

## CONDENSED LESSON PLAN FOR EDSC 8450

**Crosscutting Concept in Focus:** Energy & Matter – *Temperature change causes pressure changes in gases (and vice versa.)*

**Standard Being Addressed:** SPS5b: plan and carry out investigations to demonstrate the relationships among temperature, pressure, volume, and density of gasses in closed systems.

**Phenomenon Being Used:** [Clip](#) of tire blowing out in summer

(PRIOR KNOWLEDGE: Students have recently discovered Charles' Law & Boyles' Law and their relation to behavior of gasses. They know that temperature, volume, and pressure are the properties of gasses that describe gas behavior. Students have also been taught about atmospheric pressure.)

**Lesson Activity:** *Opening* (If your lesson will take multiple days to implement, please identify the opening activities for each day)

**Warm Up:** (10 minutes) One hot summer day, a car heads out on a road trip. The driver made sure all passengers went to the bathroom, the tank was full of gas, and the brand-new tires were full of air so they could drive as long as possible before stopping. Three hours later this happened.

A. After watching the [clip](#) of tire blowing out in summer, students will be asked to write about what ways they thought **energy and matter** played a part, and to make a prediction of a likely cause of the blowout.

- 1) What type(s) of energy were involved in the phenomenon? (Thermal energy/ kinetic energy)
- 2) What type(s) of matter were involved in the phenomenon? (Air/gas and the rubber of the tire)
- 3) Did the energy and matter interact? Your explanation should include how energy flowed and how matter cycled/ changed. (Thermal energy from the pavement & sun transferred through the tires to the air, the kinetic energy of the rolling tires also transfers to the air increases the kinetic energy, which transfers more energy in the form of pressure to the tires. This increased pressure on the tire walls is more than it is designed to take, so the tire popped.)
- 4) Are any gas properties involved? If so, which gas properties did you recognize? (temperature & pressure)
- 5) What kind of relationship do these properties have with each other in the tire incident? (direct – as temperature went up, pressure went up.)

B. **Student groups will be asked to form groups of their choice that total 4 people four.** I will appoint leaders of each group today (3 boys and 3 girls.)

C. Share your personal warm-up responses with your group, then collaborate to help each other refine them for the most accurate details.

D. Choose a representative from each group to share your groups conclusions with the class!

E. At the end of student sharing, I will ask questions in response to sharing to help students think and isolate pressure and temperature as the relevant gas properties and recognize that the two have a direct relationship (if necessary.)

F. This gas relationship is also a law. Has anyone heard of it? (Gay Lusaac's law)

G. **(15 minutes)** I will demonstrate the “soda can crush” phenomenon, telling students in advance that Gay Lusaac's law is again taking place. Their job is to identify where & how temperature and pressure directly relate to produce the can crush. Their description should specifically share how energy flowed (particle motion & direction), and matter changed/ cycled (molecule motion, state & density) in this process.

H. Students will be asked to collaborate in their group to come up with an answer and must produce a digital drawing to show the flow of energy and change in matter. I will choose a leader from 3 groups to project their image to the main screen and explain. Students will have access to a video link with the demo without narration. I will give them about 8 minutes to talk and sketch while I walk around, ask questions, and praise contributions. I will choose 2 female leaders and 1 male leader to share the groups explanation. I will be by their side to encourage, applaud and assist if they become unsure.

**Lesson Activity: (35 minutes)** *Body* (If your lesson will take multiple days to implement, please identify the main activities for each day)

Essential Question: How can I build a sealed system that shows pressure change without bursting?

- A. Groups will be challenged to design a closed container (using simple materials like soda bottles or film canisters) that can demonstrate increasing gas pressure when heated — without bursting! The following materials will be in containers on each group's table.

### Materials

- Empty film canister
- Plastic water bottle with cap
- Alka-Seltzer tablets or baking soda & vinegar (for gas generation)
- Thermometer
- Balloons
- Safety goggles
- Stopwatch
- Ruler/measuring tape
- Plastic 500 mL beaker
- Hot water (varied temperatures using plastic beaker, sink and microwave)
- Lab sheet for predictions & data collection

**B. STUDENTS, ASK YOURSELVES...**

- What is representing pressure change?
- What happened to the pressure as temperature increased or decreased?
- How does your data support or refute Gay-Lussac's Law?
- What real-scenario could this design improve?

C. I will **formatively assess** students' understanding as I walk around the room. By asking questions, students are inspired to confirm or rethink their plan or design (taking note for emphasis later.)

D. Groups will work their [lab worksheets](#) as they design (**summative assessment**) of this concept.) Students will have time for at least on revision today and describe in Part 4 of of the lab worksheet as shown below.

Design a new version of your container that prevents it from bursting while still showing increased pressure. Include energy flow, pressure change, and change in matter (perhaps molecule density.) How would you change your materials or structure? In what real-world scenario could your design improve?

Describe it here & sketch it below:

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**Lesson Activity: (5 minutes) Closing** (If your lesson will take multiple days to implement, please identify the closing activities for each day)

Students will learn 1 more real-life application of Gay Lussac's law watching this 3 minute video [What is application of Gay-Lussac's Law in daily life?](#) narrated by a [young woman](#). It closes with a summary of how the popped tire from today's warmup is explained by Gay Lussac's law.

**CCC Reflection:** How will you consistently emphasize the focal CCC throughout this lesson?

- I asked students to identify matter's changes & energy's flows during the clip of the tire blowout.
- I also had students discuss matter & energy's affect on one another in the phenomenon clip.
- I use the term(s) explicitly at every opportunity when discussing the exploration.

- I use the terms on the lab worksheet and explicitly require they discuss matter & energy's part in their design.
- Students are asked to use arrows to represent energy flow with arrows and labels, and suggest representing particle density differences for design for matter's changes in their design.

**3D Integration:** What disciplinary core idea is being used by students in this lesson?

- PS3.A: Definitions of Energy
- PS1.A: Structure and Properties of Matter
- PS3.B: Conservation of Energy and Energy Transfer
- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
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**3D Integration:** What science and engineering practices are students engaging in during this lesson?

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Developing and Using Models

**Assessment:** In what ways will you assess your students' understanding of the focal CCC? (Formatively and Summatively)

Formative Assessment: results of their investigation will be informal as I walk around and ask each group questions about what and how of their first design plan. I will be looking for a sound Gay Lussac's theory and reasonable design choices. I will offer class input before they begin the first revision.

Summative Assessment: The [lab worksheets](#) that students complete with descriptions and drawings of both the first and revised Gay Lussac's design will be the summative assessment for this concept.


**Equitable:** How does your lesson suit any needs of the focal group of learners you read about this week in *NGSS for All Students*? How does your lesson incorporate the resources these

students bring with them to the classroom? If needed, describe any modifications you would make to the lesson to specifically support the science learning of these students.

1. My **female students** typically bring a level of organization and consistency that their male counterparts have not yet achieved because of the maturity gap between the genders in middle school years. Females bring a different perspective and therefore have different, great ideas to add to problem solving. These are valuable tools that they contribute to their groups in collaboration. One way I can improve this lesson is to have a video of a female engineer speaking about what she loves about using gas laws in her field. I looked for hours and could not YET find one that was a good fit.
2. My lessons always have Google slides background on the screen. Each slide highlights the moments focus, questions, goals and illustrates with people, location context (sense of place), technology and tools. **The people are young women** & men of the multiple cultures within my classes. I pull many context images from our immediate community. NGSS framework encourages educators to highlight diverse scientists and engineers to dispel myths of “only certain people can be” at certain jobs or subjects and inspire all, including those traditionally underrepresented to pursue them (Lee, 2015).

- This lesson will feature MORE women and girls in the Google slides images.
- I asked students to choose their own today to allow girls to position themselves in comfortable positions to speak, share their thoughts and feel heard (Lee, 2015). Some girls feel freer to speak in a group that is girls only.
- Though I appointed equal numbers of male and female group leaders in this lesson, I positioned 1 additional female leader to stand and represent her groups work as she shared, positioning as many as I can to be an active learner (Lee, 2015).
- I am careful to ask girls to share only if I know (because I heard their comments on this subject or we had a conversation) they are confident about what I’m asking. I want them to gain confidence, not make them uncomfortable or nervous.
- After girls share their thoughts and I know they tend to be timid or unsure, I do a lot of active listening, and give enthusiastic praise of their ideas, proving to THEM and the males that they can be successful in this content.
- The design challenge asked everyone to improve a product or situation. Girls tend to be drawn to making improvements (Lee, 2015).
- The **What is application of Gay-Lussac's Law in daily life?** is narrated by a young woman or girl. It features young adult learners and adult engineers of a variety of marginalized cultures and marginalized females. This encourages the belief that girls CAN and should do science (Scholastic, 2018)

## References

**Lee, O. (2015).** *NGSS for all students*. Arlington, Virginia National Science Teachers Association.

**Norazila Azmi. (2020, November 13).** *What is application of Gay-Lussac's Law in daily life?* YouTube. <https://www.youtube.com/watch?v=M5xqJA0gbq8>