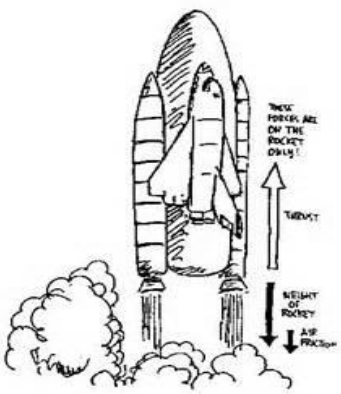
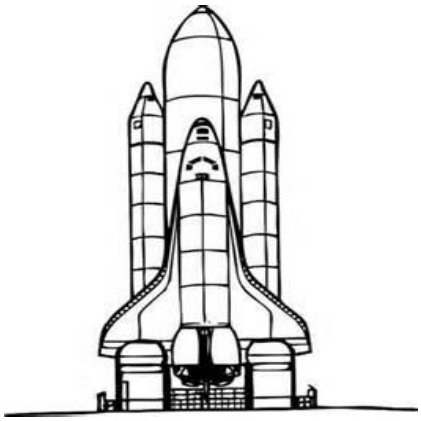
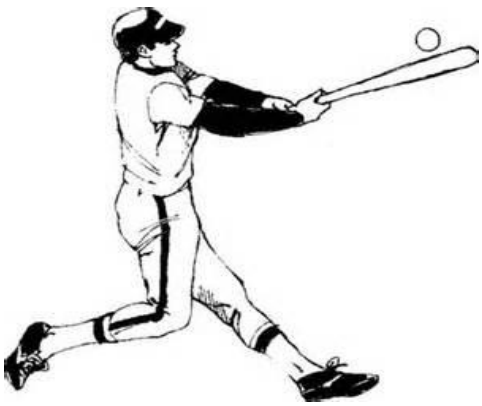
# CHAPTER 3





# "Forces & Newton's Laws of Motion"

Physical Science Notebook Table of Contents

Chapter 3 – "Forces & Laws of Motion"

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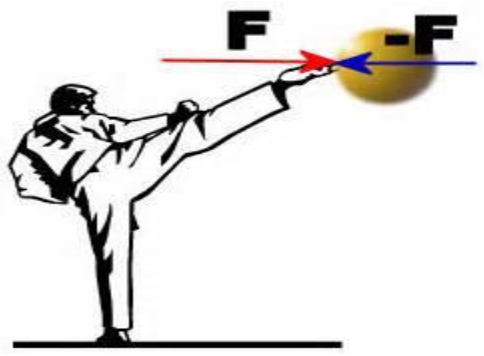
**Physical Science Vocabulary**

Vocabulary for Chapter 3: Forces Period: _____

| No.# | Term | Page # | Definition |
|---|---|---|---|
| | Air Resistance | | |
| | Centripetal Acceleration | | |
| | Centripetal Force | | |
| | Friction | | |
| | Gravity | | |
| | Momentum | | |
| | Sliding Friction | | |
| | Static Friction | | |
| | Rolling Friction | | |
| | Weight | | |
| | Newton's 1st Law of Motion | | |

**Explain the Force of the Karate Kick?**

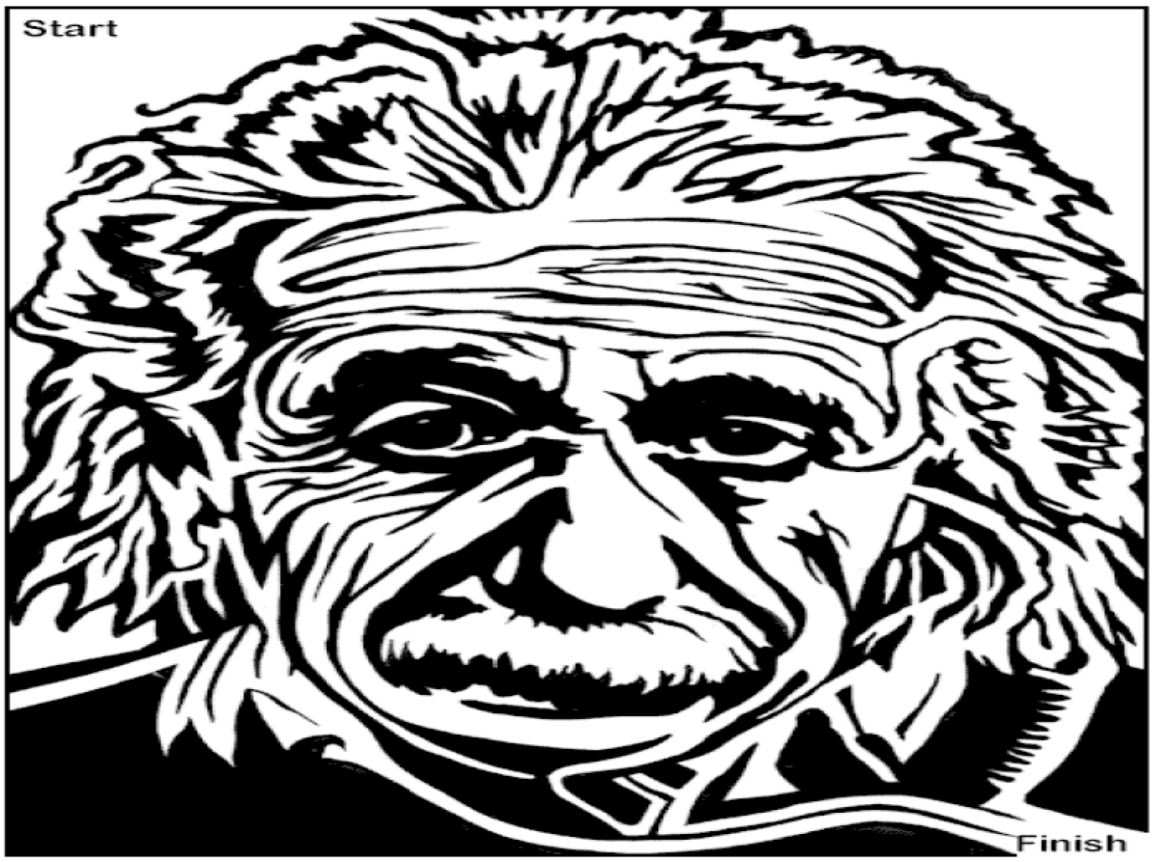
_____
_____
_____
_____
_____
_____
_____



Vocabulary for Chapter 3: Forces

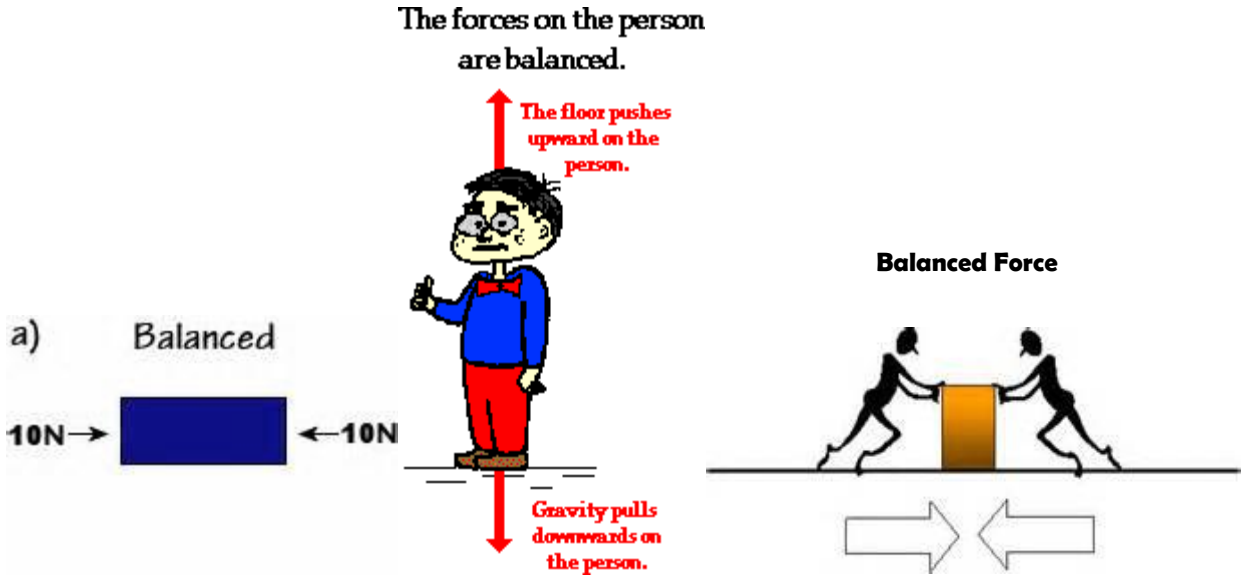
| No.# | Term | Page # | Definition |
|---|---|---|---|
| | Newton's 2nd Law of Motion | | |
| | Newton's 3rd Law of Motion | | |
| | Mass | | |
| | Law of Conservation of Momentum | | |
| | Law of Universal Gravitation | | |
| | Terminal Velocity | | |

**Einstein's Maze**



**Types of Forces**

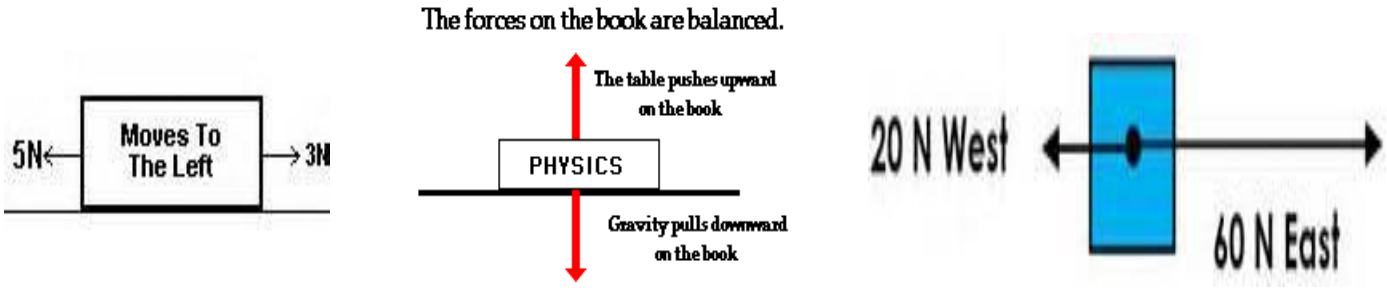
1. **Force**: is a push or pull that one object exerts on another object.
2. **Balanced Force -** is when two equal and opposite forces are applied on a body in two exactly opposite directions. When equal and opposite forces act on a body, and the body does not move then it (body) is said to be in **equilibrium** or we can also state as balanced forces acting on an object.




- **Balanced Forces** acting in opposite direction are added together to a total force.

3. **Unbalanced Force** - Forces that produce a non-zero net force, which changes an object's motion. Unbalanced forces are forces that produce a non-zero net force, which changes an object's motion. The result of an unbalanced force is acceleration of an object.

**Unbalanced Force**



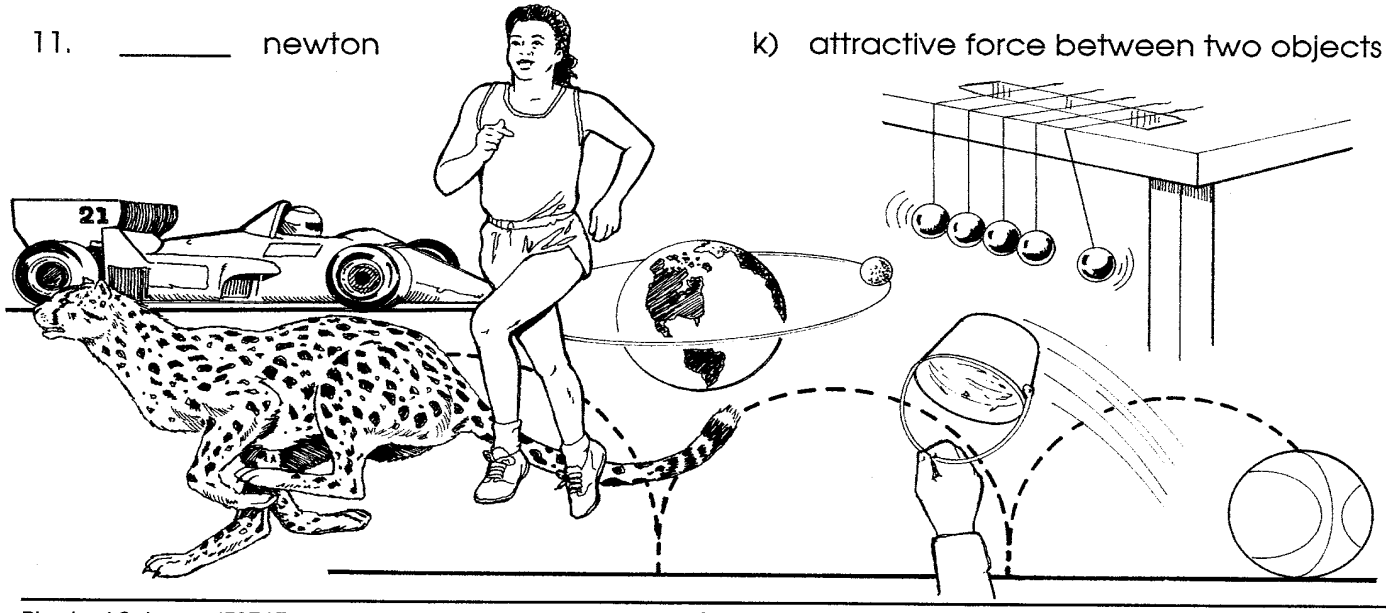

- **Unbalanced Forces** – Forces acting in opposite directions are substrated from one another to obtain the total force being exerted and the direction of the force.

# MOTION MATCHING

Name _____

Match the correct term in Column I with its definition in Column II.

| I | | | II | |
|---|---|---|---|---|
| 1. | _____ | kinetic | a) | amount of matter in an object |
| 2. | _____ | centripetal | b) | amount of force exerted on an object due to gravity |
| 3. | _____ | mass | c) | distance covered per unit of time |
| 4. | _____ | acceleration | d) | rate at which velocity changes over time |
| 5. | _____ | velocity | e) | speed in a given direction |
| 6. | _____ | weight | f) | unit of measurement for force |
| 7. | _____ | gravity | g) | energy of motion |
| 8. | _____ | inertia | h) | tendency of a moving object to keep moving |
| 9. | _____ | speed | i) | depends on the mass and velocity of an object |
| 10. | _____ | momentum | j) | type of force that keeps objects moving in a circle |
| 11. | _____ | newton | k) | attractive force between two objects |



**Newton's Laws of Motion Definitions**

**Newton's 1st Law of Motion** – referred as the "**Law of Inertia**," states that the velocity of an object will remain constant unless a net force acts on it.


**Newton's 2nd Law of Motion** – states that when a net force acts on an object, the object will accelerate in the direction of the net force.


**Newton's 3rd Law of Motion** – states that when one object exerts a force on a second object, the second object exerts a force on the second object, the second object exerts a force on the first object that is equal in magnitude and opposite in direction.


**First Law**
Objects at rest remain at rest and objects in motion remain in motion in a straight line unless acted upon by an unbalanced force.

**Second Law**
Force equals mass times acceleration (or f = ma).

**Third Law**
For every action there is an equal and opposite reaction.

# Newton's Laws of Motion A

Fill in the blanks with words from the box.

| | | | |
|---|---|---|---|
| **acceleration** | **decreases** | **equal** | **force** |
| **increases** | **inertia** | **mass** | **motion** |
| **Newton** | **opposite** | **reaction** | **rest** |

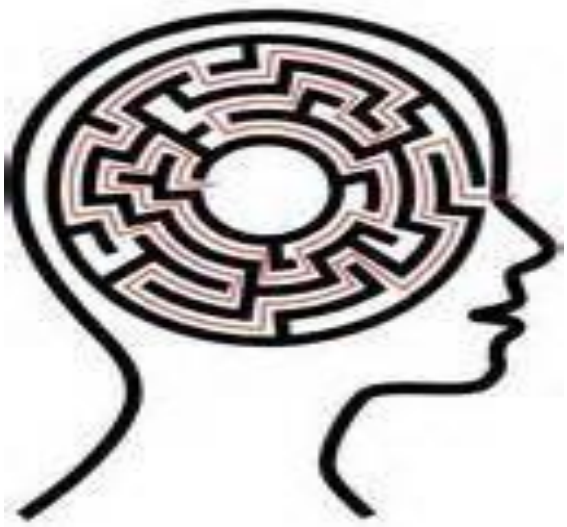
*Sir Isaac Newton*

The English scientist Sir Isaac _____ developed three laws of motions. His first law is called the law of _____. This law states that objects in motion will stay in _____ and objects at rest will stay at _____ unless acted upon by an unbalanced _____.

Newton's second law of motion states that an unbalanced force is equal to _____ time's _____. This means that as more unbalanced force is applied to an object, its acceleration _____. It also means that as an object's mass increases, the acceleration _____ for a given unbalanced force.

Newton's third law of motion states that for every action there is an _____, but _____ reaction. This means that whenever one object pushes on another object, the other object pushes equally hard back.

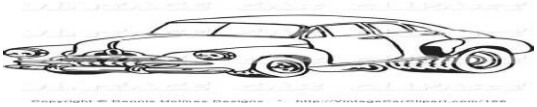
**Can your eyes follow the maze?**



# Newton's Laws of Motion B

Have you ever been riding in a car when the driver stopped suddenly? How did your body move as the car came to a stop? Did it feel like your body was moving forward?

When you felt this happening you experienced Newton's first law of motion. Newton's first law of motion says that **an object in motion will stay in motion and an object at rest will stay at rest unless acted on by an unbalanced force**. In the car your body was in motion, traveling at the same speed as the car. When the car stopped, your body stayed in motion. If you were not wearing a seatbelt and you were traveling very fast, your body could continue to move forward through the windshield!



This idea is called **inertia**.

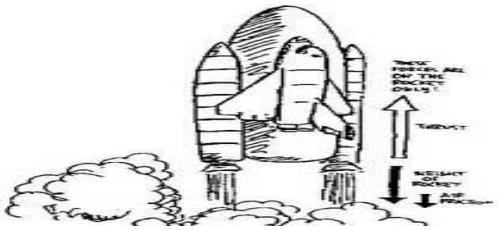
1. Explain why your body feels like it is being pushed back when the car starts back up again:

_____
_____
_____
_____

If a ping pong ball and a basketball were both dropped at the same time from the roof of our school, which would hit the ground with a greater force? Common sense tells us that the basketball ball would. The difference in forces would be caused by the different masses of the balls. Newton stated this relationship in his second law, **the force of an object is equal to its mass times its acceleration**.

2. List two other situations where Newton's 2nd Law may apply.

_____
_____
_____
_____



Imagine a rocket is being launched from the earth. Hot gases are pushed out from the bottom of the rocket as the rocket is pushed upward. The force of the gases pushing against the surface of the earth is equal and opposite to the force with which the rocket moves upward. The motion of the rocket can be explained by Newton's third law, **for every action there is an equal and opposite reaction**. In other words, when one object exerts a force on another object, the second object exerts a force of equal strength in the opposite direction on the first object.

**Fill in the table:**

| Law | Description/Definition | Everyday Example |
|---|---|---|
| 1st Law of Motion | | |
| 2nd Law of Motion | | |

| | | |
|---|---|---|
| 3rd Law of Motion | | |

# Newton's Laws of Motion Worksheet

## Newton's Laws: Using the Main Ideas

Look carefully at the illustrations below. Decide which of Newton's laws is illustrated in each example. Then explain how the situation illustrates the law.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

# "Newton's Laws of Motion: Which Law?"

We're told that Sir Isaac Newton discovered some things about motion when an apple dropped on his head. Whatever "force" was behind his discoveries, we have benefited from his discoveries. Here are his three laws of motion. You should be familiar with them.

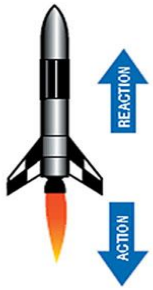
**Section1**

**Directions**: Fill in the missing words in each of the three laws. Then tell which law fits each example below.

**Which Law**? 1st Law 2nd Law 3rd Law

_____ 1. A frog leaping upward off his/her lily pad is pulled downward by gravity and lands on another lily pad instead of continuing on in a straight line.

_____ 2. As the fuel in a rocket ignites, the force of the gas expansion and explosion pushes out the back of the rocket and pushes the rocket forward.

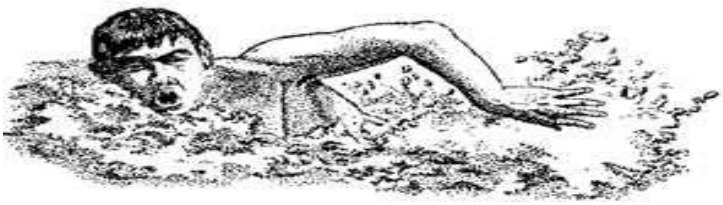



_____ 3. When you are standing up in a subway train, and the train suddenly stops, your body continues to go forward.

_____ 4. After you start up your motorbike, as you give it more gas, it goes faster.

_____ 5. A pitched baseball goes faster than one that is gently thrown.

_____ 6. A swimmer pushes water back with his arms, but his body moves forward.



_____ 7. As an ice skater pushes harder with his / her leg muscles, he/she begins to move faster.

_____ 8. When Bobby, age 5, and his dad are skipping pebbles on the pond, the pebbles that Bobby's dad throws go farther and faster than his.

_____ 9. When you paddle a canoe, the canoe goes forward.

_____ 10. A little girl who Has been pulling a sled behind her in the snow is crying because when she stopped to tie her hat on, the sled kept moving and hit her in the back of her legs.

### Newton's 1st Law of Motion

An Object at _____ stays at _____ or an object that is _____ at a _____ in a straight _____ keeps moving at that _____ unless another _____ acts on it.

### Newton's 2nd Law of Motion

The amount of _____ needed to make an object change its _____ depends on the _____ of the object and the _____ required.

### Newton's 3rd Law of Motion

For every _____ (or force), there is an _____ and _____ action (or force).

## Key Terms – Newton's Laws of Motion

### Section 2

**Directions**: Complete the following sentences using the terms below.

**Unbalanced** **Force** **First** **Second Third** **Friction Speed**

11. A _____ is a push or pull on an object.
12. When an object remains at rest or moves in a straight line with constant speed until it is acted upon by an unbalanced force, the _____ law of motion is demonstrated.
13. A(n) _____ force allows you to pick up your book bag.
14. The _____ law of motion says that for every action there is an equal but opposite reaction.
15. _____ is a way to measure the rate of motion.
16. If you are trying to ice skate and you fall, the _____ was too great between your skates and the ice.

### Section 3

### NEWTON'S LAWS - VOCABULARY REVIEW MATCHING

| | | | |
|---|---|---|---|
| ___ | 17 | Tendency for an object to resist changes in motion | a. Sir Isaac Newton |
| ___ | 18 | Also known as Law of Inertia | b. Inertia |
| ___ | 19 | Push or Pull | c. Force |
| ___ | 20 | Law based on the equation F= m x a | d. Newton's 1st Law |
| ___ | 21 | Unit of Force | e. Newton's 2nd Law |
| ___ | 22 | Object Changing Position | f. Newton's 3rd Law |
| ___ | 23 | The greater the force on an object, the greater the _____ of an object. | g. Newton's |
| | 24 | Scientist that formatted 3 Laws of Motion | h. F = m x a |
| ___ | 25 | For every action there is an equal and opposite reaction. | i. Motion |
| ___ | 26 | Equation showing relationship between force, mass, and acceleration. | j. Acceleration |
| ___ | 27 | The greater the _____ of an object, the smaller the acceleration if a similar force is a | k. Mass |

### Section 4

**Directions**: Circle the term in parentheses that makes the statement correct.

28. (Velocity, Speed) is an object's displacement divided by time.
29. (Displacement, Acceleration) is the change in an object's velocity divided by the amount of time required for the change to occur.
30. A (force, motion) is a push or a pull.
31. When scientists need to measure force, they use the (Newton, degree).
32. The first law of motion is sometimes called the law of (inertia, force).

**Section 5**

## Newton's 2nd Law AND Newton's 3rd Law

**Directions**: for each of the following, write the letter of the choice that best completes the sentence.

____ 33. When you exert a force on an object it exerts _____ force back on you.
a. a stronger b. the same

____ 34. When volleyball players jump into the air, the primary force acting to make them land back on the ground is _____.
a. mass b. gravity

____ 35. Forces always act in _____.
a. pairs b. singles

____ 36. In a game of tug of war, the team that wins has exerted a greater _____ force.
a. unbalanced b. mass

____ 37. When you are pushing on a large door, _____ friction keeps you from sliding backwards.
a. unbalanced b. static

____ 38. _____ is determined by gravity.
a. weight b. mass

____ 39. A component of inertia is _____.
a. mass b. friction

____ 40. _____ friction causes a car tire to turn on the road.
a. static b. sliding

____ 41. If the same force is applied to two different objects, the one with the _____ mass has a smaller acceleration.
a. larger b. smaller

**Section 6**

### Predicting and Explaining Newton's Laws of Motion

### THE LAWS OF MOTION

**1st Law**: states that every object maintains a constant velocity unless acted on by unbalanced force.

**2nd Law**: describes the relationship among acceleration, force, and mass.

**3rd Law**: states that every action there is an equal and opposite force.

**Directions**: Tell which law of motion is described by the following situations

_____ 42. This law of motion is activated each time you take a step on the earth.

_____ 43. The amount of force that must be applied on a car's brakes to make it stop is related to this law of motion.

_____ 44. Inertia, the resistance any object has to a change in its velocity, is related to this law of motion.

_____ 45. When you bump into someone and you both fall back, this law of motion is illustrated.

_____ 46. An empty car requires less force on the brakes to stop than a car filled with people.

_____ 47. Your body continuous traveling forward when a forward-moving vehicle to a sudden stop.

## Section 7

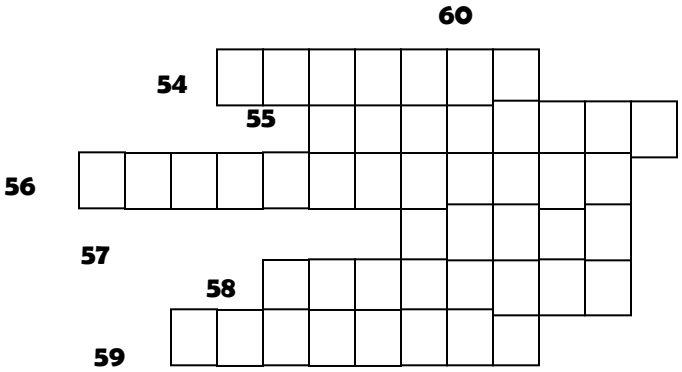
**Directions**: Complete the following sentences using the terms below.

**Acceleration** **Velocity** **direction** **negative** **positive** **time**

48. Acceleration occurs when an object's _____ changes.
49. When an object speeds up, it has _____ acceleration.
50. When an object's final velocity is less than its initial velocity, however, it has _____ acceleration.
51. _____ is accelerating, even if its speed remains the same.
52. Acceleration can be calculated by dividing the change in velocity by the _____ interval in which the change occurred.
53. The SI unit of _____ is $m/s^2$.

## Section 8

**Directions**: Write the term that matches each description in items 54 through 59 below on the spaces provided. Unscramble the boxed letters to spell the term that answers questions 60.




54. A measure of an object's tendency to remain at rest or continue at constant speed.
55. How far something travels
56. How far something ends up from its starting place
57. A push or pull
58. Forces that result in no change in an object's motion
59. The force that resists motion
60. An object will remain at rest or move in a straight line with constant speed unless it is acted upon by a force.

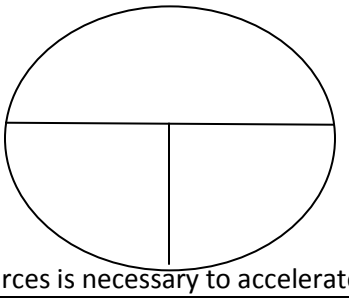
## Section 9

### Acceleration, motion, and forces – Vocabulary Review Matching

| | | | |
|---|---|---|---|
| ___ | 61 | Result in a net force of zero | A. Force |
| ___ | 62 | The tendency of an object to resist any change in its motion | B. Net Force |
| ___ | 63 | Cause an object's velocity to change | C. Unbalanced Force |
| ___ | 64 | A push or pull that can change an object's motion | D. Balanced Force |
| ___ | 65 | States that an object at rest will remain at rest unless acted upon by a unbalanced force | E. Inertia |
| ___ | 66 | The combined force on an object | F. Newton's first law of motion |

### Newton's Second Law I

Complete the following memory circle **AND** the chart below.



| | Letter stands for | Units |
|---|---|---|
| **F** | | |
| **M** | | |
| **a** | | |

67. What forces is necessary to accelerate a $1.6X10^3$ kg car at 2.0 m/sec$^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

68. What is the acceleration of a 0.143 kg baseball that is dropped if the earth pulls on the baseball with a force of 1.4 Newton's?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

69. A sailboat and its crew have a mass of 655kg. If the force on the boat is 895N, what is its acceleration?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

70. A force of 115N causes a mass to accelerate at 0.657 m/sec$^2$. What is the mass?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

71. A 4,500 kg helicopter accelerates upward at 2.0 m/sec$^2$. What force does the helicopter exert?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

## Newton's Second Law II

72. The maximum force of a grocery bag can withstand is 250 Newton's. If 20.0 kg of groceries are lifted from the floor to a table with an acceleration of 5.0 m/sec$^2$. Will the bag tear or hold?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

73. A box weighting 100 Newton's is pushed from rest to a velocity of 10 m/s. What force was applied to the box?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

74. How much force does a 90N person experience when the car they are traveling in stops from a speed of 55 m/s?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

75. What force is needed to accelerate a 1.0 kg projectile from rest to a speed of 100 m/s$^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

76. A 5,000 kg truck slows down from 30 m/s to 20 m/s. How much force is needed for this to happen?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

77. If it takes a speed skater 900 N of force to accelerate from rest to 10m/s$^2$, what is the mass of the skater?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

## Key Terms – Force and Acceleration Problems I

78. With what force will a car hit a tree if the car has a mass of 3,000 kg and it is accelerating at a rate of 12 $m/s^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

79. A 10kg bowling ball would require what force to accelerate it down an alleyway at a rate of $3m/s^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

80. What is the mass of a falling rock if it hits the ground with a force of 147 Newton's?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

81. What is the acceleration of a softball if it has a mass of 0.50 kg and hits the catcher's glove with a force of 25 N?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

82. What is the mass of a truck if it is accelerating at a rate of $5m/s^2$ and hits a parked car with a force of 14,000 N?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

83. A baseball applies 200 N to a catcher's mitt when caught. The baseball has a mass of 0.142 kg. If it takes 0.200 seconds for the ball to leave the pitcher's hand and hit the mitt, what is the baseball's velocity?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

## Force and Acceleration Problems II

84. What force is required to move a 10,000 kilogram lead ball at 18 $m/s^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

85. If you apply a 45N force on a 15 kg wagon, what is the rate of acceleration?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

86. Calculate the mass of a discus thrown with a force of 9.0N to accelerate it at 6.0 $m/s^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

87. What is the acceleration of a 15,000 kg truck with a net force of 7,500N?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

88. A runner with a mass of 60kg accelerates at 2.2 $m/s^2$. What is the runner's net force?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**What 2 forces that are acting against each other?**

_____
_____
_____
_____
_____

## Newton's Laws Worksheet III

89. While dragging a crate a workman exerts a force of 628 N. Later, the mass of the crate is increased by a factor of 3.8. If the workman exerts the same force, how does the new acceleration compare to the old acceleration?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

90. A rocket accelerates in a space at a rate of "1 g." The rocket exerts a force of 12,482 N. Later in flight the rocket exerts 46,458 N. What is the rockets new acceleration? What is the rocket's new acceleration in "g's?"

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

91. A race car exerts 19,454 N while the car travels at a constant speed of 201 mph, 91.36 $m/s^2$. What is the mass of the car?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

92. A locomotive's mass is 18,181.81 kg. What is its weight?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

93. A small car weighs 10,168.25 N. What is its mass?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

## Newton's Laws Worksheet III

94. What is the weight of an infant whose mass is 1.76 kg?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

95. An F-14's mass is 29,545 kg. What is its weight?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

96. What is the mass of a runner whose weight is 648 N?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

97. The surface gravity of the Sun is 274 $m/s^2$. How many Earth g's is this?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

98. The planet Mercury has 0.37 g's compared to the Earth. What is the mass of a person weighting 257 kg?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

99. What is the acceleration on Mercury of a 25 kg baseball thrown at 7 $m/s^2$?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

## Newton's Laws Worksheet III

100. A plane crashes with a de-acceleration of 185 m/s2. How many g's is this?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

101. A baseball traveling 38 m/s is caught by the catcher. The catcher takes 0.1 seconds to stop the ball. What is the acceleration of the ball and how many g's is this?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

102. A very fast car accelerates from a rest to 32 m/s, (71.68 mph), in 4.2 seconds. What is acceleration of the car and how many g's is this?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

103. The Space Shuttle travels from launch to 529.2 m/s in 6.0 seconds. What is the shuttle's acceleration?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

104. What is the acceleration of the shuttle and how many g's is this?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**What is Inertia?**

_____
_____
_____
_____
_____
_____

## Newton's Laws Worksheet III

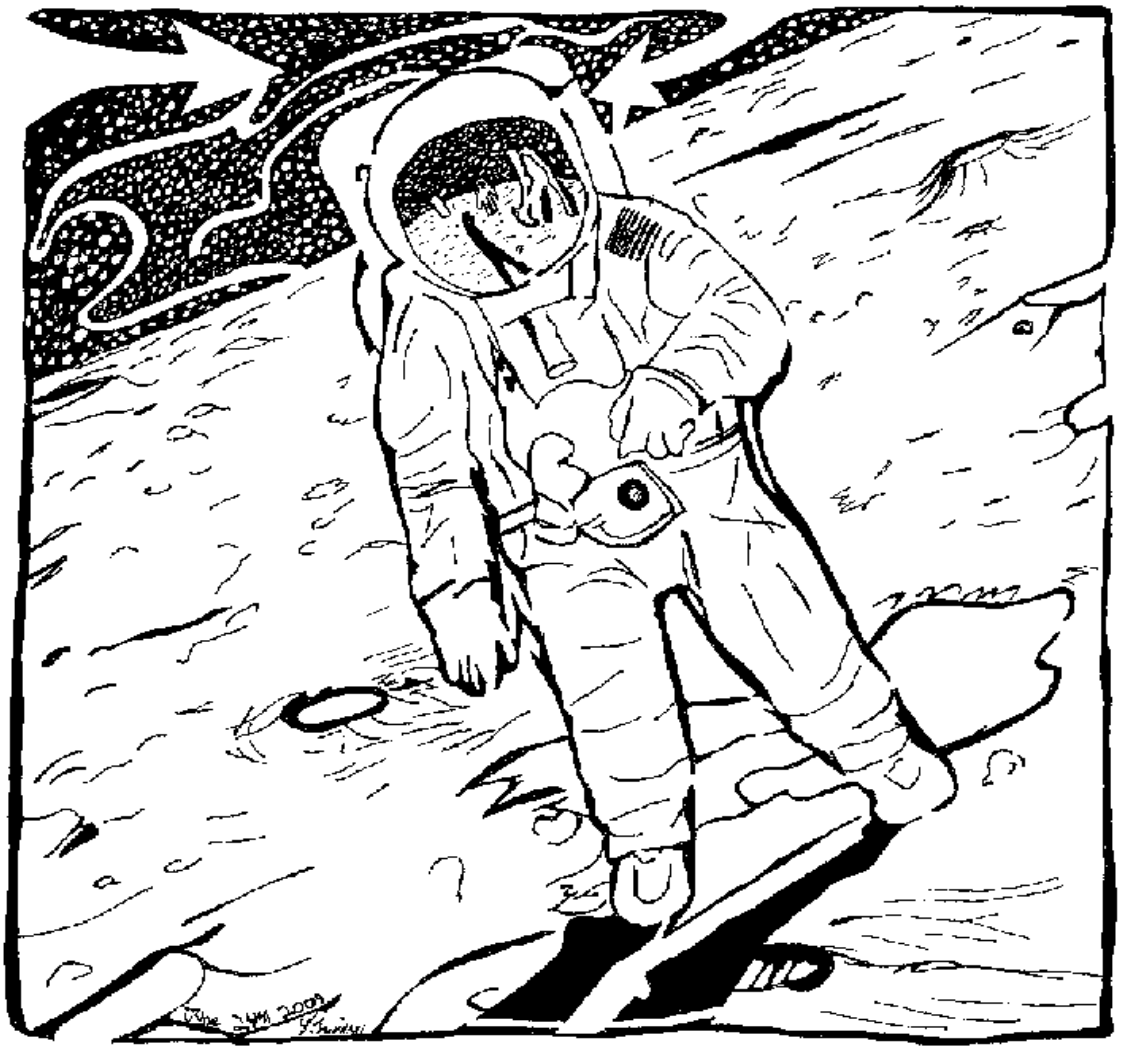
105. The space shuttle's mass, (with boosters) is 654,506 kg. The average force of the shuttle's engines is 25,656,635.2N. What is the acceleration of the shuttle in $m/s^2$ and force of gravity?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

106. What is the SI weight of a McDonald's Quarter Pounder sandwich?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Man on the Moon Maze**



**Newton's Laws Worksheet III**

**Give the equation used for each problem and show all work**.

107. What net force is required to accelerate a car at a rate of 2 $m/s^2$ if the car has a mass of 3,000 kg?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

108. A10 kg bowling ball would require what force to accelerate down an alleyway at a rate of 3 $m/s^2$?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

109. Sally has a car that accelerates at 15 $m/s^2$. If the car has a mass of 15,000 kg, how much force does the car produce?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

110. What is the mass of a falling rock if it produces a force of 1,247 N?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

## Newton's Laws Worksheet III

111. What is the mass of a truck if it produces a force of 14,000 N while accelerating at a rate of 5 $m/s^2$ ?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

112. What is the acceleration of softball if it has a mass of 0.75 kg and hits the catcher's glove with a force of 250 N?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

113. Your own car has a mass of 2,000 kg. If your car produces a force of 65,000 N, how fast will it accelerate? F=_____

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

114. Sally wants to accelerate even faster, so she removes 500 kg of mass from her car. How fast will her 1,500 kg car accelerate if it produces 45,000 N of force?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Newton's Laws Worksheet III**

114. Sally challenges you to a race. On the first turn you run off the course and your car strikes a large bale of hay. Your car still produces 5,000 N of force, but now it accelerates at only 2 $m/s^2$. What is the mass of your car now that the bale of hay is stuck to it?

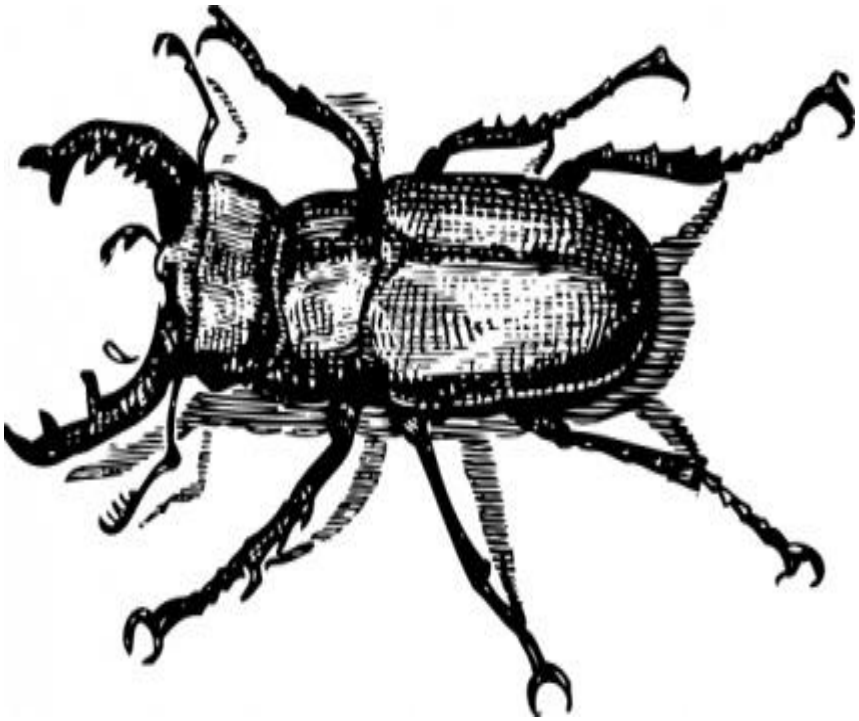
**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

115. Even though she is way ahead of you, Sally switches her car to run on nitrous oxide fuel. The nitrous oxide allows her car to develop 100,000 N of force. What is Sally's acceleration if her car has a mass of 500 kg?

**Force** = _____, **mass** = _____ **acceleration**=_____

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |



1. **What kind of insect is this?**

_____

_____

2. **How much force can the front pinchers of this insect exert?**

_____

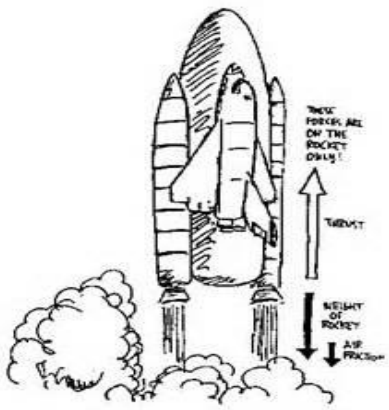
_____

_____

## Newton's Laws of Motion

**Directions**: Fill in the missing words in each of the three laws. Then tell which law fits each example below.

**Which Law**? 1st Law 2nd Law 3rd Law



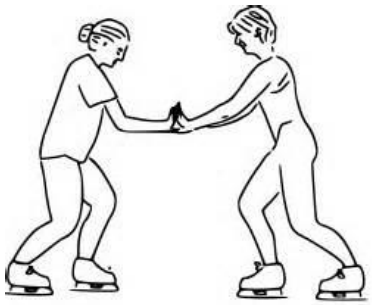

Newton's Law: _____

Newton's Law: _____

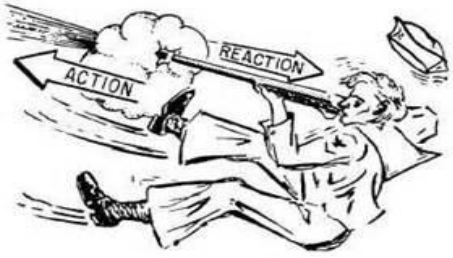
Newton's Law: _____

Newton's Law: _____


Newton's Law: _____



Newton's Law: _____




Newton's Law: _____

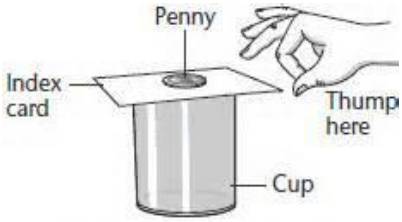
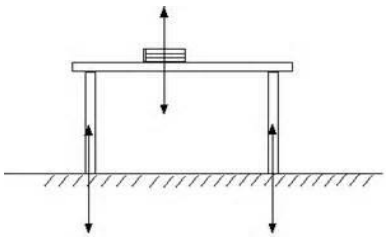



**FIGURE 3.1.** Law of Inertia

Newton's Law: _____

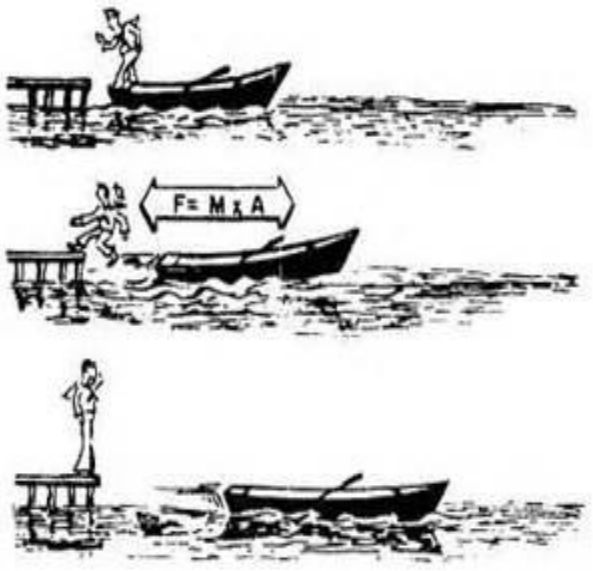


Newton's Law: _____

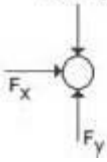
# Newton's Laws of Motion

**Directions**: Fill in the missing words in each of the three laws. Then tell which law fits each example below.

**Which Law**? 1st Law 2nd Law 3rd Law

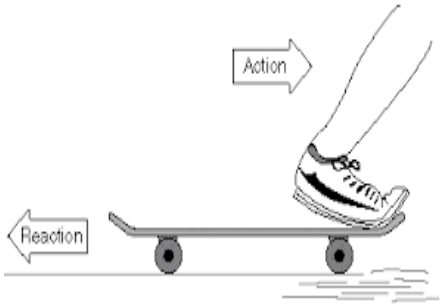




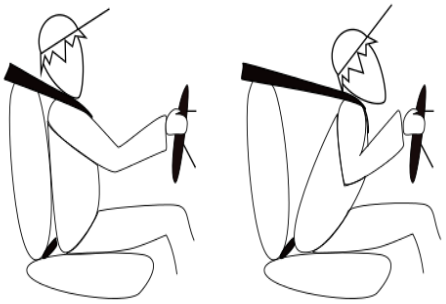



Newton's Law: _____ Newton's Law: _____ Newton's Law: _____

Newton's Law: _____




Newton's Law: _____



Newton's Law: _____

**First Law**
Objects at rest remain at rest and objects in motion remain in motion in a straight line unless acted upon by an unbalanced force.

**Second Law**
Force equals mass times acceleration (or f = ma).

**Third Law**
For every action there is an equal and opposite reaction.

**Impulse** is defined as the integral of a force acting on an object, with respect to time. This means that impulse contains the product of force and time.

- Impulse changes the momentum of an object. As a result, a large force applied for a short period of time can produce the same momentum change as a small force applied for a long period of time.
- An impulse can act on an object to change either its linear momentum, angular momentum, or both.

**IMPULSE = (FORCE) X (TIME)**

$$F = m.a$$

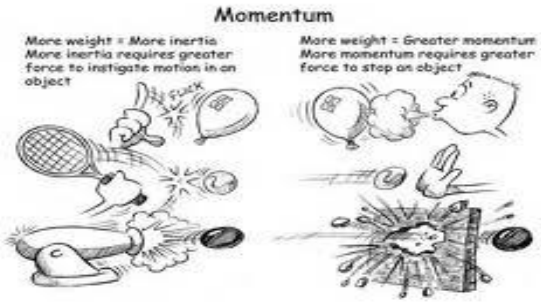
$$F = m.\frac{\text{Change in Velocity}}{\text{time interval}}$$

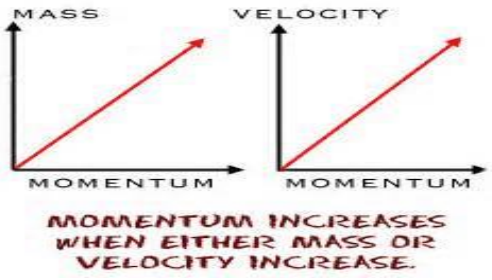
$$F.\Delta t = m.\Delta V$$

impulse change in momentum

**Momentum** is connected to force by impulse, which is simply if the force has a constant magnitude during its action. If the force changes with time, then one must integrate to find the impulse:

- Momentum is a vector. This means it has direction and magnitude. Momentum's magnitude is calculated by the formula p=mv.
- The Momentum-Impulse Theorem states that the change in momentum of an object is equal to the impulse exerted on it: (change in momentum) = (impulse)

# Impulse Practice Problems


F=m.a

F=m.(Change in Velocity) / time interval

F. $\Delta$ t=m. $\Delta$ V

impulse = change in momentum

$$\text{Impulse} = \text{Force} \times \text{time} = \vec{F}\Delta t$$

$$\Delta t = t_{final} - t_{initial}$$

## Impulse & Momentum Worksheets

**A**

V= 5 m/s

$M_R$= 60 kg

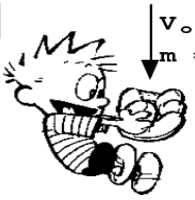
$M_B$= 20 kg

Impulse: ___

Momentum c

Momentum o

**B**



$V_o$ = 30 m/s

m = 0.150 kg

Calvin catches the ball

**C**

BEFORE

$V_o$ = 20 m/s

m = 0.150 kg

AFTER

V = 35 m/s

Line drive – straight back at the pitcher.

**D**

$V_o$ = 10 m/s

m = 0.1 kg

The snow ballhi

Susie on the hea

and sticks there

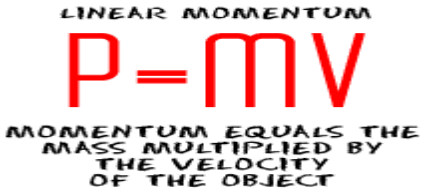
Impulse

$\overrightarrow{\text{Impulse}} = \sum \vec{F}\Delta t$ [N][s]

net force

elapsed time

# Momentum Practice Problems


1. What is the momentum of a 70 kg runner traveling at 10 m/s?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

2. What is the momentum of an 800 kg car traveling at 20 m/s?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

3. What is the momentum of a 47 gram tennis ball that is traveling at 40 m/s?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

4. What is the momentum of a 120 pound bicyclist that is traveling at 25 mph?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |