1. Introduction & How to Write Motion

Grade 11 – Physics

Introduction

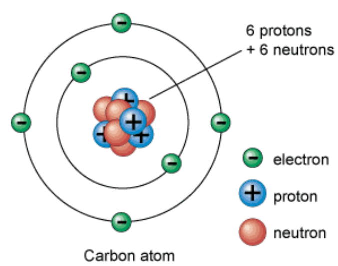
My Information

- Background

- Email:

Introduction

- Physics
  - Attempts to explain and predict interactions between matter and energy
  - Tiny: subatomic level – neutron, proton, electron and photon
  - Gigantic: super macroscopic level – meteor, planet, stars and the universe.

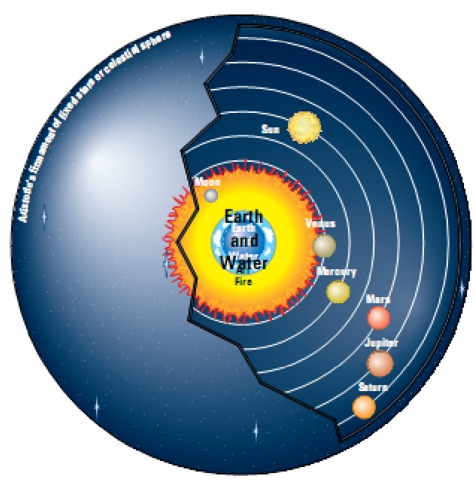


Introduction (Cont.)

- Why is Physics important?

Introduction (Cont.)

- Two Models from Aristotle
  - Movement of the objects on Earth
    - Four elements or essences: earth, water, air and fire.
    - A rightful place for all elements
  - Movement of the stars
    - Fifth essence
    - Invisible sphere – supporting the celestial bodies



Introduction (Cont.)

- Galileo and Scientific Inquiry
  - Earth and other planets orbit around the Sun in our solar system. (Primitive Telescope)
  - Conducted Experiment: Objects falls at the same rate

Introduction (Cont.)

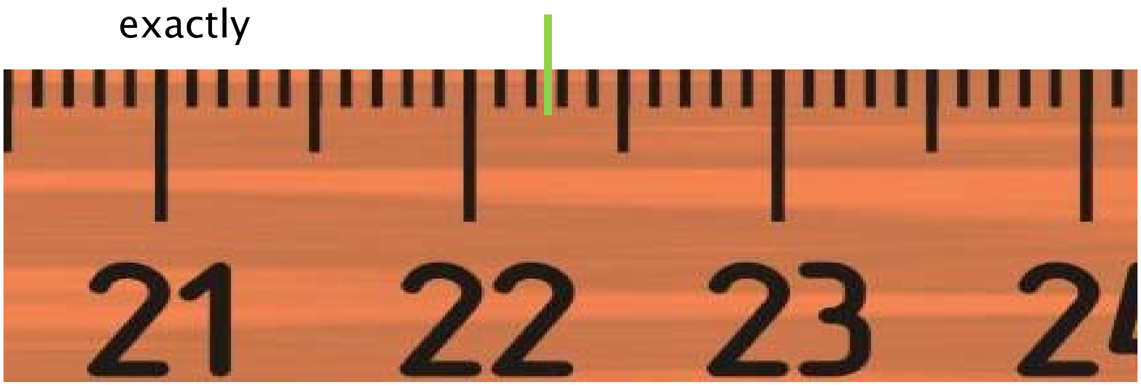
- Thinking Scientifically
  - Theory: brain storming, collect ideas
  - Model: a representation of the phenomena
  - Observation: gather information qualitatively or quantitatively.

Introduction (Cont.)

- Framing A Problem
  - Organize information: Bullet form, sketches, written text etc.
  - Understand the problem: know what the problem is asking you.
  - Solve the problem: formulate a way to solve the questions asked.
  - Review your answer: check the answer against the problem see if the answer make sense.

Introduction (Cont.)

- Significant Figures
  - We can count exactly; however, we can not **measure** exactly



  - If we are measuring the height of a table, then the height could be different when it is measured by different people.

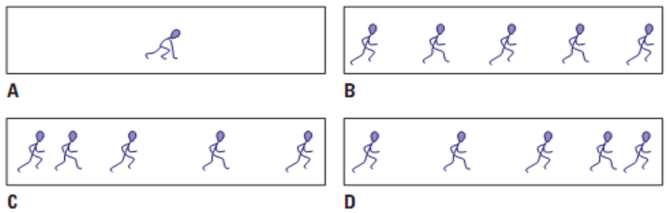
Introduction (Cont.)

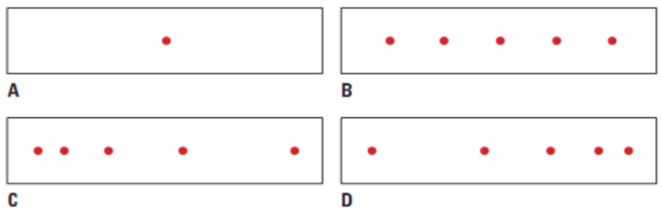
- Significant Figures
  - The last digit of the height is **VERY** important
  - **62.4** has **3** significant digits
  - **0.0310** has **3** significant digits as well, and it should be written in 3.10×10^{-2}

How to Write Motion

How to Write Motion

- Center of Weight
  - The four different picture shows four different kinds of motion





How to Write Motion (Cont.)

- Frame of Reference
  - Relative to the observer
  - A pedestrian sees a car which is moving forward pass by him. The driver sees the pedestrian which is moving backward pass by him.

How to Write Motion (Cont.)

- Relative Motion
  - Sitting in a car while viewing outside
  - Sitting in a car while viewing the driver

  - Unaware the motion relative to the ground (in a car or in a commercial airliner)

How to Write Motion (Cont.)

- Relative Motion (cont.)
  - Sudden stop of a car

  - Car Accident
    - Smashing against a brick wall
    - Smashing against another coming traffic which travels at the same speed

How to Write Motion (Cont.)

- Distance and Displacement
  - Displacement (regarding the initial and final position)
    - Vector (magnitude and direction)
  - Distance (regarding the path of movement)
    - Scalar (magnitude only)

Scalar quantities		Vector quantities	
Quantity	**Example**	**Quantity**	**Example**
distance	15 km	displacement	15 km[N45°E]
speed	30 m/s	velocity	30 m/s [S]
		acceleration	9.81 m/s^2 [down]
time interval	10 s		
mass	6 kg		

How to Write Motion (Cont.) Displacement

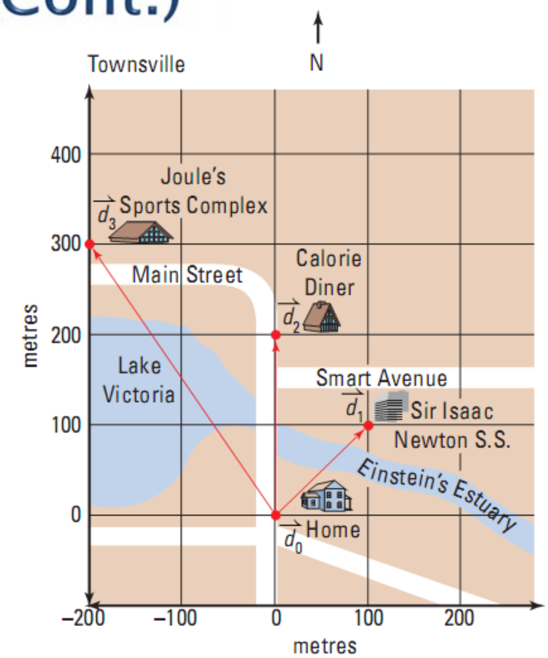
- Displacement
  - If one object travels back to the initial position, then the displacement equals 0

$$\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$$

Quantity	Symbol	SI unit
displacement	$\Delta\vec{d}$	m (metre)
final position	$\vec{d}_2$	m (metre)
initial position	$\vec{d}_1$	m (metre)

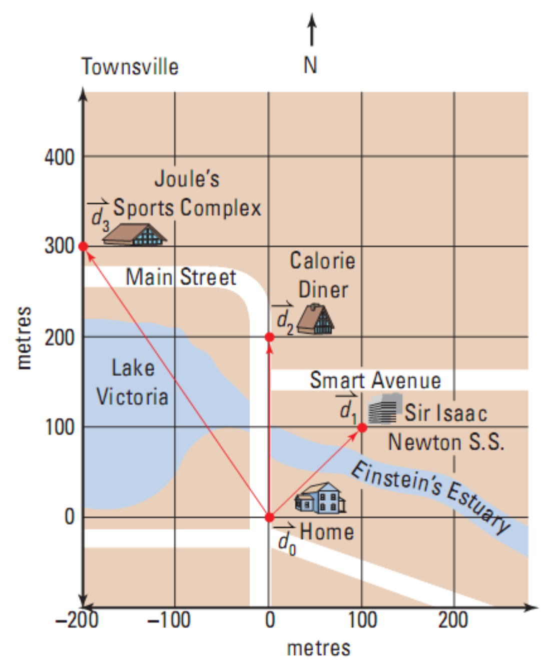
How to Write Motion (Cont.)
Displacement (Cont.)

- EX1.
  - Determine the 3 displacements between Freda's home and the other three buildings
    - Home to school
      - 141m
    - Home to diner
      - 200m
    - Home to sports complex
      - 360m



How to Write Motion (Cont.)
Displacement (Cont.)

- EX1: (Cont.)
  - What is the total distance and displacement if Freda goes to school, dinner, then sports complex everyday?
    - Total Distance
      - 700m
    - Displacement
      - 360m



How to Write Motion (Cont.) Displacement (Cont.)

- EX2:
  - Dawn starts from zero, and bikes 2km east, then 3km west. (a) Draw a vector diagram, and (b) find her final position.

- EX3:
  - Dawn starts from 0 again, but this time she goes 2km north and then 3km east, (a) Draw a vector diagram and (b) find her final position.

How to Write Motion (Cont.) Velocity

- Velocity
  - The rate of change of position.
  - Displacement over changing time.

$$\vec{v}_{\text{ave}} = \frac{\Delta \vec{d}}{\Delta t} \quad \text{or} \quad \vec{v}_{\text{ave}} = \frac{\vec{d}_2 - \vec{d}_1}{t_2 - t_1}$$

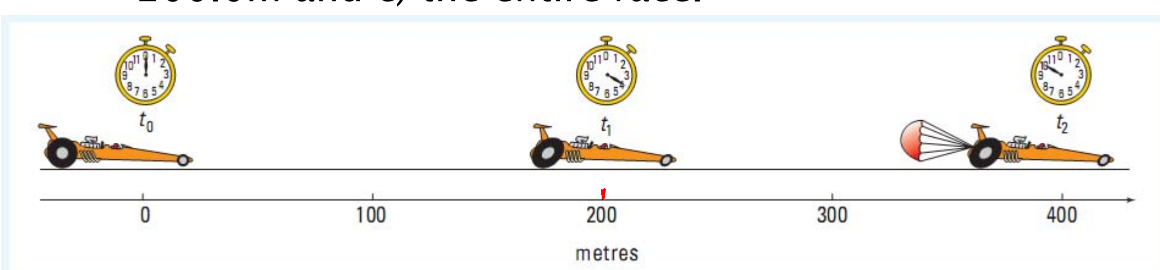
Quantity	Symbol	SI unit
average velocity	$\vec{v}_{\text{ave}}$	$\frac{\text{m}}{\text{s}}$ (metres per second)
displacement	$\Delta \vec{d}$	m (metres)
time interval	Δt	s (seconds)

How to Write Motion (Cont.) Velocity (Cont.)

- EX4:
  - Does **speedometer** of a car provide speed or velocity?
    - Speed
- EX5:
  - A student runs around a 400m oval track in 80s. Would the average velocity and average speed be the same? Explain?
    - **Depends – if the student stopped at the initial position, then the average velocity is actually 0**

How to Write Motion (Cont.) Velocity (Cont.)

- EX6:
  - A dragster in a race is timed at the 200.0m and 400.0m points. The time are shown on the stopwatches in the diagram. Calculate the average velocity for a) the first 200.0m, b) the second 200.0m and c) the entire race.

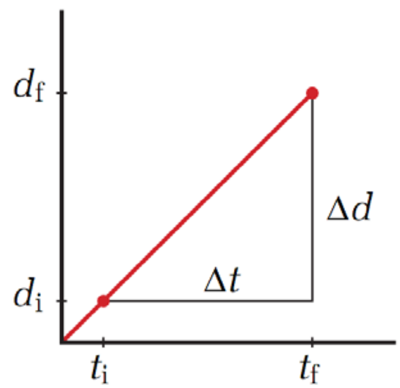


a)50.0m/s[E]
b)33.3m/s[E]
c)40m/s[E]

How to Write Motion (Cont.) Velocity (Cont.)

- Constant Velocity
  - Velocity is not changing over time

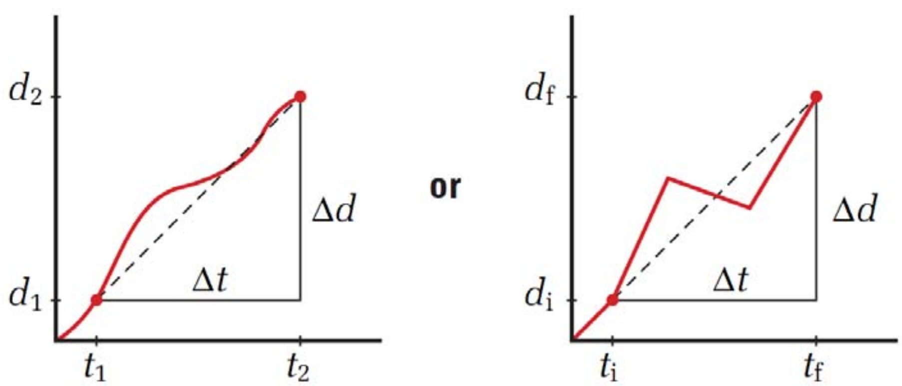
Displacement VS Time Graph



How to Write Motion (Cont.) Velocity (Cont.)

- Average Velocity
  - An average value over time

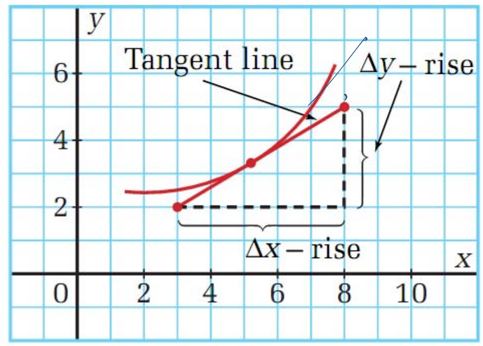
Displacement VS Time Graph



How to Write Motion (Cont.)
Velocity (Cont.)

- Instantaneous Velocity
  - The instantaneous velocity of an object, at a specific point in time, is the slope of the tangent to the curve of the position time graph of the object's motion at that specific time.

Displacement VS Time Graph



How to Write Motion (Cont.)
Acceleration

- Acceleration
  - The rate of change of velocity
  - Changing velocity over changing time

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

Quantity	**Symbol**	**SI unit**
acceleration	$\vec{a}$	$\frac{\text{m}}{\text{s}^2}$ (metres per second squared)
change in velocity	$\Delta \vec{v}$	$\frac{\text{m}}{\text{s}}$ (metres per second)
time interval	Δt	s (seconds)

Unit Analysis

$$\frac{\frac{\text{metres}}{\text{second}}}{\text{second}} = \frac{\frac{\text{m}}{\text{s}}}{\text{s}} = \frac{\text{m}}{\text{s}^2}$$

How to Write Motion (Cont.)
Acceleration (Cont.)

- EX9:
  - A skater is going +10m/s at t=0s. Five seconds later, he is going +30m/s. What is his average acceleration?

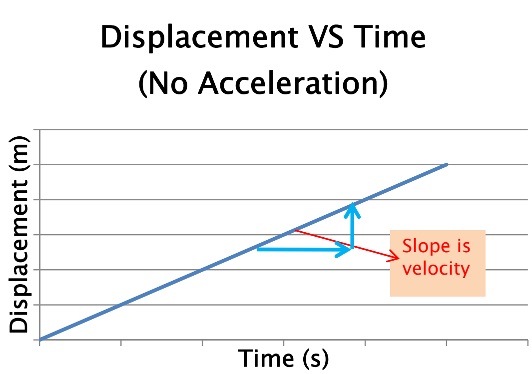
4m/s^2

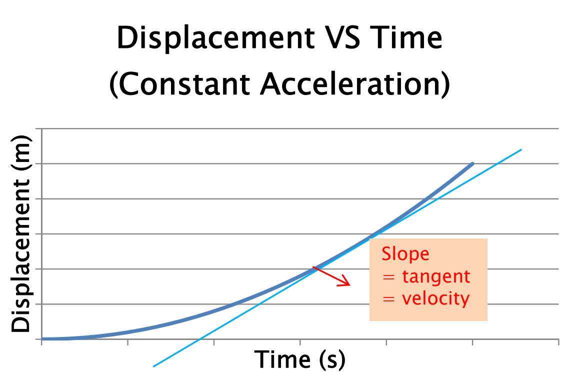
- EX10:
  - A car is traveling in a straight line along a highway at a speed of 20m/s. The driver steps on the gas pedal and, 3 seconds later, the car's speed is 32m/s. Find its average acceleration.

4m/s^2

How to Write Motion (Cont.)
DvsT – Based on Acceleration

- Uniformly Accelerated Motion
  - Displacement (m) VS Time (s)
    - Slope = velocity (m/s)

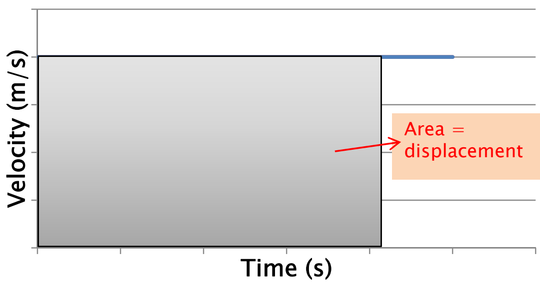




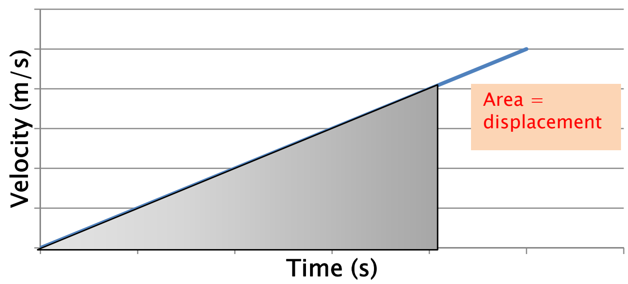
How to Write Motion (Cont.) VvsT – Based on Acceleration

- Uniformly Accelerated Motion
  - Velocity (m/s) VS Time (s)
    - Area = displacement (m)
    - Slope = acceleration (m/s^2)

Velocity VS Time
(No Acceleration)



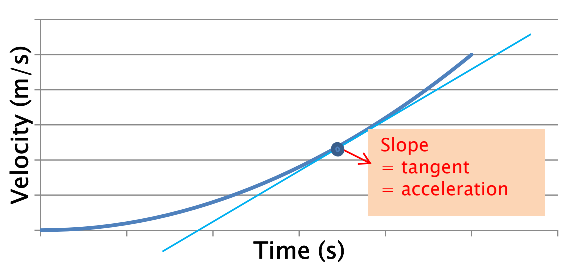
Velocity VS Time
(Constant Acceleration)

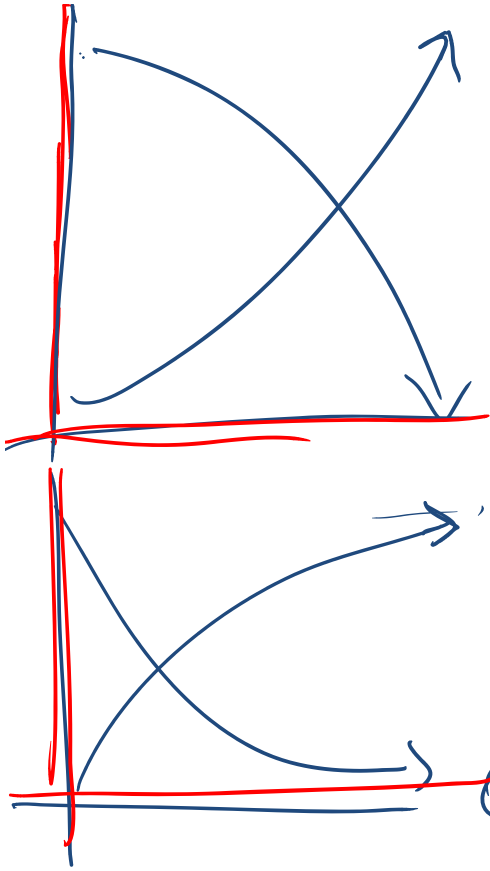


Acceleration (Cont.)

- Non-Uniformly Accelerated Motion
  - Velocity (m/s) VS Time (s)
    - Slope = acceleration (m/s^2)

Velocity VS Time
(Increasing Acceleration)





1 => slope 0 -> (+) ↓(+) -> ↑(+)
Increasing velocity
car -> (+) direction

0, -1, -2, -3, -4

2 => slope 0 -> (-) ↓(-) - ↑(-)
Increasing velocity
car -> (-) direction

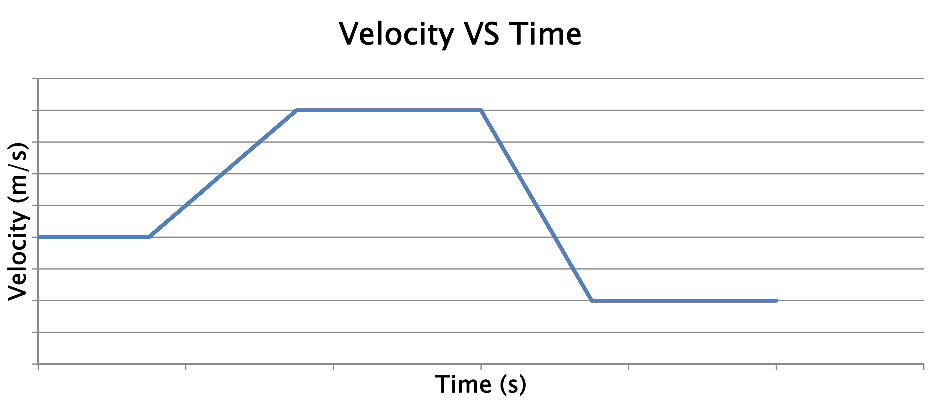
3 => Slope (+) -> 0 ↑(+) - ↓(+)
Decreasing velocity
car -> (+) direction

-9999 -> -1

4 => slope (-) -> 0 ↑(-) - ↓(-)
Decreasing velocity
car -> (-) direction

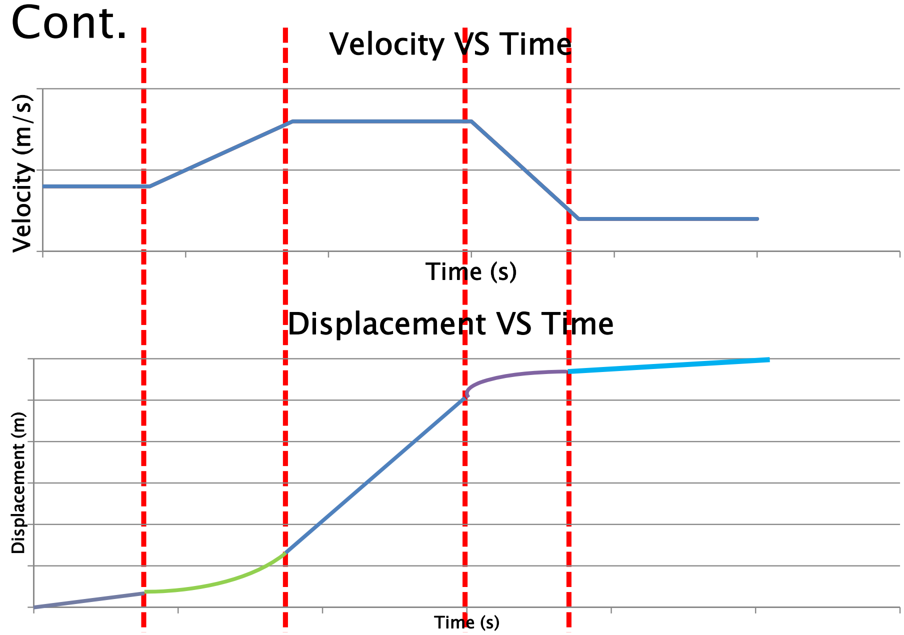
How to Write Motion (Cont.)

- Ex11. Change the following graph to Displacement VS Time graph (assuming displacement starts at zero)



Example Problem

- Ex11. Cont.



Mathematical Models of Motion 1D – Kinematics

- Final Velocity
  - Example Derivation

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

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

$$v_f - v_i = a\Delta t$$

$$v_f = v_i + a\Delta t$$

Mathematical Models of Motion 1D – Kinematics (Cont.)

- One Dimensional Motion: (The BIG FIVES)
  - In one dimensional motion, the vector indicator is not necessary because the (+) and (–) is sufficient to indicate the direction of the object.

$$\Delta d = v_1 t + \frac{1}{2} a \Delta t^2$$

$$\Delta d = v_2 t - \frac{1}{2} a \Delta t^2$$

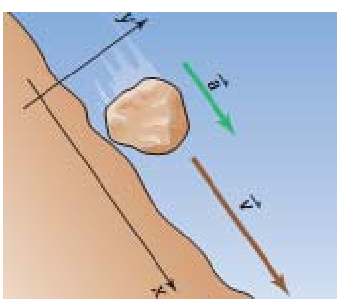
$$\Delta d = \frac{v_2 + v_1}{2} \Delta t$$

$$v_2^2 = v_1^2 + 2 a \Delta d$$

$$v_2 = v_1 + a \Delta t$$

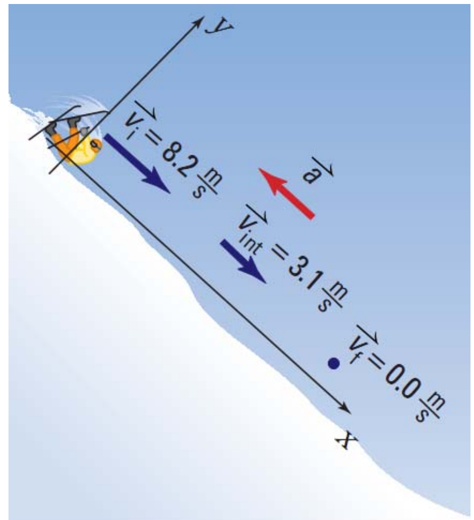
Mathematical Models of Motion 1D – Kinematics (Cont.)

- EX12:
  - A slight earth tremor causes a large boulder to break free and start rolling down the mountainside with a constant acceleration of 5.2m/s^2. What was the boulder's velocity after 8.5s?



Mathematical Models of Motion 1D – Kinematics (Cont.)

- EX13:
  - A skier is going 8.2m/s when she falls and starts sliding down the ski run. After 3.0s, her velocity is 3.1m/s. How long after she fell did she finally come to a stop? (Assume that her acceleration was constant.)



Mathematical Models of Motion 1D – Kinematics (Cont.)

- EX14:
  - A car travels east along a straight road at a constant velocity of 18m/s. After 5.0s, it accelerates uniformly for a 4.0s When it reaches a velocity of 24m/s, the car proceeds with uniform motion for 6.0s. Determine the car's total displacement during the trip.

Mathematical Models of Motion 1D – Kinematics (Cont.)

- EX15:
  - A truck is travelling at a constant velocity of 22m/s north. The driver sees a traffic light turn from red to green soon enough, so he does not have to alter his speed. Meanwhile, a woman in a sports car stopped at the red light. At the moment the light turns green and the truck passes her, she begins to accelerate at $4.8m/s^2$. How far have both vehicles travelled when the sports car catches up with the truck? How long did it take for the sports car to catch up with the truck.