Teacher Notes

- young vs old people and changing orientation, gaming as examples of accelerometer (and gyroscope)

-explain accelerometer using ball-in-a-box.

-this leads to residual g-Force, have students see g-Force on their app in each of the three directions (*z* may need some explanation) by tilting phone, describe tilt tray

-Explain that gyroscope allows app to keep track of the direction of gravity and subtract it to get pure acceleration. Have them switch to Linear Accelerometer and accelerate in each of the x, y and z directions to see them appear on their graphs.

Then talk about pendulum and relation of centripetal and tangential directions to cellphone reference frame.

Names: ______________________

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Cellphone Accelerometer

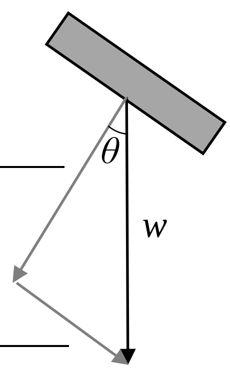
Part A: Components of Gravitational Force on an Incline. (Using the g-Force Meter)

Place your cellphone on the tilt-tray with the angle (on the main protractor on the base) set to 0°. Make sure the app is in g-Force Meter, and use to *Calibrate the g-Force Meter*. Enter the values of the *x*, *y*, and *z* components of gravity (Use two decimal places.) as given by your cellphone. Increase the angle in 15° intervals and record the components in each case.

Then calculate the theoretical components of gravity. To do this identify the two components in the free body diagram and use trig to calculate their value (as a fraction of the full weight). In one of the directions, the component of gravity is always zero. What direction is this and why why? Answer this next to the free body diagram.

Angle	Experimental Components of *w*			Theoretical Components of *w*		
	x	*y*	*z*	*x*	*y*	*z*
0°						
15°						
30°						
45°						
60°						
75°						
90°						

$w_{\square}$ = w____________



$w_{\square}$ = w____________

Put *x*, *y* or *z* as the subscript in each box and complete the line to show how to calculate each component.

The component of weight in the _____ direction is zero because:

(try holding a pencil in that direction as you change the angle of the tray – th

Part B: Accelerations in Circular Motion. (Using the Linear Accelerometer)

Set the app to Linear Accelerometer, use ⚙ to turn off total acceleration, and place it in the pendulum and pull it to one side. Hold it still for a second, then release it, let it swing across and back and catch it again. Stop the accelerometer and zoom in on the part of the graph created during the swinging motion. Use a screen capture to save the graph, email it to yourself, put it in the middle of a document page, try to lighten it to reduce ink use if possible and print. Identify with hand-written notes on the paper:

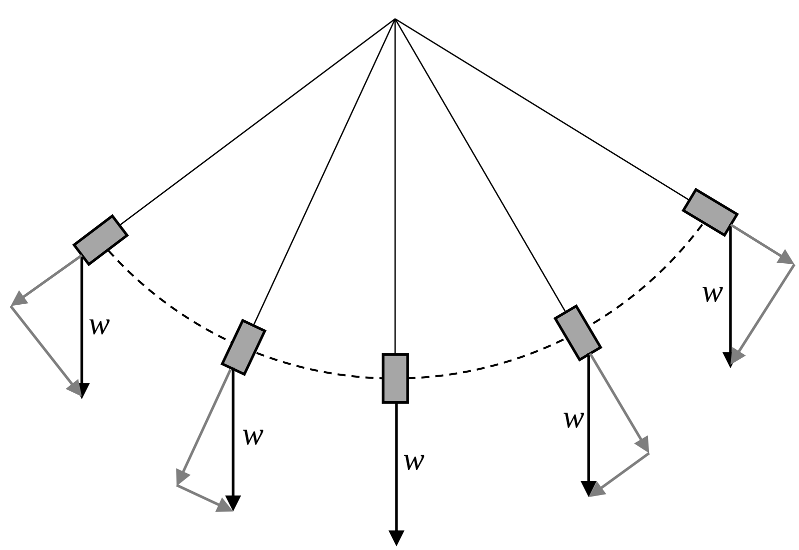
- which direction is the centripetal direction and which is the tangential acceleration.

- point out the extremes and zeroes and in each case indicate where the pendulum was in its swing.

For each direction of acceleration, write a few sentences below describing what you see on the graph and **<u>why</u>** that is happening. Note that some phones may reverse positive and negative so don't worry about that, but do pay attention to when the direction reverses.

Centripetal Acceleration (the ___ direction of the phone) Remember $a_c = \frac{v^2}{r}$.

Tangential Direction (the ___ direction of the phone). The diagrams below may be helpful. refer to how the tangential component of the weight is changing to explain how the tangential acceleration is changing.



Staple the annotated screen capture to this sheet and submit.