Detailed Lesson Plan Outline: Science (Kinetic Energy: Pumpkin Patch Smash)

Objective:
- ➔ Students will explore the definition of kinetic energy by analyzing and interpreting data they gather by investigating proportional relationships among kinetic energy, mass, and speed.
- ➔ Students will collect and analyze data from a simulation to show that kinetic energy increases in proportion to mass and increases with the square of speed.
- ➔ **I can statements:** I can explain how mass and speed change an object's kinetic energy. I can use data to support a claim about kinetic energy.

Standards:
- ➔ **MS-PS3-1:** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Confirm code and grade placement in the SD 2024 science standards]
- ➔ **Science and Engineering Practice:** Analyzing and interpreting data; constructing explanations (CER).
- ➔ **Crosscutting Concept:** Scale, proportion, and quantity (proportional vs. nonproportional relationships).

Establishing a culture for learning:
*Essential Questions:
- ➔ How do mass and speed affect an object's kinetic energy?
- ➔ Which has a greater effect on kinetic energy: doubling the mass or doubling the speed? Why?

*Student interest:
- ➔ Halloween theme: students launch a haunted wagon loaded with candy into a pumpkin patch and watch pumpkins smash.
- ➔ Game-like simulation that gives instant visual feedback; students can check their own KE calculations.
- ➔ Real-world links: school zone speed limits, car safety, and sports (a fast pitch vs. a slow toss).

*Key Vocabulary:
- ➔ **Energy:** the ability to do work or cause change.
- ➔ **Kinetic energy (KE):** the energy an object has because it is moving. $KE = \frac{1}{2} \times m \times v^2$.
- ➔ **Mass:** the amount of matter in an object, measured in kilograms (kg).
- ➔ **Speed:** the distance an object travels per unit of time, measured in meters per second (m/s).
- ➔ **Joule (J):** the unit used to measure energy.
- ➔ **Independent, dependent, and controlled variables.**

*Level of learning:
- ➔ DOK 1: Define kinetic energy, mass, and speed; calculate KE with the formula.
- ➔ DOK 2: Collect and organize data; compare trials to describe patterns (mass doubles → KE doubles; speed doubles → KE quadruples); graph the results.
- ➔ DOK 3: Write a CER that uses data to argue whether mass or speed has a greater effect

Monitoring student learning:
*Whole/ small group strategy:
- ➔ Review key vocabulary words
- ➔ Discuss answers to their predictions in part 1

*Partner or individual strategy:
- ➔ Partners rotate roles: one runs the simulation, one records data; switch roles between Part 2 and Part 3.
- ➔ Teacher circulates and checks the first two trials of each table (2 kg and 4 kg; 1 m/s and 2 m/s) to catch errors with squaring speed.
- ➔ Students check their own KE calculations with the "Show kinetic energy" box after they calculate.
- ➔ Individual exit ticket: "If a wagon's speed *triples*, how many times more kinetic energy does it have?" (9 times)

*Extra support needed:
- ➔ KE formula card with steps: 1) square the speed, 2) multiply by the mass, 3) divide by 2. Allow calculators.
- ➔ Partner students who need reading support with a peer reader; read the directions aloud.
- ➔ Graph paper with axes and scales already labeled; reduce trials to 3 per table if needed.
- ➔ Extension: find two different mass and speed combinations that each plow exactly 2.00 m and explain why both work.

*Does this pertain to SLO? If so, what data are you collecting?
- ➔ This lesson does pertain to my SLO. The data that I am collecting is student understanding of the two factors that affect kinetic energy.

on KE; apply it to school zone speed limits.	
Materials: laptops with the Pumpkin Patch Smash simulation link; Pumpkin Patch Smash student worksheet; graph paper; KE formula support cards; posted “I can” statements; exit ticket slips	Reflection: Was the purpose met? The purpose of this lesson was met. Students gained an understanding of how the mass and speed of an object affect the kinetic energy.

Lesson:

- ➔ **Opening (5 min):** Post and read the “I can” statements. Hook: show the simulation on the board and ask, “What would make this wagon smash more pumpkins?” Record student ideas (heavier, faster) to test later.
- ➔ **Mini-lesson (8 min):** Introduce energy, kinetic energy, mass, speed, and joules.
  - ◆ Write the formula $KE = ½ \times m \times v^2$. Point out that speed is squared, so it is multiplied by itself.
  - ◆ Model the worked example: a 2 kg wagon at 3 m/s has $KE = ½ \times 2 \times 3 \times 3 = 9$ J. Students try 4 kg at 2 m/s on whiteboards (8 J).
  - ◆ Explain the simulation rule: every 25 J of kinetic energy plows the wagon 1 m into the patch.
- ➔ **Predictions (4 min):** Students complete Part 1 independently, then turn and talk. Tally class predictions for doubling mass and doubling speed.
- ➔ **Simulation demo (3 min):** Model one trial: set mass and speed, click Launch, read the distance and pumpkins smashed, then click Reset patch. Remind students to calculate KE before checking the “Show kinetic energy” box.
- ➔ **Investigation (40 min):** Partners complete Part 2 (mass changes, speed held at 3 m/s) and Part 3 (speed changes, mass held at 4 kg). Students identify the independent, dependent, and controlled variables for each part. Teacher circulates.
- ➔ **Analysis (8 min):** Students answer the comparison questions and graph Distance vs. Mass and Distance vs. Speed. Discuss: the mass graph is a straight line; the speed graph curves upward.
- ➔ **CER and closure (5–7 min):** Students write their CER answering whether mass or speed matters more. Revisit the class prediction tally. Share 2–3 claims. Complete the exit ticket.

May take more than one class period depending on student understanding of concepts.

Assessment/ Product:

- ➔ **Formative:** whiteboard KE calculation, prediction tally, teacher checks of early trials, and partner conversations during the investigation.
- ➔ **Product:** completed Pumpkin Patch Smash worksheet: vocabulary, predictions, two data tables (10 trials), two graphs, analysis questions, and a CER conclusion.
- ➔ **Success criteria:** students correctly calculate KE for at least 8 of 10 trials; state that doubling mass doubles KE and doubling speed quadruples KE; and write a CER claiming speed has the greater effect, supported by specific data.
- ➔ **Exit ticket:** If a wagon’s speed triples, how many times more kinetic energy does it have? (9 times)