Forms_of_energy

Physical Science | Engineering Design Process

Visible Elements in Photo

- A large yellow and orange diesel locomotive (Union Pacific, model 2677) on railroad tracks
- A red sports car (compact, low-profile vehicle) positioned in front of the locomotive on the same tracks
- Railroad tracks and gravel ballast
- Trees and natural vegetation in the background
- Clear size contrast between the two vehicles

Reasonable Inferences

- From locomotive text "Ultra Low Emissions Diesel Genset Switcher": This is a specialized rail engine designed for efficiency and environmental performance, suggesting engineering solutions exist for reducing energy consumption in heavy transport.
- From size contrast between vehicles: The photo appears to be a safety or awareness demonstration, implying the need to design protective systems or warning mechanisms for railroad crossings.
- From both vehicles on tracks: There is an engineering challenge related to motion, collision prevention, or safe coexistence of different vehicle types in shared spaces.

Engineering Task

K-2 Challenge:

Your job is to build a stop signal that will warn a car driver when a big train is coming down the tracks. Design a signal using materials you have that:
- Can be seen from far away
- Makes a loud sound OR bright light
- Is simple to build and use

Test it by having a friend pretend to be the car driver. Can they see or hear your warning in time to stop?

3-5 Challenge:

Design a railroad crossing warning and safety system that alerts vehicle drivers to an approaching train and prevents collisions. Your system must:
- Detect an approaching locomotive at least 20 feet away (simulated with a rolling object or person walking)
- Alert a vehicle driver using at least two different signals (visual AND sound)
- Stop or redirect the vehicle before it reaches a marked "crossing line"
- Function reliably in 3 consecutive test trials
- Use only materials that cost less than $10 total and take under 30 minutes to build

Success criteria: All three test trials result in the driver stopping or turning before the crossing line, with both alert signals activated at least 5 seconds before contact.

EDP Phase Targeted

Ask / Define Problem

This photo shows a real-world scenario—a size and speed mismatch between two vehicles sharing the same space—without explicitly showing a solution. Students must first identify what problem exists (How do we prevent collisions? How do drivers know a train is coming?) before designing their response. The visible contrast between the vehicles naturally prompts the question "What if they collide?" making this ideal for the problem-definition phase.

Suggested Materials

1. LED lights or flashlights (for visual alert)
2. Bells, buzzers, or piezo speakers (for audible alert)
3. Cardboard, foam board, or PVC pipe (for structural frame)
4. Simple switch or motion sensor (mechanical or battery-powered)
5. Tape, string, and fasteners (to assemble components)

Estimated Time

- K-2: 45–60 minutes (including planning, building, and testing with peers)
- 3-5: Two 45-minute sessions (Day 1: design and build; Day 2: test, troubleshoot, and refine)

Why This Works for Teachers

This task directly addresses NGSS ETS1.B: Developing Possible Solutions, as students must identify constraints (size, speed, visibility) and design a system that combines multiple signals to solve a real transportation safety problem.