6. Student answers will vary, but should include the following recommendations.
   - Carefully read and follow the recommendations on the MSDS for every chemical substance that you use.
   - Be aware of the flammability and combustibility of solvents.
   - Use organic solvents in a well-ventilated location, such as outdoors or a room with open windows, away from ignition sources such as electrical sparks, open flames, and hot surfaces.
   - Do not store organic solvents in direct sunlight, near heat sources, or in basements.
   - Return any unused portions of solvents immediately to the appropriate storage containers.
   - Dispose of waste solvents according to environmental restrictions; never pour them down the sink.
   - Some solvents will spontaneously combust; for example, rags soaked in motor oil or linseed oil will ignite if they are stuffed in a container such as a plastic pail. The rags should be hung outside on a clothesline, to allow any heat that is produced to dissipate safely.
   - Do not inhale any solvents.

3.11 CARBOXYLIC ACIDS

TRY THIS ACTIVITY: MAKING A BATH BOMB

(Page 219)

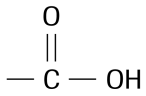
(a) citric acid + sodium hydrogen carbonate → sodium citrate + carbon dioxide + water

SECTION 3.11 QUESTIONS

(Page 220)

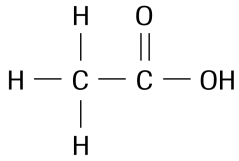
Understanding Concepts

1. (a)

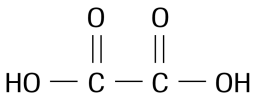


carboxyl group

   (b) The hydroxyl group in this functional group is polar and can hydrogen bond, making the molecule soluble in water. The carbonyl group is also polar and, with the hydroxyl group, increases intermolecular attractions and thus raises the melting and boiling points of carboxylic acids.
2. Carboxylic acids contain the carboxyl group, which consists of a carbonyl group and a hydroxyl group. Both carbonyl groups and hydroxyl groups are polar groups, resulting in carboxylic acids being polar molecules.
3. (a)



ethanoic acid

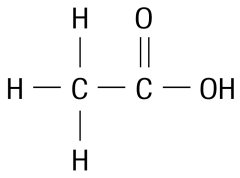


oxalic acid

   (b) Oxalic acid is a solid at room temperature because, as it is polar, the van der Waals forces between the molecules are stronger than those in ethanoic acid (vinegar). There is also more opportunity for hydrogen bonding among molecules.
4. The gas (A) has the lowest boiling point and must be an alkane, the least polar molecule. The liquid (B) has the next highest boiling point and must be the alcohol, which has a hydroxyl group.

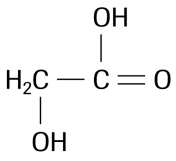
5. Student examples will vary.

Front:

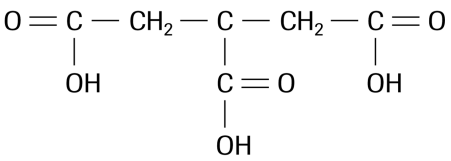
Family name and general formula	Examples		
	IUPAC name	Common name	Structural formula
Carboxylic acids R–COOH	ethanoic acid	acetic acid (vinegar)	

Back:

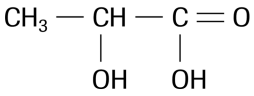
Family	Characteristic properties	Characteristic functional groups	Intermolecular forces
Carboxylic acids	soluble in water, turn litmus pink, react with alcohols to form esters	carboxyl group –COOH	hydrogen bonds, van der Waals forces

6. 

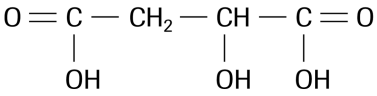
glycolic acid



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.