UNIT 5 Review

Knowledge/Understanding

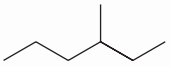
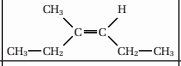
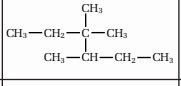
Multiple Choice

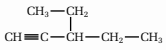
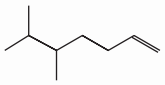
In your notebook, write the letter beside the best answer for each question.

1. An alkane contains 5 carbon atoms. How many hydrogen atoms does it contain?
   - **(a)** 5 hydrogen atoms
   - **(b)** 8 hydrogen atoms
   - **(c)** 10 hydrogen atoms
   - **(d)** 12 hydrogen atoms
   - **(e)** 14 hydrogen atoms
2. An alkyne contains 12 hydrogen atoms. What is its chemical formula?
   - **(a)** C_5H_{12}
   - **(b)** C_6H_{12}
   - **(c)** C_7H_{12}
   - **(d)** C_8H_{12}
   - **(e)** C_9H_{12}
3. Which set of properties best describes a small alkane, such as ethane?
   - **(a)** non-polar, high boiling point, insoluble in water, extremely reactive
   - **(b)** non-polar, low boiling point, insoluble in water, not very reactive
   - **(c)** polar, low boiling point, soluble in water, not very reactive
   - **(d)** polar, high boiling point, insoluble in water, not very reactive
   - **(e)** non-polar, low boiling point, soluble in water, extremely reactive
4. Which equation shows the complete combustion of propane?
   - **(a)** $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
   - **(b)** $2C_2H_6 + 5O_2 \rightarrow C + 2CO + CO_2 + 6H_2O$
   - **(c)** $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$
   - **(d)** $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
   - **(e)** $2C_3H_8 + 7O_2 \rightarrow 2C + 2CO + 2CO_2 + 8H_2O$
5. Which situation describes an exothermic reaction?
   - **(a)** The energy that is released to form the product bonds is greater than the energy that is used to break the reactant bonds.
   - **(b)** The energy that is released to form the product bonds is less than the energy that is used to break the reactant bonds.
   - **(c)** The energy that is released to form the product bonds is equal to the energy that is used to break the reactant bonds.
   - **(d)** The energy that is used to break the product bonds is greater than the energy that is released to form the reactant bonds.
   - **(e)** The energy that is used to break the product bonds is less than the energy that is released to form the reactant bonds.
6. Beaker A contains 500 mL of a liquid. Beaker B contains 1000 mL of the same liquid. What happens when 200 kJ of thermal energy is added to the liquid in each beaker?
   - **(a)** The temperature of the liquid increases the same amount in both beakers.
   - **(b)** The temperature of the liquid decreases the same amount in both beakers.
   - **(c)** The temperature of the liquid remains the same in both beakers.
   - **(d)** The temperature change of the liquid in Beaker B is twice as large as the temperature change of the liquid in Beaker A.
   - **(e)** The temperature change of the liquid in Beaker B is one half as large as the temperature change of the liquid in Beaker A.

Short Answer

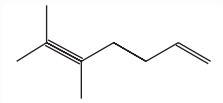
7. Copy the table below into your notebook. Fill in the blanks.

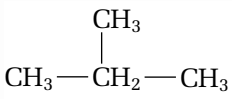
Name	Structural diagram	Molecular formula	Classification
ethane	CH_3-CH_3	C_2H_6	alkane
		C_3H_4	
			
1-ethyl-3-methy-cyclopentane			
			
1, 2-dimethyl-cyclobutane			
			
		C_4H_6 (isomer 1)	
		C_4H_6 (isomer 2)	

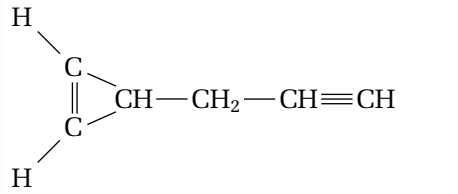
Name	Structural diagram	Molecular formula	Classification
trans-4-ethyl-6-methyl-3-heptene			
			
			
4-ethyl-3,6-dimethyl-5-propyl-decane			

8. Identify the error(s) in each structure.

(a) $CH_3 - CH_3 - CH_3$

(b) 

(c) 

(d) 

9. Identify the error(s) in each name.

(a) 2-ethene

(b) 1,2,2-trimethylpropane

(c) 3, 5-dimethyl-4-ethyl-4-hexene

(d) 4-ethyl-2-pentene

10. Copy the table below into your notebook. Complete it as follows:

- Write the general formulas for the alkane, alkene, alkyne, and cycloalkane homologous series.
- Draw the structural diagram for the third member of each homologous series. Hint: The first member of the alkene series is ethene, C_2H_4.
- Name the compound you drew.
- Indicate whether the compound you drew is saturated or unsaturated.

Homologous series	General formula	Structural diagram	Name	Saturated or unsaturated
alkane				
alkene				
alkyne				
cylcoalkane				

11. Four fuels are listed in the table below. Equal masses of these fuels are burned completely.

Fuel	Heat of combustion at SATP (kJ/mol)
octane, $C_8H_{18(\ell)}$	5513
methane, $CH_{4(g)}$	890
ethanol, $C_2H_5OH_{(\ell)}$	1367
hydrogen $H_{2(g)}$	285

(a) Put the fuels in order, from greatest to least amount of energy provided.

(b) Write a balanced chemical equation for the complete combustion of each fuel.

(c) Suggest one benefit and one risk of using hydrocarbon fuels.

12. You are given a 70 g sample of each of the following metals, all at 25°C. You heat each metal under identical conditions. Which metal will be first to reach 30°C? Which will be last? Explain your reasoning.

Metal	Specific Heat Capacity (J/g•°C)
Platinum	0.133
Titanium	0.528
Zinc	0.388

Inquiry

13. Design an investigation to differentiate between these two compounds:

$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ and
$CH_3 - CH = CH - CH_2 - CH_2 - CH_3$

14. When kerosene, $C_{12}H_{26(\ell)}$, is burned in a device such a space heater, energy is released. Design an investigation to determine the amount of energy that is released, per gram of kerosene. Discuss potential problems with using a kerosene heater in a confined area, such as a camper trailer, where the supply of air may be limited. Support your discussion with balanced chemical equations.

15. A group of students tested two white, crystalline solids, A and B, to determine their heats of solution. The students dissolved 10.00 g of each solid in 100.0 mL of water in a polystyrene calorimeter and collected the temperature data. They obtained the following data:

Time	Temperature (A)	Temperature (B)
0.0	15	25
0.5	20.1	18.8
1.0	25	16.7
1.5	29.8	15.8
2.0	31.9	15.2
2.5	32.8	15
3.0	33	15
3.5	33	15.2
4.0	32.8	15.5
4.5	32.5	15.8
5.0	32.2	16.1
5.5	31.9	16.4

(a) Graph the data in the table above, placing time on the *x*-axis and temperature on the *y*-axis. Use your graph to answer (b) to (d).
(b) Classify the heat of solution of each solid as exothermic or endothermic.
(c) From the data given, calculate the heat of solution for each solid. Your answer should be in kJ/g.
(d) Is there any evidence from the data that the students' calorimeter could have been more efficient? Explain your answer.

16. An unknown hydrocarbon gas was collected in test tubes. It was mixed with pure oxygen gas in the following ratios:

Test tube	% gas	% oxygen
1	75	25
2	50	50
3	33	67
4	25	75

A match was held up to the mouth of each test tube to ignite the contents. Afterwards, limewater was added to each test tube to test for the presence of carbon dioxide. (**Note:** The presence of large amounts of carbon dioxide indicates more complete combustion.) The following results were recorded.

Test tube	Result of combustion	Carbon dioxide test
1	no sound; smoke and black solid formed	remained almost clear, so very little $CO_{2(g)}$ present
2	small pop; less smoke; less black solid	turned slightly milky so some $CO_{2(g)}$ present
3	loud pop; no smoke or black solid	turned very milky so alot of $CO_{2(g)}$ present
4	small pop; no smoke or black solid	turned slightly milky so some $CO_{2(g)}$ present

The gas may be methane, ethane, or propane.

(a) Write balanced chemical equations for the complete combustion of methane, ethane, and propane.
(b) Which test tube indicates the most complete combustion? Why?
(c) Use your answer to question (b) and your balanced chemical equations to determine the most likely identity of the unknown gas. Support your answer with a clear explanation.
(d) Write one possible balanced equation for the incomplete combustion of the gas you chose in question (c).
(e) Both methane and propane are used in Canada to heat homes. Discuss the possible consequences if these gases are burned in furnaces or appliances that do not have adequate ventilation.

Communication

17. Use a concept map to trace the path of a six-carbon hydrocarbon molecule as it goes from its source in the ground, through processing, into a can of paint. Describe each step in its processing. Explain any changes that the molecule undergoes.

18. What do "saturated" and "unsaturated" mean when applied to hydrocarbons? Give an example of a saturated hydrocarbon and an example of an unsaturated hydrocarbon.

19. Why do alkanes and alkynes, unlike alkenes, have no geometric isomers?

20. Explain why carbon is able to form so many more compounds than any other element.

21. Discuss how you can determine whether the following compounds are alkanes, cycloalkanes, alkenes, or alkynes, without drawing their structural diagrams: C_6H_{12}, C_4H_6, C_5H_{12}, C_7H_{14}, and C_3H_4.

22. Describe the information that is included in the following thermochemical equation:

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2HN_{3(g)} + 92.2 \text{ kJ}$$

23. Define calorimetry. Describe two commonly used calorimeters.

24. When taking a calorimetric measurement, why do you need to know the heat capacity of the calorimeter?

25. Describe two exothermic processes and two endothermic processes.

26. Compare the following terms: specific heat capacity and heat capacity.
    (a) Write their symbols and their units.
    (b) Write a mathematical formula in which each term would be used.

Making Connections

27. You will often see numbers on gas pumps that indicate how efficiently the fuel burns. A higher number indicates a more efficient fuel. These numbers refer to the "octane rating" of the fuel. There is a direct relationship between the octane rating and the degree of branching in fuel hydrocarbons. The presence of branches increases the efficiency of a fuel. Arrange the following hydrocarbon compounds in order of increasing octane rating: 2-methylhexane, heptane, and 2,2,4-trimethylpentane. Explain.

28. When walking briskly, you use about 20 kJ of energy per minute. One serving of a whole wheat cereal (37.5 g) provides about 126 Cal (food calories) of energy. Hint: 1 Cal = 4.184 kJ
    (a) How long could you walk after eating one serving of cereal?
    (b) How far could you walk at 60 km/h?

29. As you learned in previous chapters, research has been focused on using hydrogen gas as a fuel. Hydrogen is being researched as a fuel. It burns according to the following equation:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(\ell)}$$

The heat of combustion for hydrogen is –141.5 kJ/g.
    (a) Calculate the energy produced by the combustion of one litre (0.702 kg) of octane, $C_8H_{8(\ell)}$, in gasoline. The heat of combustion of octane is –41.3 kJ/g.
    (b) Calculate the volume of hydrogen gas at SATP that is required to produce the same amount of energy as the octane in part (a).
    (c) How could hydrogen gas be stored in order to carry a practical amount in a passenger vehicle? What possible danger might this create?

30. Government leaders often use the perspectives of human health and well-being, the environment, and the economy to study the risks and benefits of various fuels and alternatives. Suppose you are a leader in a developing country. You need to choose one of these energy sources to meet your country's needs: hydrocarbon fuels, hydroelectric power, or nuclear energy. Write a small report, analyzing each energy source from the three perspectives given above. Which energy source would you choose? Why?

COURSE CHALLENGE

Planet Unknown

Consider the following as you continue to plan for your Chemistry Course Challenge:

- How can you measure the energy content of a fossil fuel in the laboratory?
- How can you calculate heat using mass, temperature change, and specific heat capacity?
- What conditions are necessary in order for a large amount of fungus to be converted into a fossil fuel?