AMP(2)-Lab05 – Central Collisions

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# Learning objectives

## Exam objectives

By the end of this lab you should be able to (pen and paper):

* Consider all of the underneath frictionless and with the Newtonian assumption of **point particles** (read: no rigid-body aspects need to be taken into account), implying the kinetic energies as purely translational.
* Master and apply the 3D vectorial law of **conservation** of linear momentum
* Master and apply Newton’s law of experimental impact, defining the **COR** (Coefficient Of Restitution).
* Define and apply the elastic, nonelastic and plastic collision **types**
* Apply the ‘next frame’ outgoing velocities (NFV) after a central 1D collision along their **LOC** (Line Of Impact)
* Calculate the (loss of) kinetic energy before/after various collisions

We advise you to **make your own summary of topics** which are new to you.

## Supportive objectives

Specifically related to the above you should in GeoGebra Classic be able to:

* Handle linear momenta as a vector in GeoGebra
* Calculate the ‘next frame’ outgoing velocities (NFV) of various collisions
* Calculate the kinetic energy before/after various collisions

# Exercises

Dependent of the lab session you may work individually or teamed (organized by the lab attendant). In either case make sure that throughout the course of this lab, you re-save sufficiently your solution file on your local machine as

**1DAExx-0y-name1**(+name2+name3).GGB given **xx**=groupcode, **0y**=labindex

Consider all of the underneath frictionless and with the Newtonian assumption of **point particles** (read: no rigid-body aspects need to be taken into account), implying the kinetic energies as purely translational.

## Basic exercises

### Exercise1

Two spheres respectively with masses 1 kg and 5 kg aim for a head-on collision with equal **speeds** of 30 cm/s. As well their motions as their collision happen in one dimension, so with the Newtionian assumption of being point particles.

* In case this collision occurs elastical, calculate the spheres’s outgoing ‘next frame **velocities’**
* In case this collision occurs plastical, again calculate their one outgoing ‘next frame velocity’
* Which **percentage** of the total kinetic energy originally performed (before collision) got transformed in another type of energy (after collision; such as heath, deformation, …) – for each of the above collision types?

[u1=-70cm/s and u2=-10 cm/s, u12=-20cm/s, respectively 0% then 55.6%]

### Exercise2

A railway carriage weighing 36 tons at a speed of 50 km/h collides head-to-tail at another carriage of 24 tons in front of it, riding at 30 km/h in the same direction.

* In case this collision occurs elastical, calculate both carriages’s outgoing ‘next frame velocities’
* In case this collision occurs plastical (when both carriages hook on), calculate their one outgoing ‘next frame velocity’

[u1=34km/h and u2=54 km/h, u12=42km/h]

### Exercise3

Checking the Law of Experimental Impact, we drop a ball of mass 0.1 kg at an initial height of 0.2 m above a horizontal concrete floor. Respectively calculate the rebound heights in case of

* An elastic collision
* An inelastic collision with a coefficient of restitution of 0.9
* A plastic collision

[he=0.2m, he=0.162m, he=0m]

## Bridging exercises

### Exercise4

Prove that a head-on collision between two identical cars of the same speed dissipates twice the kinetic energy compared to the head-on collision of one car against an immovable massive standing rock.

[ versus ]

### Exercise5

Checking the Law of Experimental Impact to determine the coefficient of restitution , we drop a marble of mass 0.01 kg at an initial height (in meter) above a horizontal concrete floor.

Prove that the initial free fall time (in seconds) of this marble equals

[ to solve for ]

## Contextual practice

### Exercise6

Conclude the physical results for collisions in which the Coefficient Of Restitution is respectively

* larger than one:
* less than zero:

Would the former, the latter or both of them be permissible for a collision between two solid spheres?

[Only the former would be (weird but) permissible]

# References

## Links

<https://www.youtube.com/watch?v=7_nKOET6zwI> (first 11minutes)

## Extra practice

Physics NE/6, D.C.Giancoli (Pearson Education, 2014) pp 216-218