Name: ______________________________ Phys 12

4.3 Momentum, Impulse, Conservation of Momentum review

Recall from last year, that momentum depended on both an object's **mass** as well as it's **velocity**. The heavier and/or faster it is moving, the harder it is to stop that object in it's tracks. We also related momentum to **Newton's 1st Law**, the law of **inertia**. In other words, momentum and inertia both describe how resistive an object is to changing its motion.

$p = mv$	(kg·m/s)	(N·s)

Where m = mass and v = velocity

Momentum is a vector.

The more momentum an object has, more force (F) is needed to change the object's momentum. When this force (F) is applied on the object for a given time (t), called an **impulse**, the object will undergo a **change in momentum.**

impulse = $\Delta p = F \times \Delta t$	(kg·m/s)	(N·s)

This is the essence of **Newton's 2nd Law.** Here's why:

$F_{net} = ma$

$$\Delta p = m\Delta v = F \times \Delta t$$

$$m\frac{\Delta v}{\Delta t} = ma = F$$

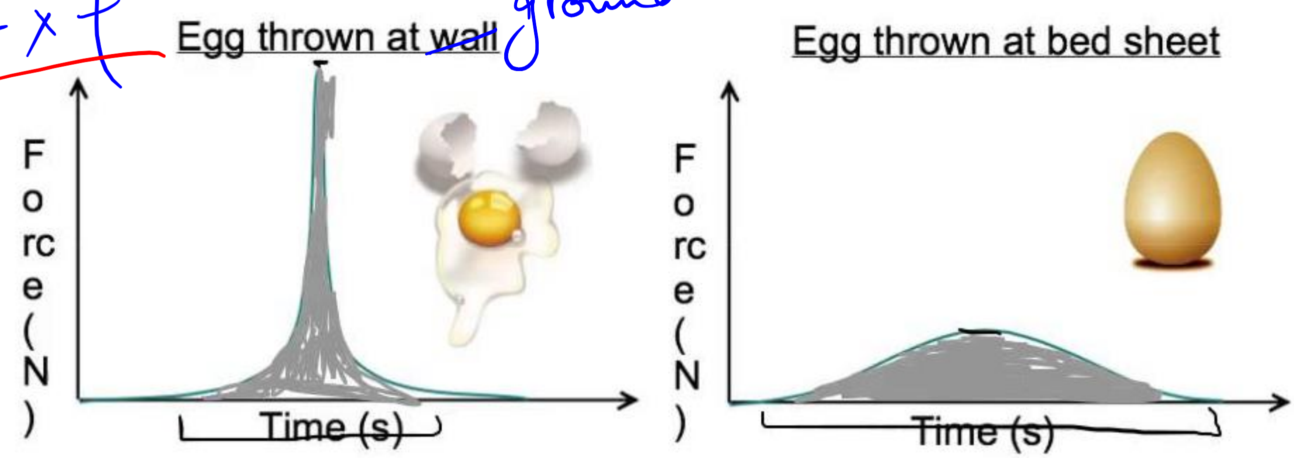
Applications: Car crumble zones, "following through" in sports, breaking a fall by rolling, average force when object bounces vs. sticks

Force-Time Graphs

Real forces are not constant

Area = y × x

F × t



Impulse is area under the curve!

Same area for both ☑ same change in momentum/impulse

Squeezed into shorter time ☑ BIG force ☐ egg breaks!

Spread out over longer time ☑ small force ☐ egg survives!

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Ex. 1: You want to knock a bowling pin of 1.5kg down. You have a 50.0g bouncy ball and a 50.0g silly putty. The bouncy ball will bounce off any surface with the same speed it was hit whereas a silly putty will stick to any surface it hits. If you can throw either object with a velocity of 21m/s, which one would transfer more impulse to the bowling pin?

After such collision, we need to consider **the conservation of momentum**. In a closed system, momentum is conserved

$p_i = p_f$	OR	$\Delta p_{total} = 0$

$$m_1v_{1i} + m_2v_{2i} = m_2v_{2f} + m_1v_{1f}$$

Collisions can be groups into two categories:

	Momentum ($p_i = p_f$)	Kinetic energy ($E_{ki} = E_{kf}$)	Total energy ($\Delta E_t = 0$)
Elastic collisions	conserved	conserved	conserved
Inelastic collisions	conserved	not conserved	conserved

Ex. 2: An alpha particle has a mass approximately 4 times larger than a proton. A proton traveling to the right at 3200m/s strikes a stationary alpha particle and rebounds backwards at 1920m/s. What is the final speed of the alpha particle? (ANS: 1280m/s)

$v_f = 1280 m/s$

HW: Worksheet 4.3 #odds (both impulse and conservation)