Standard Form Interactive Introduction

The rationale here is the Dan Meyer "give them the headache before you give them the paracetamol" idea. Here, the approach builds on the idea that the point of SF is to enable us to work conveniently with very large or very small numbers.

T: Does anyone know the mass of the earth? *(If not)* Can you give me your best estimate? *(Could discuss first in pairs for a few seconds if no responses – the point is not to get the right answer.)*
They may say things like 'millions of tonnes', which of course is not even close.
T: Well, I actually looked it up before the lesson. This is the mass of the earth:
Then write on the board (there are 24 zeroes):

6000000000000000000000000 kg

Don't be too careful about lining up the zeroes or making them all the same size as each other.
T: Now, Jupiter is another planet in the solar system. Do you think the mass of Jupiter is more or less than the mass of the earth? *(Again maybe discuss in pairs, but only very briefly.)*
Students will have seen cartoon drawings of the solar system, and some will probably say that Jupiter's mass is more. If so…
T: You've seen drawings where Jupiter looks huge, but that's its *size*. Its diameter is about 10 times the diameter of the earth. But it's a gas planet, whereas earth is made of things like rock. So being *big* doesn't necessarily mean it's got more *mass*. 'Massive' doesn't mean big!
(Give a few seconds more to think/discuss/argue. The aim is to generate disagreement.)
T: OK, I'll write up the mass of Jupiter now.
Then write on the board (there are 27 zeroes this time):

2000000000000000000000000000 kg

Again, don't be careful about lining up the zeroes or making them all the same size, and <u>start this number a bit to the left of the previous one, and let it finish before the end of that number</u>: e.g.,

6000000000000000000000000 kg
2000000000000000000000000000 kg

T: So, which one is bigger?
Students will struggle to count the zeroes from their seats (don't let them come to the board!).
T: You all seem to be fussing a lot about the number of zeros, but haven't you noticed that this one begins with 6 and this one begins with 2? So isn't that telling you which one is bigger?
Let them argue back that the number of zeroes is more important than the first digit – this is an important point. If you ask why, they may spontaneously give you examples like 60 < 200 even though 6 > 2, and you could ask other students for more examples like this (mini-whiteboards?) to check that they appreciate this point.
T: What would make it easier to compare these numbers?
Students may suggest writing the digits the same size, perhaps fitting one into each square on a squared board, or putting commas or spaces every 3 digits from the right.
T: How do you think I remembered those numbers? Did I remember 'six, zero, zero, zero, zero, …'?
S: You just remembered how many zeroes there were.
T: Yes, I remembered…
Write on the board (using the words 'followed by', like this):

6 followed by 24 zeroes
2 followed by 27 zeroes

T: How can you tell now which one is bigger?…
T: Why is 27 being more than 24 more important than 6 being more than 2? *This is a key point.*
T: *How much* bigger is the mass of Jupiter?
Students may say '3', but if they think about the zeroes they will see that 000 means 1000.
It is natural now to move to writing the numbers formally as 6×10^{24} *kg and* 2×10^{27} *kg and define standard form and explore how using decimals as the first number enables greater accuracy (*5.972×10^{24} *kg and* 1.898×10^{27} *kg). Examples and non-examples written in standard form, etc.*