UNIT #1 KINEMATICS

Acceleration

Acceleration

- acceleration = how quickly an object's velocity changes over time
- = the rate of change of velocity

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

ex: What is the average acceleration of a person who increases his velocity from 0 to 25m/s in 10s?

2 sig digs

0 m/s to 25 m/s [E]

- recall...
  - straight line on position-time graph = uniform motion
  - curved line on position-time graph = NON-uniform motion

10 s → 1 sig dig

1.0×10^{1} s → 2 sig digs

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

Δ ↓ change in

$$\vec{a} = \frac{\vec{V}_2 - \vec{V}_1}{\Delta t}$$

$$= \frac{25 \text{ m/s [E]} - 0 \text{ m/s}}{1.0 \times 10^{1} \text{ s}}$$

$$= \frac{25 \text{ m/s [E]}}{1.0 \times 10^{1} \text{ s}}$$

$$\vec{a} = 2.5 \text{ m/s/s [E]}$$

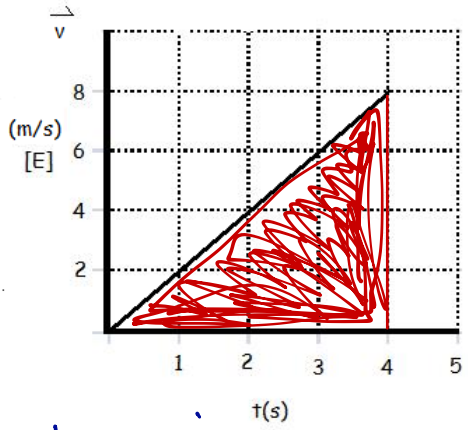
$$= 2.5 \text{ m/s}^2 \text{ [E]}$$

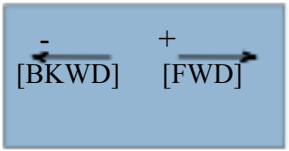
$\vec{a} = 2.5\ m/s^2\ [\vec{i}]$

every second the velocity increases by 2.5 m/s

If our answer for acceleration is (−) it means the object is slowing down.

Velocity-Time Graphs





1. type of graph
2. numbers
3. slope

Area of Triangle $= \frac{bh}{2}$

$= \frac{(s)(\frac{m}{s})}{2}$

units are metres

$\frac{\text{rise}}{\text{run}} = \frac{m/s}{s}$

$= m/s^2$

Slope $= \frac{\text{rise}}{\text{run}}$

∴ slope of v–t is acceleration

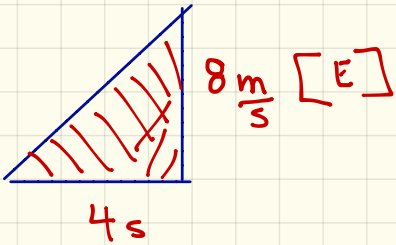
$$\frac{\frac{m}{s}}{s}$$

dividing fractions multiply by reciprocal of denominator

$$\frac{\frac{m}{s}}{\frac{s}{1}}$$

$$= \frac{m}{s} \times \frac{1}{s}$$

$$= \frac{m}{s^2}$$



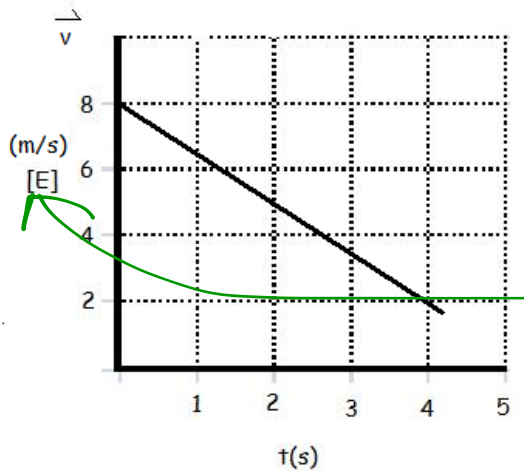
$$A = \frac{(4\text{ s})\left(8\ \frac{\text{m}}{\text{s}}\right)[\text{E}]}{2}$$

$$A = \frac{32\text{ m}\,[\text{E}]}{2}$$

$$A = 16\text{ m}\,[\text{E}]$$

∴ The object had a displacement of 16 m [E].

Velocity-Time Graph

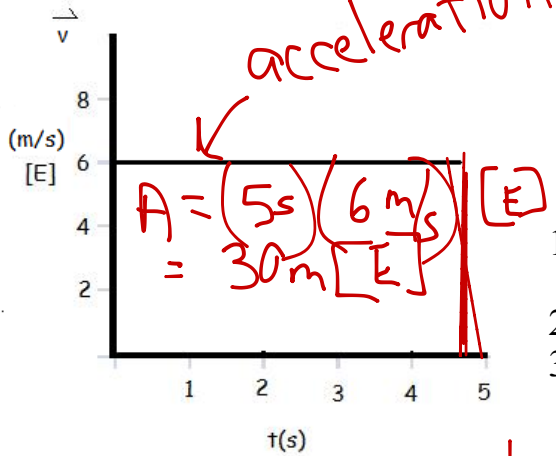


-	+
[BKWD]	[FWD]

1. type of graph
2. numbers
3. slope

Negative slope
∴ acceleration is [W]
∴ slowing down

Velocity-Time Graph



- [BKWD]
+ [FWD]

1. type of graph
2. numbers
3. slope

object moving at constant speed.

Quiz Tuesday

sig digs

position-time

class note + ~~text~~ book pg 650 - 651

$t = 100\,s$ (1 sig dig)

$d = 640\,m$ (2 sig digs)

$v = ?$

answer only 1 sig dig

$$v = d/t$$

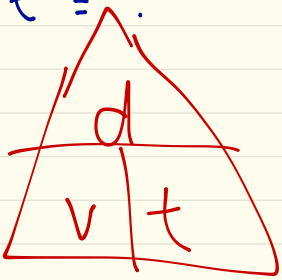
$$= \frac{640\,m}{100\,s} = 6.4\,m/s$$

$$\doteq 6\,m/s$$

$v = 6.25 \times 10^{2}$ m/s (3 sig digs)

$d = 105$ m (3 sig digs)

$t = ?$

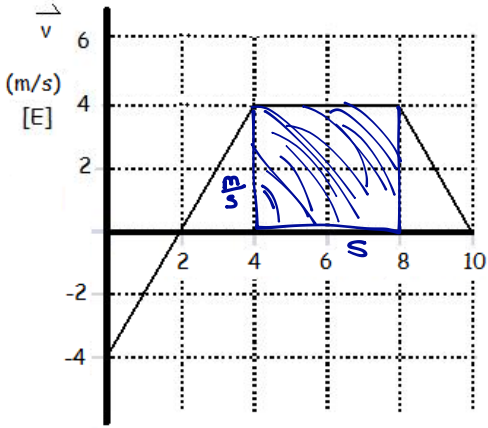


$$t = \frac{105\text{ m}}{625\text{ m/s}}$$

$t = 0.168$ s

3 sig digs

Velocity-Time Graphs



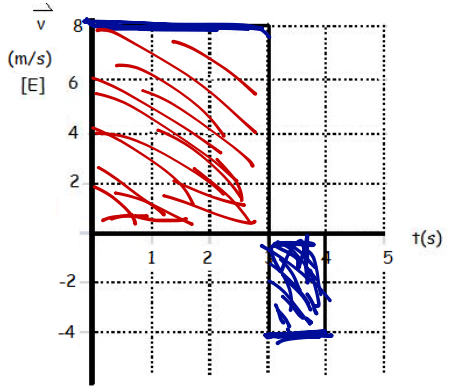
Checking units
(Dimensional Analysis)

$\frac{m}{s} \times s$

$= m$

$4\frac{m}{s} \times 4s = 16\,m\,[E]$

Area Under Velocity-Time Graph



$-[E]\ 8\frac{m}{s}[E] \times 3s = 24[E]$

$-[W]\ \frac{4m}{s}[W] \times 1s = 4m[W]$

- distance = how far you have walked (total) 28m
- displacement = how far you are from where you started...requires DIRECTION 20 m [E]

Acceleration

SPH3U: Acceleration

Acceleration is the **rate of change** of velocity (the slope of a velocity-time graph):

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$$

Example: an acceleration of 5 m/s/s (or 5 m/s^2) means that the velocity of an object increases by 5 m/s **every** second

Initial Velocity (t = 0)	t = 1 s	t = 2 s	t = 3 s
20 m/s [E]	25 m/s [E]	30 m/s [E]	35 m/s [E]

What will be the velocity of the object after 6 s?

$V = 20\,m/s\,[E] + 5\,m/s^2\,(6\,s)\,[E]$

$= 20\,m/s\,[E] + 30\,m/s\,[E]$

$= 50\,m/s\,[E]$

Dimensional Analysis

$\frac{m}{s^2} \times s$

$\frac{m}{s \times s} \times s = m/s$

Sample Problems

Problems:

1. Car A accelerates from rest (0 m/s) to 27.8 m/s in 16.0 s. Car B takes 8.0 s in the same test. Which car has the greater average acceleration?

Car A

Given:

$\Delta t =$ 16.0 s

$\vec{v}_1 =$ 0 m/s

$\vec{v}_2 =$ 27.8 m/s

$\vec{a} =$ $\frac{v_2 - v_1}{\Delta t}$

$= \frac{27.8\ m/s - 0\ m/s}{16.0\ s}$

$= \frac{27.8\ m/s\ [E]}{16.0\ s} = 1.74\ m/s^2\ [E]$

[E]

Car B

Given:

$\Delta t =$ 8.0 s

$\vec{v}_1 =$ 0 m/s

$\vec{v}_2 =$ 27.8 m/s [E]

$\vec{a} =$ $\frac{v_2 - v_1}{\Delta t}$

$= \frac{27.8\ m/s\ [E] - 0\ m/s}{8.0\ s}$

$= \frac{27.8\ m/s\ [E]}{8.0\ s}$

$\vec{a} = 3.5\ m/s^2\ [E]$

Sample Problems

Kirsten rides her bike up a ramp – at the bottom of the ramp, she is riding at 5.6 m/s. When she reaches the top, she is traveling at 1.8 m/s. If it takes her 28 s to ride up the ramp, what is her acceleration? (-0.13 m/s^2)

Given: $v_1 = 5.6\ m/s\ [\uparrow]$ [↑] +

$v_2 = 1.8\ m/s\ [\uparrow]$

$\Delta t = 28\ s$

Required: acceleration ($\vec{a}$)

Analysis: $\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$

Steps

$\vec{a} = \frac{v_2 - v_1}{\Delta t}$

$= \frac{1.8\ m/s\ [\uparrow] - 5.6\ m/s\ [\uparrow]}{28\ s}$

$= \frac{-3.8\ m/s\ [\uparrow]}{28\ s}$

$$\vec{a} = \frac{-3.8 \text{ m/s } [\uparrow]}{28 \text{ s}}$$

$$\vec{a} = -0.1357 \frac{\text{m}}{\text{s}^2} [\uparrow]$$

$$\vec{a} = -0.14 \frac{\text{m}}{\text{s}^2} [\uparrow]$$

Homework

- READ 1.3 if you haven't already done so
- p. 30 #4-10
- Read 1.4