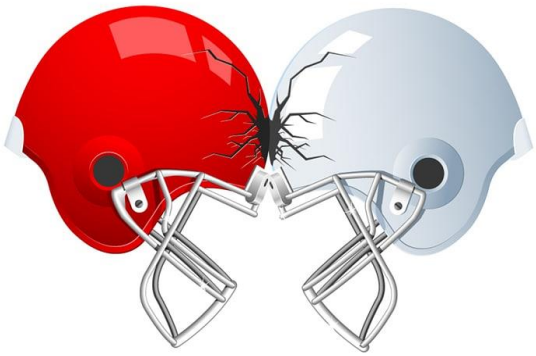
NAME:_____

U3:L3 Conservation of Mass and Energy



In physics, the term _conservation_ refers to something which _doesn't change_.

This means that the variable in an equation which represents a conserved quantity is constant over time. It has the same value both _before_ and _after_ an event.

In mechanics, there are three fundamental quantities which are conserved. These are _energy_, _momentum_ and _mass_

Energy, refers to the _TOTAL_ energy of a system. As objects move around over time, the energy associated with them—e.g., kinetic, gravitational potential, heat—might change forms, but if energy is conserved, then the total will remain the same.

Kinetic Energy is the energy an object has because of its _motion_

If we want to accelerate an object, then we must apply a force. Applying a force requires us to do work. F=m×a

After work has been done, energy has been transferred to the object, and the object will be moving with a new constant speed.

The energy transferred is known as *kinetic energy*, and it depends on the _mass_ and _speed_ achieved.

Kinetic energy can be _transferred between objects_ and transformed into _other kinds_ of energy.

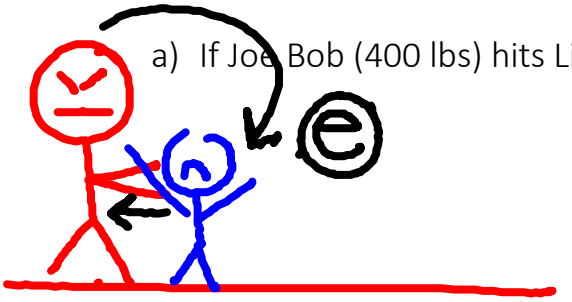
For example, a flying squirrel might collide with a stationary chipmunk. Following the collision, some of the initial kinetic energy of the squirrel might have been transferred into the chipmunk or transformed to some other form of energy.

Conservation of energy applies only to isolated systems.

A ball rolling across a rough floor will not obey the law of conservation of energy because it is not isolated from the floor. The floor is, in fact, doing work on the ball through friction. However, if we consider the ball and floor together, then conservation of energy will apply. We would normally call this combination the ball-floor system.

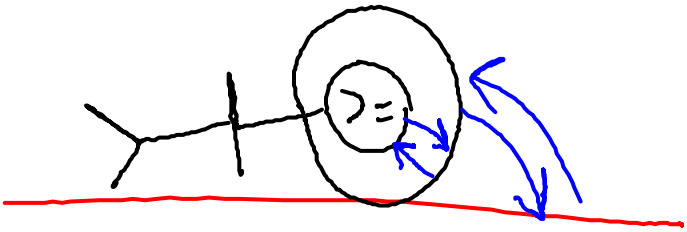
So, in football (or hockey, or wrestling, or any sport involving contact!) what does this mean?

a) If Joe Bob (400 lbs) hits Lil Jimmy (200 lbs) where does energy transfer?



b) If Lil Jimmy then hits the ground, where does energy transfer?

c) If Lil Jimmy's head hits the ground (he is wearing a helmet) where does energy transfer?



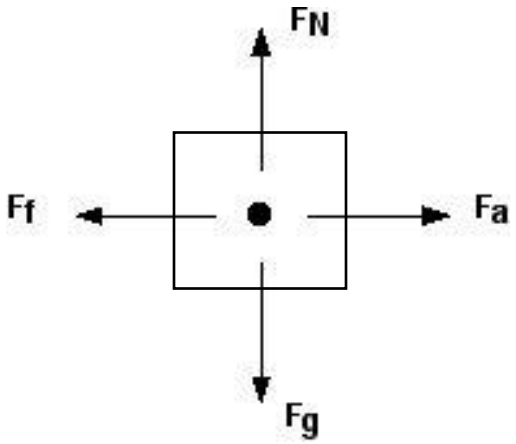
d) If Joe Bob is running at 15 km/h and hits Lil Jimmy, there is a certain amount of energy transferred. If Joe Bob hits him again, at 30 km/h what difference is there in energy transfer from the first hit?

mass + speed change energy

15 km/h → 30 km/h

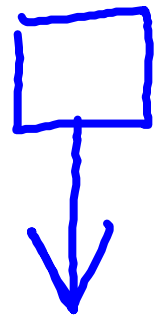
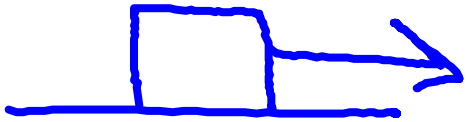
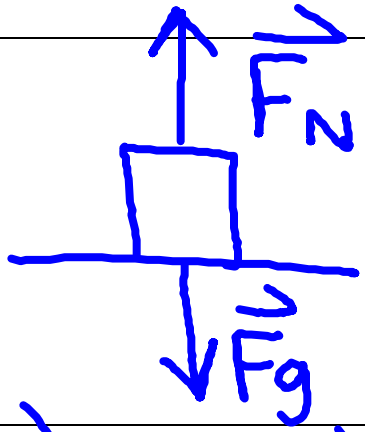
2x energy

FREE BODY DIAGRAMS (FBD)



Total Forces acting on an object
Objects are represented as a BOX.
We think of all the mass as concentrated in the middle, therefore all forces act from the middle of the box.
The direction of the arrow represents the direction of the force vector
The size of the arrow represents the magnitude of the force vector

HOW TO DRAW DIFFERENT FORCES ON FBDs

FORCE:	DRAW IT:	THE RULE:
$\vec{F}_g$ FORCE gravity		Always down
APPLIED FORCE $\vec{F}_A$		In direction of Motion
NORMAL FORCE $\vec{F}_N$		perpendicular to the surface
FRICTION $\vec{f}_f$		against the motion

Collisions

In a collision between two objects, each object is _____ with the other object.

The interaction involves a _____ acting between the objects for some amount of time.

This _____ constitutes an _____ and the impulse changes the _____ of each object.

Such a collision is governed by _____ of motion; and as such, the laws of motion can be applied to the analysis of the collision (or explosion) situation.

In a collision between object 1 and object 2, the force exerted on object 1 (F_1) is equal in magnitude and opposite in direction to the force exerted on object 2 (F_2). In equation form:

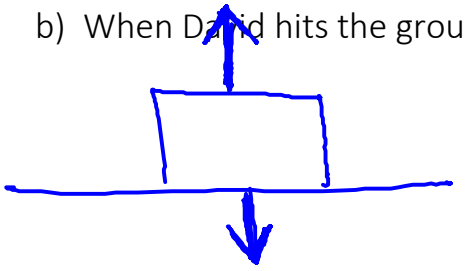
$$F_1 = -F_2$$

So…

a) If during a football game, Mike hits David, what force pairs exist?

Mike → David & David → Mike

b) When David hits the ground what force pairs exist?



c) Think specifically about David's brain and head – what force pairs exist?

helmet ↔ ground
skull ↔ helmet
brain ↔ skull