

Kinematics

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Speed Time Graphs

Definitions

For constant acceleration problems the speed time graph will be a straight line.

The gradient of the graph is the acceleration.

The area under the graph represents the distance traveled.

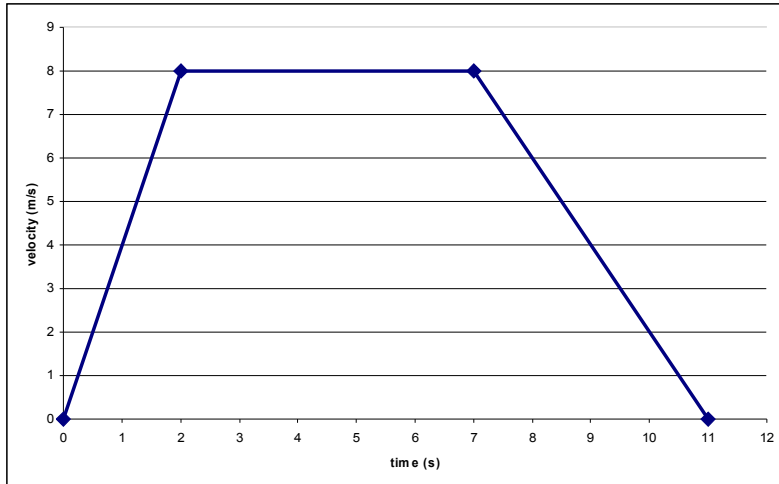
Example 1

A body starts from rest, accelerates uniformly to a velocity of 8ms^{-1} in 2 seconds, maintains that velocity for a further 5 seconds, and then retards uniformly to rest. The entire journey takes 11 seconds.

Find:

- a) the acceleration of the body during the initial part of the motion.
- b) The retardation of the body in the final part of the motion.
- c) The total distance traveled by the body

In these type of questions it is vital that you make a sketch of the motion.



a) As the definitions suggested earlier the acceleration is simply the gradient of the velocity time graph. This is:

$$\text{grad} = 8/2 = 4\text{ms}^{-2}.$$

b) Similarly for the retardation:

$$\text{grad} = 8/4 = 2\text{ms}^{-2}.$$

c) The total distance travelled by the body is equal to the area of under the graph.

$$\begin{aligned} \text{Area} &= 0.5 \times 8 \times (11 + 5) \\ &= 64\text{m} \end{aligned}$$

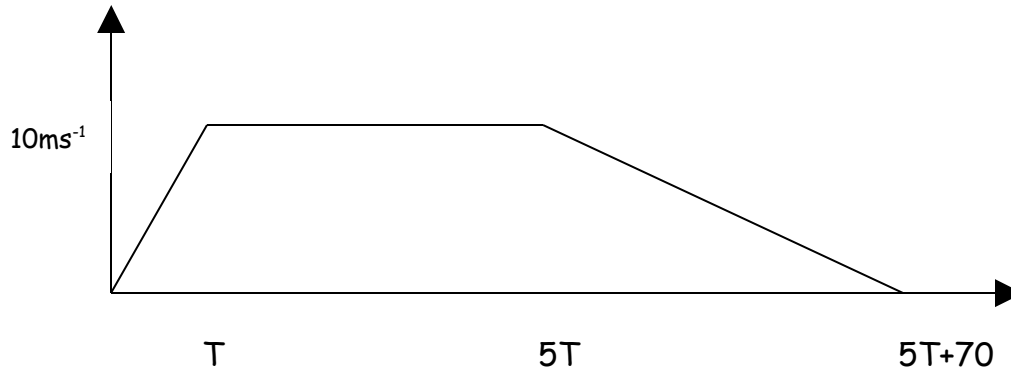
Example 2

A car accelerates uniformly from rest to a speed of 10ms^{-1} in T seconds. The car then travels for $4T$ seconds and finally decelerates uniformly to rest in a further 70s . The total distance traveled by the car is 1250m . Find:

a) the value of T .

b) the initial acceleration of the car.

Once again, sketch the journey.



a) the area under the graph must equal 1250.

$$1250 = 10T + 40T + 700/2$$

$$900 = 50T$$

$$T = 18\text{sec.}$$

b) The car accelerates to 10ms^{-1} in 18 seconds, therefore the acceleration is:

$$\text{Acceln} = 10/18 = 0.556\text{ms}^{-2}$$

Example 3

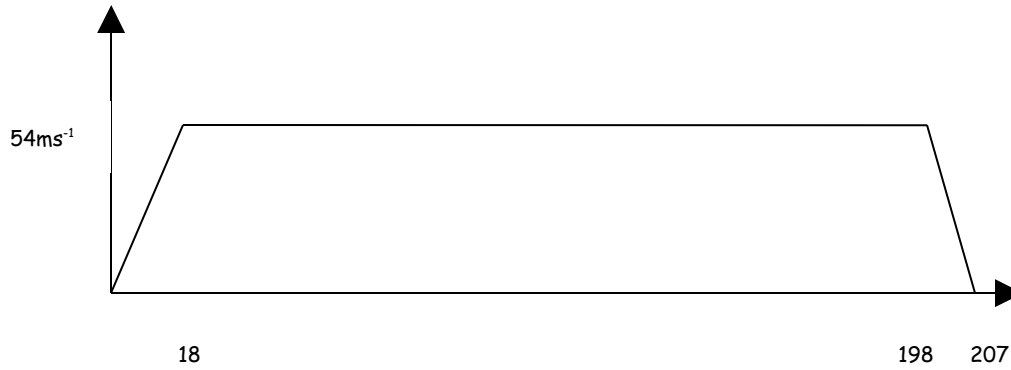
A train is traveling along a straight track between the points P and Q. It starts from rest at P and accelerates at 3ms^{-2} until it reaches a speed of 54ms^{-1} . It continues at a constant speed of 54ms^{-1} for a further 180seconds and then decelerates at a constant deceleration of 6ms^{-2} .

a) sketch a speed time graph for the train's journey.

b) calculate the total time for the journey from P to Q.

c) calculate the distance between P and Q.

a) The train will take $54/3$ seconds to reach the constant speed (18seconds). It will take $54/6$ seconds to decelerate to rest (9 seconds). Hence the graph will have the following shape.



b) the total time for the journey is 207 seconds.

c) the total distance is once again equal to the area under the graph.

$$\text{Area} = (54 \times 18)/2 + 54 \times 180 + (54 \times 9)/2$$

$$\text{Distance} = 10449\text{m} = 10.4\text{Km}$$