



Chapters 16 & 17 Cars and Fuels Cells

1. What are the three types of hydrogen vehicles being developed?
2. What advantages do fuel cells have over internal combustion engines?
3. The \_\_\_\_\_ efficiency principle limits the efficiency of an internal combustion engine. Why doesn't this principle apply to fuel cells?
4. What advantages does hydrogen have over gasoline in an internal combustion engine?
5. Why is a fuel cell like a battery? An engine? An electrical generator? How does it differ from all of these?
6. Where, besides cars, are fuel cells being used?
7. What type of electricity do fuel cells produce?
8. What is the most widely-used type of fuel cell?
9. What are the advantages of high-temperature fuel cells? Where might they be used?
10. What type of fuel cell is used in the space program? Why is it impractical to use this type of fuel cell in cars?
11. What does PEM stand for?
12. Why are PEM fuel cells currently so expensive to manufacture?

Creative Writing

- A. Imagine you have been given a ride on the Electron Odyssey and you have chosen to be the electron. Describe your ride.
- B. Imagine driving a fuel cell vehicle. Describe the sights, the sounds, what the car looks like, etc.

Discussion

- A. Discuss the ways fuel cells may be used in our homes and how it would affect daily living.
- B. Hydrogen-powered internal combustion engines have proven to be both practical and efficient, yet there are none currently in mass production. Discuss what will need to happen before H<sub>2</sub>ICEs are commonplace.

Further Research Trace the history of the fuel cell, from its discovery in the early 1800s to today. What car manufacturers are developing hydrogen vehicles, and which one do you think is most promising?

ANSWER KEY 16 & 17

1. H<sub>2</sub> internal combustion engines, H<sub>2</sub> fuel-cells, and electric hybrid cars
2. No moving parts and theoretically more efficient
3. Carnot; relates to the heat lost while making mechanical energy but since fuel cells do not produce mechanical energy, Carnot does not apply.
4. H<sub>2</sub> can run in leaner mixtures for more fuel efficiency and with a lower ignition energy, it allows for easier starting
5. A fuel cell converts chemical energy into electrical energy (battery); uses air and fuel to produce energy, while giving off exhaust and heat as by-products (engine); produces electricity (generator). However, a fuel cell does not store energy (battery), doesn't produce mechanical energy (engine), uses fuel directly (unlike a generator).
6. Space program, military, heat & power for buildings, portable devices (cell phones, laptops)
7. DC (direct current)
8. Phosphoric acid fuel cell
9. Use a greater variety of fuels and produce usable heat; for use in industrial and commercial buildings or even in the home
10. Alkaline; they require pure oxygen
11. Either 'Proton Exchange Membrane' or 'Polymer Electrolyte Membrane'
12. Platinum for the electrodes is the main expense

CROSSWORD PUZZLE 16 & 17

**ACROSS**

3. ELECTROLYTE
5. FIELD
8. CATHODE
9. LOW
11. ETHANOL
12. METHANOL
14. ALKALINE
16. PLATINUM

**DOWN**

1. PORTABLE
2. PEM
4. DUAL
6. EXCHANGE
7. COMBUSTION
10. WATER
13. HYBRID
15. ACID



NAME:

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#### Further Research

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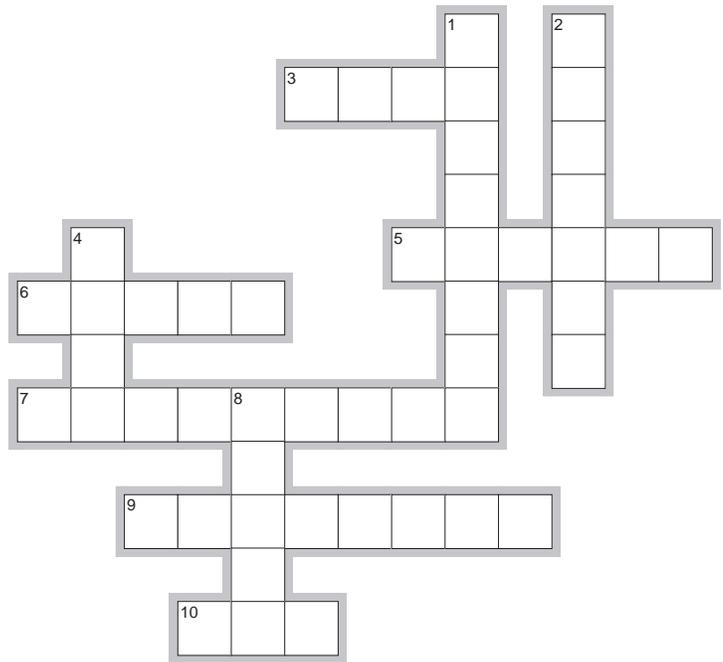
## PUZZLE #15

### ACROSS

3. Carbon \_\_\_ tubes
5. \_\_\_ borohydride (NaBH<sub>4</sub>)
6. \_\_\_ Gas Law
7. A \_\_\_ tank holds liquid hydrogen at -423 degrees F
9. One form of pure carbon
10. Pounds per square inch

### DOWN

1. Unlike gasoline, hydrogen is \_\_\_
2. Substance that chemically binds hydrogen
4. Hydrogen is undetectable because it has no \_\_\_ or color
8. \_\_\_ microspheres



## PUZZLE #16 & 17

### ACROSS

3. Polymer \_\_\_ Membrane
5. Flow \_\_\_ plates (fuel cell component)
8. Where protons and electrons reunite
9. Hydrogen has a \_\_\_ ignition energy
11. E100
12. M100
14. Type of fuel cell used in the space program
16. Fuel cell catalyst material

### DOWN

1. Fuel cells for cell phones and laptops
2. A fuel cell component (abbr.)
4. \_\_\_-fuel engines run on gasoline & hydrogen
6. Proton \_\_\_ membrane
7. Internal \_\_\_ engine
10. Exhaust from a fuel cell car
13. Fuel and electric car
15. Phosphoric \_\_\_ fuel cells

