07: Force and Motion

Key Physics Terms

- **Vector:** A quantity that represents magnitude (size) and direction. It is usually represented with an arrow to indicate the appropriate direction. They may or may not be drawn to scale.
- **Resultant:** The result of adding two or more vectors; vector sum.
- **Vector Component**: The parts into which a vector can be separated and that act in different directions from the vector.
- **Vector Addition**: The process of combining vectors; added tip to tail.
- **Friction Force:** A force that acts to resist motion of objects that are in contact.
- **Normal Force**: Support force that acts perpendicular to a surface. If the surface is horizontal, this force balances the weight of the object.
- **Force**: A vector quantity that tends to accelerate an object; a push or a pull.
- **Net Force, F_{net}**: : A combination of all the forces that act on an object.
- **Mass:** The amont of matter in an object. this quantity is independent of location. Usually measured in kilograms.
- **Weight:** The force acting upon an object due to gravity. This quantity is dependent of location on Earth, usually measured in Newtons.

Key Formulas

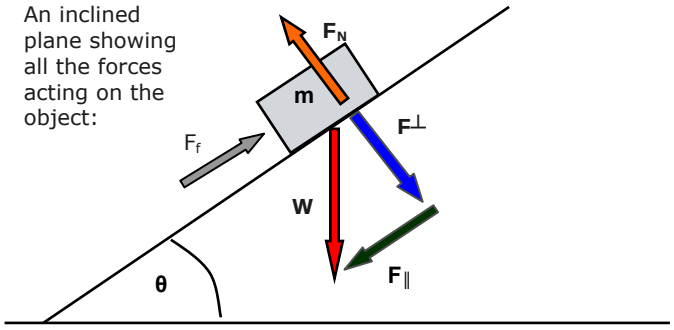
- $v=d/t$
- $a = \Delta v/\Delta t=(v_f-v_i)/t$
- $d=v_it+at^2/2$
- $v_f^2=v_i^2+2ad$
- acceleration due to gravity = -9.8 m/s^2
- Pythagorean Theorem: $c^2=a^2+b^2$
- Sin θ = opp/hyp
- Cos θ = adj/hyp
- Tan θ = opp/adj
- $F_{net}=ma$
- $\mu=F_f/F_N$
- $F_{net}=\Sigma F$ = the sum of all forces

Variables Used

- v= velocity (usually average velocity or constant velocity)
- a=acceleration
- F= force
- F_f=frictional force
- F_N=normal force
- Δ= change in
- θ= angle
- m=mass
- μ=coefficient of friction

Vector Diagram

An inclined plane showing all the forces acting on the object:



Typical Key Metric Units

- Acceleration: m/s^2, m/s/s
- Time: seconds, s
- Force: Newtons, N
- Mass: kilograms, kg
- Coefficient of friction: no units

Newton's Laws

- Newton's 1st law : An object at rest wants to stay at rest, an object in motion tends to stay in motion; inertia.
- Newton's 2nd law : $F_{net}=ma$.
- Newton's 3rd law: For every force that is an equal and opposite force; action and reaction.

Newton's Laws Problem Solving Tips

- These tips will make it easier to solve any force related physics problems.
- Thoroughly read the entire problem.
- Draw a diagram if needed. Include a diagram to show all forces acting on a particular body.
- Identify all given information.
- Identify the quantity to be found.
- Select appropriate formula(s) that incorporate what you know and what you want to find.
- Convert units if needed. Use units throughout your calculations.
- Do any mathematical calculations carefully.

Typical Dynamics Problem

Example: A model rocket of mass 3 kg has an engine that produces 100N of upward thrust/force. What is the resulting acceleration of the model rocket when it is fired. Assume its mass is constant throughout its motion. Ignore any frictional forces.

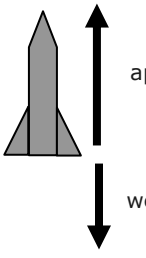
Given information:
Mass = 3 kg
Upward force = 100N

Unknown:
acceleration= ?
F_{net}= ?

First, find the weight of the rocket:
Although the mass is known, that isn't the same as its weight.
Using F=ma Weight = 3kg ($-9.8 m/s^2$)=-29.4N

Second, find the net force on the rocket:
Our upward force is considered positive, the weight negative.
$F_{net}=\Sigma F$ =100N-29.4N=70.6N

Lastly, solve for the acceleration:
Use $F_{net}=ma$ 70.6N=3kg(a) $a=23.5 m/s^2$



F_{net}=applied force - weight

How to Use This Cheat Sheet: These are the keys related this topic. Try to read through it carefully twice then recite it out on a blank sheet of paper. Review it again before the exams.