Science-1A Lecture: Week-1, Friday, August 13, 2021

The videos from the PBS Crash Course collection are excellent. We will lean upon both their Physics and Chemistry series. Those, however, were designed for one semester courses that use more than algebra. As a result, we will look at all of them, but I will provide guidance about what you need to know for Science-1A and what I will call bonus information. For example, there is some discussion about Calculus and Vectors that I would like you to listen to, but which will not be part of our discussions or testing.

A short introduction to the Crash Course video collection is at *https://www.youtube.com/user/crashcourse* . To locate the Crash Course in Physics on YouTube, I go to YouTube and search for "Crash Course Physics". This week, watch the following 43 minutes of Crash Course Physics videos, and then read the discussion at the end of the next page.

Intro to Crash Course Physics: 2 min 35 s

https://www.youtube.com/watch?v=OoO5d5P0Jn4&list=PL8dPuuaLjXtN0ge7yDk_UA0ldZJdhwkoV&index=1

Motion in a Straight Line: (CC 1) 10 min 39 s

https://www.youtube.com/watch?v=ZM8ECpBuQYE&list=PL8dPuuaLjXtN0ge7yDk_UA0ldZJdhwkoV&index=2

This is worth watching more than once.

We will use the tradition that **positive directions are to the right** in one-dimensional motion.

It is important to know that **speed is "how fast" but velocity is speed combined with direction**.

Among our printed handouts for Week-2 (*https://yosemitefoothills.com/Science-1A/Handouts/Week-02/*) are handouts entitled "Acceleration, Velocity and Distance - Simple Case" (2nd page has "Teacher Catching a Speeding Student"), and "Bicycle Trip" that are relevant to this video. The relevant equations for these are in the Chapter 2 section of your Equation Sheet at *https://yosemitefoothills.com/Science-1A/EquationAndSymbolNotes.pdf* .

The Greek letter Δ is actually a capital, not lower-case Greek delta.

Gravity equations are also in the Chapter 2 section of your Equation Sheet.

The displacement curve equation $x-x_0=vt+\frac{1}{2}at^2$ she discusses is more general than what I require you to know in this course. We will simply work with two pieces of this general equation. If the question does not involve acceleration, the distance *d* traveled during a time *t* at a **constant** velocity *v* is just $d=vt$. If, the question involves a **constant** acceleration *a* and the initial velocity is zero, the distance traveled is $d=\frac{1}{2}at^2$.

Our Equation Sheet, therefore, just shows $d=vt$ and $d=\frac{1}{2}at^2$. In this course, we will always assume that any acceleration is constant (not changing).

It is an easy mistake to combine $d=vt$ and $v=at$ to get $d=at^2$ **Incorrect!!!** . When there is constant acceleration, the velocity is not constant; a 1/2 becomes necessary, making the formula $d=\frac{1}{2}at^2$. The formula $d=vt$ is only true if *v* is constant (not changing). Similarly, the formula $v=at$ is only true if *a* is constant (not changing).

To convert 35 m/s to km/hour, we need to multiply by $\frac{1\,\text{km}}{1000\,\text{m}}$ and by $\frac{3600\,\text{s}}{1\,\text{h}}$ to get 126 km/h.
This conversion process is explained in Section 6 entitled Unit Conversion of the Algebra Refresher handout at *https://yosemitefoothills.com/Science-1A/Handouts/Week-01/AlgebraRefresher.pdf* . See also some videos I have posted on the school Canvas system for this course which explain parts of the Algebra Refresher.

On your quizzes and tests, the answer to this type of question should be written as

$$\left(35\,\frac{\text{m}}{\text{s}}\right)\cdot\left(\frac{1\,\text{km}}{1000\,\text{m}}\right)\cdot\left(\frac{3600\,\text{s}}{1\,\text{h}}\right)=126\,\frac{\text{km}}{\text{h}}$$ **which explicitly shows the conversions.**

Derivatives (CC 2) 10 min, 1 s
https://www.youtube.com/watch?v=ObHJJYvu3RE&list=PL8dPuuaLjXtN0ge7yDk_UA0ldZJdhwkoV&index=3

Bonus info: This discusses derivatives, a topic in the mathematics of Calculus. She also talks about trigonometry, another branch of mathematics that we can ignore in Science-1A. Just listen to this discussion and absorb what you can, but you will not need this material to get an A in our Science-1A course.

Integrals (CC3) 10 min, 8 s
https://www.youtube.com/watch?v=jLJLXka2wEM&list=PL8dPuuaLjXtN0ge7yDk_UA0ldZJdhwkoV&index=4

Bonus info: This discusses integrals, another topic in the mathematics of Calculus. Just listen to this discussion and absorb what you can, but you will not need this material to get an A in our Science-1A course.

2D Motion (CC4) 10 min, 5 s
https://www.youtube.com/watch?v=w3BhzYI6zXU&list=PL8dPuuaLjXtN0ge7yDk_UA0ldZJdhwkoV&index=5

The vectors part of this is bonus info.

One idea mentioned, however, should be remembered: When one ball is thrown horizontally while another is dropped at the same time, they both land at the same time. The horizontal motion of the thrown ball has no effect on its vertical motion.

Answering questions about accelerating objects

The equation $x - x_0 = vt + \frac{1}{2}at^2$ is not actually needed for the quiz and test questions relating to acceleration in this course since we will just deal with questions where x_0=0 and v=0. What you need is just $x = \frac{1}{2}at^2$.

If we are considering a drag racer (or rocket) starting from rest with a constant acceleration a=10 m/s^2 and need to know the distance d traveled after a time t=5 s, we do the following:

$$d = \frac{1}{2}at^2 = \frac{1}{2}\cdot(10\,\frac{\mathrm{m}}{\mathrm{s}^2})\cdot(5\,\mathrm{s})^2 = 125\,\mathrm{m} \quad .$$

Notice that it makes no difference that we use the letter d here to represent the distance instead of the letter x.

The same formula is used for a falling object accelerated by the gravitational field at the surface of the earth. In that case, we replace the letter a for the acceleration by the letter g which is traditionally used for the constant acceleration of gravity at the surface of the Earth. Your Equation Sheet gives $g = 9.80\,\mathrm{m/s^2}$ (the video uses 9.81 m/s^2, but we will use just 9.80 m/s^2), so if the question asks how far does an object fall (ignoring air resistance) in 5 seconds, the answer will be

$$h = \frac{1}{2}gt^2 = \frac{1}{2}\cdot(9.80\,\frac{\mathrm{m}}{\mathrm{s}^2})\cdot(5\,s)^2 = 122.5\,\mathrm{m} \quad .$$

Here, we used the letter h to represent the height that it fell, rather than d or x.

In both of these solutions, you are expected to clearly show the units and see that the s^2 at the bottom of the acceleration unit is cancelled by the s^2 from the square of time, leaving the answer with the unit of m.

A common student error in this kind of problem is to forget the square in t^2 and/or in (5 s)^2, but then the units will not produce m, but rather m/s. That should let you know that you made an error since you were supposed to be calculating a distance which must end up with units of m, not m/s. The units are important and help you check your work. **This is why I stress treating the units carefully and will delete points if they are not handled correctly.**

Next week, we will go over the practice material for Quiz 1 in Monday's lecture, and practice using scientific notation on your calculators during the Wednesday Lab notes.