

(MM: 56.1 g/mol)

1. A solution was prepared by dissolving 2.38 g of KOH in sufficient water to fill a 500.0 mL volumetric flask to the mark. A 20.00 mL sample of this solution was pipetted into an Erlenmeyer flask and titrated using a 0.118 M H₂SO₄ solution. What volume of this H₂SO₄ solution would be required to reach the end point of titration? (4)

$$M \text{ of initial KOH solu: } 2.38 \text{ g KOH} \times \frac{1 \text{ mol}}{56.1 \text{ g}} \times \frac{1}{0.5000 \text{ L}} = 0.0848 \text{ M}$$



$$\text{mol KOH} = 0.0848 \text{ M} \times 0.02000 \text{ L} = 0.001697 \text{ mol}$$

$$\text{mol H}_2\text{SO}_4 = 0.001697 \text{ mol KOH} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol KOH}} = 0.000848 \text{ mol}$$

$$V_{\text{H}_2\text{SO}_4} = \frac{0.000848 \text{ mol}}{0.118 \text{ M}} = 0.00719 \text{ L} = 7.19 \text{ mL}$$

2. To determine the formula of an unknown compound containing C, H and O, combustion analysis was performed. 2.115 g of sample was burned in excess oxygen and 3.100 g of CO₂ (MM = 44.0 g/mol) and 1.269 g of H₂O (MM = 18.0 g/mol) were collected. Determine the empirical formula of the compound. (6)

$$\text{mass of C: } 3.100 \text{ g CO}_2 \times \frac{C}{\text{CO}_2} = 3.100 \text{ g} \times \frac{12}{44} = 0.8455 \text{ g}$$

$$\text{mass of H: } 1.269 \text{ g H}_2\text{O} \times \frac{2\text{H}}{\text{H}_2\text{O}} = 1.269 \text{ g} \times \frac{2}{18} = 0.141 \text{ g}$$

$$\text{mass of O: } 2.115 \text{ g} - 0.8455 - 0.141 = 1.1285 \text{ g}$$

$$\text{mol of C: } 0.8455 \text{ g} \times \frac{1 \text{ mol C}}{12 \text{ g}} = 0.0705 \text{ mol}$$

$$\text{mol of H: } 0.141 \text{ g} \times \frac{1 \text{ mol H}}{1 \text{ g}} = 0.141 \text{ mol}$$

$$\text{mol of O: } 1.1285 \text{ g} \times \frac{1 \text{ mol O}}{16 \text{ g}} = 0.0705 \text{ mol}$$

$$\text{C} \frac{0.0705}{0.0705} \text{ H} \frac{0.141}{0.0705} \text{ O} \frac{0.0705}{0.0705} : \text{CH}_2\text{O is the EF.}$$

3. Hydrogen sulfide, H_2S (g), can be prepared by the following reaction:



In a reaction 6.45 g of $\text{Al}_2\text{S}_3(\text{s})$ (MM: 150.2 g/mol) was reacted with 2.70 g of $\text{H}_2\text{O}(\text{l})$ (MM: 18.0 g/mol), determine the following:

(a) Which one is the limiting reagent? How many grams of the other reagent will be left over after the completion of the reaction? (6)

$$\text{Al}_2\text{S}_3 : 6.45\text{g} \times \frac{1\text{mol}}{150.2\text{g}} \times \frac{3\text{mol H}_2\text{S}}{1\text{mol Al}_2\text{S}_3} = 0.129\text{mol H}_2\text{S}$$

$$\text{H}_2\text{O} : 2.70\text{g} \times \frac{1\text{mol}}{18.0\text{g}} \times \frac{3\text{mol H}_2\text{S}}{6\text{mol H}_2\text{O}} = 0.075\text{mol H}_2\text{S less,}$$

So, H_2O is the L.R.

$$\begin{aligned} \text{Al}_2\text{S}_3 \text{ left} &= \text{Al}_2\text{S}_3 \text{ total} - \text{Al}_2\text{S}_3 \text{ used} \\ &= 6.45\text{g} - 2.70\text{g H}_2\text{O} \times \frac{1\text{mol}}{18.0\text{g}} \times \frac{1\text{mol Al}_2\text{S}_3}{6\text{mol H}_2\text{O}} \times \frac{150.2\text{g}}{1\text{mol Al}_2\text{S}_3} \\ &= 6.45 - 3.755 \\ &= 2.695\text{g Al}_2\text{S}_3 \text{ left.} \end{aligned}$$

(b) Determine the theoretical yield of $\text{H}_2\text{S}(\text{g})$ (MM: 34.1 g/mol) expected from this reaction in grams. (2)

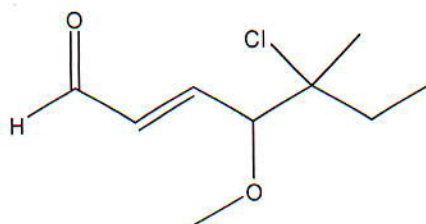
$$0.075\text{mol H}_2\text{S} \times \frac{34.1\text{g}}{1\text{mol}} = 2.56\text{g}$$

(c) Under 25 °C, 1.08 atm, how many liters of H_2S (g) will be produced if the percent yield of the reaction is 79.5%. (4)

$$\text{actual yield of H}_2\text{S} = 2.56\text{g} \times 79.5\% = 2.03\text{g}$$

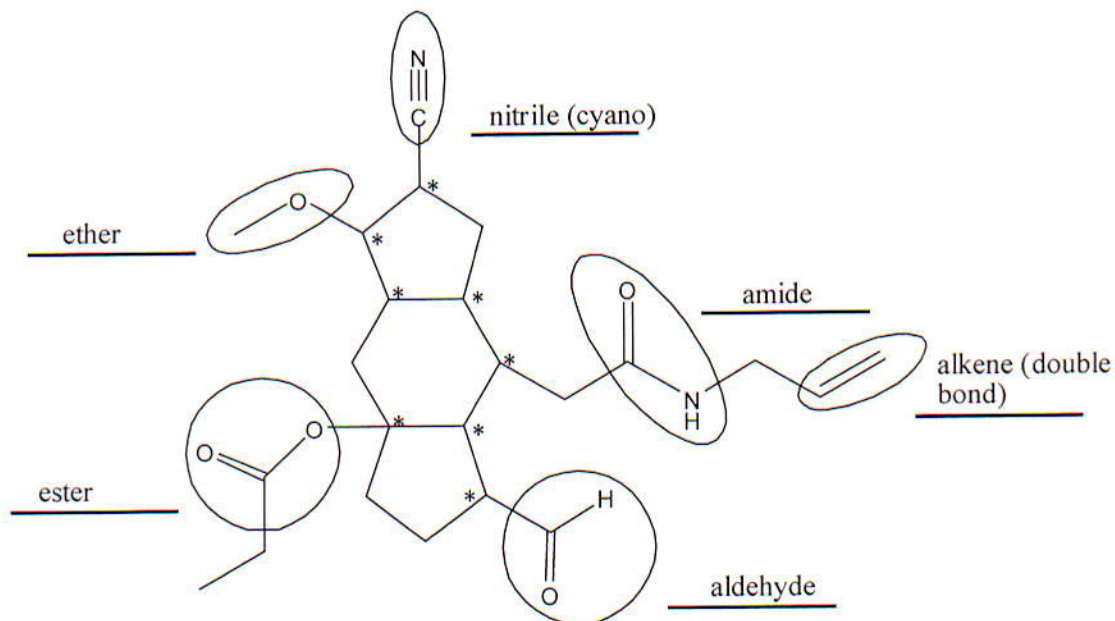
$$\begin{aligned} P \cdot V &= n \cdot R \cdot T & T &= 25^\circ\text{C} + 273.15 = 298.15\text{K} \\ V &= \frac{n \cdot R \cdot T}{P} = \frac{2.03\text{g} \times \frac{1\text{mol H}_2\text{S}}{34.1\text{g}} \times 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \times 298.15\text{K}}{1.08\text{atm}} \\ &= 1.35\text{L} \end{aligned}$$

4. Answer the following questions based on the compound given: (7)

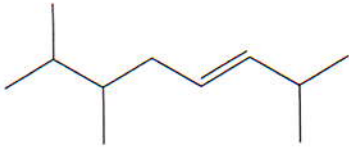
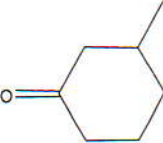


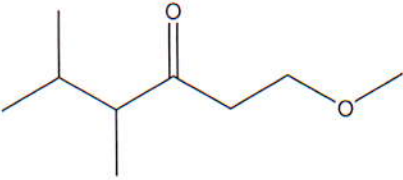
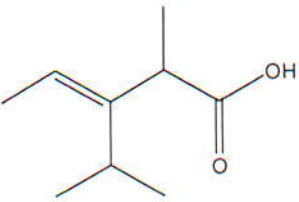


- a) The compound contains 2 chiral carbons.
- b) The double bond can be labeled as *cis* **trans** (circle one).
- c) The chloride is 1° 2° **3°** 4° (circle one).
- d) The compound would give **positive** **negative** (circle one) result when reacts with Na.
- e) The compound would give **positive** **negative** (circle one) result when reacts with Br_2 .
- f) 1 mol of this compound would require 2 mole(s) of $\text{H}_2(\text{g})$ for complete reduction.

5. Name the functional group circled in the structure below and label each chiral carbon with “*”. (8)

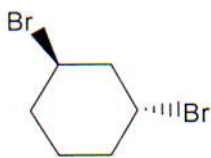


6. Name the following compounds: (12)

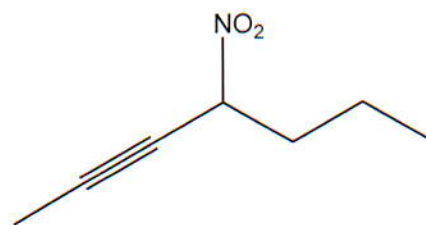
- a) 
2,6,7-trimethyl-3-octene
- b) 
3-methylcyclohexanone
- c) 
3-methyl-4-cyclopropylbutanal
- d) 
4-tert-butylphenol
- e) 
1-methoxy-4,5-dimethyl-3-hexanone
- f) 
2-methyl-3-isopropyl-3-pentenoic acid

7. Draw the structure based on each of the following name: (12)

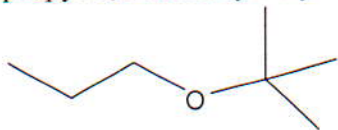
a) *trans*-1,3-dibromocyclohexane



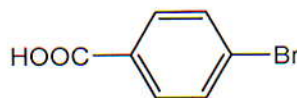
b) 4-nitro-2-heptyne



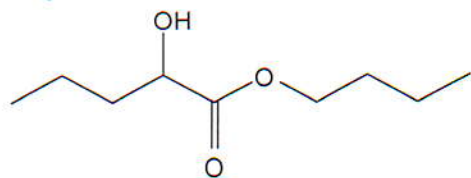
c) propyl 1,1-dimethylethyl ether



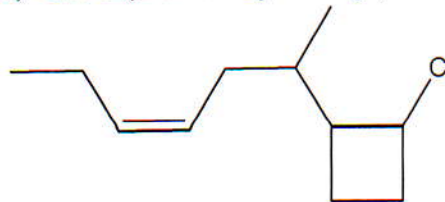
d) *p*-bromobenzoic acid



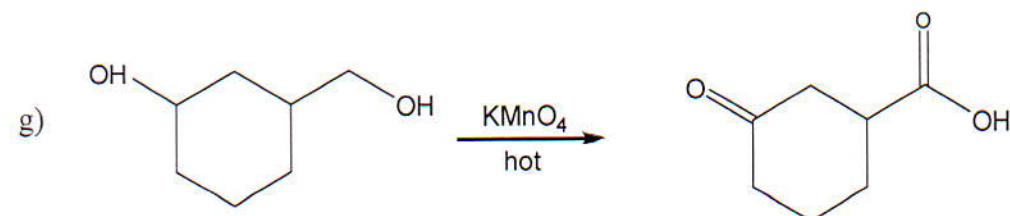
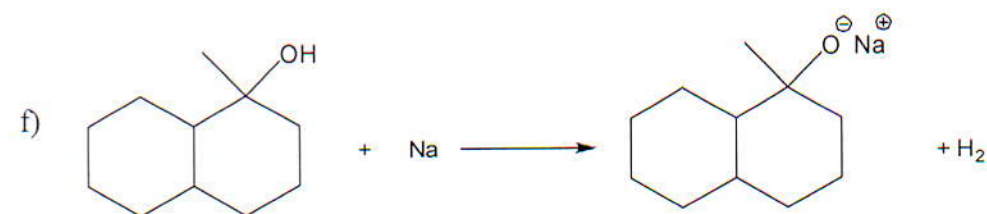
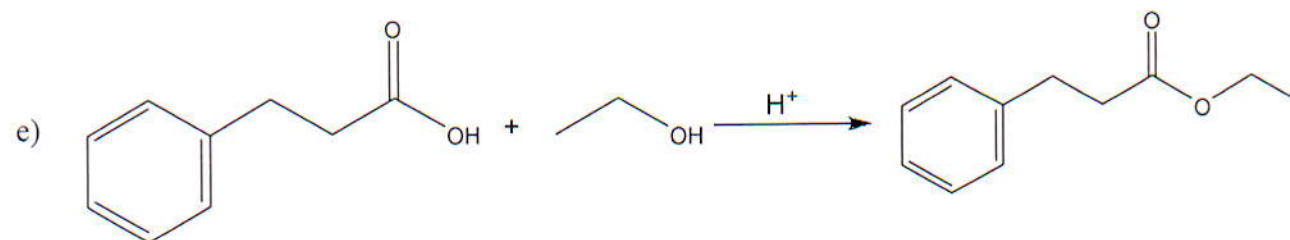
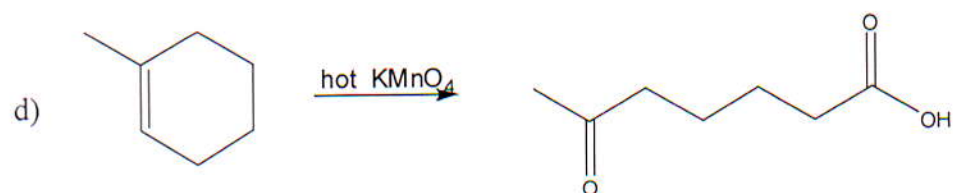
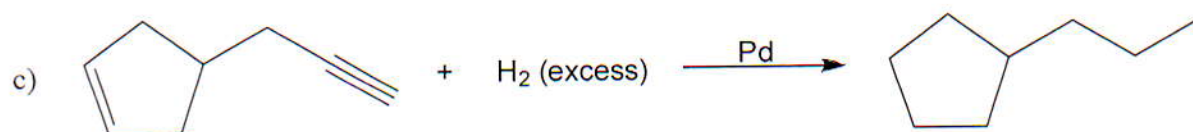
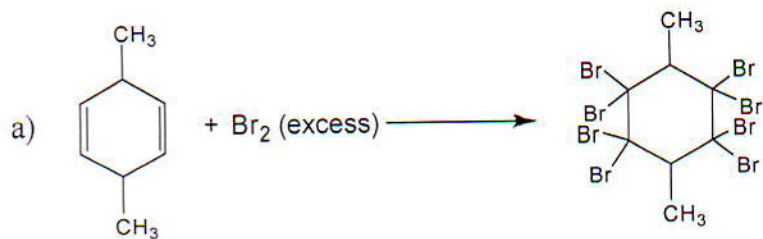
e) 2-hydroxy butyl pentanoate

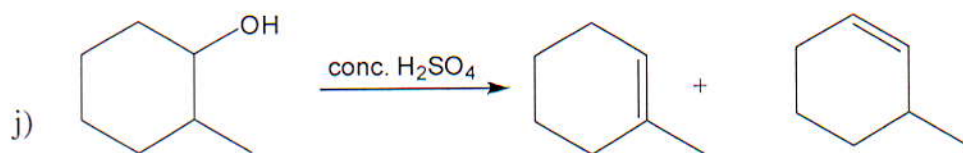
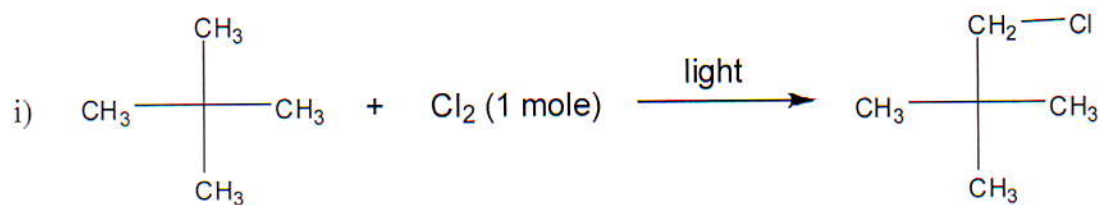
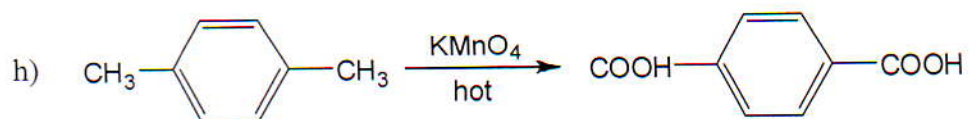


f) *cis*-6-(2-chlorocyclobutyl)-3-heptene



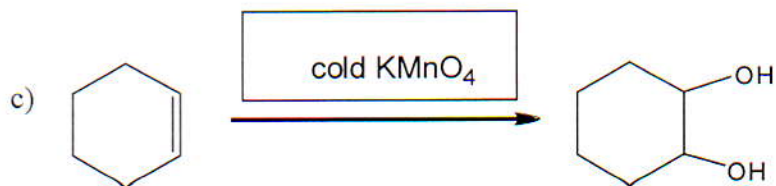
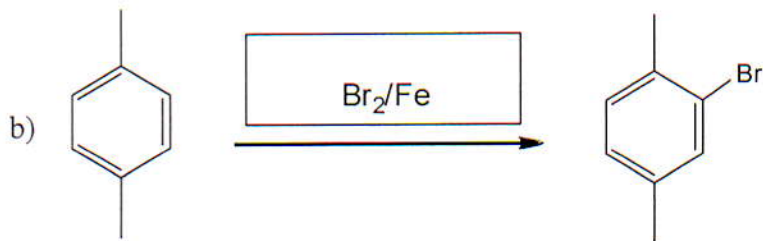
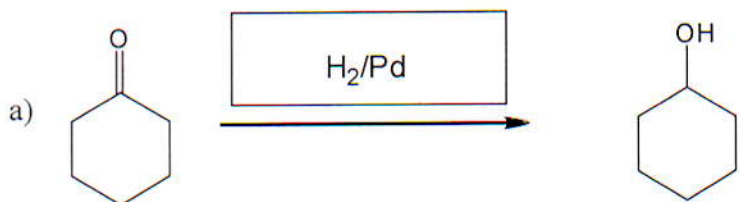
8. Complete the following reaction by providing the structure of the major organic product(s). (20)





Hint: two major products

9. Provide the reagent(s) and condition that are necessary for the following reaction. (3)

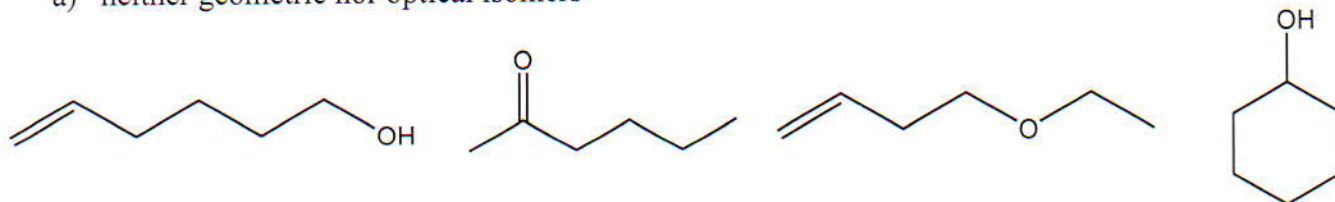


10 Draw a structural formula for organic compound of molecular formula $C_6H_{12}O$ that meet the following requirements respectively: (7)

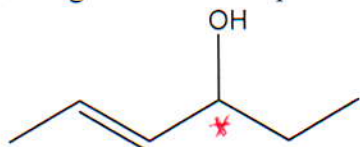
Hint: the degree of unsaturation= 1

There maybe more than one correct answers for each part.

a) neither geometric nor optical isomers



b) both geometric and optical isomers



c) optical isomers but not geometric isomers



11. Compound **A**, **B** and **C** all has the same molecular formula C_5H_8O , and they all contain a 4-membered ring in the structure. Propose one reasonable structure for **A**, **B** and **C** respectively based on their reactivity show below. (5)

Hint: the degree of unsaturation= 2

There maybe more than one correct answers for A and C.

