g by freefall
Teacher Notes

Introduction

This activity is about measuring the acceleration due to gravity.

Students record motion data using a CBR2 and a football. The TI-Nspire software automatically creates velocity and acceleration variables from the distance data. Students can then use straight-line tools to calculate a value for g. This result can be compared with the international standard value, 9.81m/s^2, and a meaningful discussion of accuracy can then take place.

Resources

There is a TI-nspire document entitled gbyfreefall.tns which includes example data.

You will need

A CBR2, TI-Nspire handheld with USB cable (mini to micro USB) and a small football, 25 to 30cm in diameter.

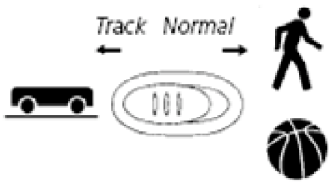
The activity

Stage 1

1. Clamp the CBR 2 about 2m above the ground so that there is a clear space (about half a metre all round) to the floor. Ensure the sensitivity switch on the CBR 2 is set to normal, pointing towards the images of a person and a ball.

Sensitivity switch

The sensitivity switch has two modes—Track and Normal. The Track mode is intended for activities using dynamics tracks and carts; the Normal mode is intended for all other activities, such as, walking, ball toss, bouncing ball, pendulum, etc.

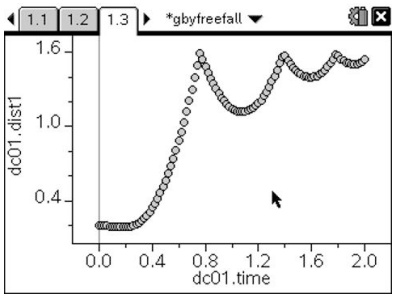


2. Plug the CBR 2 into the USB port on the TI-Nspire handheld.

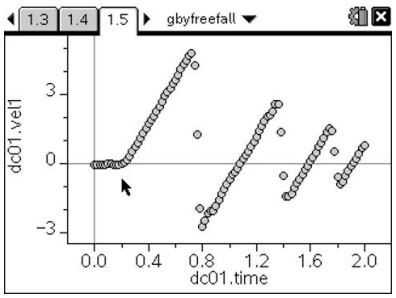
3. A dialogue box will open - select Data & Statistics, press *tab* to *OK* and press *enter*.

4. Hold the football about 30cm underneath the CBR 2 and press *enter*. As soon as you hear rapid clicking from the CBR 2, drop the ball.

5. Moving the cursor over the left hand or bottom edge of the screen, press *enter* to reveal the variables which can be selected.



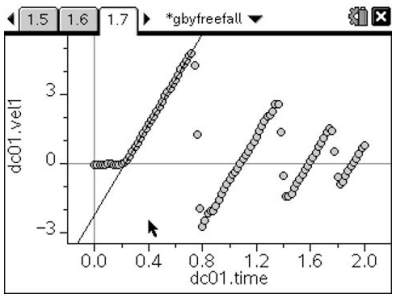
6. Change the y variable from dc01.dist1 to dco1.vel1. The gradient of the velocity time graph is the acceleration.
7. Identify the regions of freefall. What do you notice about these regions?
8. Identify the bounces, what do can you deduce about the acceleration here?



Stage 2

1. Press *menu*, select *Analyse/Add Moveable Line* and press *enter*. Moving the cursor over the movable line will reveal a *rotate* symbol at each end and a *translate* symbol in the middle. N.B. Pressing *ctrl* whilst the *rotate* symbol is showing allows you to rotate the line. Pressing *ctrl* whilst the *translate* symbol is showing allows you to move the line.
2. Fit the line to the first freefall region and then drag the line over the other regions to check that the acceleration is the same in each region.

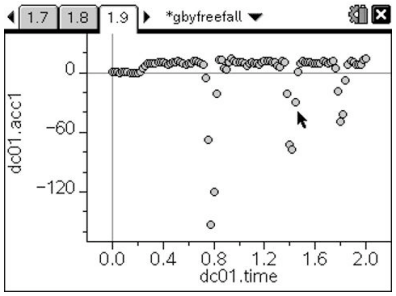
   What is the value of g?

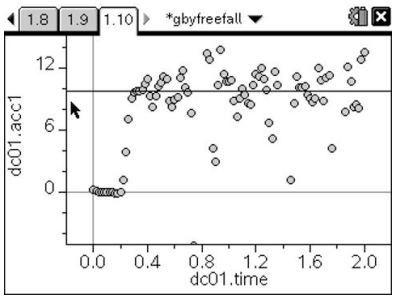


Stage 3

1. Change the y variable from dco1.vel1 to dc01.acc1.

   Identify the bounce regions. What is happening to the acceleration here?
2. Identify the freefall regions and adjust the window to remove the extreme acceleration points during the bounces. To do this, press *menu*, then *Window/Zoom/Zoom – In* and press *enter*.
3. Add a horizontal movable line by pressing *menu*, then *Analyse/Add Moveable Line* and press *enter*. Move the line until the y-intercept is the value for g you have already obtained.





Which is the better method for finding g: the gradient of the velocity time graph or the y-intercept of the acceleration time graph? Why?