Physics 11 – Impulse and Momentum
~~Lesson and Assignment for the Week of May 4, 2020~~

Resources: This unit is not in the usual Physics 11 Textbook.

- ~~Go to "Phys 11 Resources" channel~~
- ~~Then click on "Files"~~
- ~~Then open the folder, "Impulse Momentum"~~

~~You may wish to download that whole folder to your computer. That way you won't have be on line when you refer to the resources (it's faster if you work from your computer – there's always a bit of delay opening the files on line)~~

The primary textbook resource is the file titled:

- ***"Physics 11 level chapter -Momentum and conservation"***

The other files in the "Impulse Momentum" folder are Worksheets and answer keys, providing examples of problem solving strategies.

~~Week of May 4 – Lesson and Assignment~~

Theory –
The video lesson provided ~~this week (May 4) is~~ for Section 9.1 (impulse-momentum).
The lesson ~~for next week (May 11) is~~ for Section 9.2 (conservation of momentum).
When attempting the Question sets ~~for this week and next week~~, refer to the example worksheets and answer keys for problem solving strategies, and theory.

~~Assignments: There are 3 question sets for this unit (worksheets).~~

- ~~Question set #1 is for the week of May 4~~
- ~~Question sets #2 and 3 is for the week of May 11.~~

~~Lesson for the week of May 4 –~~ Reference: pdf of "Chapter 9 – Momentum and its Conservation"

- Section 9.1: Impulse and Change in Momentum (omit "Angular Momentum" pg 179)

~~Assignment:~~

- **~~Question set #1: Section 9.1 – Impulse and Change in Momentum~~**

Scroll down this document for the notes associated with the video lesson.
Here is the link to the video lesson – Section 9.1 of the booklet, "Momentum and its Conservation":

Lesson: Section 9.1 – Impulse and Change in Momentum

Definition of momentum = quantity of motion = mass x velocity

mass
velocity

Symbol for momentum is p (it's important that it's a small p, not capital P … capital P represents Power)

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

vector

Impulse-momentum theorem

math equation

units $= (kg)(m/s)$

$(kg \cdot m/s)$

Newton's 2nd Law $\sum \vec{F} = m\vec{a}$

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

$\sum \vec{F} = m\left(\frac{\Delta \vec{v}}{\Delta t}\right)$

$F \cdot \Delta t = m\Delta \vec{v} = \Delta \vec{p}$

$= \Delta(mv)$

impulse ≡ change in momentum

$\Delta \vec{p} = \vec{F}\Delta t$

units $(N)(s)$

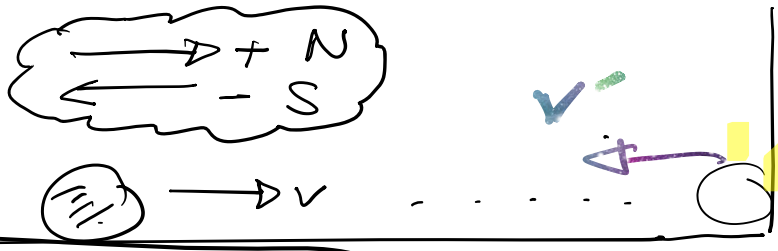
$\left(kg \cdot \frac{m}{s^2}\right)(s)$

$\left(kg \cdot \frac{m}{s}\right)$

Example problem:

A 0.150 kg ball is rolling along the floor with a velocity of 2.00 m/s [North].
The ball hits a wall, then rebounds with a velocity of 1.80 m/s [South] (it's moving more slowly because some kinetic energy was transformed into sound and heat during the impact with the wall).
The ball was in contact with the wall for a time of 0.100 s (duration of impact).

a) Determine the momentum of the ball *before* it hit wall.
b) Determine the momentum of the ball *after* it hit wall.
c) Determine the impulse exerted on the ball during impact with the wall.
d) Determine the Force that the wall exerts on the ball during the collision (when the ball was in contact with the wall). *[*note – this is an oversimplification – the force between the ball and the wall is not constant during impact – but, at the physics 11 level we don't go into depth regarding variable forces]*



with $\vec{p}$ we don't use v_i and v_f

we use v and v'

$m = 0.150\,kg$

$\vec{v} = 2.00\,m/s$

$\vec{v}' = -1.80\,m/s$

$\Delta t = 0.100\,s$

(a) $\vec{p} = m\vec{v}$

$= (0.150\,kg)(2.00\,m/s)$

$= 0.300\,kg \cdot m/s$

$\vec{p} = 0.300\,kg \cdot m/s$ [North]

(b) $\vec{p}' = m\vec{v}' = (0.150\,kg)(-1.80\,m/s)$

$= -0.270\,kg \cdot m/s$

$\vec{p}' = 0.270\,kg \cdot m/s$ [South]

(c) $\Delta\vec{p} = \vec{p}' - \vec{p} = mv' - mv = m(v' - v)$

$= (0.150\,kg)(-1.80\,m/s - 2.00\,m/s)$

$\Delta\vec{p} = -0.570\,kg \cdot m/s$

$\Delta\vec{p} = 0.570\,kg \cdot m/s$ [South]

(d) $\Delta \vec{p} = F \cdot \Delta t$ impulse

$F = \frac{\Delta p}{\Delta t} = \frac{-0.570\ kg \cdot m/s}{0.100\ s}$ $\quad \frac{kg \cdot m/s}{s}$

$F = -5.70\ kg \cdot m/s^2$

$\vec{F} = 5.70\ N$ [South] — Force wall exerts on the ball

Newton's 3rd Law

Force of the ball on the wall

$\vec{F} = 5.70\ N$ [North]

$F = \frac{\Delta \vec{p}}{\Delta t}$