Comparing Auto Racing Fuels
Teacher Guide/Answer Key - Secondary

Objectives

Students will compare racing fuels and their properties.

Students will identify positive and negative attributes of racing fuels.

Vocabulary

- chemical energy
- combustion
- distilled
- efficiency
- emissions
- energy
- energy density
- enthalpy
- ethanol
- exothermic
- fermentation
- gasoline
- glucose
- greenhouse gas
- hydrocarbon
- methanol
- nonrenewable
- octane
- performance
- renewable
- surroundings
- suspension
- system
- thermal energy
- transmission
- viscous
- volatile

Time

- 1-2 class periods

Materials

- Molecular modeling kits
- Internet access
- Comparing Auto Racing Fuels worksheets

Preparation

1. Make copies of student worksheets, or prepare digital copies, as needed.
2. Gather modeling kits and ensure students have enough parts to assemble the molecular models for this activity.

NOTE: Common household or food items can also be substituted for molecular modeling kits, if needed. Marshmallows and toothpicks, for example, work very well for this activity.

3. Have students read the background information individually, or as a group.
4. Have students answer the questions and create their models.
5. When students are ready, they may begin researching the properties of each fuel. Students should complete the remainder of the activity once they have completed their research. Students may search independently, or you may provide them with reliable information using the list of resources below.

Research Resources

NEED's *Transportation Fuels Infobook*: www.NEED.org

The Engineering ToolBox: www.engineeringtoolbox.com

New Jersey Department of Health Hazardous Substance Fact Sheets: http://nj.gov/health/eoh/rtkhsfs/indexfs.aspx?lan=english

Energy Information Administration: www.eia.gov

Aus-e-tute: www.ausetute.com.au/heatcomb.html

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1. Write chemical reaction equations for ethanol and octane, and balance the equations.

Ethanol:

$C_2H_5OH + 3\ O_2 \dashrightarrow 2\ CO_2 + 3\ H_2O$ **$\Delta H = -1371$ kJ/mol**

Gasoline:

$2\ C_8H_{18} + 25\ O_2 \dashrightarrow 16\ CO_2 + 18\ H_2O$ **$\Delta H = -5330$ kJ/mol**

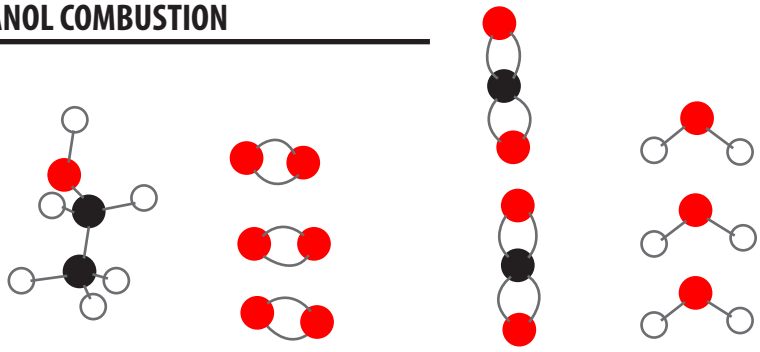
2. How many moles of ethanol must be burned to obtain the same amount of energy released by burning one mole of octane?

$$\frac{\textbf{530 KJ/mol}}{\textbf{1371 KJ/mol}} = \textbf{3.89 mol ethanol}$$

3. Use a molecular modeling kit to build the molecules in the ethanol and octane combustion reactions in the proper proportions. Combine kits with a partner or two if necessary. Visually compare the combustion reactions. Make a sketch of each molecule present in each reaction in the space below. Which reaction releases more energy? Which produces more carbon dioxide?

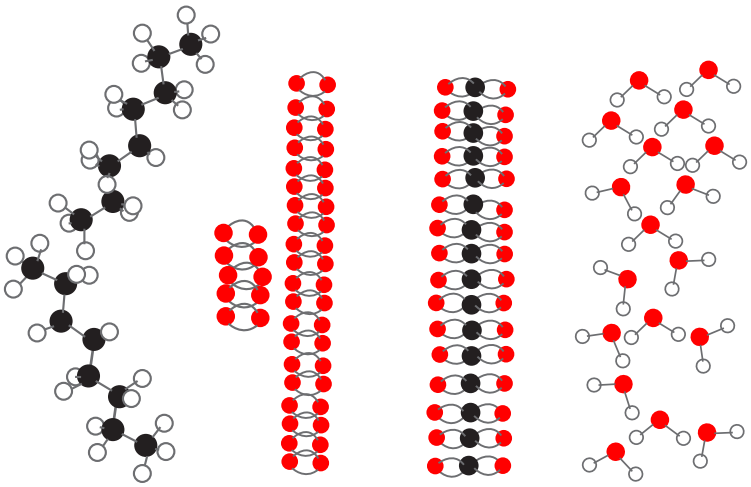
Octane releases more energy and produces more carbon dioxide.

ETHANOL COMBUSTION



$C_2H_5OH + 3\ O_2 \dashrightarrow 2\ CO_2 + 3\ H_2O$ $\Delta H = -1371$ kJ/mol

OCTANE COMBUSTION



$2\ C_8H_{18} + 25\ O_2 \dashrightarrow 16\ CO_2 + 18\ H_2O$ $\Delta H = -5330$ kJ/mol

4. Research the processes required to manufacture gasoline and ethanol. Fill in the chart below with information you find.

	GASOLINE	ETHANOL
Which substance(s) produce the fuel?	Gasoline is produced from petroleum, or crude oil.	Ethanol is produced from corn, sugar cane, and other plant materials.
Renewable or nonrenewable? How do you know?	Nonrenewable. Petroleum is a nonrenewable resource.	Renewable. Plants can be grown each year.
What type of facility is needed to produce the fuel?	Petroleum refinery with fractional distillation equipment.	Production facility with equipment designed for fermentation with yeast.
How many production facilities are located around the U.S.?	143	211
How is the fuel distributed to the consumer?	Pipeline and tanker truck	Train or tanker truck
Average cost per gallon of the fuel, and the date you obtained the data.	$3.50 on 7/10/2013 (Price will vary by date or season)	$2.42 on 7/10/2013 (Price will vary by date or season)
Health and environmental hazards of the fuel.	• Gasoline can affect you when inhaled and by passing through the skin. • Gasoline should be handled as a carcinogen with extreme caution. • Contact can irritate and burn the skin and eyes with possible eye damage. • Inhaling gasoline can irritate the nose, throat, and lungs. • High exposure can cause headache, dizziness, lightheadedness, and passing out. • Prolonged or repeated exposure can cause drying and cracking of the skin with redness. • Repeated high exposure may affect the lungs and brain. • Gasoline may damage the liver. • Gasoline may contain lead and benzene. • Gasoline is a flammable liquid and a dangerous fire hazard.	• Ethanol can affect you when inhaled and by passing through the skin. • High concentrations may damage the fetus. • Contact can irritate the skin and eyes. Prolonged or repeated exposure can cause drying and cracking of the skin with peeling, redness, and itching. • Inhaling ethanol can irritate the nose, throat, and lungs. • Exposure to ethanol can cause headache, drowsiness, nausea and vomiting, and unconsciousness. It can also affect concentration and vision. • Repeated high exposure may affect the liver and the nervous system. • Ethanol is a flammable liquid and a dangerous fire hazard.

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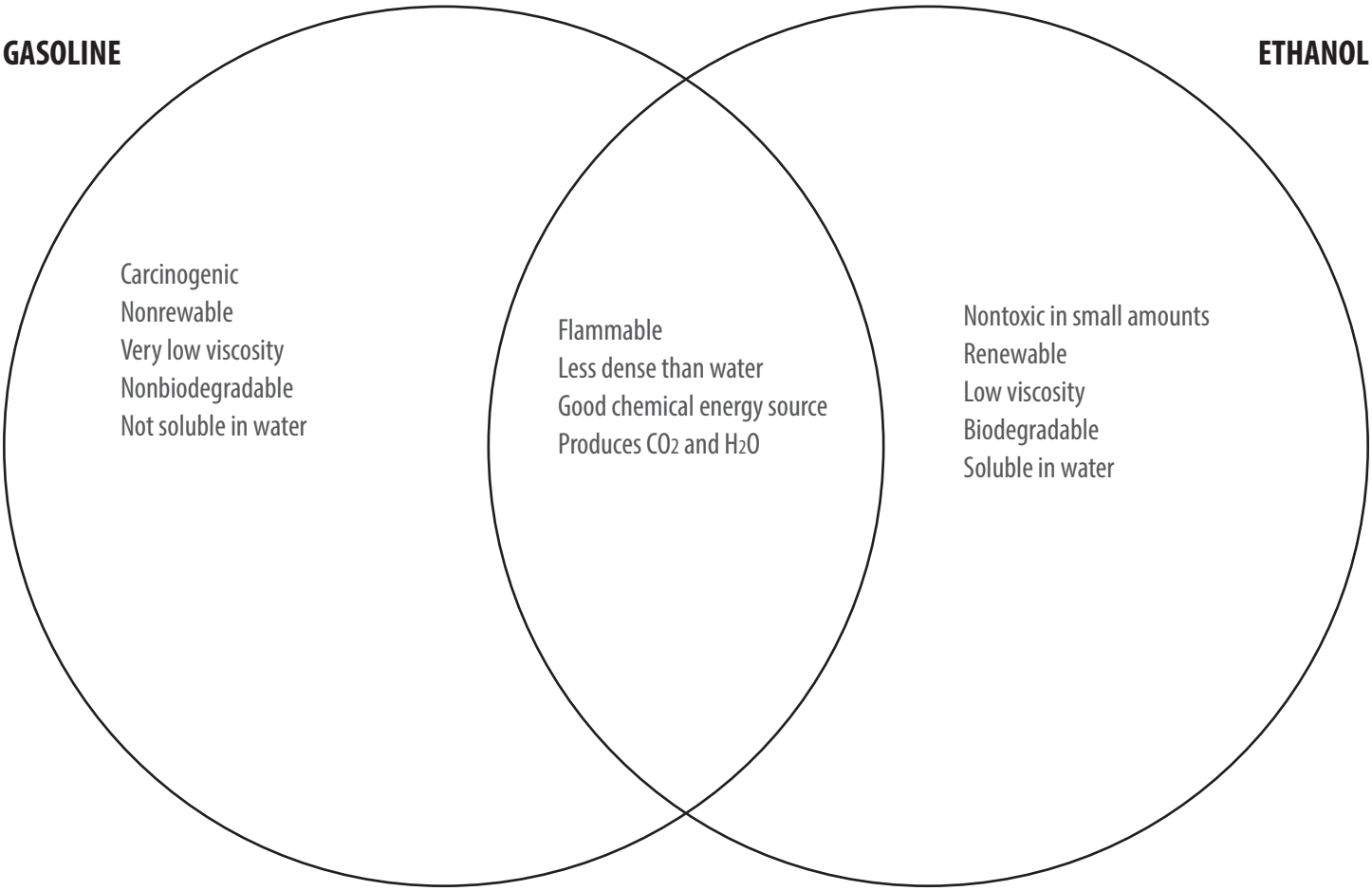
5. Complete the Venn diagram below using the properties of ethanol and octane discussed in this activity.



6. Write a short essay comparing and contrasting ethanol and gasoline.

Answers will vary

7. Which fuel, in your opinion, is better, ethanol or gasoline? Use the evidence from this activity to justify your decision.

Answers will vary

ETHANOL VS GASOLINE

RENEWABLE

BIODEGRADABLE

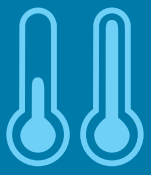
NOT BIODEGRADABLE

NON RENEWABLE

SPECIFIC GRAVITY .787 kg/L

.739 kg/L SPECIFIC GRAVITY

FREEZING -114 °C BOILING 77 °C



BOILING 37 - 204 °C FREEZING -60 to -40 °C

ENERGY DENSITY

23-26 MJ/L

35 MJ/L ENERGY DENSITY

SOLUBLE

NOT SOLUBLE

VISCOSITY

1.2 - 1.52 cSt

.4 - .88 cSt VISCOSITY

NON TOXIC IN SMALL AMOUNTS

CARCINOGEN

MADE FROM

SUGAR OR STARCH

PETROLEUM OR CRUDE OIL MADE FROM

CO_2 +

BURNING PRODUCES

BUT CAN BE RECYCLED TO MAKE MORE ETHANOL

CO_2 +

BURNING PRODUCES

CAN'T BE RECYCLED

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