Physics 2204
Unit 2: Dynamics
Worksheet 5: Newton's First Law

Student Name:_____

Sir Isaac Newton was one of the greatest scientists and mathematicians that ever lived. He was born in England on December 25, 1643. He was born the same year that Galileo died. He lived for 85 years.

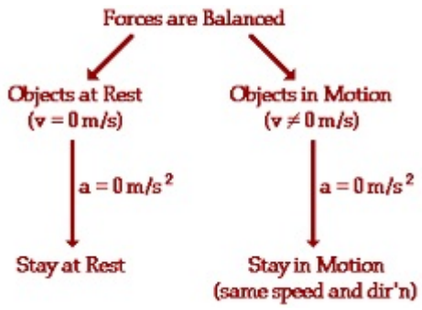
Isaac Newton was raised by his grandmother. He attended Free Grammar School and then went on to Trinity College Cambridge. Newton worked his way through college. While at college he became interested in math. physics, and astronomy. Newton received both a bachelors and masters degree.

While Newton was in college he was writing his ideas in a journal. Newton had new ideas about motion, which he called his three laws of motion. He also had ideas about gravity, the diffraction of light, and forces, Newton's ideas were so good that Queen Anne knighted him in 1705. His accomplishments laid the foundations for modem science end revolutionized the world. Sir Isaac Newton died in 1727.

Newton's First Law (Sometimes called INERTIA):

Objects at rest tend to stay at rest, and objects in motion tend to stay in motion in a straight line unless acted upon by an external unbalanced force.

There are actually two parts to the 1st law:



Inertia is that quantity which is solely dependent upon mass. The more mass which an object has, the more inertia it has - the more tendency it has to resist changes in its state of motion

Examples of Part I - If an object is stopped (at rest) it tends to remain that way.

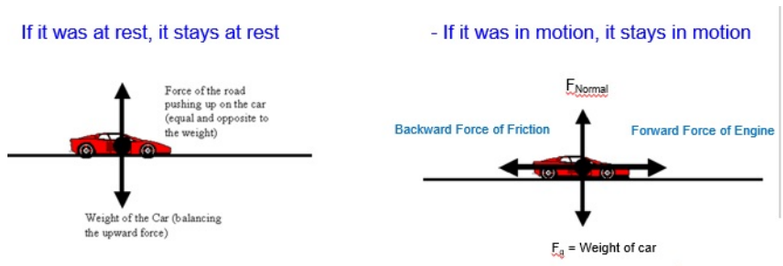
-the old Magician's trick of pulling the table cloth from underneath the dishes
-Card and coin on a GLASS
-Dust being removed from a mat.
-headrests are placed in cars to prevent whiplash injuries during rear-end collisions.

Examples Part II - If an object is moving at a constant speed in a straight line it tends to remain that way.

-the head of a hammer can be tightened onto the wooden handle by banging the bottom of the handle against a hard surface
-Snow is removed by stamping you feet.
-Getting thrown from a car in an accident

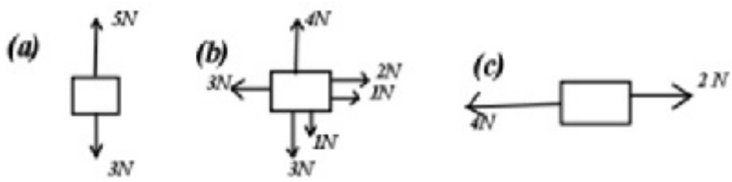
Newton's First Law – Balanced Forces

- In order for Newton's First Law to apply, all forces that act on an object must be balanced. In other words, once you add up all the forces, the Net Forces (or Unbalanced Force) on the object must be 0. If forces are balanced, the object will maintain its state of motion:



Example 1 :

Determine which of the following is obeying Newton's First Law.



Example 2:

A) You see a car pass by at a fixed speed in a straight line. Are there any forces acting on it?

B) If the force of friction between is 1000N, how is the car able to travel with uniform motion

Example 3:

A driver pushes his car at a fixed speed along a level straight road. A "special" set of bathroom scales between the driver's hands and the car indicates he is pushing with a force of 400 N. What is the force of friction acting on the car?

Inertial and Non-inertial Frames of Reference:

Frame of reference is a place from which motion is observed.

Inertial frame of reference is one in which Newton's First Law is valid.
When there is no motion or When there is uniform motion
(Constant speed in straight line)

Example: Box at rest on the floor. Car travelling uniformly at 12 m/s along a straight stretch of roadway.

Non-Inertia frame of reference is one where Newton's First Law is NOT Valid.
There is acceleration involved in a non- inertia reference frame:

Either: The magnitude of an object's velocity changes (speeds up or slows down).
or The direction of an object's velocity changes (object travels around a turn).

Examples: A car applies its brakes and stops. An airplane accelerates at takeoff.
A motorcycle travels around a turn in the highway, at a constant speed.

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. Which of Newton's laws best explains how a magician can pull a tablecloth from underneath dishes?

   (A) Action-reaction
   (B) F = ma
   (C) Law of inertia
   (D) Universal law of gravitation

2. Which best explains why people should wear seatbelts?

   (A) Newton's First Law
   (B) Newton's Second Law
   (C) Newton's Third Law
   (D) Newton's Law of Universal Gravitation

3. Which of Newton's Laws explains why a plate stays on the table when a table cloth is quickly pulled from beneath it?

   (A) Newton's First Law
   (B) Newton's Second Law
   (C) Newton's Third Law
   (D) Newton's Law of Universal Gravitation

4. Which describes an object where the net force is zero?

   (A) An airplane coming to a stop
   (B) A ball accelerating down an incline
   (C) A baseball thrown vertically into the air
   (D) A lab cart being pulled at a constant rate

5. You stop your car suddenly and your Physics textbook slides off the back seat. Which of Newton's Laws best explains why this happens?

   (A) Newton's 1st Law of Motion
   (B) Newton's 2nd Law of Motion
   (C) Newton's 3rd Law of Motion
   (D) Newton's Law of Universal Gravitation

6. You are standing in a moving bus with your back to the driver and looking out the rear window. Suddenly you stumble into the seat to your right. Which of the following would be the correct conclusion for you to make?

   (A) The bus speeded up
   (B) The bus slowed down
   (C) The driver swerved the bus to the right
   (D) The driver swerved the bus to the left

7. Which of the following examples is NOT explained by Newton's First Law?

(A) A car leaving the road on a sharp turn
(B) Astronauts accelerate in space using thrusters
(C) Knocking snow off you boots by stamping them
(D) Seatbelts seem to press against you when the brakes are applied

8. The inertia of an object depends most on its:

(A) Acceleration
(B) Displacement
(C) Mass
(D) Velocity

9. When an object like a car is moving with uniform velocity which of the following is true? (Fapp = applied force)

(A) $F_{app} = 0$
(B) $F_{app} = F_{fr}$
(C) $F_{net} = F_{fr}$
(D) $F_{fr} = 0$

10. Which object has the greatest INERTIA?

(A) A 2 kg rock is moving at 30 m/s.
(B) A 0.1 kg bullet is moving at 400 m/s.
(C) A 5 kg concrete block is sitting stationary on the ground.
(D) A 1 kg ball is accelerating at 2 m/s2.

11. An object is remaining perfectly stationary. Which statement is correct?

(A) There is no net force acting on the object.
(B) There could be a small net force acting on the object.
(C) There is a large unbalanced force acting on the object.
(D) All of the above are correct.

12. Which choice represents a NON-INERTIAL frame of reference?

(A) Bicycle traveling at 20 km/h [West]
(B) Race car going around a circular track at 200 km/hr
(C) Balloon moving at constant velocity straight upwards.
(D) Spacecraft sitting on the surface of Mars

13. Newton's First Law of Motion BEST explains which observation?

(A) Gravity affects all objects.
(B) When you let the air out of a balloon it tends to fly around.
(C) A force tends to accelerate your bicycle.
(D) Curling stones tend to move at constant speeds in a straight line.

PART B: WRITTEN RESPONSE

1. Which has more inertia, a car with a mass of 900 kg or a car with a mass of 1,500kg? Explain your answer

2. Why does a computer sitting on a desk remain at rest?

3. Why does a hockey puck moving across smooth ice move at a constant velocity?

4. Why does a wagon pulled across a rough surface by a child move at a constant velocity?

5. Older cars did not have headrests, but all new cars do. How do headrests help prevent injuries during a rear-end collision? Use Newton's fi rst law to explain your answer

6. When Jane drives to work, she always places her purse on the passenger's seat. By the time she gets to work, her purse has fallen on the floor in front of the passenger seat. One day, she asks you to explain why this happens in terms of physics. What do you say?