1. The table below shows the normal boiling point of four compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Normal Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF(ℓ)</td>
<td>19.4</td>
</tr>
<tr>
<td>CH₃Cl(ℓ)</td>
<td>-24.2</td>
</tr>
<tr>
<td>CH₃F(ℓ)</td>
<td>-78.6</td>
</tr>
<tr>
<td>HCl(ℓ)</td>
<td>-83.7</td>
</tr>
</tbody>
</table>

Which compound has the strongest intermolecular forces?

1) HF(ℓ)  2) CH₃Cl(ℓ)  3) CH₃F(ℓ)  4) HCl(ℓ)

2. Argon has a higher boiling point than neon because argon has

1) fewer electrons in its 2nd principal energy level
2) more electrons in its outermost principal energy level
3) weaker intermolecular forces of attraction
4) **stronger intermolecular forces of attraction**

3. Which statement explains why Br₂ is a liquid at STP and I₂ is a solid at STP?

1) Molecules of Br₂ are polar, and molecules of I₂ are nonpolar.
2) Molecules of I₂ are polar, and molecules of Br₂ are nonpolar.
3) Molecules of Br₂ have stronger intermolecular forces than molecules of I₂.
4) **Molecules of I₂ have stronger intermolecular forces than molecules of Br₂.**

4. At 25°C, F₂ is a gas but I₂ is a solid. This is most likely due to the fact that

1) F₂ is a dipole but I₂ is not
2) I₂ is a dipole but F₂ is not
3) F₂ molecules have stronger intermolecular attractions
4) **I₂ molecules have stronger intermolecular attractions**

5. The **strongest** attractions exist between molecules of...? (Hint: The mass of these elements is presented on the Periodic Table)

1) I₂  2) Br₂  3) Cl₂  4) F₂

6. Which diagram best illustrates the hydration of sodium ions in an aqueous solution? [The diagrams are not drawn to scale.]

1) 2) 3) 4)
7. Which diagram best illustrates the ion-molecule attractions that occur when the ions of NaCl(s) are added to water?

1)  

2)  

3)  

4)  

8. In which system do molecule-ion attractions exist?

1) KCl(s)  

2) KCl(aq)  

3) KCl(ℓ)  

4) KCl(g)  

9. What happens when NaCl(s) is dissolved in water?

1) Cl⁻ ions are attracted to the oxygen atoms of water molecules.  

2) **Na⁺ ions are attracted to the oxygen atoms of water molecules.**  

3) Cl⁻ ions are repelled by the hydrogen atoms of water molecules.  

4) Na⁺ ions are repelled by the oxygen atoms of water molecules.  

10. When calcium chloride is dissolved in water, to which end of the adjacent water molecules will a calcium ion be attracted?

1) **the oxygen end, which is the negative pole**  

2) the oxygen end, which is the positive pole  

3) the hydrogen end, which is the negative pole  

4) the hydrogen end, which is the positive pole  

11. Hydrogen bonding is a type of

1) strong covalent bond  

2) weak ionic bond  

3) **strong intermolecular force**  

4) weak intermolecular force  

12. The relatively high boiling point of water is due to water having

1) **hydrogen bonding**  

2) metallic bonding  

3) nonpolar covalent bonding  

4) strong ionic bonding  

13. Based on intermolecular forces, which of these substances would have the highest boiling point?

1) He  

2) O₂  

3) CH₄  

4) NH₃  

14. In which system do molecule-ion attractions exist?

1) NaCl(aq)  

2) NaCl(s)  

3) C₆H₁₂O₆(aq)  

4) C₆H₁₂O₆(s)  

15. The diagrams below represent an ionic crystal being dissolved in water.

![Ionic Crystal and Water Molecule Diagrams]

According to the diagrams, the dissolving process takes place by

1) hydrogen bond formation  

2) network bond formation  

3) van der Waals attractions  

4) **molecule-ion attractions**
16. Which statement explains why \( \text{H}_2\text{O} \) has a higher boiling point than \( \text{N}_2 \)?

1) \( \text{H}_2\text{O} \) has greater molar mass than \( \text{N}_2 \).
2) \( \text{H}_2\text{O} \) has less molar mass than \( \text{N}_2 \).
3) **\( \text{H}_2\text{O} \) has stronger intermolecular forces than \( \text{N}_2 \).**
4) \( \text{H}_2\text{O} \) has weaker intermolecular forces than \( \text{N}_2 \).

17. Which electron dot formula does not represent a dipole molecule?

1) \[
\text{H} : \text{C} : \text{Cl} : \text{H}
\]
2) \[
\text{H} : \text{N} : \text{H}
\]
3) \[
\text{H} : \text{C} : \text{H} : \text{H}
\]
4) \[
\text{H} : \text{O} : \text{O}
\]

18. Which best describes the difference between a dipole and a nonpolar molecule?

1) Dipoles are symmetrical and nonpolar molecules are not.
2) **Dipoles are asymmetrical and nonpolar molecules are symmetrical.**
3) Both dipoles and nonpolar molecules are symmetrical.

19. Given the formula representing a molecule:

\[
\text{H} \equiv \text{C} \equiv \text{C} \equiv \text{H}
\]

The molecule is

1) symmetrical and polar
2) **symmetrical and nonpolar**
3) asymmetrical and polar
4) asymmetrical and nonpolar

20. Which formula represents a polar molecule?

1) \( \text{H}_2 \)
2) **\( \text{H}_2\text{O} \)**
3) \( \text{CO}_2 \)
4) \( \text{CCL}_4 \)

21. Which formula represents a nonpolar molecule?

1) \( \text{HCl} \)
2) \( \text{H}_2\text{O} \)
3) \( \text{NH}_3 \)
4) **\( \text{CH}_4 \)**

22. Why is a molecule of \( \text{CO}_2 \) nonpolar even though the bonds between the carbon atom and the oxygen atoms are polar?

1) **The shape of the \( \text{CO}_2 \) molecule is symmetrical.**
2) The shape of the \( \text{CO}_2 \) molecule is asymmetrical.
3) The \( \text{CO}_2 \) molecule has a deficiency of electrons.
4) The \( \text{CO}_2 \) molecule has an excess of electrons.

23. Which formula represents a nonpolar molecule?

1) **\( \text{CH}_4 \)**
2) \( \text{HCl} \)
3) \( \text{H}_2\text{O} \)
4) \( \text{NH}_3 \)

24. Which formula represents a polar molecule?

1) \( \text{Br}_2 \)
2) **\( \text{CO}_2 \)**
3) \( \text{CH}_4 \)
4) \( \text{NH}_3 \)

25. Molecules in a sample of \( \text{NH}_3(\ell) \) are held closely together by intermolecular forces

1) existing between ions
2) existing between electrons
3) caused by different numbers of neutrons
4) **caused by unequal charge distribution**
1. 
2. 4
3. 4
4. 4
5. 1
6. 2
7. 1
8. 2
9. 2
10. 1
11. 3
12. 1
13. 4
14. 1
15. 4
16. 3
17. 3
18. 2
19. 2
20. 2
21. 4
22. 1
23. 1
24. 4
25. 4