Scalars and Vectors

Describing Motion with Words

- We will devote the next several months to learning about the physics of motion.
- As we focus on the language, principles, and laws which describe and explain the motion of objects, your efforts should center around internalizing the meaning of the information.
- Avoid memorizing the information; and avoid abstracting the information from the physical world which it describes and explains.
- Rather, contemplate the information, thinking about its meaning and its applications.

Kinematics

- Kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations.
- The goal of any study of kinematics is to develop sophisticated mental models which serve us in describing (and ultimately, explaining) the motion of real-world objects.

Scalars

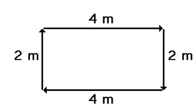
- Scalars are quantities which are fully described by a magnitude alone
- Distance is a scalar quantity which refers to "how much ground an object has covered" during its motion.
- Speed is a scalar quantity which refers to "how fast an object is moving."
  - A fast-moving object has a high speed while a slow-moving object has a low speed.
  - An object with no movement at all has a zero speed.

Vectors

- Vectors are quantities which are fully described by both a magnitude and a direction.
- Displacement is a vector quantity which refers to "how far out of place an object is"; it is the object's change in position (ΔX, ΔY, Δd)
- Velocity is a vector quantity which refers to "the rate at which an object changes its position." (V)

Displacement

I walk 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North.



Even though I walked a total distance of 12 meters, my displacement is 0 meters.
Displacement, being a vector quantity, must give attention and regard to direction.
The 4 meters east is *canceled* by the 4 meters west; and the 2 meters south is *canceled* by the 2 meters north.

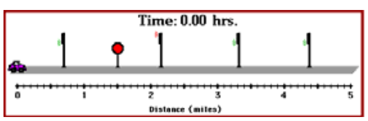
Average Speed

Average Speed

- Average speed is a measure of the distance traveled in a given period of time; it is sometimes referred to as the distance *per* time ratio.
- During a typical trip to school, your car will undergo a series of changes in its speed.
- If you were to inspect the speedometer readings at regular intervals, you would notice that it changes often.
- The speedometer of a car reveals information about the instantaneous speed of your car; that is, it shows your speed at a particular instant in time.

$$\text{Avg speed} = \frac{\text{Total distance}}{\text{Total time}}$$

$$s = \frac{d}{t}$$



$$\text{Avg speed} = \frac{5 \text{ miles}}{0.2 \text{ hours}} = 25 \text{ miles/hour}$$

Practice

If you want to travel 250 mi in 4.5 hours what must be your average speed in meters per second?

S = ?
d = 250 mi
t = 4.5 hr

$$s = \frac{d}{t} \qquad s = \frac{250\ mi}{4.5\ hr}$$

$$s = 55.56\ mi/hr$$

$$\frac{55.56\ \cancel{mi}}{1\ \cancel{hr}} \cdot \frac{1600\ m}{1\ \cancel{mi}} \cdot \frac{1\ \cancel{hr}}{3600\ s}$$

$$\boxed{s = 24.69\ m/s}$$

Practice

You maintain an average speed of 25 m/s. How long (in minutes) does it take you to travel 34 km?

S = 25 m/s
d = 34 km=34000m
t = ? min

$$s = \frac{d}{t} \qquad 25\ m/s = \frac{34{,}000\ m}{t}$$

$$t = 1360 s$$

$$\frac{1360\ \cancel{s}}{1} \cdot \frac{1\ min}{60\ \cancel{s}}$$

$$\boxed{t = 22.67\ min}$$