Lab: AP Review Sheets Kayla Chu

Laws of Motion

Background:

The Laws of Motion entail *Newton's Three Laws of Motion.* Additionally, we will cover *free-body diagrams, inclined planes, and pulley*s.

Important Terms to Know:

- *Force*: push or pull on an object; vector quantity; Newtons
  - $F_{net} = ma$
- *Mass*: measure of amount of inertia a body has; measure of how hard it is to change an object's motion; kilograms
- *Weight*: measure of how strongly earth's gravity pulls on a mass; measure of Force
  - $W = mg$

Newton's First Law of Motion:

Law of Inertia: "Every body continues its state of rest or uniform speed in a straight line, unless it is compelled to change that state by a net force acting on it."

Newton's Third Law of Motion:

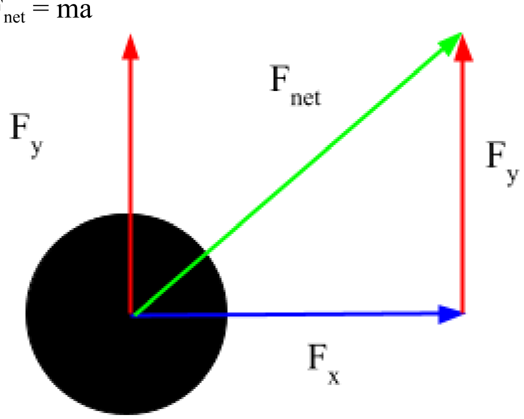
"Whenever one object exerts a force on a second object, the second object exerts a force (equal in magnitude, in the opposite direction) back on the first."

- *Force Pairs*: A force pair is the two forces that occur when two objects interact

Newton's Second Law of Motion:

Describes what happens when a net (resultant) Force is applied to a mass

$F_{net} = ma$



In this situation, we can use the pythagorean theorem to solve for F_{net}:

$$F_{net} = \sqrt{F_x^2 + F_y^2}$$

Free Body Diagrams:

1. Draw an arrow so that it points in the direction of the force applied.
2. Draw the arrow so that its base is located at the point where the force is applied.
3. Draw the arrow with a length that represents the relative magnitude of the force.

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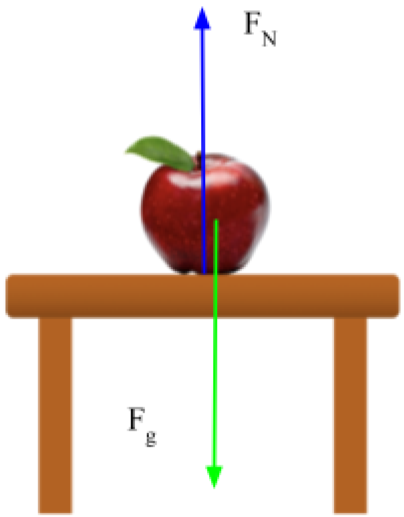
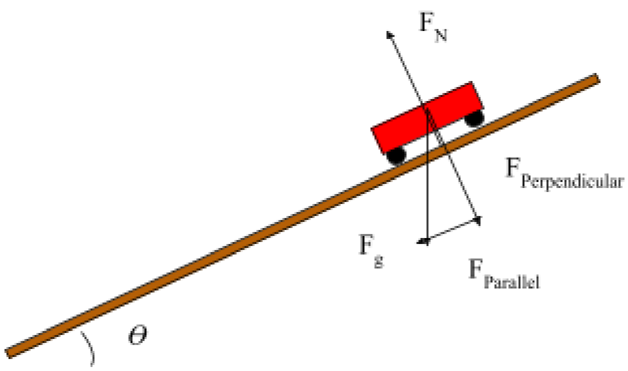


The Normal Force: "Normal" means perpendicular to the plane of the surface

Inclined Planes:



In this situation, you would tilt your axes (tilt axes based on acceleration)

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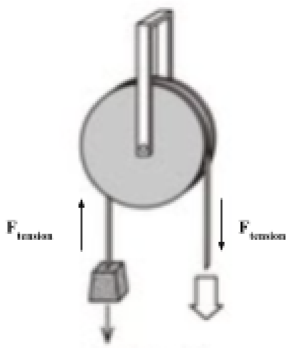
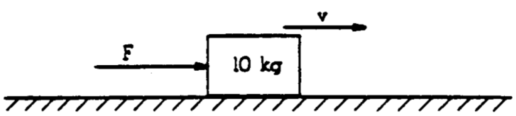
Pulleys:

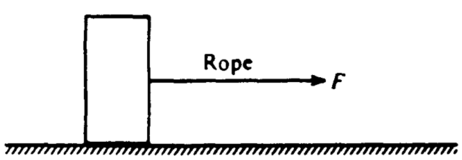


The pulley is an "ideal" pulley, meaning that it is "massless and frictionless"

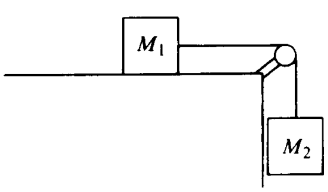
Problems:



1. A 10-kilogram block is pushed along a rough horizontal surface by a constant horizontal force F as shown above. At time t = 0, the velocity v of the block is 6.0 meters per second in the same direction as the force. The coefficient of sliding friction is 0.2. Assume g = 10 meters per second squared.
    a. Calculate the force F necessary to keep the velocity constant.



2. A box of uniform density weighing 100 newtons moves in a straight line with constant speed along a horizontal surface. The coefficient of sliding friction is 0.4 and a rope exerts a force F in the direction of motion as shown above.
    a. Draw and identify all the forces on the box.



3. In the system shown above, the block of mass M_1 is on a rough horizontal table. The string that attaches it to the block of mass M_2 passes over a frictionless pulley of negligible mass. The coefficient of kinetic friction μ_k between M_1 and the table is less than the coefficient of static friction μ_s.
    a. Draw and identify all the forces acting on the block of mass M_1.

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Answers:

1. You need to know friction to solve this equation; constant velocity means acceleration = 0:

$F_{net} = 0,$

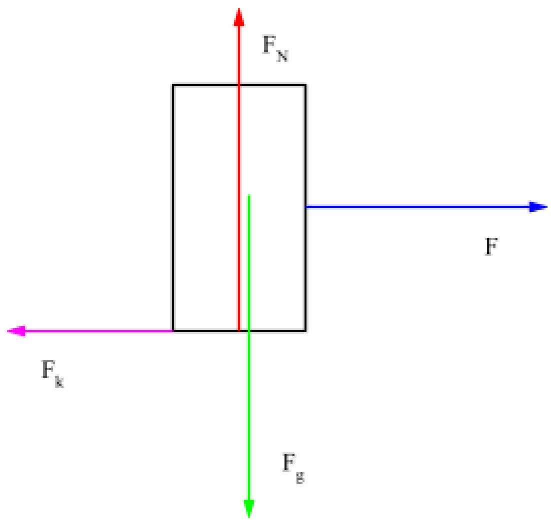
$F - F_K = ma$

$F - \mu_K mg = 0$

$F = (0.2)(10\ kg)(9.8 \frac{m}{s^2})$

$F = 19.6\ N$

2.



3.