CHAPTER 2: NEWTON'S LAWS STUDY GUIDE

I. Newton's First Law

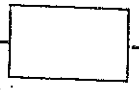
A. Objects in motion stay in motion, objects at rest stay at rest unless a force acts on it.

B. Also called the Law of Inertia.
   1. Inertia is the tendency of an object to resist changes in motion.
   2. The more mass an object has, the more inertia it has.
   3. Inertia is the reason why you can pull a tablecloth out from beneath objects and the objects still stay on the table.

C. In space, objects will not need any force to keep moving as there is no friction. So the net force on the object would be zero.

D. All the forces that are on an object can be added together to get the net force.
   1. If the two forces are equal and opposite, the object won't move and the net force is zero.
   2. If the two opposite forces aren't equal, you subtract them and that will tell in what direction and with how much force an object moves.
   3. *Write in the following examples.*

Ex. 1  net force = 0N

Ex. 2  net force = 75N Left

E. There are different kinds of forces.
   1. Friction—the force that opposes motion.
      a. There are two types of friction…starting and sliding.
         i. Starting friction is always more than sliding friction.
      b. Friction is caused by small bumps on the surfaces of two objects touching which causes the objects to get "hung up" on each other.
   2. Weight—the force of gravity on mass.
      a. Mass—how much "stuff" is in an object and doesn't change no matter where the object is.
      b. Weight can change depending on gravity.
      c. On Earth, the **acceleration due to gravity is 10 m/s^2**. Therefore, use this number in your equation of **F= ma** for the acceleration whenever you are finding or using weight in the problem.

3. Air resistance is another force. It is actually a form of friction as it is going against your motion (down...duh...as you're falling). When air resistance pulling up equals the force of gravity pulling you down, you stop accelerating but you still fall...just at the same speed. This speed is called terminal velocity.

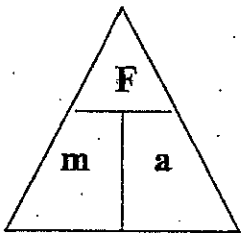
4. Normal force—the force that an object exerts upwards and cancels out the force of gravity (the weight).
   a. So, if a book weighs 3 N and is put on a table, the table has a normal force of 3 N.
   b. This is an example of Newton's third law, by the way.

II. Newton's Second Law

A. **F = ma**

1. **F**—force and measured in *newtons (N)*
2. **m**—mass and is measured in *kilograms (kg)*
3. **a**—acceleration and is measured in *meters per second squared (m/s^2)*
4. Therefore, accelerations are caused by unbalanced forces and a constant force would produce a constant acceleration. If the force doubles, the acceleration doubles!!

B. Use the triangle to solve for whatever missing letter you are looking for. Don't forget your units!! Here's the triangle and here is a special (difficult) problem for you to solve. Good luck!!



You pull on an object with a force of 40 N. There is 20 N of friction in the opposite direction. If the mass of the object is 5 kg, what is the acceleration?

$4 m/s^2$

III. Newton's Third Law

A. For every action, there is an equal and opposite reaction.

B. In other words, forces always occur in pairs. So when you catch a ball in a glove, the ball exerts a force on the glove but the glove also exerts a force on the ball.

IV. Finally, in regards to motion in two directions (tossing a ball in the air while you are riding in a car), *your forward motion does not affect the up and down motion of the ball.* Therefore, if the car is going 45 miles per hour, that means the ball is also going the same speed. Just because you throw it up in the air does NOT mean it stops going 45 miles per hour forward. This is the reason that it lands back in your hand and not in the seat behind you.

REVIEW OF NEWTONS THREE LAWS

1. Define Newton's First Law: "Law of Inertia"

2. The reason why objects slow down is because of friction. If there is no friction, then the object would never stop. So when something is fired into space, it will keep going forever because there is no friction.

3. Define Inertia. If you pull a tablecloth off a table quickly, the objects on the table will stay. Why?

   Stay the way they are

4. Inertia depends on the Mass of an object.

5. What is the difference between mass and weight?

   Stuff ↘ gravity

6. In order to determine weight on Earth, you have to multiply the mass by 10 (because of gravity). So, if an object has a mass of 20 kg, what would be its weight? 200N If an object has a weight of 30 N, what would be its mass? 3kg

7. Define friction. What is static friction? Kinetic friction? What is stronger, static or kinetic friction?

   Opposition to motion
   Over come to get object moving
   Over come to keep going

(p. 2)

8. What is a net force? What are balanced forces? If you pull with a force of 20 N to the east and your friend pulls with a force of 30 N also to the east, what is the net force? Suppose your friend pulls with a force of 30 N to the west?

50N East / 10 N west

9. Define Newton's Second Law.

10. According to Newton's Second Law, all accelerations are caused by:

Force push or pull

11. When something reaches its terminal velocity, what is its acceleration?

0

12. If the force on an object cuts in half, what happens to the acceleration?

1/2

13. Air resistance is a type of friction. So if an object has a weight of 10 N and it encounters an air resistance of 5 N, its net force is: 5 N If an object is traveling through space, it will keep going forever because of no friction.

14. Define Newton's Third Law:

15. According to Newton's Third Law, if your foot pushes on the Earth, then: Earth pushes back

16. Solve the following problems:
    a. A 10 kilogram object is moving at 1.5 m/s^2. What is the force of the object?

15 N

    b. A 30 kg object strikes with a force of 150 N. What was its acceleration?

5 m/s^2

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CP Test Review
Newton's Laws

Forces: Use the word bank to complete the following statements.

acceleration	subtract	balanced
air	gravity	sliding
support	net	friction
Inertia	equal	fluid
reaction	applied	pairs
unbalanced	static	

a. Objects always feel at least 2 forces because forces always act in pairs.

b. When two forces are acting in the same direction, we add the forces together. When two forces act in opposite directions, we subtract the forces.

c. Combining all the forces together gives us the applied net force.

d. If the net force is 0 (zero) then the forces are balanced.

e. If the net force is greater than 0, the forces are considered unbalanced. This causes changes in the velocity of the object.

e. Newton's 1st Law of Motion says that an object in motion wants to stay in motion, while an object at rest wants to stay ~~in motion~~ at rest. This is known as inertia.

f. Friction is the force that always exists when objects slide against one another.

g. It is harder to get a still object to start moving. During this time, you are pushing against static friction. Once the object is moving it is easier to push. During this time you are pushing against kinetic friction.

h. Newton's 2nd Law of Motion said that force equals mass multiplied by acceleration

i. Newton's 3rd Law states that for every action, there is an action and opposite reaction.

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j. Depending on the situation, there are many different types of forces:

- Any push or pull by a person or machine is known as an applied force.
- The downward force all objects feel from the Earth is gravity.
- The upward force from the ground, floor, or table that holds up the weight of an object is the Normal force.
- Any time you move through a liquid (swimming) or gas, the friction is known as fluid friction. Air resistance is one specific type of fluid friction.

Problems:

1. What force is needed to accelerate a car at a rate of 30 m/s^2 if the car has a mass of 4500 kg?

Unknown: F

Formula: $F = m \times a$

Plug & Chug: $4500 \times 30 = 135,000\ N$

2. What is the acceleration of a 10 kg book being pushed with 50 N of force?

Unknown: ACC.

Formula: $a = F/m$

Plug & Chug: $50/10 = 5\ m/s^2$

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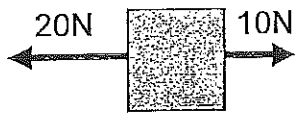
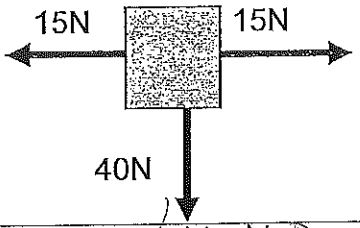
Units: Complete the table below. The first one is done for you.

	Measurement	...is measured in the unit...
a.	Distance	Meters (m)
b.	Force	Newtons (N)
c.	mass	kg
d.	acceleration	m/s^2
e.	Momentum	kg · m/s
f.	Speed/velocity	m/s
g.	Weight	Newtons

Free Body Diagrams: For each diagram or description below, determine the magnitude and direction of the net force.

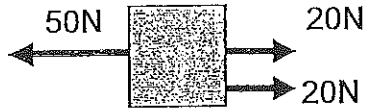


Net Force: 10N Left



Net Force: 40N Down

Net Force: 15N left



Net Force: 10N left

Fanny Friction is pushing with a force of 100 N to the right. The friction of the surface is 90 N.

Net Force: 10N Right

Skydiving Sally is falling to the Earth with a force of 300 N. The air resistance she feels is 300 N.

Net Force: 0N

Key

Force and Motion Review

Test Format

Modified True/False; Multiple Choice; Fill in the Blank; Problems; Free-Body Diagrams

Key Vocabulary Words

- Force
- Net force
- Balanced forces
- Unbalanced forces
- Friction
- Static friction
- Sliding/kinetic friction
- Rolling friction
- Fluid friction
- Gravity
- Air resistance
- Acceleration due to gravity
- Newton's 1st Law of Motion (aka Law of Inertia)
- Newton's 2nd Law of Motion
- Newton's 3rd Law of Motion

Applied Force

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3. What is the mass of a falling rock if it produces a force of 147 N?

Unknown: mass

Formula: $m = F/a$

Plug & Chug: $\frac{147}{9.8} = 15\ kg$

4. If a plane is moving at 3,000 m/s and has a momentum of 85,000 kg m/s, what is the mass?

Unknown: m

Formula: $m = F/a$

Plug & Chug: $85{,}000 / 3{,}000 = 28.3\ kg$

Identify the Law: Identify which of Newton's Laws is being described.

2 a. I can throw a ping pong twice as fast as a bowling ball.

1 b. When I start pulling on a sled, my dogs fall off the back.

2 c. I have to use twice the force to pick up an object with twice the mass.

3 d. A bird pushes his wings backwards in order to fly forwards.

1 e. If my car quickly comes to a stop, I feel pushed towards the windshield.

3 f. A rocket pushes gases out the back to move upward.

____ 18. Whenever a body is in motion, there is always ____ to oppose the motion.
a. friction
b. inertia
c. gravity
d. acceleration

____ 19. The upward force on an object falling through the air is ____.
a. air resistance
b. inertia
c. gravity
d. terminal velocity

____ 20. The relationship among force, mass, and acceleration is stated in ____.
a. the law of conservation of momentum
b. Newton's first law of motion
c. Newton's second law of motion
d. Newton's third law of motion

____ 21. A feather falls through the air more slowly than a brick because of ____.
a. gravity
b. air resistance
c. inertia
d. momentum

____ 22. According to Newton's second law of motion, ____.
a. $F = mv$
b. $F = m/a$
c. $a = F_{net}/m$
d. $F = ma$

____ 23. A 3,000-N force gives an object an acceleration of 15 m/s^2. The mass of the object is ____.
a. 45,000 kg
b. 1,500 kg
c. 200 kg
d. 15 kg

____ 24. A 300-N force acts on a 25-kg object. The acceleration of the object is ____.
a. 7,500 m/s^2
b. 300 m/s^2
c. 25 m/s^2
d. 12 m/s^2

____ 25. The statement "for every action, there is an equal but opposite reaction" is a statement of ____.
a. the law of conservation of momentum
b. Newton's first law
c. Newton's second law
d. Newton's third law

____ 26. With action-reaction forces, ____.
a. the action force is created first
b. the reaction force is created first
c. the forces are created at the same time
d. both forces already existed

____ 27. After a cannonball is fired into frictionless space, the amount of force needed to keep it going equals
a. the same amount of force with which it was fired
b. one half the force with which it was fired
c. zero, since no force is needed to keep it moving
d. twice the force with which it was fired