Kinematics

24-03-23

① Time & Speed conversion (Review)

② Distance - time graphs

③ Speed - time graphs

④ Conversion of Graphs

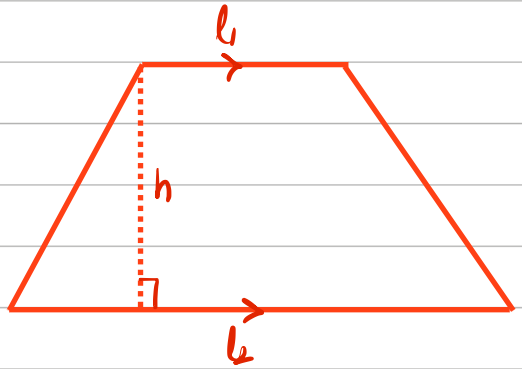
Key Points

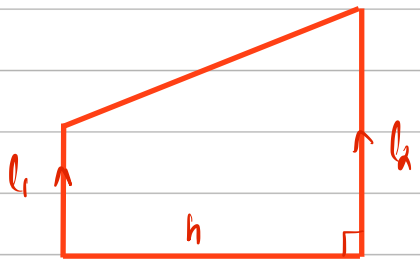
① Gradient of D-t graph gives Speed. The steeper the line, the greater the speed.

② Gradient of S-t graph gives acceleration

③ Area under the speed-time graph gives distance travelled.

Area of Trapezium = $\frac{1}{2}$ x (Sum of parallel sides) x height





$$A = \frac{1}{2} \times (l_1 + l_2) \times h$$

④ Average Speed = $\frac{\text{Total Distance}}{\text{Total time}}$

① 2h ¢ 45m = 2.75h $S = \frac{D}{T}$

$\frac{45}{60} = 0.75$

② 4.6h = 4 h ¢ 36 m

↓

$0.6 \times 60 = 36$

Convert Speed

① km/h ⟶ m/s

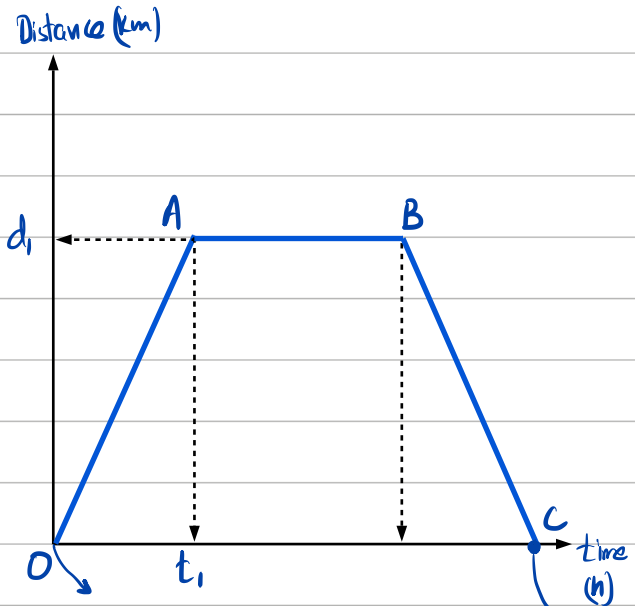
$\times \frac{1000}{3600}$

② m/s ⟶ km/h

$\div \frac{1000}{3600}$

$\times \frac{3600}{1000}$

Distance-Time Graphs



Starting point (Home)

Back to the starting point

OA : Distance is increasing at a constant rate

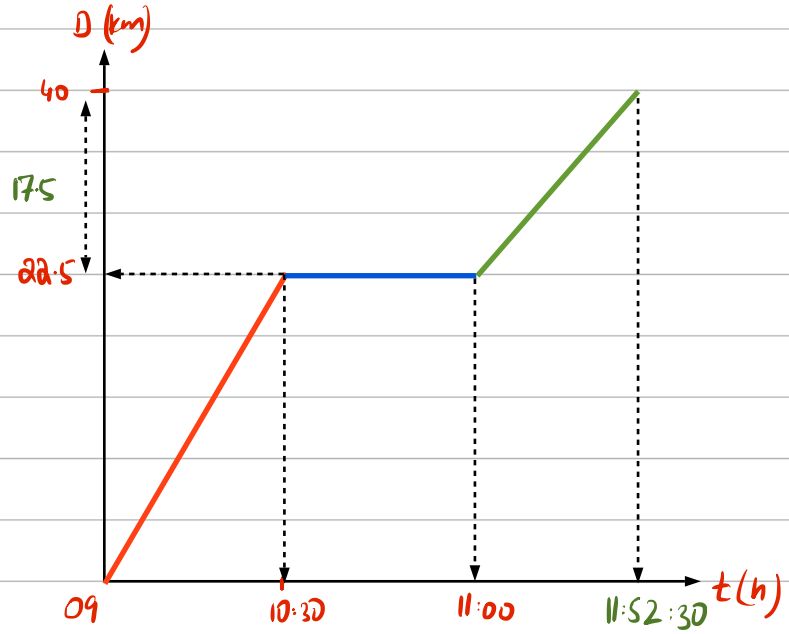
$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{Distance}}{\text{time}} = \text{Speed}$ Constant speed

AB : Distance is not changing
Speed = 0 km/h

BC : Distance is decreasing at a constant rate

Constant speed.

1. A cyclist set out at 0900 for a destination 40 km away. He cycled at a constant speed of 15 km/h until 1030. Then he rested for half an hour before completing his journey at a constant speed of 20 km/h.
   (i) Draw the distance-time graph to represent the journey.
   (ii) Hence, find the time at which the cyclist reached his destination, giving your answer to the nearest minute.



Speed = 15km/h
Time = 1h & 30m
Distance = S x T
15 x 1·5
22·5km

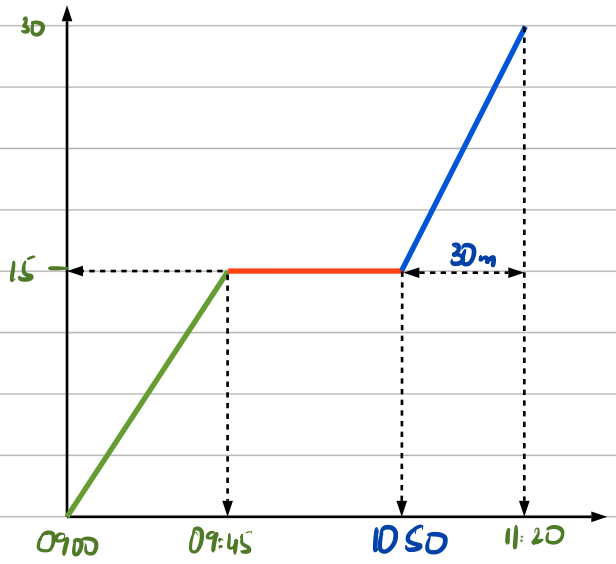
Speed = 20km/h
Time = ?
Distance = 17·5km

$T = \frac{D}{S}$

$T = \frac{17.5}{20_1} \times 60^3 = 52.5$

2. Raj starts a 30-km journey at 0900. He maintains a constant speed of 20 km/h for the first 45 minutes and then stops for a rest. He then continues his journey at a constant speed of 30 km/h, finally arriving at his destination at 1120.
   (i) Find the distance travelled in the first 45 minutes.
   (ii) Draw the distance-time graph to represent the journey.
   (iii) Hence, state the duration of his stop, giving your answer in minutes.

(ii)



(i) $D = S \times T$

$D = 20 \times \frac{45}{60}$

$D = 15\text{km}$

Time = ?
Speed = 30km/h
Distance = 15km

$T = \frac{D}{S} = \frac{15}{30} = 0.5\text{h} \times 60 = 30\text{m}$

(iii) 65minutes

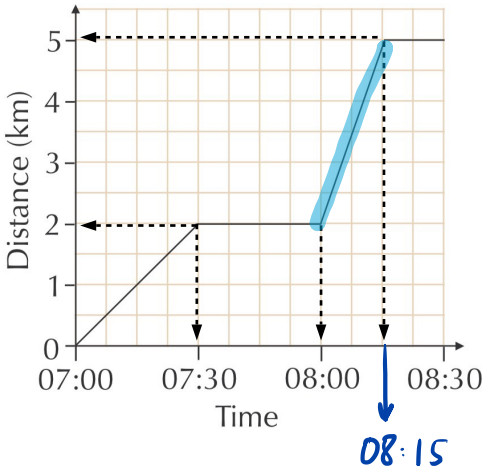
This graph shows Gil's journey to work. His journey consisted of two stages of travelling, separated by a break of 30 minutes.

a) Without carrying out any calculations, state which of the journey's two stages was at a higher speed. Explain your answer. 2nd (steeper line)

b) (i) How far did he travel in stage 1 of his journey (the first 30 minutes)? 2km

   (ii) What was his speed (in km/h) for the first stage?

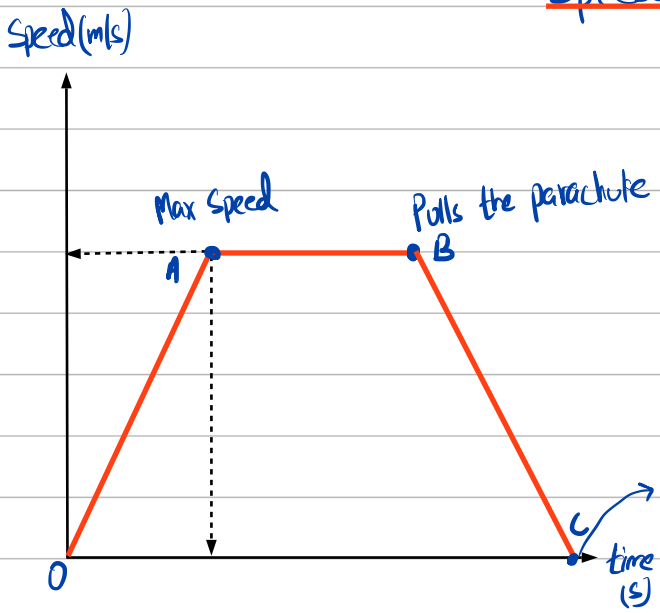
c) What was his speed (in km/h) during the second stage of his journey?



(ii) $\frac{2}{0.5} = 4\text{km/h}$

(c) $\frac{3}{\frac{1}{4}} = 3 \times 4 = 12\text{km/h}$

Speed - Time Graphs



OA : Speed is increasing at a constant rate

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acc. is constant

Speed is 0 AB : Speed is constant

acc is $0 m/s^2$

BC : Speed is decreasing at a constant rate

Negative acc or deceleration

Acceleration : Rate of change of speed.

Time	Speed m/s
0	0 m/s
1	2 m/s
2	4 m/s
3	6 m/s
4	8 m/s
5	10 m/s
6	12 m/s
7	12 m/s
8	12 m/s
9	12 m/s
10	8 m/s
11	4 m/s
12	0 m/s

→ Rate of change of Speed is constant

→ $a = 0 m/s^2$

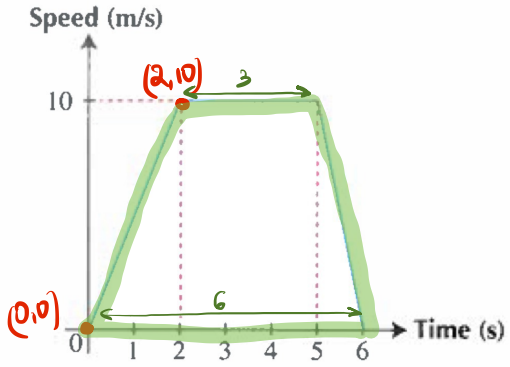
→ $a = -4 m/s^2$

$a = \frac{\text{Speed}}{\text{time}}$ $a = \frac{2 m/s}{1 s}$ $\frac{m}{s} \div s$

$a = 2 m/s^2$ $\frac{m}{s} \times \frac{1}{s}$

1.

The graph shows the speed-time graph of a car.



(i) Find the acceleration in the first 2 seconds.

(ii) Given that the distance travelled is given by the area under the speed-time graph, find the average speed during the whole journey.

(i) $a = \frac{10-0}{2-0} = 5\,m/s^2$

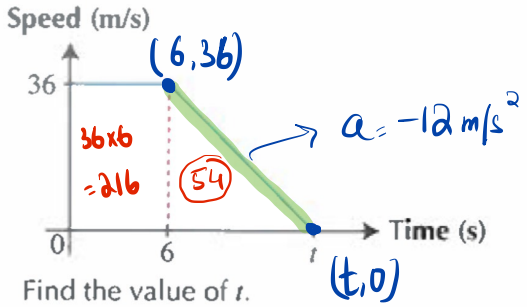
(ii) $A = \frac{1}{2} \times (6+3) \times 10$ (5)

$A = 45\,m$

$\frac{45}{6} = 7.5\,m/s$

3.

The diagram shows the speed-time graph of an object which travels at a constant speed of 36 m/s and then slows down at a rate of 12 m/s², coming to rest at time t seconds.



(i) Find the value of t.

(ii) Given that the distance travelled when the object is slowing down is 54 m, find the average speed for the whole journey.

(i) $\frac{+36}{t-6} = +12$ (3, 1)

$3 = t-6$

$9 = t$

$t = 9s$

(ii) $A.S. = \frac{TD}{Tt} = \frac{270}{9} = 30\,m/s$