Math Lab Lesson #5:
Exponent Laws

How can we manipulate expressions and solve equations that involve exponents?

SITUATING THE LESSON:

During Saturday Academy and Weekday NEXT WEEK, students will:

- Review the five exponent laws:
  - $(x^a)^b = x^{a \cdot b}$
  - $x^a \cdot x^b = x^{a+b}$
  - $\frac{x^a}{x^b} = x^{a-b}$
  - $x^0 = 1$
  - $x^{-a} = \frac{1}{x^a}$

Summary: In this lesson, students will:

- Explore properties of exponents through a grouping activity (Group Activity)
- Learn about how the exponent laws can be derived, and rewrite equivalent exponential expressions using different bases (Videos)

Preparation Before Class: Work through all problems and watch videos in advance. Read through and annotate the Lesson Plan in a way that will be useful to you.

Materials:

- **Math Lab Lesson #5: Classwork** (1 per student and instructor)
- **Math Lab Lesson #5: Group Activity** (1 per student and instructor)
- **Math Lab Lesson #5: Instructor Answer Key** (instructor only)
- **Math Lab Lesson #5: Sorting Cards** (one set per pair of students, cut up before the lesson)
- **Glue sticks** (one set per pair of students)
- **Blank 8 ½ x 11 white paper** (two per student)
- **Blank Note Cards** (at least 5 per student)
- **Whiteboards and Dry Erase Markers** (1 per pair of students)

1st Hour

1. Lesson Launch (SHORTENED TO 5 min)

A) SATURDAY ACADEMY AND WEEKDAY REVIEW

- Explain that this week we will be reviewing material that students will cover during their next Saturday Academy. The goal of this is to help students feel more prepared as they enter this upcoming lesson.
- Ask students to take out their Classwork (or Homework or Daily Double) from Saturday Academy and find a problem that they feel confident that they understand. Have students pair up and use a whiteboard to explain their work to their partner. After a few minutes, have them switch who is explaining and repeat. Circulate and listen.

B) REVIEW KEY IDEAS

- Bring the whole class together again, and ask a few students to share out what they just learned from their partner. Review any key ideas and common mistakes that you noticed as you circulated.

2. Group Activity and Presentations (50 min)

TEACHER NOTE: This lesson is reproduced from "Applying Properties of Exponents", MARS, Shell Centre, University of Nottingham

A) ACTIVITY LAUNCH (5 minutes)

Hand out the Group Activity and whiteboards. Give students a few minutes to work on the Opening Activity individually (no group work). After they are done, explain that you will revisit this work at the end of the lesson, and that students should feel much more comfortable with many of the problems.

B) MINI-LESSON (10 minutes)

- Ask students "what does it mean to talk about "powers of 2"? Who can give an example of a power of 2?" Share out an example (i.e. $2^3 = 8$)
- Write the following four equations on the board:

A: $8 \times 4 = 32$

B: $16 \div 8 = 2$

C: $8 \div 16 = \frac{1}{2}$

D: $8 \div 8 = 1$

- Tell students that all of the numbers that they see on the board can be rewritten **using only a powers of 2**. Give them a few minutes to work on this with partners, then have students come to the board and share out.

Answers:

$A: 2^3 \times 2^2 = 2^5$; $B: 2^4 \div 2^3 = 2^1$; $C: 2^3 \div 2^4 = 2^{-1}$; $D: 2^3 \div 2^3 = 2^0$

- Ask students: how could you predict the final power of 2 from the calculation? Briefly review the exponent laws that come up from this discussion.

C) GROUP ACTIVITY (35 minutes)

- Have students work in pairs. Give each pair of students a few pieces of blank paper, a glue stick, and a set of cards (marked E for Expression and S for Single Exponent). Explain the rules:
    - One student chooses one card, then both students have to find ALL OF THE OTHER CARDS that have the same value as the one chosen. Once you have them all, glue the cards onto the blank sheets of paper and write a brief explanation.
    - The other student chooses one card, and repeat.
- Make sure that students understand that some groups may contain three or four different cards.
- Also, there are a few blank cards for students to make up examples of their own.
- Allow students to use calculators to verify their work if needed.

- Once groups are finishing, have them get up out of their seats and compare their answers with other groups.
- Choose one or two nice groupings for students to put on the board and discuss as a whole class.

Answers:

Expressions		**Single Exponents**	
E12 $2^3 \times 2^3$	E10 $(2^3)^2$	S6 2^6	S10 4^3
E2 $3^2 - 2^3$		S5 2^0	
E7 $3^2 + 3^3$	E1 $2^2 \times 3^2$	S8 6^2	
E4 $2^2 \div 2^3$		S4 2^{-1}	
E6 $2^2 - 2^2$		S9 0^2	
E8 $4^2 \div 2^3$		S1 2^1	
E9 $2^3 \div 2^{-2}$		S2 2^5	
E3 $2^2 + 2^3$	E11 3×2^2		

E13 $5^2 - 3^3$		S3 $(-2)^1$
E14 $(3^2 \times 2^2)^2$	E5 $6^8 \div 6^4$	S7 6^4

3. **Break** (5 min)

- Snacks and chill.

2nd Hour

4. Math Lab Videos (40 min)

- Hand out the Classwork and a few flashcards. and help students access the following videos. They are located on seoscholars.org → For Students → Resources → Learning Portal → Math Lab.
    - Video #1: EXPONENT LAWS: WHERE DO THEY COME FROM?
    - Video #2: COMPARING EXPRESSIONS WITH DIFFERENT BASES
- Direct students to **take notes on the videos on their Classwork**. Let them know that they should feel free to pause or rewind the video if anything is unclear, and they should raise their hand if they would like you to help them one-on-one. Circulate, keep students on track, and provide hints and help as needed.
- Tell students to **answer any questions embedded in the video.**
- Once a student has finished watching a video, they should **complete the Classwork problems that relate to that video.**
- After watching a video and completing the Classwork, they should **create one or two flashcards that relate to what they learned from the video.**
    - Explain that you can create and use flashcards to study math concepts in the same way that you use them to learn vocabulary.
    - You can write examples, key ideas, definitions, or even pictures.
    - **If necessary, model how to study with flashcards**: introduce one flashcard at a time, and mix them up as you study so you don't memorize them in a particular order.
- Once they have finished, they should go to the next video.

TEACHER NOTE: Students will go at different paces. In fact, that's one of the benefits of video-based instruction. If some students finish before other students, feel free to have them discuss their answers with each other, or practice studying with their flashcards. They can even work on their Saturday Academy Homework (although make sure not to go over answers to this HW so that their Saturday Academy instructors will have data that the need to accurately assess student performance).

5. **Closing** (15 min)

A) REVISIT ACTIVITY LAUNCH

- Give students a few minutes to review their Activity Launch work, and discuss the correct answers as a whole group. Ask students to articulate what they learned today.

Answers:

1a). $2 \times 2 \times 2 = 2^3$

b). $3 + 3 + 3 = 3^2$

c). $6^2 \times 6^4 = 6^6$

d). $3^3 \times 4^3 = 12^3$

e). $4^5 = 2^{10}$

f). $(6^2)^4 = 6^8$

g). $10^6 \div 10^3 = 10^3$

h). $10^2 - 6^2 = 4^3$

i). $4^5 \div 4^7 = 4^{-2} = \frac{1}{16}$

2). The correct order is (greatest first): 2^5 5^2 10^0 11^{-1} 0^{10}

B) MATH LAB PARKING LOT

- There will be chart paper on the wall titled "Math Lab Parking Lot." This is for students to use to bring up any questions that they have that relate (somewhat) to math. For example:
  - **Are you unsure about some idea that you learned in your SEO math class?**
  - **Are you unsure about some idea that you learned in your regular school math class?**
  - **Are you curious about something that is related to math that you saw on TV or that you heard about in the news?**
- Give students these prompts as an example of the types of questions that they can bring to add to the Parking Lot.
- Explain that each week, you will spend 5 – 10 minutes at the end of class answering these Parking Lot questions. See if anyone has any questions and write them on the Parking Lot (or have students do this). When there are a bunch, answer one if there is time.

C) REFLECTION WALL

- There will be chart paper on the wall titled "Math Lab Reflection Wall." If they haven't already, have them decide their Math Lab Team name (build a little competition into this) to add to this chart paper.
- Explain that each week, they will be asked to come to the reflection wall and write a response to a prompt. This week, the prompt is:

One goal I have for Weekday or Saturday Academy Math this week is

_____.

- After all students have written a response to this prompt somewhere on the butcher paper, dismiss the class.