Name **KEY P** (Print last name in CAPS)

**SECTION** (same as your lab section)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Read each question carefully before answering.</td>
</tr>
<tr>
<td>2.</td>
<td>Mark the choice that best answers the question or completes the statement.</td>
</tr>
<tr>
<td>3.</td>
<td>Use the scantron provided. Use a no. 2 pencil and clearly mark your choice. If you change an answer, completely erase your previous mark.</td>
</tr>
<tr>
<td>4.</td>
<td>Answer each question. There is no penalty for guessing. However, multiple answers are graded as incorrect, and blank answers are graded as incorrect.</td>
</tr>
<tr>
<td>5.</td>
<td>On the scantron, fill in your last name, first name and initial. Blacken the corresponding letters.</td>
</tr>
<tr>
<td>6.</td>
<td>Fill in your ID, the department=CHEM, Course no. = 101, and Section= your lab section. Blacken the corresponding letters and numbers.</td>
</tr>
<tr>
<td>7.</td>
<td>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.</td>
</tr>
<tr>
<td>8.</td>
<td>Use the test for scratch paper.</td>
</tr>
<tr>
<td>9.</td>
<td>Mark your answers on the test so you can check them with the key when it is posted.</td>
</tr>
<tr>
<td>10.</td>
<td>***Turning in a blank scantron results in a grade of zero. ***</td>
</tr>
<tr>
<td>11.</td>
<td>Turn in both the scantron and the exam, have your ID and your calculator ready to be checked.</td>
</tr>
<tr>
<td>12.</td>
<td>Work at a steady pace and you will have ample time to finish.</td>
</tr>
<tr>
<td>13.</td>
<td>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.</td>
</tr>
</tbody>
</table>

There are 35 questions for 125 points. Good Luck!
KEY

Possibly Useful Information

1 \text{ cal} = 4.184 \text{ J}

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

\[ M_1V_1 = M_2V_2 \]

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

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

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

\[ \text{Volume} = l \times h \times w \]

\[ \lambda_v = c \]

\[ E = hv \]

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

\[ PV = nRT \]

\[ \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \]

1 atm = 101.325 kPa

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

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

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

\[ \frac{\text{time A}}{\text{time B}} = \sqrt{\frac{\text{MW(A)}}{\text{MW(B)}}} \]

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

Q.1 Which of the following is not a diprotic acid?

\[ a) \quad \text{H}_2\text{SO}_4 \text{ (aq)} \]

\[ b) \quad \text{HNO}_2 \text{ (aq)} \]

\[ c) \quad \text{H}_2\text{CO}_3 \text{ (aq)} \]

\[ d) \quad \text{H}_2\text{SO}_3 \text{ (aq)} \]

\[ e) \quad \text{H}_2\text{S} \text{ (aq)} \]

Q.2 Calculate the density of CH\textsubscript{4} gas at 65\textdegree C and 725 torr.

\[ g \quad \frac{P}{V} = \frac{P (\text{mw})}{RT} = \frac{(725/760)(16.04)}{(0.08206)(65+273)} = 0.55 \text{ g/L} \]
Q.3 A gas container has only N₂ at a pressure of 0.560 atm. If O₂ is pumped into it until the total pressure is 2.50 atm. What is the partial pressure of O₂?

\[ P_{\text{Total}} = P_{\text{N}_2} + P_{\text{O}_2} \]

\[ P_{\text{O}_2} = 2.50 - P_{\text{N}_2} = 2.50 - 0.560 = 1.94 \text{ atm} \]

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

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

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

\[ \frac{40}{32} = \frac{28}{28} = \frac{83.8}{83.8} = \frac{\boxed{12}}{\boxed{12}} \]

\[ M_{\text{mol}} \text{ mass } \boxed{\text{CO}_2} \approx 44 \text{ amu} \]

Q.6 Which of the following substances is amphoteric?

a) NaOH   b) Ca(OH)₂   c) Sr(OH)₂   d) Co(OH)₂   e) H₂

\[ 3.58 \text{ atm} \times \frac{101.325 \text{ kPa}}{1 \text{ atm}} = 362.6 \text{ kPa} \]

Q.7 Convert 3.58 atmospheres to kPa.

a) 283 kPa   b) 0.363 kPa   c) 28.3 kPa   d) 2.83 kPa   e) 363 kPa

Q.8 Which of the following substances show(s) significant hydrogen bonding?

Choose the "best" answer.

a) CH₃OH   b) NH₃   c) HF   d) a, b, and c   e) a and b, only
Q. 9 What is the molar mass of a gas if 8.40 g if the gas occupies a volume of 16.5 liters at 225 °C and a pressure of 0.950 atm?

\[ m \cdot w = \frac{9RT}{PV} = \frac{(8.40 \text{ g})(0.0821)(225 + 273)}{(16.5)(0.950)} = 21.9 \text{ g/mol} \]

Q. 10 Which of the following would you expect to have the highest boiling point?

a) CH₄  b) C₂H₂  c) Xe  d) C₂H₅OH  e) NO₂

Q. 11 Which of the following is the strongest acid?

a) HClO₃  b) HClO₄  c) HClO  d) HClO₂  e) HBrO

Q. 12 Choose the Brønsted-Lowry acids and bases in the following equation:

\[ \text{HSO}_4^- + \text{OH}^- \rightarrow \text{SO}_4^{2-} + \text{H}_2\text{O} \]

A  B  B  A

a) acids SO₄²⁻, OH⁻  bases H₂O, HSO₄⁻

b) acids H₂O, HSO₄⁻  bases SO₄²⁻, OH⁻

c) acids H₂O, SO₄²⁻  bases HSO₄⁻, SO₄²⁻

d) acids H₂O, OH⁻  bases HSO₄⁻, SO₄²⁻

e) acids HSO₄⁻, SO₄²⁻  bases SO₄²⁻, H₂O

Q. 13 What mass of KOH is required to react exactly with 85.0 mL of 1.6 M H₂SO₄?

\[ 2 \text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O} \]

\[ (0.85)(1.6) \text{ mol H}_2\text{SO}_4 \times \frac{56.20 \text{ g}}{1 \text{ mol KOH}} = 15.28 \text{ g KOH} \]
Q.14 The physical change of a substance from the liquid phase to the gas phase is called,
   a) Condensation
   b) Evaporation
   c) Melting
   d) Sublimation
   e) Fusion

Q.15 A mixture of gases contains He at a partial pressure of 0.348 atm and Ar at a partial pressure of 0.588 atm. What is the mol fraction of Argon in this mixture?
   a) 1.69
   b) 0.592
   c) 0.098
   d) 0.362
   e) 0.628

Q.16 A steel needle floats on water because of
   a) Capillary action of the water on the needle
   b) The surface tension of the water
   c) Differences in the temperature of the needle and the water
   d) Differences in the density of the needle and the density of water at room temperature
   e) A standard magic trick

Q.17 Water under a pressure of 1.5 atm would boil at,
   a) less than 100°C
   b) greater than 100°C
   c) 100°C
   d) Water would not boil under these conditions.
   e) None of these

Q.18 Which of the following is correctly paired?
   a) Lewis acid : proton donor
   b) Lewis base : electron pair acceptor
   c) Brønsted-Lowry acid : proton acceptor
   d) Brønsted-Lowry base : proton acceptor
   e) Brønsted-Lowry base : proton donor
Q.19 Which of the following statements is correct?
   a) The shapes of molecules has no effect on the boiling points.
   b) The volume of a liquid changes dramatically with increased pressure.
   c) A given mass of liquid occupies a much smaller volume than the same mass of that substance in the gas phase.
   d) Gas molecules do not attract and repel each other.
   e) None of these statements are correct.

Q.20 A sample of N₂ gas effuses through a small hole in 15.0 s. How long would it take a sample of CO₂ (g) to effuse under the same conditions?

\[
\begin{align*}
\text{time N}_2 & = \sqrt{\frac{m_{N_2}}{m_{CO_2}}} = \sqrt{\frac{28}{44}} = 0.7977 \\
\text{time CO}_2 & = \frac{15.0}{0.7977} = 18.8 \text{ s}
\end{align*}
\]

Q.21 How many grams of Na₂CO₃ (molar mass = 106.0 g/mol) are required for complete reaction with 85.0 mL of 0.165 M HNO₃?

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

\[
\begin{align*}
\text{mol HNO}_3 & = 0.085 \times 0.165 = 0.014175 \\
\text{mol Na}_2\text{CO}_3 & = \frac{0.014175 \times 106.0}{1 \text{ mol Na}_2\text{CO}_3} = 0.743 \text{ g Na}_2\text{CO}_3
\end{align*}
\]

Q.22 How many moles of KBr are needed to make up 250 mL of a 0.0425 M KBr solution?

\[
\begin{align*}
\text{mol KBr} & = \frac{0.250 \text{ L} \times 0.0425 \text{ mol L}^{-1}}{1} = 0.010625 \text{ mol KBr}
\end{align*}
\]
Q.23 At room temperature, which of the following compounds has the strongest interparticle or intermolecular forces?

a) CO₂   b) H₂O   c) NaCl   d) C₂H₆   e) CH₃OH

Q.24 Which of the following is not an amphiprotic species?

a) HS⁻   b) HCO₃⁻   c) OH⁻   d) CH₄   e) H₂PO₄⁻

Q.25 What is the volume of one mole of pentane, C₅H₁₂, gas at 500 °C and a pressure of 860 torr?

\[ V = \frac{nRT}{P} = \frac{(1)(1.0821)(500 + 273)}{(860/760)} \]
\[ V = 56.08 \text{ L} \]

Q.26 A soft drink contains an unknown amount of citric acid, C₆H₈O₇. If 200.0 mL of the soft drink requires 12.55 mL of 0.175 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 200.0 mL? The reaction is:

\[ C₆H₈O₇(aq) + 3 \text{NaOH (aq)} \rightarrow \text{Na₃C₆H₅O₇(aq)} + 3 \text{H₂O (l)} \]

\[ \text{a) 0.141 g} \]
\[ \text{b) 0.844 g} \]
\[ \text{c) 26.8 g} \]
\[ \text{d) 0.104 g} \]
\[ \text{e) 0.282 g} \]

\[ \text{\(0.01255\) mol NaOH \times \frac{192.13 g}{1 \text{ mol citric}} = 0.1406 g \text{ citric acid}} \]
\[ = 0.141 g \]

Q.27 Hydrogen bonding,

a) is a special case of ionic bonding
b) is a weak dispersion force
\[ \text{c) is a special case of strong dipole-dipole interaction} \]
d) refers to the covalent bond of H to O
e) None of the above are correct statements.
Q.28 When a substance is above its critical temperature and pressure,
   a) It is constantly boiling
   b) It is unstable and explosive
   c) It is considered a plasma
   d) It can no longer be condensed to a liquid
   e) All the above are incorrect

Q.29 Which of the following statements is true?
   a) Volatile liquids have high vapor pressures.
   b) Volatile liquids have low vapor pressures.
   c) Vapor pressure decreases as temperature increases.
   d) High molecular weight substances have higher vapor pressures than low molecular weight substances.
   e)  a and c are correct.

Q.30 When the following $\frac{1}{2}$ - reaction is balanced in basic solution using the smallest integer coefficients, what is the coefficient of H$_2$O?

$$3\text{OH}^- + 3\text{H}^+ + \text{O}_2 \rightarrow \text{OH}^- + \text{H}_2\text{O} + 3\text{OH}^-$$

a) 0 \quad b) 1 \quad c) 2 \quad d) 3 \quad e) 4

$$4\text{e}^- + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{OH}^-$$

Q.31 Which of the following is correctly paired?
   a) critical point : solid phase
   b) hydrogen bonding: H$_2$
   c) heat of fusion : evaporation
   d) condensation point : STP
   e) Clausius-Clapeyron Equation : vapor pressures at different temperatures

Q.32 Consider three 1-L flasks at STP. Flask A contains H$_2$ gas, flask B contains O$_3$ gas, and flask C contains O$_2$ gas. Which flask contains the largest number of molecules?
   a) A \& C \quad b) A \quad c) C \quad d) B \quad e) all are the same
Q.33 When the following ½ reaction is balanced in acid using the smallest integer coefficients, the sum of the coefficients (including moles of electrons) is ...

\[ 2e^- + H^+ + HBrO \rightarrow Br^- + H_2O \]

a) 4  b) 6  c) 8  d) 10  e) 12  

\[ \sum = 2 + 1 + 1 + 1 + 1 = 6 \]

Q.34 In the reaction \( \text{Fe}_2\text{O}_3 (s) + 3 \text{H}_2 (g) \rightarrow 2 \text{Fe} (s) + 3 \text{H}_2\text{O (l)} \), how many moles of iron can be produced using 55.7 liters of hydrogen at STP?

a) 0.268  b) 3.73  c) 2.49  d) 1.66  e) 0.0670  

\[
\frac{x}{55.7} = \frac{1\text{mol}}{22.414}\Rightarrow x = 2.485 \text{ mol H}_2
\]

\[
2.49 \text{ mol H}_2 \times \frac{2 \text{ Fe}}{3 \text{ H}_2} = 1.66 \text{ mol Fe}
\]

Q.35 What is the volume in liters of one mole of an ideal gas at \(-65.0^\circ\text{C}\) and 1 atm pressure?

a) 25.3  b) 17.1  c) 5.34  d) 10.7  e) 87.4  

\[
V = \frac{nRT}{P} = \frac{(1)(0.0821)(-65.0 + 273.15)}{1} = 17.089 \Rightarrow 17.1 \text{ L}
\]

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>C</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>5</td>
<td>D</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
</tr>
<tr>
<td>7</td>
<td>E</td>
</tr>
<tr>
<td>8</td>
<td>D</td>
</tr>
<tr>
<td>9</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>11</td>
<td>D</td>
</tr>
<tr>
<td>12</td>
<td>B</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
</tr>
<tr>
<td>14</td>
<td>B</td>
</tr>
<tr>
<td>15</td>
<td>E</td>
</tr>
<tr>
<td>16</td>
<td>B</td>
</tr>
<tr>
<td>17</td>
<td>B</td>
</tr>
<tr>
<td>18</td>
<td>D</td>
</tr>
<tr>
<td>19</td>
<td>C</td>
</tr>
<tr>
<td>20</td>
<td>C</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>D</td>
</tr>
<tr>
<td>25</td>
<td>E</td>
</tr>
<tr>
<td>26</td>
<td>A</td>
</tr>
<tr>
<td>27</td>
<td>C</td>
</tr>
<tr>
<td>28</td>
<td>D</td>
</tr>
<tr>
<td>29</td>
<td>C</td>
</tr>
<tr>
<td>30</td>
<td>C</td>
</tr>
<tr>
<td>31</td>
<td>E</td>
</tr>
<tr>
<td>32</td>
<td>E</td>
</tr>
<tr>
<td>33</td>
<td>B</td>
</tr>
<tr>
<td>34</td>
<td>D</td>
</tr>
<tr>
<td>35</td>
<td>B</td>
</tr>
</tbody>
</table>