Standard Assumptions in Physics

Unit: Mathematics

NGSS Standards: N/A

MA Curriculum Frameworks (2006): N/A

AP Physics 1 Learning Objectives: N/A

Knowledge/Understanding Goals:

- what are the usual assumptions in physics problems

Language Objectives:

- understand and correctly use the term "assumption," as it pertains to setting up and solving physics problems.

Notes:

Many of us have been told not to make assumptions. There is a popular expression that states that "when you assume, you make an ass of you and me":

ass|u|me

In science, particularly in physics, this adage is crippling. Assumptions are part of everyday life. When you cross the street, you assume that the speed of cars far away is slow enough for you to walk across without getting hit. When you eat your lunch, you assume that the food won't cause an allergic reaction. When you run down the hall and slide across the floor, you assume that the friction between your shoes and the floor will be enough to stop you before you crash into your friend.

assumption: something that is unstated but considered to be fact for the purpose of making a decision or solving a problem. Because it is impossible to measure and/or calculate everything that is going on in a typical physics or engineering problem, it is almost always necessary to make assumptions.

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Standard Assumptions in Physics

In a first-year physics course, in order to make problems and equations easier to understand and solve, we will often assume that certain quantities have a minimal effect on the problem, even in cases where this would not actually be true. The term used for these kinds of assumptions is "ideal". Some of the ideal physics assumptions we will use include the following. Over the course of the year, you can make each of these assumptions unless you are explicitly told otherwise.

- Constants (such as acceleration due to gravity) have the same value in all parts of the problem.
- Variables change in the manner described by the relevant equation(s).
- Ideal machines and other objects that are not directly considered in the problem have negligible mass, inertia, and friction. (Note that these idealizations may change from problem-to-problem. A pulley may have negligible mass in one problem, but another pulley in another problem may have significant mass that needs to be considered as part of the problem.)
- If the problem does not mention air resistance and air resistance is not a central part of the problem, friction due to air resistance is negligible.
- The mass of an object can often be assumed to exist at a single point in 3-dimensional space. (This assumption does not hold for problems where you need to calculate the center of mass, or torque problems where the way the mass is spread out is part of the problem.)
- Sliding (kinetic) friction between surfaces is negligible. (This will not be the case in problems involving friction, though even in friction problems, ice is usually assumed to be frictionless unless you are explicitly told otherwise.)
- Force can be applied in any direction using an ideal rope. (You can even push on it!)
- Collisions between objects are perfectly elastic or perfectly inelastic unless the problem states otherwise.
- No energy is lost when energy is converted from one form to another. (This is always true, but in an ideal collision, energy lost to heat is usually assumed to be negligible.)
- The amount that solids and liquids expand or contract due to temperature differences is negligible. (This will not be the case in problems involving thermal expansion.)

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- The degree to which solids and liquids can be compressed or expanded due to changes in pressure is negligible.
- Gas molecules do not interact when they collide or are forced together from pressure. (Real gases can form liquids and solids or participate in chemical reactions.)
- Electrical wires have negligible resistance.
- All physics students do all of their homework. ☺ (Of course, real physics students do not always do their homework, which can lead to much more interesting (in a bad way) results on physics tests.)

In some topics, a particular assumption may apply to some problems but not others. In these cases, the problem needs to make it clear whether or not you can make the relevant assumption. (For example, in the "forces" topic, some problems involve friction and others do not. A problem that does not involve friction might state that "a block slides across a frictionless surface.")

If you are not sure whether you can make a particular assumption, you should ask the teacher. If this is not practical (such as an open response problem on a standardized test), you should decide for yourself whether or not to make the assumption, and *explicitly state what you are assuming as part of your answer*.

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