UNIT 3 ORGANIC CHEMISTRY

GETTING STARTED

(Page 119)

TRY THIS ACTIVITY: KEEPING BABY DRY WITH POLYMERS

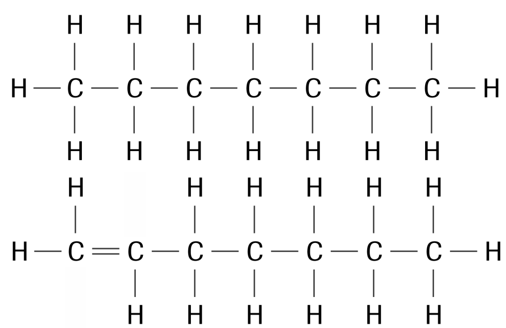
6. The brand name disposable holds more water (possibly). The difference is the type and amount of polymer that is used in each diaper.
7. The disposable diaper held much more water than the cloth diaper. Comparisons will depend on the diapers used.

3.1 EXTENSION EXERCISE

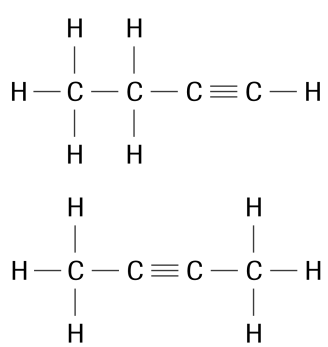
(Pages 121–123)

NAMING AND DRAWING HYDROCARBONS—ADDITIONAL PRACTICE

1. (a) hexane, C_6H_{14} (b) butane, C_4H_{10}
   (c) propyne, C_3H_4 (d) 3-octyne, C_8H_{14}
   (e) methane, CH_4 (f) 2-pentene, C_5H_{10}
2. (a) alkane: butane (b) alkyne: 1-pentyne
   (c) alkene: 1-butene or 2-butene (d) alkane: pentane
3. The alkene has a double bond between two adjacent carbon atoms so the minimum number of carbon atoms has to be two. The alkyne has a triple bond so again the minimum number of carbon atoms has to be two. An alkane, on the other hand, does not have a double or triple bond, so it is possible to have a 1-carbon alkane.
4. (a)

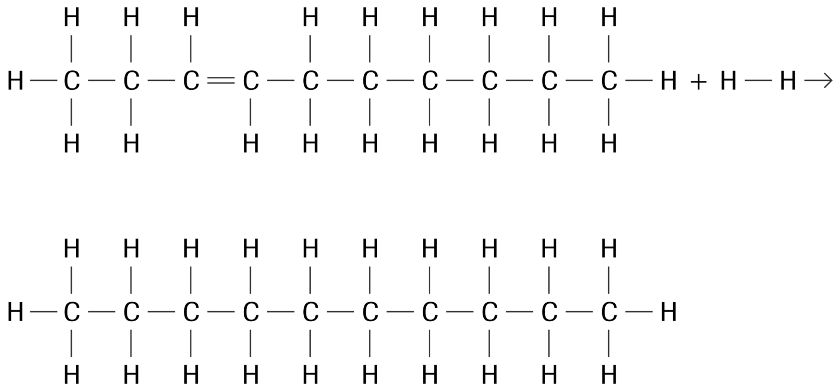


   (b) Both have seven carbon atoms. Heptane has only single bonds and is therefore saturated. 1-heptene has a double bond and less than the maximum number of hydrogen atoms, so is unsaturated.
5. (a)



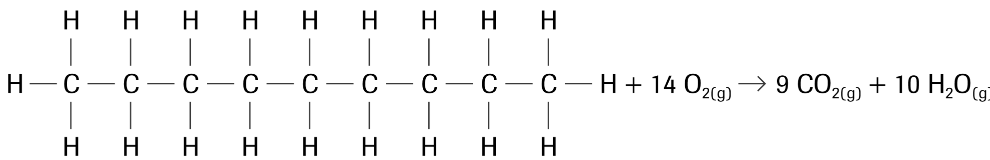
   (b) They both have four carbon atoms. The position of the triple bond is different: between the first and second carbon in one molecule, but between the second and third carbon in the other.

6.



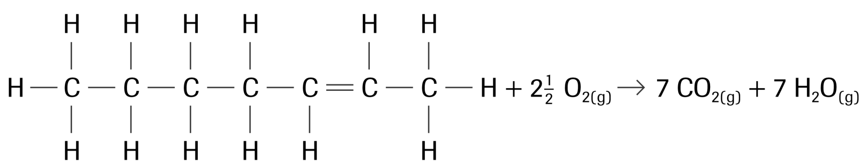
or $CH_3CH_2CH{=}CH(CH_2)_5CH_3 + H–H \rightarrow CH_3(CH_2)_8CH_3$

7. (a)



or $C_9H_{20} + 14\ O_2 \rightarrow 9\ CO_2 + 10\ H_2O$

(b)



or $C_7H_{14} + 2\tfrac{1}{2}O_2 \rightarrow 7\ CO_2 + 7\ H_2O$
or $2\ C_7H_{14} + 5\ O_2 \rightarrow 14\ CO_2 + 14\ H_2O$

3.1 EXTENSION EXERCISE

(Pages 124–125)

CONDENSED STRUCTURAL FORMULAS—ADDITIONAL PRACTICE

1. (a) $CH_3CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_3CH_3$ or C_5H_{12}
   (b) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_6CH_3$ or C_8H_{18}
   (c) $CH_3CH_2CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_4CH_3$ or C_6H_{14}
   (d) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_7CH_3$ or C_9H_{20}
   (e) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_8CH_3$ or $C_{10}H_{22}$
   (f) $CH_3CH_2CH_2CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_5CH_3$ or C_7H_{16}
2. (a) 2-butene
   (b) propyne
3. (a) $CH_3CH{=}CH(CH_2)_2CH_3$ or C_6H_{12}
   (b) $CH_3CH_2C{\equiv}C(CH_2)_3CH_3$ or C_8H_{14}

3.1 EXTENSION EXERCISE

(Page 126)

BE HEART SMART!—EXTRA CHALLENGE

1. The consumption of large quantities of saturated fats is linked to high levels of blood cholesterol. This excess can, over time, clog your arteries and increase your risk for heart attack and stroke.
2. fatty meats: beef, pork, lamb
   poultry with skin
   processed meats
   whole and 2% milk, butter, cheese, and lard
   palm kernel oil, palm oil, coconut oil, cocoa butter
3. Answers will depend upon the students' weekly eating plan.
4. Cooking
   - Bake, steam, roast, broil, or stew instead of frying.
   - Remove poultry skin before eating.
   - Use a non-stick pan instead of greasing with lard, etc.
   - Trim visible fat from meats.

   Shopping
   - Read labels carefully and choose
     – poultry breasts instead of wings or thighs;
     – low fat milk;
     – lean cuts of meat;
     – more vegetables, fruits, beans, and grains.

   Daily diet
   - Use lower fat milk in hot drinks and cereal.
   - Remove skin from meat.
   - Bake, roast, or broil food instead of frying.
   - Avoid cream and cream sauces.
   - Read labels.

3.2 EXTENSION EXERCISE

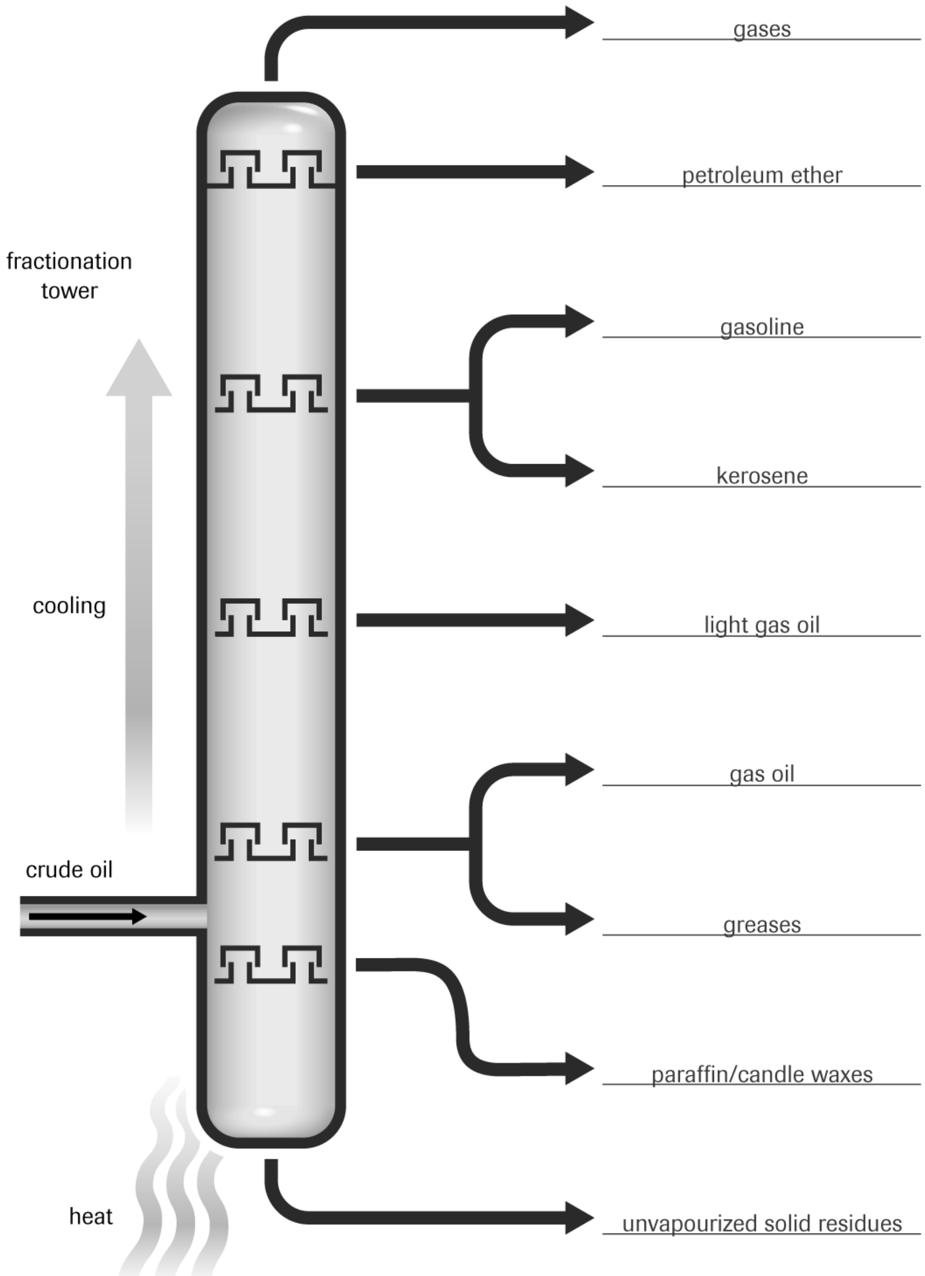
(Page 129)

IDENTIFYING ISOMERS—ADDITIONAL PRACTICE

2, 4, 6, 9, and 10 are all isomers of the alkane hexane.

(Page 131)

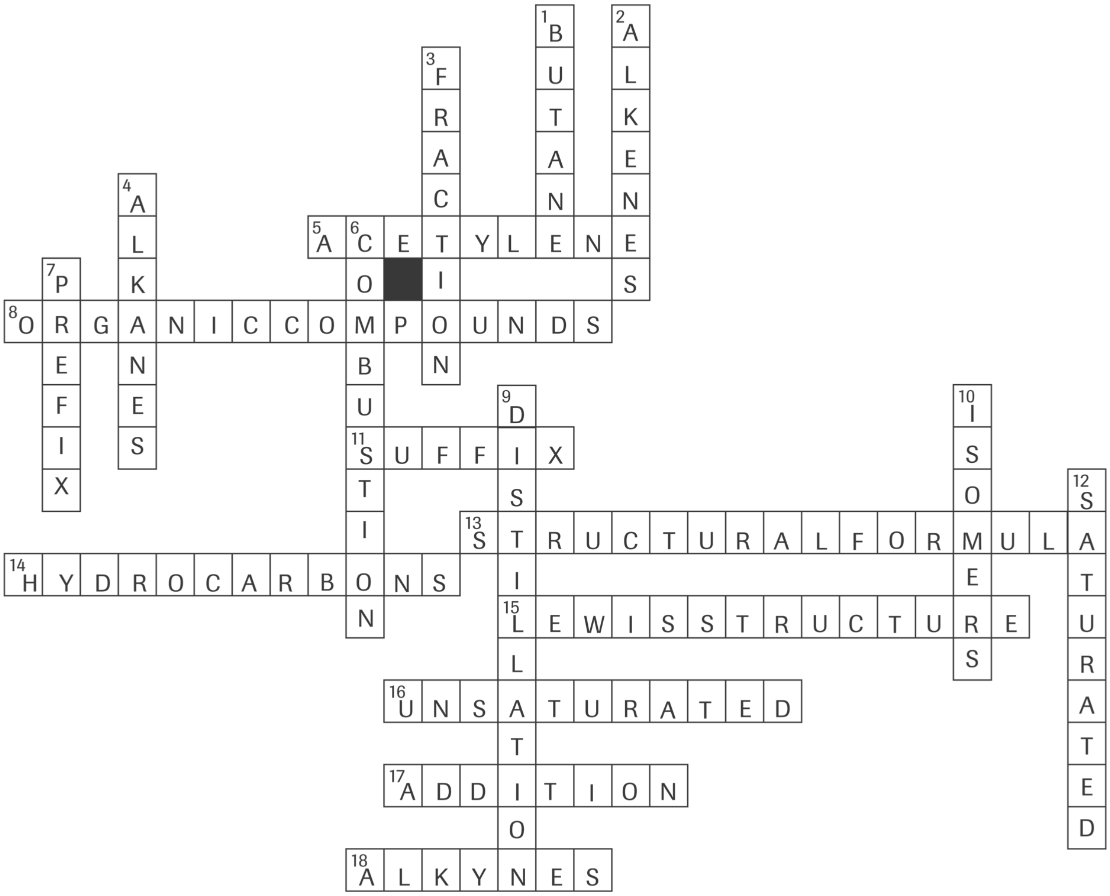
A FRACTIONATION TOWER—ADDITIONAL PRACTICE



3.1 – 3.3 SELF QUIZ

(Page 132)

Completion

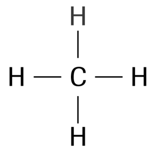


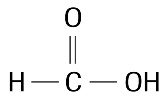
3.5 EXTENSION EXERCISE

(Pages 137–138)

FUNCTIONAL GROUPS—ADDITIONAL PRACTICE

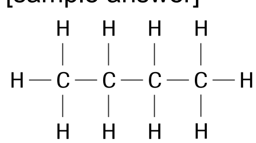
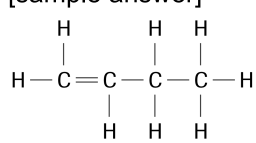
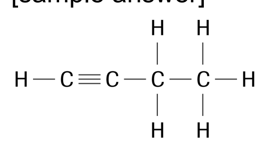
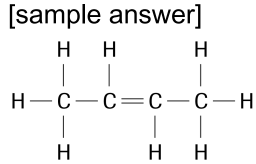
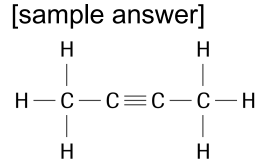
1. (a) alcohol (—OH circled)
   (b) carboxylic acid (—COOH circled)
   (c) ester (—COO— circled)
   (d) halogenated compound (halogen circled)
   (e) alcohol (—OH circled)
   (f) halogenated compound (halogens circled)
2. (a) An ester is an organic compound characterized by the presence of a carbonyl group bonded to an oxygen atom that is part of the chain.
   (b) A halogenated compound is a compound in which one or more hydrogen atoms have been replaced by F, Cl, Br, or I.
3. (a) Both alcohols and carboxylic acids have hydroxyl groups.
   (b) A carboxylic acid has a double-bonded O atom (carbonyl group) whereas an alcohol does not.

4. (a) methane: 

(b) methanoic acid 

3.4–3.6 SELF QUIZ

(Pages 141–142)

	Alkanes	**Alkenes**	**Alkynes**
Definition	A hydrocarbon with only single bonds between C atoms	A hydrocarbon that contains at least one C=C double bond	A hydrocarbon that contains at least 1 C≡C triple bond
General formula	C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}
Properties	Have strong covalent bonds, low boiling points and melting points, and low solubility in water; are relatively non-polar; undergo substitution reactions	Undergo addition reactions; are unsaturated; are more reactive than alkanes	Undergo addition reactions; are unsaturated; are more reactive than alkenes
Relative reactivity	Not reactive	More reactive	Most reactive
Example **(Draw structural formula.)**	[sample answer] 	[sample answer] 	[sample answer] 
Isomer **(example and name)**	(You may not be able to complete this box with your current knowledge.)	[sample answer]  2-butene	[sample answer]  2-butyne

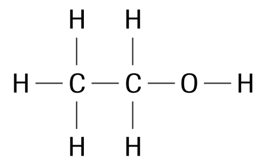
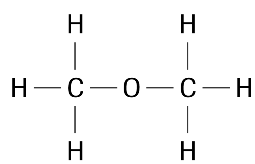
2. Student answers may vary. In some instances there is more than one correct answer.
   (a) magnesium: all the others ore organic
   (b) double bond: not part of an alkane
   (c) carbon–carbon single bond: not related to a functional group
   (d) $C_{12}H_{24}$: others are alkynes
   (e) same boiling point: others relate to fractional distillation

(f) CaO: not an organic compound
(g) alkynes: others are substituted hydrocarbons
(h) KFCs: others are all halogenated compounds

3.7 EXTENSION EXERCISE

(Page 143)

COMPARING ALCOHOLS AND ETHERS—ADDITIONAL PRACTICE

Alcohols	**Functional group:** **R—OH**
Properties: Boiling points of alcohols are higher than those of the parent alkanes. Alcohols are more soluble in polar solvents than are parent alkanes. The hydrocarbon part of the molecule is nonpolar, making some alcohols good solvents for nonpolar molecular compounds.	**Sample structural diagram:** [sample answer]  Name: ethanol Formula: CH_3CH_2OH
Ethers	**Functional group:** **R—O—R**
Properties: Ethers cannot form H bonds to themselves or other molecules. Ethers are more polar than hydrocarbons but less polar than alcohols. The boiling points of ethers are slightly higher than those of analogous hydrocarbons but lower than those of analogous alcohols.	**Sample structural diagram:** [sample answer]  Name: methoxymethane Formula: CH_3OCH_3

1. Alcohols and ethers are both substituted hydrocarbons. An alcohol has one hydroxyl group while an ether has two alkyl groups which can be the same or different.
2. Alcohols do not ionize in water to produce OH^- ions.
3. The freezing point of a solution of methanol in water is lower than the freeing point of water. Therefore, the freezing point of methanol is lower than the freezing point of water.
4. Ethoxyethane is irritating, nauseating, and highly flammable.

3.7 EXTENSION EXERCISE

(Page 144)

NAMING AND DRAWING ALCOHOLS—ADDITIONAL PRACTICE

1. (a) 1-propanol
   (b) 3-hexanol
   (c) 2-pentanol
   (d) methanol
   (e) ethanol
2. (a) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$ or $CH_3(CH_2)_7OH$
   (b) $CH_3CH(OH)CH_3$
   (c) $CH_3CH_2CH_2CH_2OH$ or $CH_3(CH_2)_3OH$
   (d) $CH_3CH_2CH_2CH_2CH(OH)CH_3$ or $CH_3(CH_2)_3CH(OH)CH_3$
   (e) $CH_3CH_2CH_2CH_2CH(OH)CH_2CH_3$ or $CH_3(CH_2)_3CH(OH)CH_2CH_3$
3. 1-pentanol $CH_3(CH_2)_4OH$
   2-pentanol $CH_3(CH_2)_2CH(OH)CH_3$
   3-pentanol $CH_3CH_2CH(OH)CH_2CH_3$

3.7 EXTENSION EXERCISE

(Page 145)

NAMING AND DRAWING ETHERS—ADDITIONAL PRACTICE

1. (a) propoxybutane
   (b) methoxypentane
   (c) methoxymethane
   (d) methoxyethane
   (e) propoxypropane
2. (a) $CH_3O(CH_2)_3CH_3$
   (b) $CH_3CH_2OCH_2CH_3$
   (c) $CH_3O(CH_2)_2CH_3$
   (d) $CH_3CH_2OCH_3$
   (e) $CH_3CH_2O(CH_2)_3CH_3$
3. methoxypropane: $CH_3O(CH_2)_2CH_3$ or $C_4H_{10}O$
   ethoxyethane: $CH_3CH_2OCH_2CH_3$ or $C_4H_{10}O$
   Yes, they are structural isomers.

3.7 EXTENSION EXERCISE

(Pages 146–147)

EXPLORE AN ISSUE: GASOHOL—EXTRA CHALLENGE

Answers may vary but should contain the following ideas:

Table 1 Arguments For and Against the Statement

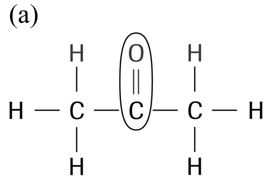
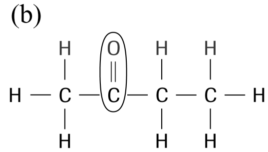
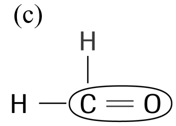
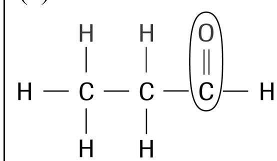
Arguments for	Arguments against
• Biological renewability • Less emissions than regular gasoline • Rural economic development • Decreased need for petroleum imports	• Too costly—not financially self-supporting • Environmental damage (e.g., pesticides, insecticides, soil erosion from crop production) • Energy-inefficient to produce

3.9 EXTENSION EXERCISE

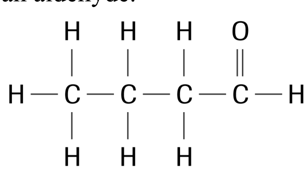
(Pages 152–153)

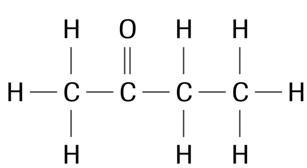
MORE FUNCTIONAL GROUPS—ADDITIONAL PRACTICE

1.

(a)	(b)	(c)	(d)
			
ketone	ketone	aldehyde	aldehyde

2. (a) carbonyl group
   (b) The carbonyl group is never at the end of the hydrocarbon chain in a ketone, whereas it is always at the end of an aldehyde.
   (c)





3.9 EXTENSION EXERCISE

(Page 154)

NAMING AND DRAWING ALDEHYDES—ADDITIONAL PRACTICE

1. (a) octanal
   (b) hexanal

(c) nonanal
(d) decanal

2. (a) $CH_3(CH_2)_2CHO$
   (b) CH_3CH_2CHO
   (c) CH_3CHO
   (d) HCHO
3. The presence of the C=O group causes aldehydes to have different properties from hydrocarbons. Aldehydes have stronger intermolecular forces and thus have higher melting points and boiling points than corresponding hydrocarbons. Aldehydes are also more polar than hydrocarbons.

3.9 EXTENSION EXERCISE

(Page 155)

NAMING AND DRAWING KETONES—ADDITIONAL PRACTICE

1. (a) 2-pentanone
   (b) butanone
   (c) 3-hexanone
   (d) 4-heptanone
2. (a) $CH_3CH_2COCH_3$
   (b) $CH_3CO(CH_2)_3CH_3$
   (c) $CH_3CH_2CO(CH_2)_3CH_3$
   (d) $CH_3(CH_2)_2CO(CH_2)_3CH_3$ (for example)
3. 2-pentanone: $CH_3CO(CH_2)_2CH_3$
   3-pentanone: $CH_3CH_2COCH_2CH_3$

3.10 ALTERNATIVE EXERCISE

(Pages 156–157)

SAFETY ON THE JOB

How do solvents enter the body?	
• Solvent vapour can be breathed into the lungs. • Liquid solvent can be absorbed through the skin. • Solvents can be swallowed and cause poisoning.	
How do solvents affect your health?	
Short-term effects	**Long-term effects**
• headaches • drowsiness • forgetfulness • damage to skin and eyes • weakness • irritability and mood changes • giddiness and balance disturbance • nausea • abnormal tiredness	• lack of concentration • loss of memory • depression • blunting of mental skills

Ways to reduce exposure	Protective equipment
• Use other products in place of solvents. • Use a less volatile solvent. • Use a less toxic solvent. • Reduce the quantity of solvent used. • Keep containers sealed. • Clean up spills immediately. • Place solvent-contaminated rags in a sealed bin. • Work with solvents in a well-ventilated area.	• correctly fitted respirator with appropriate solvent filter • air-supplied respirator for use in confined spaces • safety goggles • gloves that are suitable for use with solvents

1. MSDS sheets
2. mechanical ventilation; eye-wash station; fire extinguisher, appropriate respirator
3. Entering confined spaces where solvents are present is potentially lethal. Solvents can enter the body through the lungs or through the skin. Special training and protective gear are required.
4. The Education and Training Representative should make sure that all employees are informed about the hazards and precautions necessary to prevent possible harm to their health.
5. Occupational Safety and Health Office of the Department of Labour

3.11 EXTENSION EXERCISE

(Page 158)

NAMING AND DRAWING CARBOXYLIC ACIDS—ADDITIONAL PRACTICE

1. (a) methanoic acid
   (b) ethanoic acid
   (c) heptanoic acid
   (d) butanoic acid
2. (a) $CH_3(CH_2)_8COOH$
   (b) $CH_3(CH_2)_3COOH$
   (c) $CH_3(CH_2)_7COOH$
   (d) $CH_3(CH_2)_6COOH$
3. $CH_2CHCOOH$ or $CH_2{=}CHCOOH$

3.11 EXTENSION EXERCISE

(Page 159)

ACTIVITY: MAKING ASPIRIN—EXTRA CHALLENGE

Observations

Step 5: Colour changes slightly; becomes translucent.
Step 6: White crystals form.
Step 7: [Sample answer] Mass—about 1 g
Grayish crystalline solid
Step 8: white crystalline solid
[Sample answer] The theoretical yield would be between 5.5 g and 6.0 g but students would likely get less than that (perhaps 50–60% of the theoretical yield).

(a) The appearance should be similar except that the Aspirin produced will not have been pressed into tablet form.
(b) The two samples should look similar.

Analysis

(c) The mass of ASA produced in the lab will be less than the mass of ASA in two commercial tablets.

Synthesis

(d) white colour
powder or solid
sour taste (although the lab-made product should not be tasted)
soluble in water

3.7 – 3.12 SELF QUIZ

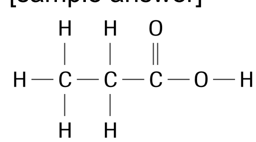
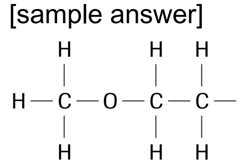
(Pages 162–163)

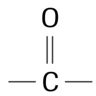
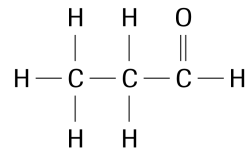
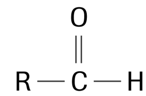
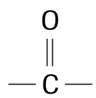
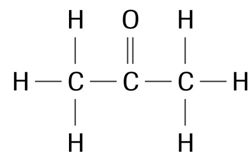
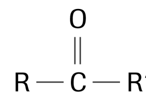
Vocabulary Check

1. Q	2. H	3. M	4. R
5. D	6. I	7. E	8. J
9. N	10. S	11. L	12. F
13. T	14. B	15. C	16. A
17. G	18. K	19. O	20. P

SUMMARY OF SUBSTITUTED HYDROCARBONS

Table 1 Substituted Hydrocarbons Summary Chart

Family name	Functional group	Example (name)	Structural formula
halogenated compounds	—F, —Cl, —Br, —I	[sample answer] CH_3Cl chloromethane	R—X
alcohols	—OH	[sample answer] $CH_3(CH_2)_2OH$ 1-propanol	R—OH
carboxylic acids	$-\overset{\displaystyle O}{\overset{\|}{C}}-OH$	[sample answer]  CH_3CH_2COOH propanoic acid	$R-\overset{\displaystyle O}{\overset{\|}{C}}-OH$
ethers	—O—	[sample answer]  $CH_3OCH_2CH_3$ methoxyethane	R — OR′

Family name	Functional group	Example (name)	Structural formula
aldehydes		[sample answer]  CH_3CH_2COH propanal	
ketones		[sample answer]  CH_3COCH_3 propanone	

3.13 EXTENSION EXERCISE

(Pages 164–165)

NAMING AND DRAWING ESTERS—ADDITIONAL PRACTICE

1. (a) pentyl butanoate
   (b) ethyl butanoate
   (c) methyl ethanoate
2. (a) $CH_3CH_2COO(CH_2)_3CH_3$
   (b) $CH_3(CH_2)_5COOCH_3$
   (c) $CH_3COO(CH_2)_2CH_3$
3. (a) ethyl propanoate
   (b) methyl butanoate
4. (a) Ethyl propanoate could be made from propanoic acid and ethanol.
   (b) Methyl butanoate could be made from butanoic acid and methanol.

3.13 EXTENSION EXERCISE

(Pages 166–167)

ACTIVITY: ARTIFICIAL FLAVOURS—EXTRA CHALLENGE

Observations

Table 1 Summary for Making Esters

Test tube	Alcohol	Organic acid	Odour
1	3-methyl-1-butanol	butanoic acid	apricot
2	ethanol	butanoic acid	pineapple
3	ethanol	decanoic acid	grape
4	3-methyl-1-butanol	2-hydroxybenzoic acid	wintergreen

Analysis

(a) Test Tube #1: 3-methylbutyl butanoate (isoamyl butyrate)
Test Tube #2: ethyl butanoate
Test Tube #3: ethyl decanoate
Test Tube #4: methyl 2-hydroxybenzoate (methyl salicylate)

Synthesis

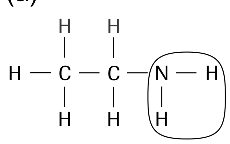
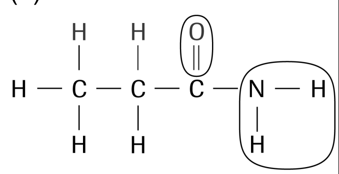
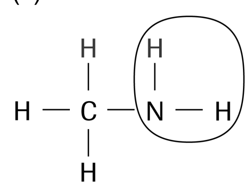
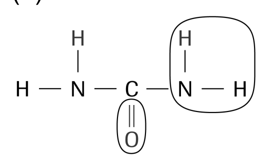
(b) (i) 3-methyl-1-butanol and butanoic acid (or 3-methylbutyl butanoate)
(ii) ethanol and decanoic acid (or ethyl decanoate)
(iii) methanol and butanoic acid (or methyl 2-hydroxybenzoate or methyl salicylate)
(iv) ethanol and butanoic acid (or ethyl butanoate)
(c) The concentrated sulfuric acid acts as a catalyst and speeds up the reaction.

3.15 EXTENSION EXERCISE

(Page 170)

FURTHER FUNCTIONAL GROUPS—ADDITIONAL PRACTICE

1.

(a)	(b)	(c)	(d)
			
amine	amide	amine	amide

2. (a) an amino group
(b) Amides have their amino group bonded to the carbon atom of the carbonyl group, whereas amines have their amino group attached directly to the hydrocarbon chain.

3.15 EXTENSION EXERCISE

(Page 172)

NAMING AND DRAWING AMINES—ADDITIONAL PRACTICE

1. (a) 1-aminooctane
(b) 3-aminoheptane
(c) 4-aminononane
(d) 2-aminobutane
2. (a) $CH_3CH_2CH(NH_2)(CH_2)_4CH_3$
(b) CH_3NH_2
(c) $CH_3(CH_2)_2CH(NH_2)(CH_2)_5CH_3$
(d) $CH_3(CH_2)_4CHNH_2$
3. An amine is a class of organic compounds that has a nitrogen atom attached to one or more hydrocarbon chains.

3.15 EXTENSION EXERCISE

(Page 173)

NAMING AND DRAWING AMIDES—ADDITIONAL PRACTICE

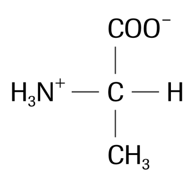
1. (a) propanamide
   (b) methanamide
   (c) heptanamide
   (d) pentanamide
2. (a) $CH_3(CH_2)_6CONH_2$
   (b) $CH_3(CH_2)_8CONH_2$
   (c) $CH_3(CH_2)_4CONH_2$
   (d) $CH_3(CH_2)_7CONH_2$
3. Both have an amino group. However, in the amide the amino group is attached to the carbon atom of the carbonyl group, whereas in the amine the amino group is attached directly to an alkyl group.

3.15 EXTENSION EXERCISE

(Pages 174–175)

UREA AND AMINO ACIDS—EXTRA CHALLENGE

1. (a) Most of our nitrogenous wastes come from the breakdown of amino acids. This breakdown occurs by the process of deamination, resulting in the production of ammonia, NH_3.
   (b) Amino acids are the building blocks (monomers) of proteins. Twenty different amino acids are used to synthesize proteins. The shape and other properties of each protein are dictated by the precise sequence of amino acids linked together to make the protein.
   (c)

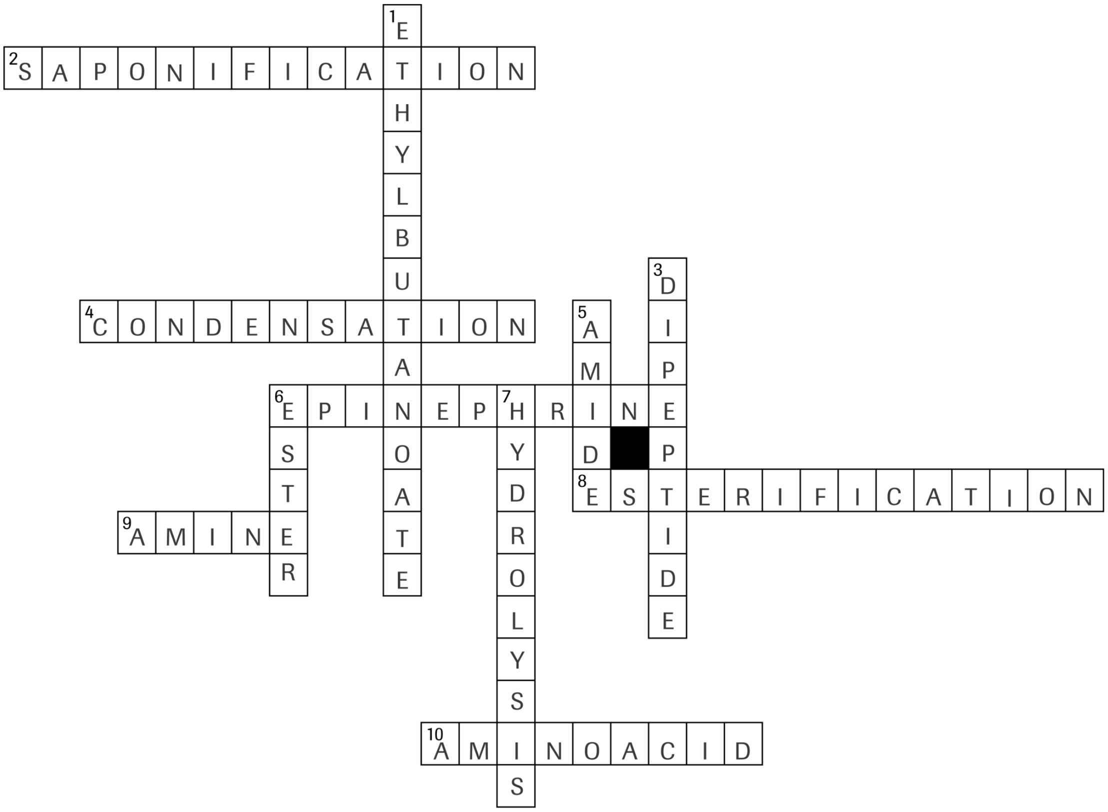


2. (a) The liver contains a system of carrier molecules (ornithine) and enzymes that temporarily bond with ammonia (produced by deamination) and carbon dioxide, forming them into less toxic urea. Each carrier molecule is then returned to its initial form. This cycle is known as the urea cycle.
   (b) An inherited disease that affects the urea cycle is ornithine transcarbamoylase deficiency. Illness occurs because of a deficiency of the enzyme that converts ornithine to citrulline, so ammonia cannot be excreted fast enough. This enzyme deficiency results in elevated levels of ammonia, which can be life-threatening.
3. (a) uric acid: a product of nucleic acid metabolism
   (b) gout
   (c) Uric acid is only slightly soluble in water and can precipitate out of solution. Precipitation tends to occur in the tiny blood vessels of the toes, causing inflammation and pain.
   (d) Humans and apes are most susceptible to this condition as they lack the enzyme for breaking down uric acid into a soluble product.
4. Insects, birds, lizards, and snakes convert the waste products of protein and nucleic acid metabolism into uric acid. Because of its low solubility in water, these animals are able to eliminate waste nitrogen as a semi-solid waste, with little loss of water.

3.13–3.16 SELF QUIZ

(Page 178)

Completion



3.18 EXTENSION EXERCISE

(Pages 182–183)

ACTIVITY: NATURAL OR SYNTHETIC POLYMERS?—EXTRA CHALLENGE

Observations

(Assuming that A is polyester, B is nylon, C is acetate, D is cotton, E is wool, and F is silk)

Table 1 Observations of Six Fabric Types

Fabric type	Original colour and texture	Burning character-istics	Type of residue	Ease of tearing	Absorp-tion	Chemical damages or changes
A (polyester)	[Depending on the sample, texture could be smooth or coarse and the finish could be matte or shiny.]	Sample burns slowly with a dark smoke and aromatic odour. It will melt first and drip away from the flame.	plastic bead-like residue	variable, depending on the manufact-urer; no loss of strength when wet	very low	good resistance to weak bases; moderate resistance to strong bases; hot, strong bases degrade fabric
B (nylon)	[Nylon is generally smooth in texture with a satin to shiny finish.]	melts	forms a gummy grey or tan residue that hardens when cooled	very strong; loses 10–20% of strength when wet	low	resistant but will result in colour loss
C (acetate)	[Acetate is usually smooth in texture and has a shiny finish resembling silk.]	melts and burns with a chemical smell	leaves a hard black bead ash	fairly easily torn; not much difference between wet and dry strength	low	good resistance to dilute bases; concentrated bases cause gradual thinning and stiffening of fibres
D (cotton)	[Depending on the sample, cotton's fibres are finer than those of wool, but coarser than those of silk.]	burns readily with a smell like burning paper	fluffy, grey ash	moderate; strength increases 10–20% when wet	high	highly resistant to bases
E (wool)	[Depending on the sample, wool is usually fuzzy, made from loosely twisted yarn with coarse fibres.]	burns slowly with a smell like burning hair	leaves a brittle, bead-like residue	relatively weak	high	very little resistance to bases: a 5% solution of sodium hydroxide will dissolve wool

Fabric type	Original colour and texture	Burning character-istics	Type of residue	Ease of tearing	Absorp-tion	Chemical damages or changes
F (silk)	[Depending on the sample, silk usually has a smooth texture and shiny finish.]	burns with a smell like burning hair	leaves a brittle ash	very strong; loses 10–15% of strength when wet	medium to high	very low resistance to bases

(a) Natural fabrics burned; synthetics melted.
(b) Synthetic polyester and nylon were the hardest to tear.
(c) Polyester and nylon were the most water repellent. Cotton was the most absorbent.
(d) Wool held its colour best with exposure to bleach. All were easier to tear after than before being soaked in bleach.

Analysis

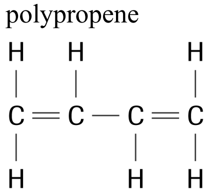
(e) The polymers that leave a residue like a plastic bead have structures similar to other plastics.
(f) Synthetic fabrics burned and melted while natural fabrics tended to burn to an ash.
(g) Synthetic fabrics are stronger than natural fabrics.
(h) Natural fabrics are less water repellant and absorb more water than synthetic fabrics.
(i) All lose some fibre strength when bleached. However, synthetic fabrics were still stronger than the natural fabrics.
(j) [Sample answer] Stain resistance, durability, wrinkle resistance, drying time, the effect of sunlight, flammability, and tensile strength could be tested.
(k) [Sample answer] Today's synthetic fabrics save us time: they are more wrinkle resistant than natural fibres and so need less ironing, and are lightweight and strong. We have more options for clothing, furnishing, and industrial fabrics. We have fabrics that are quicker-drying, more easily dyed, more elastic, and waterproof. Many of these properties are not available in natural fabrics.

3.18 EXTENSION EXERCISE

(Page 184)

TRY THIS ACTIVITY: MODELS OF POLYMERS—EXTRA CHALLENGE

(a) polyethene
(b) polypropene
(c)



Formula: C_4H_6

3.19 ALTERNATIVE EXERCISE

(Page 185)

THE INVENTION OF NYLON

1. Wallace Carothers invented nylon while he was working for DuPont. Carothers had studied and taught organic chemistry with a specialization in polymers.
2. Carothers made a major contribution to the understanding of polymer structures and polymerization. Until that time, these molecules were little understood.
3. DuPont's goal was researching polymers with an eye to possible industrial applications, especially in the field of artificial materials.
4. Carothers combined amine, hexamethylene diamine, and adipic acid. It created fibres, but they were weak.
5. Carothers realized that water from the condensation reaction was dropping back into the mixture and getting in the way of more polymers forming. He adjusted the equipment so that the water was distilled and removed. The resulting fibres were long, strong, and very elastic.
6. It was named Nylon-66 because the adipic acid and the hexamethylene diamine each contain 6 carbon atoms per molecule. The name "Nylon" came from New York and London.
7. toothbrushes, fishing line, lingerie, surgical thread, parachutes, tubing, fasteners

3.21 EXTENSION EXERCISE

(Page 189–190)

BUCKYBALLS—EXTRA CHALLENGE

1.

Table 1 C_{60}: Buckyballs

Chemical properties	Physical properties	Possible applications in industry
• reacts with elements from across the periodic table • reacts with free radicals • can be a superconductor when "doped" • can absorb large numbers of H atoms without disrupting its structure	• roundest, most symmetrical large molecule know • very rugged • very stable • capable of surviving temperature extremes of outer space • resistant to shock	• may replace silicon in computers and communication devices • as a surface coating to improve wear resistance • in components in scientific instruments • in drug delivery sytems

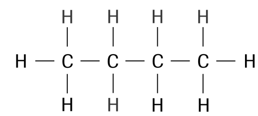
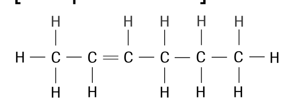
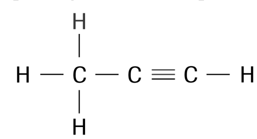
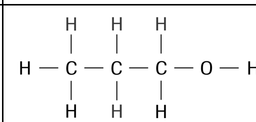
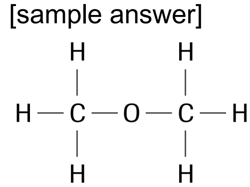
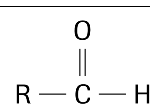
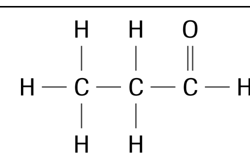
2. • make improved scanning force microscopes
   • tiny abacuses for computation using a STM
   • better computer chip

UNIT 3 SUMMARY

(Pages 191–192)

SUMMARY TABLES

Table 1 Families of Organic Compounds

Family name	Properties	General formula	Example (name and structural formula)
alkanes	• higher melting points and boiling points with more Cs in chain • nonpolar • relatively unreactive • insoluble in water	C_nH_{2n+2}	[sample answer]  butane
alkenes	• more reactive than alkanes • readily undergoes synthesis reactions • melting point and boiling point increase with size of molecules • insoluble in water	C_nH_{2n}	[sample answer]  2-hexene
alkynes	• very reactive • melting points and boiling points increase with increasing number of C atoms • insoluble in water	C_nH_{2n-2}	[sample answer]  propyne
alcohols	• polar • high boiling point • water soluble (if small molecules)	R—OH	 1-propanol
ethers	• most reactive • insoluble in water • volatile	R—O—R´	[sample answer]  methoxymethane
aldehydes	• very reactive • distinct odours • relatively less soluble than comparable alcohols in water		 propanal

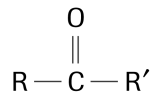
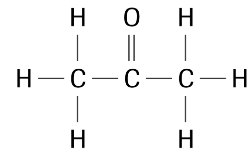
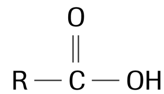
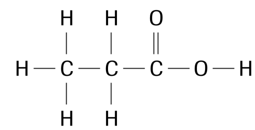
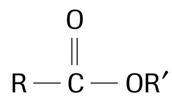
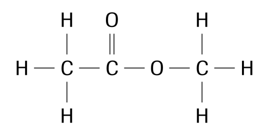
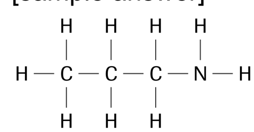
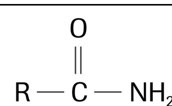
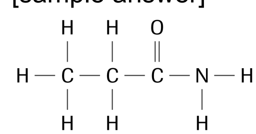
Family name	Properties	General formula	Example (name and structural formula)
ketones	• very reactive • distinct odours • many have useful solvent properties • solubility in water decreases with increasing molecular size		[sample answer]  propanone
carboxylic acids	• acidic • usually soluble in water • strong unpleasant odour • form metal salts in acid–base reaction		[sample answer]  propanoic acid
esters	• strong aromas • volatile • ester with low molar mass have pleasant, fruity odours • soluble in water if fewer than five Cs in the chain		[sample answer]  methylethanoate
amines	• basic • pungent, ammonia-like odour • soluble in water if fewer than five Cs in the chain	$R—NH_2$	[sample answer]  propanamine
amides	• neutral • mostly solids		[sample answer]  propanamide

Table 2 Polymers

Polymer	Example of monomer(s)	Example of polymer	Structure	Physical properties
synthetic polyesters	ester	Dacron polyester	many ester molecules joined in a long chain	strength durability water resistance
synthetic polyamides	amide	nylon	many amide molecules joined in a long chain	strength elasticity
proteins	amino acids	polypeptide	long strings of amino acids in a specific order	provide structure and support, transport, and regulation in a living system

UNIT 3 SELF QUIZ

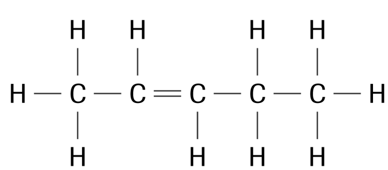
(Pages 195–196)

Multiple Choice

1. (c)
2. (c)
3. (b)
4. (a)
5. (c)
6. (b)
7. (c)
8. (b)
9. (a)
10. (b)

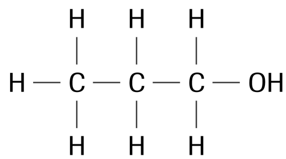
Completion

11. carbonyl
12. ethanol
13. alkenes
14. isomers
15. addition polymer
16. amine
17. carboxyl
18. unsaturated
19. boiling points
20. condensation
21. (a)



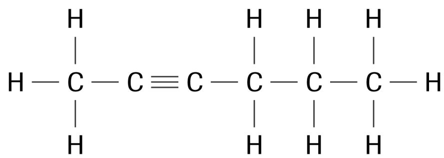
$CH_3CH{=}CHCH_2CH_3$ or C_5H_{10}

(b)



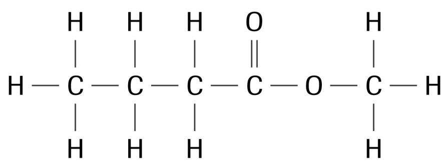
$CH_3(CH_2)_2OH$ or C_3H_7OH

(c)



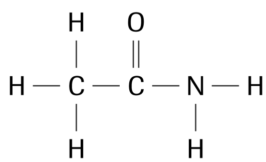
$CH_3C{\equiv}C(CH_2)_2CH_3$ or C_6H_{10}

(d)



$CH_3(CH_2)_2COOCH_3$

(e)



CH_3CONH_2