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1. Why isn't the ChargePort block on the ElectricalCircuit BDD?

The Block Definition Diagram (BDD) defines the Electrical Circuits in terms of their features. That is its components. The electrical circuit's components include a Source, Resistor, and Ground. The ChargePort block which represents electrical energy in the connectors defines an interface between the components.

2. What does the constraint in ResistorConstraint mean?

The constraint in ResistorConstraint (i.e.  $v = r * i$ ) defines the relationship between voltage, resistance and current. It defines Ohm's law.

3. What are the components of the Pendulum block? What is their purpose?

The pendulum block is divided into two compartments. The properties compartment defines fundamental structural elements of the pendulum's mathematical model and the constraints compartment which defines equations that defines the behavior of the pendulum.

The element in the properties compartment includes  $F$  which is force,  $g$  which is the acceleration due to gravity (constant),  $L$  which is the length of the Pendulum,  $m$  which is the mass of the pendulum,  $x$ , and  $y$  which are the coordinates in two-dimensional space, and  $v_x$  and  $v_y$  represent the speed at which the pendulum moves in two-dimensional space.

The equations in the constraints compartment include `Newton_pendulum_balance_x` which defines the equation that constrains the horizontal aspect of the pendulum, `Newton_pendulum_balance_y` which defines the equation that constrains the vertical aspect of the pendulum, `RightTriangle`, and `SimpleDer` which defines the rate of change of the co-ordinates against time.

4. What is the purpose of the RightTriangle constraint block?

The `RightTriangle` constraint block defines the relationship between the length of the pendulum and the coordinate values. It is based on the Pythagoras theorem.

Simulate the Pendulum model.

Plot (using the default plot) and examine the results:

**x, (x, y), (x, vx)**

1. What does this represent?

Plotting x represents the pendulum's horizontal position over time.

Plotting x, y represents the pendulum's horizontal and vertical position over time.

Plotting x, vx represents how the velocity of the pendulum changes with respect to time. It shows how the velocity is continuously changing as the pendulum goes back and forth.

2. Does the plot correspond to your understanding of the pendulum physics?

Yes, it does. The position of the pendulum bob is a function of the sine of the time

Plot using parametric plot and examine the results:

**(x, vx)**

1. What does this represent?

Unlike the default plot, the pendulum's horizontal position is plotted against its velocity. Therefore showing a clear description of their relationship. The plot shows that the velocity is least when the displacement is greatest and the velocity is greatest when the displacement of the pendulum is least. That is, when x is 0, velocity is at its maximum value.

**(F, x)**

1. What does this represent?

Plotting F, x represents the relationship between the pendulum's tension force and its horizontal position.

2. Does the plot correspond to your understanding of the pendulum physics?

Yes, it does. At the position when the pendulum is displaced to its maximum displacement to the right, it has a velocity of 0 m/s and is changing its direction. At this instant in time, the object is momentarily paused, there is no need for a force. However, when the pendulum moves back to its equilibrium position (i.e 0), velocity is at its maximum. Therefore given the mass of the pendulum, we can say that force is at its maximum value.