**Name _____** **Honors Physics**
**Mr. Dove** **Based on Chapters 2 and 3**

# Unit 2: 1D Motion
# A: Kinematics

**Unit Objectives:**

1. Know how to use and manipulate kinematic equations
2. Know how to calculate free fall problems
3. Describe and plot motion for distance vs time, velocity vs. time, and acceleration vs. time graphs
4. Calculate the velocity from a position vs. time graph and acceleration from a velocity vs. time graph
5. Calculate displacement from a velocity vs. time graphs

## I. Distance vs. Displacement

Kinematics: The study of motion without regard to the cause (i.e. – force).

**Position: Location at a specific time**

| **Displacement:** | **Distance:** |
|---|---|
| • _____ quantity<br>• Change in _____<br>WITH _____<br>• | • _____ quantitfy<br>• |

**Examples**:

1. Joe has a date with Jill. Her house is 5 km east of his, but he has to do some things before he picks her up. He first heads 7 km N of his house to get flowers. He then travels 5 km east to pick up the movie tickets. Then he heads to her house. What was he distance? What was his displacement?

2. Lance HoPhan bikes 15 km east then 30 km north. (a) What is the distance he traveled? (b) What is the magnitude of his displacement?

## II. Speed vs. Velocity

| **Average Velocity:** | **Average Speed:** |
|---|---|
| • _____ quantity | • _____ quantity |
| • _____ divided by time | • _____ divided by time |
| Equation: | Equation: |

**Examples**:

1. If Joe's drive in example 1 above takes him 30 min., determine his average speed and average velocity.

**Instantaneous Velocity:**

- Velocity at a particular instant in time.

**Instantaneous Speed:**

- Speed at a particular instant in time

**Questions**:

1. Is it possible to travel at a constant speed, but not a constant velocity? Explain.

2. A car travels 10 km due north, then 8 km due east in 30 minutes. Find the car's a) distance, b) displacement, c) average speed, and d) average velocity

## III. Acceleration

- _____ quantity
- Rate of change in _____

- **Acceleration Equations (see reference table):**

- **Units**:

**HOW TO COMPLETE ANY PHYSICS PROBLEM:**

1. List Givens
2. List what you want to find
3. Find correct equation and manipulate it to solve for desired variable
4. Plug in numbers with units

- **Examples**:
  a. A car starts from rest and reaches a speed of 55 m/s in 10 s. What is the car's acceleration?

b. A car is traveling 55 m/s and comes to a stop in 10 s. What is the car's acceleration?

c. Joe Fasulo is going 20 m/s and pushes down on the gas peddle and accelerates at 5 $m/s^2$ for 7 s. What is his final speed?

:

d. A car is accelerated at 4.0 $m/s^2$ from rest. When will the car reach a speed of 28 m/s?

## IV. Equation 2

- **When to use:**

| | d | a | $v_f$ | $v_i$ | t |
|---|---|---|---|---|---|
| ? ? ?? ? ? ? ?? | | | | | |

- **Examples**:
- A dragster accelerates at 8 $m/s^2$ from rest for 10s. What is the displacement of the object?

- What is the car's position at 3 s into the race?

- **Whiteboard**: A speedboat has an acceleration of +2.0 $m/s^2$. The initial velocity of the boat is +6m/s. What is the displacement of the boat after 8 s?

- **Whiteboard**: Billy starts riding his bike from rest and it takes him 10 s to travel 100 m. What was his acceleration?

- **Whiteboard**: Bear Grylls is in the Amazon and being chased by a jaguar. He starts to run away from the animal and hides behind a tree 100 m away. A) If his acceleration was 0.75 $m/s^2$, how long did it take him to hide? B) What was his final speed?

## V. Equation 3

- **When to use:**

| | d | a | $v_f$ | $v_i$ | t |
|---|---|---|---|---|---|
| ?? ? ?? ? ??? | | | | | |

- **Examples**:
- Linda is traveling to the mall at a speed of 30 m/s. She pushes down on the gas peddle and accelerates at 5 $m/s^2$ for 20 m. What is her final speed?

- What was her speed when she 5 m into her acceleration?

- **Whiteboard**: A man is running and accelerates at 2 $m/s^2$ for a distance of 7 m. He reaches a speed of 13 m/s. What was his initial speed?

- **Whiteboard**: David Ortiz hits a ball from Jaba Chamberlain. The ball starts from rest travels a distance of 150 m. It leaves the field traveling 90 m/s. What was the ball's acceleration?

- **Whiteboard**: Jim runs to the bathroom from class that is 30 m away. He starts from rest and flies into the bathroom with a speed of 9 m/s. A) What was his acceleration? B) How long did it take him to make it to the bathroom?

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# Unit 2: 1D Motion
# B: Free Fall

## I. Free Fall

- **Definition** – acceleration due to gravity is the acceleration of an object in free fall that results from the influence on Earth's gravity
- **Acceleration** is a **VECTOR** quantity (magnitude AND direction)
- Acceleration due to gravity = _____ = _____
- Neglecting air resistance, _____ fall with the same

  _____ (regardless of _____ )

## II. Example: Setting up Free Fall Problems

1. A man pushes a huge boulder off a cliff 50 meters high.

A) What is the boulder's velocity when it hits the ground?

B) When does the boulder hit the ground?

## III. Motion Graphs for Acceleration Due to Gravity

**Example:** From the above example, make position vs. time, velocity vs. time, and acceleration vs. time graphs.

Position (m)

Velocity (m/s)

Acceleration ($m/s^2$)

## IV. Tossing a Ball up in the Air

- **Velocity at top of the flight (max. height) = _____**
- **Time to reach max. height = _____**
- **Magnitude of initial speed = _____**

_____

## V. Free Fall Examples

1. A stone falls freely from rest for 8.0 s.
   A) Calculate the stone's velocity after 8.0 s.

   B) What is the stone's displacement during this time?

2. A ball is thrown directly up with a speed of 12.0 m/s.

A) What is its maximum height?

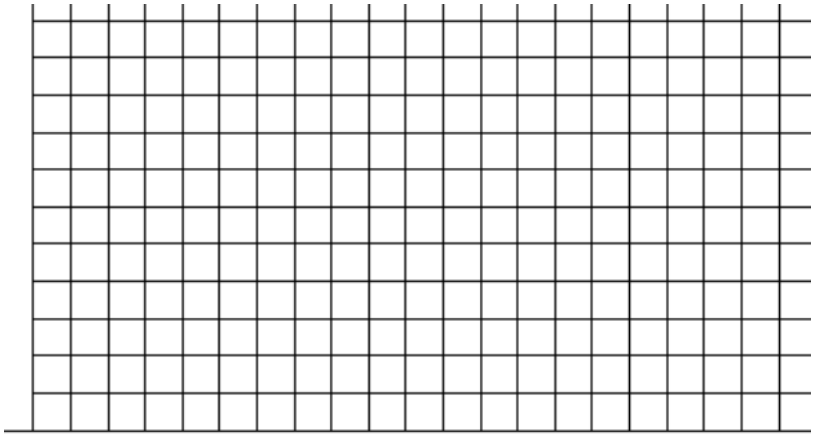
B) How long does it take the ball to reach its maximum height?

C) How long does it take for the ball to land back in your hand?

# Unit 2: 1D Motion
# C: Graphing Motion

## I. Graphing Motion

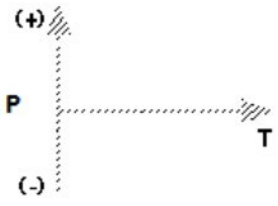
- A student starts at 0 meters and walks away traveling 10 m in 5 seconds. Then he stops for 5 seconds. Finally, he walks 4 m in 10 seconds back towards the detector and stops. Make distance vs. time graph of the student's motion below.

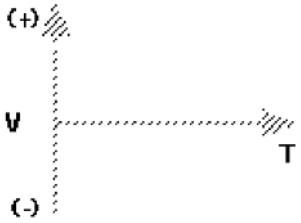


- **How to Calculate Velocity from a Position vs. Time graph:**

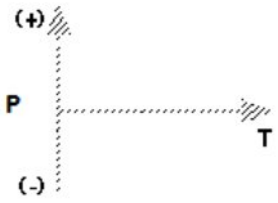
## II. Velocity vs. Time Graphs for Constant Velocity

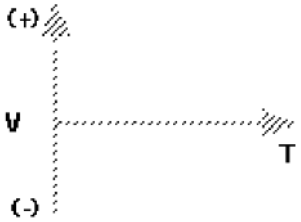
1. How would you plot a P vs. T and V vs. T graph for a person walking at a constant speed:



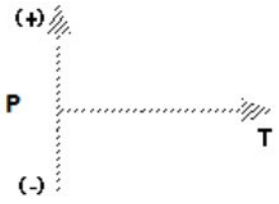



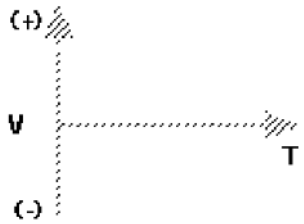

2. How would you plot a P vs. T and V vs. T graph for a person standing still:



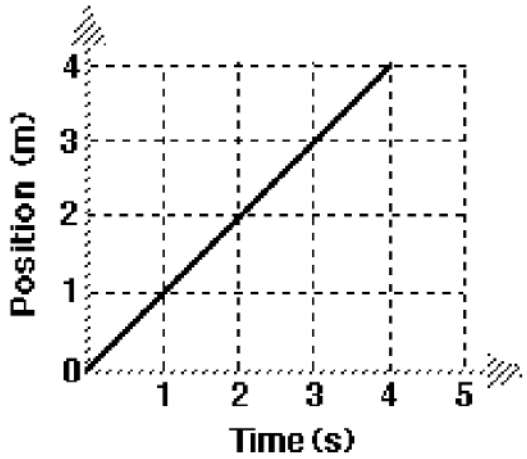



- How would you plot a P vs. T and V vs. T graph for a person moving toward the origin at a steady speed for 10 s, then stands still for 10 s.

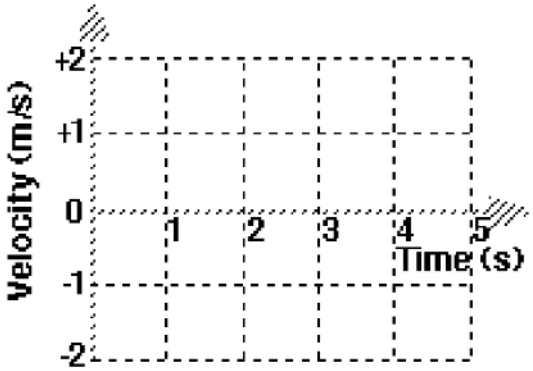


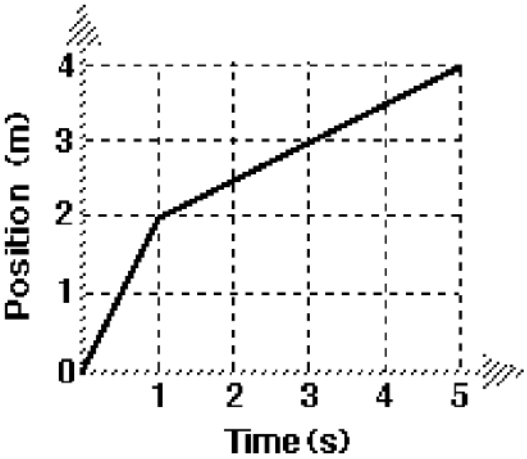




3. Calculate the slope of each graph then sketch what the corresponding velocity vs. time graph:

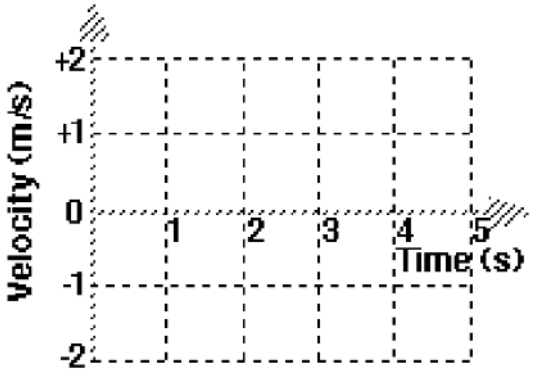



**Slope**:



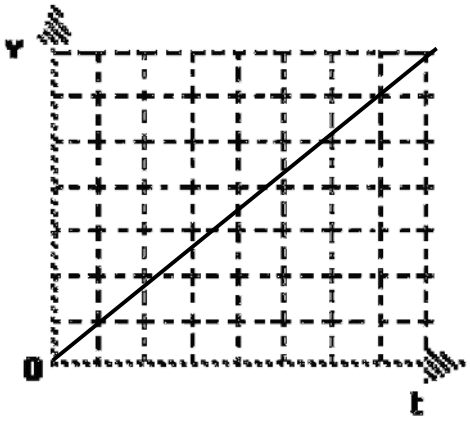




**Slope:**



## III. Velocity vs. Time Graphs for Non-Constant Velocity

You pull out of the EZ-Pass lane starting from rest and reach a reach a velocity of 25 m/s (≈55 mph) in 8 s. Graph this below:

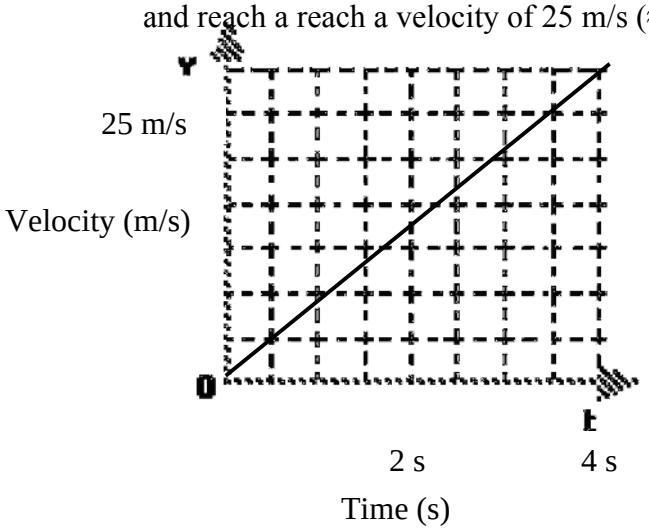



1. What is changing in the graph:

2. Calculate the slope of the line:

## IV. Area Under a Velocity vs. Time Graph

Consider the same situation from above:You pull out of the EZ-Pass lane starting from rest and reach a reach a velocity of 25 m/s (≈55 mph) in 8 s.



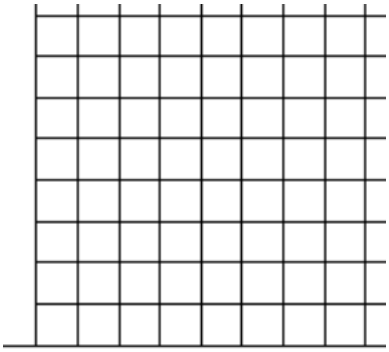

Calculate the area under the line:

Conclusion:

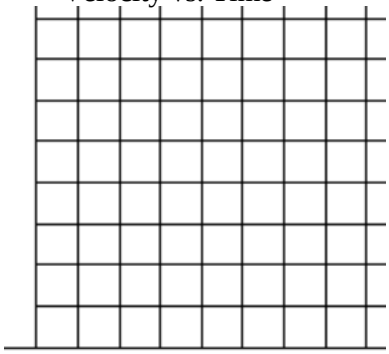
## V. Position, Velocity, and Acceleration vs. Time Graphs for Motion

- An object goes from 0 to 5 m/s in 2 seconds then remains at a constant speed for 3 s. Sketch what the three motion graphs would look like:

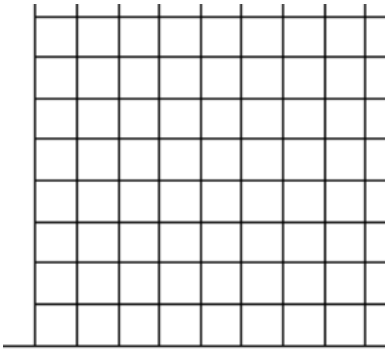
Position vs. Time



Velocity vs. Time



Acceleration vs. Time



## VI. Summary of Graphing Motion

- **Position vs. Time Graphs**
  - Straight horizontal lines indicate _____
  - Straight angled lines indicate _____
  - Curved lines indicate _____
  - Slope equals _____
- **Velocity vs. Time Graphs**
  - Straight horizontal lines indicate _____
  - Straight angled lines indicate _____
  - Slope equals _____
  - Area under the line equals _____