell \times h \times w \)

\[ \lambda, v = c \]

\[ E = hv \]

\[ \lambda = \frac{h}{mv} \]

\[ PV = nRT \]

\[ \frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2} \]

1 atm = 101.325 kPa

\[ P_{\text{total}} = P_A + P_B + P_C + \ldots \]

\[ P_A = X_A P_{\text{total}} \]

Rate A = \( \sqrt{\frac{\text{MW}(B)}{\text{MW}(A)}} \)

Rate B = \( \sqrt{\frac{\text{MW}(A)}{\text{MW}(B)}} \)

Time A = \( \sqrt{\frac{\text{MW}(A)}{\text{MW}(B)}} \)

\[ \ln \left( \frac{P_2}{P_1} \right) = \frac{\Delta H_{\text{vap}}}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right) \]

Q.1 Molecules that have strong cohesive forces will have,

a) Low boiling points

\( \text{\textcolor{red}{\textcircled{C}}} \)

b) Will be easily vaporized

d) Low vapor pressures

e) High vapor pressures

e) None of these are correct.

Q.2 Use the Ideal Gas Law to predict the relationship between \( n \) and \( P \) as temperature and volume are held constant.

\( \text{\textcolor{red}{\textcircled{A}}} \)

\( n \propto P \)

b) \( n \propto \frac{1}{P} \)

c) \( \frac{P}{R} = \text{constant} \)

d) \( Pn = TRV \)

e) \( \frac{PV}{T} = n \)

\[ PV = nRT \]

\[ P = n \text{ (constant)} \]
Q.3  A gas sample is held at constant pressure. The gas occupies 4.70 L of volume when the temperature is 28.6°C. Determine the temperature at which the volume of the gas is 8.45 L.

\[
\frac{R \cdot V_i}{n \cdot T_i} = \frac{R \cdot V_f}{n \cdot T_f} \\
T_f = \frac{V_f}{V_i} \cdot T_i = \left(\frac{8.45}{4.70}\right) \times 28.6°C = 54.2°C
\]

Q.4  Which one of the following substances would exhibit dipole-dipole intermolecular forces?

a) NaCl  
   b) Br₂  
   c) O₂  
   d) BF₃  
   e) O₃

Q.5  Which would have a lower rate of effusion than CO₂?

a) Xe  
   b) O₂  
   c) Ar  
   d) H₂  
   e) CO

Q.6  Convert 421 kPa to atmospheres.

a) 0.554 atm  
   b) 0.00415 atm  
   c) 4.16 atm  
   d) 4.27 \times 10^5 atm  
   e) 320 atm

Q.7  Which of the following substances show(s) significant hydrogen bonding?

Give the "best" answer.

a) CH₃OH  
   b) NH₃  
   c) PH₃  
   d) a, b, and c  
   e) a and b, only

Q.8  Methanol has a vapor pressure of 404 torr at 50°C, and a vapor pressure of 1126 torr at 75°C. Which temperature would most likely be its normal boiling point?

a) 50°C  
   b) 75°C  
   c) 125°C  
   d) 86°C  
   e) 85°C
Q. 9 A gaseous compound weighing 2.290 g occupies a volume of 325 mL at 25 °C and 760 mm Hg. What is the molar mass of this compound?

\[ m_w = \frac{m}{PV} = \frac{2.290 \text{ g}}{0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1} \times 298 \text{ K}} \]

a) 14.5 g/mol
b) 0.227 g/mol
c) 43.1 g/mol
d) 172 g/mol
e) 0.0190 g/mol

Q. 10 The pressure correction in the van der Waals equation is due to the fact that,

- manometers are not reliable
- gas molecules attract and repel each other
- gas molecules have a virtual existence
- gas molecules occupy a volume
- none of these

Q. 11 What volume would be occupied by 8.40 g of oxygen gas, O₂, at 0.400 atm and 145 °C?

\[ PV = nRT \]
\[ V = \frac{nRT}{P} = \frac{(8.40/32.00)(0.08206)(145 + 273)}{0.400} \]

\[ V = 22.52 \text{ L} \]

Q. 12 When the following \( \frac{1}{2} \) reaction is balanced in acidic solution, what is the coefficient of H₂O?

\[ \text{NO}_3^- \rightarrow \text{N}_2 \]

- a) 1
- b) 2
- c) 3
- d) 6
- e) 9

\[ 10e^- + 12H^+ + 2\text{NO}_3^- \rightarrow \text{N}_2 + 6\text{H}_2\text{O} \]
Q.13 A soft drink contains an unknown amount of citric acid, C₆H₈O₇. If 100.0 mL of the soft drink requires 42.51 mL of 0.0112 M NaOH to completely neutralize the citric acid, how many grams of citric acid (molar mass = 192.13 g/mol) does the soft drink contain per 100 mL? The reaction is:

\[
\text{C}_6\text{H}_8\text{O}_7(aq) + 3 \text{NaOH (aq)} \rightarrow \text{Na}_3\text{C}_6\text{H}_5\text{O}_7(aq) + 3 \text{H}_2\text{O (l)}
\]

\[
(0.04251)(0.0112) \text{ mol NaOH} \times \frac{1 \text{ cit.}}{3 \text{ NaOH}} \times \frac{192.13 \text{ g}}{1 \text{ mol cit.}} = 0.030491 \text{ g citric acid}
\]

Q.14 Choose the Brønsted-Lowry acids and bases in the following equation:

\[
\text{H}_3\text{O}^+ + \text{HSO}_4^- \rightarrow \text{H}_2\text{SO}_4 + \text{H}_2\text{O}
\]

\[
\begin{align*}
\text{A} & \quad \text{B} & \quad \text{A} & \quad \text{B} \\
\text{a) } & \text{acids } & \text{HSO}_4^- & \text{bases } & \text{H}_2\text{O}, \text{ H}_2\text{SO}_4 \\
\text{b) } & \text{acids } & \text{H}_3\text{O}^+, \text{ H}_2\text{SO}_4 & \text{bases } & \text{HSO}_4^-, \text{ H}_2\text{O} \\
\text{c) } & \text{acids } & \text{H}_3\text{O}^+, \text{ H}_2\text{O} & \text{bases } & \text{HSO}_4^-, \text{ H}_2\text{SO}_4 \\
\text{d) } & \text{acids } & \text{HSO}_4^-, \text{ H}_2\text{O} & \text{bases } & \text{H}_2\text{SO}_4, \text{ H}_3\text{O}^+ \\
\text{e) } & \text{acids } & \text{H}_2\text{O}, \text{ H}_2\text{SO}_4 & \text{bases } & \text{H}_3\text{O}^+, \text{ HSO}_4^- \\
\end{align*}
\]

Q.15 What mass of KOH is required to react exactly with 50.0 mL of 1.8 M H₂SO₄?

\[
(0.050)(1.8) \text{ mol H}_2\text{SO}_4 \times \frac{2 \text{ KOH}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{56.119}{1 \text{ mol KOH}} = 10.0998 \text{ g KOH}
\]
Q.16 The physical change of going from solid phase directly to gas phase is called,
   a) Condensation
   b) Evaporation
   c) Melting
   d) Sublimation
   e) Fusion

Q.17 It is found that 450.0 mL of a gas at STP has a mass of 4.50 g. What is the molar mass of this gas?

   a) \[ \frac{166 \text{ g}}{\text{mol}} \]
   b) \[ \frac{224 \text{ g}}{\text{mol}} \]
   c) \[ \frac{24.7 \text{ g}}{\text{mol}} \]
   d) \[ \frac{333 \text{ g}}{\text{mol}} \]
   e) \[ \frac{54.9 \text{ g}}{\text{mol}} \]

\[ \frac{X}{4500} = \frac{1\text{ mol}}{22.414} \]

\[ X = 0.02008 \text{ mols gas} \]

Molar mass \[ = \frac{4.50}{0.02008} = 224.1 \text{ g/mol} \]

Q.18 The forces which exist between noble gas atoms in the solid and liquid state are:
   a) Ionic forces
   b) Dipole-dipole forces
   c) Dispersion forces
   d) Hydrogen bonds
   e) Ion-dipole forces

Q.19 A sample of O₂ gas effuses through a small hole in 25.0 s. How long would it take a sample of N₂O₂ (g) to effuse under the same conditions?

\[ \frac{\text{time O}_2}{\text{time N}_2\text{O}_2} = \sqrt{\frac{0.2}{N_2\text{O}_2}} = \sqrt{\frac{32}{60}} = 0.730 \]

\[ \frac{25.0 \text{ s}}{0.730} = x = 34.24 \text{ s} \]
Q.20 How many moles of NaCl are needed to make up 65 mL of a 0.0035 M NaCl solution?
   a) \(1.8 \times 10^{-4}\) mol  
   b) \(5.4 \times 10^{-3}\) mol  
   c) \(2.3 \times 10^{-1}\) mol  
   d) \(2.3 \times 10^{-3}\) mol  
   e) \(2.3 \times 10^{-4}\) mol

\[
0.065 \text{ L} \times 0.0035 \text{ mol/L} = 2.275 \times 10^{-4} \text{ mol}
\]

Q.21 The normal boiling point of CS\(_2\) is 46°C. Based upon this, the attraction between CS\(_2\) molecules is ____ (than) the attraction between H\(_2\)O molecules in the liquid state.
   a) greater  
   b) less  
   c) equal to  
   d) more information is needed to answer this

Q.22 The conjugate acid of HS\(^-\) is,
   a) HS  
   b) HS\(^2-\)  
   c) HS\(^+\)  
   d) S\(^2-\)  
   e) H\(_2\)S

Q.23 Which of the following is an endothermic process?
   a) Condensation  
   b) Acid-base neutralization reaction  
   c) Combustion  
   d) Fusion  
   e) All of these are endothermic

Q.24 A proton donor best describes,
   a) A Lewis acid  
   b) A Lewis base  
   c) A Brønsted-Lowry acid  
   d) A Brønsted-Lowry base  
   e) An Arrhenius acid

Q.25 Which of the following is the strongest acid?
   a) H\(_2\)CO\(_3\)  
   b) HI  
   c) HF  
   d) HBr  
   e) HCl

p.7
Q.26 Hydrogen bonding,
a) refers to the covalent bond of H to O
b) is a special case of ionic bonding
c) is a special case of strong dipole-dipole interaction
d) is a weak dispersion force
e) None of the above are correct statements.

Q.27 The portion of the phase diagram in which the solid phase and liquid phase exist in equilibrium is called the,
a) critical point
b) critical pressure
c) melting curve
d) triple point
e) sublimation curve

Q.28 Which of the following are correctly paired?
a) critical point : solid phase
b) hydrogen bonding : H₂
c) heat of fusion : melting a solid
d) Clausius-Clapeyron Equation : ideal gas
e) condensation point : STP

Q.29 In the following reaction: \( BF_3 + NH_3 \rightarrow BF_3\cdot NH_3 \),
NH₃ acts as a
a) Lewis base
b) Brønsted acid
c) Lewis acid
d) Brønsted base
e) Arrhenius acid

Q.30 Which of the following would you expect to have the highest boiling point?
a) CH₄  
b) C₂H₂  
c) NO₂  
d) C₂H₅OH  
e) Xe

\[ \text{dipole-dipole} \quad \text{+ H-bond} \]
Q. 31  How many grams of Na\textsubscript{2}CO\textsubscript{3} (molar mass = 106.0 g/mol) are required for complete reaction with 50.0 mL of 0.155 M HNO\textsubscript{3}?

\[
\text{Na}_2\text{CO}_3 (s) + 2 \text{HNO}_3 (aq) \rightarrow 2 \text{NaNO}_3 (aq) + \text{CO}_2 (g) + \text{H}_2\text{O} (l)
\]

\[
\begin{align*}
\text{a)} & \quad 0.410 \text{ g} \\
\text{b)} & \quad 0.205 \text{ g} \\
\text{c)} & \quad 0.614 \text{ g} \\
\text{d)} & \quad 10.3 \text{ g} \\
\text{e)} & \quad 0.820 \text{ g}
\end{align*}
\]

\[
= 0.41075 \Rightarrow 0.411 \text{ g}
\]

Q. 32  Consider three 1-L flasks at STP. Flask A contains NH\textsubscript{3} gas, flask B contains NO\textsubscript{2} gas, and flask C contains N\textsubscript{2} gas. Which flask contains the largest number of molecules?

\[
a) \quad \text{A & B} \quad \quad b) \quad \text{C} \quad \quad c) \quad \text{A} \quad \quad d) \quad \text{B} \quad \quad e) \quad \text{all are the same}
\]

Q. 33  When the following \(\frac{1}{2}\) reaction is balanced in acid using the smallest integer coefficients, the sum of the coefficients (including moles of electrons) is ...

\[
4\text{e}^- + 4\text{H}^+ + \text{ClO}_2^- \rightarrow \text{Cl}^- + 2 \text{H}_2\text{O}
\]

\[
\begin{align*}
\text{a)} & \quad 14 \\
\text{b)} & \quad 10 \\
\text{c)} & \quad 17 \\
\text{d)} & \quad 16 \\
\text{e)} & \quad 12
\end{align*}
\]

\[
\sum 4 + 4 + 1 + 1 + 2 = 12
\]
Q.34 In the reaction \( \text{Fe}_2\text{O}_3 \) (s) + 3 \( \text{H}_2 \) (g) → 2 \( \text{Fe} \) (s) + 3 \( \text{H}_2\text{O} \) (l), how many moles of iron can be produced using 27.4 liters of hydrogen at STP?

\[
\frac{x \text{ mol}}{27.4 \text{ L}} = \frac{1 \text{ mol}}{22.414 \text{ L}} \times 1.222 \text{ mol} \text{ H}_2 \times \frac{2 \text{ Fe}}{3 \text{ H}_2} = \frac{0.8149}{0.815} \text{ mol Fe}
\]

a) 0.815  

Q.35 Calculate the density of \( \text{SO}_2 \) gas at 45°C and 635 torr.

\[
\frac{n}{V} = \frac{P}{RT}
\]

\[
\frac{n}{V} = \frac{(635/760)}{(0.0821)(273 + 45)} = \frac{0.320}{1 \text{ mol L}} \times \frac{64.07 \text{ g}}{1 \text{ mol SO}_2} = 2.05 \text{ g/L}
\]

End of Test
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
</tr>
<tr>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
</tr>
<tr>
<td>6</td>
<td>E</td>
</tr>
<tr>
<td>7</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
</tr>
<tr>
<td>9</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>B</td>
</tr>
<tr>
<td>11</td>
<td>D</td>
</tr>
<tr>
<td>12</td>
<td>C</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
</tr>
<tr>
<td>14</td>
<td>B</td>
</tr>
<tr>
<td>15</td>
<td>C</td>
</tr>
<tr>
<td>16</td>
<td>B</td>
</tr>
<tr>
<td>17</td>
<td>C</td>
</tr>
<tr>
<td>18</td>
<td>B</td>
</tr>
<tr>
<td>19</td>
<td>C</td>
</tr>
<tr>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>21</td>
<td>B</td>
</tr>
<tr>
<td>22</td>
<td>D</td>
</tr>
<tr>
<td>23</td>
<td>C</td>
</tr>
<tr>
<td>24</td>
<td>A</td>
</tr>
<tr>
<td>25</td>
<td>D</td>
</tr>
<tr>
<td>26</td>
<td>A</td>
</tr>
<tr>
<td>27</td>
<td>A</td>
</tr>
<tr>
<td>28</td>
<td>C</td>
</tr>
<tr>
<td>29</td>
<td>C</td>
</tr>
<tr>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>31</td>
<td>B</td>
</tr>
<tr>
<td>32</td>
<td>E</td>
</tr>
<tr>
<td>33</td>
<td>D</td>
</tr>
<tr>
<td>34</td>
<td>E</td>
</tr>
<tr>
<td>35</td>
<td>E</td>
</tr>
</tbody>
</table>

Total points = 125

Each question = 3.572 points