EXAM 2
CHEMISTRY 220a
Friday, October 18, 2002

NAME (print): _____

TA:_____ Day:_____ Time:_____

Take a few moments to look over the exam. Answer each question on the exam paper.

Important clues, points, and structures are in **bold**.

 Do all **preliminary** drawing or computations on the work sheets at the end of the exam. The work sheets will not be graded

There is a Periodic Table on page 10 and a Bond Dissociation Energy Table on page 11.

The exam is 55 minutes.

STOP writing and hand in your exam when you are asked to do so.

REMEMBER: Neatness is to your advantage.

1. (34 pts)   _____

2. (16 pts)   _____

3. (25 pts)   _____

4. (25 pts)   _____

_____
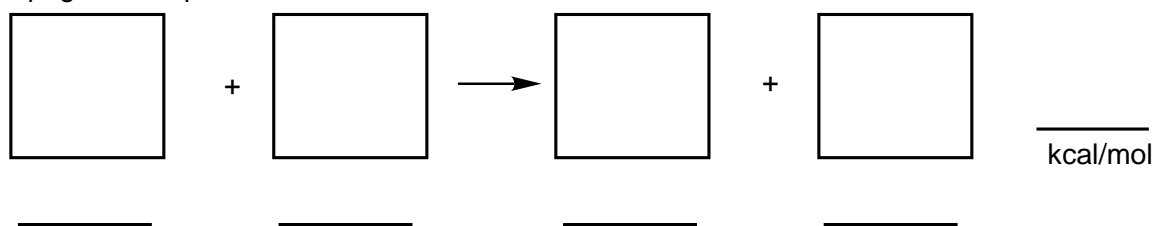
Total (100 pts)

1. Radical Chain Reactions (40 pts. total)

a) (10 pts) Provide the propagation steps and overall reaction for the **major monochlorination product** in the free radical chlorination of isobutane (2-methylpropane). Place the alkane in the first box on the left. Place the other reactants and products in the remaining boxes with their BDEs on the appropriate lines. (relative rates: $k(1°) = 1$; $k(2°) = 4.5$; $k(3°) = 5.5$)

Propagation step 1
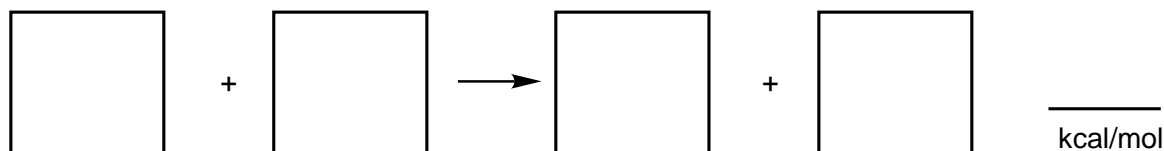
☐ + ☐ → ☐ + ☐   _____
                                    kcal/mol

_____   _____   _____   _____
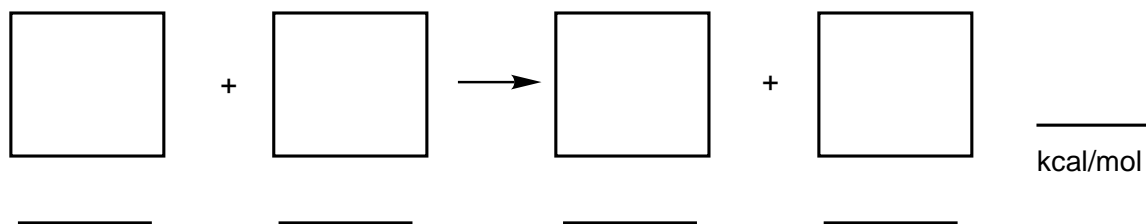
Propagation step 2

☐ + ☐ → ☐ + ☐   _____
                                    kcal/mol

_____   _____   _____   _____

Overall reaction

☐ + ☐ → ☐ + ☐   _____
   kcal/mol

b) (6 pts.) Calculate the heat of reaction for each propagation step and for the overall reaction. Place your answers over 'kcal/mol' above.

c) (8 pts.) Calculate the heat of formation ($\Delta H_f°$) for the alkyl halide given the following data: $\Delta H_f°$ (kcal/mol): n-butane, -30; isobutane, -32; HCl, -22; HBr, -9. Show work.

d) (10 pts.) Provide an energy profile of the reaction that does justice to the Hammond Postulate. Locate the heat liberated in each propagation step and in the overall reaction.

Energy

Reaction Coordinate ⟶

2. (16 pts.) The terpene carvone exists in nature as the separate enantiomers **A** and **B**. (R)-(-)-carvone smells like spearmint while (S)-(+)-carvone has the fragrance of caraway (dill) seeds.
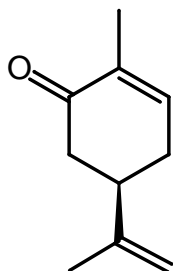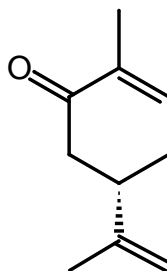
A   B

a) (5 pts.) Place the correct Cahn-Ingold-Prelog (CIP) configuration at the chiral center in A and B above.

b) (11 pts.) The optical rotation ($[\alpha]_D$) of pure laevorotatory carvone is 62.5°. A student needs 5.0 mL of this enantiomer for an experiment. S/he only has 4.5 mL so s/he unwittingly makes up the difference in volume with the other enantiomer. What is the optical rotation of the final mixture? Show work.

3.   (25 pts, equal weight) Potpourri: **Circle** the best answer(s) in a-e.

a) The difference in the heat of formation of two isomers is equal to their difference in

heat of combustion   heat of vaporization   bond dissociation energy
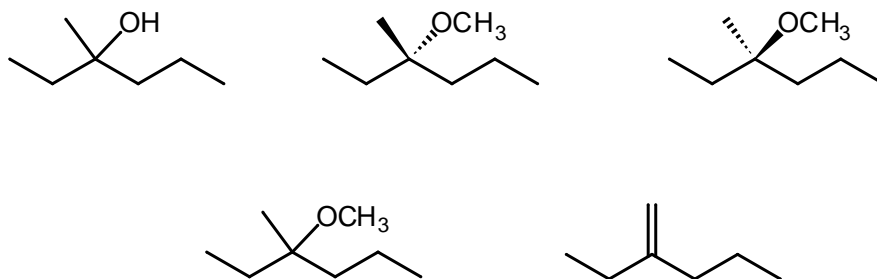
enthalpy   strain energy

b) "One of these things is not like the other. One of these things doesn't belong."
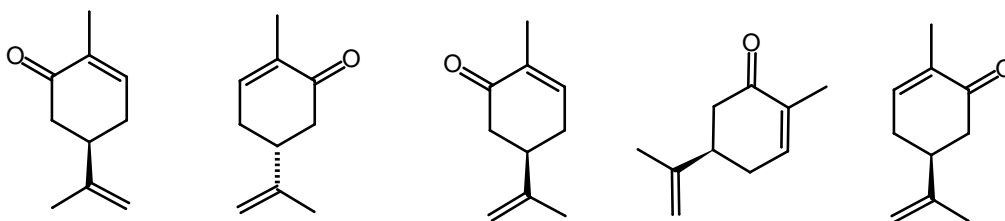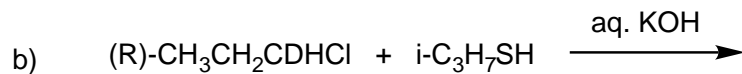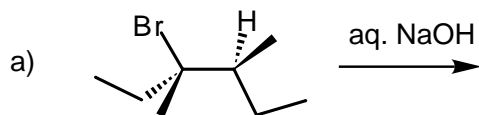

c) Terms associated with an E2 elimination

k[RX]   intermediate   deuterium isotope effect

inversion of stereochemistry   stereospecific

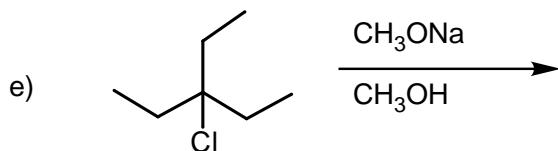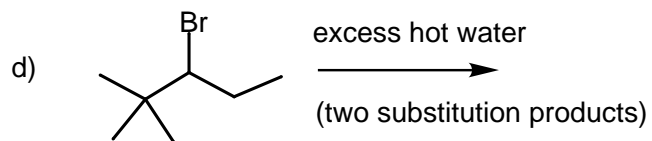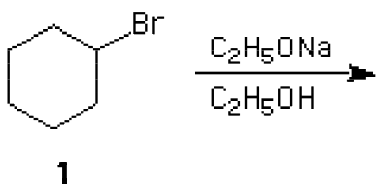d) The product of solvolysis of (S)-3-bromo-3-methylhexane in excess methanol

e) Draw a Fischer projection of (R,R)-tartaric acid [HO$_2$CCH(OH)CH(OH)CO$_2$H]

4. (25 pts.) Provide the expected products in each of the following reactions. Give a **very brief** rationale. **Pay attention to stereochemistry**.

a)

aq. NaOH
→

b) (R)-CH_3CH_2CDHCl + i-C_3H_7SH $\xrightarrow{\text{aq. KOH}}$

c) [ORGO, alkyl halides, #2]

$\xrightarrow[C_2H_5OH]{C_2H_5ONa}$

1

d)

excess hot water
→

(two substitution products)

e)

$\xrightarrow[CH_3OH]{CH_3ONa}$

Work Sheets

Work Sheets

Work Sheets

Periodic Table

BDE Table