IT FAILED EMISSIIONS 101

Performance Standards 12C/11B/13A/13B.I

Students will apply the concepts, principles and processes of technological design to investigate heat (and sound) mechanics accordingly:

- *Knowledge:* understand the principles of heat mechanics and the historic progression of technological designs associated with engine design and fuel compositions and ratios.
- *Application:* design and test models which relate air-fuel ratio, hydrocarbon production and heat of a four-stroke engine.
- *Communication:* analyze and report applied research of hydrocarbon and heat production from an historic to current (and future) progression of engine designs and fuel combinations.

Procedures

1. ***In order to know and apply the concepts that describe properties of matter and energy and the interactions between them (12C); the concepts, principles and processes of technological design (11B); the accepted practices of science (13A); and concepts that describe the interaction between science, technology and society (13B),*** students should experience sufficient learning experiences to develop the following:
   - Identify and research historic (including recently historic) dilemmas associated with heat mechanics (engine cylinder designs, air-fuel ratios, emissions testing, etc.) from which engineering designs were imagined, tested and proven (or disproved).
   - Brainstorm the circumstances associated with the setting of the selected historic dilemma.
   - Identify the simulation materials and procedural sequence which can replicate the historic conditions.
   - Determine success criteria, design constraints and testing logistics for the class testing.
   - Realize and explain the necessity of single variable changes.
   - Sketch progressive schematics of the design.
   - Incorporate appropriate safety precautions for working with running engines and using test equipment.
   - Construct and test the model through multiple trials, according to the success criteria and design constraints.
   - Collect reliable and precise data, using appropriate tables or charts.
   - Compare and summarize data from multiple trials, evaluating data for validity and precision.
   - Correlate historic conditions and observations to testing of models.
   - Report the design data with appropriate graphic displays.
   - Communicate the investigation conclusions for peer review.
   - Relate historic setting and impact to the scientific and engineering solutions and eventual progression of designs of heat mechanics, hydrocarbon formulations and emissions or air-fuel ratios.
   - Identify how such engineering studies demonstrate how scientific conclusions are open to modification as new data are collected.
   - Generate alternative design modifications which can be or could have been tested.

   Note to teachers: This activity relates the knowledge associated with Standard 12C, while addressing the Performance Descriptors of Stage I within Standard 11B. The concepts of safety and the interactions of science, technology and society from Standard 13B are also addressed. Auto mechanics students need to understand what factors associated with a car's engine impact the quality of exhaust emission from that vehicle. When cars cannot pass emission tests, something is wrong that must be corrected.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Set the stage for this investigation by brainstorming how the designs for engines, the possible fuel combinations and the heat production have evolved in the past century. Direct their initial discussion into the kinds of testing processes (and regulations) that are currently used for the improvements of engines, fuel mixes and waste products. Briefly explain the chemistry associated with hydrocarbon fuels (reactants and products). Discuss common reasons why cars do not pass emission tests. Continue the discussion by considering ways that previous heat mechanics designs and developments have changed over the years. The technological design investigation will focus on proposing, constructing, testing and analyzing ideas about past engine cylinder designs, air-fuel ratios, emissions testing, etc. Allow students to consider as many variables as possible.

Depending on availability of materials and equipment, the activity might include items such as engine RPM, viscosity of oil, air-fuel ratios, length of test time, size of engine, the temperature of the engine, the temperature of exhaust, octane of fuel and others. Determine how students will be grouped for this investigation and the variety of the investigations that can be arranged in the class setting (whether all groups will be testing the same or different design variables). Students will need to determine the 'success criteria' (how will designs be evaluated – what will be the parameters for the testing – how long, how big, how extensive, etc.) They will need to determine the materials and equipment that are needed, the safety factors that must be addressed and the kinds of data collection processes that will be needed and recorded. They must test only one variable at a time and collect data over multiple trials. They need to determine and follow the procedural sequence for the testing and data collection. Teams will analyze their data and present their findings. Students will compare the findings between groups and relate the findings to the historic progression of engine/fuel design improvements. They will need to correlate their findings to current career decisions and propose additional ways to investigate heat mechanics from questions that arose from their tests.

4. Evaluate each student's work using the science rubric as follows, and add the scores to determine the performance level:
   - *Knowledge:* The principles of heat transfer and the historic progression for technological designs for engine designs and fuel composition are explained completely and correctly.
   - *Application:* The model testing design and procedures were completed safety with appropriate data collection and correlation to appropriate variables.
   - *Communication:* The testing data analysis and correlations between heat mechanics, the historical progression of technological designs and connections to current career decisions were accurate, well reasoned and thorough.

Examples of Students Work
- **Meets**
- **Exceeds**

Time Requirements
- Three-to-five class periods. One class period to discuss the assignment. Two-to-three class periods to perform the experiment. One class period to discuss the results, make conclusions and list changes.

Resources
- Four-stroke carbureted engine
- Tachometer
- Exhaust gas analyzer
- Pyrometer (something to measure engine temperature)

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STUDENT WORKSHEET

1. What historic setting will you study and replicate?

2. What scientific principles are/were involved?

3. What circumstances were associated with the original setting?

4. What were the design constraints originally?

5. What are the design constraints for the class investigation? (What are the rules?)

6. What are the safety considerations?

7. What materials do you need?

8. What is your procedure? (Try to think of all of the steps.)

9. What is your prediction?

10. What is your (single) variable?

11. Sketch the design.

12. Design a table to record your data from multiple trials. (How many times should you test your design?)

13. What does the data mean? What are your findings? Did it work?

14. How did your test compare to the original design testing?

15. Present your findings to the class and compare them to the findings from other groups.

16. How did the original innovation change engine designs from then on?

17. How has new information changed engine designs over time?

18. What new questions came from your investigations?

POSSIBLE VARIABLES TO CONSIDER
CAN YOU THINK OF MORE?

Test Variable____________________			
RPM			
Mixture Screw Settings			
Exhaust Temp.			
H2 Readings			
Engine Temp.			
Oil Viscosity			
Octane of Fuel			

SCIENCE RUBRIC

Exceeds - must receive no more than one 3 and the rest 4s in the other areas of the rubric.
Meets - may receive no more than one 2 and a combination of 3s and 4s in the other areas of the rubric.
Approaches - may receive no more than one 1 and a combination of 2s, 3s or 4s, in the other areas of the rubric.
Begins - must receive at least a 1 in all 3 areas of the rubric.

	KNOWLEDGE Knows and understands scientific terms, facts, concepts, principles, theories and methods.	**APPLICATION** Applies scientific knowledge, skills and methods to manipulate, analyze, synthesize, create and evaluate.	**COMMUNICATION** Communicates scientific knowledge and applications through writing, speech and visual displays.
4	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are complete and correct.	• Applications are thorough, appropriate and accurate.	• Written, oral and/or visual communication is well organized and effective.
3	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are mostly complete and correct.	• Applications are mostly thorough, appropriate and accurate.	• Most of the written, oral and/or visual communication is well organized and effective.
2	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are somewhat complete and correct.	• Applications are somewhat appropriate and accurate.	• Some of the written, oral and/or visual communication is organized and effective.
1	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are minimally present or correct.	• Applications are minimally appropriate and accurate.	• Little of the written, oral and/or visual communication is organized and effective.
0	• All descriptions of scientific terms, facts, concepts, principles, theories and methods are missing and/or incorrect.	• All applications are missing and/or incorrect.	• All of the written, oral or visual communication is missing and/or lacks organization.
Score			