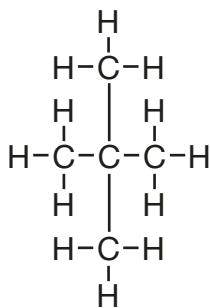


## Chapter 2: The Chemical Legacy of Human Activity

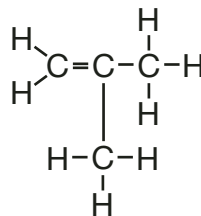
### Practice, page 245

1. a. ethane  
b. prop-1-ene or propene  
c. methane

2. a.

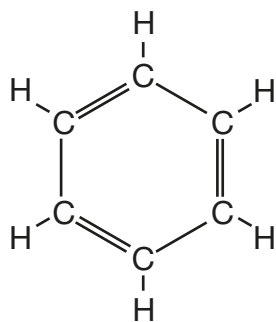


b.



### Practice, page 247

3.



**Note:** The positions of the double bonds in benzene are not fixed.

4. Aromatic ring and phenyl ring are used to describe the chemical structure of benzene.

### Practice, page 248

5. a. Particulate matter is divided into two groups,  $PM_{10}$  and  $PM_{2.5}$ , based on the size of the particles.

b.


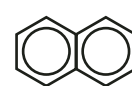
Particle Size	PM <sub>10</sub> (larger particles, up to 10 μm in diameter)*	PM <sub>2.5</sub> (smaller or fine particles, up to 2.5 μm in diameter)
Source	<ul style="list-style-type: none"> <li>• combustion</li> <li>• road building</li> <li>• use of brittle materials</li> <li>• mould (biological sources)</li> <li>• spores (biological sources)</li> <li>• pollen (biological sources)</li> </ul>	<ul style="list-style-type: none"> <li>• automobile exhaust</li> <li>• burning plant matter (including forest fires)</li> <li>• smelters and smoke from the combustion of coal</li> </ul>
Examples	<ul style="list-style-type: none"> <li>• smoke, dirt, and dust from factories, farming, and roads</li> <li>• mould</li> <li>• spores</li> <li>• pollen</li> </ul>	<ul style="list-style-type: none"> <li>• toxic organic compounds (e.g., PAH)</li> <li>• heavy metals</li> </ul>

\* All particles of this size can be transferred by wind.

6. a. Will diesel particulate filters function in colder conditions?
- b. Local environmental conditions refers to the normal conditions under which the bus would be operating. For example, the coldest temperatures in Edmonton occur during January and February. Many technologies do not work at optimal levels in such extreme conditions.
- c. Many controlled variables are identified, including
- type of bus (Flyer model)
  - emissions testing done on the road
  - identical diesel particulate filters were installed in both buses
  - diesel particulate filters were installed after buses were made
  - identical grade of diesel fuel (low sulfur) was used by both buses
  - filters installed in both buses one month prior to testing and were in service for that time
  - buses travelled the same route
  - same number of samples collected for each bus during the test

7.

**SOME COMPONENTS OF GASOLINE**

Component	Chemical Formula	Structural Diagram	Alkane	Alkene	Aromatic Compound	Hydrocarbon
2-methylpropane	$C_4H_{10}$	<pre>       H             H-C-H           H       H             H-C-C-C-H               H   H   H           </pre>	✓			✓
cyclohexane	$C_6H_{12}$	<pre>     H H H H                   C - C     /   \    H     H   /       \  H         H  /         \ C           C  \         /   H       H    \     /     C - C                  H H H H           </pre>	✓			✓
butane	$C_4H_{10}$	<pre>     H H H H               H-C-C-C-C-H                 H H H H           </pre>	✓			✓
1,3,5-trimethylbenzene	$C_9H_{12}$	<pre>       H             H-C-H           H       H             H-C--C-H               H   H   H           </pre>			✓	✓
naphthalene	$C_{10}H_8$				✓	✓
2-methylbut-2-ene	$C_5H_{10}$	<pre>       H             H-C-H           H       H             H-C-C=C-C-H               H   H   H           </pre>		✓		✓

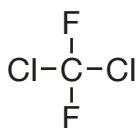
**Note:** Alkane is a hydrocarbon with single bonds between carbon atoms.

## Practice, page 252

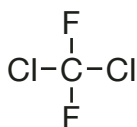
8. The end of dichlorodifluoromethane shows that the parent chain consists of 1 carbon.



The prefix of *dichlorodifluoromethane* shows that there are 2 chlorine atoms and 2 fluorine atoms bonded to the parent chain.



There are no empty bonds to fill with hydrogen; therefore, the chemical structure of dichlorodifluoromethane is



9. Your table should be similar to the following.

Chemical Formula	Systematic Name	Structural Diagram	Trade Name and Uses
$\text{CH}_2\text{Cl}_2$	dichloromethane	$\begin{array}{c} \text{H} \\   \\ \text{Cl}-\text{C}-\text{Cl} \\   \\ \text{H} \end{array}$	<ul style="list-style-type: none"> <li>solvent used to remove paint and grease</li> <li>used to remove caffeine from coffee beans</li> </ul>
$\text{CCl}_3\text{F}$	trichlorofluoromethane	$\begin{array}{c} \text{F} \\   \\ \text{Cl}-\text{C}-\text{Cl} \\   \\ \text{Cl} \end{array}$	<ul style="list-style-type: none"> <li>CFC-11</li> <li>used as a coolant in refrigerators and to make the insulating foam</li> <li>used as an aerosol propellant</li> </ul>
$\text{CCl}_2\text{F}_2$	dichlorodifluoromethane	$\begin{array}{c} \text{Cl} \\   \\ \text{F}-\text{C}-\text{F} \\   \\ \text{Cl} \end{array}$	<ul style="list-style-type: none"> <li>CFC-12</li> <li>used in home and vehicle air conditioners</li> <li>used as an aerosol propellant in medicines and pesticides</li> </ul>
$\text{CHClF}_2$	chlorodifluoromethane	$\begin{array}{c} \text{H} \\   \\ \text{Cl}-\text{C}-\text{F} \\   \\ \text{F} \end{array}$	<ul style="list-style-type: none"> <li>HCFC-22</li> <li>used as a refrigerant</li> <li>used in the production of fire retardants and polymers like Teflon</li> </ul>
$\text{CHClFClF}$	2-chloro-1,1,1,2-tetrafluoroethane	$\begin{array}{c} \text{Cl} \ \text{F} \\   \ \   \\ \text{H}-\text{C}-\text{C}-\text{F} \\   \ \   \\ \text{F} \ \ \text{F} \end{array}$	<ul style="list-style-type: none"> <li>HCFC-124</li> <li>used as a refrigerant</li> <li>used as a replacement for Halon-1301 in fire extinguishers</li> </ul>

$\text{CH}_2\text{FCF}_3$ or $\text{C}_2\text{H}_2\text{F}_4$	1,1,1,2-tetrafluoroethane	<pre>       H   F             F - C - C - F                   H   F           </pre>	<ul style="list-style-type: none"> <li>HFC-134a</li> <li>used as a coolant in refrigerators and to make insulating foam</li> <li>used as an aerosol propellant in canned air and inhalers for asthmatics</li> </ul>
$\text{CBrClF}_2$	bromochlorodifluoromethane	<pre>       Br         F - C - Cl               F           </pre>	<ul style="list-style-type: none"> <li>Halon-1211</li> <li>fire retardant</li> <li>used in some types of fire extinguishers</li> <li>no longer produced (since January 1996)</li> </ul>
$\text{CBrF}_3$	bromotrifluoromethane	<pre>       Br         F - C - F               F           </pre>	<ul style="list-style-type: none"> <li>Halon-1301</li> <li>fire retardant</li> <li>used in some types of fire extinguishers</li> <li>no longer produced (since January 1996)</li> </ul>

### Did You Know?, page 253

Where applicable, refer to the structural diagrams in the answer to Practice question 9 for confirmation.

#### CFC-12

$$90 + 12 = 102$$



#### HCFC-22

$$90 + 22 = 112$$



#### HCFC-124

$$90 + 124 = 214$$



#### HCFC-134a

$$90 + 134 = 224$$



#### CFC-15

$$90 + 15 = 105$$



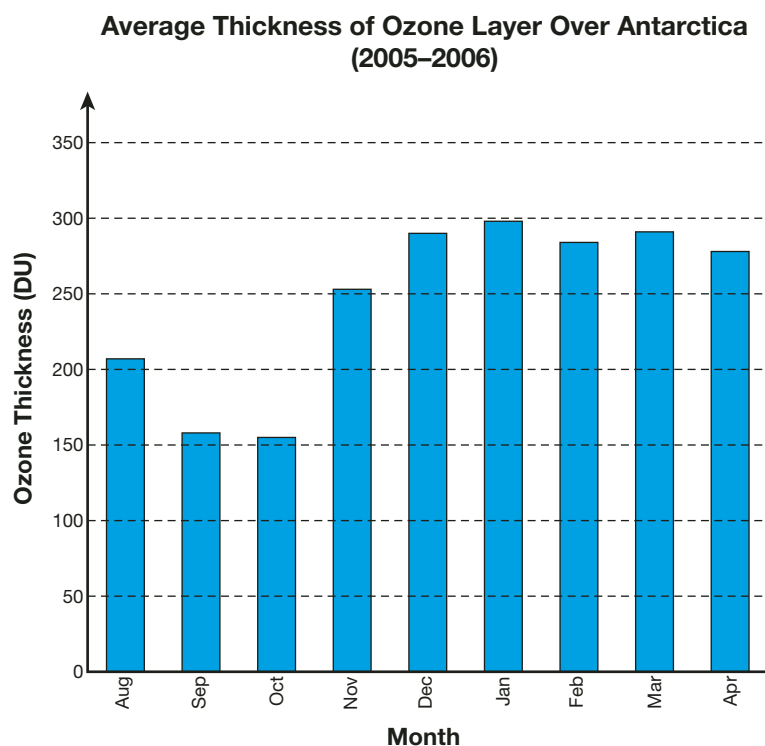
Because 1 carbon can only bond to 4 other atoms, CFC-15 is not possible.

### Practice, page 257

10. 
$$\% \text{ loss} = \frac{321 \text{ DU} - 139 \text{ DU}}{321 \text{ DU}} \times 100\%$$

$$= 56.7\%$$

11. Antarctica (between 125 DU and 175 DU)  
Greenland and Baffin Island (between 175 DU and 200 DU)
12. Answers will vary. A general trend that will appear is that ozone levels will be the lowest at the South Pole.
13. Graphs will vary slightly. A sample graph is given.



Ozone levels in the Antarctic are lowest in September and October due to the absence of UV radiation to regenerate ozone that occurs during the Antarctic winter.

14. The pattern would be shifted since the Arctic experiences total darkness from December to late March. Therefore, the lowest values would be expected to be around March 22.

### Practice, page 258

15. TOMS: Total Ozone Mapping Spectrometer  
OMI: Ozone Monitoring Instrument
16. Using different equipment or methods to measure the same phenomenon improves the validity of the experimental design. Agreement between data measured by balloon sondes and by satellites provides confidence that the values are authentic, representing the concentrations of substances in the atmosphere.

17. Values expressed as parts per million are 1000 times more concentrated than a similar value expressed as parts per billion. Chlorine monoxide is a radical produced during ozone depletion and is involved in the regeneration of chlorine radicals. The regeneration of chlorine radicals results in numerous reactions with ozone. Estimates suggest that each chlorine radical causes the depletion of over 1000 ozone molecules. Therefore, a small change to the concentration of chlorine, or chlorine monoxide, could result in a large change to the ozone concentration.

## 2.1 Questions, page 262

### Knowledge

1. Answers will vary. A sample summary is given.

Group Name	Example	Important Structures/Atoms	Environmental Concerns
hydrocarbons (e.g., alkanes and alkenes)	methane, ethane, and ethene	C and H	<ul style="list-style-type: none"> <li>• components of natural gas and crude oil</li> <li>• oil spills</li> <li>• combustion risk</li> <li>• contamination of surface water, groundwater, and soil</li> </ul>
benzene (aromatics)	benzene and xylene	C and H (form a hexagonal ring)	<ul style="list-style-type: none"> <li>• persistent compounds</li> <li>• can be toxic</li> <li>• possibly a carcinogen</li> </ul>
polycyclic aromatic hydrocarbons (PAHs)	benzopyrene	C and H (contain multiple benzene rings)	<ul style="list-style-type: none"> <li>• contained within particulate matter</li> <li>• can bind to DNA</li> <li>• persistent compounds</li> </ul>
halogenated hydrocarbons	CFC and vinyl	C, along with H, F, Cl, Br, or I	<ul style="list-style-type: none"> <li>• CFCs and other types of halogenated hydrocarbons (e.g., HCFC and halons) involved in ozone depletion</li> <li>• some appear in pesticides</li> <li>• many involved in biomagnification to higher concentrations in organisms at higher trophic levels</li> <li>• body metabolism of chlorinated compounds may result in free-radical production and damage to tissues</li> </ul>

## Applying Concepts

2. Answers will vary. As this question asks you to propose possible substances, the examples may not be actual compounds used for these purposes. Science 30 students are only required to name organic compounds containing up to three carbon atoms in the parent chain.

Abbreviation	Structural Diagram	Chemical Formula	Systematic Name
CFC	<pre>       F             F-C-Cl               Cl           </pre>	$\text{CCl}_2\text{F}_2$	dichlorodifluoromethane
	<pre>       F   F                 Cl-C-C-Cl                   Cl  Cl           </pre>	$\text{C}_2\text{Cl}_4\text{F}_2$	1,1,2,2-tetrachloro-1,2-difluoroethane
HCFC	<pre>       F             H-C-Cl               H           </pre>	$\text{CH}_2\text{ClF}$	chlorofluoromethane
	<pre>       F   F                 Cl-C-C-Cl                   H   Cl           </pre>	$\text{C}_2\text{HCl}_3\text{F}_2$	1,1,2-trichloro-1,2-difluoroethane
HBFC	<pre>       F   F                 Br-C-C-H                   H   H           </pre>	$\text{C}_2\text{H}_3\text{BrF}_2$	1-bromo-1,2-difluoroethane
	<pre>       Br Br F                 H-C-C-C-H                   F F H           </pre>	$\text{C}_3\text{H}_3\text{Br}_2\text{F}_3$	1,2-dibromo-1,2,3-trifluoropropane
HFC	<pre>       F             H-C-F               F           </pre>	$\text{CHF}_3$	trifluoromethane
	<pre>       F   F                 F-C-C-F                   H   H           </pre>	$\text{C}_2\text{H}_2\text{F}_4$	1,1,2,2-tetrafluoroethane



HC	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{H} \\   \\ \text{H} \end{array}$	$\text{CH}_4$	methane
	$\begin{array}{c} \text{H} & \text{H} & \text{H} \\   &   &   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\   &   &   \\ \text{H} & \text{H} & \text{H} \end{array}$	$\text{C}_3\text{H}_8$	propane
PFC	$\begin{array}{c} \text{F} \\   \\ \text{F}-\text{C}-\text{F} \\   \\ \text{F} \end{array}$	$\text{CF}_4$	tetrafluoromethane
	$\begin{array}{c} \text{F} & \text{F} \\   &   \\ \text{F}-\text{C}-\text{C}-\text{F} \\   &   \\ \text{F} & \text{F} \end{array}$	$\text{C}_2\text{F}_6$	hexafluoroethane*
Halon	$\begin{array}{c} \text{H} \\   \\ \text{Cl}-\text{C}-\text{F} \\   \\ \text{Br} \end{array}$	$\text{CHClBrF}$	bromochlorofluoromethane (Halon-1211)
	$\begin{array}{c} \text{Br} \\   \\ \text{F}-\text{C}-\text{F} \\   \\ \text{F} \end{array}$	$\text{CBrF}_3$	bromotrifluoromethane (Halon-1301)
* This compound is saturated with fluorine atoms; therefore, numbers are not required.			

- HCFCs have hydrogen atoms in place of some of the chlorine or fluorine atoms that normally surround the carbon atoms in a CFC.
- Butane and ammonia both have safety concerns. Butane is flammable and, because of its low boiling point, is a volatile organic compound (VOC) that can contribute to the production of smog and ground-level ozone. Ammonia can be toxic at certain concentrations.
- The polar vortex consists of high-altitude winds that can act to carry CFCs and other ozone-depleting substances into the stratosphere. Over time, the vortex will permit the accumulation and possible increase in concentration of these substances in the area over the poles, resulting in significant ozone loss.



- b. nontoxic, non-flammable, chemically stable to high temperatures (will not produce toxic vapours at high temperatures nor cause ozone depletion at same level as the substance it is replacing)

7. Free radicals are atoms or other substances that have unpaired electrons in their outermost energy level. Substances with unpaired electrons tend to be highly reactive. They combine with other molecules to form bonds that will leave the radical with paired electrons in its outermost energy level.
8. Answers will vary. A sample answer is given.

Antioxidant	Food Sources
vitamin E	vegetable oils, nuts, green leafy vegetables (e.g., broccoli and spinach), asparagus
vitamin C	citrus fruits and their juices, strawberries, tomatoes, broccoli, sweet and white potatoes, cantaloupes
beta-carotene	broccoli, carrots, spinach, sweet potatoes, acorn or butternut squash, apricots, cantaloupes
lycopene (strongest antioxidant)	tomatoes and other red fruits, but is more concentrated in tomato products

9. Answers will vary. A sample answer is given.

#### NATURAL SUBSTANCES CONTAINING AROMATIC RINGS

Substance	Source or Importance
phenylalanine, tryptophan	amino acids used in the production of proteins
vitamin E	essential vitamin, antioxidant
vanillin	natural flavouring
capsaicin	active ingredient in hot peppers

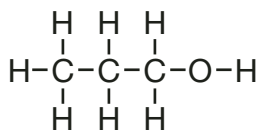
#### SYNTHETIC SUBSTANCES CONTAINING AROMATIC RINGS

Substance	Source or Importance
dioxins	PAHs, persistent compounds, carcinogens
furans	PAHs, persistent compounds, carcinogens
benzopyrene	PAH, persistent compound, carcinogen
naphthalene	pesticide (mothballs) also used in many synthetic reactions
trinitrotoluene (TNT)	explosive

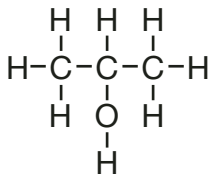
10. Aromatic rings are slightly more soluble in water than linear hydrocarbons; thus, they can accumulate in water. The ring is a very stable structure due to the unique bonding between carbons. Compounds with this structure tend to persist in the environment.

### Practice, page 266

18.

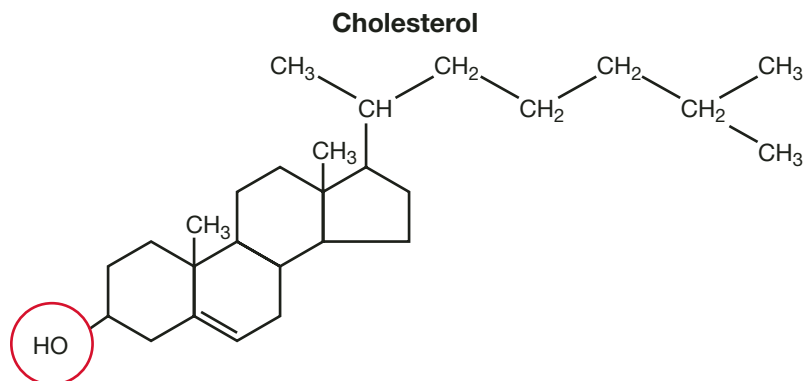


**Propan-1-ol or Propanol**



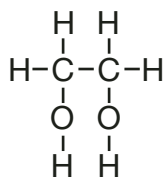
**Propan-2-ol**

19. a.



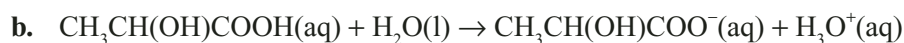
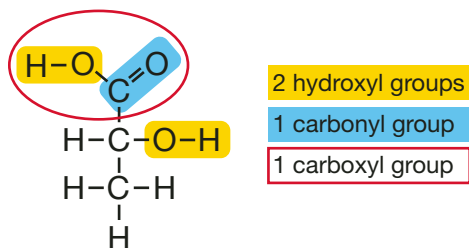
b. The *ol* ending of the name identifies that cholesterol has a hydroxyl functional group.

20.



### Practice, page 267

21. a.



c. Hydrogen phosphate,  $\text{HPO}_4^{2-}(\text{aq})$ , and dihydrogen phosphate,  $\text{H}_2\text{PO}_4^-(\text{aq})$ , are listed as conjugate bases and could accept a hydrogen ion from the hydronium ion. This would neutralize the accumulation of acid produced by the ionization of lactic acid.

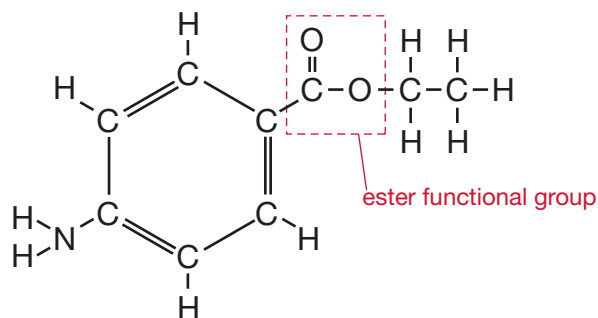
## Practice, page 269

22. Your table should look like the following.

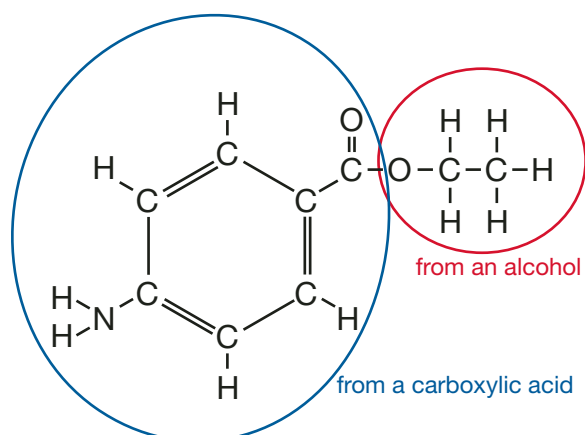
Number of Carbons	Chemical Structure	Systematic Name
1	$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C} \\ \backslash \\ \text{O}-\text{H} \end{array}$	methanoic acid
2	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{C} \\   \quad \parallel \\ \text{H} \quad \text{O} \\ \quad \backslash \\ \quad \text{O}-\text{H} \end{array}$	ethanoic acid
3	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{C} \\   \quad   \quad \parallel \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \backslash \\ \quad \quad \text{O}-\text{H} \end{array}$	propanoic acid

## Practice, page 273

23. a.



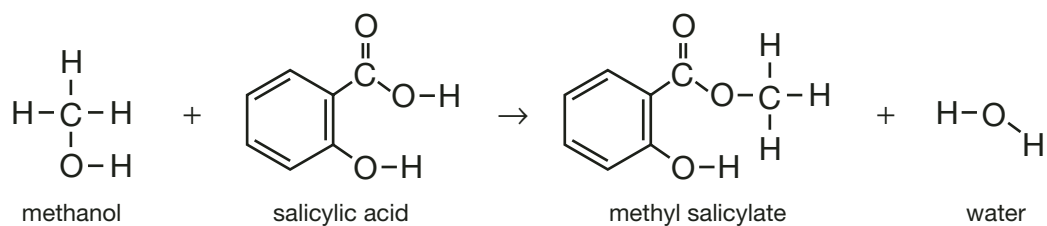
b.



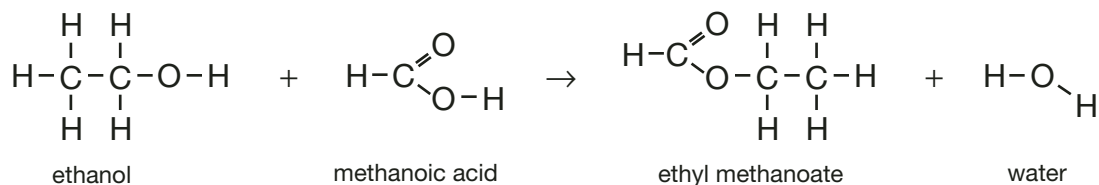
c. ethanol

d. A large portion of the benzocaine molecule is similar to PABA. Benzocaine is unique because of the ester functional group. The similarities between the structures may be sufficient to cause an allergic response.

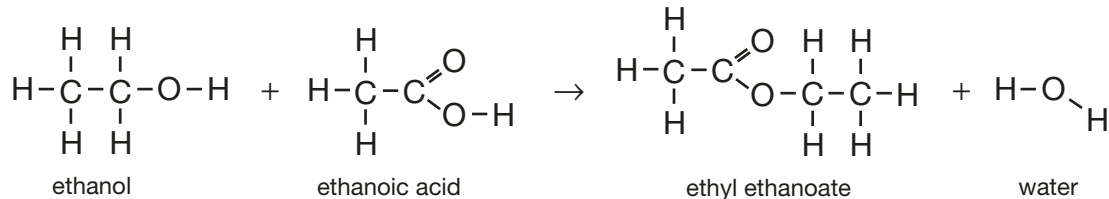
24. a.



b.



c.



## 2.2 Questions, pages 277 and 278

### Knowledge

1. Your table should look like the following.

Type of Organic Compound	Drawing of Functional Group	Name of Functional Group	Suffix Used During Naming
alcohol	-O-H	hydroxyl	-ol
carboxylic acid	$\begin{array}{c} \text{O} \\    \\ -\text{C} \\   \\ \text{O}-\text{H} \end{array}$	carboxyl	-oic acid
ester	$\begin{array}{c} \text{O} \\    \\ -\text{C} \\   \\ \text{O}- \end{array}$	ester	-oate

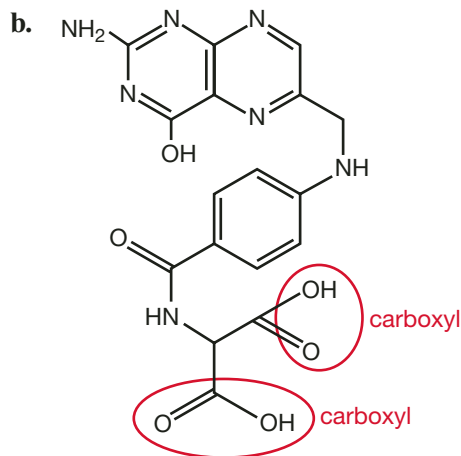
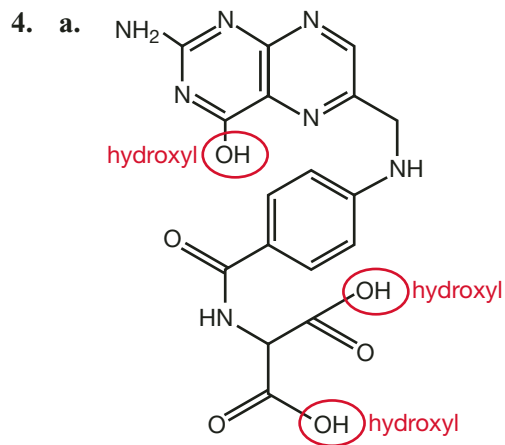
2. Compare your lists to the following table.

Group	Common Uses
alcohol	disinfectant, solvent
carboxylic acid	foods, cleaners
ester	natural and artificial flavours and odours

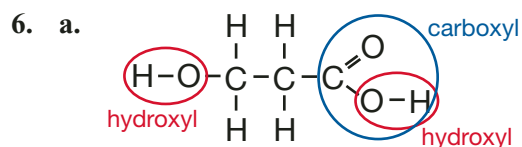
3. Empirical properties of acids include the following:

- tastes sour
- turns blue litmus red
- changes the colour of pH indicators
- neutralizes basic solutions
- reacts with magnesium, iron, and zinc to produce hydrogen gas

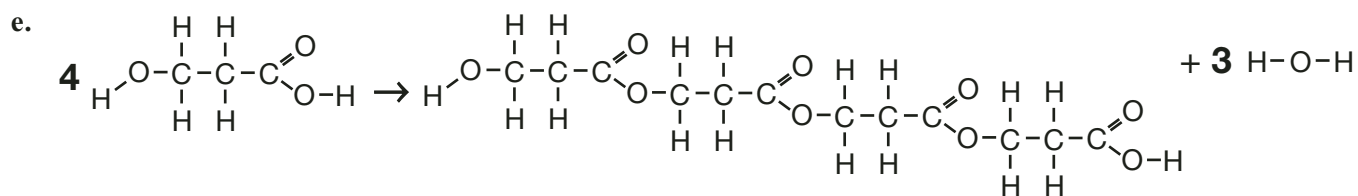
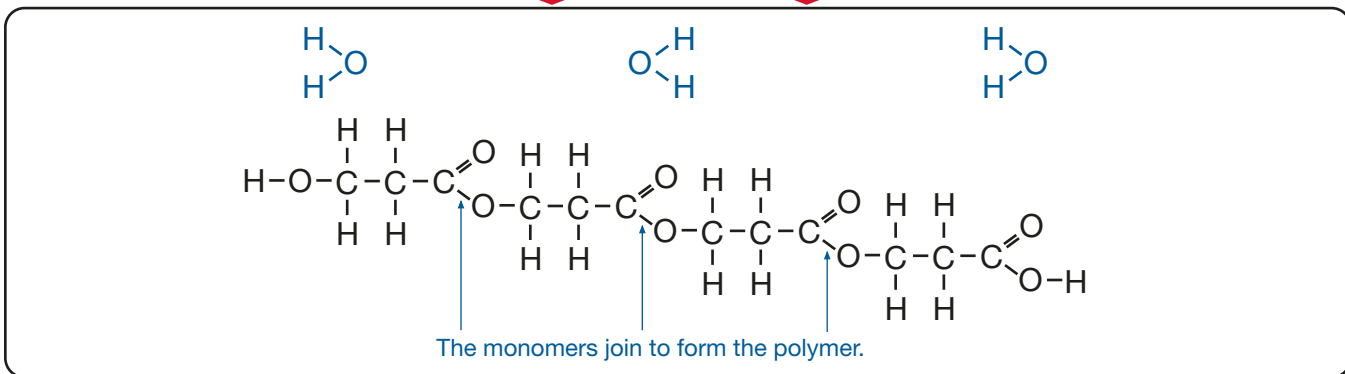
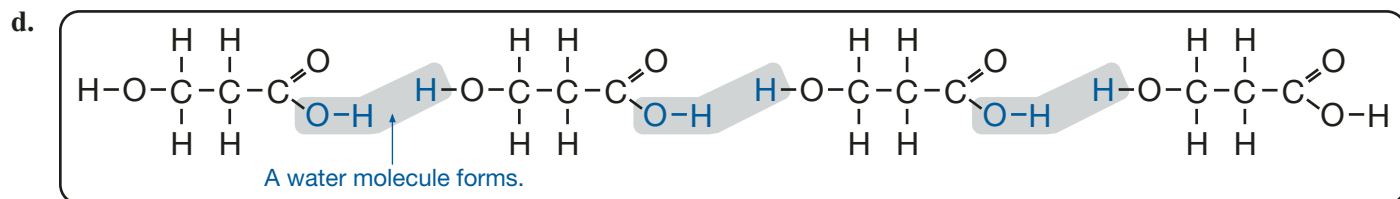
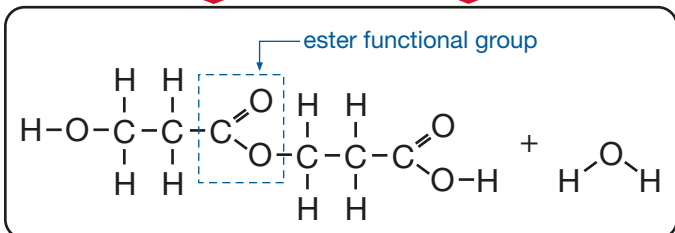
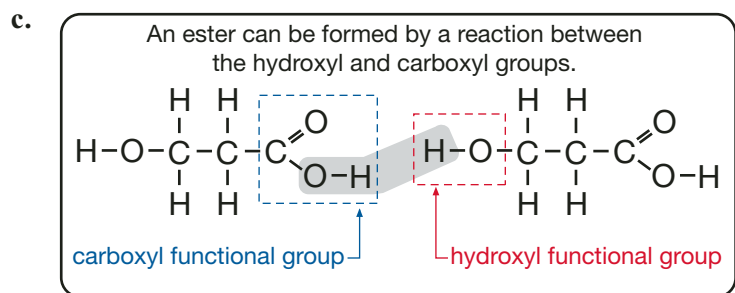
### Applying Concepts



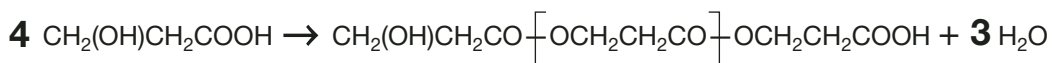
5. a. Similarities between the two substances include the benzene ring, the nitrogen group, and the position of a functional group containing a double bond to an oxygen atom.
- b. The similarity between the structures may result in the body producing an allergic response to the sulfanilamide molecule.
- c. An allergic response to either of these substances could be very quick and lead to a life-threatening anaphylactic reaction. Knowledge of a patient's sensitivity to PABA allows doctors to avoid drugs that have a similar structure and to use alternative medications.



- b. ester functional group

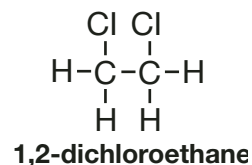


OR



### Practice, page 280

25. Small halogenated hydrocarbons have the potential to produce chlorine radicals and cause ozone depletion. Although the ozone-depleting potential of 1,2-dichloroethane is considered to be extremely low, it is also possible that it will tend to act as a persistent chemical compound similar to other halogenated hydrocarbons.



26. Removing the halogenated hydrocarbons from paint prevents the offgassing of that substance into the environment. Removing the use of this substance in paint further reduces the requirement for its production, thereby reducing the risk of it entering the environment.

### Practice, page 284

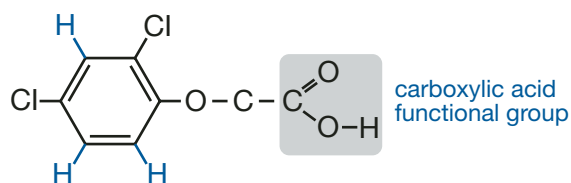
27. a. **Advantage:** control of selected pest without harming other species

**Disadvantage:** may cause indirect harm to other organisms that rely on the target organism (depend on them for food or are involved in a symbiotic relationship)

- b. **Advantage:** control of multiple pests with one application

**Disadvantage:** may affect significant parts of a food chain or ecosystem

28. a. The lower concentration at which the organisms showed effects of the compound indicates that the 2,4-D ester has the greater toxicity.
- b. An assessment of a herbicide's effect on animal populations is an attempt to determine its toxic effects on other organisms that may have been exposed in the same biological system.
- c. The carboxylic acid functional group present on the 2,4-D molecule can participate in a reaction with an alcohol to form an ester functional group.



29.  $LD_{50}$  and  $LC_{50}$  test the effects on organisms of short-term exposure to a substance.

### Practice, page 289

30. a. The samples ranked from lowest to highest BOD are A, C, B.

b.

Possible Source	Sample
raw sewage	B
river water upstream of major city	A
river water downstream of major city	C



## Practice, page 290

31. In areas that may be occasionally visited by rodent pests, there is the possibility that individuals possessing resistance to the poison will come into contact with it and not be killed. If this is the only type of pest control, the survival of the resistant organisms enables their offspring to inherit the resistance trait. In many situations, resistance to pesticides requires the inheritance of a single allele from one parent. Traps are an effective mechanism to deal with occasional visitors.

32.

Product Name	Intended Use*	Specificity <sup>†</sup>	Type of Pesticide	Active Ingredient	LD <sub>50</sub> (mg/kg in mice)	Persistence	Resistant Organisms
Sevin	caterpillars, beetles, earwigs, aphids, fruit flies, millipedes	broad	insecticide	imidacloprid	131	moderate	potato beetles, silverleaf whiteflies
Killex	dandelions, plantains, clover, chickweed	broad	herbicide	2,4-D, mecoprop, dicamba	370 (2,4-D)	low (2,4-D)	wild carrots, field bindweed
Lagon 2E	aphids, leafhoppers, mites, thrips	broad	insecticide	dimethoate	160	low	cattle ticks, aphids
Bugban-C	ants	target specific	insecticide	dursban	60	high	mosquitoes, cockroaches
Doktor Doom	mosquitoes, ants, ticks, black flies, silverfish, crickets	broad	insecticide	permethrin	250 to 4000	low	cockroaches, head lice
House and Garden Insect Spray	whiteflies, spider mites, aphids, thrips, gnats, moths, red spiders, beetles, cabbage worms	broad	insecticide	pyrethrins, piperonyl butoxide	370	low	filth flies, cockroaches

\* refers to controlling the population of the species listed / <sup>†</sup> as determined by the intended use

## Practice, page 291

33.

Category	Good and Bad Points of Category
Persistent Substances	<p><b>Good:</b> The persistence of some organic compounds in the environment has been known to be a problem.</p> <p><b>Bad:</b> Ranking persistence is relative. Persistence can be influenced by environmental conditions, such as temperature and exposure to light.</p>
Bioaccumulative Substances	<p><b>Good:</b> Substances that bioaccumulate are often associated with biomagnification and may result in toxic levels being found higher up the food chain.</p> <p><b>Bad:</b> Similarities and differences between bioaccumulative and persistent rankings are not clear.</p>
Inherently Toxic to the Environment	<p><b>Good:</b> It conveys essential information.</p> <p><b>Bad:</b> The time frame of toxic effects should be made clear (e.g., short or long term).</p>

34. Evidence demonstrates that DDT would be classified under all three headings (persistent, bioaccumulative, and inherently toxic to environment).

## Practice, page 293

35. **Note:** Because the graph uses a logarithmic scale, estimates and answers may vary substantially from the numbers given.

- a. In 2003, approximately 8 100 000 kg of active ingredient of pesticides was used by agriculture and approximately 65 000 kg was used by domestic users.

b. 
$$\frac{\text{agriculture}}{\text{domestic use}} = \frac{8\,100\,000\text{ kg}}{65\,000\text{ kg}}$$

$$= 125$$

Agriculture uses approximately 125 times more pesticide compared to domestic use.

- c. The divisions on the vertical axis of this graph represent a 10-fold increase in the mass of pesticide used. This scale is a logarithmic scale similar to the pH scale describing the concentration of hydronium ions in a solution.

## Practice, page 294

36. Observations after the use of a pest-control strategy are important to determine whether the strategy is working. Observations can provide information about the population size of pests. Other observations may include changes to the health of pests and population size of other organisms in the ecosystem.

37. Strategies used in integrated pest management that can reduce the use of synthetic organic compounds in pest control include
- using natural predators and parasites
  - using biological agents (e.g., naturally produced toxins to pests)
  - using crop varieties that have increased pest resistance
  - managing habitat that may create conditions that reduce the success of pest infestation and breeding in the area
  - carefully monitoring crop conditions and pest abundance to determine whether the strategies used are having the desired effect (reassuring that the use of chemical pesticides is not necessary)

38. Spontaneous mutation is a process that could result in the development of resistance to a toxin produced by *Bacillus thuringiensis*.

39.

Controlling Bertha Armyworms	Integrated Pest-Management Strategies
tilling (ploughing fields after harvest) and removing stubble from fields	carefully managing habitat by using strategies, like flooding or burning, to deter the growth of pests
biological control strategies (e.g., introducing viruses and other insects)	using natural predators, parasites, and biological agents for controlling target pests
planting alternative crops	using crop varieties resistant to pests
using selective pesticides (if needed)	using pesticides only when necessary

**Practice, page 295**

40. Answers will vary. A sample answer is given.

Risks	Benefits
<ul style="list-style-type: none"> <li>• higher frequency of accidents on major roadways</li> <li>• environmental hazards (e.g., potential for leakage into nearby waterways)</li> <li>• potential exposure to highly populated areas</li> </ul>	<ul style="list-style-type: none"> <li>• easy access to industrial location</li> <li>• wider, better-engineered roadways</li> </ul>

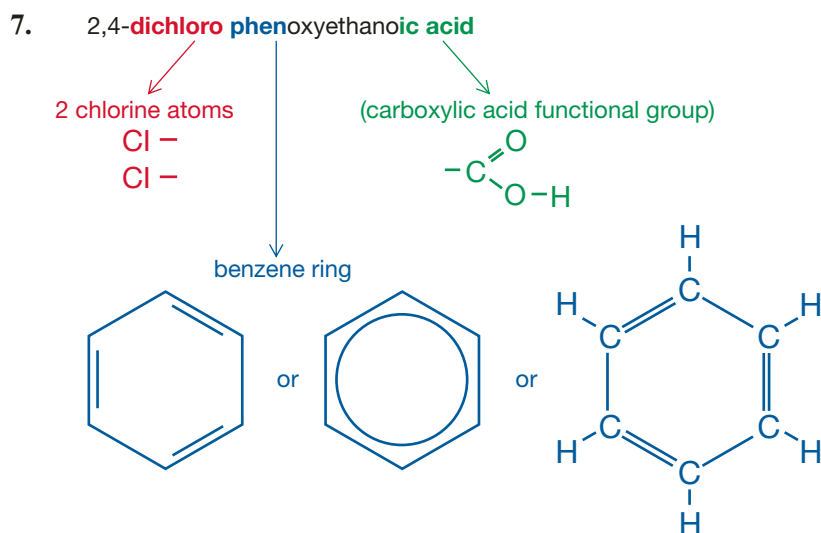
## 2.3 Questions, page 299

### Knowledge

- Answers will vary. One type of substance released during off-gassing is a volatile organic compound (VOC).
- Toxicity is the ability of a substance to cause damage to living tissue, impair the function of a body system, or cause death when ingested, inhaled, or absorbed through the skin.
- Knowledge of effects of the pesticide on organisms other than the target species can be used to determine appropriate levels for use. This data can also be used to assess whether a substance has such high toxicity to many organisms that it should be prohibited in some circumstances.
- Two sources of dioxins are from the manufacture of pesticides and the low-temperature combustion of chlorinated plastics (e.g., garbage incineration). Health effects from the exposure to dioxins include skin conditions (e.g., chloracne), decreased function of the immune system, damage to liver and kidneys, and cancer (exposure to carcinogens).
- organochlorines or halogenated hydrocarbon compounds

### Applying Concepts

- The testing of many organisms, especially those that may appear in the same ecosystem, provides information about possible widespread effects of a substance's use. This includes the effect on higher-level consumers and other non-target species.



8. a.

Effect on Concentration of Pesticide Due to Rain Shower After Spraying	
air	decreases (dissolves in water droplets)
surface water	increases (dissolves or leaches into water from runoff)
soil	increases (pesticide washed off plant into soil)

b.

Effect on Concentration of Pesticide Due to Hot Day	
air	increases (evaporation of pesticide, a volatile organic compound)
surface water	decreases (evaporation of pesticide, a volatile organic compound)
soil	decreases (evaporation of pesticide, a volatile organic compound)

9. Consulting with local experts may provide information about the most appropriate pesticide to use. Advice may result in limiting use of substances that may have a reduced effect on the pest as well as unwanted effects on human health. Observation of the effect of the pesticide used can show that the desired effect has been achieved and that the pesticide is no longer required, thereby reducing exposure once it is removed.

10.

Principle of Organic Farming	How Use of Synthetic Compounds as Pesticides or Fertilizers Is Inconsistent with Principle
Protect the environment, minimize soil degradation and erosion, decrease pollution, optimize biological productivity, and promote a sound state of health.	<ul style="list-style-type: none"> <li>• Many pesticides contain persistent organic compounds.</li> <li>• Fertilizer use can result in soil degradation.</li> </ul>
Maintain long-term soil fertility by optimizing conditions for biological activity within the soil.	<ul style="list-style-type: none"> <li>• Fertilizer use is designed for short-term effect of improved crop growth.</li> <li>• Fertilizer use can decrease the population of nitrogen-fixing bacteria present in soil.</li> </ul>
Maintain biological diversity within the system.	<ul style="list-style-type: none"> <li>• Pesticides can selectively reduce biodiversity.</li> </ul>
Provide attentive care that promotes the health and meets the behavioural needs of livestock.	<ul style="list-style-type: none"> <li>• Increased reliance on pesticides may lead to decreased attention to other aspects of animal health or behaviour in order to achieve desired effect.</li> </ul>
Prepare organic products, emphasizing careful processing and handling methods in order to maintain the organic integrity and vital qualities of the products at all stages of production.	<ul style="list-style-type: none"> <li>• Pesticides are often used to reduce damage that can occur during storage and transportation.</li> </ul>

11. Chemical pesticides may be selected when all other pest-management strategies have been ineffective or are impractical.
12. Variation exists within all populations. There is a possibility that some individuals within the population have, by chance, developed resistance to the toxin. Genetically modified plants that contain one of the toxins within their tissues become a constant source of exposure to the pest population. Individuals possessing resistance will have a higher survival rate compared to non-resistant individuals. Ample food and decreased competition will enable breeding between resistant individuals, resulting in the development of a population of individuals resistant to the toxin.