HOW ENGINES WORK

NAME_____ SCHOOL _____

DATE STARTED_____ DATE COMPLETED _____

PREREQUISITE: Engines course. Simple Machines course recommended.

HOW TO DO THIS COURSE: Do the steps one at a time, in order. When you finish a step, put your initials and the date on the sign-off line on the right. A split line means to get a pass (and an initial) from another student (or your Academic Supervisor if it says that). Essays are turned in to the Academic Supervisor.

PURPOSE: Learn about the structure, function and fuels of several common types of engines.

ESTIMATED TIME: 20 hours.

MATERIALS NEEDED FOR THIS COURSE

Study booklet, *How Engines Work*, with these data sheets (DS):
3328 3329 3330 3331 3332 3333 8155 (glossary)
Exams: 3334, 8085 (answers)

Other materials: Models (transparent plastic ones may be available) of each of the following: gasoline engine; diesel engine; steam engine; a steam, water or gas turbine; turbojet; a small working electric motor; a small working two-stroke gasoline engine (may be a model airplane propelling type); access to a working four-stroke gasoline engine for student to start (could be an automobile); access to a diesel engine for observation; square piece of stiff paper, pin and pencil eraser to make into a pinwheel; a rubber balloon; access to a single-cylinder gasoline engine, v-type engine and in-line engine for observation.

Optional other materials: Toy rocket (provided by student) that operates on air pressure and water; access to a horizontally opposed gasoline engine (any Volkswagen, Subaru or small airplane engine) for observation.

A. GASOLINE ENGINES

1. READ: Data Sheet (DS) #3328 Gasoline Engines to heading "How a Gasoline Engine Works." _____
2. DEMONSTRATE: Show something producing one horsepower. _____
3. READ: DS #3328, section "How a Gasoline Engine Works." _____
4. DEMONSTRATE: Study a model of a gasoline engine. Notice how the flywheel stores energy and helps keep the engine turning between power strokes. _____
5. DEMONSTRATE USING CLAY: A gasoline engine. Label and show the function of each of the following parts. Alternatively, if you wish, you may show fuel injection in place of a carburetor.

carburetor	cylinder	piston	valves
spark plug	connecting rod	crankshaft	
flywheel	radiator	block	

____ ____

6. READ: DS #3328, section "Four-Stroke Cycle Engines." _____

7. DEMONSTRATE USING CLAY: Each stroke of a four-stroke cycle engine. Show the purpose of each stroke. ____ ____

8. DEMONSTRATE: Look at a single cylinder gasoline engine, an in-line gasoline engine (automobile four- or six-cylinder engine), a V-type engine (automobile V-8), and (if available) a horizontally opposed engine (any Volkswagen, Subaru or small airplane engine). _____

9. READ: DS #3328, section "Electronic Fuel Injection." _____

10. DEMONSTRATE: How the ECU detects air and oxygen and controls fuel delivery to the engine. _____

11. READ: DS #3328, section "Two-Stroke Cycle Engines." _____

12. DEMONSTRATE: Show the difference between a fan-scavenged two-stroke engine and a crankcase-scavenged two-stroke engine. ____ ____

13. DEMONSTRATE: Study a small two-stroke gasoline engine. Look through the ports to see the piston and cylinder. Turn the flywheel and see the piston move. _____

14. DEMONSTRATE: Work out very carefully how the power and exhaust sequence in two-stroke gas piston engines works. _____

15. PRACTICAL APPLICATION: Start and control the throttle of a four-stroke gasoline engine and a two-stroke gasoline engine. Notice the difference in sound the two make. _____

B. DIESEL ENGINES

1. READ: DS #3329 Diesel Engines to heading "How a Diesel Engine Works." _____

2. DEMONSTRATE:
   a) Some advantages of diesel engines. ___
   b) Some disadvantages of diesel engines. ___ _____

3. READ: DS #3329, section "How a Diesel Engine Works." _____

4. DEMONSTRATE: Look at a diesel engine. (If one is not immediately available, do this step before you finish this course.) _____

5. DEMONSTRATE: Study a model of a diesel engine. Notice why diesel engines are heavier than gas engines. _____

6. READ: DS #3329, section "Four-Stroke Cycle Diesel Engines." _____

7. DEMONSTRATE USING CLAY: The operation of a four-stroke cycle diesel engine. Show all major parts and show the function of each stroke. ____ ____

8. READ: DS #3329, section "Two-Stroke Cycle Diesel Engines." _____

9. DEMONSTRATE: The operation of a two-stroke diesel engine. _____

10. ESSAY: Compare the operation and structure of a diesel engine and a gasoline engine. _____

C. STEAM ENGINES

1. READ: DS #3330 Steam Engines to heading "Advantages and Disadvantages." _____

2. DEMONSTRATE: The basic differences between a steam engine and a steam turbine. _____

3. DEMONSTRATE: Study a model of a steam engine. Turn the flywheel to see its operation. Be sure you understand the purpose and function of the flywheel. _____

4. READ: DS #3330, sections "Advantages and Disadvantages" and "Why Steam Can Do Work." _____

5. DEMONSTRATE: Show how steam can do work. _____

6. READ: DS #3330, section "Types of Steam Engines."

7. DEMONSTRATE: A compound steam engine. _____

8. DEMONSTRATE USING CLAY: The operation of a simple steam engine. ____ ____

D. TURBINES

1. READ: DS #3331 Turbine Engines to heading "How to Make a Model Turbine Wheel." _____

2. DEMONSTRATE: Show why turbines are more efficient than reciprocating engines. _____

3. DEMONSTRATE: Follow the directions in DS #3331, section "How to Make a Model Turbine Wheel." (You don't have to make the pinwheel if one is available.) In an impulse turbine the fan blades move *with* the flow of gas or liquid. In a reaction turbine the flow is deflected one way while the blades react to it and go the other way. Be sure you notice this difference as you do this demonstration. _____

4. READ: DS #3331, from section "Steam Turbines" to the end of the data sheet. _____

5. DEMONSTRATE: Study a model of a steam, gas or water turbine. _____

6. DEMONSTRATE USING CLAY: The operation of an impulse type steam turbine.

7. DEMONSTRATE USING CLAY: The operation of a reaction type water turbine.

8. DEMONSTRATE USING CLAY: The operation of a gas turbine. ____ ____

9. ESSAY: Discuss the major uses of steam turbines, water turbines and gas turbines. _____

E. JET PROPULSION

1. READ: DS #3332 Jet Propulsion to heading "Types of Jets." _____

2. DEMONSTRATE:
   a) Fill a balloon with air, let it go and observe the jet propulsion of the balloon. ___
   b) Fill a balloon with water, put it in a basin filled with water and let it go. Observe the balloon's propulsion from the water jet. ___ _____

3. READ: DS #3332, section "Types of Jets" to heading "Rockets." _____

4. DEMONSTRATE: The operation of a ramjet. ____ ____

5. DEMONSTRATE: Study a model of a turbojet. Locate the compressor, combustion chamber and turbine. Demonstrate the relationships of compression, combustion and expansion carefully. _____

6. DEMONSTRATE USING CLAY:
   a) The operation of a turbojet. ___
   b) The function of an afterburner. ___ ____ ____

7. READ: DS #3332, section "Rockets." _____

8. DEMONSTRATE: The operation of:

   a) a solid fuel rocket ___

   b) a liquid fuel rocket. ___ _____

9. ESSAY: Discuss the major uses of ramjets, turbojets and rockets. _____

10. (Optional) PRACTICAL APPLICATION: Get a toy rocket that operates on air pressure and water. Launch it. _____

F. ELECTRIC MOTORS

1. READ: DS #3333 Electric Motors. _____

2. DEMONSTRATE:

   a) Study a small electric motor. Remove the case if you need to so you can see each of the four basic parts. In particular, notice how narrow the space is between the rotor and stator. Making this "air gap" narrow is one way to increase the efficiency of an electric motor. ___

   b) Start and stop this motor and observe its operation. ___ _____

3. DEMONSTRATE USING CLAY: The operation of an electric motor. Label all of the basic parts. ____ ____

4. (Optional) PRACTICAL APPLICATION: Research DC motors and AC motors. Some motors run on direct current (e.g., battery power) and some run on alternating current (e.g., from electric power lines). AC motors are different from DC motors. For one thing, they don't need commutators, because they use the alternating current to cause the magnetic field in the armature to reverse. Find out about some different DC and AC motor designs. _____

5. (Optional) PRACTICAL APPLICATION: Research generators. One way to make the electrical power needed to run an electric motor is to (in effect) run an electric motor in "reverse," turning the motor with mechanical energy so the wires of the motor become a source of electricity. Engines designed to do this are called generators. Find out some things about generators, such as where the mechanical energy to turn them comes from. Which of the other types of engines you studied are most often used for this? _____

G. FINAL APPLICATION SECTION

1. PRACTICAL APPLICATION: Build an impulse water turbine out of any available materials and use a stream of water to operate it. ____ ____

2. PRACTICAL APPLICATION: Write a report describing the structure, function and fuels of these six engines. Tell a major use of each. Use diagrams for each engine and make the report neat and complete.
   a) four-stroke gasoline engine ___
   b) two-stroke diesel engine ___
   c) steam engine ___
   d) impulse water turbine ___
   e) turbojet ___
   f) electric motor ___

   Supervisor pass. ____ ____

I have completed the steps of this course. I understand what I studied and can use it.

Student_____ Date _____

The student has completed the steps of this course and knows and can apply what was studied.

Academic Supervisor _____ Date _____

The student has passed the exam for this course.

Examiner _____ Date _____