Motion Suite

Team Members: Noah P, Wendy Adams, Kathy Perkins, Trish Loeblein, Sam Reid
Lead designer: Noah Podolefsky
Developer: Sam Reid

A suite of sims for introductory mechanics, integrated with similar interfaces and representations. Includes the following sims (The Ramp shown first - other sims can be derived from Ramps):

The Ramp

Learning Goals

TL: I wonder if we should expand or explain these more clearly to help teachers . Any thoughts?
NP: Sure, any additions you would like, feel free to add them.
TL: I started a few that I thought of as I read the doc. I would like to talk about these some more. One thing that sticks out is that some of the goals are not written in measurable terms.

1. Calculate the net force on an object on an inclined plane
2. Explain the motion of an object on an inclined plane with Free Body Diagrams (FBD's)

3. Explore how rotating your coordinate system allows you to re-represent the forces in useful ways. It makes it much easier to think about the relevant forces and solve ramp problems when you do this.
4. ~~Learn how to rotate coordinate system and how vector components change with different coords~~
   TL: How would this be measured? It is not a priority for the workshop. Also, someone other than me should try to complete about this goal since it is not a typical first year goal.-trish loeblein 4/25/09 11:44 AM
5. Relate the FBD to graphical representations of force
6. Interpret graphs of energy and work for an object on a inclined plane
7. Relate energy and work to force, velocity, and position
8. TL: Relate how mass and friction effects motion and energy on an angle
9. TL: Roughly "Use ideas in the game mode to be successful"
10. TL: Roughly "Describe how thermal energy allows total energy to be conserved - be able to explain that work done by friction goes into thermal energy."

Todo List

- Rework learning goals
- Generate list of physics/everyday words
  - Or...consider removing this feature. Might actually be better just to have all words that make sense to novices and experts alike. TL: I like the idea of using words that make sense to novices and experts. I think that it would be difficult to image everyday words because they can be regional. It seems like translations would be more difficult too.-trish loeblein 4/25/09 11:38 AM
- Finalize decision on recording control behavior
- write teaching tips -pat loeblein 12/10/09 6:46 AM

Development todo list has been relocated here
.

Tab 1 "Intro" - Learning Goals 1,2

Start state, fixed coordinate system

Under Discussion

TL: Another thing is that the when you select a new object, the robot is in the way of moving the truck up and down. I have seen in Projectile that most users don't find out that the cannon is on a height movable platform and I can see that this may have the same problem.

SR: It's possible to grab the ramp anywhere along its length, so I'm not sure how the robot was in the way; perhaps we should make it more obvious that the ramp can be grabbed anywhere?

The robot will be in the way if you try to move the truck up and down by grabbing. You cannot do this in the current version, but it does seem like something users will try and

I think they should be allowed to move the truck by grabbing it. -Noah Podolefsky 5/4/09 7:06 PM

TL: I don't like all the extra labels on the forces. I think the subscripts get blurred into other things for example I was confused for a few minutes thinking that the friction force was being indicated as downward because the red arrow was small, but the label was on the brown ramp. see the attached

NP:

1. We'll need to discuss how to show the force labels - I think it is necessary to distinguish these component vectors somehow, so we have to have different sets of labels. Maybe we can move the labels around so it is less confusing.

TL:

I think you are right that the labels are going to be important. Right now, they blend in too much. Do you think it would be enough to label them in the force diagram widow? I think they are easy to read there.

SR: If it's too busy in the play area to have arrow labels there, we could instead have a legend that indicates which color corresponds to which type of force.

I'm not crazy about legends - usually students either do not read them, or think they are clickable. It is also an extra cognitive step to figure out which vector is which. We can work on tweaking the labels to be less intrusive as part of polishing the sim (which will come later) -Noah Podolefsky 5/4/09 7:14 PM

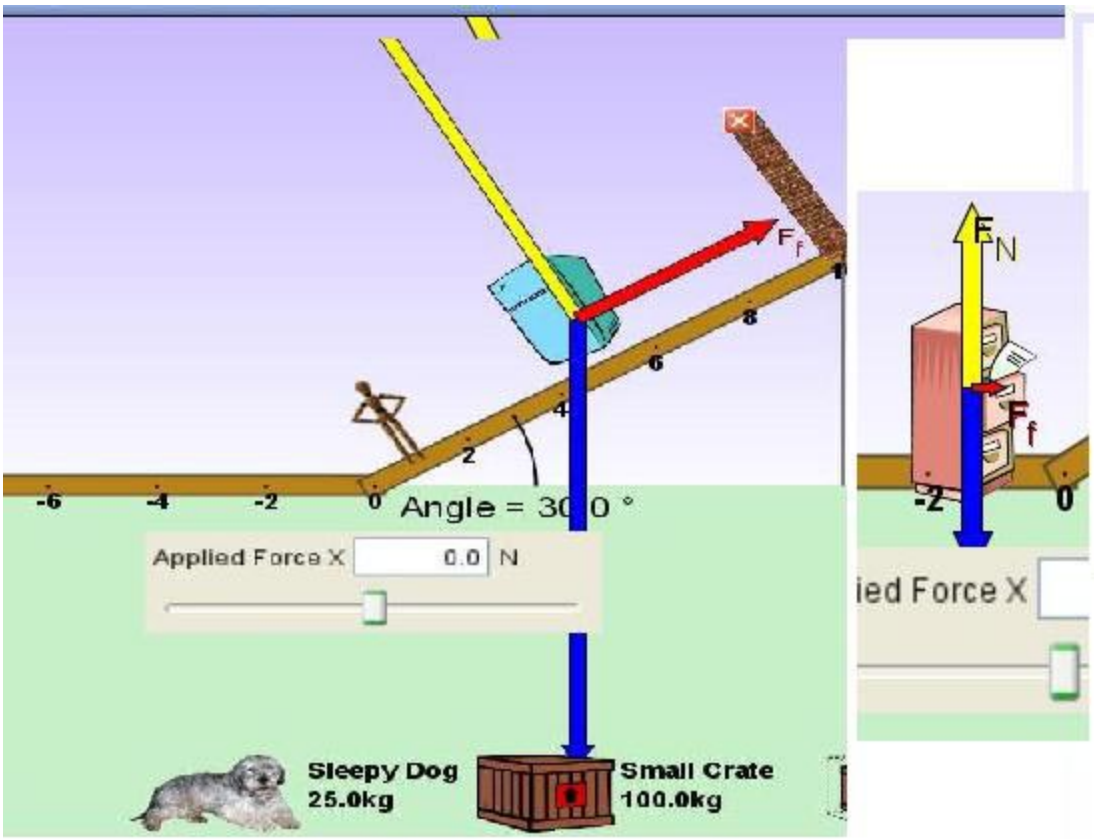
One thing that I saw repeatedly at the workshop was that the labels for the vectors can be unviewable in several situations and teachers raised their hands to get help. Since the refridgerator is the second item that many tried, it was the most asked about. I sent an email with screen captures trish loeblein 5/7/09 6:21 AM

Maybe the vectors should be in the top-most layer? -Noah Podolefsky 5/7/09 12:58 PM

Part of the problem is that the vector is so large that the label is out of the window (see fridge) Also, would it be diffficult to make the force control box movable, so that the user could put it where it makes sense to them? -trish loeblein 5/7/09 8:58 AM

Maybe if the force vectors are limited in how far they can be from the object. So if the vectors are short enough, labels are at the end. If the vectors get too long, the force labels sit a fixed distance from the object so they are still visible -Noah Podolefsky 5/7/09 3:48 PM

I really do not want sliders to be moveable. Too much potential for users to put it somewhere and lose it or forget what they did with it. Front and center people are sure to see it, use it, and not lose track of it -Noah Podolefsky 5/7/09 3:49 PM



To Do

- See the [todo doc]

Should we animate the wall springs?

SR: I'd recommend against animating the wall springs, since this will introduce a new energy component, which will increase the sim complexity.

Since the moving man, forces and motion, and ramp are part of the same project, we could make it so they could launch each other.

NP says this may be a good idea, KP says we should be more careful so people don't just launch all sims

CM points out that this will raise issues when we want to launch a sim from a different project

SR: Let's omit this feature for now, but consider it for future work and in other sims

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Adjustable Coords / FBD (same tab as above) - Learning Goal 3

Discussion

- TL:I like that "adjustable" is the default on the second tab, but it seems that the free body diagram should be open as well, because if there aren't any components selected, nothing visible happens.. I think the name " Coordinates" is not very descriptive. I think something that

indicates that the student can rotate the axes. It might be helpful if someone would clarify the learning goal.

- NP : I think the learning goal is to explore how rotating your coordinate system allows you to re-represent the forces in useful ways. It makes it much easier to think about the relevant forces and solve ramp problems when you do this.

  The real value here comes in when you have selected x-y components. I'd be tempted to have these as default, but I'd also be afraid users might not notice that the vector type had changed....so I'd like this to be something users have to do themselves to make the connection. Same for the FBD - I'd rather have the users activate this on their own. If it is up initially, I'm afraid this might be too much on the screen at once - we want users to activate things as they are ready to explore them.

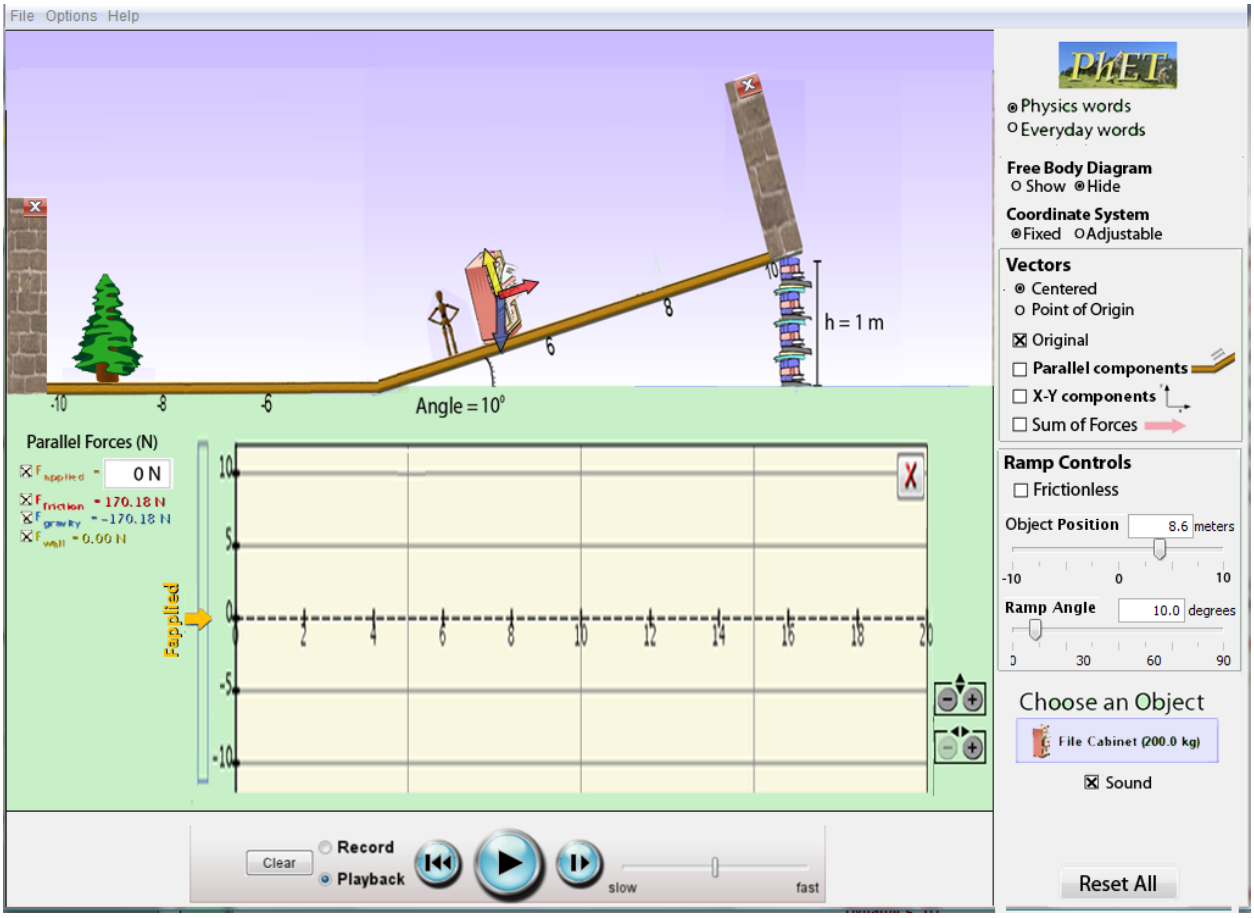
  My 2c...feel free to disagree of course.
  - TL: Your description of the learning goal seems good, would you put it into the doc? What I felt like when I went to the tab was that there was not clue that this tab was different from the first and I feel like people may not explore any features without a prompt; they may just jump onto the game tab. Maybe a wiggle me would be better than having more features open? Otherwise, we could add a note to the teaching tips about how to use this tab.

Tab 2 "Force Graphs" - Learning Goal 4

- Objects are in pull-down menu in control panel
- Graph "parallel forces" - these are the forces parallel to the direction of motion
- "F_sum" or sum of forces should be option to graph as well.

  Can turn on/off forces graphed with check boxes to left of graph force labels Can enter applied force in the box next to label

  Graph force labels should color match to vectors Timeline is not used, replaced with graph and handle in graph as it fills up
- Applied force is now adjusted to left of graph (to coordinate with the up/down graphing of force)
- KP: I know there have been lots of conversations about record and playback and when sim should start going or should stop in emails, can you please summarize current design thoughts here?
  - NP: In this case I think recording should stop at the end of the graph (same behavior as we presently have in ramps, moving man, etc.). I think that it is plausible scrolling graphs could work, but not sure it would be needed in this case.
    - NP: recording should end at 20 sec (end of graph), but user can keep playing past this point. Anything past 20 sec will not be recorded.

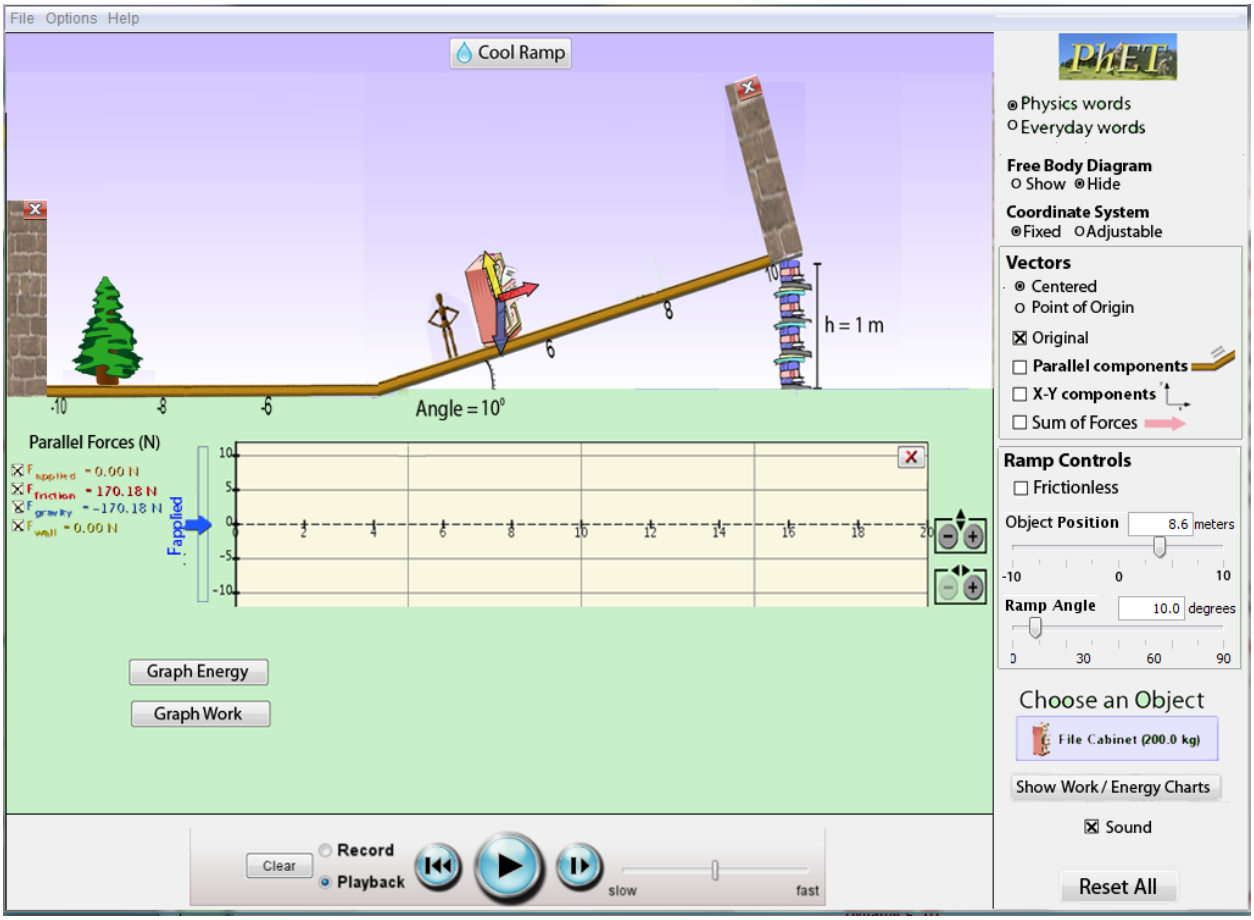


Tab 3 "Work-Energy" - Learning Goals 5,6

Normal State

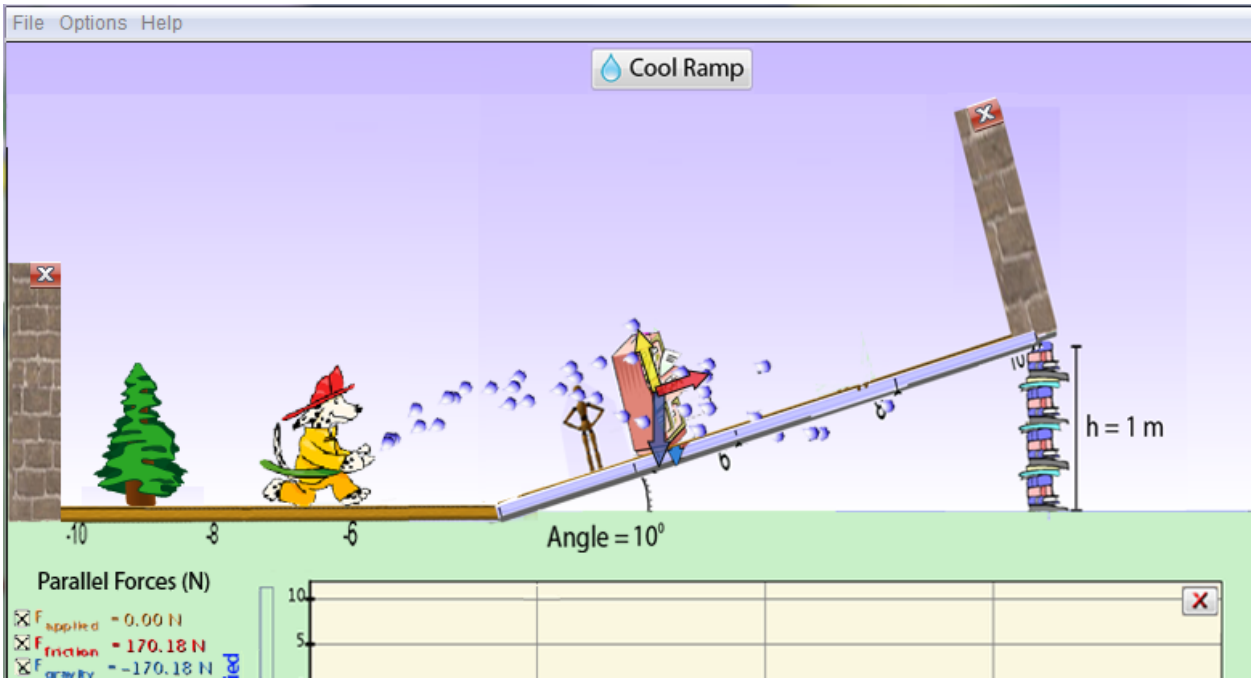
- Buttons to open Energy and/or Work graphs.
- I think we need to keep Force graph also so that force can be related to work
- Probably OK to have graphs smaller here, since it is the 3rd tab and users will be more accustomed to the interface at this point (we hope)
- Energy should be exactly conserved, see #179

- Can cool ramp as thermal energy is absorbed (see image below)
    - Cool Ramp button only appears after ramp has heated up
    - Ramp should turn red as it heats up (thermal energy absorbed by ramp)



Cooling the ramp

- When ramp heats up, can cool it back to normal by clicking "Cool Ramp" button
- Fire dog runs out and sprays the ramp
    - Ramps turns blue as it cools
    - Friction is temporarily reduced while ramp is wet (blue) - say friction is about 25% of normal



Tab 4 "Robot Game"

This is a game where a robot sets objects at the top of the ramp of a moving truck. The objects slide down and slide along the group. The goal is to get objects to arrive just at the door.

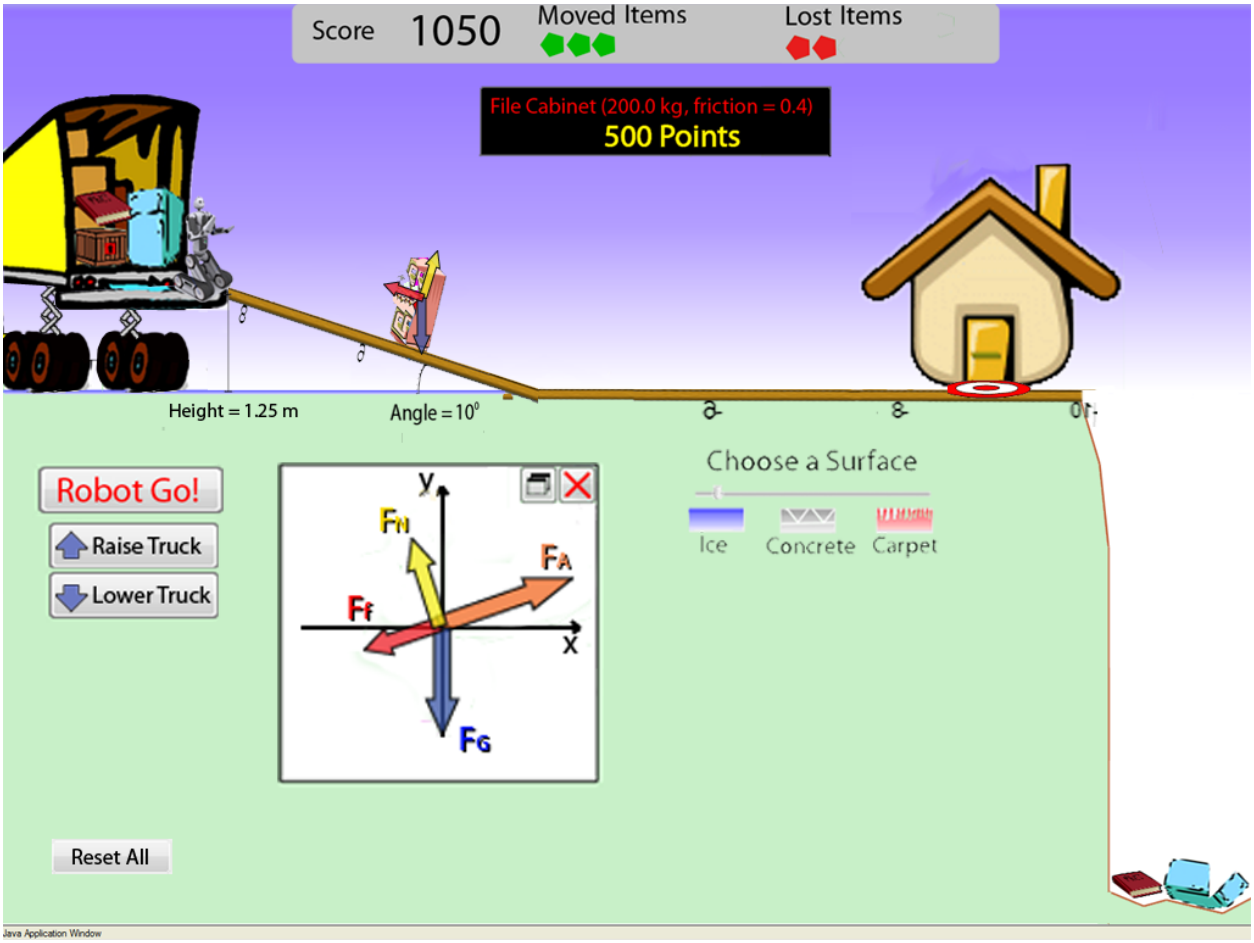
Should be a tab in The Ramp application. We may wish to create a separate sim for the game in addition to the tab in The Ramp (as has been done with some other sims, e.g. Faraday).

Similar to robot game in Forces and Friction.

- Grab truck to raise-lower ramp height
    - NP: the object should shrink and disappear into the house when you score. (And it would be neat if the robot jumped up and down a little bit showing it is happy that you scored).
- The robot grabs an object from the truck - which object it grabs is random. The possible objects are same as in other tabs.
- Click "Robot Go!" and the robot lets the object go at the top of the ramp. The robot just moves back a little bit to let the object go down the ramp.
- Maybe this button should actually be "Let go!", and all it does is make the robot release the object at the top of the ramp. This way you can set the ramp angle with the robot holding the object in place. If you apply a force, the robot automatically lets go when you stop applying force. Want people to figure this out, so have to see if it is intuitive to use either the button or force slider...Maybe start with the robot right against object so it looks as if it is being held. If you use the force slider, "Let go" button is grayed out since no longer needed. Does that seem right? Open to other ideas on this. -Noah Podolefsky 4/29/09 9:12 PM

        - "Let go" button did not seem to be intuitive; many teachers at the workshop asked "how do we start?". Maybe it is the location. I don't want to recommend a wiggle me, but it might be required or move the "Let go" to a more obvious place like the "Return Skater" button?I do like the ""let go" wording more than "Robot go" because I think part of the fun of the game is to use the Robot as little as possible.-trish loeblein 5/7/09 6:00 AM
            - Did you give teachers a minute or two to try and figure it out? This often happens where people right away want you to tell them how to start, and if you leave them alone they figure it out. However, if they had been looking for a while and still not figured it out, then that is a problem. -Noah Podolefsky 5/7/09 12:53 PM I
                - it seemed to be more of a problem with the teachers who had never used PhET. Since this is a sim that will be used early in first semester, I think we want to make sure that it is obvious how to start the game. I like the idea of making the button close to the truck.-trish loeblein 5/7/09 8:54 AM
        - ~~Actually, I don't think using ramp angle to overcome static friction will work - I think we just want to worry about kinetic friction or the game will be way too difficult (or maybe impossible, depending on the difference in coefficients).~~
            - If kinetic friction is high enough, it is static friction. -Samrreid 4/29/09 8:24 PM
        - ~~What should happen is that when you click "Robot Go", the robot gives just enough instantaneous force to overcome static friction, and the object begins to slide from the top of the ramp (initial velocity is zero). In the model, what this really means is setting initial conditions as if static friction had just been overcome, but net force is only due to gravity.~~
            - I think this is an awkward initial condition, and will be difficult to do any computations with. -Samrreid 4/29/09 8:24 PM
                - Leave static and kinetic friction according to normal physics. Force applied by robot will be user controlled with slider, as described below -Noah Podolefsky 4/29/09 9:04 PM
- If the object arrives right at the door, you score points. When the object hits the door exactly it goes inside.
    - Different objects are worth different numbers of points.
    - If the object goes past the house it falls off the cliff and you get zero points.
    - You can use the force slider to apply force to the object with the robot
    - Robot has a finite amount of energy.
        - Energy is used up as you apply more force. Energy is measured in joules - need some indicator (bar graph probably) showing how much energy was used. This way you can compare the ramp height with energy used (and for ice they should be equal if you do it perfectly.)
        - The more energy you have left when you get the object into the house, the higher your score.
        - If the robot runs out of energy before the object gets to the house, the object is lost and you have to start again. Maybe you get three robots - if you run them all out of energy, game over. (Robot falls down and disappears...means we need some indicator of "robots left")

- Energy used by robot is work done = force * distance traveled. (Note that this is only the distance where force is applied - which is why the robot has to just appear next to the object.)



Features in the Advanced tab that are no longer available:

There are some features that seem nice that are now unavailable ...
sliders to control mass and friction and see how this changes vector diagram in continuous fashion. Could have a "custom object" in drop down which then allows controlling these 2 things?

TL: Understanding how mass and friction effects situations on an angle, should be added to the learning goals. These are difficult concepts that I believe teachers are using the present Ramp sim for student exploration)

NP: As I stated above, I'd like to keep this sim as simple as possible and not duplicate features and learning goals that can be covered in other motion sims. If effect of mass and friction changing continuously on an angle is important, I'm OK with adding this. But you can do this with the different objects, and you can explore how mass and friction affect forced in the Forces sim.

TL: It seems to me that the custom crate addresses this issue well.

Old version has sound on/off. Is there sound? If so, can you turn it off or no?

From Trish: FYI, my students do not have access to the control panel, so if the sound is on and there is no control in the sim, they can't turn it off, but there is a manual volume control on the speakers.

NP: I'll add buttons for sound on/off.

Being able to adjust PE zero line is something I've gotten feedback that teachers like to be able to do. But since sim is busy, probably good to leave off. But for new "work-energy" simulation that has horizontal, vertical, and ramp work-energy, it would be good to have this feature there.

From Trish: I agree that this is important, but might be better addressed in a different sim. Right now the only sim where students can investigate changing PE is in Skater.

NP: Can you clarify what you mean by "new work-energy" sim? Do you mean the last two tabs (which are part of The Ramp sim), or a completely separate sim? Also, what do you mean by horizontal and vertical work-energy?

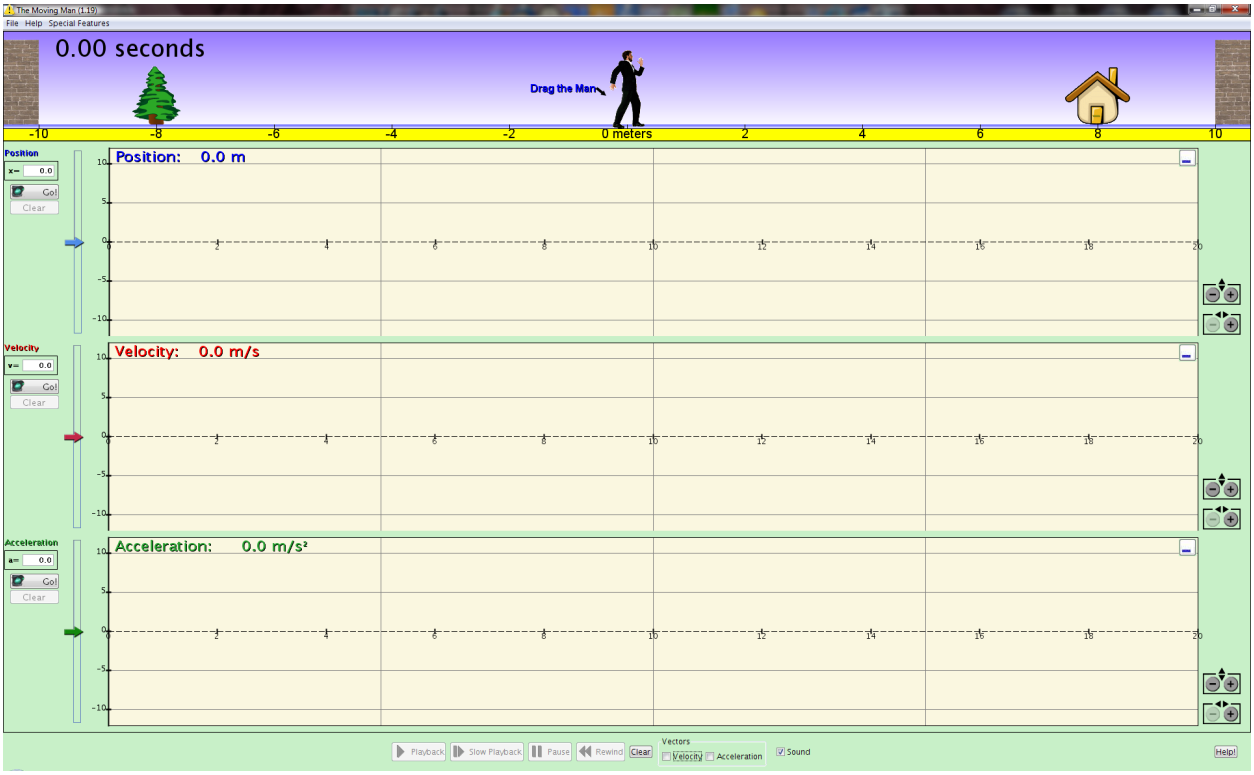
> TL: As I look at the learning goals and number of tabs and features of this version of Ramps, I think that about how Faraday became so complex that we need to break it apart. One thing we are doing with the Acid Base series of sims is making decisions about what should be in the "next sim". I think this discussion relates to the one above about whether we should include velocity and acceleration. I see this version of Ramps as addressing "work-energy" in 2D and I wonder if we should think about a simple work-energy sim that is only 1D. This comes to mind after watching the middle school teachers use Ramps. I realize that there is a horizontal portion where they could use this sim, but the ramp is so much more interesting that students and teachers gravitate towards it. I think one thing that a 1D work-energy sim would allow is lifting. I see my students and teachers try to use the ramp in the vertical position to simulate problems that are in the texts.

Moving Man

Learning Goals

1. Interpret velocity and acceleration vectors for an object moving in 1D
2. Relate the motion of an object to the vector representations
3. Interpret and draw position , velocity, and acceleration graphs for common situations
4. Relate the vector representation to graphical representation

Original Version (for comparison)

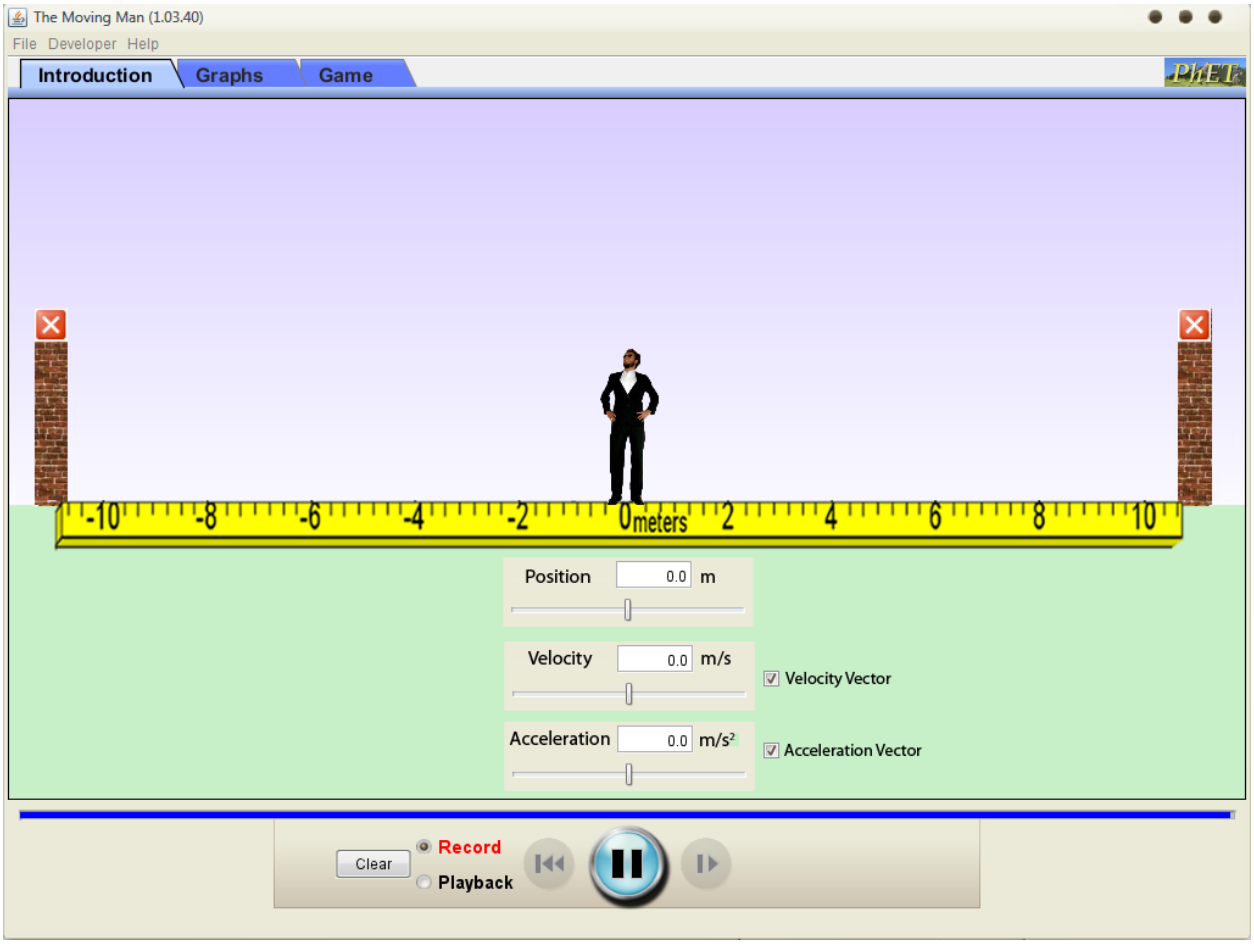


New Version (single panel, no tabs)

Start State (Learning Goals 1,2)

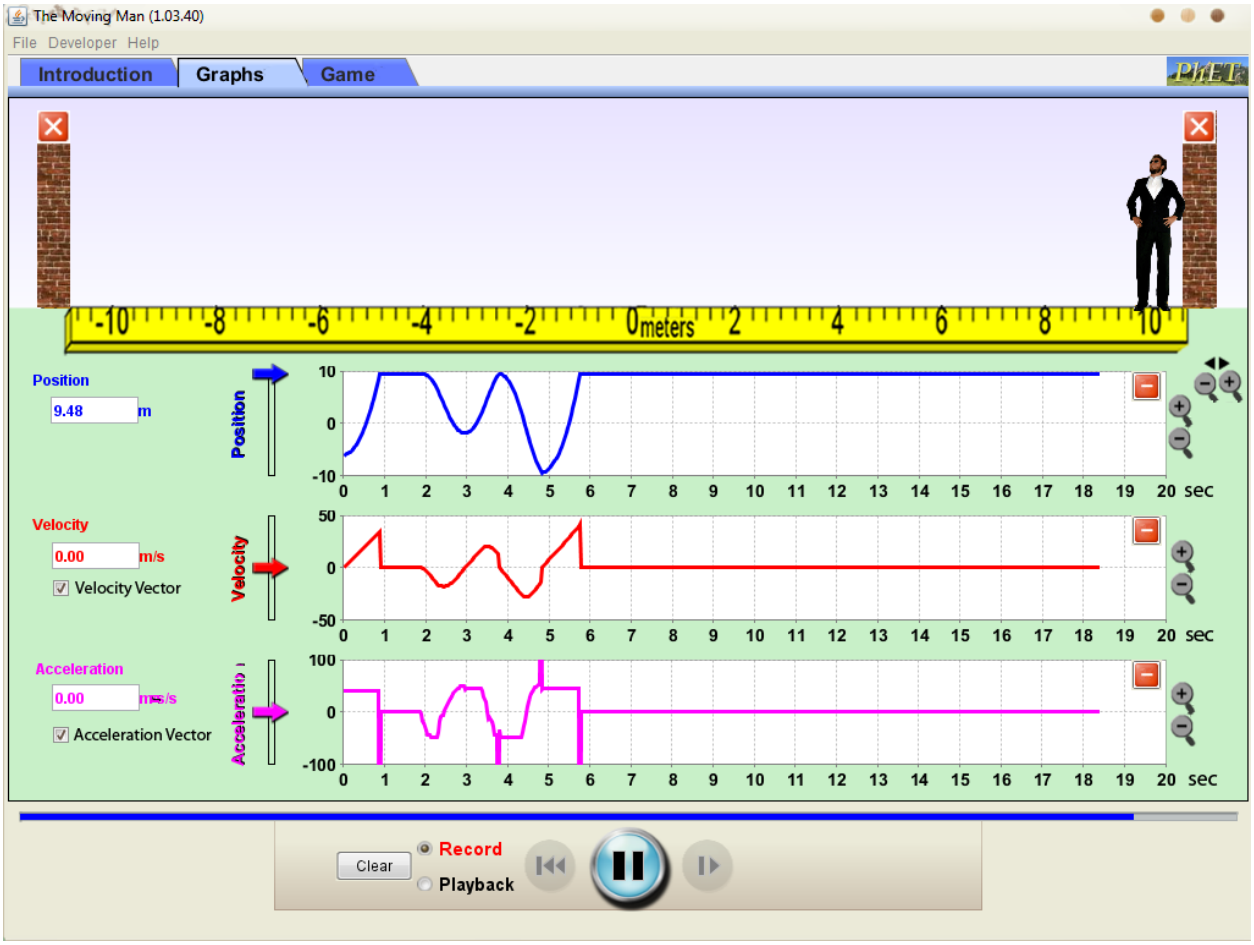
- Start state has no graphs
- Horizontal sliders for position, velocity, acceleration (similar force slider in Forces and Motion)
- Can grab the man or use the sliders.
- Red Xs remove walls (green +s put walls back).
- Vectors are moved up to man's center
- Check boxes turn on velocity and acceleration vectors (default on)
    - Do we want a position vector as well? This would probably have it's base at 0 and point to where the man is. -Noah Podolefsky 9/12/09 3:16 PM
    - I think a position vector sounds excellent; it will cue the student that (x,v,a) are all of the same "family". -Samrreid 9/12/09 6:52 PM
    - I'm also concerned about showing (x,v,a) at the same time on the same graph. I know we went ahead with this for ladybug motion 2D, and it is a typical thing to do in physics class, but I think it can be a bit confusing since (x,v,a) all have different units and technically shouldn't be shown on the same chart (unless e.g. we are using natural units or equivalent) -Samrreid 9/12/09 6:53 PM
    - Do you mean the x,v,a vectors shown in the same play area? The charts are all separate for x,v,a. It could be confusing, but as you say it is a common thing to do (and only gets confusing when you really start thing about it...at which point you are probably beyond the scope of this sim). -Noah Podolefsky 9/12/09 7:29 PM

    - Yes, the (x,v,a) shown in the same play are could lead students to make erroneous conclusions like "velocity is twice as big as acceleration". But maybe it's okay for this sim. -Samrreid 9/12/09 9:52 PM
    - It is true that they are different units, which could lead to confusion. So I agree is a concern. However, the trade off is that if you don't show them at the same time, it is harder to see things like "the velocity is opposite to the acceleration, that must be why it is slowing down". I think it is worth this trade off, and it should be noted that I've never seen students get confused about this so it may not be an issue in practice. -Noah Podolefsky 9/13/09 2:36 PM
- Meter stick (below man) changed to look more like a real meter stick (I can supply the graphic for this)
- Stop recording when time runs out (20 sec), but the man can still move and show vectors



Graphing Tab *(Learning Goals 3,4)*

- Upper play area moves up
- Vector check boxes moved to left (below labels)
- Horizontal zoom controls all graphs at once



Ladybug 2D

Ba
sed on 2D Motion and Maze Gam

See the todo document for outstanding issues and "wishlist".

Learning Goals

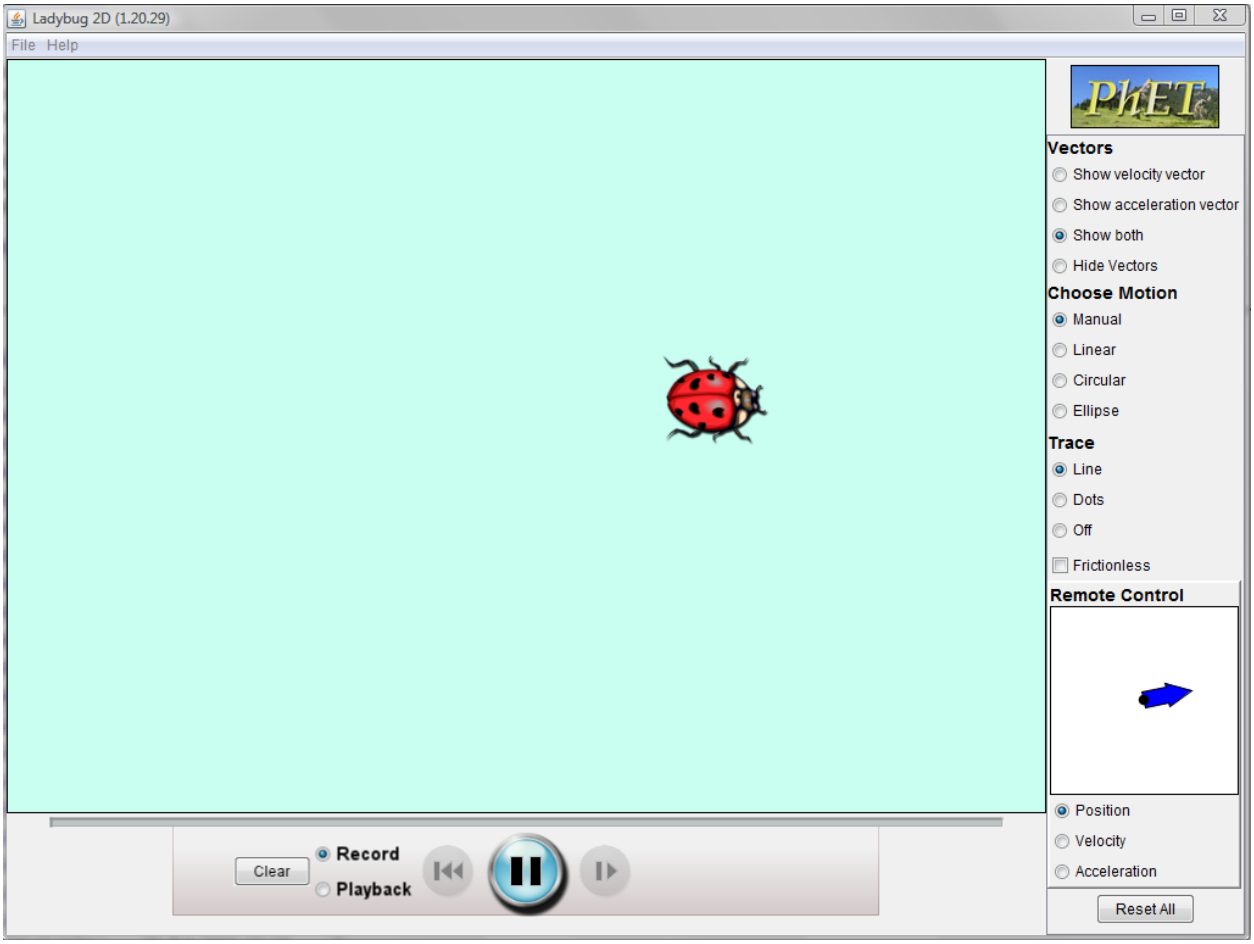
- Same as moving man, but in 2D.
- **Updated design to reflect v 1.20.29 of sim.**

Tab 1 - Ladybug

Recording State

- Can move ladybug around manually by dragging

Can also use "Remote Control" to change position, velocity, acceleration Mouse-over shows "rewind", "pause" for buttons in this state "Step" and "Rewind" buttons grayed out in this state (becomes active in playback state) Play/pause have normal functions in this state Trace only for last 20 sec Timeline fills up with blue as motion is recorded Click "Playback" button to go to playback mode Click "Clear" to clear trace and recording Checkbox for frictionless - if checked and you drag and release bug while moving, bug will continue in straight line Trace fades away from present bug position (all trace is shown, but lighter so that it doesn't look like a mess of lines) Recording stops when timeline is full. You can still move the bug, but it does not record any more.



Playback State

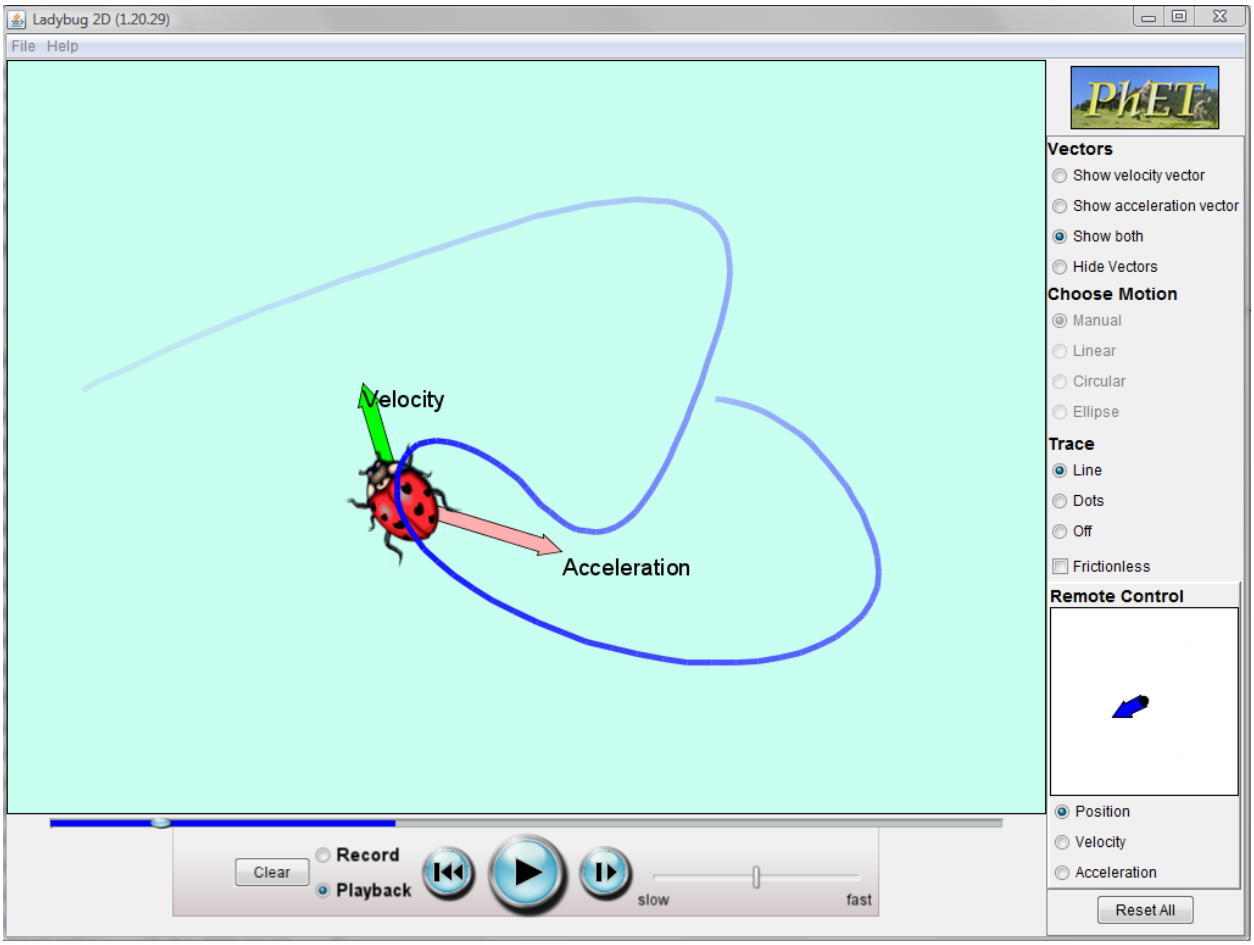
- After hitting "Playback", timeline rewinds and thumb is shown on timeline
- Can grab thumb and slide to move in time

  Rewind grayed out when t=0 Step grayed out when playing, usable when paused

  Speed control for playback Cannot move ladybug manually in this state (must go back to record state) Clicking "record" erases timeline after thumb
    - sim goes into pause state in record mode

- does not start recording again until you hit play or move bug

Clicking clear erase recording and sets sim back to record state



Tab 2 - Aphid Maze Game

- Use the remote control to move the ladybug through the maze
- Ladybug smaller to fit in the maze (unless there is a better solution for this space issue)

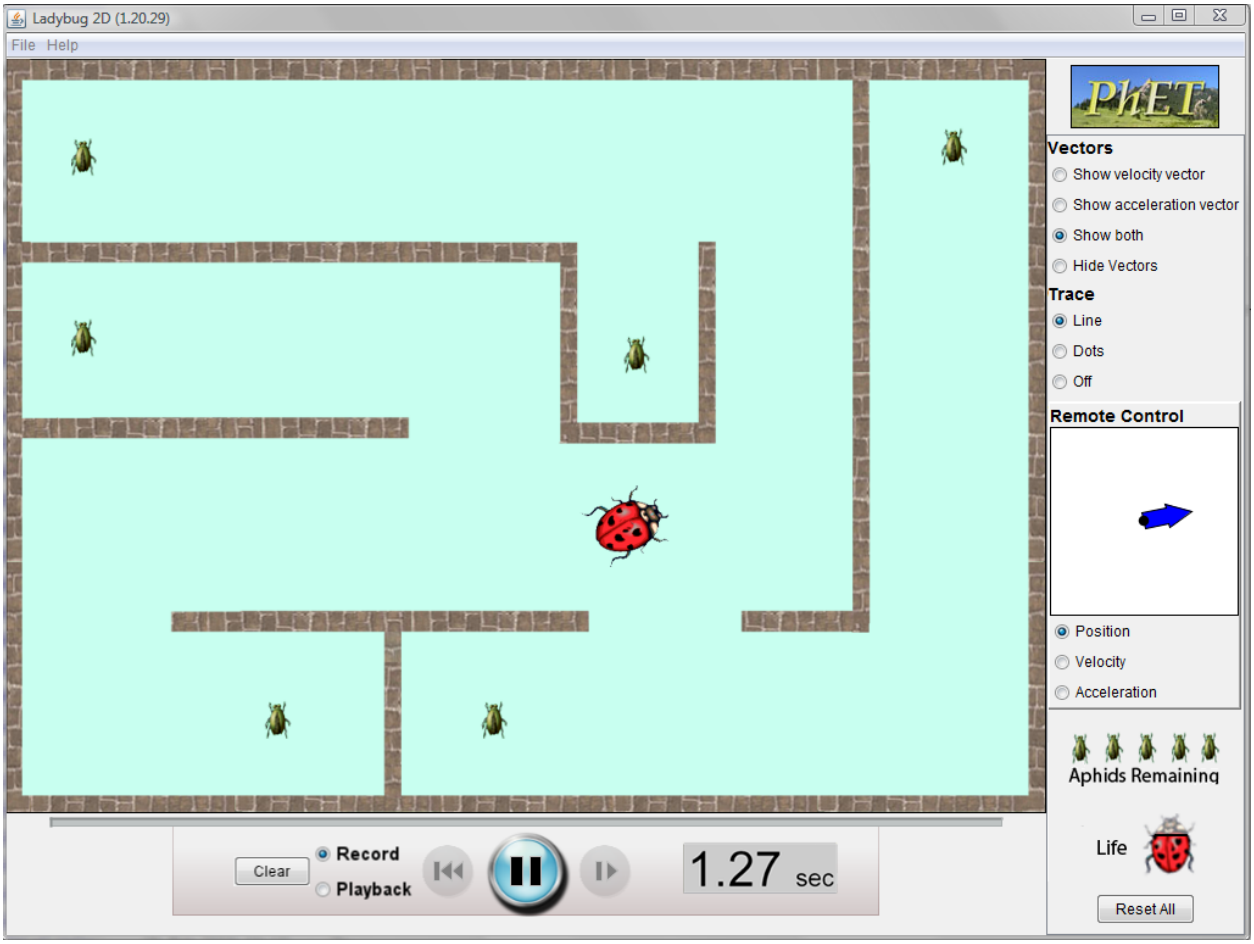
  Cannot move the Ladybug by dragging bug - only with remote control

- Eat all the aphids to win - see how fast you can eat them all
  - digital timer stops when you eat the last aphid
  - aphids in "Aphids Remaining" gets an X over it when eaten

  Hitting a wall causes "damage"
  - you can only hit the wall 3 times
  - each time wall is hit, "Life" meter is reduced by 1/3

  Same recording / playback controls. Remove slow/fast playback to make room for digital timer in play controls panel. Not sure if the trace is necessary.

Might want different difficulty levels at some point
    - if so, have to find a place to put control for level.
    - might also be neat to have a custom level so you can make your own maze (this seems like a lot of work though, so maybe add to wish list)



Forces and Motion

Tips for Teachers

Based on Forces in 1D sim.

Learning Goals

1. Predict, qualitatively, how an external force will affect the speed and direction of an object's motion
2. Explain how friction affects motion of an object
    1. (Advanced) Explain the differences between coefficient of static friction, coefficient of kinetic friction and friction force I think this second part is a

separate goal because it is a separate skill and it would be difficult for students to complete on the first tab-trish loeblein 8/10/09 12:15 PM

I made this an advanced sub-goal -Noah Podolefsky 8/11/09 9:09 AM

I think it would be better to just give this its own number, but since there are other references I didn't want to make the change , now somehow I have messed up all your numbering anyway, sorry-trish loeblein 8/11/09 9:28 AM

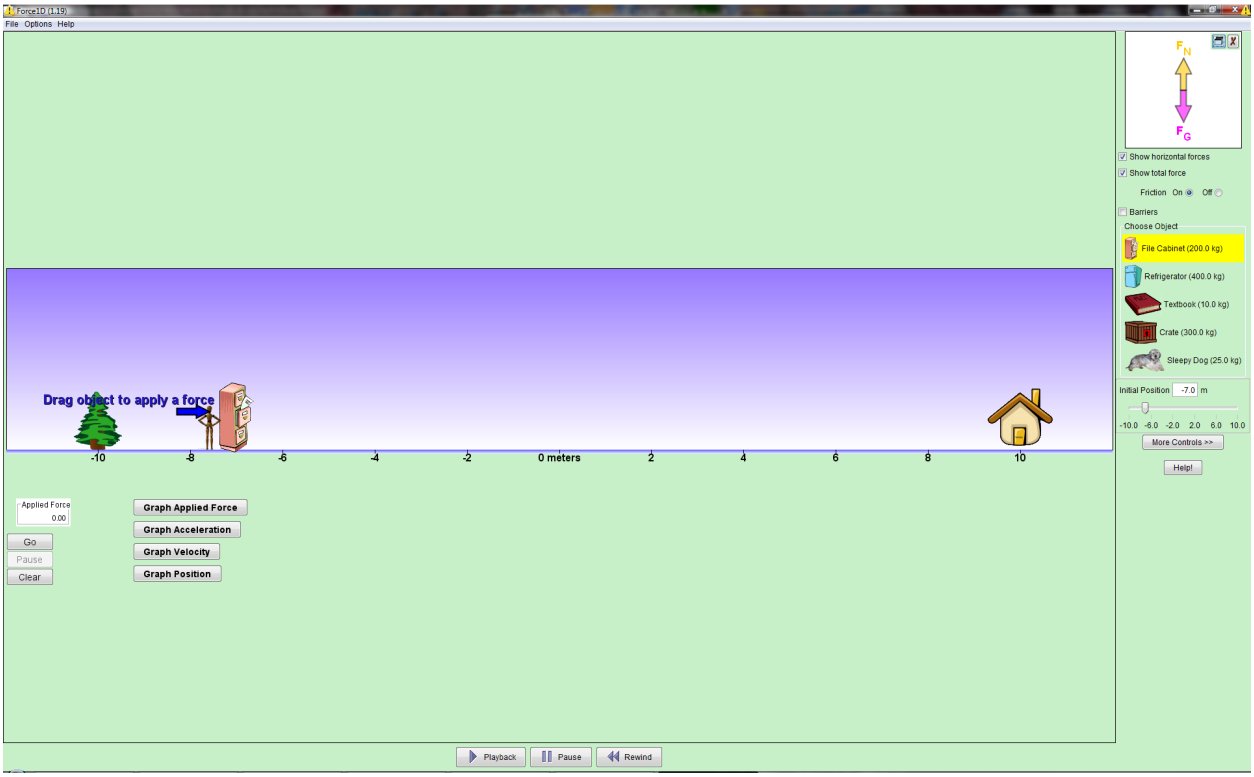
1. Explain how the mass of an object affects the friction force
2. Explain the effects of force with the help of a free body diagram
3. Interpret and draw force, position, velocity, and acceleration graphs for common situations
4. Use free body diagrams to draw position, velocity, acceleration, and force graphs (and vice versa)
5. Explain how the graphs relate to one another

I would like a goal that explicitly states that using a FBD is helpful for determing external force. Could we add another goal like: "Use a free body diagram to help explain how the "external force" is determined. I am not sure if this can be addressed in the first tab. I think it might come after number 4-trish loeblein 8/10/09 12:33 PM

Can you explain what you mean by "external force"? Do you mean the applied force? -Noah Podolefsky 8/11/09 9:09 AM

In the first goal we used the expression "external force". Do we want to change this to "Sum of Forces" or delete the adjective? Then the new goal would say "Use free body diagram to explain how the Sum of forces is determined -trish loeblein 8/11/09 9:26 AM

Original (for comparison)

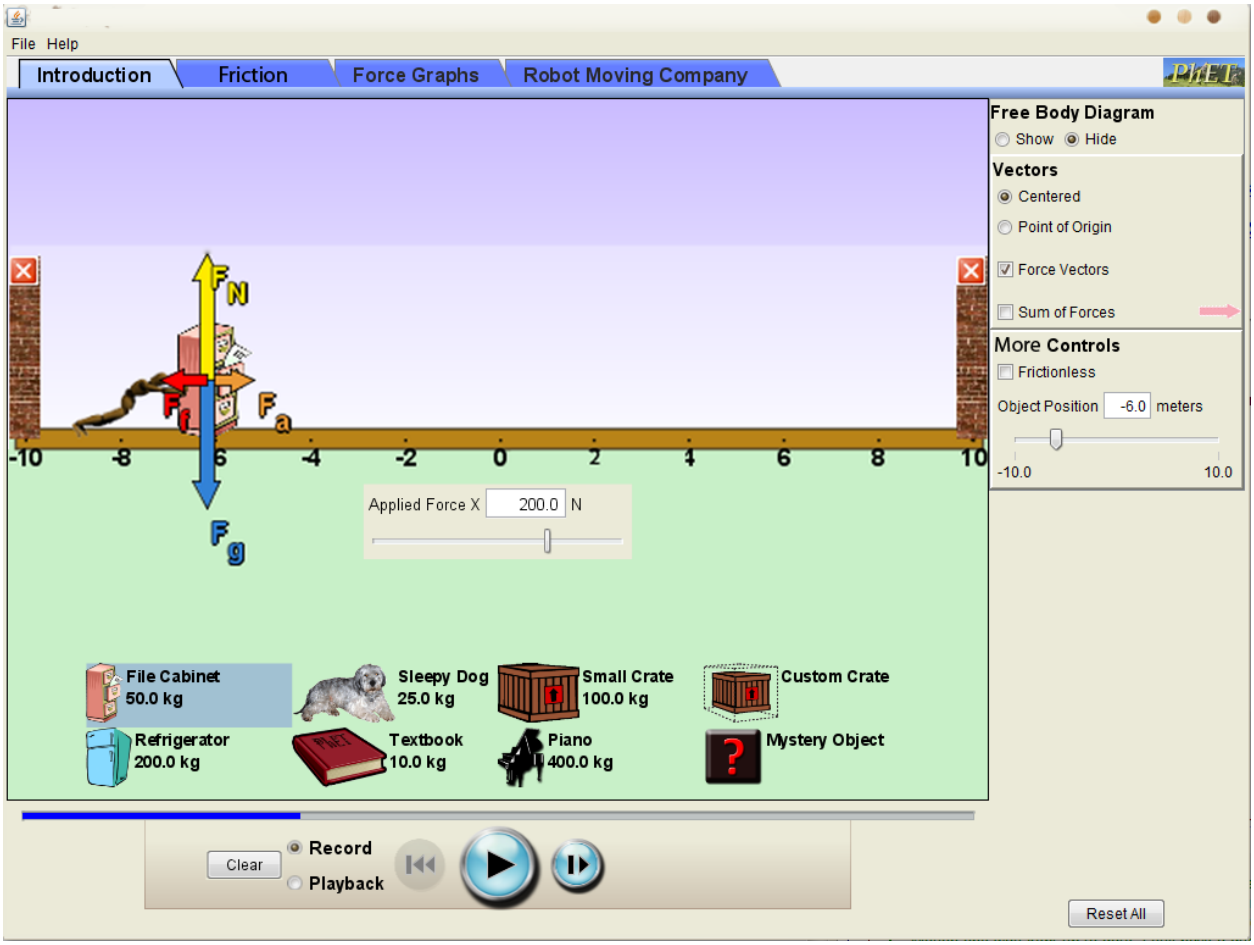


New Version Updated, date to right -Noah Podolefsky 8/10/09 4:10 PM

Tab 1 "Intro"
- Learning goals 1,2,3,4

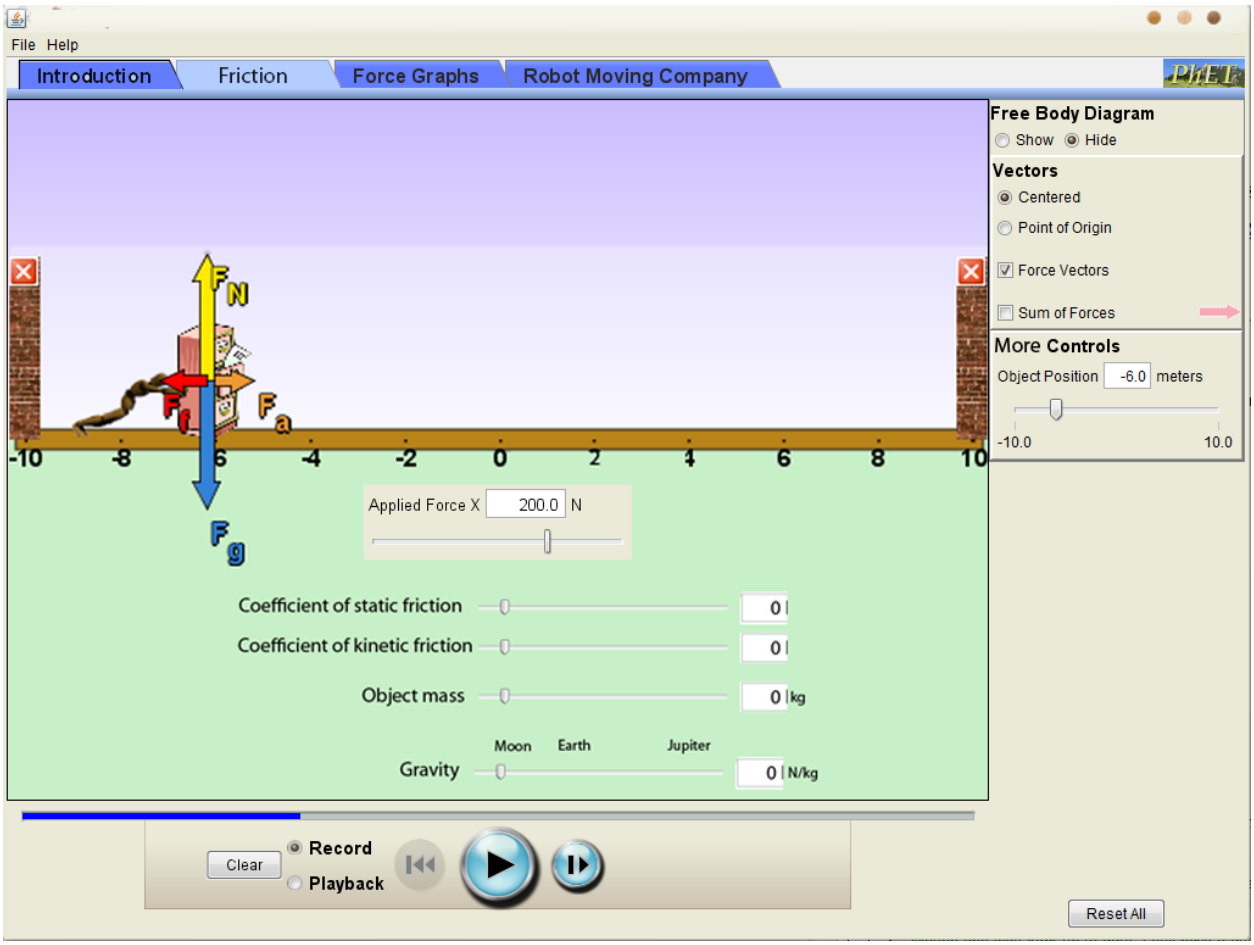
- Essentially the ramp without ability to change angle.
- Walls move to edge and objects/person in play are are larger (a bit more playful this way, since this is also a more basic sim)

- Can apply force by dragging object or using slider
- Slider snaps back to zero, can set constant force with text box
  Put in TIPS that the force can be set -trish loeblein 8/10/09 12:06 PM
- Easy access to objects in play area
- Mystery objects add intrinsic goal to figure out properties of these object



Tab 2 "Friction" - Learning Goals 1,2,3,4

- Adjustable friction, mass, and gravity with sliders
- Only one object (probably file cabinet) - instead of different objects, you change properties with sliders



Tab 3 "Graphing" - Learning Goals 5,6,7

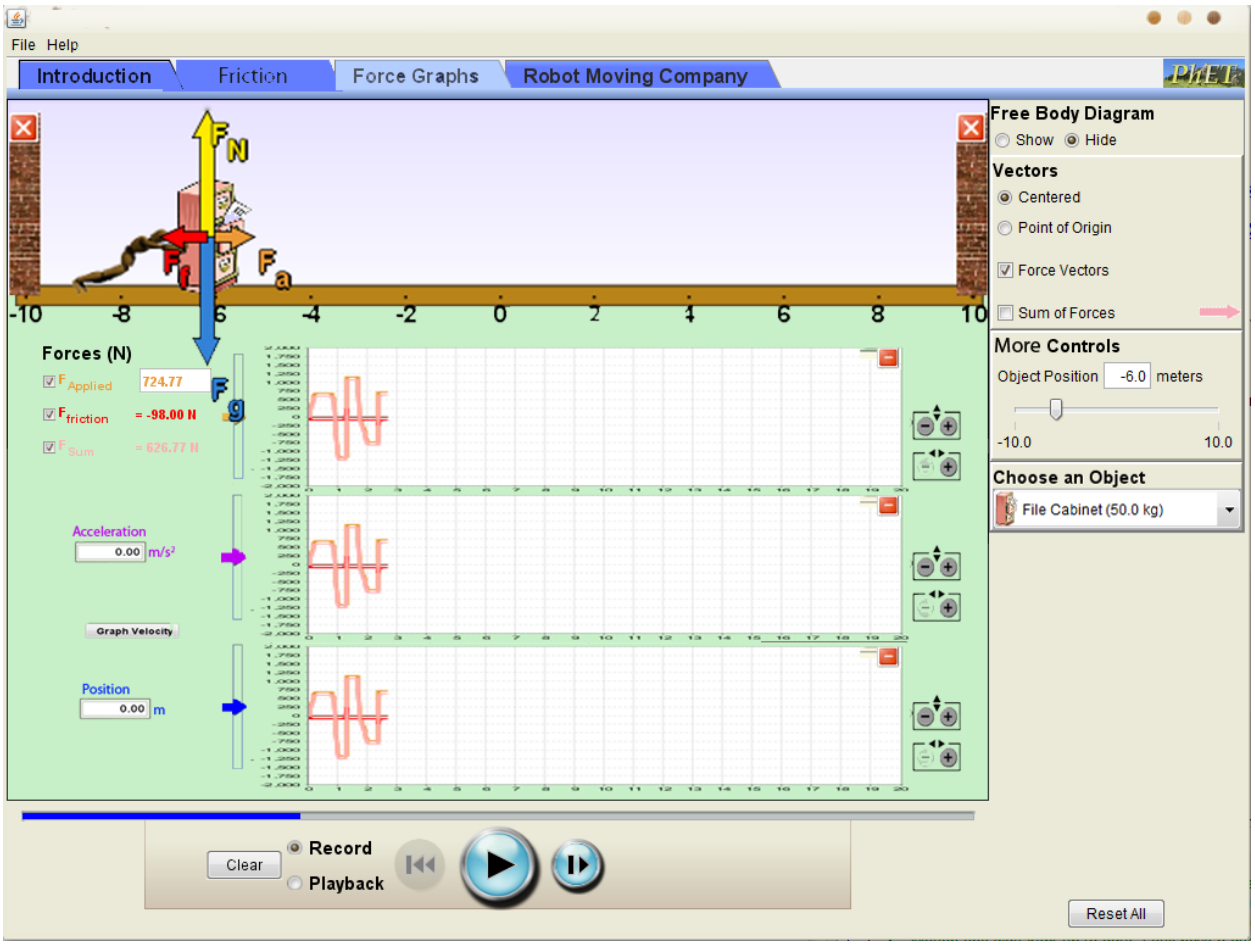
- Objects are now moved into control panel (scrolling menu with "more" buttons, similar to Eating & Exercise)
- Move play area up to make room for graphs

- Can control forces from object or from FBD
- Graphs are same as in Ramps (but need to shrink to fit)

- Starts with only force graph open - acceleration, velocity, position are closed - buttons open them

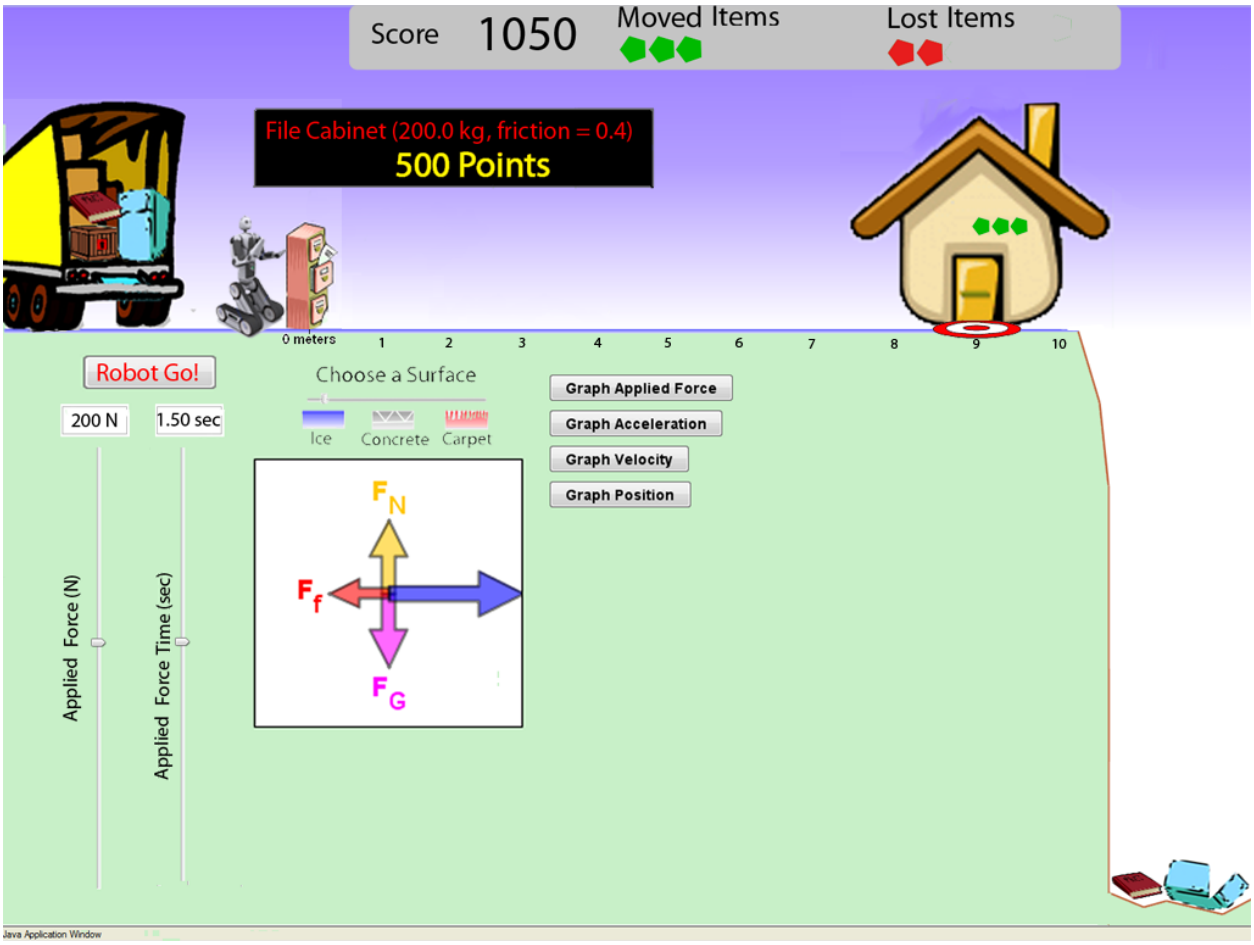
- Force slider is now near the graph instead of in control panel
- Choice of forces to graph with check-boxes to left of labels - only F_applied is on to start
- Values are shown with graph labels (cannot enter values for F_friction or F_total, output onlyAnother thing for TIPS -trish loeblein 8/10/09 12:09 PM)

- Can enter values for F_applied, acceleration, velocity, position in boxes on left of graphs

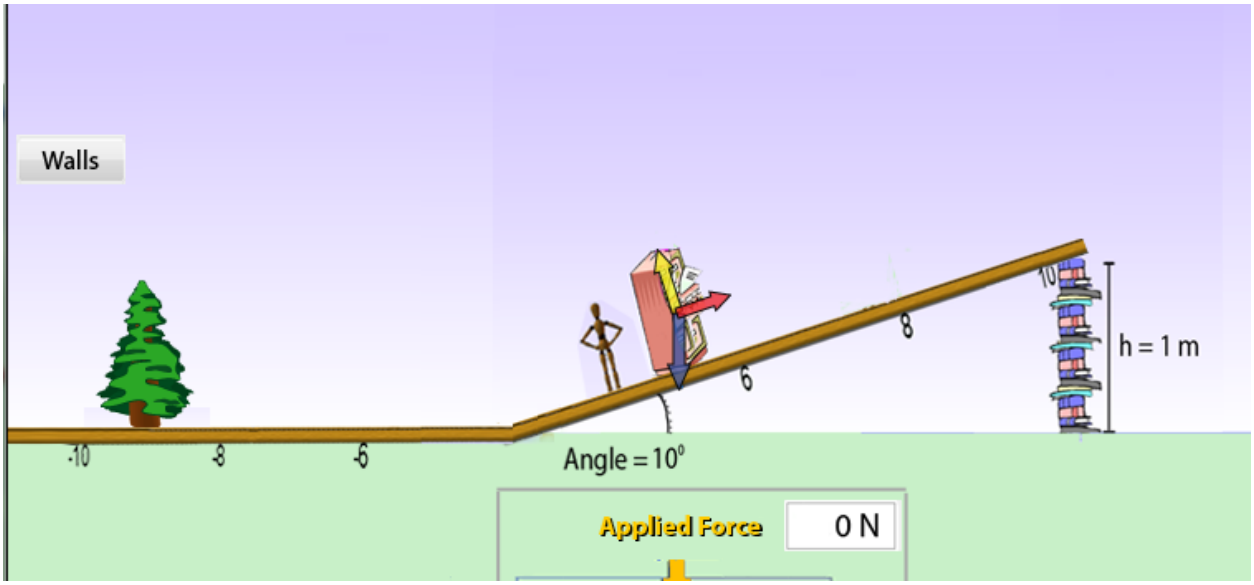


Tab 4 - "Robot Moving Company" I haven't made any changes to this yet -Noah Podolefsky 8/10/09 4:09 PM

- Set initial conditions and try to get objects exactly to the door (without overshooting and going over the cliff)
- If you don't make it far enough, you can push again but get less points
- Target in front of door is to give hint of what to do - may or may not need this



Finished Work and Archived Discussion for Ramp First Tab



Finished Work

- Change ramp graphic as shown

- Can choose different objects from images at bottom of play area
- Can change ramp angle by dragging ramp or with slider in control panel
    - Hovering on the ramp changes mouse cursor to double-arrow (to cue that you can move the ramp)
- Can choose object by clicking on an object
- Selecting "Custom Crate" pops up sliders to change mass, coef of static friction and coef of kinetic friction (see next picture below)

- Mystery Object is fixed, just do not show the mass (so you have to figure it out)
- No ramp heating in the intro tab (will have ramp heating / cooling only in work/ energy tab)
- Can select fixed or adjustable coordinate system

    - Adjustable coordinates can be activated with or without FBD

    - Fixed has coordinate system hidden, adjustable shows the coordinate system (you can always see the fixed coords in the FBD)

    - In fixed, x-axis is always horizontal (but not shown)

    - In adjustable, can rotate coordinates (see next image below)
- Applied force is 0 in center, negative to left and positive to right
- Can show FBD (appears in upper right of play area - see next picture below)
    - Why not show this in the top left where the ramp can't be elevated? -Samrreid 4/22/09 8:37 PM

        - Top left is good idea - see comment in adjustable coords section below -Noah Podolefsky 4/22/09 8:59 PM
- Applied force is always parallel to surface
- Vectors
    - Radio buttons to choose "Centered" (center of mass) or "Point of Origin" (POI) for position of vectors
        - This will put the tail of each vector in a different spot
        - "Sum of forces" vector is always above the object - its position does not change
        - Centered is shown below (tails of vectors all on center of mass of object)
        - Point of origin:
            - Applied force is at center of mass (could also be where figure is pushing, but this seems unnecessarily complicated)

            - Gravity is at center of mass
            - Friction is at base of object
            - Normal force is at base of object
- Vector colors:
    - Applied: orange
    - Gravity: blue
    - Normal: yellow
    - Friction: red
    - Total (sum of forces): pink

    - Can show "Sum of Forces Vector" which is net force, shown at top of object (pink vector)
- Ramp Controls
    - Can make ramp frictionless
    - Can change object position and ramp angle from control panel
        - Bottom of ramp is position = 0
- Mouse hover on object icons (only objects at the bottom of the play area) shows pop-up with info for object
    - Coef of static friction
    - Coef of kinetic friction
    - Mass
        - NP: let me know what you think of this idea. Trish seemed to think it would work well. I've seen students use mouse hover pop-ups like this in other sims (Eating & Exercise for example) without issue.
        - Why would the pop-up show Mass if Mass is already indicated on the icon text? -Samrreid 4/22/09 8:49 PM
            - NP: Once on the ramp, you can still use the pop-up on the icon to get info on the object you have selected. Mass does not need to be shown in pop-up if you can still see it next to the icon when the pop-up appears.
- Object selection panel layout changed when tooltips were introduced
- Vectors
    - Can show original (the usual vectors), parallel (to surface), or X-Y components
        - parallel is also perpendicular (just labeling this "parallel" to save space)
- Make adjustable coordinates snap to important frames
- Start with man standing next to object (as in Forces sim)
- Fixed: The Frictionless feature doesn't seem to work because the Ff force still shows. 1.03.02 trish loeblein 4/25/09 6:58 PM
- Fixed: The Reset all doesn't work. 1.03.02 trish loeblein 4/25/09 6:48 PM
- Fixed Vectors don't update when changing ramp angle and paused
- Fixed: Add support for changing coefficients of friction for objects and ramp
- Fixed: Don't show tooltip for mystery object icon
- Fixed: Don't show tooltip for custom object icon, or make it mutable
- Remove walls by clicking red "X", return walls with "Walls" button which appears when walls are removed (see image below)
    - NP: Please let me know what you think of this - I think it could work very nicely, but relies on users finding the red X's
    - **Clicking red "X" on walls removes them. Button labeled "Walls" appears on left which is clicked to return the walls.** (see image below)
        - Might want a 2nd walls button on the right for the other wall
- Should the object slide on the grass on the west side? If so, does it have a different friction than the ramp surface? -Samrreid 4/22/09 10:44 AM

    - Note sure what this question is asking, but attempt to answer - ground is drawn as same material as ramp, so same friction. When walls are down, ramp material extends to the west (left) as shown in image -Noah Podolefsky 4/22/09 8:57 PM

- SR: Are we implementing projectile motion for when the object is launched off the ramp? Should it crash or slide on landing?
    - If it is not a significant amount of time to implement projectile motion, I think we should. I think object should crash...this is more fun than sliding away. -Noah Podolefsky 4/22/09 9:57 AM
    -

- Remove the tree - it is much more distracting than I had imagined.
    - I agree that it is distracting. I hit reset and thought that I was supposed to move the tree out of the way or something, so I tried pushing it. I reopened the sim and realized it was just part of the scenery.-trish loeblein 4/27/09 12:31 PM

- Center applied force slider and make box 20% taller, 50% wider.
- Make selectable objects and accompanying text slightly larger, so that objects take up the rest of room available in lower green area.
- Fixed: Object should stop at edge of wall - currently objects overlap walls before stopping.
- Remove "mass" from object pop-up.
- Switch "piano" for "big crate". Keep the same parameters as big crate (400 kg is about right).
- Make object pop-up appear faster (almost instant if possible).
- What color for wall force? -Samrreid 4/24/09 8:29 AM
    - I was not aware that there was an issue with the old color, so I don't have an opinon-trish loeblein 4/25/09 12:01 PM
        - Make wall force olive: that is the original color and fine to use again -Noah Podolefsky 4/27/09 3:08 PM
- NP: I'd like to try just the one button for wall creation and see how it works. Less clutter this way.
    - Using the "+" instead of the word "Walls" doesn't look like too much clutter to me, and seems more symmetric and user friendly -Samrreid 4/26/09 10:02 AM

        - I like the "+" - very intuitive (to me) -Noah Podolefsky 4/27/09 2:57 PM

- Make walls thinner and taller as shown in image below.
- Add numbers measuring meters on ground and ramp - zero should be at base of ramp.
- Man should start standing next to crate (not pushing, just standing there).
- Can choose physics words or everyday words (still need to come up with what these will be)
    - This feature is under discussion over email, will this feature be dropped? -Samrreid 4/22/09 8:44 PM

See comment above: remove this for now with option to put it back in when we decide -Noah Podolefsky 4/27/09 3:11 PM

- Hard to see here, but the custom crate icon has dotted lines around it to cue the idea that the size can change
- Object width is a bit buggy
- Put in icons for vector checkboxes as shown in image below (NP can provide images).
- added Bold font for selectable objects.
- Put a bit more padding between selectable objects so that text does not touch adjacent object (particularly "sleepy dog" and the crate).
- Make "custom crate" text label match font for other labels.
- fixed: Original forces checkbox should update when sim is paused -Noah Podolefsky 4/27/09 3:15 PM
- Fixed TL: When the game ends, I get a message about my score, but hitting "ok" does nothing, not close the little window, or the program, also the game will not restart. Also, I cannot close the program. I can restart a second version.
  SR: Reproduced the problem and will notify when fixed
  NP:
  -the endgame bug that Trish also noticed (sim crashes when game ends)
  Fixed: NP: -robot energy is only taken up when robot is doing positive work (i.e., when force and displacement in same direction). I thought about this and realized that when the robot is slowing the object, the robot is doing negative work (force and displacement in opposite directions)...which in a way means its batteries should be getting charged up. That's where the object's energy goes when it slows down...but that's the opposite of what I was thinking, which is that the robot should use energy to slow the object down as well as to speed it up. Not sure what to do about this...ideas?
  TL:
  I was thinking that any time you use the robot that his energy should drop. I didn't see much change and I was under the impression that the feature wasn't fully operational.
  NP:
  I agree - the robot should use energy to slow the object down or speed it up. Energy_used = magnitude(force*displacement). We can pretend that when slowing down the object, the robot is spinning it's wheels (so the energy goes into thermal from friction....).
  SR: I changed this behavior, will be ready in 1.03.15
  Looks good. -Noah Podolefsky 5/4/09 7:16 PM
  Fixed: TL: 3.On a more controversial note, I am not comfortable with the " adjustable" , "x-y" component , "point of origin", option being on the first tab. I feel strongly that the point of redoing the motoin suite was to make the first panels more simple. The more I play with this panel, the more concern I have. I wonder if we could consider a tab called "Cooridinate Systems"
  NP:
  3. I had the coordinate system stuff in the 2nd tab in an earlier design. If you feel strongly that this would make the sim easier to use, perhaps we should separate these controls into a 2nd tab, and make the 1st tab simpler.
  TL:
  I would vote strongly for this option.
  Let's try this: make the current 1st tab into the 2nd tab - call it "Coordinates" (for now, maybe a better name?). Make a new first tab, called "Intro" with the following controls **removed**: Coordinate System, Parallel Components, X-Y Components. Change "Whole Vectors" to "Force Vectors" (the more I think about it, the more I like the label "Force Vectors" for both tabs). I think that if we are keeping "Point of Origin", it should be in the 1st tab...but we can see how it looks - Noah Podolefsky 5/4/09 7:08 PM

- Fix flickery dynamics and vector behavior near right Wall
- Fixed: Pusher graphic doesn't always update properly, for example after the block goes airborne; he updates location after the ramp is rotated -Samrreid 4/26/09 11:58 AM
- Cannot duplicate**:** Sum of forces checkbox should cause update even when sim is paused -Samrreid 4/25/09 10:45 PM
- ~~Move left wall to left edge, as shown in design image below.~~
    - I don't think we want to dynamically change the length of the ground based on the aspect ratio of the user's screen. -Samrreid 4/28/09 12:54 PM
        - Agree with SR: leave left wall as-is, with fixed length of ground - Noah Podolefsky 4/29/09 3:10 PM

- NP: -if you are not careful to release the mouse before the next object comes up, it starts right away where you last had the force slider. I guess having the next object button avoided this. What if when you score or lose the object, you get a dialog that either says "You scored XXX points." and "Next Object" button, or "You lost the refrigerator" (or whatever it is) and the button. Now that I've played it this way, I think some transition dialog like this would be nice. What do you think?
  TL:
  I had my son play with the game and he was surprised when another object appeared and lost some points trying to figure out what to do, so I think we may need some type of pop-up.
  Let's try this pop-up as I described above. It is much more of an abrupt transition than I was expecting without it. -Noah Podolefsky 5/4/09 7:07 PM
  TL: 2. I don't think students will understand what "original" vectors are. At first, I thought that they were representing a starting position to which I could reference my changes. I think just "force vectors" would be more clear.
  NP:
  2. "Force vectors" might be OK, but they are all force vectors. It is kind of an ambiguous label. Maybe "Standard" vectors?
  TL:
  I am not sure about what adjective to use. We typically say "Vector" and "Vector Components". By adding the different types of ways to look at the components, we are going to have to use non-standard vocabulary. This is another reason that I would like to see these features moved to a different tab. I think that many teachers will not need to use " adjustable" , "x-y" component , "point of origin".
  SR: I agree that maybe some of these features should be delegated to other tabs, but that for now, I recommend calling this vector the "Whole Vector" to distinguish it from components,
  I changed this behavior, will be ready in 1.03.15
  See comment on this above. -Noah Podolefsky 5/4/09 7:15 PM

- For object selection panel, even out the arrangement of objects to have even spacing
- I made improvements to this, will be available in 1.03.13, does it still need more work? -Samrreid 5/3/09 1:51 PM
    - Seems to be shifted slightly to the right - can you center the entire selection panel? -Noah Podolefsky 5/3/09 3:20 PM

Archived Discussion

KP: Tabs need names, do you have ideas?
NP: Will work on this, will have new names in next design doc version.

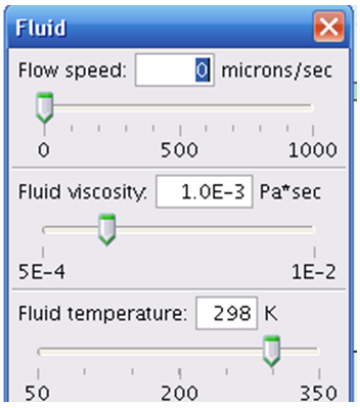
- KP: Is this available when Free Body Diagram is closed, or only when it is open?
- NP: always available.

- KP: I'm assuming, applied force is always parallel to surface here
- NP: That would be simplest - so yes, should always be parallel to surface. Means making it switch on you in FBD as you go on/off ramp (which I think is OK).

- KP: Is scale shown on the ruler or the slider correct? One goes -10 to 10, other is different
- NP: They should be the same - whichever makes more sense. MM goes -10 to 10, so probably the same here.

- KP: Need to define what changes between Physics and Everyday words ... put in your thoughts of the exact wordings.
    - NP: Still have not come up with the 2 sets of words. This will be on the todo list. I'm leaving this for later since it is just a matter of changing string variables later on.

KP: I like these type of slider controls with numeric value near title - its a bit more compact and seems easier to understand.
NP: I like these better as well. I'll implement this in next design cycle.
WA: I am guessing that these were for the control panel and not the force slider in the play area. If you're talking about changing that, have to be careful to match vertical slider in graph panel. I'm sure Noah is on this but wanted to be sure since I don't know what the visual was for this comment when it was made.
NP: This suggestion was for sliders in control panel, I believe. This comment was made before the force slider was moved into the play area.



WA: Maybe don't need to use the word vector in the labels since it's in the title. "Sum of Forces" or "Original"
NP: Good idea. Will remove word "vectors" on button labels.

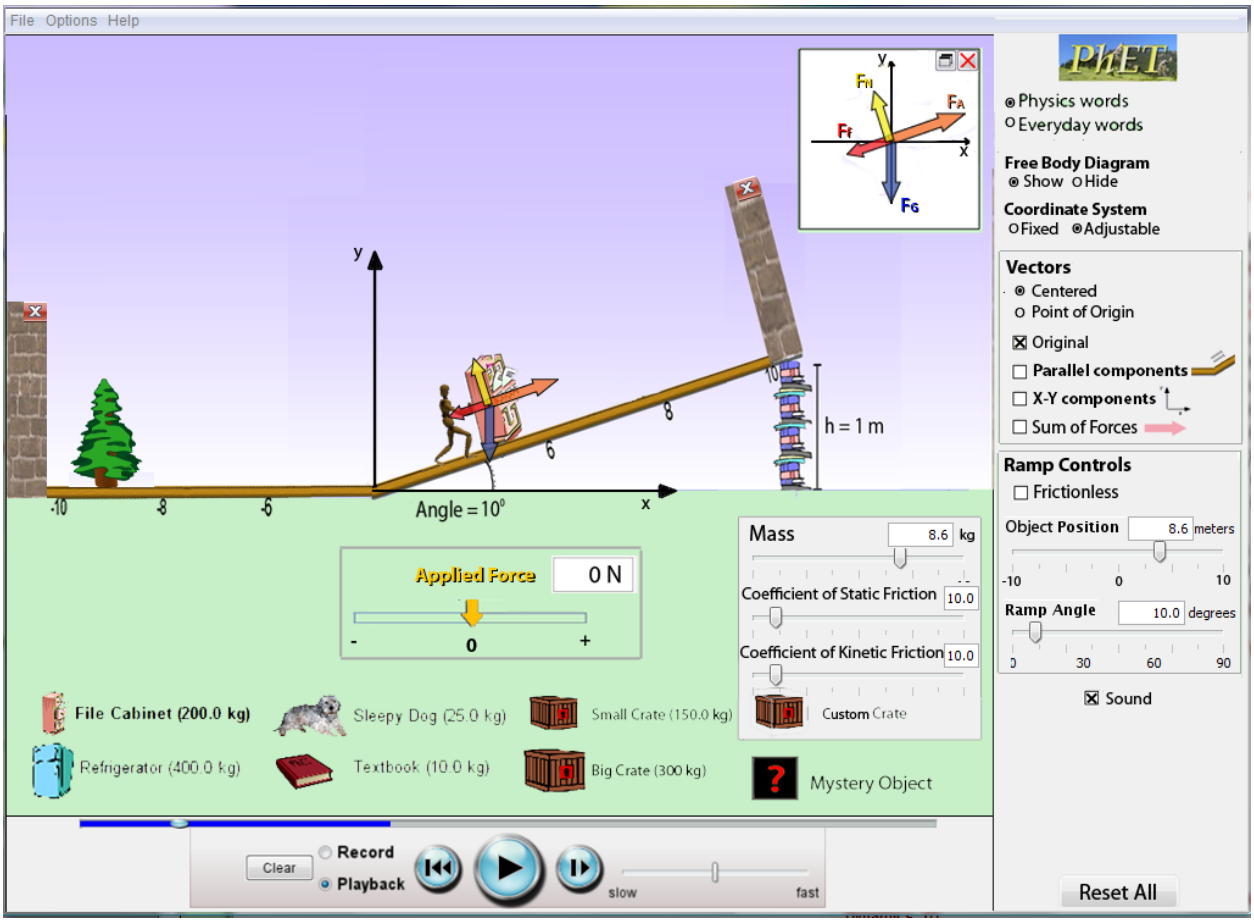
- TL: I really like the slder in the play area (as opposed to in the control panel in the old version). I think this will help my students.
    - NP: Cool. I like it too - glad to get positive feedback on this idea.

WA: maybe make Walls check box negative "Hide Walls" Frictionless is fairly important control. It's pretty buried now. Maybe hide walls does not belong in this box and frictionless could have more space around it to set it off. Walls could be below the sliders or a red x on the actual brick walls themselves and nothing in the control panel.

NP: I like the idea of red X on walls - I added this in new picture below.
Question is how to bring the walls back. A button maybe on the left side of play area that says "Add Walls" or just "Walls"??
NP: See image below for how this would look with "Walls" button.

Playback/Record Is record/playback a high priority for the upcoming workshop? -Samrreid 4/24/09 5:01 PM I think it would be ok to tell the participants to look for more features soon. Most of these teachers will not be using the sim until fall. I think it would be nice to tell them a "projected completed date". -trish loeblein 4/25/09 11:41 AM Agree with trish - low priority for now, can demo recording with Ladybug at workshop -Noah Podolefsky 4/27/09 3:06 PM

Archived Discussion for Adjustable Coordinates Tab



Coordinates Tab

The coordinate tab was removed for now, but here is some feedback we may wish to consider if/when it is restored.

-Coordinates tab: start the axis aligned with the ramp

-Rotatable coordinate axis missing in Coordinate tab

Need some modifications to vectors for parallel and X-Y components (like striped backgrounds or similar)

NP: Black lines through vectors might be more noticeable than white, especially on light colored vectors

NP: Diagonal cross-hatch might work for parallel/perp vectors -Noah Podolefsky 4/27/09 3:17 PM

SR: I think at our Thursday meeting NP said he would think about what is best for these vectors; we thought the arrows were probably too thin for stripes, and that we would consider switching to a dotted outline for component vectors

NP: I'll think about dotted outlines and other options for arrows

I think best might be to have the same background color for all types of vectors, with dotted outline for parallel and x-y components. Parallel vs X-Y can be distinguished by having different labels (as is already the case). -Noah Podolefsky 6/14/10 1:35 PM

Interview/Discussion Issues

There have been some issues with students playing for a while with the graph closed, then opening the graph, seeing it full and not understanding that it was recording the whole time. This should be resolved in new versions since at least one graph is open by default.

During interviews, do people notice that the coefficient of friction changes while the ramp is wet?

NP should interview and see if the missing dog + drops are confusing on playback

In the Forces and Motion sims, there is a seam between the left and right halves of the platform. It would be a disproportionately large amount of work to remove this problem. Is it okay to leave the seam showing?

Consensus: Fix it if it's confusing during interviews

Friction force jumps in instants in which the object turns around

This is apparently because the object temporarily comes to rest and instantaneously uses static friction, so I think it's physically correct. What do you think?

NP: Seems correct to me. Let's leave it and see if it is an issue in interviews.

Do we need to record and playback firedog and water drops? This feature was dropped in the interest of time and we said we'd check in interviews to see if it's necessary.

See if people still click on the stick figure, and if so, what a good solution would be.

Some text in the "press arrow keys" icon is obscured, behind the scoreboard, after score changes
SR: Low priority, since if the score changed, the user has demonstrated usage of the keyboard. Also, this object is already at the rightmost of the stage.

Wall and friction force vectors overlap, how about offsetting them so they are adjacent?
SR: Sometimes friction and applied forces also overlap, this should also be addressed, or if we've decided that is okay, then perhaps wall overlapping with friction is okay too.
NP said it's more important that the vectors have the same point of origin, so we'll leave this alone.

TL: Is there an unfuddle ticket that we might want to update about [the decision to omit speed readouts]? I don't have any disagreement about leaving it off, I just remember the discussion came up from some teacher who requested it. I was thinking we might want to include a note in the Tips. I think in the "Students.." section, we could put a note that when students are given quantities they tend to focus less on qualitative concepts. Is that about right?

Finished Work

- Show x-y axes (the coordinate system)
  - Adjustable option doubles as show coordinates option
- Can grab and rotate the coordinate system
  - Mouse pointer is replaced with double arrow when hovering on coordinate axes (to cue user that they can move axes)
  - Axes snap to horizontal or aligned with ramp when close to these orientations (but you can still rotate it anywhere you want)

  Custom crate
  - This is always available, just showing it here for convenience
  - Choosing custom crate makes sliders pop up, with box surrounding crate as shown in picture
  - Can change mass (which is reflected in size of crate), and coefs of friction
- FBD
  - Appears in upper-right of play area.
  - SR: Why not show this in the upper-left of the play area, since the ramp elevates to the upper-right?
    - Probalby a good idea - I wanted to keep it near the control that turns it on, but probably not necessary. Moving to the left would give us more room for the ramp on the right. Try it on the left, and we can move it back later if necessary (note that you can detach the FBD and put it where you want as well) -Noah Podolefsky 4/22/09 9:59 AM
  - Can be turned off with X or clicking "hide" button.
  - Can be moved into it's own window with button next to X
  - Forces do not rotate, but the axes in FBD do rotate (you can grab and rotate these too, and both sets of axes move together
  - Can apply force using FBD
  - You can always see coordinate system in FBD (even when "fixed")
-

Archived Discussion

- KP: Might want to allow show axes to be turned off and on?

  KP: You allow fixed and adjustable coordinate system. What if this was just always adjustable if shown? Are you thinking that selection is necessary to cue on fact that it is adjustable? Is not having fixed, to confusing? (Just thinking that might be able to drop one control, possibly).

    - NP: In present design, coordinates shown and adjustable are the same. There is only one control, since it does both (I think this is what you meant above.) Then not shown, also not adjustable. So could have this selection either adjustable/fixed or show/hide coords - I chose the first in order to cue on the idea that they are adjustable.

- KP: Again, does this display when FBD is closed or not? Might want to have this ability without FBD open, but then need to rework drawing above to include these features.

    - NP: This will be available with FBD closed. See drawing below for how it is implemented (this drawing has FBD open, but this is not necessary, just showing the option.)

- KP: Would a double arrowed curved handle help? As in the graph handles in Interaction Potential.
- NP: Maybe. I'd like to try and minimize the number of arrows that are in the play area - I think that a mouse over on the axes might be enough to cue users they can move the axes.
- WA: Plus you had to choose Adjustable.

Can show vectors as:

- the original vectors (as shown below)
- parallel components (parallel to the direction of motion or surface you are on)
- X-Y components (splits vectors into components along x-y axes) - might want to keep original vectors in this case and also show x-y components, but make all thinner to easier to distinguish.
- KP: Would check-boxes work for these options? It seems nice in original design that can turn on and off different components while leaving originals on ... a bit easier to understand well at least explain the component view them when see both at once.

    - NP: In my opinion, allowing all of these to be shown at the same time makes the vector display very messy - this is why I chose radio buttons so that you can only have one at a time. If you think that it is pedagogically much better to have them shown simultaneously, happy to discuss that.

  KP: Will you show parallel-perpendicular components both when you hit parallel? Is there a way to get perpendicular in there?

    - NP: Space is tight if we are going to keep wording to one line. Hopefully when users click on "parallel components" and see both parallel and perpindicular it will be obvious what that selection does. If not we can think about other wording.

  KP: Will these components draw in FBD and on ramp?

    - NP: I think so - same vector (or compenents) shown in FBD and ramp.

- KP: Control panel has a lot of one-of things in it. I'm wondering if there are some grouping, or things that are more related that should be near each other, or some

graphical lines that would help group things? The Sum of Forces vector seems to go more with the components stuff (displaying forces). Also might want to have a group label or something that makes it more clear that when you displaying components you are talking about forces.

    - NP: I think walls could move down (right above selectin for physics words). If room, I think putting something like "Vectors" above the selection for compenents would help.
    - NP: On the compenent selection - do you think maybe this selection should always be available, not just for adjustable coordinate system?

- KP: Can you apply a force by clicking in FBD? - can do this now.

    - NP: Yes.

- KP: Maybe Walls, Frictionless and Object Start/Angle go together as properties of the ramp?
    - NP: I like that. Have to think of what to label this group - "Ramp Controls" would work.

KP: Maybe put physics words and everyday words at top, above FBD button?

    - NP: If you think students will see them there, I'd be OK with that.

KP: This is a tough problem. A different possible grouping from what you have here might be:
Coordinate system (on / off)
Force vectors

- at center of mass or at point of origin
- Sum of forces
- Original vectors (? Are there other options than original ?)

X-Y components Parallel/Perpendicular components NP: I am assuming you intend these to be checkboxes? If so, I would prefer to constrain all the different vectors that can be shown at once. If not checkboxes, I'm not sure what this scheme buys us (but open to having it explained to me). NP: I changed my mind on this - made them all check boxes. See how this works out. If confusing or too messy, can change back to radio buttons.

KP: Maybe think about which of these might benefit from little icons next to them (e.g. Walls?, perhaps x-y and parallel/perp could benefit from a little axis image (possibly that rotates with the orientation?), perhaps sum of forces with a vector showing color of sum?

- NP: Good ideas. I always like icons to go with buttons, so I'll try to implement something.

- NP: do we necessarily need both coef of static and kinetic? Instructors will probably want this, but we have discussed before having only one coef of friction. Just wondering.
- TL: I really like the information in the play area (as opposed to in the control panel in the old version). I think this will help my students. My text book and other HS books emphasize the 2, so I would vote to keep them. I wonder if it would be ok to enable the students to see the information for each object; maybe with a right or double click?

NP: Info for each object is a good idea. Not sure how best to do this without complicating things - maybe a tool tip on mouse over? The is room to the left of the force slider - but I hate to clutter this area any more.

- TL: Mouse over seems like a good solution because nothing has to be turned on or off. I think there might be some record of students and teachers not finding a 'right click", but I am not sure. What I see in SKate park is that students right click on the purple dots to get readings about energy etc, but they don't right click again to get rid of them, so the play area gets very cluttered.

KP: I also thought Wendy had wanted to have selection that was:
Draw forces at

- center of mass
- point of origin
  If drawn at point of origin, how would you do component drawings?

NP: The more I worked on this and talked to people about it (like Mike D), the less comfortable I became with the idea of having point-of-origin forces. We should discuss this in person I think. There are a number of complications and issues, and I don't want to discuss them here. Happy to discuss in another venue. We can talk about this next week. I still think it'll really help students who are learning about free body diagrams.

- TL: Is the learning goal to be able to draw and use free body diagrams complicated enough for us to consider a separate sim. Perhaps a Flash one. ONe thing Mike found with Faraday is that teachers wanted a simple sim that allowed students to really focus on induction. What if we had a Falsh sim called Free Body diagrams and one of the important features would to be able to rotate the axes.

NP: Now that the control panel is more tidy, there might be room to add this in the "Vectors" section as radio buttons.
TL: I really like the FBD in the play area (as opposed to in the control panel in the old version). I think this will help my students.

Archived Discussion for *Tab 2 "Force Graphs" - Learning Goal 4*

- KP: Can no longer type in an applied force? That precision can be useful. Thoughts?
  - TL: I think being able to type exact numbers is very important. The chem and flash sims include this feature.
    - NP: Agreed - I should add this in.

- KP: Also, would be good to note for the record here what vectors are what colors ... also control for applied force should be same color as applied force vector.
  - NP: This is now spelled out in the first section above. The vectors shown here are the correct colors (I'm pretty sure).

- With fixed coords, forces graphed are parallel to object motion
- With adjustable coords, forces graphed are the ones selected for the coordinate system (original, parallel, or x-y); change label from "Parallel Forces" to reflect the forces graphed in this state

- KP: I'm trying to visualize this and how it will help students ... can you elaborate here on what you visualize students doing and thinking while doing? This is perhaps where a use scenario would help).
    - NP: This may not be helpful after all. I just thought it was kind of odd that you could change the vectors shown, but the graph would stay the same. If you think this is not a problem, I'm happy to have the graph always show the same (parallel forces). It is true that these are the only forces that affect the object motion directly, so it makes sense to graph them and not others.

- KP: Some of questions from above apply here, but won't repeat. Please let me know if there are remaining questions from above not covered here yet.

KP: Just a thought ... but would plotting acceleration or velocity be useful here? TL: I think so.

- NP: Current version of Ramps does not have this. Have there been specific requests for it, or times when you found it would be useful? I'd like to keep this sim as simple as possible - the Forces sim should cover the relationship between force, acceleration, and velocity. Trish has said that teachers already use this sim to do everything, so if we make it possible to do all this, then there might be even less motivation to use the other sims.
    - TL: Maybe we should wait to see if the learning goals around force, acceleration and velocity are sufficiently addressed in Forces 1D. I know that my students get confused when the axis is rotated, so I was thinking this sim could be an opportunity to reinforce. I agree that this sim is complex. Could there be a tab with just the custom crate and the graphs? or a version that empahisizes energy and one that emphasizes motion? I have seen many teachers try to use this sim for "force and motion". In our last workshop, 2 MS teachers spent several hours and were frustrated. I think because they were not relating the motion to energy; they had difficulty, and I think it is because energy is not well established in MS, so they were trying to relate the motion without using energy. I think offering a sim that help the students with F, a, v and d, other than Forces 1D and Moving Man would enable practice. (Rotation will not be used in conceptual physics or MS)
        - WA: Trish you've mentioned several times about teachers trying to use Ramps for everything. At first I took your comments to mean you don't want them to be able to do this. However, here I'm starting to think I misunderstood and you actually do want them be able to use this sim for the things they've been trying to use it for. I can see both sides of the argument. If we can keep the sims very simple, it'll be clear what can be taught with them. I think when we add lots of ability to a sim, it becomes harder to quickly see what it's purpose is so easy to assume stuff is there that is not.
            - TL: I do think there are pro's and con's. I have observed more con's because the teachers skip Forces 1D; they say that it is not very easy for students to understand and that they have had difficulty writing activities that are inquiry. I am hoping that a revised forces 1D will have a more inviting look and invite more inquiry. Also that the addition of the game will encourage the students to want to investigate more. My best hope is that teachers be able to scaffold their teaching more.

        - NP: I gather from this thread that we don't need to plot acceleration or velocity in this sim. Leave those for Forces sim.

Done items for Robot Moving Company Game:

- Note the FBD diagram shown below doesn't match the forces correctly. It will in the real sim (I'm just too lazy to change the image here.)
- You can choose different surfaces which effectively changes the coefficient of friction.These will be three options each with a radio button **(note this is different from the slider shown in the image below.)**

    - The objects will have friction coefficients listed in the box- they are a combination of object and surface. The friction coefficients will change with the surface in the following way:

Ice: all coefficients are zero (frictionless).
Concrete: default friction coefficients (same as in other tabs)
Carpet: 1.5x all coefficients. (we may need to tweak this up to 2x depending on how noticeable this change turns out to be)

- ~~Raise/lower the truck with the buttons below. This changes the height and angle of the ramp.~~
    - Why not grab the ramp to change its angle, as in the other module? This seems like a friendlier user interface to me. -Samrreid 4/29/09 8:23 PM
        - Agreed - remove raise/lower buttons and allow moving ramp with mouse. Maybe should be able to grab the truck to raise lower as well? -Noah Podolefsky 4/29/09 9:01 PM
        - At the workshop on May 5, I saw several teachers try to move the truck up and down by grabbing the truck (the yellow side) as opposed to the other places like the ramp. I asked why they thought the truck could move up and down and they said that the image of the scissor like pieces were a good clue, so that seems to be a good image. Many had not played with the first tab much -trish loeblein 5/7/09 5:54 AM

- ~~Users cannot do anything while the object is sliding. Buttons should gray out while the object is sliding to help indicate this.~~
    - This will make the game less entertaining and less interactive; it would be funner if there is something that can be done as the object moves,
    - such as changing friction, changing ramp angle, or adding a small amount of thrust. -Samrreid 4/29/09 8:25 PM
        - Add an "applied force" slider as in Tab 1 that can be used to control robot force. Robot instantly appears next to object when you apply a force, stands still when not applying (like man in other tabs) -Noah Podolefsky 4/29/09 9:03 PM
            - I found it is fun to change the surface and angle to save Robot energy. Should you lose energy if you change the ramp angle? -trish loeblein 5/7/09 6:05 AM
- ~~If the ramp angle is not enough to overcome static friction, the object does not go anywhere.~~
- ~~Target in front of door is to give players a hint of the goal of the game (hit the target).~~

- I don't think a target icon is necessary; it's obvious to me that the house is the target -Samrreid 4/29/09 8:26 PM
    - I agree- try without and look for more elegant solution if needed - Noah Podolefsky 4/29/09 9:02 PM