Lab 06: Intermolecular Forces - Procedure and Safety Notes

Materials

- Digital Thermometer
- Beakers
- Test Tubes (10 mL)
- Test Tube Rack
- Ring Stand and Clamp
- Filter Paper Strips
- Masking Tape
- Liquids: Methanol (CH_3OH), 1-Propanol ($CH_3(CH_2)_2OH$), 1-Butanol ($CH_3(CH_2)_3OH$), Hexane ($CH_3(CH_2)_4CH_3$), Acetone (CH_3COCH_3), Deionized Water (H_2O), Unknown Liquid

Procedure Outline

1. **Preparation**:
    - Draw Lewis structures for each liquid, indicating 3D structure with wedged and dashed bonds.
    - Identify the intermolecular forces (IMFs) each liquid exhibits, comparing similarities and differences.
2. **Predict Evaporation Rates**:
    - Rank compounds based on predicted evaporation rates, considering molecular size, dipole presence, and hydrogen bonding capability.
3. **Temperature Measurement**:
    - Add 3-5 mL of the first solvent to a test tube. Place it in a fume hood.

- Immerse thermometer until temperature stabilizes; record as initial temperature T_i.

4. **Evaporation Process**:
   - Remove the thermometer and clamp it on the stand. Begin timing evaporation as soon as it leaves the liquid.
   - Record the minimum temperature T_{min} and evaporation time t_{evap} when temperature begins rising.
   - Calculate temperature change $\Delta T = T_i - T_{\text{min}}$ and evaporation rate $\text{Rate}_{\text{evap}} = \frac{\Delta T}{t_{\text{evap}}}$.
5. **Increasing Evaporation Time** (if rates are too close to distinguish):
   - Wrap a filter paper strip around the thermometer tip to increase liquid contact and prolong evaporation.
6. **Repeat**:
   - Follow steps 3-5 for each liquid.
7. **Cleanup**:
   - Dispose of organic liquids in the designated waste container; dump water into the sink.
   - Return equipment to storage.

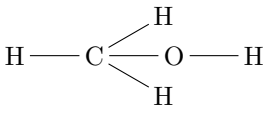
Safety Concerns and SDS Summary

- **Methanol ($\mathbf{CH_3OH}$)**: Highly flammable and toxic by inhalation, ingestion, and skin contact. Use in a fume hood with gloves and goggles.
- **1-Propanol ($\mathbf{CH_3(CH_2)_2OH}$)**: Flammable, irritant to eyes and skin, toxic if ingested. Requires gloves, goggles, and fume hood.
- **1-Butanol ($\mathbf{CH_3(CH_2)_3OH}$)**: Flammable, causes eye and skin irritation. Use standard protective equipment.
- **Hexane ($\mathbf{CH_3(CH_2)_4CH_3}$)**: Extremely flammable, may cause dizziness or drowsiness. Proper ventilation and protective gear required.
- **Acetone ($\mathbf{CH_3COCH_3}$)**: Highly flammable, irritant to eyes and respiratory system. Use with appropriate protective measures.
- **Deionized Water ($\mathbf{H_2O}$)**: Generally safe but should be disposed of properly after use.

Each compound should be handled minimally, kept closed when not in use, and worked with in the fume hood to avoid inhaling fumes.

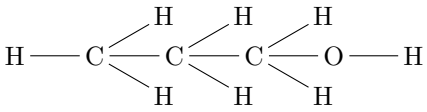
Lewis Structures and VSEPR Shapes

- **Methanol (CH_3OH)**



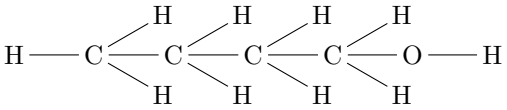
  - **VSEPR Shape**: Tetrahedral around carbon, bent around oxygen.

- **1-Propanol ($CH_3CH_2CH_2OH$)**



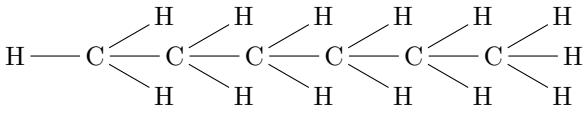
  - **VSEPR Shape**: Tetrahedral around each carbon, bent around oxygen.

- **1-Butanol ($CH_3CH_2CH_2CH_2OH$)**



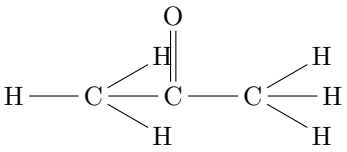
  - **VSEPR Shape**: Tetrahedral around each carbon, bent around oxygen.

- **Hexane ($CH_3(CH_2)_4CH_3$)**



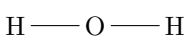
  - **VSEPR Shape**: Tetrahedral around each carbon.

- **Acetone (CH_3COCH_3)**



  - **VSEPR Shape**: Trigonal planar around C=O, tetrahedral around other carbons.

- **Water (H_2O)**



  - **VSEPR Shape**: Bent (due to two lone pairs on oxygen).