Motion

Physical Science

Chapter 9

Motion

- **Motion described by**
  - Speed (rate)
  - Velocity
    - Speed & direction
  - Acceleration
  - Distance/Displacement
    - How far it moved
- **Types of motion**
  - Accelerated motion
  - Irregular motion
  - Uniform (constant motion)

Motion

- **Motion**
  - A change in position relative to a *point of reference*
  - An object is in motion when its distance from another object is changing
- **Reference point**
  - Any object used to detect motion
  - A reference point is a place or object used for comparison to determine if something is in motion
  - All reference points must be stationary
- **Speed (Rate)**
  - Any change over time
    - Amount of rain per hour (inches/hr)
    - Amount of sleep each night (hrs/night)
    - Amount of distance covered in an hour (miles/hr)

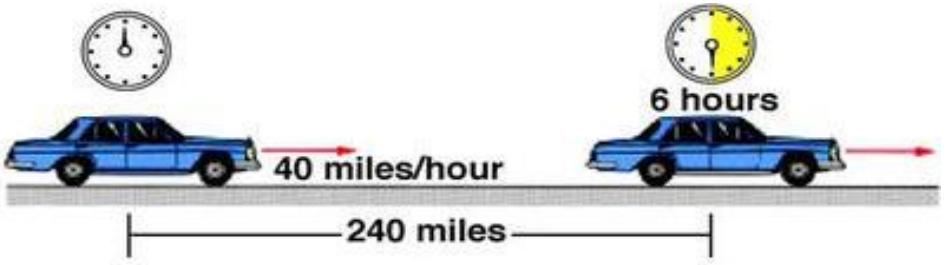
Speed

- **Speed**
  - The rate at which something moves a given distance.
  - Faster speeds = greater distances

- **General formula for speed:**
  - Speed = distance / time
  - Abbreviations commonly used:

    d = distance *t* = time *v* = speed
    - SI units, meters/second (m/s)

$$v = d/t$$



Speed vs. Velocity

- **Speed** – how fast an object is moving
  - described by a ***Magnitude*** alone
  - Example: car moving 25 miles/hour

- **Velocity –** how fast an object is moving in a given direction
  - described by both a ***Magnitude*** and ***Direction***
  - Example: Car moving 25 miles/hour to the north

Speed $v = \left(\frac{d}{t} \right)$

Speed

Given:
D= 100 miles
Time = 2.5 hours
V=?

Soln:

$$v = \left(\frac{d}{t} \right) =$$

Distance

Given:
D= ?
Time = 6 hours
V=30 miles/hr

Soln: $v = \left(\frac{d}{t} \right)$

$$d = v \cdot t$$

Time

Given:
D= 100 miles
Time = ?
V=40 miles/hr

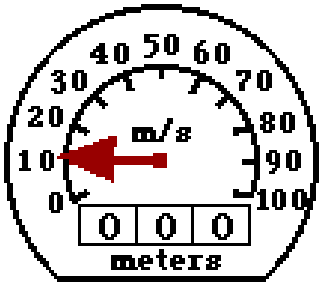
Soln: $v = \left(\frac{d}{t} \right)$

$$t = \left(\frac{d}{v} \right)$$

3 common types of speed

- **Average speed**
  - Total distance divided by total time
  - Example: Speed you drive from home to school

- **Instantaneous speed**
  - The speed on an object at any given moment
  - Example: speed indicated on speedometer



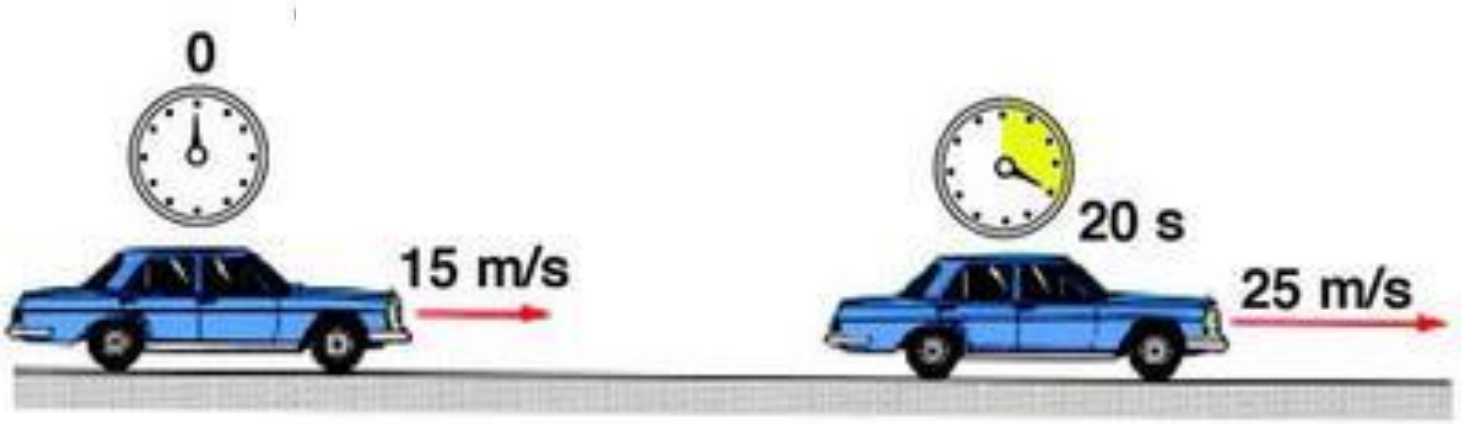
- **Constant speed**
  - The speed of the object does not change
  - Example: Speed of a train traveling without stops

Acceleration

- **Acceleration**
  - The rate at which an object changes its velocity
  - An object is accelerating if velocity is changing
  - SI Units: m/s^2

$$\text{Acceleration} = \frac{\text{change in speed}}{\text{time interval}}$$

$$a = \frac{v_f - v_i}{t}$$



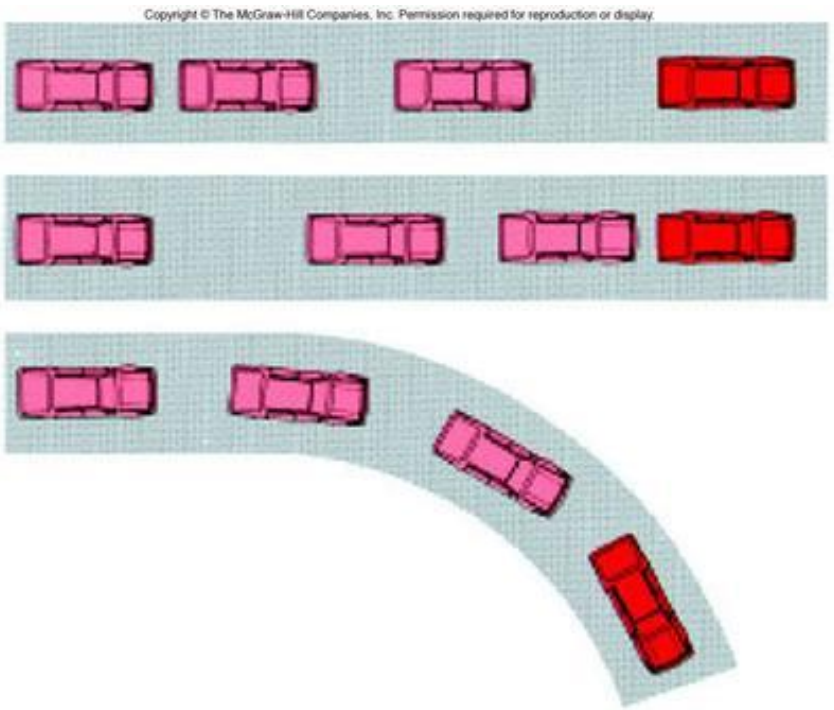
Acceleration

3 Types of Acceleration

Speeding Up

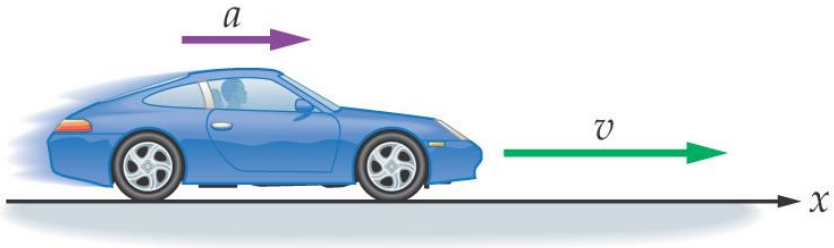
Slowing Down

Turning



Acceleration

Under which scenarios does the car's speed increase? Decrease?



(a)

Reviewing Graphing

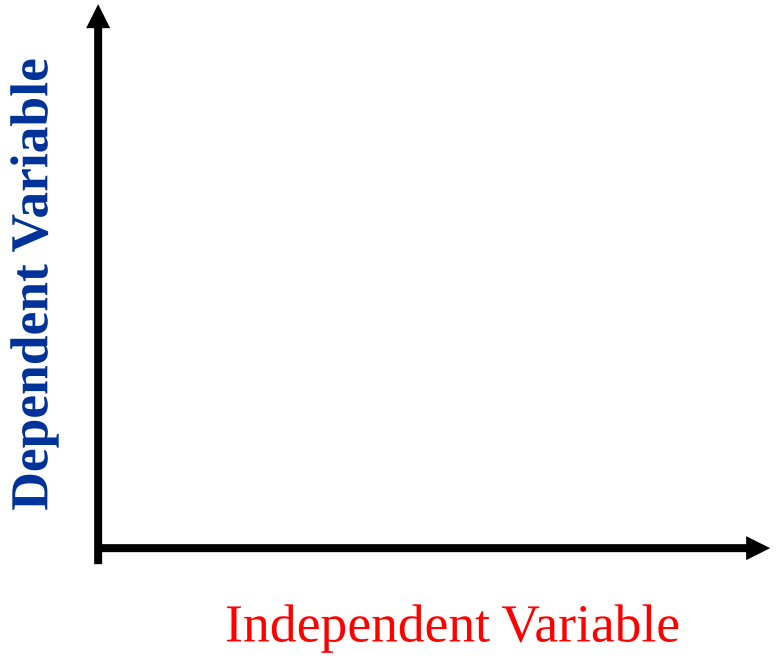
Independent variable

- Manipulated variable
- Factor adjusted by experimenter

Dependent Variable

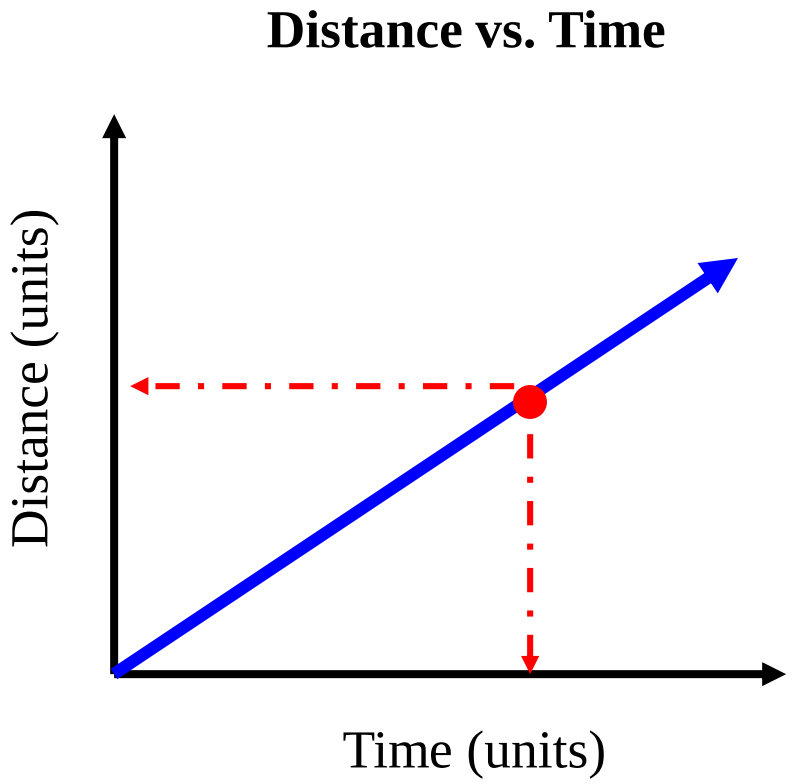
- Responding variable
- Depends on the independent variable
- Variable that is expected to change

Title: Dependent vs Independent



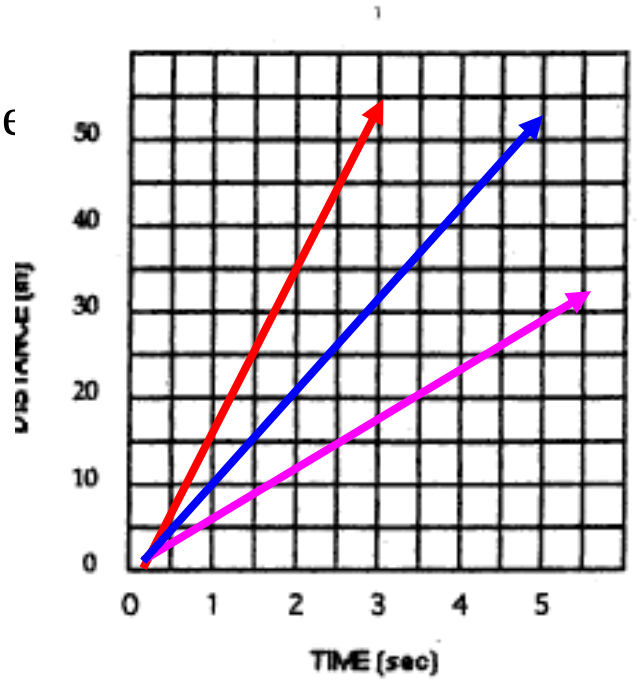
Graphing Motion

- To show the motion of an object on a line graph
  - plot distance against time.
  - Time is on the horizontal, or x-axis.
  - Distance is shown on the vertical, or y-axis.
- A point (x,y) on the graph represents the location of an object at a particular time.

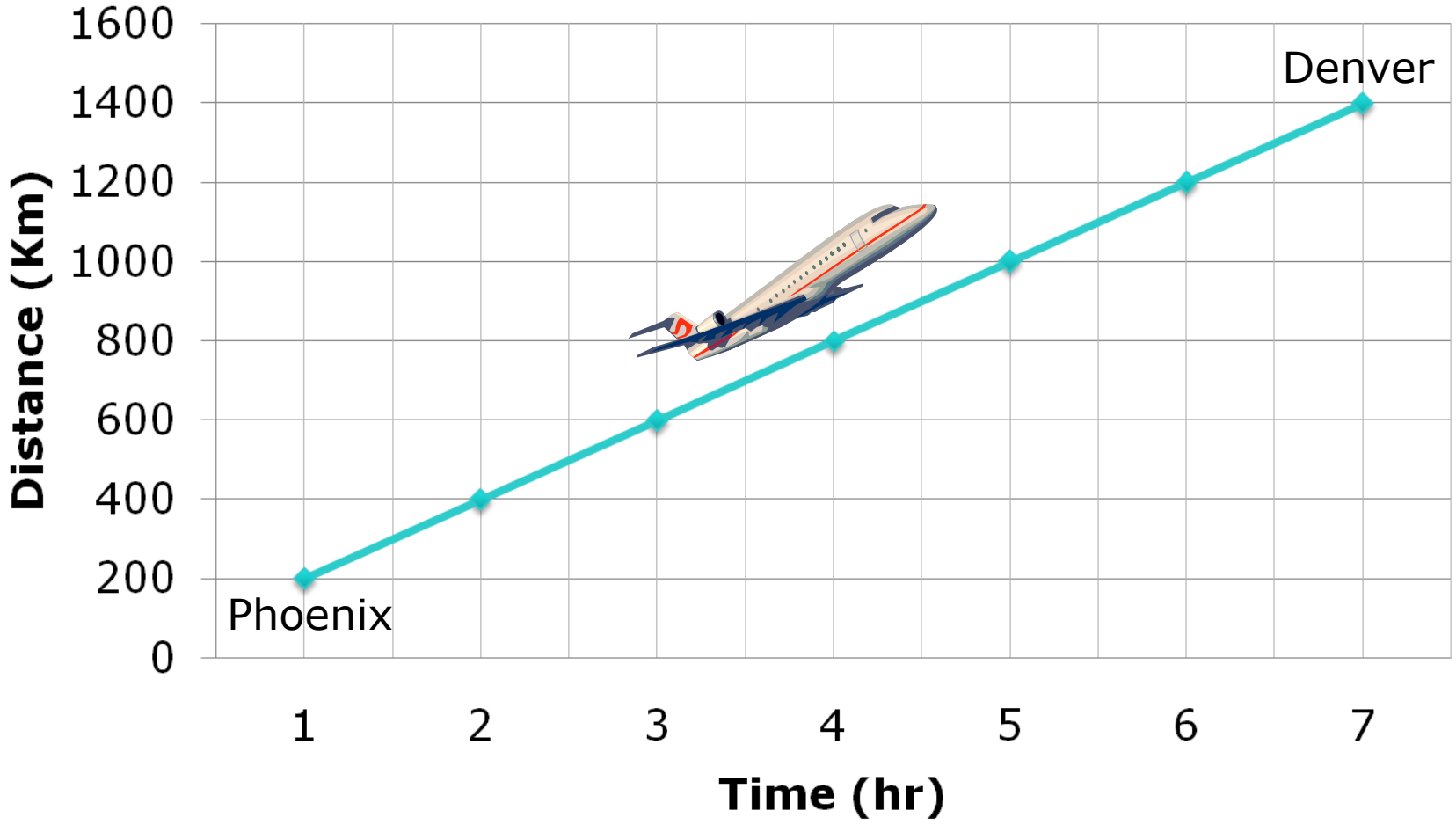


Graphing Motion

- The steepness, or slant, of a line on a graph is called its **slope**.
  - A distance-time graph with a constant slope represents motion at a constant speed
- The slope tells you how fast one variable changes in relation to the other variable.
  - Slope tells you the rate of change
    - SPEED!
    - The slope of a distance-time graph represents speed.
- The faster the motion, the steeper the slope
  - Because the object moves a greater distance in a given amount of time.
- A slight slope (not as steep) means a lower speed



Graphing Speed: Distance vs. Time Graphs



Graphing Speed: Distance vs. Time Graphs

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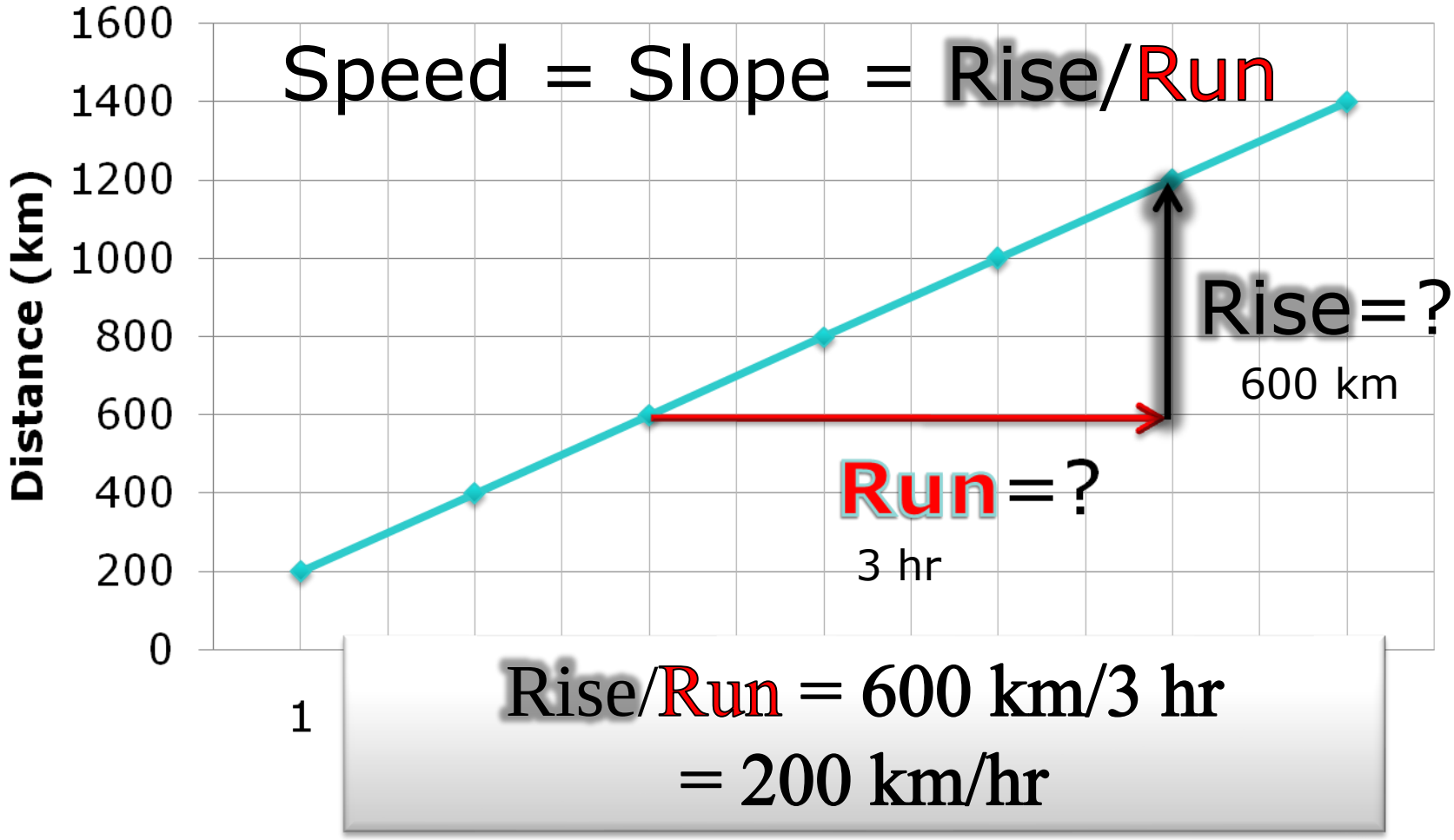
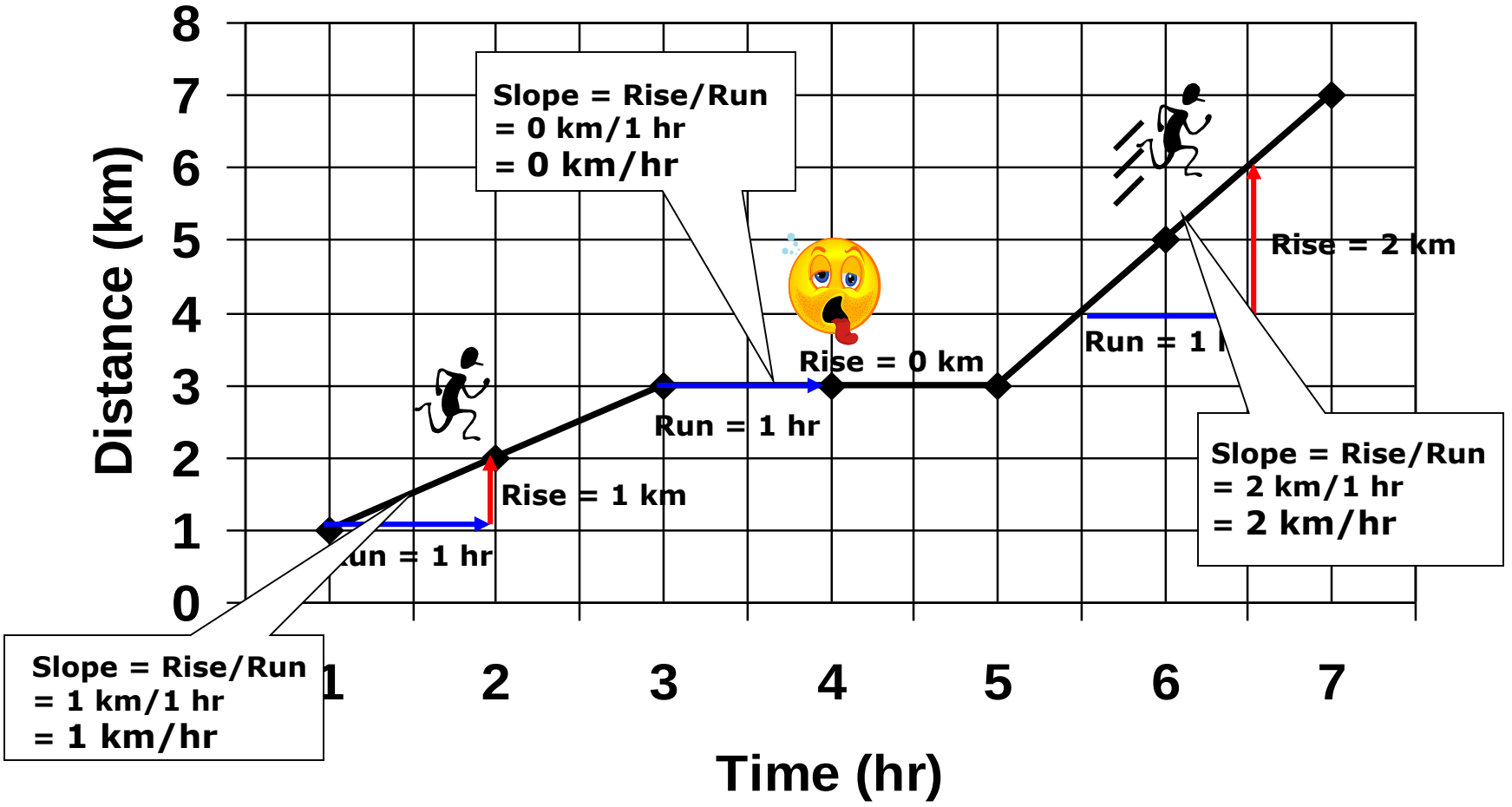
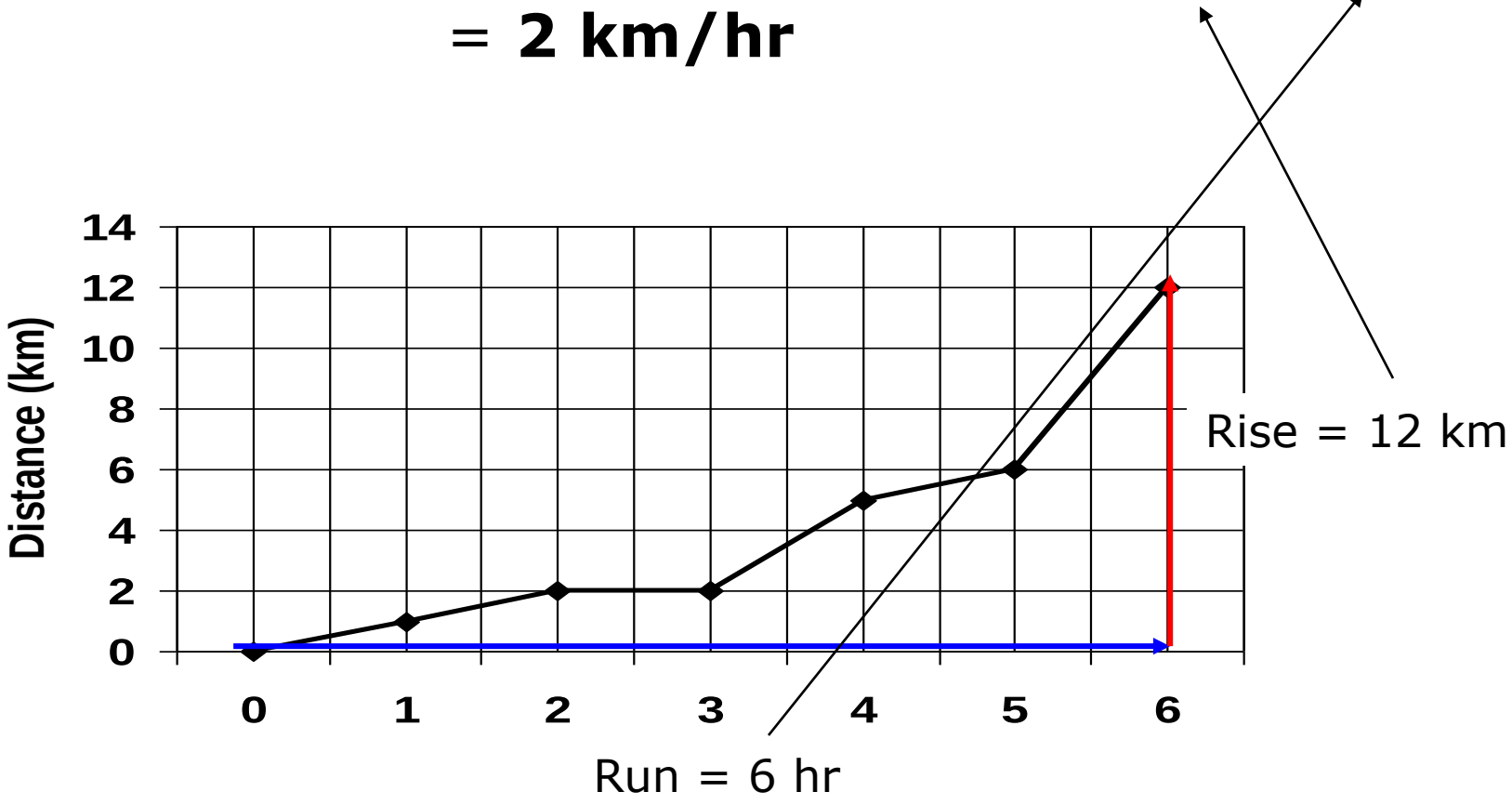


Different Slopes



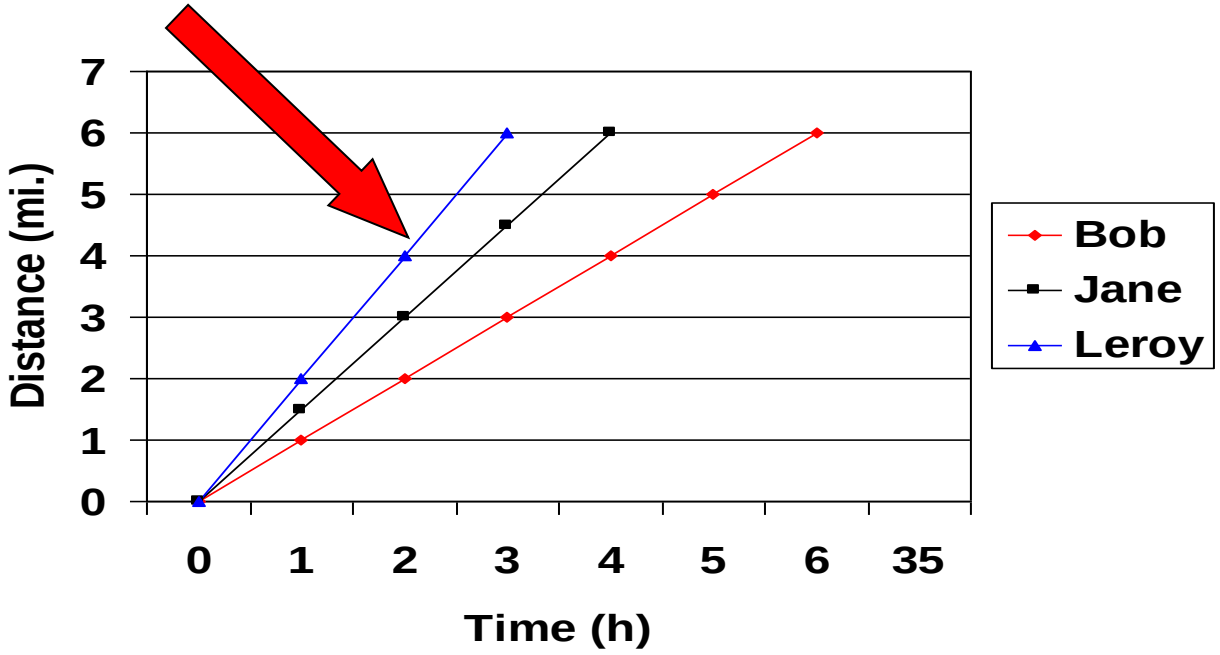
Question

Average Speed = Total distance/Total time = 12 km/6 hr
= **2 km/hr**



Question

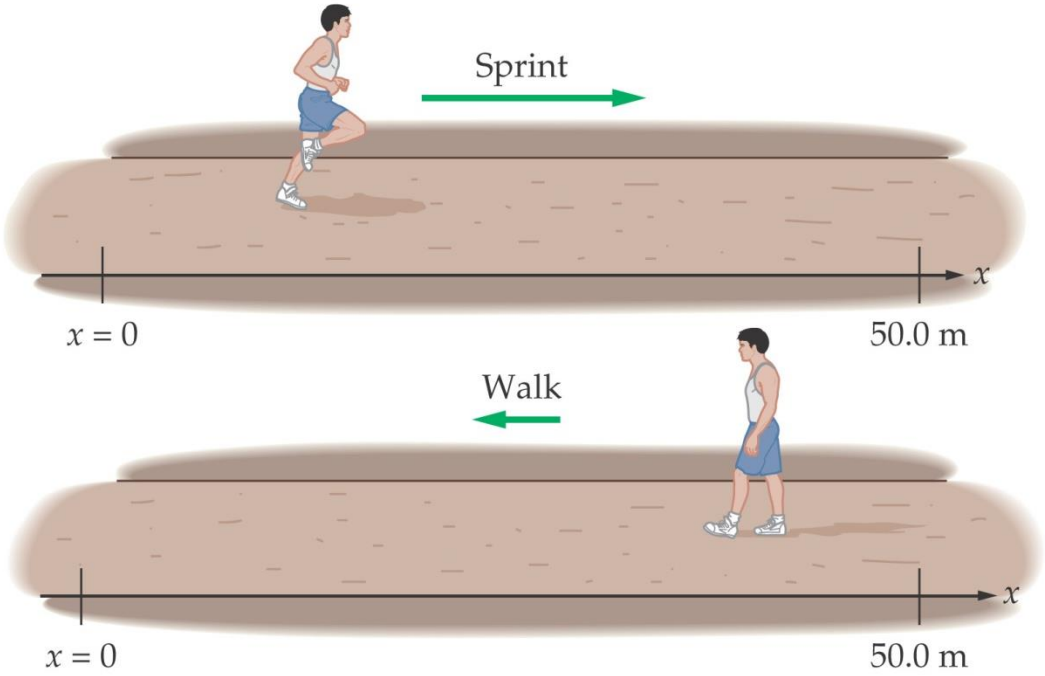
- Below is a distance vs. time graph for 3 runners. Who is the fastest?



Leroy is the fastest. He completed the race in 3 hours

Average speed and velocity

- **Average velocity = displacement / elapsed time**



What's your average velocity if you return to your starting point?

What if the runner sprints 50 m in 8 s?

What if he walks back to the starting line in 40 s?

Can you calculate: What is his average sprint velocity? His average walking velocity? And his average velocity for the entire trip?