Simulator Kit 1: Spaceball

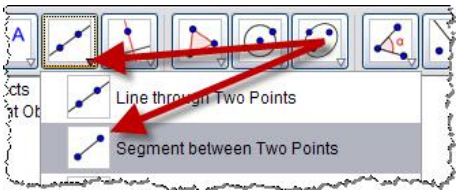
Simulator goal: To create a simulation of a ball in space being bounced back and forth between the same 2 points on 2 boards forever and ever.

In your kit:

1. GeoGebra files: spaceball.ggb (starter) and spaceballA.ggb (done)
2. Images (4): space.jpg, ball.gif, bd1.png and bd2.png
3. spaceball.pdf (this file)

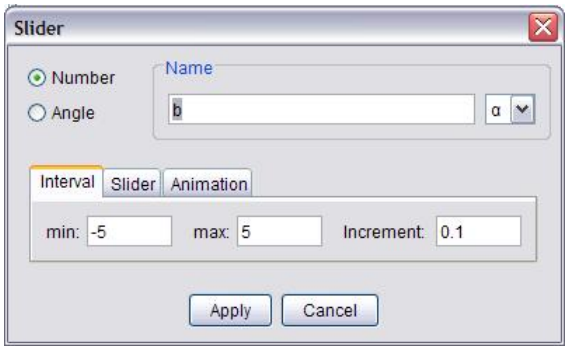
Starter simulator (no images)

1. Open spaceball.ggb (double-click, GeoGebra should start and this file will open).
2. Make a line segment AB
   a. Select segment tool 

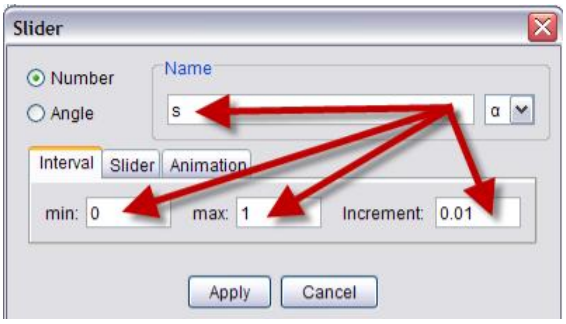


   b. In the Graphics View (drawing pad), click once left of center and then click again right of center (we want a horizontal line segment mostly spanning the center of the view – you can move the endpoints using the select tool ).
   c. Look in the Algebra View (window at left).
      i. Free objects: point A and point B
      ii. Dependent object: segment a
3. Make a slider. This will be our animator.
   d. Select slider tool 

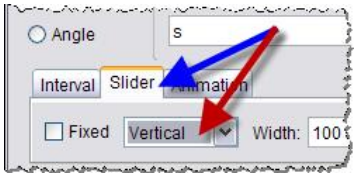
   e. In the Graphics View, click once towards the left corner (once created you can move the slider using the select tool ). A dialog box will open.

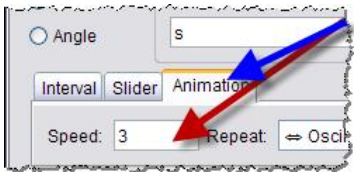


      i. First, type s (a small s) to change the **name of the slider to s**.
      ii. Click in min box and change to 0.
      iii. Click in max box and change to 1.
      iv. Click in increment box and change to 0.01 (for smooth animation)



v. Click on the Slider tab and change slider type to vertical.





vi. Click on Animation tab and change speed to 3.

vii. Click on Apply.

Use the  to click and drag the slider into a good location in upper left corner.

Then use  to drag **s=0.5** (doesn't have to be exact - we can see point P below).

4. Make the moving ball point P.

Ooh – here comes the mathematics. Don't be alarmed.

What do we want? We want a point P that slides back and forth along the segment as the slider moves from s=0 to s=1. Remember that the left endpoint of segment is point A and right endpoint is point B.

So we want: **P = A when *s*=0 and P = B when s=1**

Let's look at: **P=A*(1-s)+B*s** Does this work?

a. Click in the Input field (bottom left).

b. Type: P=A*(1-s)+B*s and hit Enter. (Remember –case-sensitive.)

Since we set s=0.5, *P should show up on the midpoint of AB*. Why?

5. Animate point P.

a. Right-click on s (either the slider point or the value) and from the drop-down menu, select Animation On. The point P on the segment should start to move from end to end.

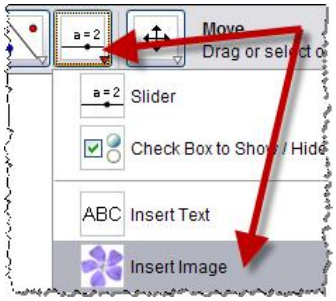
The pause  and play  buttons are always at the bottom left of Graphics View.

6. Save your file!

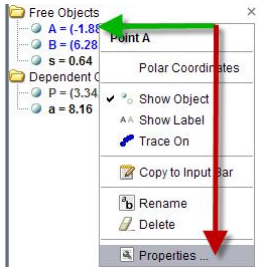
Now let's make it look interesting by adding a story. If you want, add your own images.

SpaceBall simulator

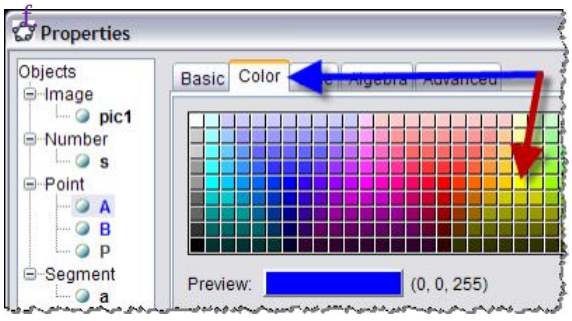
The images are sized for a GeoGebra window that ~900x650 (standard window). You may need to resize them if you greatly increase or decrease this window size.

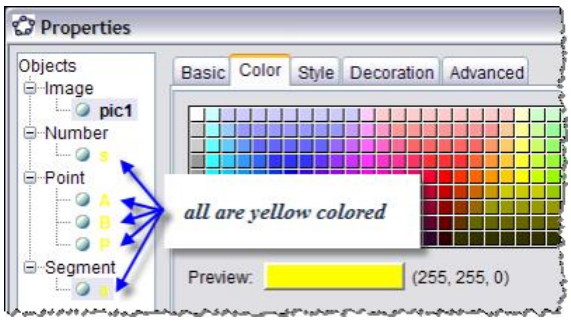


1. Add starry space background.
   a. Select the Insert image tool
   b. Click (anywhere) in the Graphics View. A dialog box will open.
   c. Locate space.jpg and double-click to open.
   d. Select the Move tool and click and drag the image to cover the Graphics View.
2. Change the color and layer of our objects.
   a. In the Algebra View, right-click on point A.



   b. Select Properties from drop-down menu. The properties dialog box will open.
   c. Click on the Color tab.
   d. Click on a bright color like yellow.
   e. Click on s at left and again on yellow. Do the same for B, P and a.
   f.



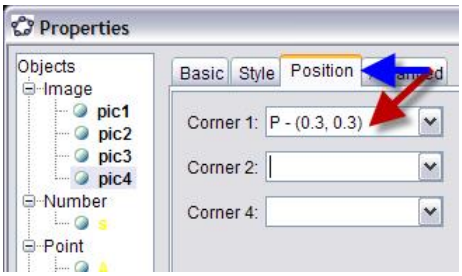


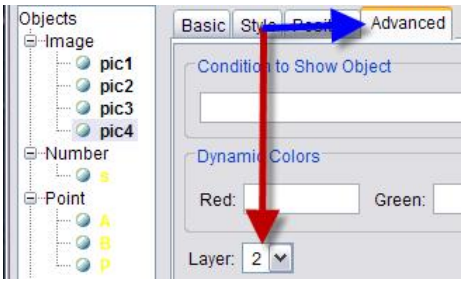
   g. Click on the Advanced tab and change the layer of s, A, B, P and a to 1.
   h. Click on Close.

   Of course, you can choose your own colors – just make them bright and on top.
3. Put in the bouncing boards (and yes they are a bit too slanted for supposedly parallel – feel free to design your own!)
   a. Select the Insert image tool and click (anywhere) in the Graphics View.
   b. Locate bdl.jpg and double-click to open.
   c. Again, click (anywhere) in the Graphics View.
   d. Locate bdr.jpg and double-click to open.
   e. Select the Move tool and click and drag the images under the left and right endpoints of the segment.

   (The reason we put the boards in first is that they are on layer 1 with the segment. If you advance the layer of an image, the next image you insert will be on this layer. Of course, you can always change the layer using right-click -> Properties -> Advanced.)

4. Add a ball and connect it to point P.
   a. Select the Insert image tool  and click (anywhere) in the Graphics View.
   b. Locate ball.gif and double-click to open.
   c. Right-click on the (orange) ball and select Properties.
   d. Click on Position tab and then by Corner 1 select P from the arrow.





   e. Unfortunately, this is not the center, but the bottom left hand corner. So after selecting P, click in the box and type P-(0.3,0.3). You may have to adjust the coordinates according to the size of your GeoGebra window.
   f. Click on Advanced tab and change layer to 2 (to bring it to top).
5. Save your file!

- Now try the animation (press the play button)

A little mathematics to think about …

1. First we made the simulation and then decided that outerspace was a good place to put this simulation. Why do you think we decided on outerspace?
2. Why do we want the boards to be parallel to each other?
3. Our formula for P is P=A*(1-s)+B*s.
   a. If A=(1,1), B=(6,1) and s=0.2, where is P? To check your answer, pause the animation, move A and B to these points and slide s manually to 0.2
   How many units has the ball traveled?
   b. If A=(1,1), B=(6,6) and s=0.2, where is P? Check your answer. How many units has the ball traveled?
4. (This is the same as question asked in 4b of directions.) How do we find the midpoint between 2 points A and B? Does this agree with our formula that P=A*(1-s)+B*s is the midpoint between A and B when s=0.5?
5. Suppose that we had made the slider s=[0,2]. How would we have to change the formula for P? Do you see why we used [0,1?]
6. Pretty hard… Suppose that the slider s=[3,8]. Now, what would be the formula for P?