2. Linear motion

1. Distance covered by Kinyua in $1\frac{2}{3}$ hrs
   \[ 5 \times 90 = 150 \text{ km} \]
   Distance traveled by Nyaboke during the rest \((\frac{1}{3} \times 120) = 40 \text{ km} \)
   \[
   x = \frac{390-x}{90} \Rightarrow 120x = 90(390 - x) \\
   = 167.1 \text{ km} \\
   Time = \frac{167.1}{90} = 1.86 \\
   8.33 + 1.86 = 10.19; \text{ they met at } 10.11 \text{ a.m.} \\
   580 - (150 + 167.1) = 262.9 \text{ km from M} \\
   Before the rally driver started, Nyaboke had traveled for 1 \frac{1}{2} \text{ hrs} \]
   \[
   \left(\frac{1}{2} \times 120\right) = 180 \text{ km} \\
   \frac{x}{120} = \frac{x + 180}{80} \\
   120x - 120x = 21600 \\
   x = 360 \text{ km} \\
   Distance from K = 580 - (180 + 360) \\
   x = 40 \text{ km} \\
   Time = \frac{540}{180} = 3 \text{ hrs} \\
   (9.30 + 3 \text{ hrs}) = 12.30 \text{ p.m.} \\
   
2. Distance covered by the car after 15 min \((\frac{1}{4} \times 80) \text{ km} = 20 \text{ km} \)
   Distance covered together = 130 \text{ km} \\
   Relative speed = (80 + 40) = 120 \text{ km/h} \\
   Time taken to meet
   \[
   = \frac{(130)}{120} \text{ hrs} \\
   = 1 \text{ hr } 5 \text{ min} \\
   Time they met = 10:15 \text{ a.m. } + 1:05 = 11:20 \text{ a.m.} \\
   
3. a) \frac{1}{2} \times 50h + \frac{1}{2} \times 100h + 150h = 2700 \\
   225h = 2700 \\
   \[ H = \frac{2700}{225} = 12 \text{ m/s} \]
   Maximum speed \(= \frac{12 \times 60 \times 60}{1000} = 43.2 \text{ km/h} \)
   b) Acceleration \(\frac{12}{50} \text{ m/s} \)
   \[ = \frac{6}{25} \text{ m/s} \]
   c) \(\frac{1}{2} \times 50 \times 6 \)
   150 \text{ m} \\
   d) Time for half of journey
   \[
   \frac{1}{2} \times 12 \left(50 + t + t\right) = \frac{1}{2} \times 2700 \\
   6(50 + 2t) = \frac{1}{2} \times 2700 \\
   50 + 2t = 225 \\
   T = \frac{225 - 50}{2} = 87.5 \text{ sec.} \\
   
\[
\text{Speed m/s} \\
\text{Time in seconds}
\]

\[
\begin{array}{c|c|c|c|c}
50 & 200 & 300 \\
\hline
540 & 750 & 900 \\
\end{array}
\]
Total time
\[= 50 + 87.5 = 137.5 \text{ sec}\]

4. Time taken at 10km
\[= \frac{45}{10} = 4.5 \text{ hrs}\]
Time taken at 15km/hr
\[= \frac{45}{15} = 3 \text{ hrs}\]
Total time taken = \((4.5 + 3) = 7.5\)
(4.5 + 3) = 7.5 hrs
Average speed
\[= \frac{90}{7.5}\]
\[= 12 \text{ km/hr}\]

5. \(D = \frac{5 \times 80 + 50}{4} = 100.05\text{ km}\)
Speed = 120 – 80 = 40km/h
\[T = \frac{D}{S} = \frac{100.05}{40}\]
\[= 2.50125\text{ hours}\]

\(b) D = S \times T = 120 + \frac{100.05 + 199}{4000 + 800}\)
\[= 120 \times 11000\]
\[= 330\text{ km}\]

\(c) \text{Total time} = \frac{330}{80}\)
\[= 4\frac{1}{8}\text{ hrs}\]
Time lapse = \(\frac{41 - 5 + 100.05 + 199}{40000 + 800}\)
\[= 41 - 4\]
\[= 18\text{ hrs}\]

6. a) Distance traveled by bus before the matatu started off the journey is
Distance = speed x time
\[= 60 \times 2 \frac{1}{2}\]
\[= 150\text{ km}\]
Relative speed = 100 - 60 = 40km/hr
The matatu would cover the bus head start of 150km in 150/40 hrs = 3.75hrs = 3hrs 45 min
\(\therefore\) The matatu will overtake the bus after 3hrs 45 minutes
This will be 1:15 + 3:45 = 5.00pm

b) Time taken by the matatu to complete the remaining 350km = \(\frac{350}{100} = 3 \frac{1}{2}\) hrs
\[= 3\text{ hours 30 minutes}\]

Time taken by the bus to complete the remaining 350
\[= \frac{350}{60} = 5\frac{5}{6}\text{ hrs} = 5\text{ hours 50 minutes}\]
Matatu waits for 5hrs 50min – 3hr 30 min = 2 hrs 20 min
7. Total distance = 100 + 140 + 150 = 490
   Total speed = 88 + 164 = 252 km/hr
   252 km/hr into m/h = \( \frac{252 \times 1000}{3600} \) = 70 m/h

   Time taken = \( \frac{490}{70} \) = 7 sec

8. Distance = (5 + 15)m = 20m = 0.02 km
   S ⇒ Bus = 40 km/h
   Trailer = x km/h
   Relative speed = (40 – x) km/h
   T = 4.8 sec. = \( \frac{4.8}{3600} \)

   \[ \frac{S}{T} = \frac{D}{T} \]
   \[ (40 - x) = \frac{0.02}{48} \]
   \[ = 0.02 \times 3600 \]
   \[ = 15 \text{ km/h} \]
   \[ 40 - x = 15 \]
   \[ x = 25 \text{ km/h} \]

9. L.C.M = \( 2^4 \times 3^2 \times 5^3 \) = 1800

   G.C.D. = \( 2 \times 3 \times 5^2 \) = 150

10. Total distance = 60 cm
    Total time taken = \( 3 \frac{1}{5} \) hrs
    Let speed in still water be x km/h
    Speed upstream = (x – 5) km/h
    Speed downstream = (x + 5) km/h

    \[ \frac{30}{x-5} + \frac{30}{x+5} = 16 \]
    \[ \frac{5}{x-5} + \frac{5}{x+5} = 16 \]

    \[ 30x - 150 + 30x + 150 = 16(x^2 - 25) \]
    \[ 300x = 16x^2 - 400 \]
    \[ x = -\frac{5}{4} \text{ or } 20 \]

    ∴ Speed in still water is 20 km/hr

11. When David left, Ojwang had covered \( 15 \times \frac{3}{2} = 22.5 \) km.
    a) i) Remaining dist. = 40 – 22.5 = 17.5 km
    Relative speed = 15 + 25 = 40 km/h
    Time taken before meeting = \( \frac{17.5}{40} \) = 0.4375 hrs
    Ojwang covered \( 15 \times 0.437 = 5.5625 \) km
Distance from Ojwang’s house = 22.5 + 6.5625 \sqrt{} = 29.0625 km

(ii) 0.4375 = 26 min 15 sec
:: They met at 10.30 + 26.15 = 10.56. 15 am.

(iii) 40 – 29.0625 \sqrt{} = 10.9375 km\sqrt{}

b) Time take = \frac{10.9375 \sqrt{}}{12} = 0.9115 hrs
= 54 min, 41 sec.
They arrived at 10.56. 15 + 54.41 + 10 min = 12.00. 56 pm.

12. (a) In 10 minutes Kamau has travelled
10 x 24 = 6km
60
Distance left = 42 – 6 = 36km
Relating speed = 24 + 50.4k/hr
= 74.4km/hr
Time taken to meet = \frac{42}{74.4} = 0.565hrs
= 34 minutes
Time for meeting is 6.10
34
6.44a.m
34 x 50.4 = 28.56km from R or 13.44 from S
60

(b) Kamau arrival time
\frac{42km}{24km/hr} = 1.75hrs
1hr .45 minutes
6.00a.m
1.45
7.45a.m

(c) Mrs Ronoh speed = \frac{D}{T} = 50.4km/hr
Twice = 50.4 x 2 = 100.8
7.00a.m, Mr. Kamau covered = 1x24= 24km
Retain speed = 100.8- 24 = 76.8km/hr
So 24 = 8.75
76.8
He was overtaken at 7.00
+ 18.75
7.18am
At distance of $D = S \times t$

$$= \frac{100.8 \times 189.75}{60}$$

31.5km from S or 10.5km from R

13. i) A gains on B at the rate of $(72 - 56)$ Km/hr or 16km/h

$\therefore$ in 1 hr A gains on B 16km

In 545 A gains on B

$$\frac{16 \times 1000 \times 54 \text{ m}}{60 \times 60} = 240$$

The sum of the lengths of the two trains is 240m but the length of the first train is 100m

ii) Relative speed = $(72 + 56)$ km/h = 128km/hr

Distance between A and B decrease at the rate of 128km/hr

The distance decreases by 240m

$$\frac{60 \times 60 \times 240 \text{ s}}{128 \times 1000 \times 4} = 27 \text{ seconds}$$

$$= 6 \frac{3}{4} \text{ s}$$

14. (a) Time = $\frac{D}{S}$

$$= \frac{5}{x} \text{ hrs}$$

(ii) Time = $\frac{7}{x + 24}$ hrs

(b) $\frac{5 - 36}{x} = \frac{7}{x + 24}$

$$\frac{7}{x + 24} = \frac{25 - 3x}{5x}$$

$35x = 25x - 3x^2 + 600 - 72x$

$3x^2 + 82x - 600 = 0$

$(3x + 100)(x-6) = 0$

$$x = \frac{-100 \text{ or 6}}{3}$$

His speed = 6km/hr

(c) Time = $\frac{S \times T}{6}$

= $\frac{5 \times 60}{6}$

= 50mins

15. a) Relative speed = 80 - 60

= 20 km/h

Time = 40 hrs

$$= \frac{20}{2} = 2 \text{ hrs}$$

(b) 1.50 p.m. = 13.50 hrs.

Time = $13.50 + 2 = 15.50 \text{ hrs}$
16. (a) Nairobi 400km Kisumu
Speed = 120km/h
Distance = 400km
Time taken = \[\frac{400}{120} = 3\text{hrs 20min}\]
8.30 + 3hrs 20min = 11:50a.m

(b) at 8.30a.m distance covered by bus = \(\frac{1}{2} \times 80 = 40\text{km}\)
Dist. Left = 360km speed = 200km/h
Time taken = \[\frac{360}{200} = 1\text{hr 48mins}\]
They met at 8:30+ 1hr 48mins = 10:18a.m

(c) 8 – 10.18a.m is 2hrs 18mins distance = \[2 \times 80 + \frac{18 \times 80}{60}\]
= 160 + 24km = 184 from Nairobi

(d) car arrived in Nairobi after 3hrs 20mins
Bus traveled a time of 3hrs 20mins + 30mins
3hrs 50mins
Dist. = \(3 \times 80 + \frac{50 \times 80}{60} = 240 + 66 \frac{2}{3}\)
Distance from Kisumu = 93 \(\frac{1}{3}\) km

17. Total distance = 25m
Relative speed = 54km/hr
\[\text{To m/s} = \frac{54 \times 1000}{60 \times 60} = 15\text{ms}\]
Time they met = \[\frac{25}{15}\]
= \(1\frac{2}{3}\) sec