pH Scale

PhET Sim design document

version 6

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Contents

Recent Changes

- molecule count and spec views controlled by check-boxes
- linear scale has an arrow at the top if it's going off-scale
- no more tag/label on the pH scale
- faucets changed for more room in the play area

Basic Sim Operation

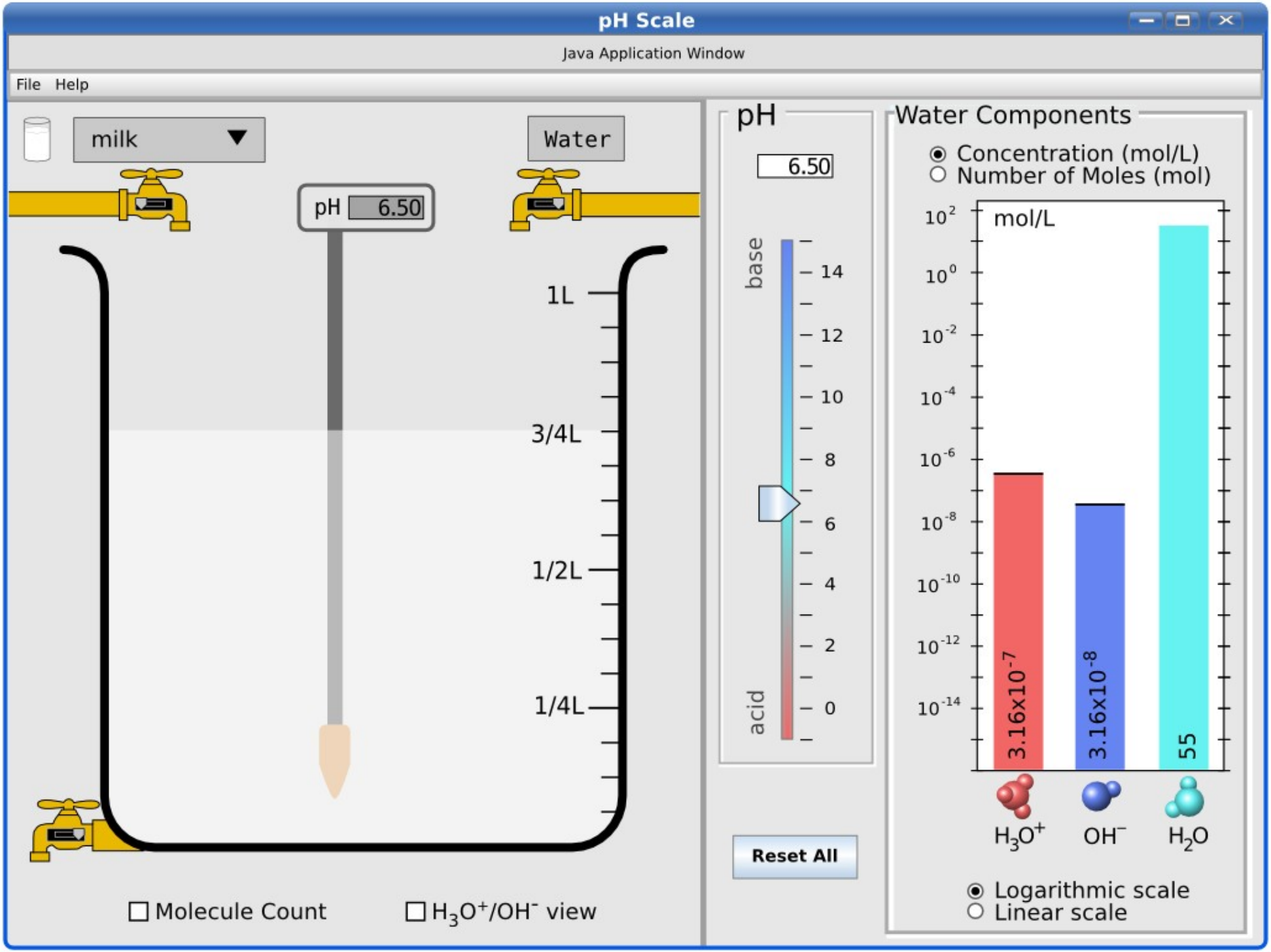
(rough notes only, presently)

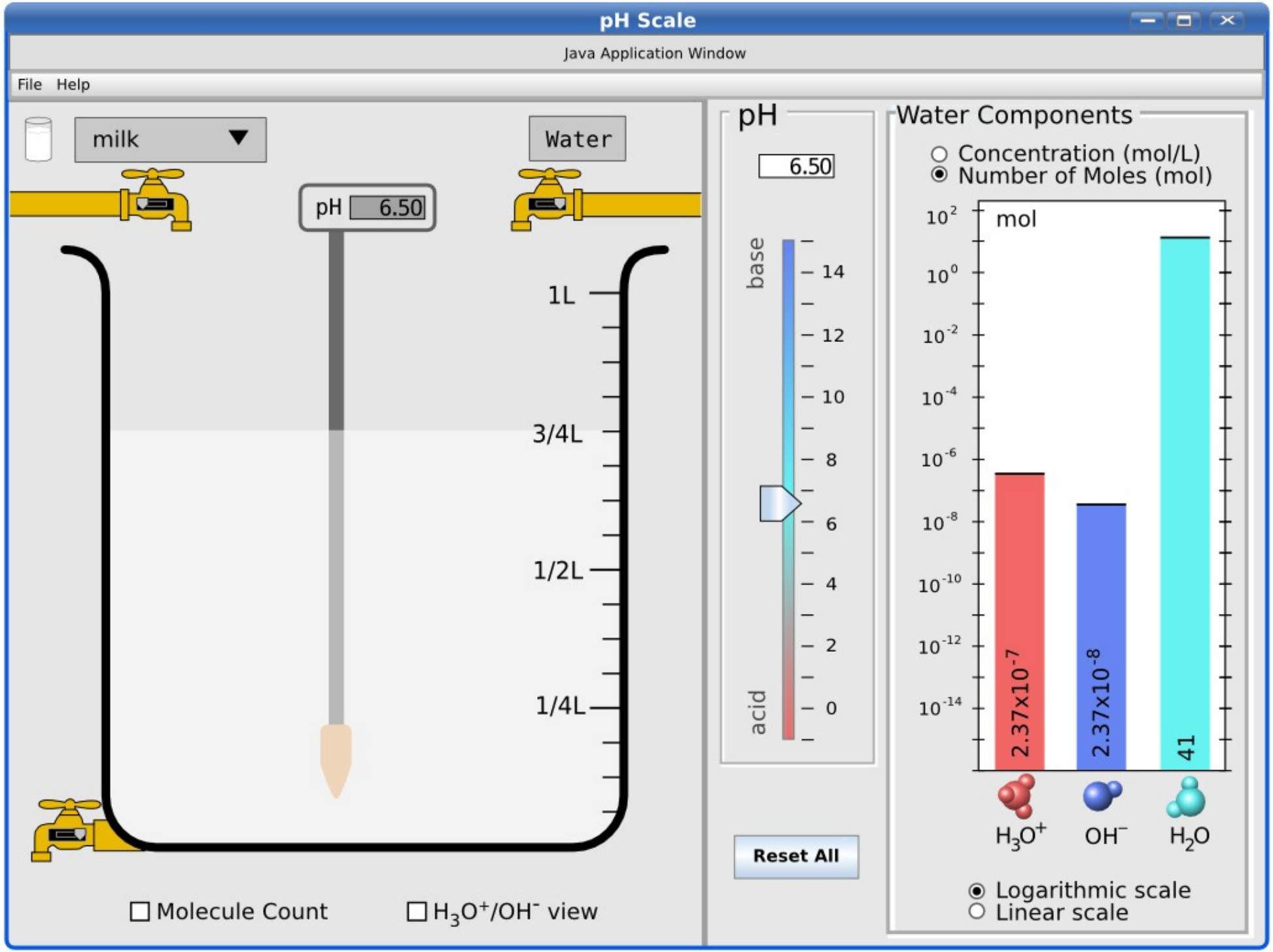
- pH slider
  - changes liquid pH directly
  - adjustment results in liquid type becoming “custom”
- bar charts
  - radio buttons for "concentration" and "number of moles"
    - concentration
      - mol/L bars of both OH and H3O are drag-able, and tied to the pH slider
      - water bar is not a control
    - number of moles
      - all three bars are drag-able
      - changing the OH and H3O bars moves the pH slider
      - changing the H2O slider turns on the faucet/drain (for increasing/decreasing the bar height) to change volume in beaker
  - radio buttons for "logarithmic scale" and "linear scale"
    - logarithmic view is default
    - linear scale view
      - when selected, the view shows a linear scale that includes the values 0 and 55 (the other two bars will be 1 pixel tall)
      - zoom buttons will scale by a factor of ten; zero is always shown on the bottom of the scale
      - when zoomed in, water will be off-scale, so it is represented by bar that turns into an arrow pointing upwards off the chart (see mockup)
- faucet and drain
  - cannot fill above 1.1 liter
  - the drop down menu includes the liquids shown on page 12; menu shows "choose a liquid" at the beginning, and "custom" if the pH is changed by any means
  - Neutral water can be added to any liquid (it then becomes "custom"). When water is added the liquid's color becomes more transparent. At a certain minimum transparency, the liquid should begin to acquire the aqua color of the water molecule.
- Choose a liquid
  - when a new liquid is chosen, the beaker liquid disappears and the faucet turns on to rapidly fill with the new liquid up to 1L (if the faucet is not manually stopped)
  - liquid is “custom” if its pH is changed by some other means
- H30+ OH- view / molecule count
  - when "molecule count" is checked, the beaker shows a continuous display of the number of the three molecules in the beaker
    - the water count has only one significant figure (ion counts have three significant figures)
  - "H30+ OH- view" shows particles as dots in the beaker

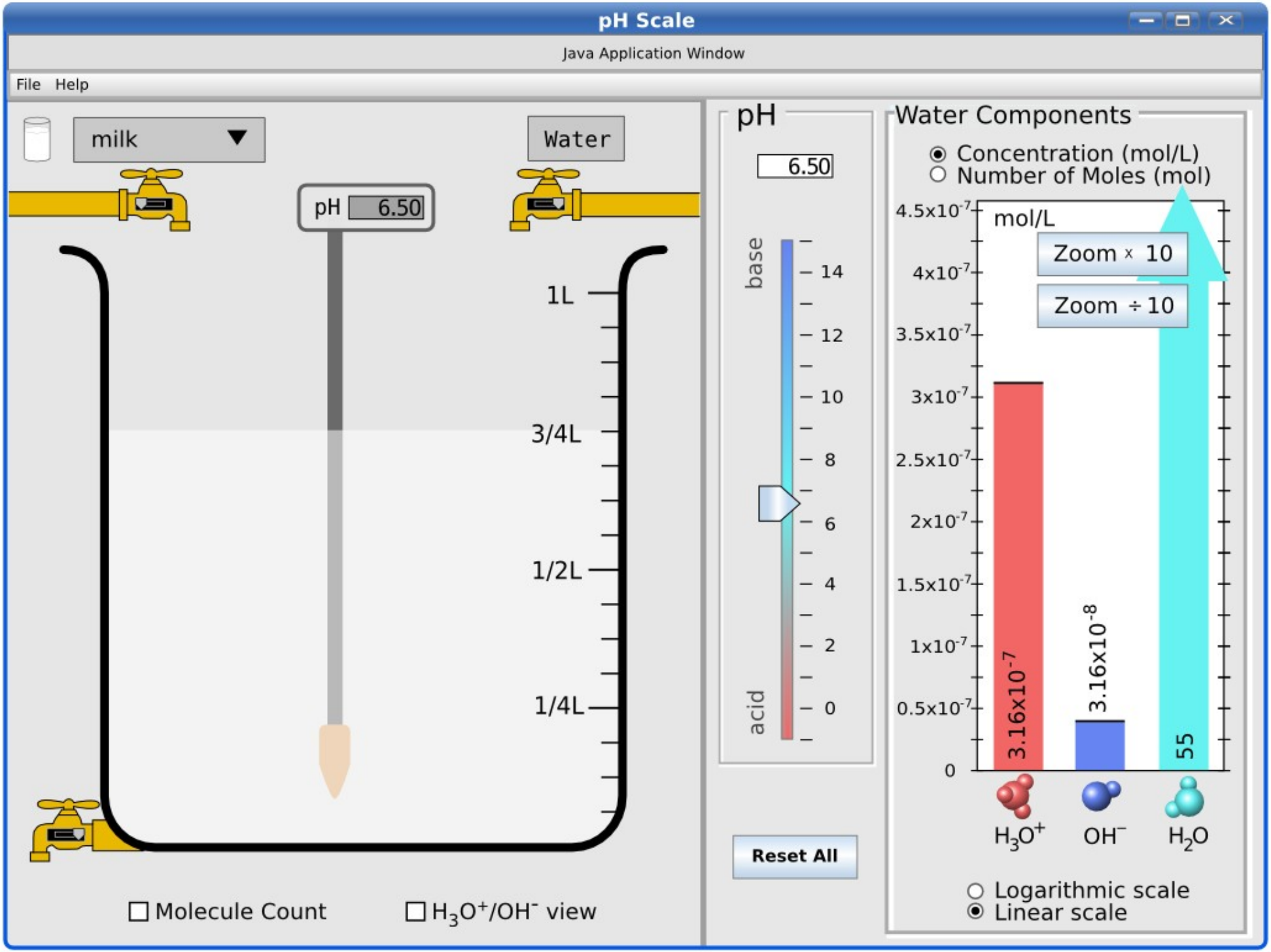
Mockups

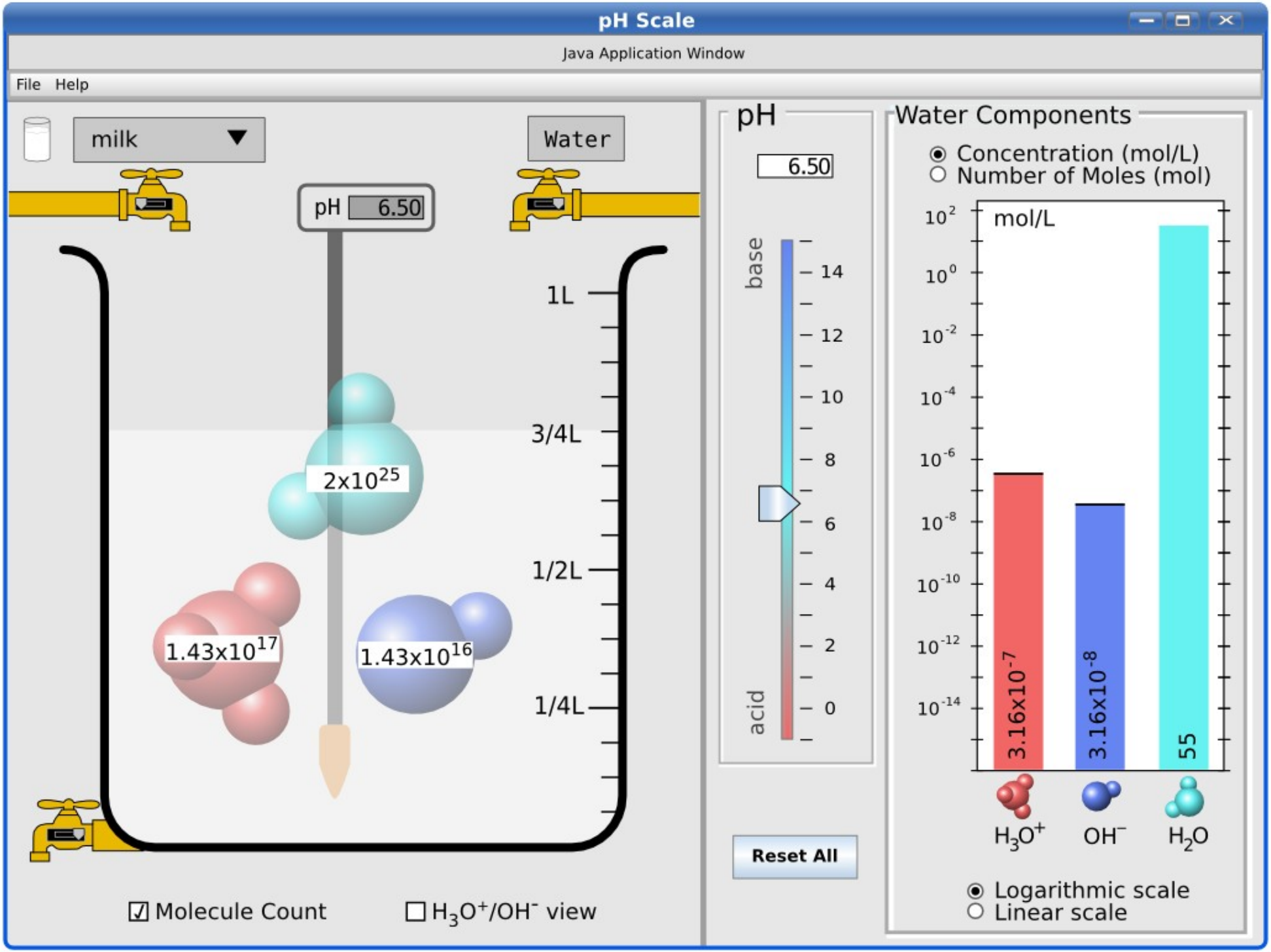
The following mockup screenshots are shown in the next pages:

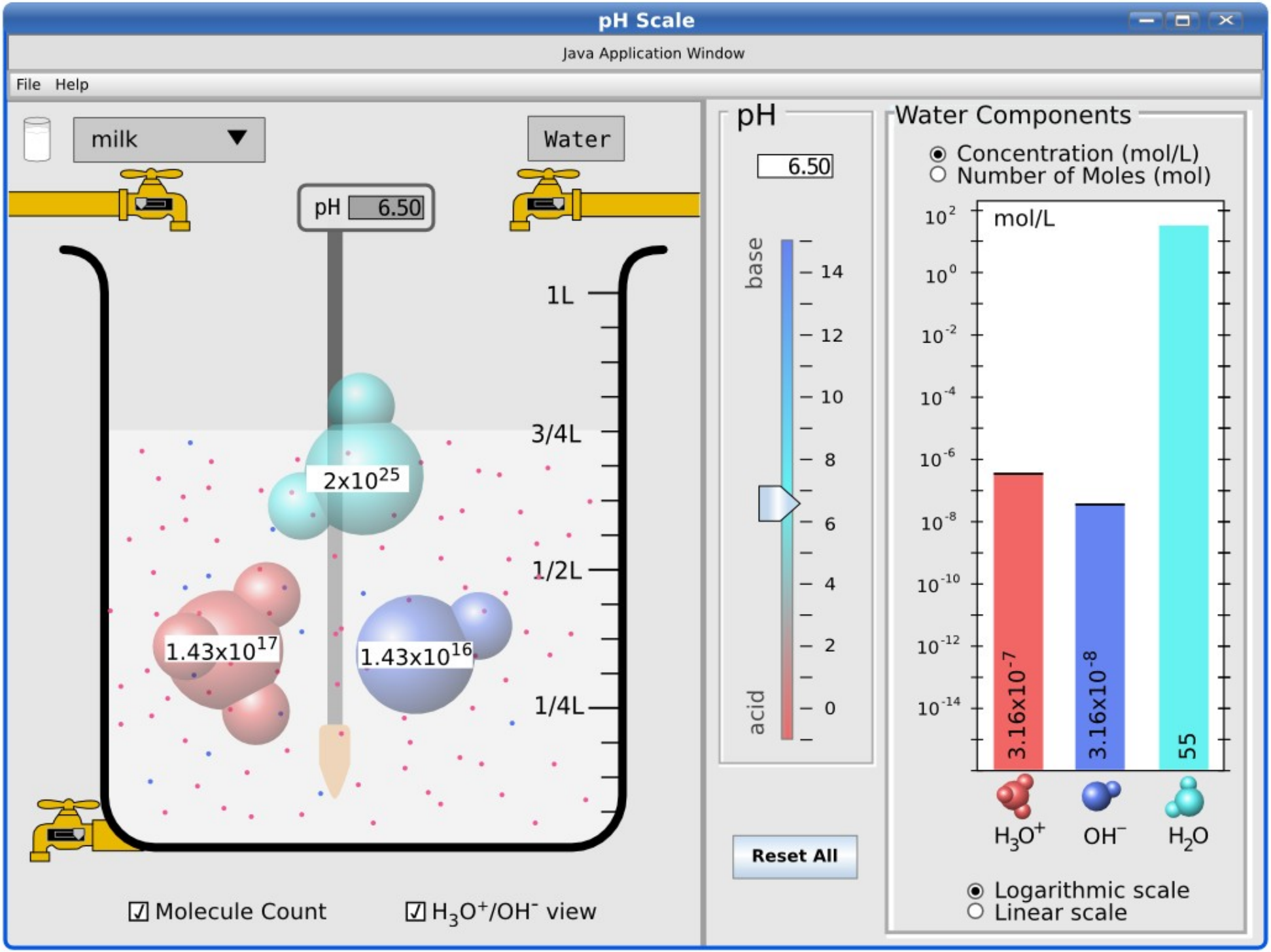
- p5. default view, milk selected
- p6. bar charts showing number, not concentration
- p7. showing linear scale
- p8. checkbox for "molecule count" is checked
- p9. checkbox for "H3O/OH view" is checked


pH Scale
Java Application Window
File Help
milk
Water
pH 6.50
1L
3/4L
1/2L
1/4L
Molecule Count
H3O+/OH- view
pH
6.50
base
acid
14
12
10
8
6
4
2
0
Reset All
Water Components
Concentration (mol/L)
Number of Moles (mol)
mol/L
10^2
10^0
10^-2
10^-4
10^-6
10^-8
10^-10
10^-12
10^-14
3.16x10^-7
3.16x10^-8
55
H3O+
OH-
H2O
Logarithmic scale
Linear scale


pH Scale
Java Application Window
File Help
milk
Water
pH 6.50
1L
3/4L
1/2L
1/4L
Molecule Count
H3O+/OH- view
pH
6.50
base
acid
14
12
10
8
6
4
2
0
Reset All
Water Components
Concentration (mol/L)
Number of Moles (mol)
mol
10^2
10^0
10^-2
10^-4
10^-6
10^-8
10^-10
10^-12
10^-14
2.37x10^-7
2.37x10^-8
41
H3O+
OH-
H2O
Logarithmic scale
Linear scale


pH Scale
Java Application Window
File Help
milk
Water
pH 6.50
1L
3/4L
1/2L
1/4L
Molecule Count
H3O+/OH- view
pH
6.50
base
acid
14
12
10
8
6
4
2
0
Reset All
Water Components
Concentration (mol/L)
Number of Moles (mol)
mol/L
Zoom x 10
Zoom ÷ 10
4.5x10-7
4x10-7
3.5x10-7
3x10-7
2.5x10-7
2x10-7
1.5x10-7
1x10-7
0.5x10-7
0
3.16x10-7
3.16x10-8
55
H3O+
OH-
H2O
Logarithmic scale
Linear scale


pH Scale
Java Application Window
File Help
milk
Water
pH 6.50
1L
3/4L
1/2L
1/4L
2x10^25
1.43x10^17
1.43x10^16
Molecule Count
H3O+/OH- view
pH
6.50
base
acid
14
12
10
8
6
4
2
0
Reset All
Water Components
Concentration (mol/L)
Number of Moles (mol)
mol/L
10^2
10^0
10^-2
10^-4
10^-6
10^-8
10^-10
10^-12
10^-14
3.16x10^-7
3.16x10^-8
55
H3O+
OH-
H2O
Logarithmic scale
Linear scale


pH Scale
Java Application Window
File Help
milk
Water
pH 6.50
1L
3/4L
1/2L
1/4L
2x10^25
1.43x10^17
1.43x10^16
☑ Molecule Count
☑ H3O+/OH- view
pH
6.50
base
acid
14
12
10
8
6
4
2
0
Reset All
Water Components
Concentration (mol/L)
Number of Moles (mol)
mol/L
10^2
10^0
10^-2
10^-4
10^-6
10^-8
10^-10
10^-12
10^-14
3.16x10^-7
3.16x10^-8
55
H3O+
OH-
H2O
Logarithmic scale
Linear scale

Learning Goals

Students will be able to use pH scale to write descriptions that demonstrate how to:

A. Determine if a solution is acidic or basic
B. Determine if a solution weak or strong by looking at the pH
C. Place acids or bases in relative order
D. Describe on a molecular scale, with illustrations, how the water equilibrium varies with pH
E. Determine concentration of hydroxide, hydronium and water at a given pH

New learning goals (rough):

1. pH does not change with volume
2. diluting with water moves pH closer to 7

Outstanding Issues

1. When diluting with water, how does the color of liquid in the vessel change? Can we simply make the color more transparent, or do we need to make the color approach whatever color we use for water?
2. When the height of the bars in the graph isn't tall enough to fit the text (eg, 1x10^-14), where is the text placed?
3. How do we show the bar chart on a linear scale? Auto-scaling? Buttons to change scale?
4. How should we do the "microscope view"?
   - none: beaker with dots and the ion counters over the top
   - if none, it's hard to do small volumes in beaker correctly
   - show both beaker and microscope view always?
5. How/whether to do log/linear scales (could do another sim for learning log scales?)
6. Remove water from molecule count on beaker? (then change “molecules” to “ions”)
7. Still unclear on how the drag-able H2O bar (in the bar chart with "number of moles" selected) is tied to the faucet and drain. Use water faucet? Drain all liquid?
8. Should the pH scale be upside-down, so that the pH value matches the exponent on the molar scale?

pH of Common Liquids

The following were taken from the web (http://www.healthnews-nz.com/table5.html).

Acid Mine Runoff	-3.6 – 1.0
Battery Acid	< 1.0
Gastric Acid	2.0
Lemon Juice	2.4
Cola	2.5
Vinegar	2.9
Orange or Apple Juice	3.5
Beer	4.5
Coffee	5.0
Tea	5.5
Acid Rain	< 5.6
Milk	6.5
Pure Water	7.0
Human Saliva	6.5 – 7.4
Blood	7.34 – 7.45
Sea Water	8.0
Hand Soap	9.0 – 10.0
Household Ammonia	11.5
Bleach	12.5
Household Lye	13.5