1.1 Practice Questions

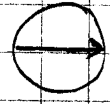
P1 a) 1D b) 1D c) 2D

d) 3D e) 2D f) 3D

P2 a) Vector b) Scalar c) vector

d) scalar e) Scalar

P3 Speedometer indicates instantaneous speed - the car's speed at any given moment is displayed. This is a scalar quanity as direction is not displayed.

P5 a)  $\Delta d = 16m$ $\Delta t = 21s$ $V_{av} = ?$

$V_{av} = \frac{\Delta d}{\Delta t}$

$= \frac{16m}{21s}$

$= 0.76 m/s$

b) Circumference $= \pi \Delta d$ ($\Delta d_2 =$)

$= 50.265m$

$V_{av} = 0.76 m/s$

$\Delta t = ?$

$\Delta t = \frac{\Delta d}{V_{av}}$

$= \frac{50.265m}{0.76 m/s}$

$= 65.973s$

$\simeq 66s$

P8 a) Yes if an object continues moving in one direction, eg. A train travels 50 km [E] then 30 km [E] and finally 40 km [E]. The total distance travelled is 120 km and the displacement is 120 KM [E].

b) Yes - the total distance travelled can exceed the displacement magnitude if the object changes direction. eg. A runner runs one full lap of a 400m oval track; the distance travelled is 400m but the resultant displacement is zero as the runner ends up back at the starting point.

c) No displacement magnitude cannot exceed total distance travelled. The maximum value of of a combination of vectors occurs when they are aligned in the same direction. ⟶⟶ Thus, displacement magnitude can equal the distance travelled but not be greater.

9 Yes, average speed can equal average velocity magnitude provided the object continues moving in a constant direction so that distance travelled equals the displacement magnitude.

$(V_{av} = |\vec{V}_{av}|$ if $\Delta d = |\Delta \vec{d}_x|)$

10 a) $\Delta \vec{d}_1 = 12 km [E]$ ⟶ ⟵ $\Delta \vec{d}_2 = 12 km [W]$

$\Delta t = 24 + 24 = 48 min$

$\Delta d_T = 12 km + 12 km = 24 km$

$V_{av} = ?$

$V_{av} = \frac{\Delta d_T}{\Delta t} = \frac{24 km}{48 min} = 0.50 \frac{km}{min}$

or $0.50 \frac{km}{min} \times \frac{60 min}{h} = 30. \frac{km}{h}$

b) $\Delta \vec{d}_1 = 12 km [E]$

$\Delta t = 24 min = 0.40 h$

$\vec{V}_{av} = ?$

$\vec{V}_{av} = \frac{\Delta \vec{d}_1}{\Delta t} = \frac{12 km [E]}{0.40 h} = 30 \frac{km}{h} [E]$

c) $\Delta \vec{d}_R = 12 km [E] + 12 km [W] = 0$ $\vec{V}_{av} = 0.0 \, km/h$

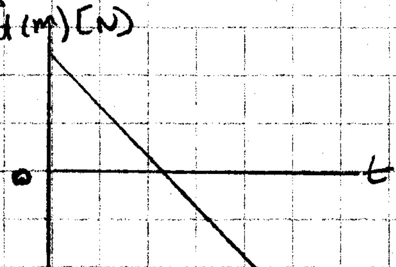
d) The average velocities differ as the bus changed direction.

11) $\Delta t = 0.32\,s$
$\vec{v} = 27\ m/s\ [F]$
$\Delta\vec{d} = ?$

$\Delta\vec{d} = \vec{v}\,\Delta t$
$= \left(27\,\frac{m}{s}\,[F]\right)(0.32\,s)$
$= 8.6\,m\ [F]$

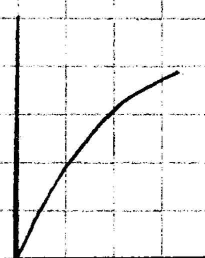
13a) A windsock shows wind direction and indicates a rough value for wind speed. These two components indicate wind velocity which is a vector quantity.

P14 a)



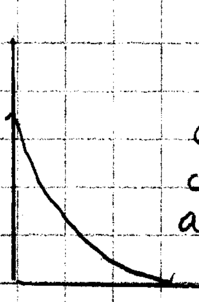
An object starts north of the origin and then moves at a constant velocity south past the origin.

b)



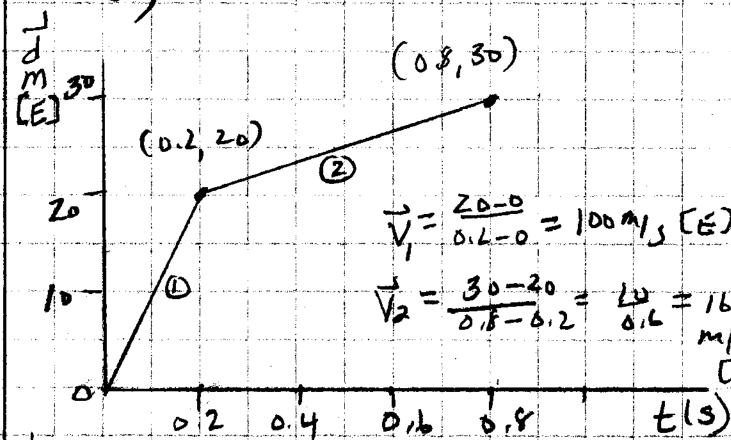
An object starts with a high speed moving north from the origin & slowing down uniformly as it travels.

c)



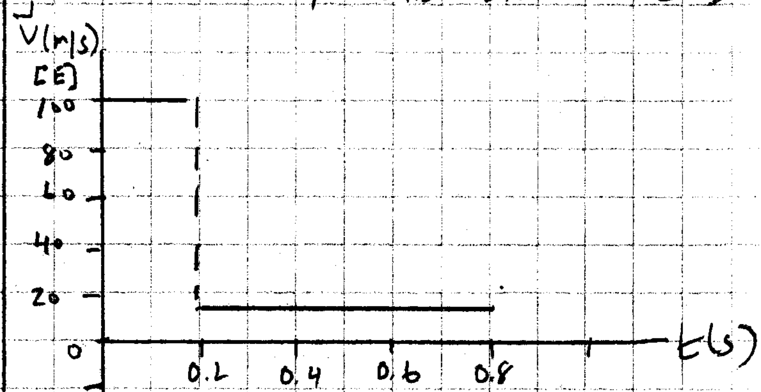
An object start west of the origin at a high speed and moves east back to the origin, slowing down uniformly as it travels.

P15 a)

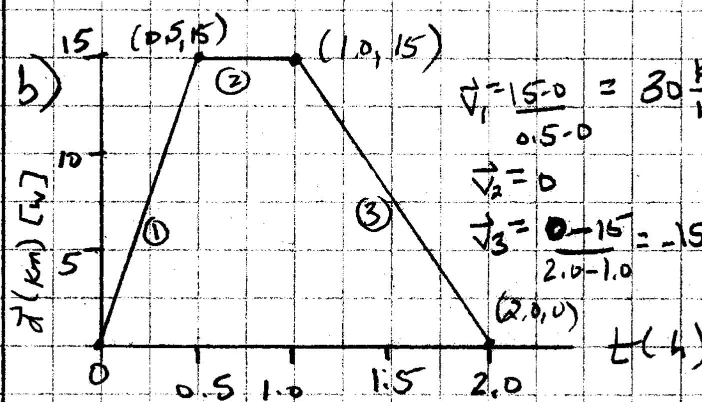


$\vec{v}_1 = \frac{20-0}{0.2-0} = 100\ m/s\ [E]$

$\vec{v}_2 = \frac{30-20}{0.8-0.2} = \frac{10}{0.6} = 16.7\ m/s\ [E]$



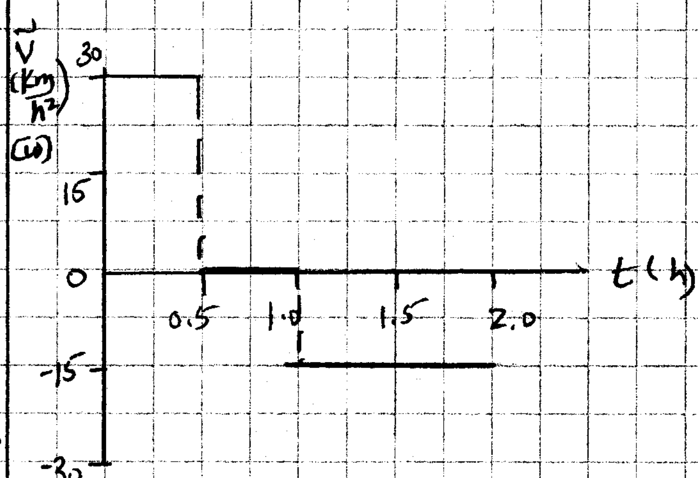
b)



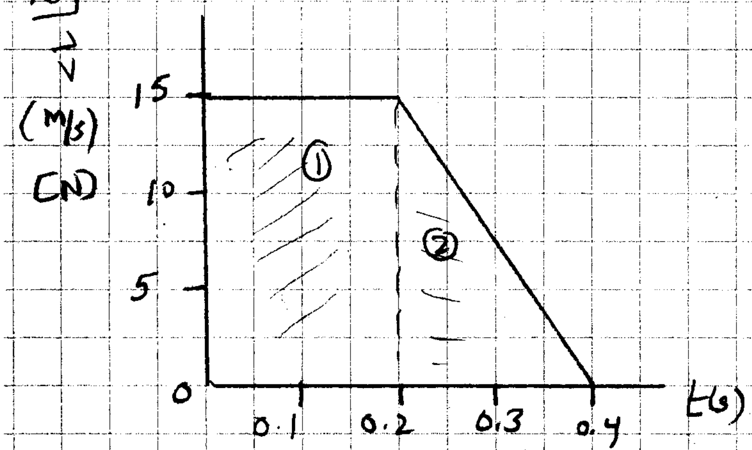
$\vec{v}_1 = \frac{15-0}{0.5-0} = 30\ \frac{km}{h^2}\ [W]$

$\vec{v}_2 = 0$

$\vec{v}_3 = \frac{0-15}{2.0-1.0} = -15\ \frac{km}{h^2}\ [W]$



16



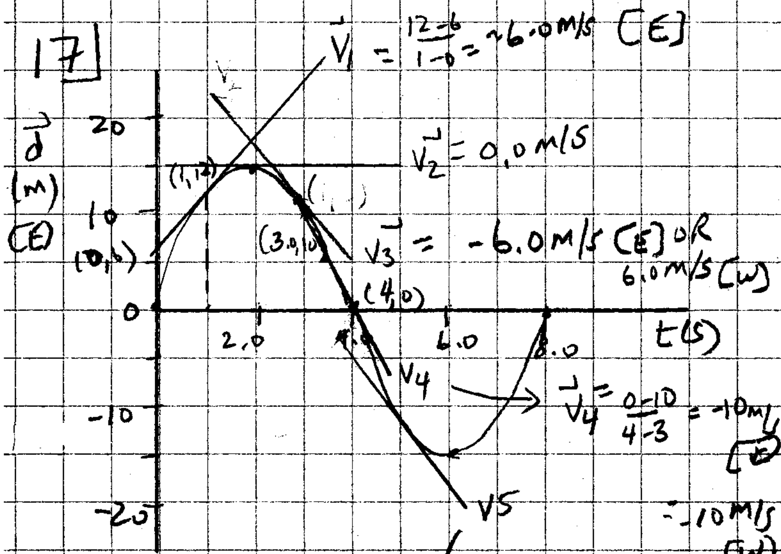
$\Delta\vec{d}_1 = \text{area } ① = (15\ m/s)(0.2s) = 3.0m\ [N]$

$\Delta\vec{d}_2 = \text{area } ② = \frac{1}{2}(15 m/s)(0.2s) = 1.5m\ [N]$

$\Delta\vec{d}_R = \Delta\vec{d}_1 + \Delta\vec{d}_2$
$= 3.0m\ [N] + 1.5m\ [N]$
$= 4.5\ m\ [N]$

The area represents the resultant displacement of the object.

17



$\vec{V}_5$ - by symmetry - same as $\vec{V}_3$

Section Questions

2 a) constant velocity - a car travelling west at a constant speed of 100 km/h

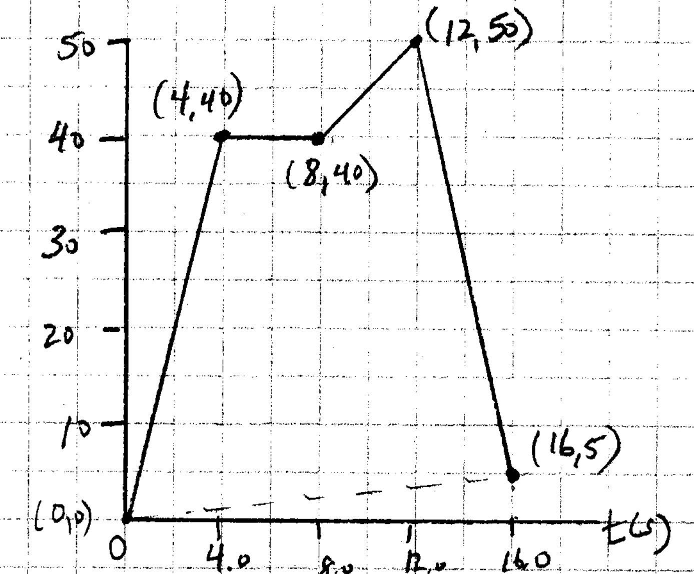
b) speed constant; velocity changing → a rider on a ferris wheel travelling around at constant speed

c) 1-D motion, $\Delta d > |\Delta\vec{d}|$
→ a subway train shuttles back and forth on a straight track

d) 1 D - $v_{av} > 0$, $|\vec{v}_{av}| = 0$
- a ball is tossed straight up in the air
- it rises, falls back down and is caught at its release point.

e) 2D - $v_{av} > 0$, $\vec{v}_{av} = 0$
→ a runner jogs one full lap of a circular track.

s5



a) $v_{av}(4\text{–}8s) = 0.0$ m/s

$v_{av}(0\text{–}8s) = \frac{\Delta d}{\Delta t} = \frac{40m}{8.0s} = 5.0$ m/s

b) $\vec{v}_{av}(8\text{–}12s) = \frac{50-40}{12-8} = \frac{10}{4} = 2.5$ m/s [E]

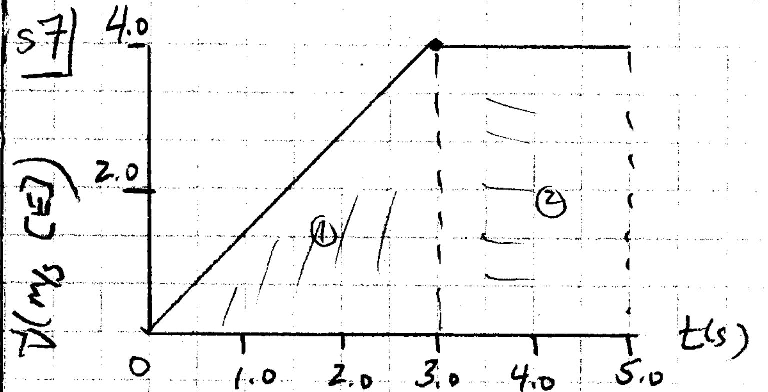
$\vec{v}_{av}(12\text{–}16) = \frac{5-50}{16-12} = \frac{-45}{4} = -11$ m/s [E]

$\vec{v}_{av}(0\text{–}16) = \frac{5-0}{16-0} = -0.33$ m/s [E]

c) $v_{(6.0s)} = 0.0$ m/s $v_{(9.0s)} = 2.5$ m/s

d) $v_{(14s)} = -11$ m/s [E]

s7



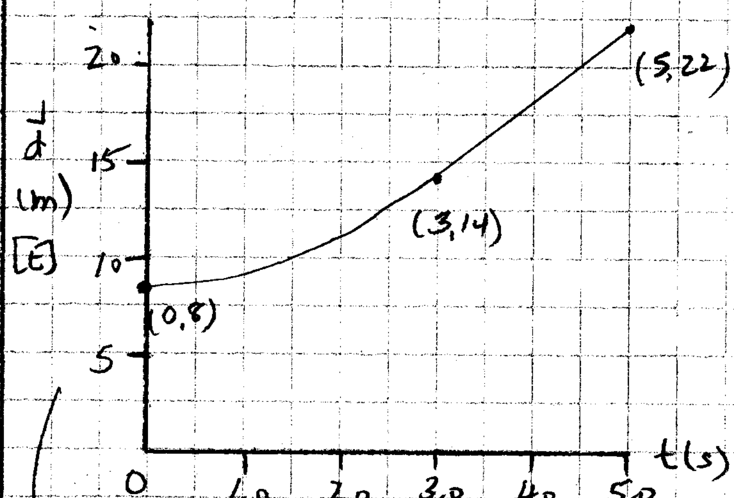
$\Delta \vec{d}$ = area ① + area ②

$= \frac{1}{2}(3.0s)(4.0\ m/s) + (2.0s)(4.0\ m/s)$

$= 6.0$ m [E] + 8.0 m [E]

$= 14.0$ m [E]

Starting position → 8.0 m [E]



t(s)	$\vec{d}$(m) [E]
0	8.0
3.0	14.0
5.0	22.0

1.2 Practice Questions

P1 a) acceleration units: $\boxed{\dfrac{\text{distance}}{\text{time}^2}}$

a) $\dfrac{km/s}{h} = \dfrac{km}{s \cdot h}$

b) $mm\,s^{-2} = \dfrac{mm}{s^2}$

c) $\dfrac{Mm}{min^2}$

d) $\dfrac{km}{h^2}$

e) $km/min/min = \dfrac{km}{min^2}$

<u>All</u> are acceleration units.

P2 a) Yes - if a car is travelling east and slowing down then its acceleration is west.

b) Yes - imagine a ball tossed up into the air; it slows down as it rises due to the acceleration due to gravity and it stops momentarily at its peak.

P3 Flock moving south (+)

a) $\vec{a} \to$ south $\to$ Flock speeding up

b) $\vec{a} \to$ (north) $\to$ Flock slowing down

c) $\vec{a} \to$ zero $\to$ Flock maintains constant velocity

P4 $\vec{v}_1 = 0.0\ m/s$

$\vec{v}_2 = 9.3\ m/s\ [F]$

$\Delta t = 3.9\ s$

$\vec{a} = ?$

$[F] = +$

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{9.3 - 0.0}{3.9} = 2.4\ m/s^2\ [F]$$

P5 $\vec{v}_1 = 0.0\ m/s$

$\vec{v}_2 = 26.7\ m/s\ [F]$ let $[F] = +$

$\vec{a} = 9.52\ m/s^2\ [F]$

a) $\Delta t = ?$

$$\Delta t = \frac{\vec{v}_2 - \vec{v}_1}{a} = \frac{26.7 - 0.0}{9.52} = 2.80\ s$$

b) $v = 26.7\ \dfrac{m}{s} \to v = ?\ \dfrac{km}{h}$

Conversions:
$1000\ m = 1\ km \qquad 3600\ s = 1\ h$

$$\frac{26.7\ \cancel{m}}{\cancel{s}} \times \frac{3600\ \cancel{s}}{h} \times \frac{1\ km}{1000\ \cancel{m}} = 96.1\ km/h$$

b) <u>Dimensions</u>:

- Time $\to T$
- Length $\to L$
- Speed $\to \frac{L}{T}$
- Acceleration $\to \frac{L}{T^2}$

$$LS = \Delta t = T \qquad RS = \frac{v_2 - v_1}{a} = \frac{\frac{L}{T}}{\frac{L}{T^2}} = \frac{L}{T} \times \frac{T^2}{L} = T$$

$\therefore LS = RS$

Equation is dimensionally correct.

P6] $\vec{a} = 14 \frac{km}{h/s}$ [F]

$\Delta t = 4.7s$

$\vec{v}_1 = 42 \frac{km}{h}$ [F]

$\vec{v}_2 = ?$ Let [F] = +

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

$= 42\frac{km}{h} + \left(\frac{14\ km/h}{s}\right)(4.7s)$

$= 42\ km/h + 65.8\ km/h$

$= 107.8\ km/h$ [F]

$\sim 108\ km/h$ [F]

$\therefore$ its final velocity is $108 \frac{km}{h}$ [F].

P7] $\vec{a} = 1.37 \times 10^3\ m/s^2$ [W]

$\Delta t = 3.12 \times 10^{-2} s$

$\vec{v}_2 = 0.0\ m/s$

$\vec{v}_1 = ?$ Let [E] = +

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

$= 0.0 - (-1.37 \times 10^3 \frac{m}{s^2})(3.12 \times 10^{-2} s)$

$= 42.74\ m/s$

$\sim 42.7\ m/s$ [E]

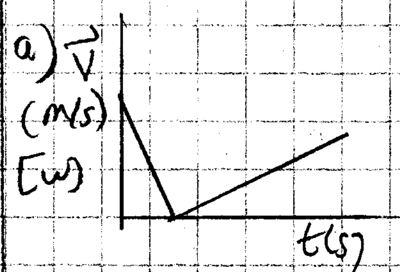
the arrow's initial velocity was 42.7 m/s [E].

P8]

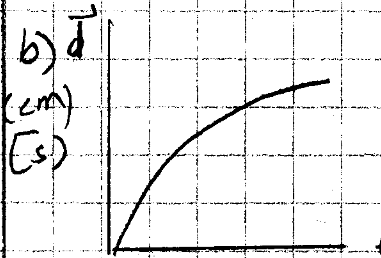
a) to get average acceleration from a velocity-time graph take slope from the start to end point

b) to get change in velocity from an $\vec{a}$-t graph take area under the curve.

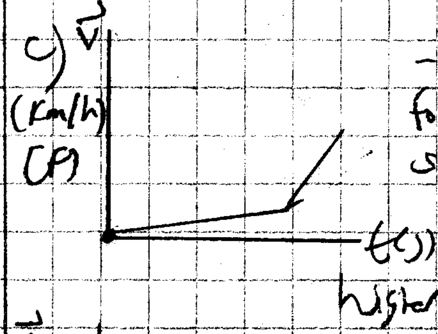
P9]

a) 

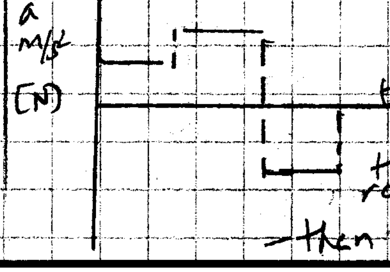
- object slows down to zero as it moves west then begins to speed up at lower acceleration rate

b) 

- object moves south from origin slowing down uniformly to a stop

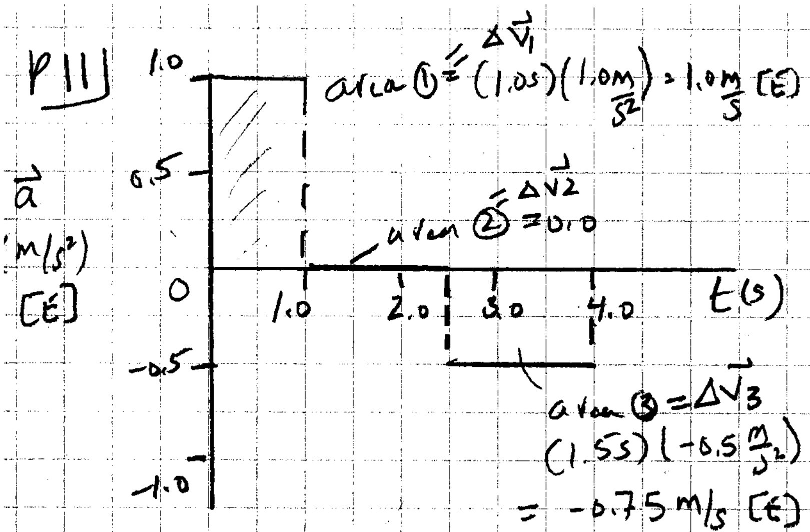
c) 

- object moves forward from rest speeding up uniformly then continues moving forward at higher acceleration rate

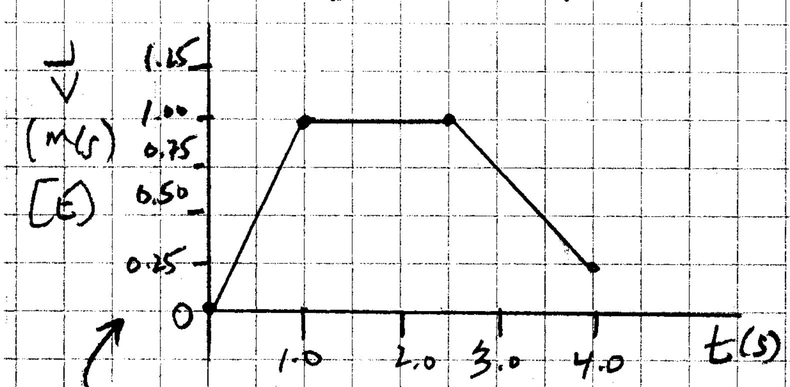


- object undergoes northward acceleration at moderate rate then accelerates at greater rate in north direction
- then undergoes large southward acceleration

P11



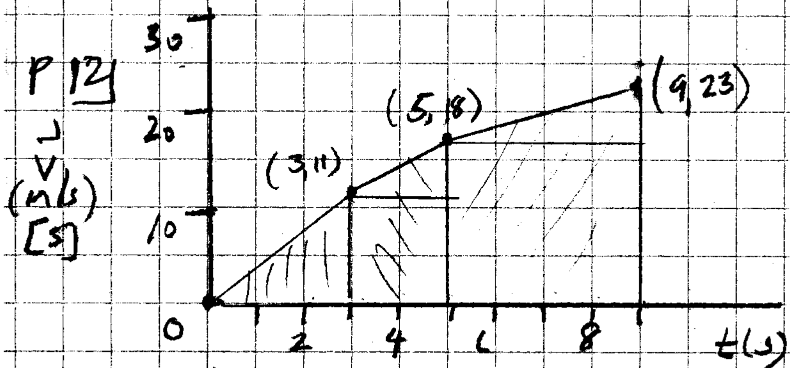
Initial velocity of lineman is zero.



t (s)	v (m/s) [E]
0	0
1.0	1.0
2.5	1.0
4.0	0.25

← add up $\Delta\vec{v}$'s

P12



$$\Delta\vec{d} = \Delta\vec{d}_1 + \Delta\vec{d}_2 + \Delta\vec{d}_3$$
$$= \tfrac{1}{2}(3)(11) + (2)(11) + \tfrac{1}{2}(2)(7) + (4)(18) + \tfrac{1}{2}(4)(5)$$
$$= 16.5 + 22 + 7 + 72 + 10$$
$$= 127.5\text{ m [S]}$$
$$\sim 130\text{ m [S]}$$

1.2 Section Questions

S7

$\vec{v}_1 = 26$ m/s [E]

$\vec{a} = 5.5$ m/s² [W]

$\vec{v}_2 = ?$ [E] = +

$\Delta t = 2.6$ s

$$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$$
$$= (26\text{ m/s}) + (-5.5\text{ m/s}^2)(2.6\text{ s})$$
$$= 11.7\text{ m/s}$$
$$\simeq 12\text{ m/s [E]}$$

∴ the final velocity is 12 m/s [E].

S8

$a = 9.7$ m/s² [B]

$\Delta t = 2.9$ s

$\vec{v}_2 = 0.0$ m/s

$\vec{v}_1 = ?$ [F] = +

$$\vec{v}_1 = \vec{v}_2 - \vec{a}\Delta t$$
$$= (0.0\text{ m/s}) - (-9.7\text{ m/s}^2)(2.9\text{ s})$$
$$= 28.13\text{ m/s}$$
$$\simeq 28\text{ m/s [F]}.$$

∴ the initial velocity is 28 m/s [F].

S 10)

$\vec{v}_1 = 0.0 m/s$

$\Delta t = 3.4 s$

$\vec{a} = 4.4 m/s^2$ [F]

$\vec{v}_2 = ?$

$\Delta \vec{d} = ?$

[F] = +

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

$= 0.0 m/s + (4.4 \frac{m}{s^2})(3.4 s)$

$= 14.96 m/s$

$\approx 15 m/s$ [F]

$\Delta \vec{d} = \cancel{\vec{v}_1 \Delta t}^{0} + \frac{1}{2}\vec{a}\Delta t^2$

$= \frac{1}{2}(4.4 m/s^2)(3.4 s)^2$

$= 25.432 m$

$\approx 25 m$ [F]

∴ the jumper's final velocity and displacement are 15 m/s [F] and 25 m [F].

11)

$\vec{v}_1 = 0.0 m/s$ Let E = +

$\vec{v}_2 = 2.0 \times 10^7 m/s$ (E)

$\Delta d = 0.10 m$ [E]

$\vec{a} = ?$

$\Delta t = ?$

Solving for $\vec{a}$:

$\Delta \vec{d} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2\vec{a}}$

$\therefore \vec{a} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2(\Delta \vec{d})}$

$= \frac{(2.0 \times 10^7 m/s)^2 - (0.0 m/s)^2}{2(0.10 m)}$

$= \boxed{2.0 \times 10^{15} m/s^2 [F]}$

Solve for Δt:

$\Delta t = \frac{\vec{v}_2 - \vec{v}_1}{a} = \frac{2.0 \times 10^7 m/s}{(2.0 \times 10^{15} m/s^2)} = \boxed{1.0 \times 10^{-8} s}$

S 12)

$\vec{v}_1 = 204 m/s$ (F)

$\vec{v}_2 = 508 m/s$ [F]

$\Delta t = 29.4 s$ Let [F] = +

$\Delta \vec{d} = ?$

$\Delta \vec{d} = \frac{1}{2}(\vec{v}_1 + \vec{v}_2)\Delta t$

$= \frac{1}{2}(204 m/s + 508 m/s)(29.4 s)$

$= 10,466.4 m$

$\sim 1.05 \times 10^4 m$ (F]

∴ the rocket underwent a displacement of $1.05 \times 10^4 m$ (F].

S 13)

$\vec{v}_2 = 4.2 \times 10^2 m/s$ [F]

$\Delta \vec{d} = 0.56 m$ [F]

$\vec{v}_1 = 0.0 m/s$ ∵ bullet starts at rest

$\vec{v}_{av} = ?$

$\Delta t = ?$

$\vec{v}_{av} = \frac{1}{2}(\vec{v}_1 + \vec{v}_2) = \frac{1}{2}(0 + 4.2 \times 10^2 m/s)$

$= 2.1 \times 10^2 m/s$ (F)

Solving for Δt:

$\Delta \vec{d} = \frac{1}{2}(\vec{v}_1 + \vec{v}_2)\Delta t$

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

$\therefore \Delta t = \frac{\Delta \vec{d}}{\vec{v}_{av}} = \frac{0.56 m [F]}{(2.1 \times 10^2 m/s)[F]}$

$= 0.00266 s$

$\sim 2.7 \times 10^{-3} s$