Phys 111: General Physics I

"Dawn of The Second Day"

University of Idaho

August 29, 2019

Today's Announcments

Homework Wk #1 Due Today

Starting Next Week

- Physics labs
- Tutoring (Library, Think Tank, EP 309)
- Recitation & Office Hours

Recomendation: Read Open Stax College Physcis 1.3 and 1.4 as prep for lab.

Today's Topics

- Significant Digits (Figures)
- Quantifying & Describing Motion
- Vector vs Scalar Quantities

Significant Digits in Calculations

A **Significant Digit** is any digit that contributes meaning to a measurement.

Four Concise Rules

1. All non-zero digits are significant: 1, 2, 3, 4, 5, 6, 7, 8, 9.
2. Zeros between non-zero digits are significant: 301, 7004, 80003.
3. Leading zeros are never significant: 0.04, 003.857, 0.000719.
4. In a number with or without a decimal point, trailing zeros (those to the right of the last non-zero digit) are significant provided they are justified by the precision of their derivation: 389,000; 2.02000; 5.400; 57.5400. [1]

Some Arithmetic Rules

- When **adding** two numbers, you must round to the least precise place value. Ex. $13.74213 + 1.2 = 14.9$
- When **mulitplying** two numbers, you must round to the least **number** of significant digits. Ex. $143.02 \times 0.02 = 3$

[1] More detailed rules apply. In general, trailing zeros after a decimal place are significant.

Sig. Fig. Examples

State how many significant figures are proper in the results of the following calculations:

1. $(106.7)(98.2)/(46.210)(1.01)$
2. $(18.7)^2$
3. $(1.60 \times 10^{-}19)(3712)$

State the result with the proper number of significant digits for the following calculations:

1. $(1.80 + 0.94)\ cm$
2. $(2.05 - 0.32)\ s$
3. $(360 - 273.15)\ K$

Sig. Fig. Examples

State how many significant figures are proper in the results of the following calculations:

1. $(106.7)(98.2)/(46.210)(1.01)$ [3]
2. $(18.7)^2$ [3]
3. $(1.60 \times 10^-19)(3712)$ [3]

State the result with the proper number of significant digits for the following calculations:

1. $(1.80 + 0.94)\ cm = 2.7\ cm$
2. $(2.05 - 0.32)\ s = 1.72\ s$
3. $(360 - 273.15)\ K = 87\ K$

Concept Check 1

State the results with the proper number of signifcant digits if possible:

1. $42.0\ m + 18.0\ m/s =$
2. $(10.0)(0.4) + 3.2 =$
3. $(102.1 + 32.7 + 40 + 51.2 + 6 + 107.2) \times 0 =$

Results

1. $42.0\ m + 18.0\ m/s = nonsense$
2. $(10.0)(0.4) + 3.2 = 7$
3. $(102.1 + 32.7 + 40 + 51.2 + 6 + 107.2) \times 0 = 0$

Describing Motion: Kinematics

When you're in motion, the basic questions to ask are:

- Where are you?
- Where are you going?
- How fast are you getting there?

The answers to these questions require that you specify your

- position
- your displacement
- your average velocity

Mechanics $=$ **Kinematics** $+$ **Dynamics**

Kinematics is the science of describing motion.

Dynamics is the science of explaining motion.

Which Path is Shorter?

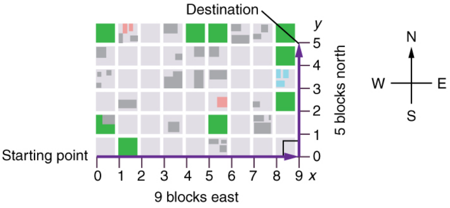


Figure: 3.3 A pedestrian walks a two-dimensional path between two points in a city.

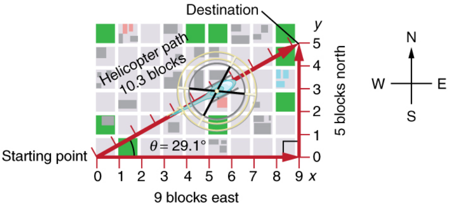


Figure: 3.5 The straight-line path followed by a helicopter between the two points is shorter than the 14 blocks walked by the pedestrian.

Key Words (Don't Copy Yet)

Position

Displacement

Distance

Elapsed Time

Speed

Velocity

Acceleration

Scalars

Vectors

Where Are You? Where Are You Going?

Position: Where an object is at any moment. Denoted $\vec{\mathbf{x}}$, $\vec{\mathbf{r}}$, x, r, etc

Distance: Total length traveled for a given path. Denoted d, l, etc.

Displacement: A change in position. Denoted $\Delta\vec{\mathbf{x}}$, $\Delta\vec{\mathbf{r}}$, Δx, Δr, etc

$$\Delta\vec{\mathbf{x}} = \vec{\mathbf{x}}_f - \vec{\mathbf{x}}_o$$

$$\Delta\vec{\mathbf{x}} = \vec{\mathbf{x}}_f - \vec{\mathbf{x}}_i$$

All quantities related to position must be expressed in terms of a reference frame!

Positions & Displacement

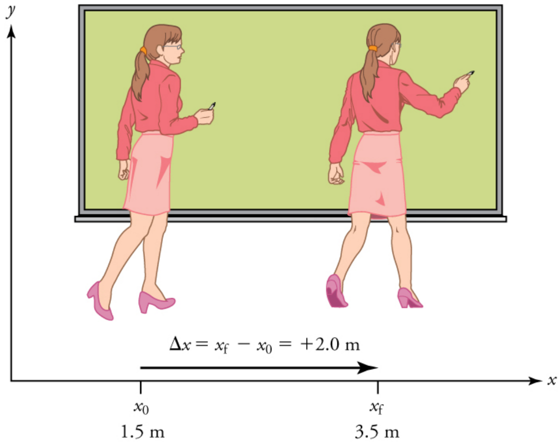


Figure: 2.3 A professor paces left and right while lecturing. Her position relative to Earth is given by x. The + 2.0 m displacement of the professor relative to Earth is represented by an arrow pointing to the right.

The difference between a **vector** quantity and a **scalar** quantity is easier to understand if you know the answer to the question:

What is the fundamental difference between a speed and a velocity?

Direction!

Scalar: A quantity that <u>only</u> has a magnitude or amount. No direction.

Vector: A quantity that has <u>both</u> a magnitude and a direction.

Vector or Scalar

Are the following a vector or a scalar?

Everyday Quantities

1. $91^\circ F$
2. $120\ lb\ downwards$
3. $35\ mi/h\ north$
4. $45.5\ ft$

More Technical Quantities

- $20.0\ N\ upwards$
- $310\ K$
- $-4.9\ m/s^2$

Vector or Scalar

Are the following a vector or a scalar?

Everyday Quantities

1. $91^\circ F$ - **Scalar**
2. $120\ lb\ downwards$ - **Vector**
3. $35\ mi/h\ north$ - **Vector**
4. $45.5\ ft$ - **Scalar**

More Technical Quantities

- $20.0\ N\ upwards$ - **Vector**
- $310\ K$ - **Scalar**
- $-4.9\ m/s^2$ - **Depends**

How Fast Are You Getting There?

Velocity: The rate at which an object is changing position. Denoted $\vec{\mathbf{v}}$, v etc

Speed: The rate at which an object is traveling a distance. Denoted s, v

Average Speed = Distance/Time. Denoted v, s, speed, etc

Average Velocity = Displacement/Time. Denoted $\vec{\mathbf{v}}$, $\overline{\vec{\mathbf{v}}}$, $< \vec{\mathbf{v}} >$, $\vec{\mathbf{v}}_{ave}$ etc

Example: A runner makes one lap around a 400 m track in 50 s. What are the runner's average speed and average velocity?

Remember: You are not making progress when you run in a circle...

Is All Progress Equal?

Example: A runner makes one lap around a 400 m track in 50 s. What are the runner's average speed and average velocity?

Remember: You are not making progress when you run in a circle...

Answers:

$$s = \frac{d}{\Delta t} = \frac{400\ m}{50\ s} = 8.0\ m/s$$

$$< \vec{\mathbf{v}} >= \frac{\Delta \vec{\mathbf{x}}}{\Delta t} = \frac{0\ m}{50\ s} = 0\ m/s = 0$$

Concept Check 2 (Collecting)

Jill sets out from her home to deliver flyers for her yard sale, traveling due east along her street lined with houses. At **0.5 km** and **9 minutes** later he runs out of flyers and has to retrace her steps **back to her house** to get more. This takes an **additional 9 minutes**. After picking up more flyers, she sets out again on the same path, continuing where she left off, and ends up **1.0 km from her house**. This third leg of her trip **takes 15 minutes**. At this point she <u>turns back toward her house</u>, heading west. After **1.75 km** and **25 minutes** she stops to rest.

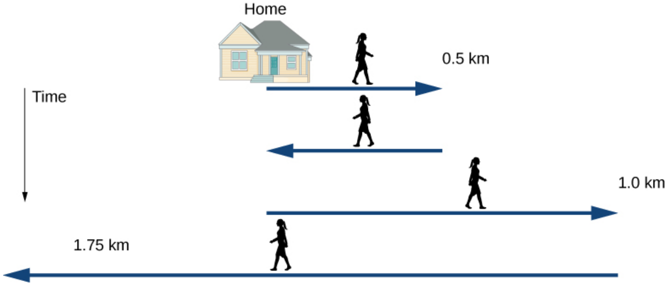
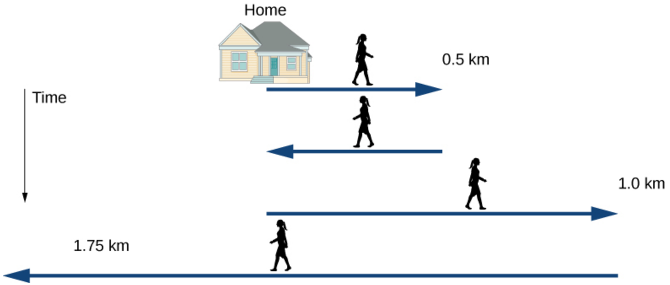


Figure: Jill's displacement is tracked. Take +x to be to the right of Jill's home.

Concept Check 2 (Collecting)

Jill starts at home and leaves heading east (+ x-direction). At **0.5 km** and **9 minutes** later she stops and retraces her steps **back to her house**. This takes an **additional 9 minutes**. She then sets out again on the same path, continuing where she left off, and ends up **1.0 km from her house**. This third leg of her trip **takes 15 minutes**. At this point she turns back toward her house, heading west (- x-direction). After **1.75 km** and **25 minutes** she stops to rest.



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Collecting

1. What is Jills total displacement to the point where she stops to rest?
2. What is the magnitude of the final displacement?
3. What is the average velocity during her entire trip?
4. What is the total distance traveled?

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Collecting

1. $\Delta x = -0.75\ km = -75\ m$
2. $|\Delta x| = 75\ km = 75\ m$
3. $\vec{\mathbf{v}}_{ave} = (-0.75\ km)/(58\ min) = -12.9\ m/min = -0.78\ km/h$
4. $d = 3.75\ km = 375\ m$

Acceleration

Acceleration is the rate of change of the velocity of an object. This can be a change in the magnitude (speed) or direction of the velocity. Denoted $\vec{\mathbf{a}}$, magnitude of $\vec{\mathbf{a}}$ denoted a.

Average Acceleration = (Final Velocity - Initial Velocity) / Elapsed Time

- Trip to store and back takes 25 min: $< \vec{\mathbf{a}} >= 0\ m/s^2$.
- 0 to 60 mph in 8.0 s: $\vec{\mathbf{a}}_{ave} = 27000 mi/h^2$.
- Sprinting 0 to 7.00 m/s in 7.0 s: $a = 1.0 m/s/s$.

$$\vec{\mathbf{a}}_{ave} = \frac{\vec{\mathbf{v}}_f - \vec{\mathbf{v}}_o}{\Delta t}$$

Instantaneous Acceleration Wait hold up! What about instantaneous velocity?

Instantaneous (Top Ramen)

Instantaneous quantities indicate that quantity at each instant of time. In physics we say this means Δt gets really darn small. To be mathematically consistent we write dt for such small amounts of time:

$$\lim_{t \to 0} \Delta t = dt$$

Instantaneous Velocity of an object is the velocity at each instant of time:

$$\vec{\mathbf{v}} = \lim_{t \to 0} \frac{\Delta \vec{\mathbf{x}}}{\Delta t} = \frac{d\vec{\mathbf{x}}}{dt}$$

Instantaneous Acceleration of an object is the acceleartion at each instant of time:

$$\vec{\mathbf{a}} = \lim_{t \to 0} \frac{\Delta \vec{\mathbf{v}}}{\Delta t} = \frac{d\vec{\mathbf{v}}}{dt}$$

The End

Thank you for your time and attention!
I'll take more questions now.