1. Consider a balloon filled with 5 L of an ideal gas at 20 °C. If the temperature of the balloon is increased by 70 °C and the external pressure acting on the balloon remains constant, what would be the new volume of the balloon?
   A. 4.27 L  
   B. 5.85 L  
   C. 6.19 L  
   D. 17.5 L  
   E. 22.5 L

2. A 15.0 L flask of CH₄ is at 30 °C and 0.965 atm. How many molecules of methane are in the flask?
   A. 3.50 \times 10^{23}  
   B. 2.88 \times 10^{22}  
   C. 1.44 \times 10^{23}  
   D. 3.54 \times 10^{24}  
   E. 1.77 \times 10^{25}

3. What is the pressure of the gas in the bulb in the figure below if the height of the column of Hg is 23.5 mm and atmospheric pressure is 0.945 atm?
   A. 48.3 torr  
   B. 718. torr  
   C. 695. torr  
   D. 742. torr  
   E. 95.3 torr

4. A 1.0 L container at 20 °C and 1 atm contains 5.46 g of an unknown gas. What is the gas?
   A. O₂  
   B. N₂  
   C. Ne  
   D. Xe  
   E. CF₄

Go on to the next page
5. The normal boiling points of 5 liquids are given below. Which one has the highest vapor pressure at 25°C?

<table>
<thead>
<tr>
<th>substance</th>
<th>bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. water</td>
<td>100°C</td>
</tr>
<tr>
<td>B. ethanol</td>
<td>78.3°C</td>
</tr>
<tr>
<td>C. propanol</td>
<td>97°C</td>
</tr>
<tr>
<td>D. hexane</td>
<td>68°C</td>
</tr>
<tr>
<td>E. diethyl ether</td>
<td>34.6°C</td>
</tr>
</tbody>
</table>

6. Which one of these phase diagrams belongs to a substance that does not have a normal boiling point?

A. 1
B. 2
C. 3
D. 4
E. all of them have a normal boiling point.

7. A container of a gas mixture (described by the table below) is held at standard temperature and pressure (STP). What would be the average rms velocity of the molecule (or atom) with the greatest rate of diffusion?

<table>
<thead>
<tr>
<th>Gas</th>
<th>mole fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>0.78084</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.20946</td>
</tr>
<tr>
<td>Argon</td>
<td>0.00934</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.00039445</td>
</tr>
</tbody>
</table>

A. 393 m/s
B. 411 m/s
C. 493 m/s
D. 461 m/s
E. 515 m/s

8. Rank the following molecules in increasing order of viscosity.

A. i < ii < iii
B. i < iii < ii
C. iii < ii < i
D. iii < i < ii
E. ii < i < iii
9. The distributions of speeds shown above are for the 5 molecules listed below at the same temperature. Which one of the distribution functions corresponds to F_2?

He  Ne  Kr  F_2  Xe

A. I  
B. II  
C. III  
D. IV  
E. V.

10. Which of the following statements is **false** about a substance with the phase diagram shown below?

A. More than one phase of the substance coexist at points A and B. 
B. The substance at point C can melt if the pressure is increased. 
C. The substance at point D exists as a supercritical fluid. 
D. Process E represents vaporization of the substance. 
E. G is the normal boiling point of the substance.
11. Which of the following pairs are both weak electrolytes?
   A. HClO₄ and NaOH
   B. HClO₄ and NH₃
   C. CH₃COOH and NH₃
   D. CH₃COOH and C₃H₈
   E. HI and C₃H₈

12. A solution of camphor (C₁₀H₁₆O) in ethanol (CH₃CH₂OH) is a mild topical antiseptic. If this solution contains 1.47 g of camphor dissolved in 125 mL of ethanol and has a density of 0.785 g/mL, what is the molarity of this solution? (Assume that the volume of ethanol is the volume of the solution.)
   A. 15.0 M
   B. 11.8 M
   C. 0.0986 M
   D. 0.0772 M
   E. 0.0582 M

13. Which of the following aqueous solutions would have the lowest conductivity?
   A. 0.1 M NH₄NO₃ (aq)
   B. 0.1 M HBr (aq)
   C. 0.1 M MgCl₂ (aq)
   D. 0.1 M KOH (aq)
   E. 0.1 M CH₃COOH (aq)

14. A 250 mL beaker contains a saturated solution of ammonium chloride in water with some solid NH₄Cl(s) on the bottom. Which of the following is/are true statements about the contents of the beaker?
   I. The solution contains NH₄⁺ and Cl⁻ ions.
   II. The rate of dissolution is faster than the rate of precipitation.
   III. At the same temperature, an increase in pressure will cause dissolution of more NH₄Cl.
   A. I only
   B. II only
   C. III only
   D. I and II only
   E. I and III only
Use the diagram below for the next two questions.

15. A clear, colorless solution forms when 80.0 g of KBr is dissolved in 100g of water at 95 °C. The solution is cooled to 40 °C and remains clear and colorless. Which statement below is true?
   A. The solution is unsaturated.
   B. The solution is saturated.
   C. The solution is supersaturated.
   D. The solution is at equilibrium with the solute.
   E. None of these statements are true.

16. You have a beaker with an aqueous glucose solution with solid glucose on the bottom. These contents are in equilibrium. Which of the following actions would let you increase the concentration of glucose in solution?
   A. Add more glucose to the beaker.
   B. Remove solid glucose from the beaker.
   C. Increase the temperature of the solution.
   D. Decrease the temperature of the solution.
   E. Add more water to the beaker.

17. Which of the following compounds will be most soluble in hexanes?
   A. CaCO₃
   B. H₂S
   C. CH₃CH₂OH
   D. CH₃CH=CHCH₃
   E. NH₃
18. A mole of fuel (molecular weight = 50.0 g/mole) is burnt to produce $5.00 \times 10^4$ J of heat. A coolant with a specific heat of 2.5 J/g°C has a boiling point of 125 °C. What is the minimum amount of this coolant at 25 °C required to absorb the heat produced by burning 100.0g of the fuel without boiling the coolant?

   A. 12.5 g  
   B. 67 g  
   C. 100 g  
   D. 267 g  
   E. 400 g

19. Which aqueous solution would have the greatest concentration of Cl\(^{-}\) (aq) ions?

   A. $1.0 \times 10^{-2}$ M NaCl  
   B. $5.5 \times 10^{-3}$ M CaCl\(_2\)  
   C. $4.3 \times 10^{-3}$ M NCl\(_3\)  
   D. $4.0 \times 10^{-3}$ M FeCl\(_3\)  
   E. $3.3 \times 10^{-3}$ M CCl\(_4\)

20. How much heat is needed to produce 100.0g of CO\(_2\)(g) at 200.0 °C from 100.0g of dry ice at −100.0 °C? The pressure of the vessel is held constant at 1.0 atm. Use the following data for CO\(_2\).

   Triple point = 5.11 atm at −56.6 °C  
   Critical point = 73.0 atm at 31.1 °C  
   Sublimation point at 1 atm = −78.5°C  
   Molar heat of sublimation = 25.2 kJ/mol  
   Specific heat of solid = 1.24 J/g·K  
   Specific heat of gas = 0.82 J/g·K

   A. 2.06 kJ  
   B. 22.3 kJ  
   C. 82.8 kJ  
   D. 281 kJ  
   E. 321 kJ

21. A mixture of CO\(_2\) and hydrogen is collected over water at 28 °C and 760 torr. If the mole fraction of CO\(_2\) in the gas is 0.4, what is the partial pressure of hydrogen? The vapor pressure of water at 28 °C is 28 mmHg.

   A. 228 torr  
   B. 400 torr  
   C. 428 torr  
   D. 456 torr  
   E. 532 torr

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22. You are an anesthesiologist about to administer Propofol (shown below). You need to administer 50 µg (= 50 × 10⁻⁶ g) of the drug, and have a stock solution with a concentration of 0.11 mM. What volume of the stock solution do you need to use?

![Propofol structure](image)

A. 1.0 mL  
B. 1.4 mL  
C. 2.6 mL  
D. 4.0 mL  
E. 5.0 mL

23. What is the molarity of chloride ions after 140 mL of 0.25 M NaCl is added to 380 mL of 0.75 M CaCl₂? (Assume that the volume of the solutions are additive.)

A. 0.357 M  
B. 0.631 M  
C. 0.892 M  
D. 1.06 M  
E. 1.16 M

24. Solid potassium permanganate, KMnO₄, is much more soluble in water than in hexane (C₆H₁₄). Which one of the following is primarily responsible for the greater solubility of KMnO₄ in water than in hexane?

A. ionic bonding  
B. ion-dipole forces  
C. London dispersion forces  
D. dipole-dipole forces  
E. the molecular weight of the solvent.

25. 66.2 mg of an unknown protein (a non-electrolyte) is dissolved in 1.00 mL of water at 300 K yielding a solution with an osmotic pressure of 35.0 mmHg. What is the molecular weight of the protein?

A. 3.54×10⁴ g/mol  
B. 7.23×10⁴ g/mol  
C. 2.30×10⁵ g/mol  
D. 6.94×10⁵ g/mol  
E. 3.95×10⁷ g/mol

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26. 0.149 moles of an unknown substance is dissolved in 175.0 g of water yielding a solution with a freezing point of –3.17 °C. What can you conclude about the substance?

\[ K_b \text{ for water } = 0.52 \text{ °C/m} \]
\[ K_f \text{ for water } = 1.86 \text{ °C/m} \]

A. The substance is a strong electrolyte.
B. The substance is a weak or non-electrolyte.
C. The substance would lower the boiling point of the resulting solution.
D. The substance would lower the osmotic pressure of the resulting solution.
E. No conclusion can be drawn about the substance.

27. A 1.0 L vessel containing 1 mole of gas molecules at 250 °C has a composition that is 5% CO₂, 60% N₂, 10% SO₂, and 25% He. What is the partial pressure of the most polar gas?

A. 10.7 atm
B. 2.14 atm
C. 4.29 atm
D. 25.7 atm
E. 429 atm

28. Correctly identify the compressibility curves for the real gases ammonia, carbon dioxide and neon.

<table>
<thead>
<tr>
<th></th>
<th>I.</th>
<th>II.</th>
<th>III.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>CO₂</td>
<td>NH₃</td>
<td>Ne</td>
</tr>
<tr>
<td>B.</td>
<td>Ne</td>
<td>NH₃</td>
<td>CO₂</td>
</tr>
<tr>
<td>C.</td>
<td>NH₃</td>
<td>Ne</td>
<td>CO₂</td>
</tr>
<tr>
<td>D.</td>
<td>Ne</td>
<td>CO₂</td>
<td>NH₃</td>
</tr>
<tr>
<td>E.</td>
<td>NH₃</td>
<td>CO₂</td>
<td>Ne</td>
</tr>
</tbody>
</table>
CHEMISTRY 110 EXAM 3
NOVEMBER 12, 2012
Answer Key

FORM A
1. C
2. A
3. C
4. D
5. E
6. A
7. C
8. B
9. C
10. D
11. C
12. D
13. E
14. A
15. C
16. C
17. D
18. E
19. D
20. C
21. C
22. C
23. E
24. B
25. A
26. A
27. C
28. D