

Basic Air Resistance

When solving physics problems, we very frequently say “ignore air resistance” or “air resistance is negligible.”

This is because

Air resistance is a force that *resists motion* of anything moving on earth. It is caused by collisions with the air molecules that are everywhere on the surface of the earth.

The direction of air resistance is always in the opposite direction of something moving. Because of this, air resistance *only* causes objects to stop moving, never begin moving.

The magnitude of air resistance depends upon 3 things:
the surface area of the object,
the speed the object is moving,
the density of the air.

When can you *not ignore* air resistance?

I think there are four cases when you cannot ignore air resistance:

- 1) an object is moving at a very high velocity
- 2) an object is moving and has a very high surface area
- 3) an object is moving and has a very low inertia. In this case, even if the magnitude of air resistance is small, it has a large effect on the motion of an object.
- 4) you are making a measurement that requires an extremely high degree of accuracy

For each of the following situations, indicate if it is worthwhile to include air resistance in your calculations. If you say it is, indicate why, and if you say it is not, indicate why not.

- 1- You are calculating the force needed to push a sofa across the room.
- 2- You are modeling the motion of a racecar during a major race.
- 3- You are modeling the motion of someone falling with a parachute
- 4- You are modeling the motion of a feather falling to the ground.
- 5- You are modeling to determine if an arrow will strike its target from across a football field.
- 6- You are trying to figure out how long it takes a shot from Mr. Kuncik's nerf gun to fly across his room.

Answer the following questions regarding air resistance:

A physics student is making calculations to predict the distance an marble will travel when fired out of a toy cannon. He is ignoring air resistance during these calculations. He finds that if the marble is launched at a slow speed, his calculations are close to accurate. But if the marble is launched at a high speed, his calculations are highly inaccurate. Explain why this might be the case?

Answers:

- 1 – No, the sofa moves very slowly when pushed, so the effect of air resistance is minimal.
- 2 – Yes, a racecar moves extremely fast and is subject to very high air resistance
- 3 – Yes, the parachute has a very high surface area and is subject to very high air resistance.
- 4- Yes, the feather has extremely low inertia, so even though air resistance is a small force on the feather, it has a very significant effect on the motion of the feather
- 5 – Yes, even though air resistance has a very small effect on the arrow, extreme precision is required to strike a target from so far away, so the effect of air resistance must be considered.
- 6 – No, air resistance has some effect on the nerf gun shot, but this calculation is not important enough to go through the effort necessary to include air resistance in this calculation. Plus, by our observations, we can see the nerf shot travels at a very nearly a constant velocity over short distances.