From a 1992 Seinfeld episode entitled “The Pick” written by L. David and M. Jaffe:

GEORGE: It'll be different this time.

SUSAN: I need someone a little more stable.

GEORGE: I'm not stable? I'm like a rock. I take these glasses off, you can't tell the difference between me and a rock. I put these glasses on a rock. You know what jumps into most people's minds? Costanza!

SUSAN: People don't change.

GEORGE: I change I change. Two weeks ago I tried a soft boiled egg. Never liked it before. Now I'm dunkin a piece of toast in there and I'm loving it.

SUSAN: I'm not a soft boiled egg.

GEORGE: And I am not a piece of toast.
1. Which product (or products) would you expect to obtain from each of the following reactions? In each part specify the mechanism (SN1, SN2, E1 or E2) by which the product is formed and predict the relative amount of each product (i.e., would the product be the only product, the major product, a minor product, etc.?)  20 pts

\[
\begin{align*}
\text{t-Bu} & \quad \text{Cl} \quad \text{NaI} \quad \text{acetone, 50 °C} \\
\end{align*}
\]

Write the chemical structure(s) in the space provided and under each specify "major/minor" and "SN1, SN2, E1, or E2"

\[
\begin{align*}
\text{MeOH} & \quad \text{25 °C} \\
\end{align*}
\]

\[
\begin{align*}
\text{CH}_3\text{ONa} & \quad \text{CH}_3\text{OH, 50 °C} \\
\end{align*}
\]

\[
\begin{align*}
\text{EtOH} & \quad \text{50 °C} \\
\end{align*}
\]

2. When the deuterium-labeled compound shown at right is subjected to dehydrohalogenation using sodium ethoxide in ethanol, the only alkene product is 3-methylcyclohexene (the product contains no deuterium). Use a 3D chair transition state representation to explain this result.  6 pts

3. Compounds I and J both have molecular formula C\textsubscript{7}H\textsubscript{14}. Compounds I and J are both optically active and both rotate plane-polarized light in the same direction. On catalytic hydrogenation I and J yield the same compound K (C\textsubscript{7}H\textsubscript{16}). Compound K is optically active. Propose possible structures for I, J, and K.  6 pts

4. (S)-(3-Chloro-2-methylpropyl) methyl ether (A) on reaction with azide ion (N\textsubscript{3}⁻) in aqueous ethanol gives (R)-(3-azido-2-methylpropyl) methyl ether (B). Compound A has the structure CICH\textsubscript{2}CH(CH\textsubscript{3})CH\textsubscript{2}OCH\textsubscript{3}. (a) Draw wedge-dashed wedge-line formulas of A and B. (b) Is there a change in configuration during this reaction? Explain.  6 pts
5. Assuming the following reactions take place by $S_N2$ displacement, choose the faster reaction of each pair and explain your reasoning in six words or less. 12 pts

reaction of cyanide ion with $n$-iodoheptane or 1-chloroheptane in ethanol

reaction of ethanol or sodium ethoxide with 1-bromobutane

reaction of azide ion with $t$-butyl tosylate or sec-butyl tosylate

reaction of chloride ion with ethyl bromide in methanol or acetone

6. Propose a synthesis of cyclopentane from cyclopentanol. You may use any other needed reagents and you DO NOT need to show any mechanistic detail. 6 pts

7. Propose a synthesis of $\text{tert}$-butyl methyl ether using starting materials containing 4 or few carbon atoms. You may use any other needed reagents and you DO NOT need to show any mechanistic detail. 6 pts

8. Which alkene would liberate the most heat when subject to catalytic hydrogenation? Why? 6 pts

9. Going back to question 8, why do alkenes liberate heat when hydrogenated? A few words and a few structures will suffice. 6 pts

10. Assign $E$/Z descriptors to the following molecules (you need not name the entire structure). 6 pts
11. When alkyl halides are treated with aqueous silver nitrate, silver halide precipitates and an alcohol is formed. The silver ion is a Lewis acid with exceptional affinity for halide ions. With this information in hand, propose a step-by-step mechanism to account for the following transformation. As the reaction proceeds, would the pH of the solution decrease / stay the same / increase? 10 pts

![Mechanism Diagram]

12. A recent paper in the Journal of the American Chemical Society reported the following data for 1,4,7-trimethyloxatriquinane 1:

![Diagram]

One of these reactions is mechanistically well-behaved, from the standpoint of Table 6.7. Which is it, and explain with an arrow-pushing mechanism using a truncated structure: 5 pts

One of these reactions is mechanistically surprising, from the standpoint of Table 6.7. Which is it, and what aspect of the data is causing you to classify it as 'surprising.' Explain your reasoning with an arrow-pushing mechanism using a truncated structure. Suggest an additional experiment to lend further support for the mechanistic nature of this surprising transformation. 5 pts
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