

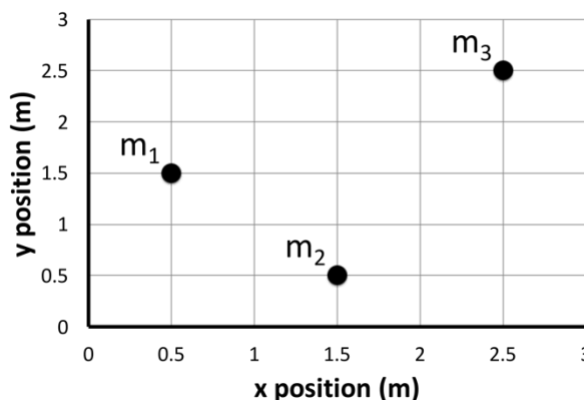


**BIG PICTURE IDEAS**

- #1) *Weight*: Weight is synonymous with (or the same as) the force of \_\_\_\_\_.
- #2) *The Force of Friction*: The two types of friction between two surfaces are \_\_\_\_\_ friction and \_\_\_\_\_ friction.
- #3) *Newton’s Three Laws*: Newton’s Three Laws are about the \_\_\_\_\_ of objects.
- #4) *Free Body Diagrams or Force Diagrams*: Free Body Diagrams show all the \_\_\_\_\_ which act on objects.

**Topic 2.1 – Systems and Center of Mass**

- 1) A collection of objects is called a \_\_\_\_\_.
- 2) Objects are treated as having no \_\_\_\_\_ structure.
- 3) A collection of particles in which the particles have little or no interaction are treated as an \_\_\_\_\_.
- 4) The center of mass of a system of particles can be found using the equation:
- 5) The displacement, velocity, and acceleration of a system all refer to the \_\_\_\_\_ of the system.
- 6) The y-position center of mass of this three-particle system where  $m_1 = 1$  kg,  $m_2 = 2$  kg, and  $m_3 = 3$  kg, is:



**Topic 2.2 – Forces and Free Body Diagrams**

- 1) All forces are \_\_\_\_\_, not scalars. That means all forces have both \_\_\_\_\_ and \_\_\_\_\_.
- 2) All forces are the result of an \_\_\_\_\_ between two \_\_\_\_\_.
- 3) An object \_\_\_\_\_ exert a force on itself.
- 4) Free Body Diagrams show all the forces acting on an object. Examples of vectors which are never in free body diagrams are \_\_\_\_\_.
- 5) All the forces drawn in a free body diagram start at the \_\_\_\_\_ of the object or system.

### Topic 2.2 – Forces and Free Body Diagrams (continued)

- 6) Five steps to help solve any free body diagram problem are:
  - a) Draw the \_\_\_\_\_.
  - b) Break forces into \_\_\_\_\_.
  - c) \_\_\_\_\_ the free body diagram.
  - d) \_\_\_\_\_.
  - e) Sum the forces in a \_\_\_\_\_.
- 7) On the AP Physics Exam, we should \_\_\_\_\_ break forces into \_\_\_\_\_ in our initial free body diagram.
- 8) The force normal caused by a surface is always \_\_\_\_\_ to the surface and \_\_\_\_\_ from that surface.

### Topic 2.3 – Newton's Third Law

- 1) Newton's Third Law states that for every force object \_\_\_\_\_ exerts on object \_\_\_\_\_, object \_\_\_\_\_ exerts an \_\_\_\_\_ but \_\_\_\_\_ force on object \_\_\_\_\_.
- 2) The equation form of Newton's Third Law is:
- 3) Forces internal to a system \_\_\_\_\_ change the motion of the center of mass of the system.
- 4) When looking at the force of tension in a rope, string, cable, chain, or something similar:
  - a) If the rope is ideal, it has \_\_\_\_\_ mass and \_\_\_\_\_ stretch.
  - b) The magnitude of the force of tension in an ideal rope is \_\_\_\_\_ at all points in the rope.
  - c) If the rope does not have \_\_\_\_\_ mass, the force of tension may not be the same at all points in the rope.
  - d) The force of tension is always \_\_\_\_\_ to the direction of the rope, wire, string, or cable.
- 5) An ideal pulley has \_\_\_\_\_ mass and rotates around its center of mass with \_\_\_\_\_ friction.

### Topic 2.4 – Newton's First Law

- 1) Newton's First Law, which is also called the Law of \_\_\_\_\_ states that ... An object at \_\_\_\_\_ will remain at \_\_\_\_\_ and an object in \_\_\_\_\_ will remain \_\_\_\_\_ unless acted upon by a \_\_\_\_\_ force.
- 2) Newton's First Law can only be verified from \_\_\_\_\_ reference frame.
  - a) The acceleration of an inertial reference frame is \_\_\_\_\_.



### Topic 2.5 – Newton's Second Law

- 1) Newton's Second Law is an equation. That equation is \_\_\_\_\_.
- 2) The units for force are \_\_\_\_\_ which, in base S.I. units are \_\_\_\_\_.
  - a) A simple way to remember this is using Newton's \_\_\_\_\_ Law.
- 3) When using Newton's Second Law we always have to identify the \_\_\_\_\_ on which we are summing the forces and the \_\_\_\_\_ in which we are summing the forces.
- 4) An object in \_\_\_\_\_ has zero net force acting on it. Due to Newton's Second Law, this means the \_\_\_\_\_ of the object is zero; therefore, the object is either at \_\_\_\_\_ or moving with a \_\_\_\_\_.
- 5) The phrase "unbalanced forces" refers to a situation where the net force exerted on a system is \_\_\_\_\_ to zero.
- 6) The \_\_\_\_\_ of an object is always in the same direction as the net force on the object.
- 7) If an object is accelerating, the net force acting on the object cannot be \_\_\_\_\_.
- 8) If an object is at rest, there \_\_\_\_\_ be forces acting on the object from other objects, however, the \_\_\_\_\_ force acting on the object is \_\_\_\_\_.

### Topic 2.6a – Gravitational Force

- 1) The interaction between an object with \_\_\_\_\_ and another object with \_\_\_\_\_ is described by the gravitational force.\*
  - a) To be clear, because all forces are \_\_\_\_\_ between \_\_\_\_\_ objects, the gravitational force is always between \_\_\_\_\_ objects.
- 2) The magnitude of the gravitational force exerted on a mass in a gravitational field is determined using the equation: \_\_\_\_\_.
- 3) The gravitational force exerted on a mass in a gravitational field is in the \_\_\_\_\_ direction as the gravitational field.
- 4) The magnitude of the gravitational field is determined by taking the \_\_\_\_\_ of the object and dividing it by its \_\_\_\_\_.
  - a) Gravitational field is defined in unit 2b.
- 5) The direction of the force of gravity acting on the object is always towards the \_\_\_\_\_ of the planet or \_\_\_\_\_.
- 6) \_\_\_\_\_ are the result of the interaction of one object touching another object and result from electric forces between the \_\_\_\_\_ of the objects.

\* The terms "gravitational force" and "force of gravity" mean the same thing.

### Topic 2.6a – Gravitational Force (continued)

- a) Five examples of contact forces are \_\_\_\_\_.
- 7) Inertial mass is the measure of an object's \_\_\_\_\_ or a measure of its resistance to \_\_\_\_\_.
  - a) Inertial mass is the mass in Newton's \_\_\_\_\_ Law which is:
- 8) Gravitational mass is the mass used to determine the \_\_\_\_\_, of an object.
  - a) Gravitational mass is the mass in the \_\_\_\_\_ force equation which is:
- 9) Inertial mass and gravitational mass are \_\_\_\_\_ equivalent. This has been \_\_\_\_\_ verified.

### Topic 2.7 – Kinetic and Static Friction

- 1) The direction of the force of friction always \_\_\_\_\_ to the surface, always opposes \_\_\_\_\_, and is \_\_\_\_\_ of the direction of the force applied.
- 2) The equation for the force of kinetic friction is \_\_\_\_\_.
- 3) The equation for the force of static friction is \_\_\_\_\_.
- 4) The maximum force of static friction which would prevent an object from sliding on a surface is \_\_\_\_\_.
- 5) For two surfaces, the coefficient of \_\_\_\_\_ friction is almost always less than the coefficient of \_\_\_\_\_ friction.
- 6) The force of friction \_\_\_\_\_ depend on the size of the surface area of contact between the two surfaces.
- 7) Before summing the forces on an object on an incline, typically we will break the force of gravity into its components into directions which are \_\_\_\_\_ and \_\_\_\_\_ to the incline.
- 8) The force of gravity perpendicular to an incline equals mass times acceleration due to gravity times the \_\_\_\_\_ of the incline angle.
- 9) The force of gravity parallel to an incline equals mass times acceleration due to gravity times the \_\_\_\_\_ of the incline angle.
  - a) The force of gravity parallel to an incline is always directed \_\_\_\_\_ the incline.

Topic 2.7 – Kinetic and Static Friction (continued) 

- 10) The very large block on the incline shown to the right is being lowered down the incline at a constant velocity by the person. The person is pushing on the block, up and parallel to the incline. On the center of mass of the block, draw and label all the forces acting on the block with proportionally correct vector lengths.  
(In other words, make sure the force vector lengths are correct relative to one another.)

