1) Draw the molecule and identify it as polar or non-polar:

a) CH$_3$OH

```
H
\(\text{\H\CH}_3\text{\H\O\H}\\
\text{\H\O\H}\text{\H\CH}_3
```

Polar – O atom has large EN, creates bond dipole and a molecular dipole.

b) CCl$_4$

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\text{\Cl\Cl\Cl\Cl}\\
\text{\Cl\Cl\Cl\Cl}
```

Non-polar – Cl atom has large EN, but bond dipoles cancel, no molecular dipole.

c) CHCl$_3$

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\text{\Cl\Cl\Cl\H}\\
\text{\Cl\Cl\Cl\H}
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Slightly Polar - Cl atom has large EN, but bond dipoles mostly cancel, small molecular dipole.

d) C$_2$H$_6$

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\text{\H\CH\CH\H}\\
\text{\H\CH\CH\H}
```

Non-polar – C & H have very small ΔEN, some cancellation, essentially no molecular dipole.

2) Will sugar (C$_6$H$_{12}$O$_6$) dissolve in gasoline (octane C$_8$H$_{18}$)? Why or why not? Will sugar (C$_6$H$_{12}$O$_6$) dissolve in water (H$_2$O)? Why or why not?

Sugar is a polar molecule due to all the oxygen atoms in the formula. The highly electronegative O atoms create an unequal distribution of electrons that results in partial atomic charges. Octane is a non-polar molecule. Both C & H have similar electronegativities resulting in a fairly equal distribution of charge and no permanent dipole. The weaker dipole-induced dipole forces between sugar and octane will not be able to overcome the stronger dipole-dipole forces between sugar molecules.

The polar sugar molecules will dissolve in a polar solvent such as water that has a large molecular dipole due to the large difference in EN between O & H and the structure of water that is such that bond dipoles do not cancel out. This is in accord with our rule of thumb that “like likes like”.

3) Arrange the following compounds in order of increasing polarity and explain your reasoning.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl₂</td>
<td>Rigorously covalent – ( \Delta \text{EN} = 0 ) as any two Cl atoms pull on e⁻'s equally. No dipole. Not Polar.</td>
</tr>
<tr>
<td>CCl₄</td>
<td>Non-polar. Bond dipoles cancel out in vector sum. No molecular dipole</td>
</tr>
<tr>
<td>CHCl₃</td>
<td>Weakly polar. Bond dipoles do not cancel out resulting in a small molecular dipole.</td>
</tr>
<tr>
<td>CsCl</td>
<td>Ionic, large ( \Delta \text{EN} ), Cs is found in column 1, Cl in column 7.</td>
</tr>
<tr>
<td>MgCl₂</td>
<td>Ionic, large ( \Delta \text{EN} ), Mg is found in column 2, Cl in column 7.</td>
</tr>
</tbody>
</table>

4) Molecule ‘A’ migrates on a chromatogram with a \( R_f = 0.8 \). Molecule ‘B’ migrates with an \( R_f \) of 0.4. If the masses of A and B are equal, what can you deduce about the relative attraction of A and B for the alumina and the solvent?

The molecule that travels farther with the solvent (greater \( R_f \) value) is more “like” the solvent and should have greater attraction to and miscibility with the solvent. There is less attraction to the stationary alumina surface relative to the attraction to the flowing solvent, as a result a greater distance is traveled.