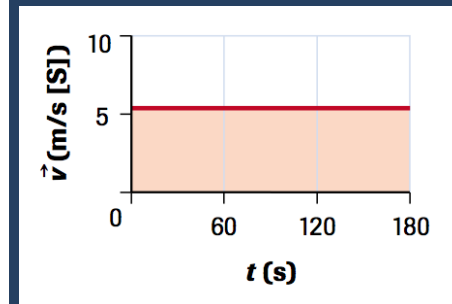
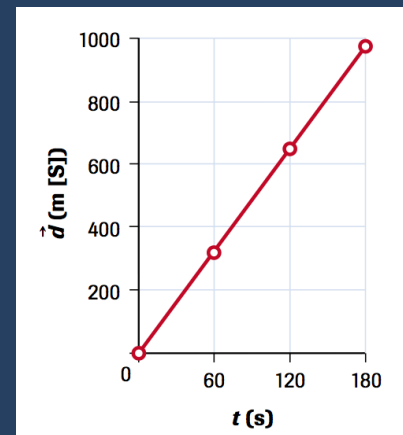


# One-Dimensional Motion

- Motion Terms
- SI Units
- Scalar Quantities
- Average and Instantaneous Speed
- $v = d/t$
- Linear Motion
- Velocity
- Position and Displacement
- Position-Time and Velocity-Time Graphs



# Motion Terms

- \_\_\_\_\_
- Uniform motion is a movement at a constant speed in a straight line.
- Nonuniform motion means movement which changes in speed or direction or both.

# Check Your Understanding

- Classify each as uniform or nonuniform motion. Explain.
  - a) A rubber stopper is dropped from your raised hand to the floor.
  - b) A car is travelling at a steady rate of 85 km/h due west.
  - c) A rocket begins rising from the launch pad.
  - d) A motorcycle rider applies the brakes to come to a stop.

# International System of Units (SI Units)

- These are the internationally accepted units of measurement.
- There are 7 base units in the SI system. We can then use these to derive further units i.e.  $m^2$ , km/h, etc.

Base Quantity	Name	Symbol
Length		
Mass		
Time		
Electric current	Ampere	A
Temperature	Kelvin	K
Amount of a substance	Mole	mol
Luminous intensity	Candela	cd

# Scalar Quantity

- \_\_\_\_\_
  - i.e. km/h, m/s, kg
- Vector quantities have both magnitude and direction
  - i.e. km/h [west], m/s<sup>2</sup> [N 23° W]

# Check Your Understanding

- State whether the quantity is a scalar or vector.
  - a) 9 ms
  - b) 3.1 m [up]
  - c) 15 cm<sup>2</sup>
  - d) 500 Hz
  - e) 113 km/h [west]
  - f) 50 mL

# Average and Instantaneous Speed

- Instantaneous speed is the speed at a particular instant.

- \_\_\_\_\_

(The symbol for average speed,  $v_{av}$ )

- The equation for average speed is  $v_{av} = \frac{d}{t}$

– where  $d$  is the total distance travelled in a total time  $t$ .

# $v_{av}$ , $d$ and $t$

- Since  $v_{av} = \frac{d}{t}$ , we can rearrange the variables to solve for either of the other two.
- One equation now becomes three

$$v_{av} = \frac{d}{t} \quad t = \frac{d}{v_{av}} \quad d = v_{av} t$$



# Check Your Understanding

- A track star, aiming for a world outdoor record, runs four laps of a circular track that has a radius of 15.9 m in 47.8 s. What is the runner's average speed for this motion?

$$v_{\text{av}} = \frac{d}{t}$$

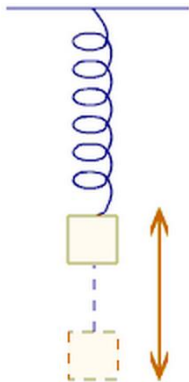
# Check Your Understanding

- The record time for a particular race is 3 h 53 min 17 s. Determine the average speed of this 42.2 km race. Express your answer in both metres per second and kilometres per hour.

$$v_{\text{av}} = \frac{d}{t}$$

# Linear Motion in One Dimension

- \_\_\_\_\_
- E.g.
  - Motion of a train along a straight line
  - An object, like a ball, falling freely, vertically under gravity
  - The vertical up and down oscillations of an object suspended from a vertical spring.



# Velocity and Other Vector Quantities

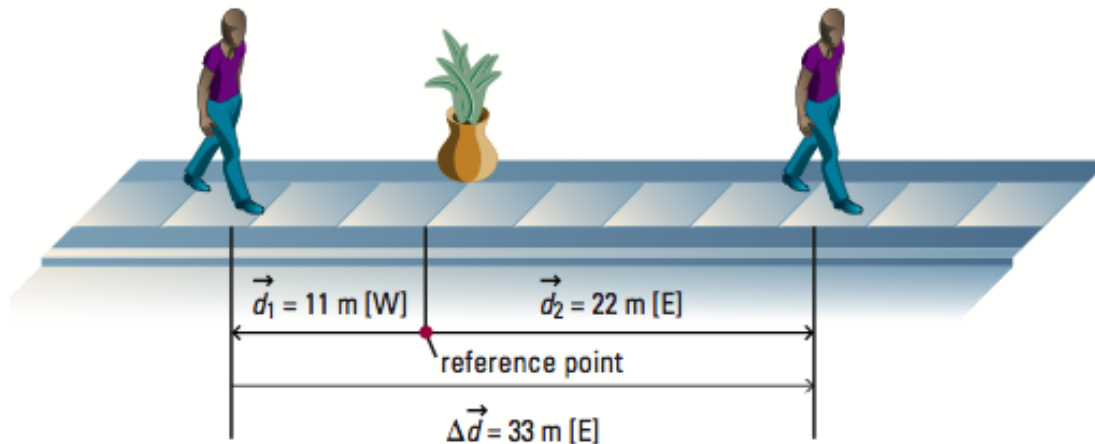
- \_\_\_\_\_
- The direction is given in [square brackets].
  - I.e. Displacement, and velocity
  - I.e. 20 km/h [E]

# Position and Displacement

- \_\_\_\_\_

- Displacement ( $\Delta d$ ) is how far an object is from its starting point ( $d_1$ )

Final position – starting position



# Check Your Understanding

- If you run around an oval track with a perimeter of 350 m and end where you began, what is your:
  - a) distance?
  - b) displacement?

# Velocity

- Recall: Average speed is the total distance travelled divided by the total time of travel.
- \_\_\_\_\_
- Average Velocity is the change of position (displacement) divided by the time interval for that change

$$\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$$

# Check Your Understanding

- If you run around an oval track in 10.0 minutes with a perimeter of 350 m and end where you began, what is your:
  - a) average speed in m/s?
  - b) average velocity in m/s?



# Check Your Understanding

A cyclist takes 25.1 s to cover the displacement of 115 m [E] from  $d_1$  to  $d_2$ .

- a) Calculate the cyclist's average velocity.
- b) If the cyclist maintains the same average velocity for 1.00 h, what is the total displacement?
- c) If the cyclist turns around at  $d_2$  and travels 565 m [W] to position  $d_3$  in 72.5 s, what is the average velocity for the entire motion?

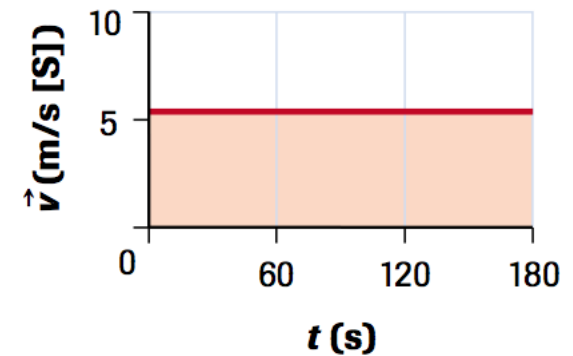
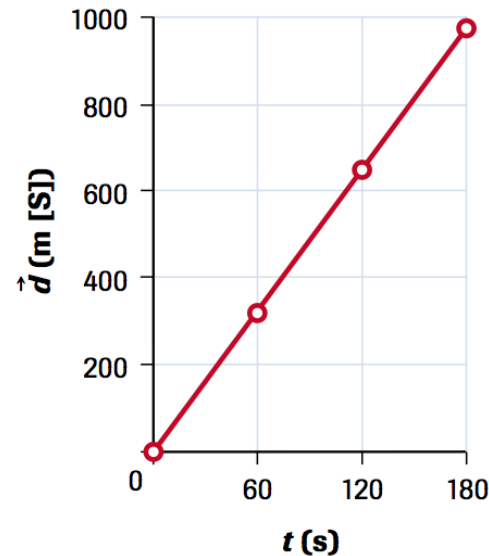
# Check Your Understanding

1. Is it possible for the total distance travelled to equal the magnitude of the displacement? If “no,” why not? If “yes,” give an example.
2. Is it possible for the total distance travelled to exceed the magnitude of the displacement? If “no,” why not? If “yes,” give an example.
3. Is it possible for the magnitude of the displacement to exceed the total distance travelled? If “no,” why not? If “yes,” give an example.
4. Can the average speed ever equal the magnitude of the average velocity? If “no,” why not? If “yes,” give an example.
5. A truck driver, reacting quickly to an emergency, applies the brakes. During the driver’s 0.32 s reaction time, the truck maintains a constant velocity of 27 m/s [fwd]. What is the displacement of the truck during the time the driver takes to react?

# Position and Velocity Graphs – Uniform Motion

- Visually show the motion of an object.

Time $t$ (s)	Position $\vec{d}$ (m [S])
0	0
60	330
120	660
180	990

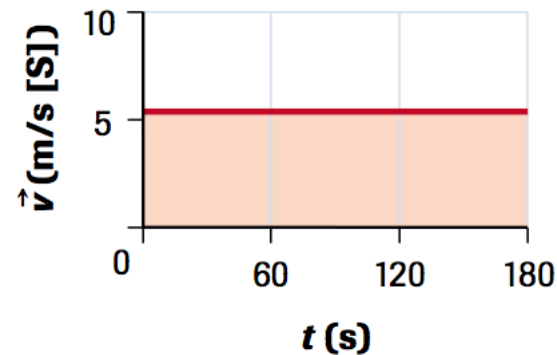
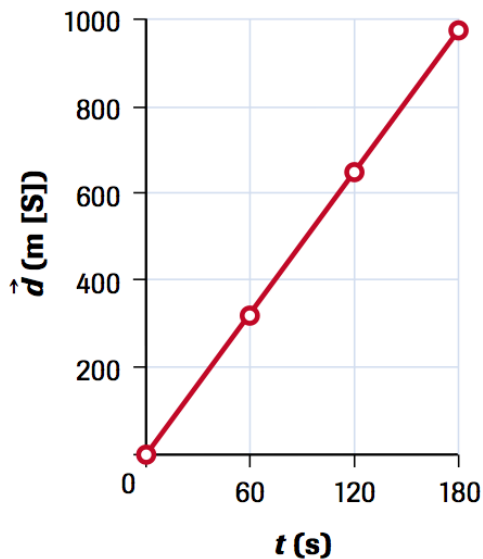


Position-Time Data

Position-Time & Velocity-Time Graphs

# Position-Time (PT) (a.k.a. Distance-Time) and Velocity Time (VT) Graphs

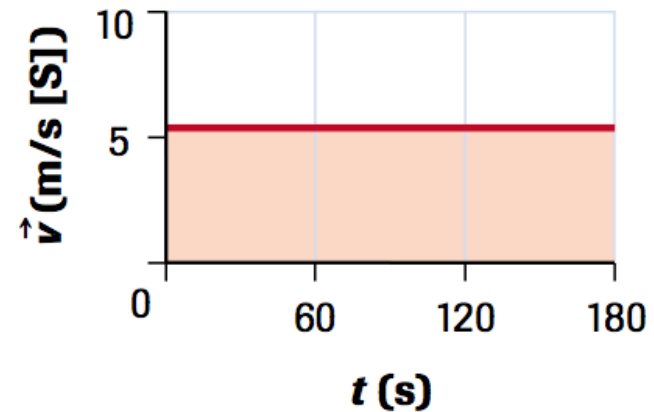
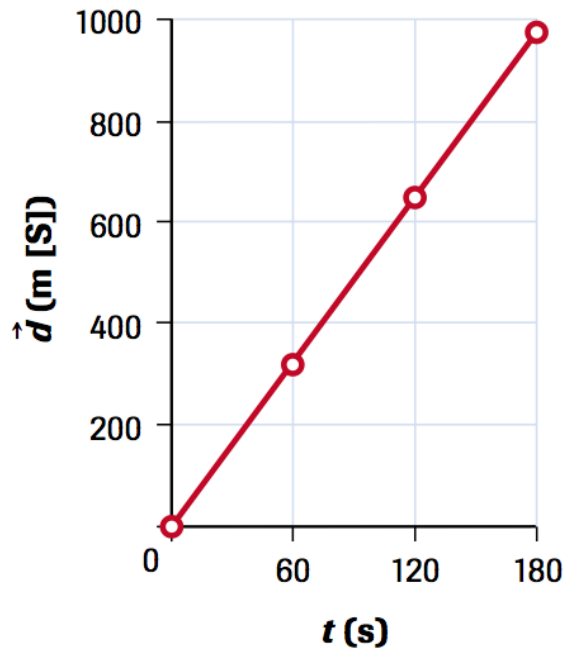
- Have a look at the graph below, they represent the same situation.
- Look at the slope of the PT graph on the left. What does it tell you?



# PT and VT Graphs

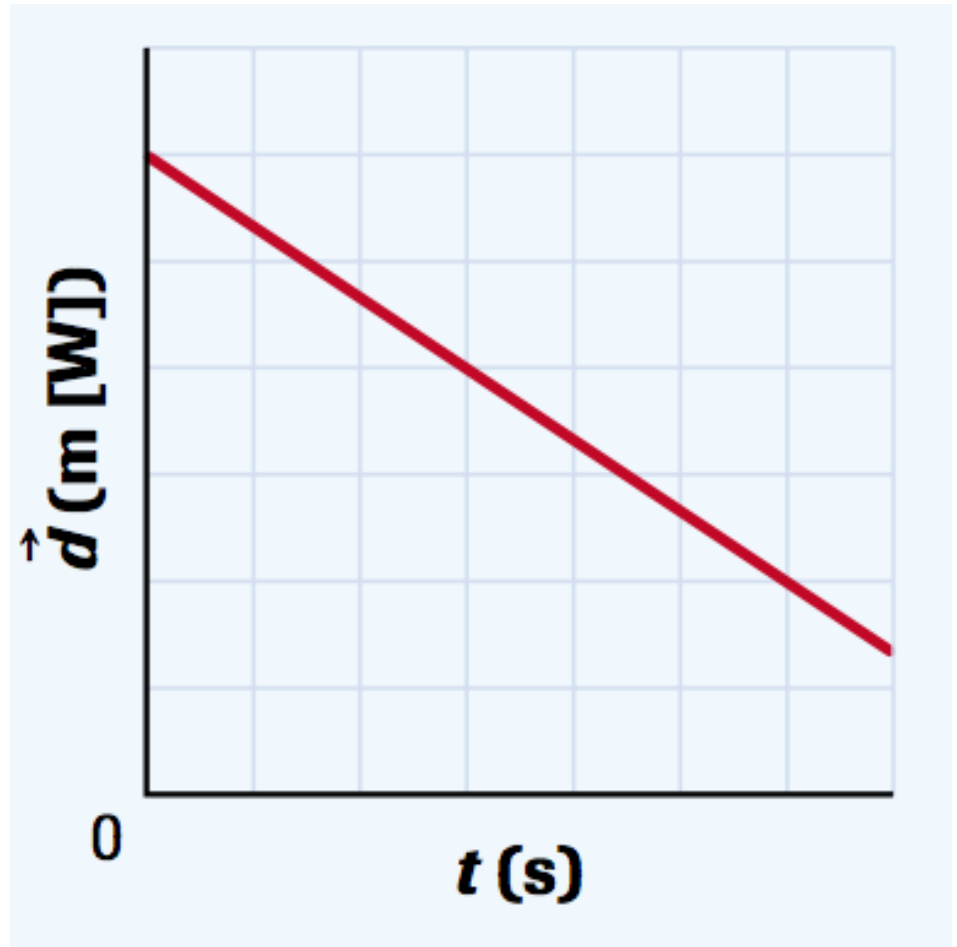
- The slope of the PT graph describes the

\_\_\_\_\_



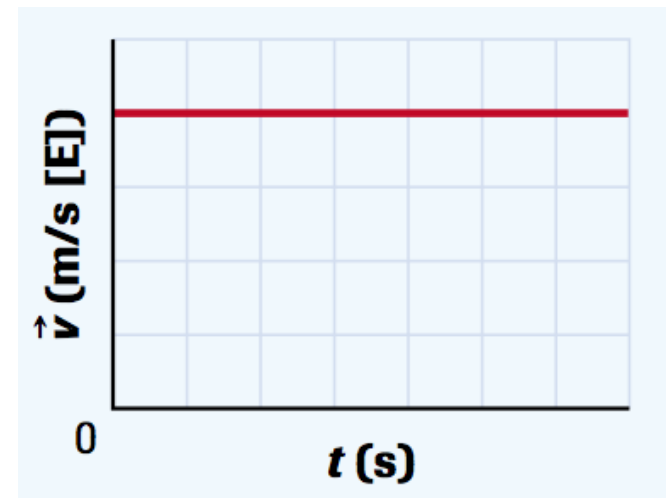
# Check Your Understanding

- Describe the motion for the graph on the right and sketch the corresponding velocity-time graph



# Check Your Understanding Solution

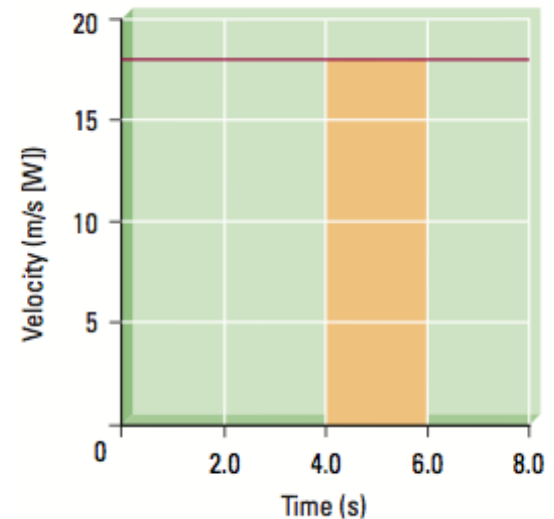
- \_\_\_\_\_



# PT and VT con't

- VT graphs also tell us about position.
- Recall our equation for average velocity (bottom left). If we rearrange it to find d,  $d = V_{AV} \Delta t$
- Using a VT graph, we can determine the displacement during any time period \_\_\_\_\_

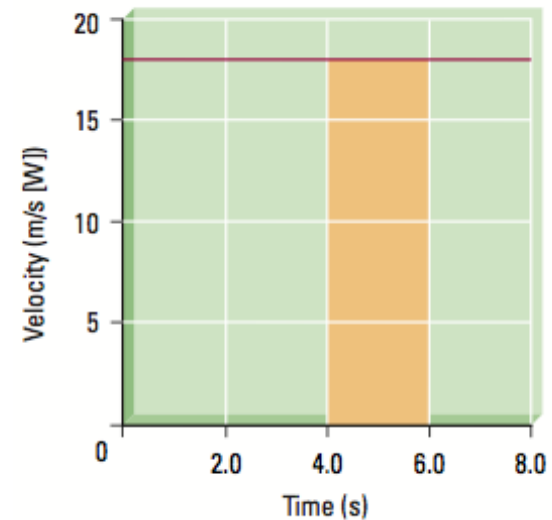
$$\vec{V}_{av} = \frac{\Delta \vec{d}}{\Delta t}$$





# Check Your Understanding

- Find the area of the shaded region in the graph below. State what that area represents.



# Check Your Understanding

- A military jet is flying with uniform motion at  $9.3 \times 10^2$  m/s [S]. At time zero, it passes a mountain top which is used as the reference point for this question.
  - a) Construct a table showing the plane's position relative to the mountain top at the end of each second for a 12 s period.
  - b) Use the data from the table to plot a position-time graph.
  - c) Find the slope of the line segment on the position-time graph. Is the slope constant? What does it represent?
  - d) Plot a velocity-time graph of the plane's motion.
  - e) Calculate the total area under the line on the velocity-time graph.
  - f) What does this area represent?