Subject: Science **Grade level: Post-secondary** **Topic: Center of mass** **Required time: 80 minutes**	
Prior knowledge about the subject:	Principle of the conservation of momentum Newton's 3rd law
Learning objectives:	Students will: - define the connection between the principle of the conservation of momentum with the subject under discussion (center of mass) - determine when and why the center of mass is stable or not - calculate attributes of the center of mass of a system (position and velocity)
Materials/Resources:	Simulations: http://astro.unl.edu/naap/ebs/centerofmass.html http://physics.bu.edu/~duffy/semester1/c12_cofm_threeballs.html Evaluation quiz
Procedure	
Introduction:	*[The teacher makes an introduction regarding the subject of the session. The students should feel free to discuss with the tutor and express any questions].* The total momentum of a closed system of objects (which has no interactions with external agents) is constant. One of the consequences of this is that the center of mass of any system of objects will always continue with the same velocity unless acted on by a force from outside the system.
Exploration:	*[The teacher continues with an example. He/She along with students involvement, solves the first part (a) and gradually moves on with the following sub-questions, while is trying to reduce his/her guidance].* A man of mass=**M** is standing on the right edge of a wooden board of mass=**2M** and length=**L**. Initially, both, the man and the board are still. (a) How much will the center of mass of the board move if the man walks up to the left edge of the board (displacement=L)? (a.2) Would it make any difference if the man runs the specific distance? (b) How much will the center of mass of the board move if the man walks up to the middle of the board (displacement=L/2)? **Equations given/used:** $x_{CofM} = \frac{m_1 x_1 + m_2 x_2}{M_{total}}$ $v_{CofM} = \frac{d(m_1 x_1 + m_2 x_2)}{dt(M_{total})}$ this means... if **p=momentum** $v_{CofM} = \frac{p}{M_{total}}$

Assessment:	After lecture and activities completion, an evaluation quiz is given. The students are asked to implement was taught and discussed during the session. **Quiz:** Two identical cylinders **A** and **B** of length=**L**, closed from both sides, are held vertically at the same height=**H**. On the bottom of each cylinder lies a fly. The two cylinders are left ($\mathbf{V_0=0}$) simultaneously ($\mathbf{T_0=0}$) to fall to the ground. During the fall, the fly in cylinder **A** starts flying up the cylinder and then hovers at a distance **L/2** from the bottom, while the fly in cylinder **B** remains at the bottom of the cylinder. Will any of the two cylinders touch the ground before the other? If yes, which one? (Assume that there is air in the cylinders and that there is no impact on the acceleration of the cylinders as a result of the presence of air in the atmosphere).
Class description-organization:	Mixed ability class.
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