

Natural Science 100

NS100 Introduction

- CHANGE OF INSTRUCTOR
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NS100 Introduction

- The NS100 website is:

sci.sdsu.edu/classes/natsci/ns100/ferguson

- The website has:
 - Syllabus & Schedule
 - Homework Assignments
 - Lecture Notes
 - Sample Exams

NS100 Schedule

- We will cover:
 - Chapters 1-5: Physics
 - Chapters 27-30: Earth Science
 - Chapters 31-32: Weather
 - Chapters 33-34: Astronomy
- Text is: Conceptual Physical Science
by Hewitt, Suchocki, and Hewitt

NS100 Administrative

- 4 Midterms/lowest score dropped

- 13 Homework Sets/lowest dropped
- 1 Final
- Total Points:

– 3 midterms	300
– 12 homework sets	60
– Final	<u>100</u>
Totals	460

NS100 Grading

- Grading is based on the percent of possible points at the end of the semester
- A 80-100%
- B 70-79%
- C 56-69%
- D 50-55%
- F <50%

What is Science?

- Science is a collection of observations of and explanations for natural phenomena
- Religion offers an alternate explanation for natural phenomena
- The basic rules for science were set in the 17th century to keep scientists from being killed by the religious authorities

The Rules of Science

- Science only deals with measurable phenomena
- Any scientific theory (explanation) must predict measurable phenomena
- A theory must be replaced if another theory makes better predictions
- General theories that stand for a century or more are usually called laws

Chapter 1: Motion

- The Law of Inertia
- Forces & Equilibrium
- Friction

- Speed & Acceleration

1.1. Aristotle on Motion

- Greek math was excellent
- Greek science was poor
- Aristotle believed that there were four basic substances on earth:
Earth, Fire, Water, Air
- Natural Motion
- Violent Motion
- Heavenly Motion

1.2. Galileo's Concept of Inertia

- Galileo was a famous Italian scientist
 - Aristotle asserted that heavier objects fall faster than light ones
 - Galileo discovered that all bodies fall at the same rate
 - He discovered that the Laws of Nature were simple
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- When complicating factors are eliminated, the rules of nature are simple
 - Galileo figured out a lot about motion, but his basic concept was that of inertia
 - Inertia is the property of matter that resists changes in its motion
 - Another way to state the idea of inertia is that an object in motion tends to continue at the same speed and in the same direction unless acted upon by an outside force

1.3. Mass - A Measure of Inertia

- The quantity of matter in an object is called its mass
- The mass is also the amount of inertia in an object
- The weight of an object is the force on an object due to gravity
- An object always has mass; it only has weight when "near" a massive body like a planet

- Weight and mass are often confused since we can't easily get away from the earth to see how objects behave when they have mass but no weight
- The MKS or SI system of units is used in science
- Mass is in kilograms
- The weight of a kilogram is about 9.8 Newtons

1.4. Net Force

- Forces are produced by many causes
- The simplest are pushes and pulls
- A single force on an object produces motion
- Forces can be added together to get a resultant force or a net force

- When the sum of all the forces cancels, there is no net force and no change in the motion
- Forces have both direction and magnitude
- When a quantity depends both on direction and on magnitude, it is called a vector
- The net force is zero when the vector sum of the forces cancels

1.5. The Equilibrium Rule

- Why does an eraser fall?
- Its fall is due to the force of gravity pulling it down toward the earth's center
- Why doesn't it fall when I hold it?
- When I put it on the table?
- Such situations when balanced forces are applied are cases of static or mechanical equilibrium
- $\Sigma F = 0$

1.6. Support Force

- Is an eraser on a table in static (mechanical) equilibrium?
- Where is the support force?
- The support force when two surfaces touch is called the normal force
- Contact forces come in pairs
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1.7. Equilibrium of Moving Things

- Any object is in equilibrium if all the forces on it cancel to zero net force
- A moving object can be in equilibrium if its motion doesn't change
- In this case an unchanging motion would be no change in speed or direction
- We call the combination of speed and direction velocity

- If there is no net force, there is no change in velocity
- So an object in motion can still be in equilibrium if it moves with a constant velocity
- An object in equilibrium with a pull force on it must have a counter force

1.8. The Force of Friction

- This counter force is called friction
- Friction tends to oppose motion across a surface
- Air resistance and viscosity are other forms of friction
- Surface friction arises from (sometimes) microscopic irregularities in surfaces
- Friction on surfaces is usually some fraction of the force that holds the surfaces together

1.9. Speed and Velocity

- Speed refers to the rate of change of distance with time

- The average speed is $v = \Delta d / \Delta t$
- The speed at an instant is called the instantaneous speed
- Instantaneous speed is hard to determine
- This difficulty in calculating the instantaneous speed was precisely what separated ancient from modern mathematics
- The problem was solved by Isaac Newton in 1667 and he called the method calculus
- Velocity is a combination of speed and direction
- Even if the speed of an object is held constant, the velocity changes if the direction changes
- Motion is relative
- There is no real way to define motion in an absolute sense
- The idea that all motion is relative was developed by Galileo
- Einstein's Principle of Relativity is based on this

1.10. Acceleration

- Acceleration is the rate of change of speed with time
- When a car speeds up or slows down, it is accelerating either positively or negatively, respectively
- A falling object (ignoring air resistance) accelerates downward at a constant rate: 9.8 m/s^2 or 32.2 ft/s^2

Falling In Vacuum

Falling At g

- This means at a falling object's speed toward the ground increases by

- 9.8 m/s for every second it is in free fall
- But it also means that an object thrown upward will gradually lose 9.8 m/s of upward speed for every second in the air until its upward speed drops to zero and it begins to fall
 - Since its fall also changes by 9.8 m/s per second of free fall downward, we can suspect that the two are related
 - The acceleration during the rise and fall is the same, a change of 9.8 m/s downward for every second in the air
 - Thus, the effect of the constant, unbalanced force of gravity is a constant acceleration directed downward
 - We will find that a constant acceleration is a result of a constant unbalanced force

Falling Odd Distances

- Note that acceleration, like velocity, is a vector with a magnitude and a direction
- There are no separate words for the magnitude and direction of the acceleration vector
- $d = gt^2/2$