Calculus-Based Physics-1: Mechanics (PHYS150-01): Week 4

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September 25th - September 29th, 2017

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WEEK 3 REVIEW

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1. Displacement, velocity and acceleration vectors as functions of time
    - Breaking into components
    - Derivatives of components
2. Combining free-fall and vector components: projectile motion
    - The independence of velocity components
    - **Lab-activity: testing component independence**
3. Relative motion and reference frames
    - Relative motion in one-dimension
    - Relative motion in two-dimensions

WEEK 3 REVIEW PROBLEMS

A pilot is performing an airdrop maneuver, in which he must release a package of supplies to land on a beach. The plane is traveling towards the beach at a speed of 100 kilometers per hour, with an altitude of 500 meters. How far offshore must the pilot release the supplies such that the package lands on the sandy beach and not in the water?

- A: 280 m
- B: 410 m
- C: 100 m
- D: 170 m

Suppose the pilot is flying straight, adjusting for a cross-wind of 3 m/s. How far to the side of the flight path of the plane does the package land, assuming the package is released 280 m from the shore?

- A: 10.1 seconds
- B: 5.4 seconds
- C: 3.2 seconds
- D: 1.1 seconds

WEEK 4 SUMMARY

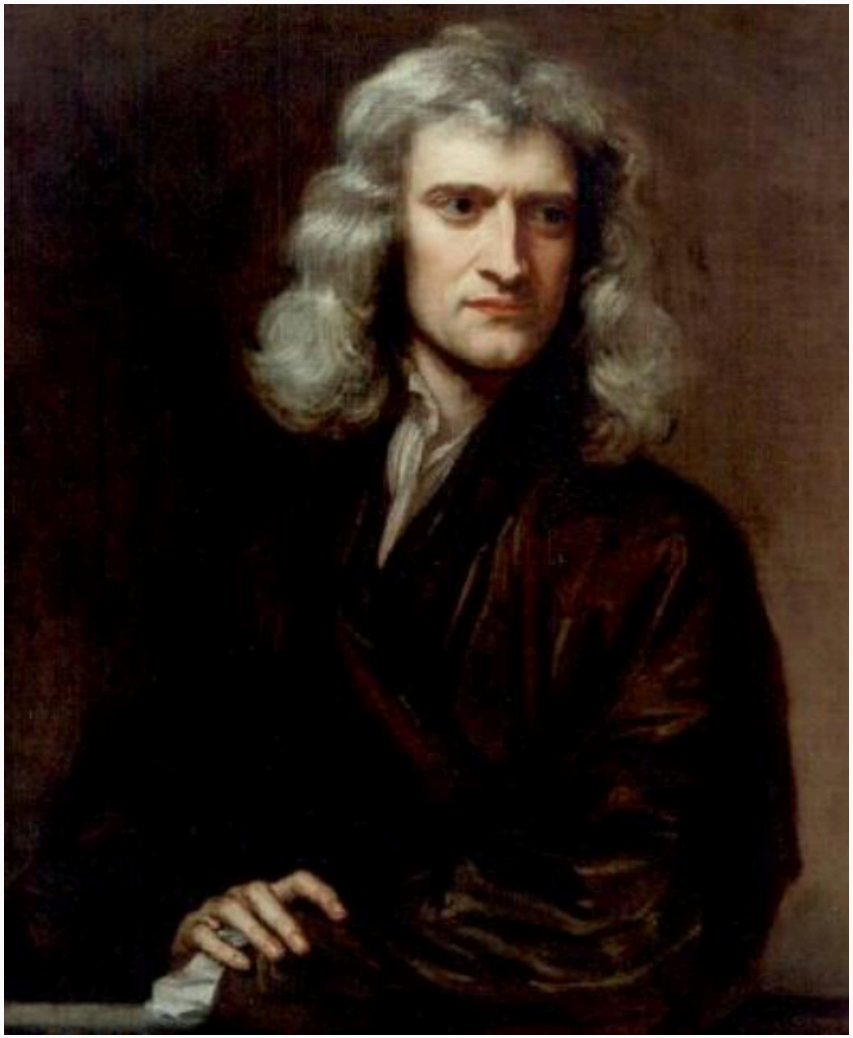

Figure 1: A portrait of Sir Isaac Newton.

WEEK 4 SUMMARY

1. Deep statements about physics: *dynamics* and *kinematics*
    - **Lab activity**: Force, mass and stretching springs
2. Newton's First Law
3. Newton's Second Law
4. Newton's Third Law
5. Applications
    - Free-body diagrams
    - Tension
    - Inclined surfaces
    - Restoring forces

DEEP STATEMENTS ABOUT PHYSICS: DYNAMICS AND KINEMATICS

Kinematics - A description of the motion of particles and systems
Dynamics - An explanation of the motion of particles and systems

What causes an object to move? **Forces**. Forces exist as a result of the **interactions** of objects or systems.

Evolution - A description of the change of biological species
Natural Selection - An explanation of change in biological species

What causes species to evolve? **Natural selection**. Natural selection exists because of election pressures, numerous offspring, and variation among offspring.

What is a force, in practice?

A force has units of *Newtons*, just like distance has units of *meters*. One Newton is the force required to make an object of mass 1 kilogram accelerate by 1 m/s^2.

A force must also be a *vector*: if a force acts on a system in a certain direction, the object will accelerate in that direction.

Force has to be related to mass in some way.

WHAT IS A FORCE, IN PRACTICE?

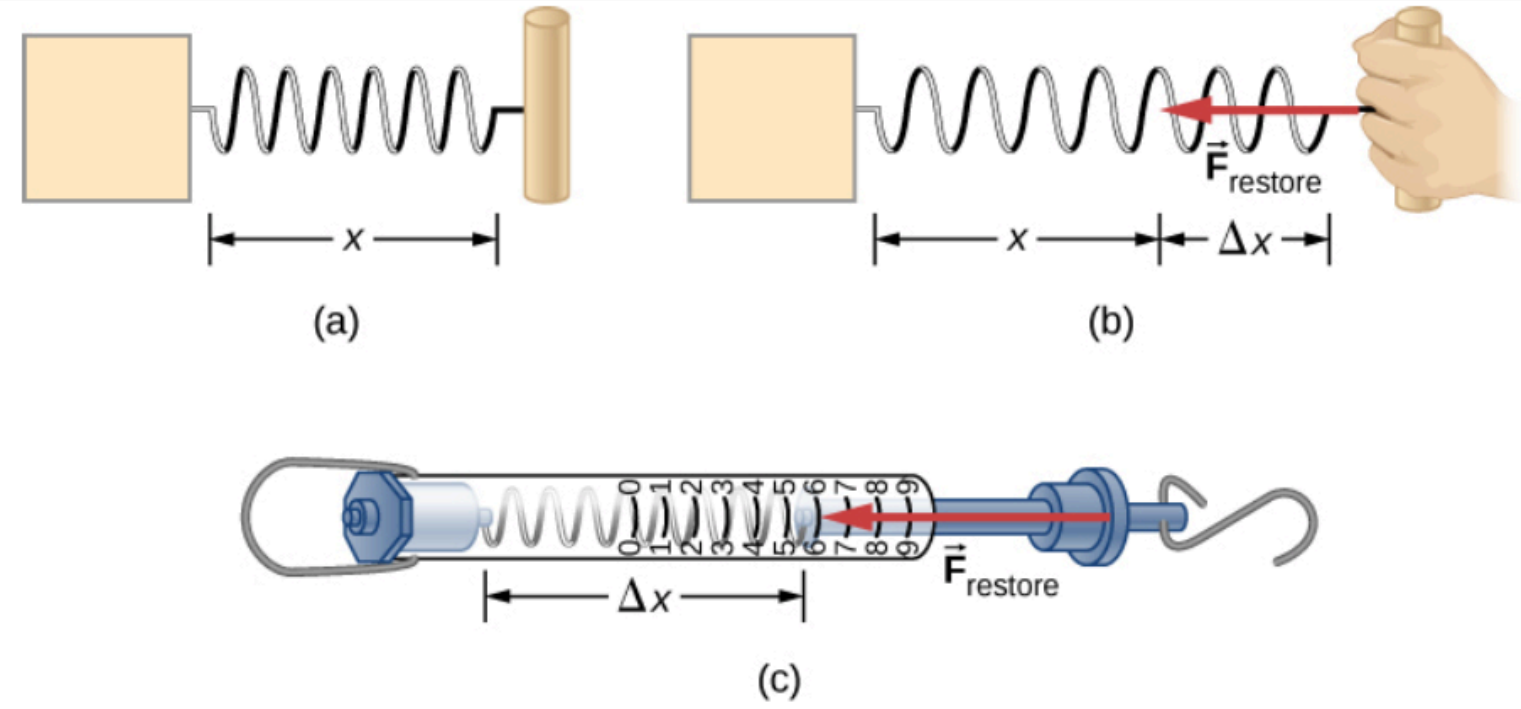

Figure 2: (a) No interaction is stretching the spring. (b) An interaction stretches the spring a distance Δx, and the spring pulls back. (c) A device that can compare forces by comparing Δx for different interactions (connecting to different weights, for example).

What is a force, in practice?

Lab activity: Force, mass, and stretched springs.

1. Obtain a set of weights, a force-meter (spring), and a ruler.
2. Hang a weight from the spring, and measure the extra distance the spring stretches.
3. Repeat with different weights, recording the stretched distances alongside the weights.
4. Compute the ratio of the mass of the weight to the stretched distance in each case. What is the result?

WHAT IS A FORCE, IN PRACTICE?

Thus, if a force causes *a system with some mass* to accelerate, the force must be *proportional to that mass*. "If it is heavier, we mush push it harder, to obtain the same acceleration."

Now, let's consider all the systems for which we have described the *kinematics*, where we made no use of the concept of a force...

Newton's First Law

Newton's First Law

Newton's First Law

A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless acted on by a net external force.

Newton's First Law

For most people in the late 15th and early 16th centuries, Newton's First Law was not intuitive. "When have you ever seen a thing move perpetually?"

The key is the last phrase: "*...unless acted on by a net external force.*" Nothing moves unless forced, and if the net force is zero, the velocity does not change. Thus, if some object has a constant velocity, then it remains at that velocity unless some force (friction, air-resistance, gravity, a wall) interrupts.

`https://openstaxcollege.org/l/21forcemotion`

CONCLUSION

ANSWERS

ANSWERS

- 280 m
- 10.1 seconds