Dynamics

Forces and Newton's Laws

Forces – Dynamics

I. **Laws of Motion: 1 & 2**
   - inertia, force, mass
   - weight

II. Law 3
   - interaction & nature of force
   - types of force: normal, friction
   - air resistance, terminal velocity

III. Applications/Problem Solving
   - components, inclines

	The student will be able to:	HW:
1	State Newton's 1st and 2nd Laws of Motion and apply these laws to physical situations in order to determine what forces act on an object and to explain the object's resulting behavior.	1 – 5
2	Recognize and state the proper SI unit of force and give its equivalence in fundamental units and use the relation $\mathbf{F}_{net} = m\mathbf{a}$ to solve problems.	6 – 10
3	Recognize the difference between weight and mass and convert from one to the other.	11 – 18
4	State and utilize Newton's 3rd Law to solve related problems.	19 – 21
5	Understand and utilize the concept of the normal force to solve related problems.	22 – 25
6	Understand and utilize the relation between friction force, normal force, and coefficient of friction for both cases: static and kinetic.	26 – 32
7	State the factors that influence air resistance and describe qualitatively the effect of each factor on the magnitude of the frictional force. And explain what is meant by "terminal velocity".	33 – 35
8	Resolve forces into components using trigonometry and use the results to solve related force problems.	36 – 40
9	Apply the concept of force components to objects on an incline and solve related problems.	41 – 47

Pretest: True or False?

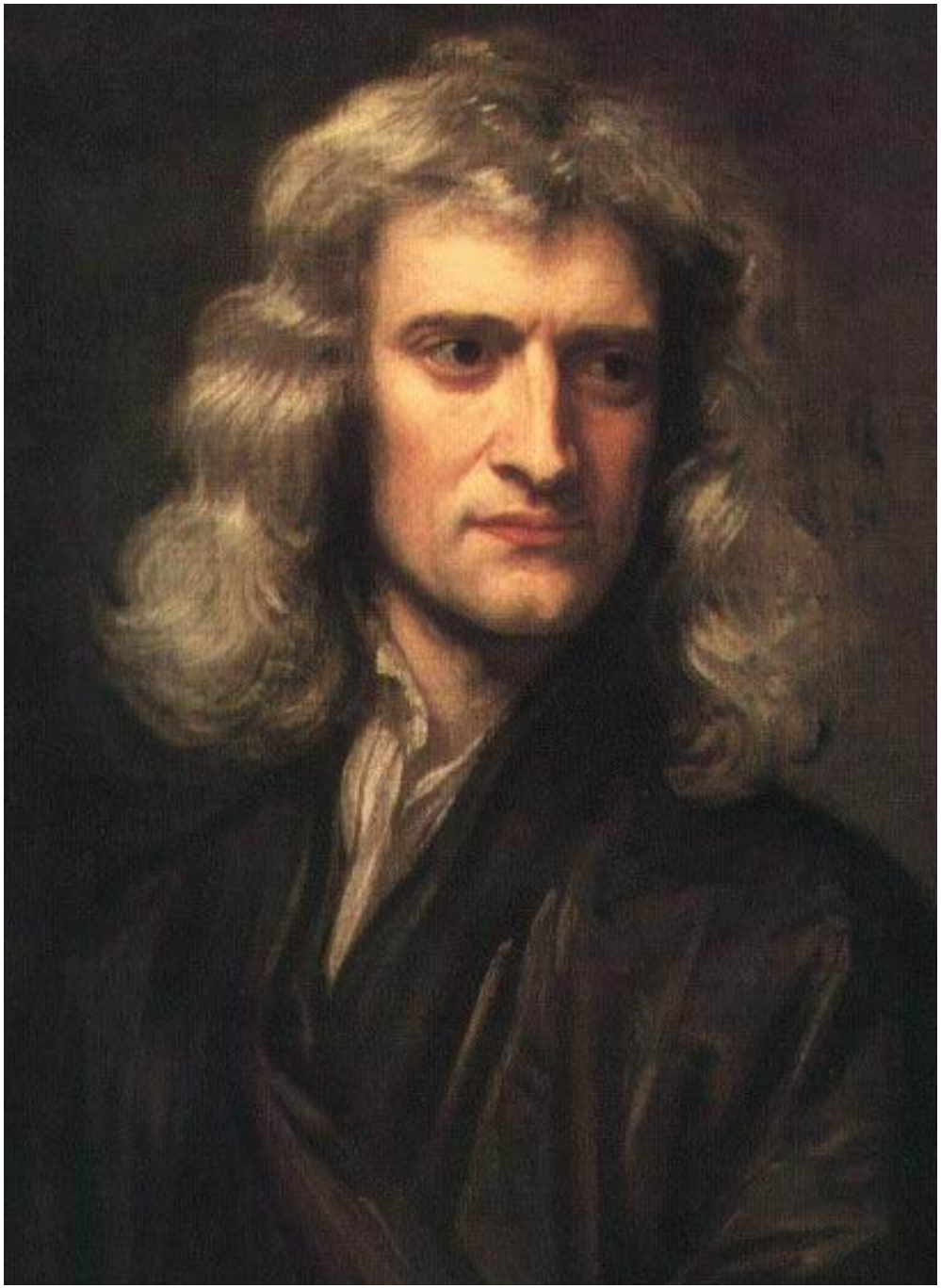
1. Force is necessary for movement.
2. The natural tendency of any object is to stop moving.
3. The force acting on an object is directly proportional to the speed of the object.
4. For every action there is an equal and opposite reaction.
5. The greater the speed of an object the greater its inertia.

Pretest: True or False?

1. Force is necessary for movement. **False**
2. The natural tendency of any object is to stop moving. **False**
3. The force acting on an object is directly proportional to the speed of the object. **False**
4. For every action there is an equal and opposite reaction. **True**
5. The greater the speed of an object the greater its inertia. **False**

What is "force"?

- A force may be thought of as a "push or pull" that can affect an object.
- Other synonyms for "force": thrust, shove, tension, compression, attraction, repulsion
- Examples of forces: gravity, friction, magnetism, electrostatic force, air resistance, bodies in contact, etc.
- Newton's Laws explain further . . .



Isaac Newton
(1643 – 1727 AD)

In 1687 Newton published the ***Philosophiæ Naturalis Principia Mathematica*** or simply "the ***Prinicipia***" in which he established **three laws of motion** and the law of universal gravitation.

This is the basis for classical physics!

Newton's 1st Law of Motion

If the net force on an object is zero the object continues in its initial state of rest or motion with a constant velocity.

This establishes the concept of *inertia*.

Inertia is the tendency of an object to maintain its state of motion.

Inertia is *not a force*, but rather a *property* of all matter. Force is not a requirement for motion!

Newton's 2nd Law of Motion

The effect of an applied force is to cause an object to accelerate in the direction of the force. The acceleration is directly proportional to the force and inversely proportional to the mass of the object.

$$\vec{F}_{net} = m\vec{a}$$

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The word "net" is extremely important! If there is more than one force acting on an object the net force is equal to the *vector sum* of all force acting on the object!

$$\vec{F}_{net} = \Sigma \vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \ldots$$

An object "responds" to anything and everything that "pushes" or "pulls" it.

$$\vec{F}_{net} = m\vec{a}$$

What is mass?

Mass is a measure of the quantity of matter within an object. (How many protons, neutrons, electrons, etc…)

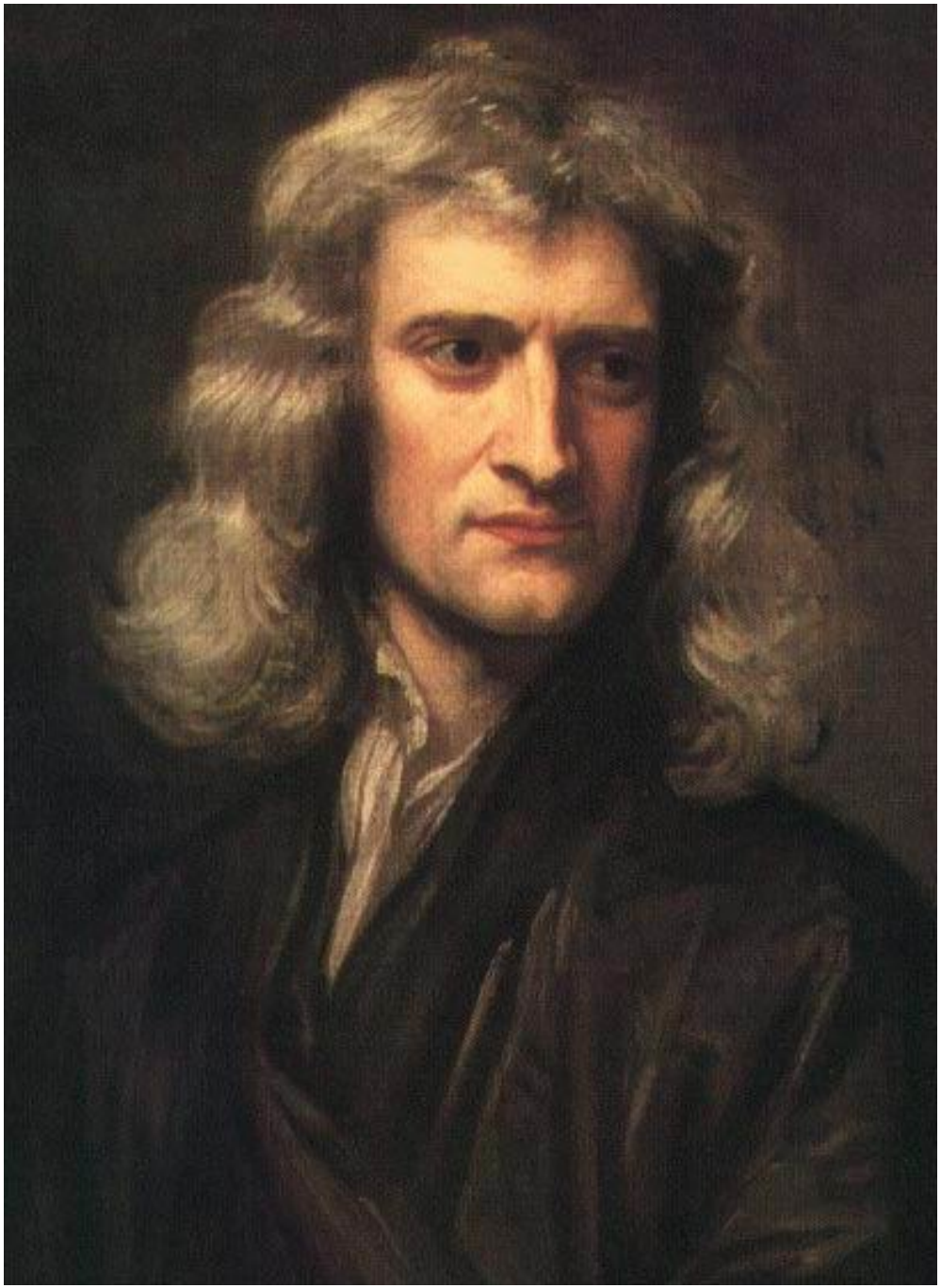
Mass is a measure of *inertia*! The more the mass of an object, the greater its tendency to maintain its state of motion (it *accelerates less*).

$$\vec{F}_{net} = m\vec{a}$$

Units of force:

The SI unit of force is the **newton**. One newton is the amount of force necessary to accelerate one kilogram at one meter per second per second.

$$N = kg \cdot \frac{m}{s^2}$$



Isaac Newton

“I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.”