Kinematics Review (Chp 1)

#1 Uniform motion is constant and follows a predicted pattern. An example for this would be placing a car in cruise control.

Nonuniform motion changes its speed. An example of this would be something that accelerates to a constant speed before slowing down to a stop.

#2 $\Delta\vec{d} = \vec{v}_{av}\Delta t$

$\Delta\vec{d} = (3.00\times10^8 m/s)(2.51s)$

$\Delta\vec{d} = 7.53\times10^8 m \div 2$

$\boxed{\Delta\vec{d} = 3.77\times10^8 m \text{ [from the Earth to the Moon]}}$

The distance betw the Earth and Moon is 3.77×10^8 meters.

#3 $\Delta t = \dfrac{\Delta\vec{d}}{\vec{v}_{av}}$

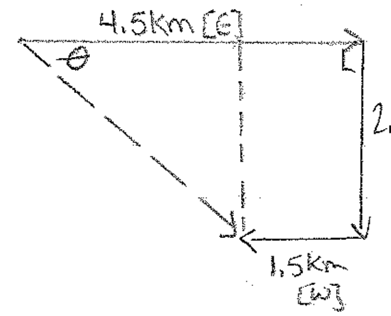
$\Delta t = \dfrac{12500m}{112 m/s}$

$\boxed{\Delta t = 112s}$

It took the driver 112 seconds (or 1.87 minutes) to complete one lap of the race.

#4 Let 1Km = 1cm

a)



b) $V_{av} = \dfrac{\Delta d}{\Delta t}$

$V_{av} = \dfrac{8.5Km}{2.0h}$

$\boxed{V_{av} = 4.3 Km/hr}$

The average speed is 4.3 Km/hr.

c) $c^2 = a^2 + b^2$

$c^2 = (3.0Km)^2 + (2.5km)^2$

$c = 3.9Km$

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

$\vec{V}_{av} = 3.9Km / 2.0h$

$\vec{V}_{av} = 2.0 Km/hr$

→

$\tan\theta = \frac{o}{a}$

$\theta = \tan^{-1}(2.5\,km / 3.0\,km)$

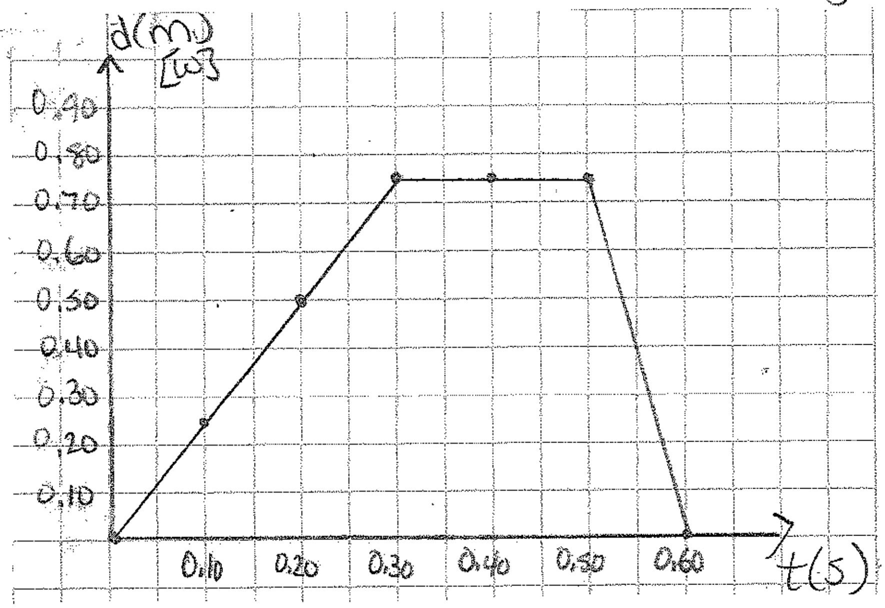
$\theta = 40°$ [S of E]

$$\boxed{\vec{V}_{av} = 2.0\,km/hr,\ 40° \text{ [S of E]}}$$

The boats average velocity is 2.0km, 40° south of east.

#5 a) Slope of position-time is <u>velocity</u>.
b) Area of velocity-time is <u>distance</u>.
c) Area of acceleration-time is <u>velocity</u>.

#6 a)



b) <u>0.10s</u>

$V = \frac{d}{t}$

$V = \frac{0.25m}{0.10s}$

$V = 2.5\,m/s$ [W]

<u>0.40s</u>

$V = d/t$

$V = \frac{0m}{0.40s}$

$V = 0\,m/s$

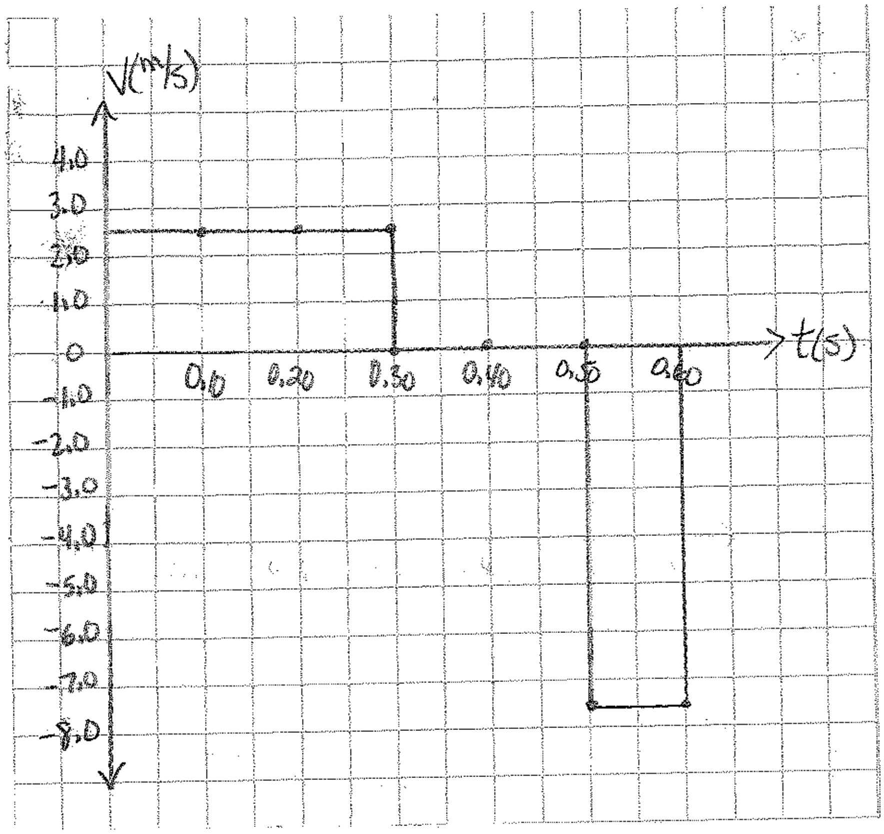
<u>0.55s</u>

$V = d/t$

$V = \frac{0.0 - 0.75m}{0.60 - 0.50s}$

$V = 7.5\,m/s$ [S]

c)



d) $A = LW$

$A = (0.30\,s)(2.5\,m/s)$

$A = 0.75\,m$

$A = LW$

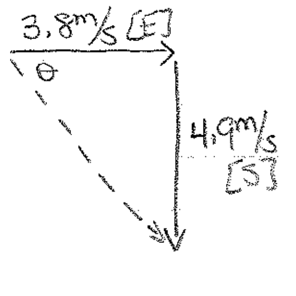
$A = (0.10\,s)(-7.5\,m/s)$

$A = -0.75\,m$

The overall displacement is found to be zero which was indicated from the distance-time graph in a).

#7 Let: V_{WS} = velocity of water relative to the shore
V_{BW} = velocity of boat relative to the water
V_{BS} = velocity of boat relative to the shore

a)



$c^2 = a^2 + b^2$

$c^2 = (4.9\,m/s)^2 + (3.8\,m/s)^2$

$c = 6.2\,m/s$

$\tan\theta = \frac{o}{a}$

$\theta = \tan^{-1}\left(\frac{4.9\,m/s}{3.8\,m/s}\right)$

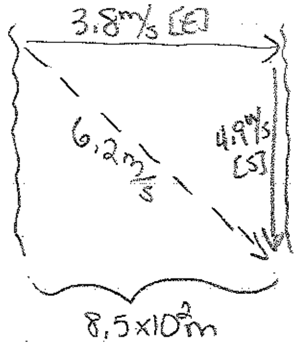
$\theta = 52°$ [S of E]

$\vec{V}_{BS} = \vec{V}_{WS} + \vec{V}_{BW}$

$\vec{V}_{BS} = 3.8\,m/s\,[E] + 4.9\,m/s\,[S]$

$\boxed{\vec{V}_{BS} = 6.2\,m/s,\ 52°\ [S\ of\ E]}$

#7 (b)



Regardless of how much the stream is pushing the boat down, it is still covering 3.8 meters each second heading east.

$\Delta t = \frac{\Delta \vec{d}}{\vec{v}_{ws}}$ $\Delta t = \frac{8.5 \times 10^2 m}{3.8 m/s}$ $\boxed{\Delta t = 2.2 \times 10^2 s}$

It will take roughly 2.2×10^2 seconds to reach the other side.

c) As it crosses north to south shore its displacement is related to the speed in which the water pushes it south only.

$\Delta \vec{d} = \vec{V}_{BW} \Delta t$

$\Delta \vec{d} = (4.9 m/s)(2.2 \times 10^2 s)$

$\boxed{\Delta \vec{d} = 1.1 \times 10^3 m, 52°, [S \text{ of } E]}$

#8 a) It is not possible because acceleration depends on the change in speed.

b) It is possible to have no acceleration but a velocity if the velocity is constant.

#9 a) $9.8 m/s^2$ [downward]

b) $9.8 m/s^2$ [downward]

c) $9.8 m/s^2$ [downward]

#10 a) Yes, the instantaneous velocity is in reference to the starting point.

b) No, the speed would not be changed because the velocity is constant.

#10 c) Yes an object can experience a northward velocity while experiencing a southward acceleration if the car is slowing down.

#11 $\frac{cm}{s} \div s \Rightarrow \frac{cm}{s} \times \frac{1}{s} \Rightarrow \frac{cm}{s^2}$

#12 $\vec{V}_i = 0$
$\vec{V}_f = 2.2 m/s$
$\Delta t = 5.0 s$

$\vec{a}_{av} = \frac{\vec{V}_f - \vec{V}_i}{\Delta t}$

$\vec{a}_{av} = \frac{2.2 m/s - 0}{5.0 s}$

$\boxed{\vec{a}_{av} = 0.44 m/s^2}$

The cyclist accelerated from rest to third gear at a rate of $0.44 m/s^2$.

$\vec{V}_i = 2.2 m/s$
$\vec{V}_f = 5.2 m/s$
$\Delta t = 10.0 s$

$\vec{a}_{av} = \frac{\vec{V}_f - \vec{V}_i}{\Delta t}$

$\vec{a}_{av} = \frac{5.2 m/s - 2.2 m/s}{10.0 s}$

$\boxed{\vec{a}_{av} = 0.30 m/s^2}$

The acceleration from third to fifth gear is $0.30 m/s^2$.

#13 a) @ 1.0s, $\vec{V} = 7.5 m/s$ [W]
@ 3.0s, $\vec{V} = 15.0 m/s$ [W]
@ 5.5s, $\vec{V} = 7.0 m/s$ [E]

b) @ 1.0s, $\vec{a}_{av} = \frac{\Delta \vec{V}}{\Delta t}$

$\vec{a}_{av} = \frac{15.0 m/s - 0 m/s}{2.0 s - 0 s}$

$\vec{a}_{av} = 7.5 m/s^2$ [W]

@ 3.0s, $\vec{a}_{av} = \frac{\Delta \vec{V}}{\Delta t}$

$\vec{a}_{av} = \frac{15.0 m/s - 15.0 m/s}{4.0 s - 2.0 s}$

$\vec{a}_{av} = 0 m/s^2$

@ 5.5s, $\vec{a}_{av} = \frac{\Delta \vec{V}}{\Delta t}$

$\vec{a}_{av} = \frac{0 - 15 m/s}{6.0 s - 5.0 s}$

$\vec{a}_{av} = 15 m/s^2$ [E]

#14a) $\vec{g} = \vec{a}_{av} = 9.8\,m/s^2$ [down]
$\Delta t = 1.4\,s$ (halfway)
$\vec{V}_f = 0$ (at the peak)
$\vec{V}_i = ?$

$$\vec{a}_{av} = \frac{\vec{V}_f - \vec{V}_i}{\Delta t}$$
$$\vec{V}_i = \vec{V}_f - \vec{a}_{av}\Delta t$$
$$\vec{V}_i = 0 - (-9.8\,m/s^2)(1.4\,s)$$
$$\boxed{\vec{V}_i = 14\,m/s\ [up]}$$

The initial speed of the ball is 14m/s upward.

b) $\Delta\vec{d} = ?$

$$\Delta\vec{d} = \vec{V}_f\Delta t - \frac{a_{av}\Delta t^2}{2}$$
$$\Delta\vec{d} = 0 - \frac{(-9.8\,m/s^2)(1.4\,s)^2}{2}$$
$$\boxed{\Delta\vec{d} = 9.6\,m\ [up]}$$

The ball travelled 9.6meters upward.

#15 $\Delta\vec{d} = 75\,cm$ [fwd] $= 0.75\,m$ [fwd]
$\vec{V}_f = 75\,m/s$ [fwd]
$\vec{a}_{av} = ?$
$\vec{V}_i = 0$

$$\vec{V}_f^2 = \vec{V}_i^2 + 2\vec{a}_{av}\Delta\vec{d}$$
$$\frac{V_f^2 - V_i^2}{2\Delta\vec{d}} = \vec{a}_{av}$$
$$\vec{a}_{av} = \frac{(75\,m/s)^2 - 0}{2(0.75\,m)}$$
$$\boxed{\vec{a}_{av} = 3.8\times10^3\,m/s^2\ [fwd]}$$

The average acceleration of the arrow is $3.8\times10^3\,m/s^2$.

#16 $\vec{V}_i = 0$
$V_f = 12\,m/s$ (down)
$\Delta d = ?$
$\vec{g} = \vec{a}_{av} = 9.8\,m/s^2$

$$\vec{V}_f^2 = \vec{V}_i^2 + 2\vec{a}_{av}\Delta\vec{d}$$
$$\Delta\vec{d} = \frac{\vec{V}_f^2 - \vec{V}_i^2}{2\vec{a}_{av}}$$
$$\Delta\vec{d} = \frac{(12\,m/s)^2 - 0}{2(-9.8\,m/s^2)}$$
$$\Delta\vec{d} = -7.3\,m\ [up]$$

The distance a person could jump from without injury is 7.3 meters downward.

#17 a) The two cars have the same velocity at roughly the 45 second mark.

b) Car A

$\Delta\vec{d}$(m)	Δt(s)
225	30
675	60
1125	90
1575	120
2025	150

Car B

$\Delta\vec{d}$(m)	Δt
	30
600	60
1200	90
	120
	150

@ 75 seconds

$\Delta\vec{d}_{Car\ A} = 900m$ ✓

$\Delta\vec{d}_{Car\ B} = 900m$

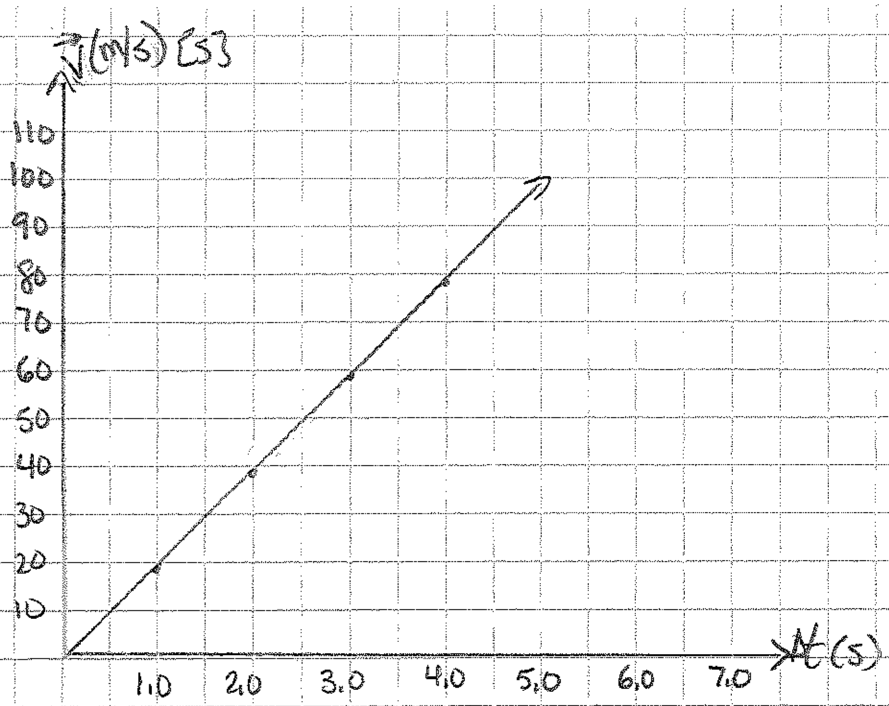
b)+c) Car B overtakes Car A just after the 75 second mark. They are 900m from the starting point.

#19 a) moving away from the starting point at a constant speed and then turning around and going back to the starting point at a different constant speed.

b) slowing down to zero speed with uniform decelleration and then uniformly accelerating again.

c) Moving at a constant acceleration before abruptly changing speed and moving with a constant decelleration.

22



@ 1.0 s, $\vec{v}_{av} = \frac{\Delta d}{\Delta t}$

$\vec{v}_{av} = \frac{19 m}{1.0 s}$

$\vec{v}_{av} = 19 m$

@ 2.0 s, $\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$

$\vec{v}_{av} = \frac{78 m}{2.0 s}$

$\vec{v}_{av} = 39 m$

@ 3.0 s, $\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$

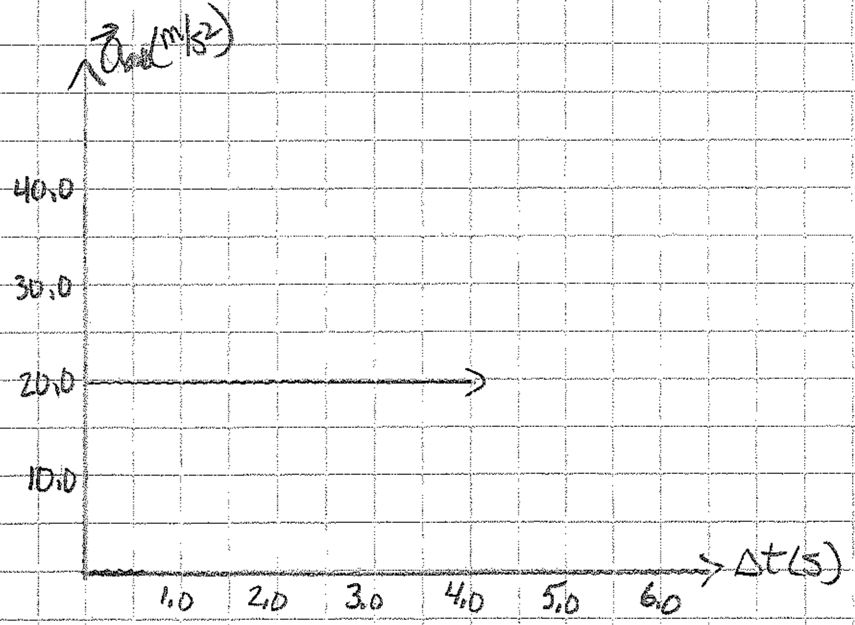
$\vec{v}_{av} = \frac{176 m}{3.0 s}$

$\vec{v}_{av} = 59 m/s$

@ 4.0 s, $\vec{v}_{av} = \frac{\Delta d}{\Delta t}$

$\vec{v}_{av} = \frac{315 m}{4.0 s}$

$\vec{v}_{av} = 79 m/s$



#23 Area under the curve of acceleration-time graphs is speed.

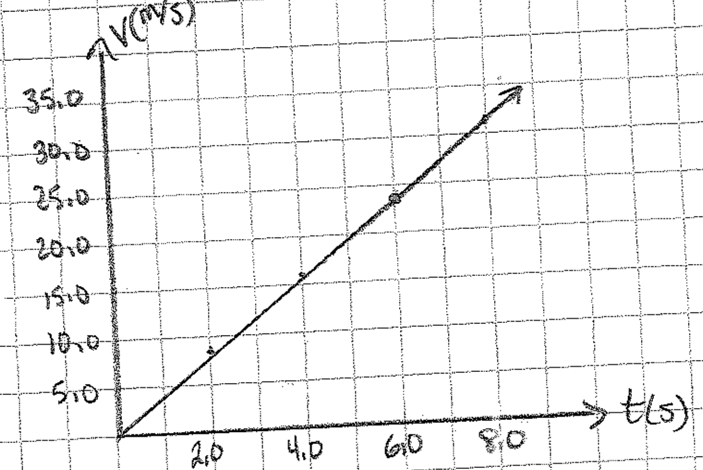
Finding the speed at acceleration-time intervals.

@ 2.0s, $A = LW$
$A = (2.0s)(4.0m/s^2)$
$A = 8.0m/s$ [Fwd]

@ 4.0s, $A = LW$
$A = (4.0s)(4.0m/s^2)$
$A = 16.0m/s$ [Fwd]

@ 6.0s $A = LW$
$A = (6.0s)(4.0m/s^2)$
$A = 24.0m/s$ [Fwd]

@ 8.0s, $A = LW$
$A = (8.0s)(4.0m/s^2)$
$A = 32m/s$ [Fwd]



Finding the distance at speed-time intervals

@ 2.0s, $A = \frac{1}{2}bh$
$A = \frac{1}{2}(2.0s)(8.0m/s)$
$A = 8.0m$ [Fwd]

@ 4.0s, $A = \frac{1}{2}bh$
$A = \frac{1}{2}(4.0s)(16.0m/s)$
$A = 32m$ [Fwd]

@ 6.0s, $A = \frac{1}{2}bh$
$A = \frac{1}{2}(6.0s)(24.0m/s)$
$A = 72m$ [Fwd]

@ 8.0s, $A = \frac{1}{2}bh$
$A = \frac{1}{2}(8.0s)(32m/s)$
$A = 130m$ [Fwd]