

# Physics of Sports

## Lesson 5: Momentum and its Measurement Teacher's Guide

### Connections:

Previous Lesson	Current Lesson	Next Lesson
Energy and its Measurement	Momentum and its measurement	Aerodynamics of ping-pong balls

Objectives:	<ul style="list-style-type: none"> <li>To define linear and angular momentum</li> <li>To estimate linear and angular momentum</li> <li>To understand the law of conservation of momentum</li> <li>To apply these theories to explain the bizarre behavior of the ball in some real situations</li> </ul>
Resources required:	<ul style="list-style-type: none"> <li>A ruler</li> <li>A pair of scissors</li> <li>A pencil or marker</li> <li>Student's Worksheet Lesson 5</li> </ul>
Useful data:	<p>Table dimensions</p> <ul style="list-style-type: none"> <li>Length = 274 cm</li> <li>Width = 152.5 cm</li> <li>Height = 76 cm</li> <li>Net height = 15.25 cm</li> </ul> <p>The Olympics size ping-pong balls have:</p> <ul style="list-style-type: none"> <li>Diameter = 4 cm = 0.04 m</li> <li>Wall thickness vary but is approximately 0.04 cm.</li> <li>Mass of the ping-pong ball = 2.7 g = 0.0027 Kg</li> <li>Material used: Celluloid (generally)</li> </ul> <p>Speeds:</p> <ul style="list-style-type: none"> <li>Rotational speed of the ball, <math>v = 1.0</math> m/s (average),</li> <li>Linear speed of the ball <math>v = 12</math> m/s (linear, at <b>tracking limit</b> or the maximum speed at which you can still see it moving)</li> </ul>
Video(s):	<p>Start by showing a short video clip where the game is played using a 44mm ball:</p> <p><a href="https://www.youtube.com/watch?v=uphkV6pLwZo">https://www.youtube.com/watch?v=uphkV6pLwZo</a></p>
Mathematics Review:	<ul style="list-style-type: none"> <li>Linear Momentum = <math>mv</math></li> <li>Impulse = Final momentum – initial momentum</li> <li>Angular Momentum = <math>mvr</math></li> </ul>
Discussion Questions:	<p>The activity starts with some questions:</p> <p>1. Assume we replace ping-pong balls by tennis balls. What will be the effect of larger mass and volume on the sport?</p>

	<p>2. If you try to play the game using a tennis ball, you feel a strong jerk in the racket. What can you do to reduce it?</p> <p>3. What is the relationship of momentum and impulse to your design change suggest above?</p> <p>4. What happens to a ball that starts rolling on the table and then stops – where has the momentum gone? (it was supposed to be conserved)</p> <p>5. If you slide a ball a certain way on the surface, it moves forward quickly and tries to return. What physics is at play here? See Mr. Beans at the Airport: <a href="https://youtu.be/QE6PvNohffc?t=2m6s">https://youtu.be/QE6PvNohffc?t=2m6s</a></p>
Fun fact	<p>Ping-pong diplomacy: China once used ping-pong as a tool to improve its foreign relations. Read more about it here: <a href="http://www.allabouttabletennis.com/history-of-table-tennis-ping-pong-diplomacy.html">http://www.allabouttabletennis.com/history-of-table-tennis-ping-pong-diplomacy.html</a></p>