Newton's Laws of Motion

Complete 3 drawings showing Newton's 3 laws of Motion

Newton's First Law:
Newton's 2nd Law:
Newton's 3rd Law:

Name: _____ pd_____

Parent's signature_____

Science Number

Section 1: Gravity & Motion

1. **Aristotle** believed that the rate at which an object falls depends on the object's _____.
2. **Galileo** believed that all objects will land at the _____ _____ when they are dropped at the same time from the _____ _____.
3. All objects accelerate towards Earth at a rate of _____ m/s^2… this acceleration is the same for all objects regardless of their _____.
4. What fluid friction opposes the motion of objects through air? _____

Complete the table below.

	Definition	Example
5. Terminal Velocity		
6. Free Fall		
7. Projectile Motion		

Section 2: Newton's Laws of Motion

8.

Newton's First Law of Motion

An object at rest remains at rest and an object in motion remains in motion at a _____ speed & in a _____ line unless acted on by an unbalanced _____.

9. Label Figure 11 from page 145.

Formulas to Know!

Speed = Distance / Time

Distance= Speed x Time

Time = Distance / Speed

Velocity = Distance/Time w/Direction

Acceleration = $V_f - V_i$ / Time

Velocity = Acceleration x Time

Time = Velocity / Acceleration

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

10. Part 1 of Newton's 1st Law basically states that "objects will not start moving until a _____ or a _____ is exerted on them." Part 2 explains that "an object moving at a certain velocity will continue to move _____ at the same speed & in the same direction unless some _____ force acts on it."

11. What is inertia? _____

_____

12.

Newton's Second Law of Motion

The acceleration of an object depends on the _____ of the object & the amount of _____ applied.

13. Name two ways to *increase* the acceleration of an object:
    - _____
    - _____

14. Name two ways to *decrease* the acceleration of an object:
    - _____
    - _____

15. What is the equation for Newton's 2nd law? _____

16.

Newton's Third Law of Motion

Whenever one object exerts a force on a second object, the second object exerts an _____ and _____ force on the first.

17. Newton's 3rd law can be simply stated as follows: _____ _____ _____ _____ _____.

18. What are the two types of forces in Figure 17 on page 150?

19. In each of the examples of force pairs, state the action force & the reaction force, as done in the example.

Example	Action Force	Reaction Force
Rabbit Jumping	*Rabbit's legs push down on Earth*	*Earth pushes up on the rabbit's legs*
Baseball bat hitting baseball		
Shuttle launching		
Hand hits a table		

20. Momentum is a property of a moving object that depends on the object's _____ & _____.

Additional Notes: _____

_____

_____

_____

_____

Part 2: Newton's Second Law

Isaac Newton expressed the relationship between force, mass, and acceleration in his second law. This law is so important that it became the basis for much of modern physics. In fact, Newton's contribution to science was so great that the unit for force, the newton (N), was named after him. A newton is defined as the force needed to produce an acceleration of 1 m/s² on a 1 kg object. Therefore, 1 N = 1 kg × 1 m/s². The equation for Newton's second law is given below.

EQUATION: Force = mass × acceleration

$$F = m \times a$$

If you know two of the values in this equation, you can calculate the third by changing the equation around, as follows:

$$\text{acceleration} = \frac{\text{Force}}{\text{mass}} \quad \textit{and} \quad \text{mass} = \frac{\text{Force}}{\text{acceleration}}$$

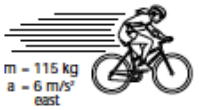
SAMPLE PROBLEM: A soccer ball accelerates at a rate of 22 m/s² forward when kicked by a player. The soccer ball has a mass of 0.5 kg. How much force was applied to the ball to produce this acceleration?

Force = mass × acceleration
Force = 0.5 kg × 22 m/s²
Force = 11 kg × m/s²
Force = **11 N**

Use the equations above to complete the following problems:

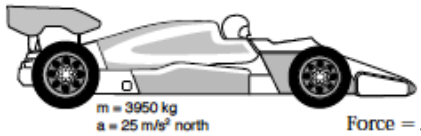
2. Calculate the force necessary to accelerate the following vehicles at the rate of acceleration shown in the illustration.

a.



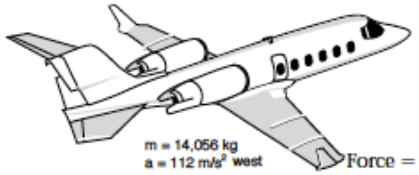
Force = _____

b.



Force = _____

c.



Force = _____

3. How much force is needed to move a 0.1 kg snowball at a rate of 15 m/s² upward?

4. A 0.02 N push accelerates a table-tennis ball along a table at 8 m/s² north. What is the mass of the ball?

5. At lift-off, an astronaut on the space shuttle experiences an acceleration of approximately 35 m/s² upward. What force does an 80 kg astronaut experience during this acceleration?

6. What is the acceleration of a train with a mass of 3.2×10^9 kg that pushes itself forward with 2.4×10^{10} N of force?

Part 3: The Force of Gravity

Forces are not always exerted on objects by direct physical contact, such as a hand pushing a door closed. For instance, the Earth exerts the force of gravity on objects even when the objects are not directly touching the ground. The acceleration on an object due to the force of gravity is 9.8 m/s² downward. In other words, for every second an object is falling, its velocity increases by 9.8 m/s downward.

7. a. A 9 kg bowling ball rolls off a table and strikes the ground. If the ball is in the air for 0.5 seconds, how fast is the ball moving when it hits the ground?

   b. Another bowling ball with one-fifth less mass rolls off the same table and strikes the ground. When this ball hits the ground, is it moving faster, slower, or the same speed as the first ball? Explain your answer.

Force and Newton's Laws

What is Newton's Second Law of Motion? Virtual Lab: (link on web page)

http://www.glencoe.com/sites/common_assets/science/virtual_labs/E25/E25.html

Force is a push or pull on an object. Net force is the difference between two opposing forces. Newton's second law of motion states that if a net force acts on an object, the object will accelerate in the direction of the force. Acceleration is a change in velocity. It can be either positive (speeding up) or negative (slowing down). If an object is not moving, the net force on it must be zero. A force that we all experience is gravity. A notebook sitting on a desk is being pulled down by the force of gravity. At the same time, it is being pushed up by the force of the desktop. The force of gravity is equal to the force of the desktop, so the net force on the notebook is zero. If an elbow pushes the notebook off the desk, the force of gravity is no longer balanced by the force of the desktop, and the notebook accelerates as it falls to the floor.

The formula for calculating a force on an object is:

F = ma F = force, m = mass, and a = acceleration

Mass is the amount of matter contained in an object**. Mass does not change with changes in gravity**. In the previous example, F refers to the force of gravity on the notebook, also known as its weight; m is the mass of the notebook; and a is the acceleration of the object caused by the force of gravity. The acceleration of any object falling to the surface of Earth is 9.8 meters per second per second, or 9.8 m/s2. This means that at the first second, the object will be falling with a speed of 9.8 m/s2. At 2 seconds, the object will be falling at the rate of 19.6 m/s2; at 3 seconds, it will be falling at the rate of 29.4 m/s2, and so on. If the mass of the notebook is 0.5 kg, and the acceleration is 9.8 m/s2, the force (weight) of the notebook can be calculated using the formula F = ma: F = 0.5 kg x 9.8 m/s2 = 4.9

The Newton (N) is the measurement used to describe an amount of force. In the example above, F = 4.9 N. Therefore, 4.9 kg.m/s2 = 4.9 N

In this Virtual Lab you will investigate the relationship between mass, acceleration, and force by experimenting with falling objects of various masses under a range of gravitational conditions. Objectives:

Relate Newton's second law of motion to the effect of gravity • on falling objects.

• **Determine the effect of mass on the acceleration rate of falling objects**.

• **Observe the effect of gravitational conditions** on the rate at which objects of identical mass fall. • Given mass and acceleration, **compute force.**

Procedure: Note: This activity assumes there are no atmospheric resistance, pressure, or temperature effects.

1. Click the arrow under Location 1 and select a planet to test. Click the arrow under Object 1 and select an object to test. Open the Table and record the gravitational rate of acceleration for this location and the mass of the object.

2. Select a second planet and object under Location 2 and Object 2. Open the Table and record the gravitational rate of acceleration for this location and the mass of the object.

3. Click the Drop button and observe the two objects as they fall. Click the Drop button again to see the objects fall again. The lines following a falling object indicate the object's relative position during each second of acceleration.
4. Using the mass and acceleration data displayed on the monitors, calculate the force (weight) of both objects. **Record your results in the Table Below**

Test	Location	Acceleration (m/s^2)	Object	Mass of Object (kg)	Weight of Object (N)
1					
2					
3					
4					
5					
6					

5. Repeat the above steps two more times with other objects and locations. Click the Reset button to clear the screen.
6. Complete the Journal questions.

Question 1: According to Newton's second law of motion, a net force on an object will cause it to accelerate. How does the Newton's law relate to the force of gravity?

_____
_____
_____

Question 2 : How does the force of gravity affect the rate of acceleration?

_____
_____
_____

Question 3 : Describe what happens when identical objects are dropped under different gravitational conditions.

_____
_____
_____

Question 4 : Describe what happens when objects of different mass are dropped under same gravitational conditions. _____

_____
_____
_____

Question 5 :What is weight? What is mass? How are mass and weight different? how does mass affect weight? _____

_____
_____

Watch these videos and then answer the questions below: (links on Webpg)
Newtons 1st law: http://www.unitedstreaming.com/videos/11278/sec11819_256k.asf
Newton's 2nd Law: http://www.unitedstreaming.com/videos/11278/sec11820_256k.asf
Newton's 3rd Law: http://www.unitedstreaming.com/videos/11278/sec11821_256k.asf

Newton's Laws Video Assignment: Use the 3 videos above to complete the 11 questions The 3 videos are a total of 5 minutes all together.

1. Summarize Newton's First Law._____

_____
_____

2. Explain three examples from the video that are used to illustrate the first law.

_____
_____
_____

3. Describe what is meant by the inertia of an object._____

_____
_____
_____

4. What is the difference between mass and weight? To which is inertia linked?

_____
_____
_____

5. Summarize Newton's Second Law. _____

_____

6. What is always true of the force and the acceleration described in the second law?

_____
_____
_____

7. What is the mathematical expression for the second law?

_____

8. Explain two examples from the video that are used to illustrate the second law.

_____
_____
_____

9. Summarize Newton's Third Law._____

_____

10. Explain three examples from the video that are used to illustrate the third law.

_____
_____
_____

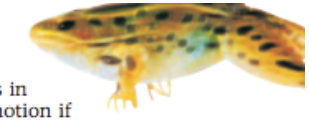
11. Newton's Third Law is applicable to construction. Explain the reasoning behind this statement. _____

Forces: Balanced or Unbalanced?

Calculate the net force for each. Remember to add forces in the same direction & subtract forces in the opposite direction. Please include units

	Force 1	Force 2	Net Force & Direction	Balanced or Unbalanced? B or U?
1	1 N east	1 N east		
2	10 N north	10 N south		
3	5 N left	4.3 N left		
4	36 N up	36 N down		
5	25 N right	25 N right		
6	46 N left	43 N right		
7	9.5 N down	9.5 N up		
8	23 N right	13 N right		
9	3.6 N left	2.5 N right		
10	14.5 N down	14.5 N up		

Chapter Review



USING VOCABULARY

To complete the following sentences, choose the correct term from each pair of terms listed below:

1. An object in motion tends to stay in motion because it has ___?___. *(inertia* or *terminal velocity)*
2. Falling objects stop accelerating at ___?___. *(free fall* or *terminal velocity)*
3. ___?___ is the path that a thrown object follows. *(Free fall* or *Projectile motion)*
4. A property of moving objects that depends on mass and velocity is ___?___. *(inertia* or *momentum)*
5. ___?___ only occurs when there is no air resistance. *(Momentum* or *Free fall)*

UNDERSTANDING CONCEPTS

Multiple Choice

6. A feather and a rock dropped at the same time from the same height would land at the same time when dropped by
   a. Galileo in Italy.
   b. Newton in England.
   c. an astronaut on the moon.
   d. an astronaut on the space shuttle.
7. When a soccer ball is kicked, the action and reaction forces do not cancel each other out because
   a. the force of the foot on the ball is bigger than the force of the ball on the foot.
   b. the forces act on two different objects.
   c. the forces act at different times.
   d. All of the above
8. An object is in projectile motion if
   a. it is thrown with a horizontal push.
   b. it is accelerated downward by gravity.
   c. it does not accelerate horizontally.
   d. All of the above
9. Newton's first law of motion applies
   a. to moving objects.
   b. to objects that are not moving.
   c. to objects that are accelerating.
   d. Both (a) and (b)
10. Acceleration of an object
    a. decreases as the mass of the object increases.
    b. increases as the force on the object increases.
    c. is in the same direction as the force on the object.
    d. All of the above
11. A golf ball and a bowling ball are moving at the same velocity. Which has more momentum?
    a. the golf ball, because it has less mass
    b. the bowling ball, because it has more mass
    c. They both have the same momentum because they have the same velocity.
    d. There is no way to know without additional information.

Short Answer

12. Explain how an orbit is formed.
13. Describe how gravity and air resistance combine when an object reaches terminal velocity.
14. Explain why friction can make observing Newton's first law of motion difficult.

Short Answer Space: _____

12._____

_____

_____

13._____

_____

_____

_14._____

_____

_____

_____pg10_____

WHICH LAW IS IT?
Match the question with the correct Newton's law.

Define:

Newton's 1st law: _____

_____

Newton's 2nd law:_____

_____

Newton's 3rd law:_____

_____

Which law is it:

_____ For every action, there is an equal & opposite reaction.

_____ In a balloon rocket, the air from the balloon pushes on the air & the air pushes the rocket up.

_____ When you are driving down the freeway, and the car suddenly stops, and your dog goes flying into forward.

_____A swimmer pushes water back with her arms, but her body moves forward.

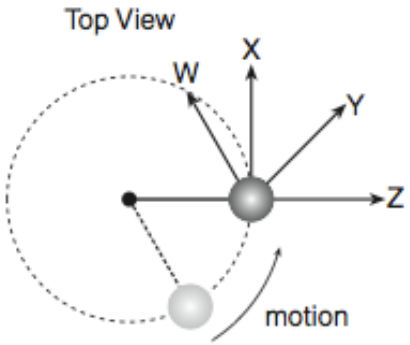
_____ A pitched baseball goes faster than one that is gently thrown.

_____ Force = mass x acceleration.

_____ An object at rest remains at rest, and an object in motion remains in motion at a constant velocity, unless an unbalanced force acts on it.

_____ This is also called the Law of Inertia.

Answer this questions:
A ball on a rope swings around a vertical pole. In which direction will the ball fly if released at the location shown? a. W b. X c. Y d. Z



Answer this question:

The picture shows the circular path of a toy plane being swung around on a string. What path would the toy take if the string broke? **Draw the direction**

Additional Note Space: (optional)