Instructions: You should have with you several number two pencils, an eraser, your 3” x 5” note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your last name, first name, middle initial, and student identification number. Leave the class section number and the test form number blank.

This exam consists of 25 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the Scantron form in the appropriate stack and present your University ID Card to the proctor. You may keep the exam packet, so please show your work and mark the answers you selected on it.

\[ R = 0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K} \]

\[ 760 \text{ mm Hg} = 760 \text{ torr} = 1 \text{ atm} \]

\[ m = \text{mol/kg} \]

\[ \Delta T_f = \text{im} \]

\[ k_f(\text{H}_2\text{O}) = 1.86 \text{ °C/m} \]

\[ k_b(\text{H}_2\text{O}) = 0.512 \text{ °C/m} \]

\[ \ln \left( \frac{A}{A_0} \right) = -kt \]

SC: \[ 2r = s \]

BCC: \[ 4r = s\sqrt{3} \]

FCC: \[ 4r = s\sqrt{2} \]
1. Consider the phase diagrams below. Which diagram could correctly describe CO₂?

(A) 
(B) 
(C) 
(D) 

2. Which of the following is **false**?

(A) Graphite is a network covalent compound. **True**
(B) Diamond is a network covalent compound. **True**
(C) Network covalent compounds typically melt at higher temperatures than molecules. **True**
(D) *Potassium chloride is a network covalent compound.* **False**
(E) Carbon dioxide is a molecule. **True**
3. Consider the phase diagram below for compound foolsgoldium. The temperature of sublimation at 1 atm is:

(A) 0 °C
(B) 50 °C
(C) 100 °C
(D) 200 °C
(E) 212 °C

4. Sodium chloride melts at 804 °C. Sodium iodide melts at 651 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3...)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)
5. MgO melts near 2800 °C. KCl melts near 776 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3...)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) The sheet-like structure

6. 1-propanol, CH₃CH₂CH₂OH, boils at +97.1 °C. Butane, CH₃CH₂CH₂CH₃ boils at −0.5 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3...)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)
7. Consider dimethyl ether, CH$_3$OCH$_3$. The intermolecular forces present in CH$_3$OCH$_3$ are:

(A) Dispersion forces only.
(B) Dipole-dipole forces only.
(C) Dispersion forces and dipole-dipole forces.
(D) Dispersion forces, dipole-dipole forces, and hydrogen bonding.
(E) Hydrogen bonding only.

8. Consider He, CH$_3$OCH$_3$, CH$_3$CH$_2$OH, diamond, LiF, CsF, MgF$_2$, and AlN. Arranged in increasing melting point, these are:

<table>
<thead>
<tr>
<th>Lowest mp</th>
<th>Highest mp</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) He &lt; CH$_3$OCH$_3$ &lt; CH$_3$CH$_2$OH &lt; LiF &lt; CsF &lt; MgF$_2$ &lt; AlN &lt; diamond</td>
<td></td>
</tr>
<tr>
<td>(B) He &lt; CH$_3$OCH$_3$ &lt; CH$_3$CH$_2$OH &lt; CsF &lt; LiF &lt; MgF$_2$ &lt; AlN &lt; diamond</td>
<td></td>
</tr>
<tr>
<td>(C) He &lt; CH$_3$CH$_2$OH &lt; CH$_3$OCH$_3$ &lt; CsF &lt; LiF &lt; MgF$_2$ &lt; AlN &lt; diamond</td>
<td></td>
</tr>
<tr>
<td>(D) He &lt; CH$_3$CH$_2$OH &lt; CH$_3$OCH$_3$ &lt; LiF &lt; CsF &lt; MgF$_2$ &lt; AlN &lt; diamond</td>
<td></td>
</tr>
<tr>
<td>(E) He &lt; CH$_3$OCH$_3$ &lt; CH$_3$CH$_2$OH &lt; AlN &lt; LiF &lt; CsF &lt; MgF$_2$ &lt; diamond</td>
<td></td>
</tr>
</tbody>
</table>

**Inert Gases**

He

**Polar Molecules**

CH$_3$OCH$_3$

**Molecules with hydrogen bonding**

CH$_3$CH$_2$OH

**Ionic Solids**

LiF

CsF

MgF$_2$

AlN

**Network**

Diamond

Cs$^+$ F$^-$

Both CsF and LiF are 1$^+$ and 1$^-$.
9. Which of the following has a hydrophilic end (polar, water-loving end) and a hydrophobic end (non-polar, water-fearing end) and has the ability to bridge water molecules to non-polar molecules?

(A) The polymer Teflon (-CF₂CF₂-)
(B) Graphite
(C) Ethane, CH₃CH₃
(D) Soap
(E) He

10. Which of the following cannot undergo free radical polymerization?

(A) C₂H₆
(B) C₂H₄
(C) C₂F₄
(D) C₂H₂

11. Which of the following molecules will not form hydrogen bonds?

(A)  
(B)  
(C)  
(D)  

No Hydrogen Bonding
12. The intermolecular forces that are most significant in accounting for the high boiling point of liquid water relative to other substances of similar molecular weight is/are the:

(A) Dispersion forces
(B) Dipole-dipole interactions
(C) **Hydrogen bonding**
(D) Network covalent forces
(E) Ionic charges

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13. Which has a higher melting point, sodium fluoride or aluminum fluoride? Why?

(A) sodium fluoride has a higher melting point because it has weaker dispersion forces than aluminum fluoride.

(B) sodium fluoride has a higher melting point because it has stronger dispersion forces than aluminum fluoride.

(C) aluminum fluoride has a higher melting point because it has stronger dispersion forces than sodium fluoride.

(D) aluminum fluoride has a higher melting point because it has a greater mass than sodium fluoride.

(E) **aluminum fluoride has a higher melting point because it has greater ionic charges than sodium fluoride.**
14. The equivalent number of atoms in the FCC unit cell is:

(A) 1  
(B) 2  
(C) 3  
(D) 4  
(E) 6

15. The structure below [from a Course Worksheet] represents:

(A) An SC unit cell  
(B) A BCC unit cell  
(C) A FCC unit cell  
(D) A cell phone  
(E) A prokaryotic cell

16. The cubic form for the fictitious element Nathanium (named for a CH 122 TA) is FCC. The atomic radius is 132.0 pm and the molar mass is 267.4 g/mol. The density of Nathanium is:

\[ \text{[1 m} = 1 \times 10^{12} \text{ pm} \quad 1 \text{ m} = 100 \text{ cm]} \]

(A) 34.2 g/cm³  
(B) 136.8 g/cm³  
(C) 8.55 g/cm³  
(D) 49.4 g/cm³  
(E) 2.03 g/cm³

\[ \text{Density} = \frac{\text{Mass}}{\text{Volume}} \]

\[ \text{Volume} = \frac{\text{Mass}}{\text{Density}} \]

\[ \text{Volume} = \frac{267.4 \text{ g/mol}}{132 \text{ pm} \times 10^{12} \text{ pm}} = 20.0 \times 10^{-23} \text{ cm}^3 \]

\[ \text{Density} = \frac{1.776 \times 10^{-21} \text{ g}}{5.20 \times 10^{-23} \text{ cm}^3} = 34.2 \text{ g/cm}^3 \]
17. The freezing point of 0.500 m aqueous AlCl₃ is:

\( \Delta T_f = \frac{1}{2} \text{m} \cdot \kappa_f = (4 \cdot 0.500 \text{m} \cdot 1.86 \frac{\text{C}}{\text{m}}) = 3.72 \text{C} \)

\[ T_f = 0 \text{C} - 3.72 \text{C} = -3.72 \text{C} \]

(A) \(-2.79 \text{C}\)
(B) \(+2.79 \text{C}\)
(C) \(+5.58 \text{C}\)
(D) \(-5.58 \text{C}\)
(E) \(-3.72 \text{C}\)

18. Which of the following sets of compounds are expected to be soluble in water?

(A) \( \text{CH}_4, \text{CO}_2, \text{CH}_3X \)
(B) \( \text{NaCl}, \text{CH}_4, \text{CH}_3\text{OCH}_3 \)
(C) \( \text{NaCl}, \text{CH}_3\text{CH}_2\text{OH}, \text{NH}_3 \)
(D) \( \text{NaCl}, \text{CH}_4, \text{C}_6\text{H}_{10} \)

\underline{polar and ionic}
19. A student dissolves 12.000 g of an unknown polymer in 800 mL of water at 320 K. She measures the osmotic pressure to be 0.0677 mm Hg. What is the molar mass of the polymer?

\[ n = \frac{\pi V}{RT} = \left( \frac{0.0677 \text{ mm Hg}}{760 \text{ mm Hg}/\text{atm}} \right) \left( 0.800 \text{ L} \right) \]
\[ n = \frac{\pi V}{RT} = \left( \frac{0.08216 \text{ L} \cdot \text{atm}/\text{mol} \cdot \text{K}}{320 \text{ K}} \right) \]

\[ n = 2.71 \times 10^{-6} \text{ mol} \]

Molar Mass \[ \text{g/mol} = \frac{12.000 \text{ g}}{2.71 \times 10^{-6} \text{ mol}} = 4.42 \times 10^6 \text{ g/mol} \]

(A) 2.71 x 10^6 g/mol
(B) 4.42 x 10^6 g/mol
(C) 1.73 x 10^6 g/mol
(D) 1.73 x 10^6 g/mol
(E) 2.26 x 10^6 g/mol

20. Generally, which of the following generally does not increase the reaction rate?

(A) Increase the temperature True
(B) Add a catalyst True
(C) Increase the activation energy False
(D) Increase the reactant concentrations True

\[ k = \frac{E_a}{RT} \]

Decreasing \( E_a \) (with a catalyst) will increase the rate.
21. The half-life is:
(A) The amount of time required for half the sample to decay
(B) 0.500 years
(C) The amount of time required for the entire sample to decay
(D) 42 years
(E) \[ \frac{A}{A_0} \]

22. A student obtains a 100.0 gram sample of $^{131}$I ($t_{1/2} = 8.00$ days). How many grams of $^{131}$I will remain after 16.00 days?

(A) 8.0 grams
(B) 16.0 grams
(C) 25.0 grams
(D) 50.0 grams
(E) 75.0 grams

23. A student obtains a 100.0 gram sample of $^{131}$I ($t_{1/2} = 8.00$ days). How long will it take so that only 10.0 grams of $^{131}$I remain?

(A) 8.2 days
(B) 16.4 days
(C) 25.0 days
(D) 26.6 days
(E) 50.0 days

- **Calc k**
  \[ \ln \left( \frac{1}{2} \right) = -kt_{1/2} \]
  \[ k = 0.0866 \frac{1}{d} \]

- **Calc t**
  \[ \ln \left( \frac{A}{A_0} \right) = -kt \]
  \[ \ln \left[ \frac{10.0}{100.0} \right] = -(0.0866 \frac{1}{d})t \]
  \[ t = 26.6 \text{ d} \]
24. The following are initial rate data for: \( A + B \rightarrow C \)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Initial [A]</th>
<th>Initial [B]</th>
<th>Initial Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10</td>
<td>0.10</td>
<td>5.1</td>
</tr>
<tr>
<td>2</td>
<td>0.20</td>
<td>0.10</td>
<td>5.1</td>
</tr>
<tr>
<td>3</td>
<td>0.10</td>
<td>0.20</td>
<td>20.4</td>
</tr>
</tbody>
</table>

(A) The rate law is \( \text{Rate} = k[A]^1[B]^2 \).
(B) The rate law is \( \text{Rate} = k[A]^4[B]^2 \).
(C) The rate law is \( \text{Rate} = k[A]^5[B]^1 \).
(D) The rate law is \( \text{Rate} = k[A]^2[B]^1 \).
(E) The rate law is \( \text{Rate} = k[A]^1[B]^4 \).

25. The Chemistry 122 final exam is Monday, March 17, 2008 at 4:00pm; yes, this is better than early in the morning. After the chemistry final I will be...

(A) Watching the C-SPAN baseball steroid hearings
(B) Making a poster for my dorm room wall that has the daily countdown to the new Indiana Jones movie (In theaters May 22)
(C) Two words: Tom and Gisele
(D) Preparing for my other seven final exams
(E) Re-watching The Oscars

[Any response will receive full credit; even no response]