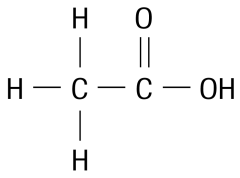
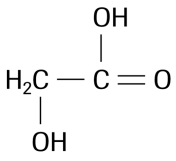
5. Student examples will vary.

Front:

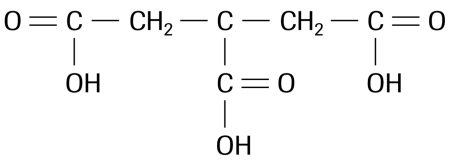
Family name and general formula	Examples		
	IUPAC name	Common name	Structural formula
Carboxylic acids R–COOH	ethanoic acid	acetic acid (vinegar)	

Back:

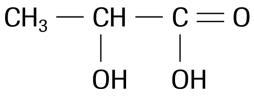
Family	Characteristic properties	Characteristic functional groups	Intermolecular forces
Carboxylic acids	soluble in water, turn litmus pink, react with alcohols to form esters	carboxyl group –COOH	hydrogen bonds, van der Waals forces

6. 

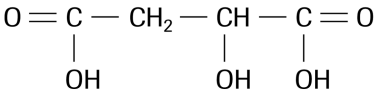
glycolic acid



citric acid



lactic acid



malic acid

Applying Inquiry Skills

7. Melting and boiling points: The ketone is more likely a liquid at room temperature, while the carboxylic acid is more likely a solid. The carboxyl group in the acid is polar and also can hydrogen bond, while the ketone does not contain the hydroxyl group.
   Litmus and pH test: Carboxylic acids turn litmus red, an acidic pH.

3.12 INVESTIGATION: PROPERTIES OF CARBOXYLIC ACIDS

(Pages 221–222)

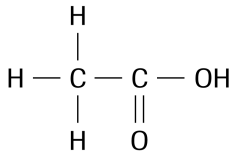
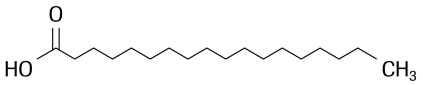
Prediction

a) [Sample answer] Stearic acid has a much longer hydrocarbon chain than does acetic acid. Thus, stearic acid is more nonpolar than acetic acid and will be less soluble in a polar solvent such as water, and more soluble in a nonpolar solvent such as vegetable oil. Stearic acid will also have a higher melting point because its long hydrocarbon chain allows intermolecular forces of attraction (van der Waals forces). Acetic acid will react readily with the basic solution, but stearic acid will react less readily because it is less soluble in the aqueous solution of the base.

Observations

(b) to (e)

Table 1 Properties of Carboxylic Acids

Property	Acetic acid	Stearic acid
structural formula	 ethanoic acid	 stearic acid
molar mass	60.05 g/mol	284.50 g/mol
melting point	16.7ºC	69ºC
boiling point	118ºC	383ºC
solubility in water	soluble in water	low solubility in water
solubility in vegetable oil	low solubility in vegetable oil	soluble in vegetable oil
reaction with base	reacts with base	does not readily react with base

Analysis

(f) Both acids contain the polar carboxyl group. In addition, stearic acid has a long hydrocarbon group with stronger van der Waals attractions than in the shorter ethanoic acid. For this reason, stearic acid has a higher melting point and boiling point than ethanoic acid.

(g) Acetic acid is more soluble in water than is stearic acid, and less soluble in oil. Stearic acid, with its long hydrocarbon component, has a longer nonpolar component and is thus more soluble in the nonpolar oil.

(h) Acetic acid reacts with sodium hydrogen carbonate, as acids do. Stearic acid is not soluble in water and does not show a reaction with aqueous sodium hydrogen carbonate.

Evaluation

(i) [Sample answer] Yes, the Procedure allowed the collection of appropriate evidence regarding all aspects of this investigation, except for the reaction with sodium hydrogen carbonate. Since stearic acid was not highly soluble in water, it is inconclusive whether it reacts with sodium hydrogen carbonate.

(j) [Sample answer] Answers obtained in the Analysis are in agreement with the Prediction. The theoretical model of carboxylic acids helped to predict the chemical properties of these acids. The effect of the polar and nonpolar components of each acid could be used to predict physical and chemical properties of the compounds.

3.13 ESTERS

SECTION 3.13 QUESTIONS

(Page 225)

Understanding Concepts

1. An ester contains an –OR group in place of the –OH group in the carboxylic acid. Both carboxylic acids and esters contain a carbonyl group.