

Grade 12 College Physics

# ENERGY TRANSFORMATIONS SIMULATOR

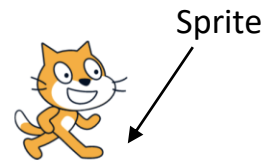
Blank link for students

<https://scratch.mit.edu/>

Ready solution

<https://scratch.mit.edu/projects/882781717>

# Getting to know Scratch!

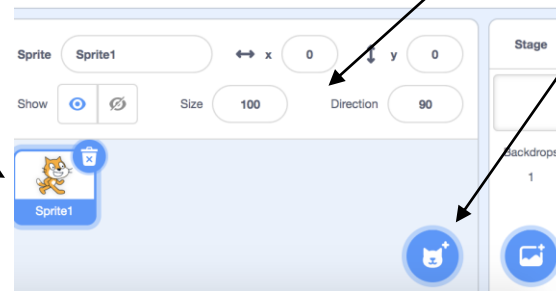


Controls for your Sprite –  
Change direction/Size

Change your Sprite.

Change your Backdrop

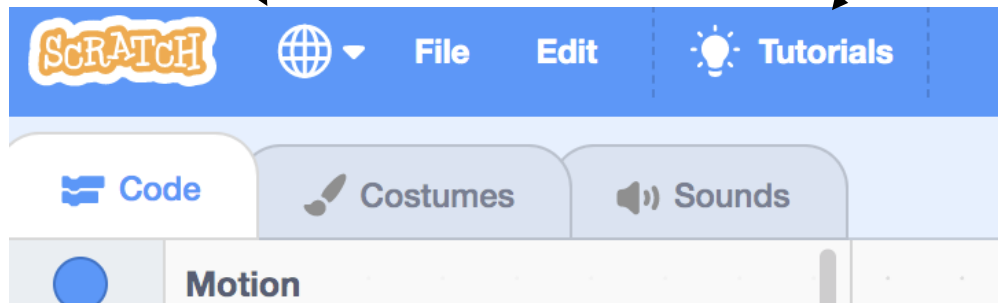
Select your sprite that you want to use before Coding. Click on Trash X to delete your Sprite.

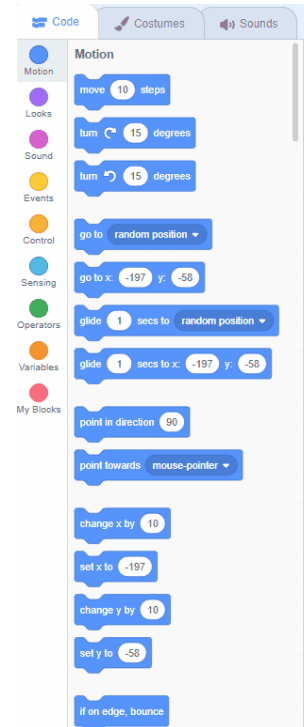
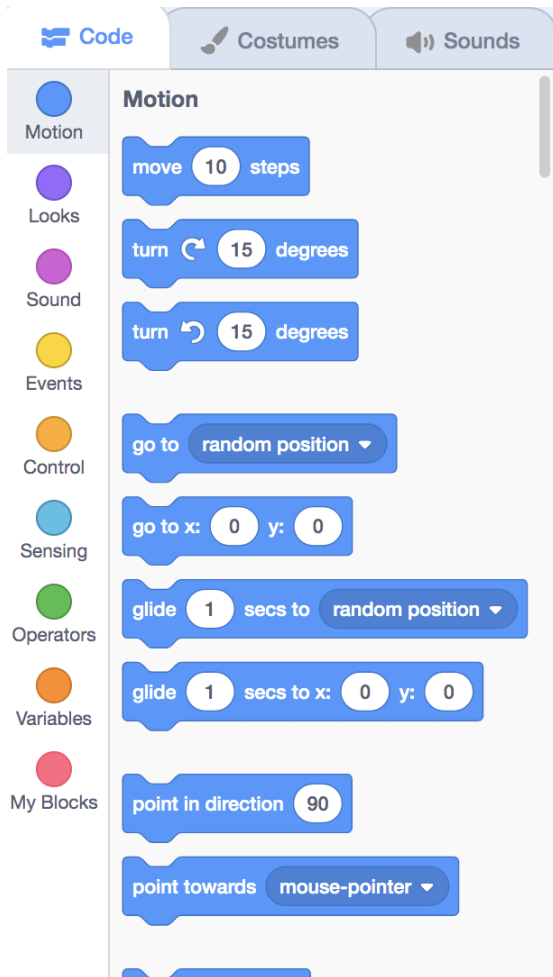


# Getting to know Scratch!

Click here to change the language

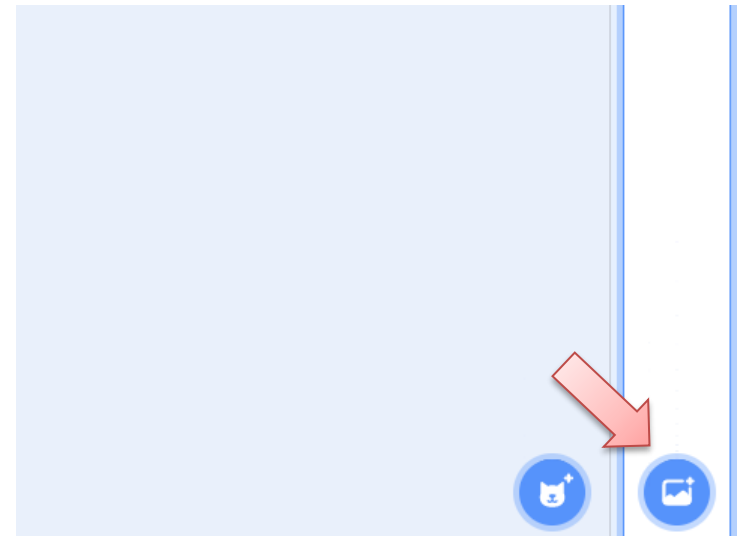
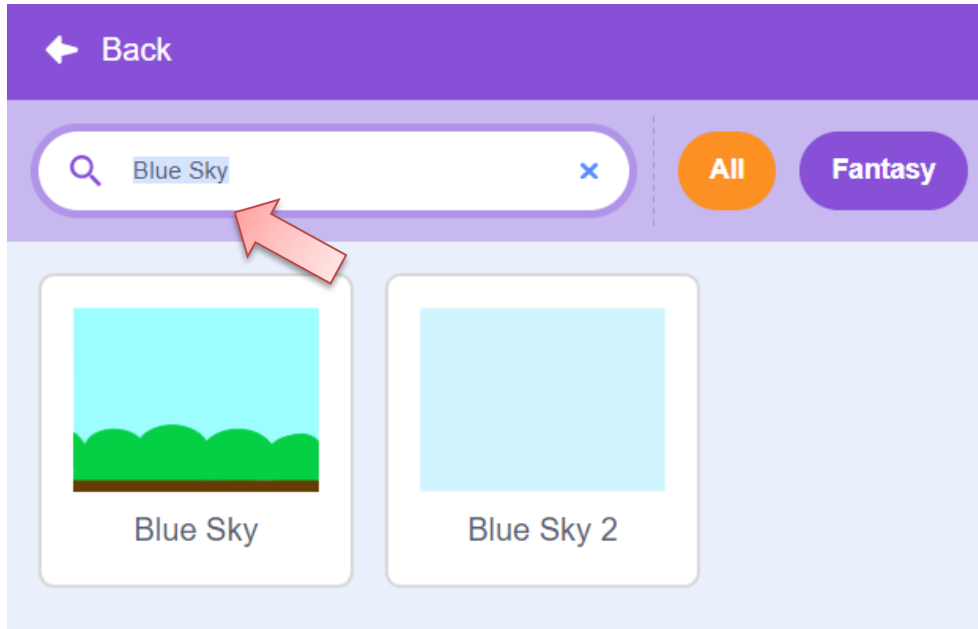
Take advantage of their Tutorials



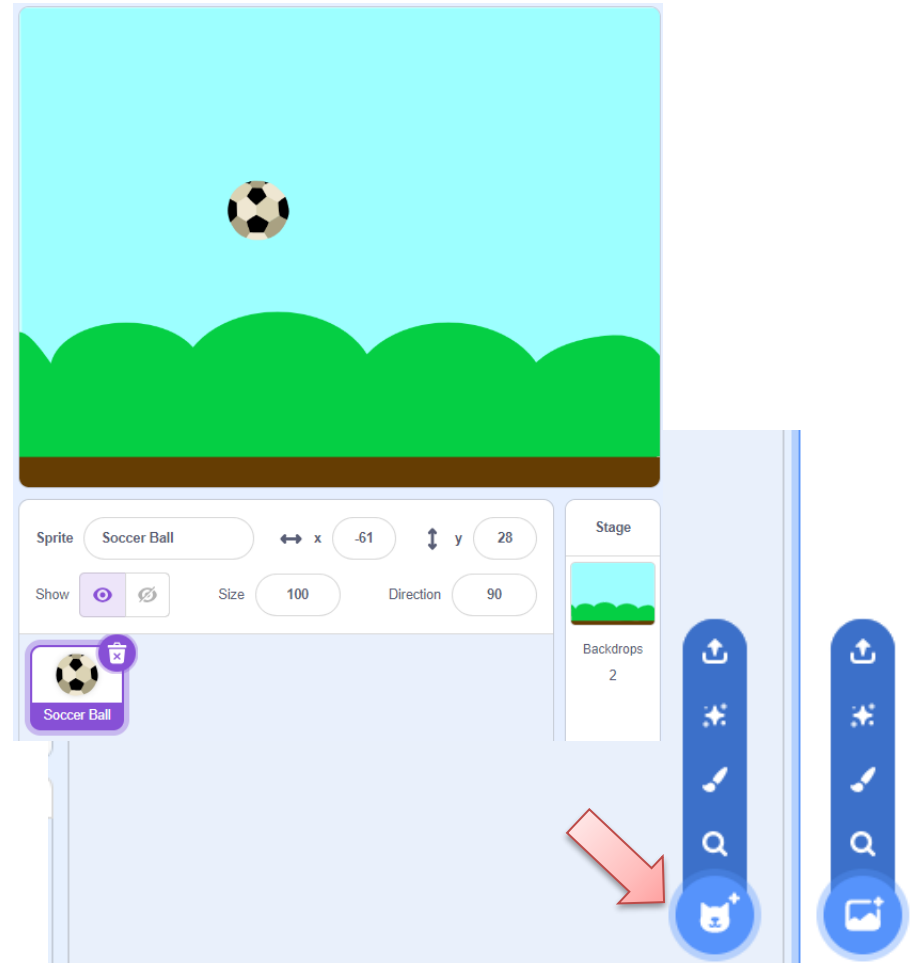
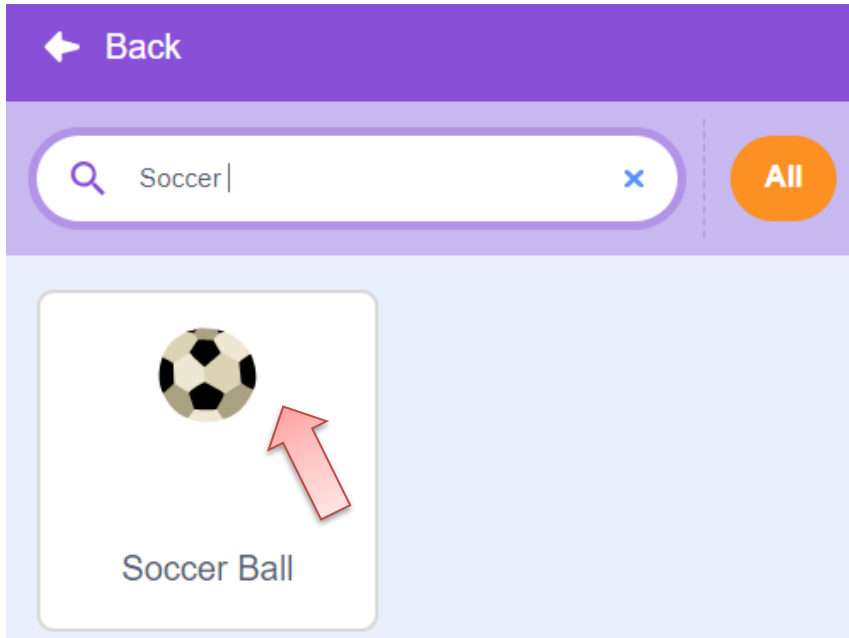


Simply click and pull coding blocks from the right into the open area on the left to make your code!

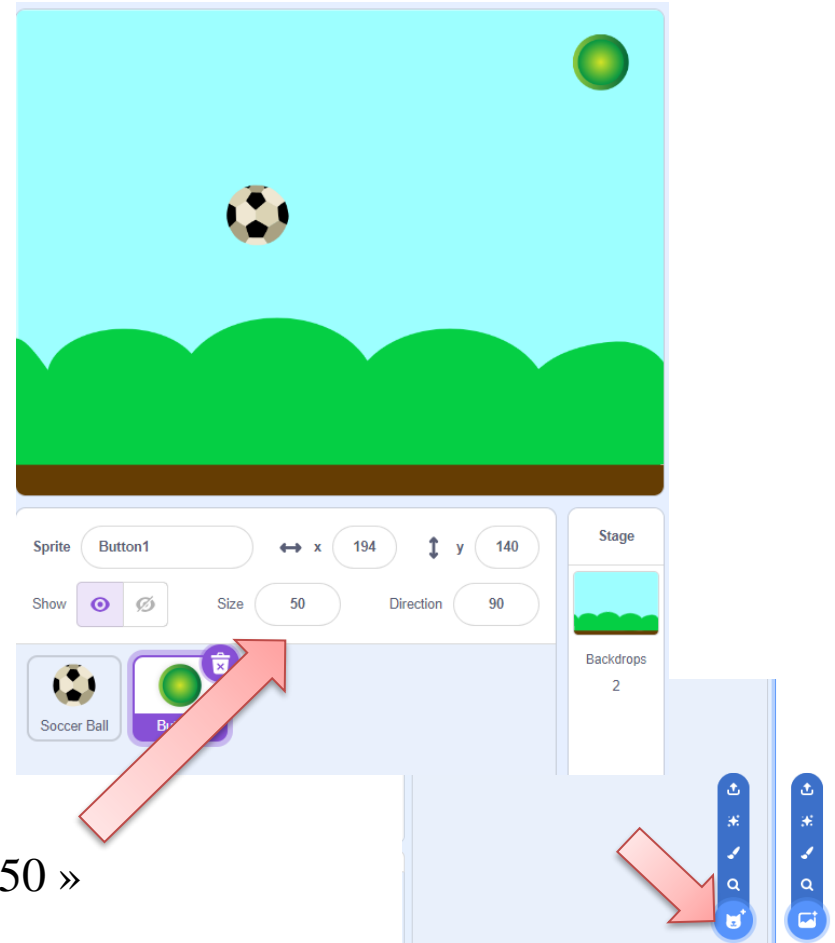
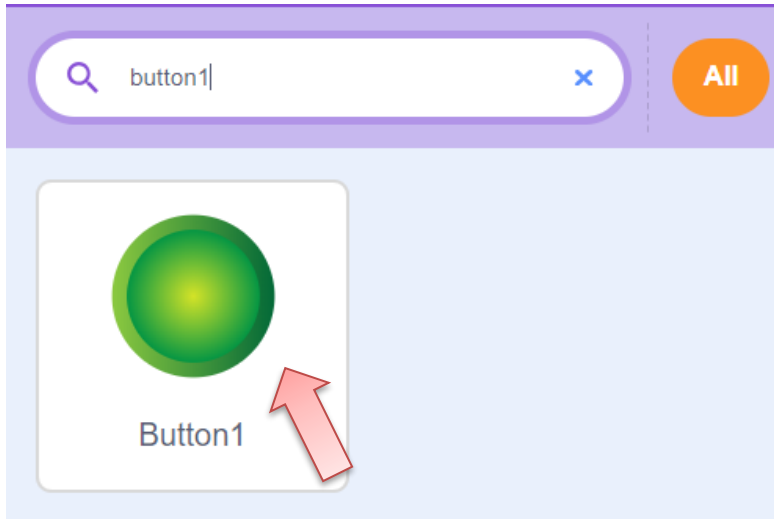
# Choose a Backdrop “Blue Sky”



# Choose a Sprite “Soccer Ball”

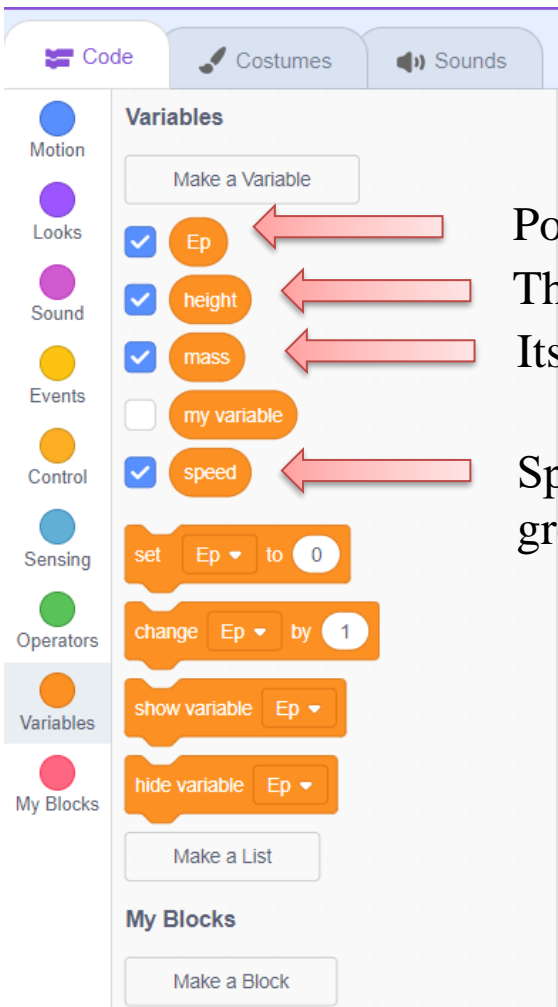


# Choose a Sprite “Button1”





# Make a Variables for sprite “Soccer Ball”



The screenshot shows the Scratch code editor interface. The 'Code' tab is selected. On the left sidebar, the 'Variables' category is highlighted with a red arrow. The 'Variables' panel contains a 'Make a Variable' button and a list of variables: 'Ep', 'height', 'mass', 'my variable', and 'speed'. Each variable has a checkbox to its left. Red arrows point from the variable names to their descriptions on the right. Below the list, there are four code blocks: 'set Ep to 0', 'change Ep by 1', 'show variable Ep', and 'hide variable Ep'. A 'My Blocks' section is visible at the bottom of the panel.

Variable Name	Description
Ep	Potential energy of the ball
height	The height from which it falls
mass	Its mass
my variable	
speed	Speed at the moment of hitting the ground

# Make a program for sprite "Soccer Ball"

when clicked

- set height to 0
- set speed to 0
- set Ep to 0
- set mass to 0
- go to x: -190 y: -70
- ask "From what height ( max 30 meters) I fall? (enter only a number) and wait"
- set height to answer
- glide 1 secs to x: 0 y:  $-150 + \text{height} * 10$
- ask "What is my mass? (kg) and wait"
- set mass to answer

Note: order of operations  
 $-150 + (\text{height} * 10)$

when I receive message1

- glide sqrt of  $2 * \text{height} / 9.8$  secs to x: 0 y: -150

height 15  
speed 294  
Ep 735  
mass 5

Sprite: Soccer Ball x: 0 y: -150  
Size: 120 Direction: 90

Backdrops: 5

# Explanation of the program for sprite “Soccer Ball”

coordinate plane



```
when clicked
  set height to 0
  set speed to 0
  set Ep to 0
  set mass to 0
  go to x: -190 y: -70

  ask "From what height ( max 30 meters) I fall? (enter only a number) and wait
  set height to answer

  glide 1 secs to x: 0 y: -150 + height * 10

  ask "What is my mass? (kg) and wait
  set mass to answer

  when I receive message1
    glide sqrt of (2 * height / 9.8) secs to x: 0 y: -150
```

We set all the variables to zero at the start of the simulation and move the ball to its initial position.

We ask for the height from which the ball will fall and type it in the field.

We move the ball according to the coordinate plane, where the center is 0.0

We ask for the mass and record it in a variable

We will receive a click message from the button, and we simulate the fall of the ball according to the physical law:

$$t = \sqrt{\frac{2h}{g}}$$

# Make a program for sprite "Button1"

The image displays the Scratch programming environment. The main stage features a light blue sky, green rolling hills, and a brown ground line. A soccer ball sprite is positioned on the left side of the hills. A green circular sprite, labeled 'Button1', is located in the top right corner of the stage. The top right of the interface contains icons for a window, a palette, and a zoom tool. Below the stage, the 'Sprite' panel shows 'Button1' selected, with its x-coordinate at 208 and y-coordinate at 149. The 'Show' panel has the visibility icon active. The 'Size' is set to 50 and the 'Direction' is 90. The 'Stage' panel shows a preview of the stage and a 'Backdrops' section with a count of 5. The 'Scripts' area on the left contains a yellow 'when this sprite clicked' block with a 'broadcast message1' block attached. A red circle highlights these two blocks, with a red arrow pointing from the left towards the circle. Another red arrow points from the 'Button1' sprite in the 'Sprites' area towards the 'when this sprite clicked' block.

# Run and test the program

The image displays the Scratch programming environment. On the left, the code editor contains the following blocks:

- when green flag clicked
- set height to 0
- set speed to 0
- set Ep to 0
- set mass to 0
- go to x: -190 y: -70
- ask "From what height ( max 30 meters) I fall? (enter only a number)" and wait
- set height to answer
- glide 1 secs to x: 0 y:  $-150 + \text{height} * 10$
- ask "What is my mass? (kg)" and wait
- set mass to answer
- when I receive message1
- glide  $\sqrt{2 * \text{height} / 9.8}$  secs to x: 0 y: -150

On the right, the stage shows a soccer ball sprite on a green field. The top right corner displays the following variables:

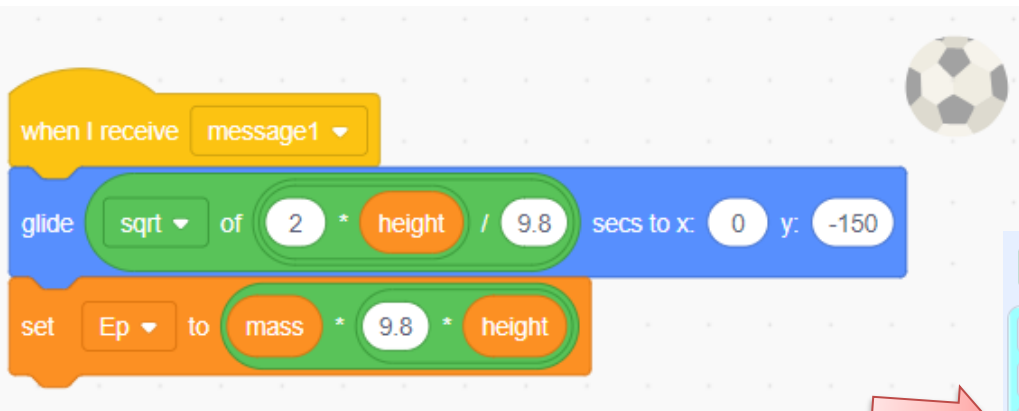
- height: 15
- speed: 294
- Ep: 735
- mass: 5

The bottom right corner shows the sprite control panel with the following settings:

- Sprite: Soccer Ball
- x: 0
- y: -150
- Show:
- Size: 120
- Direction: 90

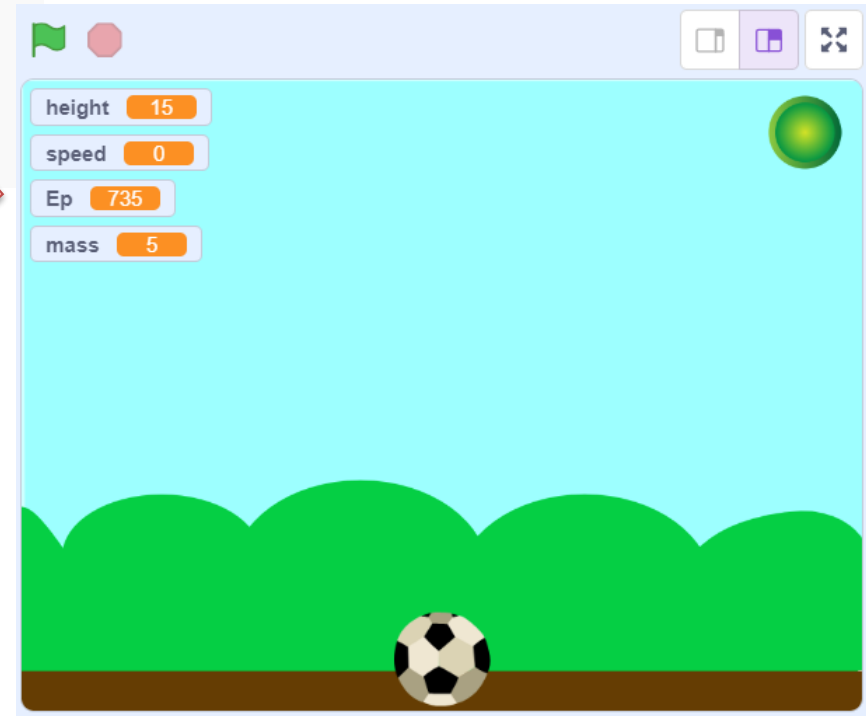
The bottom right corner also shows the Backdrops panel with 5 backdrops.

# Extension 1. We add a display of potential energy

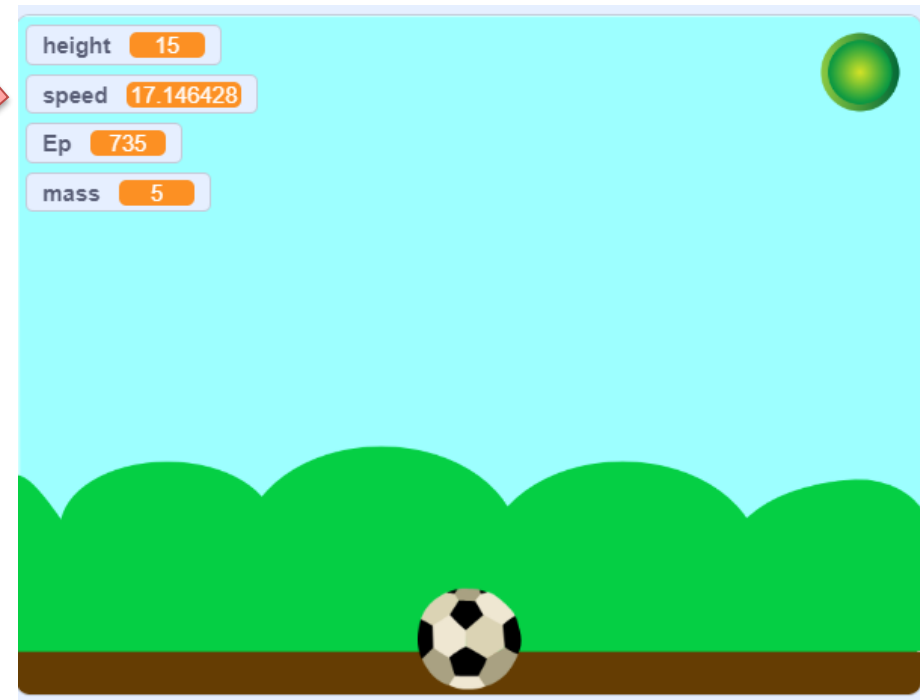


```
when I receive message1
  glide sqrt of (2 * height / 9.8) secs to x: 0 y: -150
  set Ep to (mass * 9.8 * height)
```

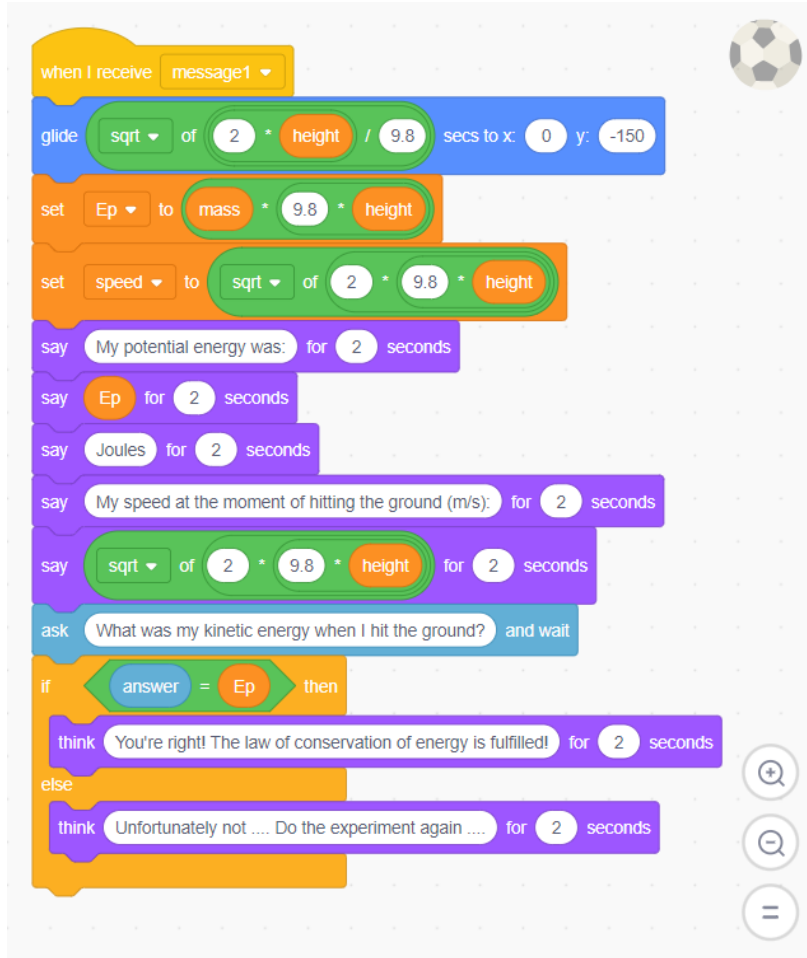
The code block consists of three parts: a yellow 'when I receive message1' block, a blue 'glide' block with a green 'sqrt' block containing the expression  $2 * \text{height} / 9.8$ , and an orange 'set' block with a green 'Ep' block containing the expression  $\text{mass} * 9.8 * \text{height}$ . A soccer ball icon is visible in the top right corner of the script area.



## Extension 2. We add a display of speed



## Extension 3.



The image shows a Scratch script for a falling ball simulation. The script starts with a 'when I receive message1' block. It then uses a 'glide' block to move the ball from (0, -150) to (0, 0) over 2 seconds. The 'glide' block's x and y coordinates are calculated as  $x: 0$  and  $y: -150$ . The script then sets the potential energy ( $E_p$ ) to  $mass * 9.8 * height$  and the speed to  $sqrt(2 * 9.8 * height)$ . It then displays several messages for 2 seconds: 'My potential energy was: for 2 seconds', 'Ep for 2 seconds', 'Joules for 2 seconds', 'My speed at the moment of hitting the ground (m/s): for 2 seconds', and  $sqrt(2 * 9.8 * height)$  for 2 seconds. It then asks the user 'What was my kinetic energy when I hit the ground?' and waits for an answer. An if-then-else block checks if the user's answer equals  $E_p$ . If true, it says 'You're right! The law of conservation of energy is fulfilled! for 2 seconds'. If false, it says 'Unfortunately not .... Do the experiment again .... for 2 seconds'.

We add interactivity and demonstrate the time the ball falls



# Full program

The screenshot displays a Scratch project titled "Energy Transformations" with a purple header bar. The header includes "Edit", "Share", "See Project Page", "Tutorials", "Save Now", and "ScienceNorthTW".

The code is organized into two columns:

- Left Column:**
  - when clicked
  - set height to 0
  - set speed to 0
  - set Ep to 0
  - set mass to 0
  - go to x: -190 y: -70
  - ask "From what height (max 30 meters) I fall? (enter only a number) and wait"
  - set height to answer
  - glide 1 secs to x: 0 y:  $-150 + \text{height} * 10$
  - ask "What is my mass? (kg) and wait"
  - set mass to answer
- Right Column:**
  - when I receive message1
  - glide  $\sqrt{2 * \text{height} / 9.8}$  secs to x: 0 y: -150
  - set Ep to  $\text{mass} * 9.8 * \text{height}$
  - set speed to  $\sqrt{2 * 9.8 * \text{height}}$
  - say "My potential energy was:" for 2 seconds
  - say Ep for 2 seconds
  - say "Joules" for 2 seconds
  - say "My speed at the moment of hitting the ground (m/s):" for 2 seconds
  - say  $\sqrt{2 * 9.8 * \text{height}}$  for 2 seconds
  - ask "What was my kinetic energy when I hit the ground? and wait"
  - if  $\text{answer} = \text{Ep}$  then
    - think "You're right! The law of conservation of energy is fulfilled!" for 2 seconds
  - else
    - think "Unfortunately not .... Do the experiment again ...." for 2 seconds

The stage view on the right shows a soccer ball sprite at x: 0, y: -150. The stage has a light blue sky and green hills. A data monitor shows: height: 15, speed: 17.146428, Ep: 735, mass: 5. The sprite control panel shows the Soccer Ball sprite with a size of 120 and a direction of 90. The backdrops list shows "5" backdrops.