DEPED - GENERAL SANTOS CITY
SIMPLIFIED
SELF-LEARNING MODULE
(S S L M)

GENSAN's ProTUNA
General Santos City's Pro-Active Response in Turbulent, Uncertain, New and Ambiguous Environment

GENERAL PHYSICS 1 – GRADE 12

Name: _____ Date: _____
Grade:_____ Section: _____

Quarter: 1 Week: 4 SSLM No.4 MELC(s): 1. Define inertial frames of reference; 2. Draw free-body Diagram; 3. Apply Newton's 1st law to obtain quantitative and qualitative conclusions about the contact and noncontact forces acting on a body in equilibrium; 4. Differentiate the properties of static and kinetic friction; 5. Apply Newton's 2nd law and kinematics to obtain quantitative and qualitative conclusions about the velocity and acceleration of one or more bodies, and the contact and noncontact forces acting on one or more bodies; 6. Solve problems using Newton's Law of motion in contexts such as, but not limited to, ropes and pulleys, the design of mobile sculpture, transport of loads on conveys belts, force needed to move stalled vehicles, determination of safe driving speeds on banked curved roads.

- Objectives: 1. Define inertial frames of reference; 2. Differentiate the properties of static friction and kinetic friction; 3. Draw free-body diagrams; 4. Solve word problems involving Newton's laws of motion.
- **LM to Study**: General Physics 1, Quarter 1, Module 7: Newton's Laws of Motion
- Topic: **NEWTON'S LAWS OF MOTION**

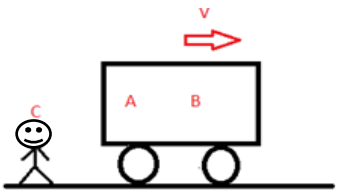
Let Us Discover

If you are riding in a car and the driver suddenly steps on the brakes. The car stops, but your body appear to keep going. It results in sliding your body forward in your seat, until the seatbelt stops you and holds you back. *What have you experienced?* You experienced **Newton's First law of Motion,** which is also known as **law of inertia,** states that: **A body at rest remains at rest, and a body in motion remains in in motion with constant velocity, unless acted upon by unbalanced applied force.**

Have you played Newton's bottle? The key to that trick is **inertia.** The two bottles are not moving and will remain at rest unless there is an **outside force or unbalanced force** acting on the bottles however, if you apply an outside **force or unbalanced force** by your chopping finger which makes the bottles move. *What is this unbalanced force?* **Unbalanced force** is a force which causes a change in the state of rest or of uniform motion of an object.

If there is unbalanced force, of course there is also a balanced force. **Balanced forces** happen when two forces are equal in magnitude and they are pointing in opposite directions. Obviously they are called balanced forces because they balance each other.

In discussing inertia, it is also important to know where the position of the observer is.



Based in the given figure, what do you think will be the answer of A if ask what is the velocity of B? How about C, if ask about the velocity of B? Do you think A and C would have the same answer? These questions will be answered if we know the concepts of **inertial frame of reference.**

Have you heard the term inertial frame of reference? How does inertial frame related to Newton's law? For A own perspective, B is at rest. But for C, B is moving with velocity V in rightward direction. So, which means that before defining the velocity we have to specify in which frame we are. An **inertial frame of reference** is a frame where Newton's law holds true. The term inertial frame is relative, first we assume a reference frame to be the inertial frame of reference. So, therefore the definition of an inertial frame is: **Inertial frame is at rest or moves with constant velocity with respect to my assumed inertial reference frame.**

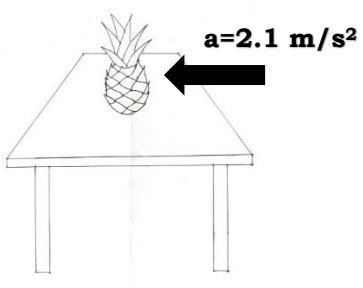
If Newton's First Law tells us that an object will stay at rest or in motion unless a force changes it. In the second law of motion, it explains how unbalanced forces cause objects to accelerate or move faster. **Newton's Second Law** says that **an object's acceleration depends on two things: force and mass.**

The **second law of motion or the law of acceleration** states that: ***The acceleration of an object is directly proportional to the net external force acting on the object and inversely proportional to the mass of the object.*** Can you translate it into mathematical symbols? In symbols $a \propto \frac{F}{m}$

In equation form, we can state that Newton's law as $\mathbf{F_{net}} = \boldsymbol{ma}$ meaning,
***net external force = mass x acceleration*.**

Example: A 2.5-kg pineapple is pushed across a table. If the acceleration of the pineapple is 2.1 m/s^2 to the left, what is the net external force exerted on the pineapple?

(Using the equation given above, solve this problem.)



Solution:

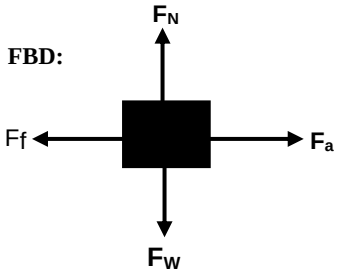
Given: mass (m) = 2.5 kg
acceleration (a) = 2.1 m/s^2 to the left
F_{net} =?
$F_{net} = ma$
= (2.5 kg) (2.1 m/s^2)
= 5.3 N

Forces always act in pairs and it always act in opposite directions. *If you punch the wall, what happens to your hand? How will you explain the action-reaction force in this situation?* The amount of force exerted by your hand on the wall is the **action force**. The wall exerts an equal, opposite force back on your hand (**reaction force)** and that is why you feel pain in your hand. The action- reaction force is the **Newton's Third law of motion** which is also known as, **law of interaction** which states that **for every action, there is an equal and opposite reaction** and these two forces are pointing into different direction.

To better understand forces, one way in presenting forces is through diagram. This diagram is called free body diagram or FBD, a simplified representations of an object in a problem, force vectors (arrow) acting on the object (body) is included. The object or the **body** is **free** from its environment or surroundings, to exclude non-essential information that is given in the problem.

Example: *A crate is pulled along the floor. What are the forces acting on the body? Can you illustrate it?*

FBD:



In the sample FBD, you can see four forces acting on the body (object); these forces are the normal force (upward), weight (downward), friction (left) and applied force [(push or pull) right

The forces identified in FBD are forces that are based on the interaction between two bodies and these can be **contact or non-contact forces. Contact forces** are involved only in two objects physically interact each other.

Types of Contact Forces

Normal force is always perpendicular to the surface in contact with the object (body). It prevents the object from falling. From the given example above, the crate is pulled along the floor, which means the crate is in contact with the floor (surface) that is why normal force is pointing upward, perpendicular to the surface.

Weight is equal to the product of mass (object) and acceleration due to gravity that is approximately equal to $9.8 m/s^2$ (Weight = mg).

Frictional force is related to normal force. If normal force is perpendicular to the surface in contact with the object, the frictional force is parallel to the surface, opposing the motion. Thus, it is pointing away from the direction of motion or movement.

Static Friction is the type of friction between the bodies which keeps the object at rest.

Kinetic Friction is when the force acting against friction overcomes static friction and body comes in motion, kinetic friction is the type of friction which slows down the moving object.

Applied Force or Applied Push or Pull. A physical **push or pull** that caused the object (body) in motion.

Tension is a force present in a rope, string, cable or chain that causes the object to move by pulling.

Types of Non-Contact Forces

Gravitational Forces are the forces which attracts any two objects with a mass.

Electrical Forces. These forces exits when there are charges present in the body.

Magnetic Forces are forces that exists between two objects due to their magnetic characteristics.

Let Us Try

Activity 1: Analyze the following problems below and answer the given questions scientifically.

A. You are standing on the back of a pickup truck that is at rest, you are throwing banana forwards with a velocity of 10 m/s.

1. *(Refer to situation A for your answer)* If your friend is standing on the sidewalk, how fast would he say the bananas are moving? Are you in the same frame of reference? _____

B. Now the truck starts to move forward at a velocity of 20 m/s. You are still throwing bananas forward with the velocity of 10 m/s.

2. *(Refer to situation B for your answer*) If you are not paying attention to what's going on around you, how fast would you say the bananas are moving?_____
3. How fast does your friend on the sidewalk say the bananas are moving? _____

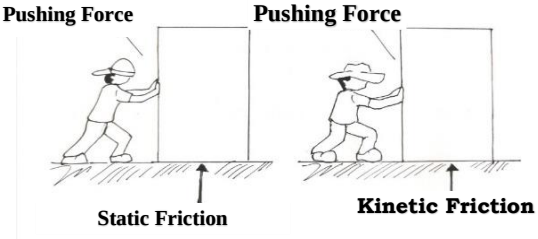
C. Now you turn around and start throwing the bananas (10 m/s) from the rear of the truck. *(For items 4 to 7 refer to the situation C)*

4. If you are ask, how fast the banana is moving? _____
5. How fast does your friend on the sidewalk say the banana is moving? _____
6. Do you think you and your friend would have the same answers? _____
7. From the given situations above, how will you define inertial frame of reference? _____

Let Us Do

Activity 2: Analyze the two pictures below and answer the following questions: Write your answer on the separate sheet of paper.

1. What are the forces acting on the body (two pictures)?
2. Draw a solid arrow to show the direction of forces in the two given pictures.
3. Explain the pictures below in terms of the relationships of static friction and kinetic friction.
4. Construct a free-body diagram.

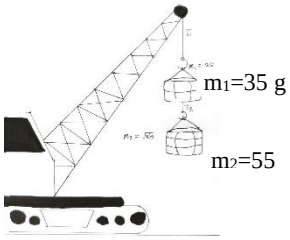


Let Us Apply

Activity 3: Let's Solve!!!

Analyze and solve the following word problems:

1. A bicycle and a rider together have a mass of 80 kg. If the bicycle moves at 5.0 m/s, how much force is needed to bring it to a stop in 5.0 s?
2. The two crates 35 kg and 55 kg are to be accelerated upward to a ship at the rate of 0.30 m/s^2 (See the illustration below). Determine the tension in each rope.



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