

Title *Momentum*

Ingredients

Sketch



At/Through

$t$

Owner

System

Quantity

Inertial mass

Instantaneous velocity

Momentum

Variable

$m_I$

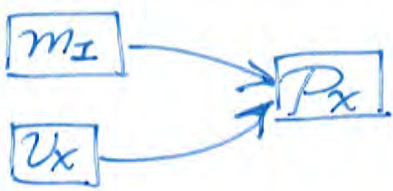
$\vec{v}, v_x, v_y$

$\vec{p}, p_x, p_y$

Giver

Recipe

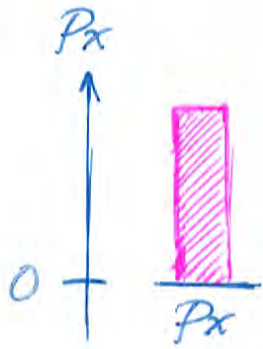
Diagram the relationship



Graphically present quantities

Momentum vector

x-momentum bar



Mathematical relationship

$$\vec{p} = m_I \vec{v}$$

$$p_x = m_I v_x \quad p_y = m_I v_y$$

The top half of this sheet consists of an “**Ingredients**” section with a row labeled “Sketch”, a row labeled “At/Through”, a row labeled “Owner”, a row labeled “Quantity”, a row labeled “Variable”, and a row labeled “Giver.”

Sketch: A block with whooshies trailing to the left indicating being in the midst of motion to the right is surrounded by a dashed system bubble. The block is labeled  $m\text{-sub-}l$ . Dashed axis arrows indicate that  $+x$  points toward the right and  $+y$  points up the page.

Remaining rows of Ingredients section are used for a flowchart illustrating the following:

At time  $t$ , the Owner is the System. The System owns the Quantity Inertial mass denoted by Variable  $m\text{-sub-}l$ . The System owns the Quantity Instantaneous velocity associated with Variables  $v\text{-vector}$ ,  $v\text{-sub-}x$ , and  $v\text{-sub-}y$ . The System also owns the Quantity Momentum associated with Variables  $p\text{-vector}$ ,  $p\text{-sub-}x$ , and  $p\text{-sub-}y$ .

The bottom half of this sheet consists of a “**Recipe**” section with a row labeled “Diagram the relationship”, a row labeled “Graphically present quantities”, and a row labeled “Mathematical relationship”.

Diagram the relationship

A flowchart arrows shows that inertial mass  $m\text{-sub-}l$  contributes to  $x$ -momentum  $p\text{-sub-}x$ . Another arrow shows that  $x$ -velocity  $v\text{-sub-}x$  also contributes to  $x$ -momentum  $p\text{-sub-}x$ .

Graphically present quantities

Title of first section: Momentum vector

Draw an arrow pointed toward the right and labeled  $p\text{-vector}$ .

Title of second section:  $x$ -momentum bar

Plot  $p\text{-sub-}x$  on the vertical axis. Draw a tickmark labeled 0. At the height of this tickmark, draw a horizontal segment to the right, labeled underneath as  $p\text{-sub-}x$ . From and extending upward from this labeled segment, draw a shaded rectangular bar.

Mathematical relationship

$p\text{-vector} = m\text{-sub-}l \text{ times } v\text{-vector}$

$p\text{-sub-}x = m\text{-sub-}l \text{ times } v\text{-sub-}x$

$p\text{-sub-}y = m\text{-sub-}l \text{ times } v\text{-sub-}y$