

Dynamics 4 Notes

Did You Know?

Relationship between force and motion: If external objects exert an unbalanced force on the system object of interest, its motion changes so that the Δv arrow in a motion diagram describing the motion of this object is in the same direction as the unbalanced force exerted on the object.

Need Some Help?

An **Explanation** is a general belief, pattern, model, or rule developed from observations. Explanations can be used to develop predictions.

A **Prediction** is a statement that describes the outcome of a specific experiment (prior to conducting the experiment). Predictions must be based on the explanation being tested.

We can use our explanation and prediction to write a **H-D statement**, which uses the logic of hypothetico-deductive reasoning:

If blah-blah is correct (describe my idea/explanation) *and* I do such and such (describe your testing experiment), *then* such and such should happen (describe your predicted outcome).

But it did not happen (describe the outcome of the experiment), *therefore* I need to revisit my explanation, examine the experiment, etc.

OR

And it did happen (describe the outcome of the experiment), *therefore* my explanation has not been disproved yet.

REMEMBER! – Your predicted outcome must be based on your explanation.

Inertial and Non-inertial Reference Frames

5.1 Observe and Analyze

You are sitting on a train and place a ping-pong ball on a tray table in front of you. The ping-pong ball is at rest. All of a sudden, the ball starts rolling towards you. At the same time, your friend who was waiting for your train to depart, saw the train starting to move in the direction in which you were facing, but she saw the ball stationary and the train leaving from under it.

- a) Describe the motion of the ball when it starts rolling using a motion diagram for each observer: you on the train and your friend on the platform.
- b) Explain the behavior of the ball when it starts rolling using a force diagram for each observer: you on the train and your friend on the platform.

Observer	You on a train that is starting to move	Your friend on the platform
Motion diagram for the ball (description of motion)		
Force diagram for the ball (explanation of motion)		
Are the diagrams consistent? Explain.		

- c) What can you say about the relationship between the unbalanced force and change in motion for the observer on the train that starts to move?
- d) How will you rewrite the relationship between force and change in motion to include the role of the observer?
- e) Why do you think your friend on the platform did not see the ball starting to move (i.e. change its motion) when the train started to move?

Did You Know?

Inertial reference frame: Inertia is the phenomenon when an object continues moving at constant velocity if no other objects interact with it or if the sum of all these interactions is zero. Reference frames in which we can observe this phenomenon are called *inertial reference frames*. If the sum of all forces exerted on the object is zero, then in an inertial reference frame, the object's velocity remains constant.

Newton's first law of motion: We choose a particular object as the object of interest—the system. If no other objects interact with the system object or if the sum of all the external forces exerted on the system object is zero (forces in the y direction are balanced and forces in the x direction are balanced), then the system object continues moving at constant velocity (including remaining at rest) **as seen by observers in the inertial reference frames**.

5.2 Reason

Consider the following idea: *The relationship between the unbalanced force and the change in motion depends on the observer.*

Apply this idea using the following videos: <http://paer.rutgers.edu/pt3/experimentindex.php?topicid=3&cycleid=1>.

For some observers, THE RELATIONSHIP between the direction of the unbalanced force and the direction of the $\Delta \vec{v}$ arrow DOES NOT WORK. Identify such observers in every experiment.

Video 1: Eugenia on Rollerblades

Video 2: Glider on Air Track

Video 3: Penny on Glider (application experiment)

Video 4: Pendulum on Rollerblades (qualitative testing experiment)

Video 5: Motion of ball in different reference frames (testing experiment)