Interactive Science and Math Simulations

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PhET Interactive Simulation

University of Colorado Boulder

Denver HTML5 Users Group, 10-22-2012

- http://phet.colorado.edu
- Over 100 simulations, 50 languages
- Launched 2 million times/month for school
- Designed by content experts
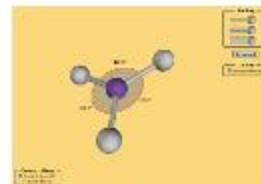- Interviewed with students and used in research

Switch to Index

Build a Fraction

Gene Expression - The Basics

Plate Tectonics

Molecule Shapes: Basics

Fractions Intro

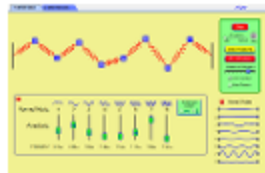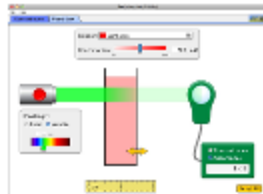**Fraction Matcher**

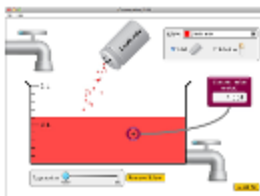**Fluid Pressure and Flow**

Sugar and Salt Solutions

Under Pressure

Normal Modes

Beer's Law Lab
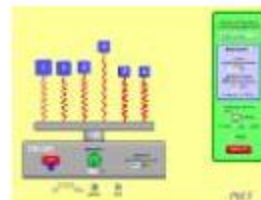
Resonance

Concentration
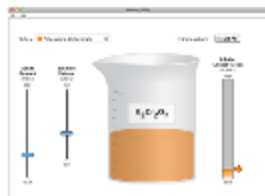
Molarity

Energy Skate Park: Basics

Bending Light

Plus 108 more!

Circuit Construction Kit (AC+DC) (3.19)

File Options Help

Current (Amps) chart — Time (s): 108, 109, 110, 111, 112

Voltage (V) chart — Time (s): 108, 109, 110, 111, 112

Grab Bag
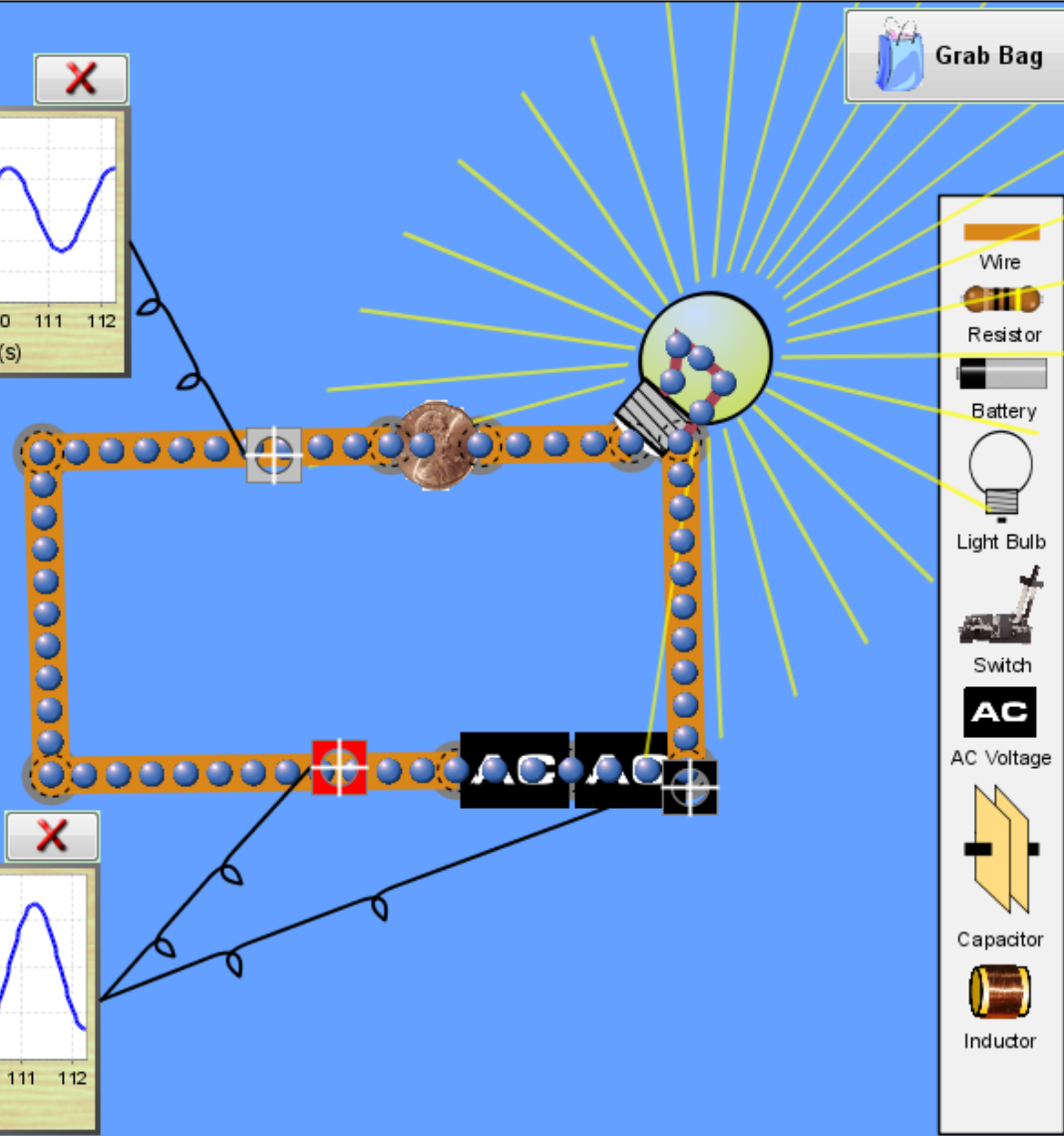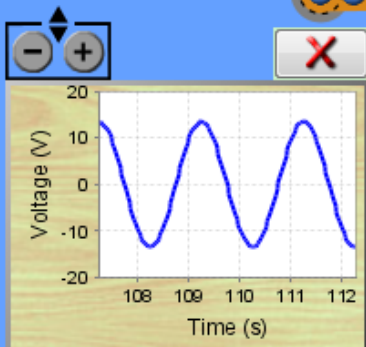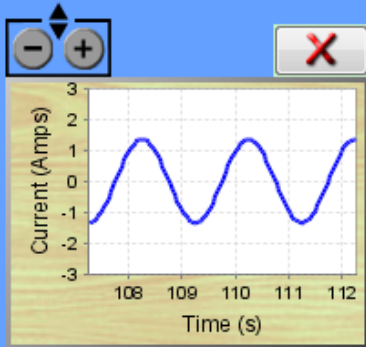
Wire

Resistor

Battery

Light Bulb

Switch

AC Voltage

Capacitor

Inductor

Circuit
Save **Load**

Reset

Visual
⦿ **Lifelike** ○ **Schematic**

Show Values **Hide Values**

Tools
☐ **Voltmeter**

☐ **Ammeter(s)**   0.00 Amps

☐ **Non-Contact Ammeter**   Move over a wire to read current.

☐ **Stopwatch**

Current Chart

Voltage Chart

Size
○ **Large**
⦿ **Medium**
○ **Small**

Advanced
Show >>

Reset Dynamics

Help!

Port to tablets with HTML5

- PhET has 3 full time developers
- Pairing with 3 different companies
  - Quick Left (Boulder)
  - Bust Out (Minneapolis)
  - Compententum (Issaquah/Moscow)
- Prototype and search for approach:
  - Performant, cross platform, scalable, maintainable

Demos

- Masses & Springs, Flash → SVG
- Concentration, Java → Canvas (CAAT + CocoonJS)

Choosing a Scene Graph

Name	Size (KB)	Lang.	GitHub Watchers	GitHub Forks	S.O. Tags
paper.js	219	PaperScript	2020	153	18
easel.js	65	JavaScript	1791	286	51
processing	226	Processing	1327	246	0
fabric.js	77-140	JavaScript	1271	144	75
kinetic.js	67	JavaScript	789	104	214
CAAT	248	JavaScript	448	65	0
...	...	...	...	...	...

Scene Graph Wish List

- 1. Text + Shape + Image + Container
- 2. Bounds before rendering
- 3. Arbitrary nested transforms
- 4. multi-touch support
- 5. paint only dirty regions
- 6. animated transitions
- 7. cache nodes as buffered images
- 8. attach listeners to each node

- 9. clipping using a shape
- 10. constructive area geometry
- 11. ability to handle input events differently on mobile than on desktop (for interacting with small objects)
- 12. non-rectangular hit regions (like dragging a circle or irregular shape)
- 13. Good performance on Android, iOS, Desktop
- 14. Integration with 3d

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CAAT

- http://www.ludei.com/tech/caat
- Canvas, WebGL and DOM/CSS renderers
- Dirty rectangles—really helps on tablets
- Good at transforms, event listeners, layouts, etc.

Technologies

- require.js (modules)
- Grunt (build)
- Hammer.js (cross-platform multi-touch)
- CocoonJS (bundle for native)
- Underscore.js (util & functional library)
- jQuery (jQuery)
- CAAT/EaselJS/??? (scene graph)

Outstanding Questions

- Which scene graph library (if any)?
- DOM or canvas for widgets?
- Use a native wrapper for iOS + Android?
- How to support translations into 50 languages and share with Java versions?
- How to support downloadable/offline use
- Pinch to zoom?
- Should we make it easy to embed in client webpages?
- Scale up/down with window size + resolution?
- Log user activity for interviews and studies?
- How to ensure good performance on Android tablets?

Conclusion

- Complex problem
- We're just beginning/still face many decisions.
- What will we regret X years down the road?
- I'd love to hear your recommendations
  - Visit me on twitter @sam6reid