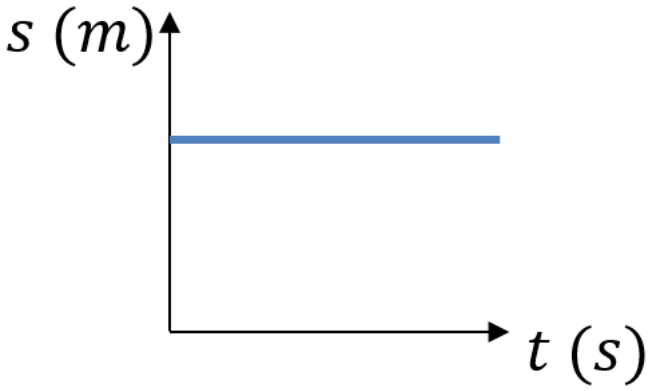
9) Constant acceleration

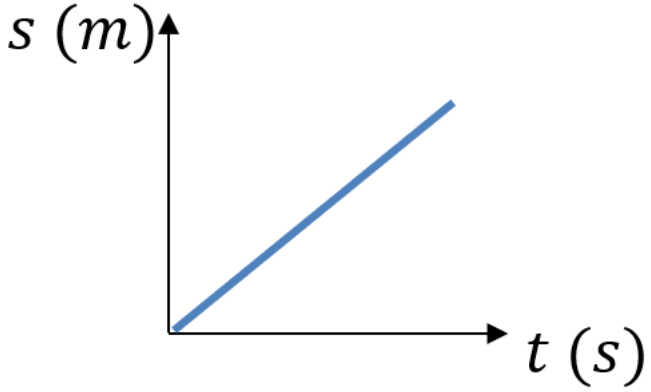
9.1) Displacement-time graphs

Chapter CONTENTS

Worked example

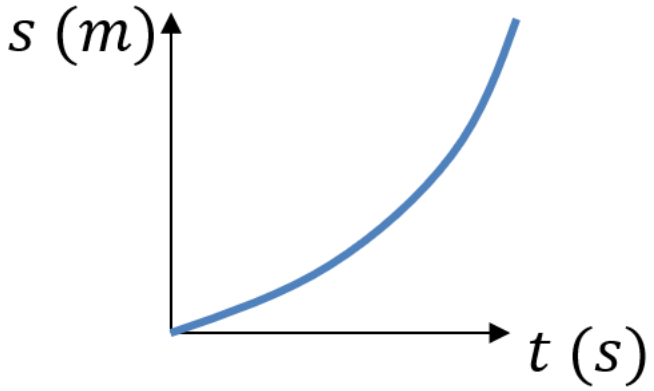
Describe the motion of each object from the displacement-time graph:





Your turn

Describe the motion of each object from the displacement-time graph:



Object is accelerating

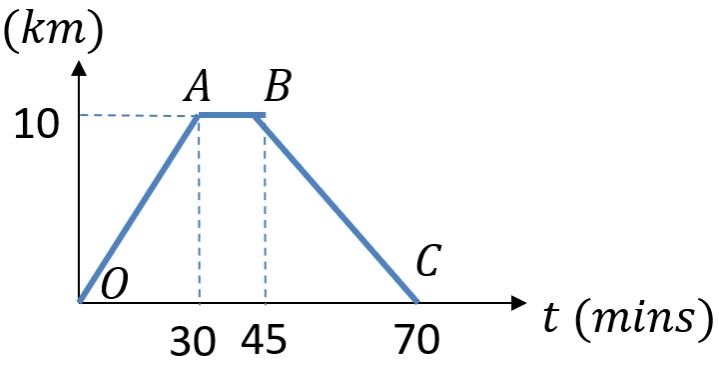
Worked example

A cyclist rides in a straight line for 30 minutes. She waits for a quarter of an hour, then returns in a straight line to her starting point in 25 minutes.

a) Work out the average velocity for each stage of the journey in km h^{-1}.

b) Write down the average velocity for the whole journey.

c) Work out average speed for the whole jo



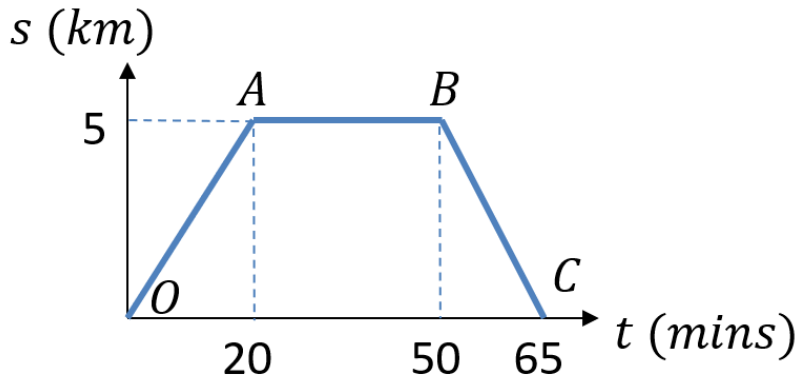
Your turn

A cyclist rides in a straight line for 20 minutes. She waits for half an hour, then returns in a straight line to her starting point in 15 minutes.

a) Work out the average velocity for each stage of the journey in km h^{-1}.

b) Write down the average velocity for the whole journey.

c) Work out average speed for the whole



a) OA: 15 $km\ h^{-1}$; AB: 0 $km\ h^{-1}$; BC: 20 $km\ h^{-1}$

b) 0

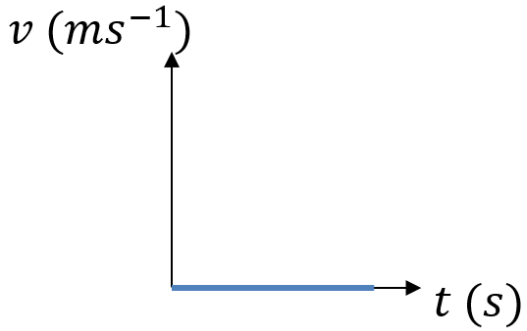
c) 9.23 $km\ h^{-1}$ $(3sf)$

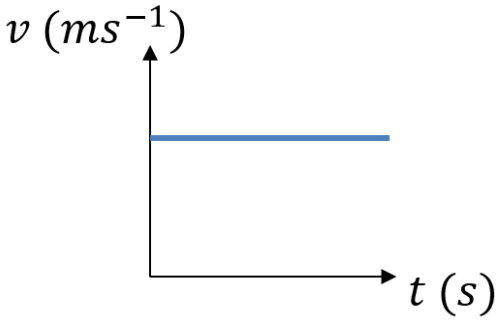
9.2) Velocity-time graphs

Chapter CONTENTS

Worked example

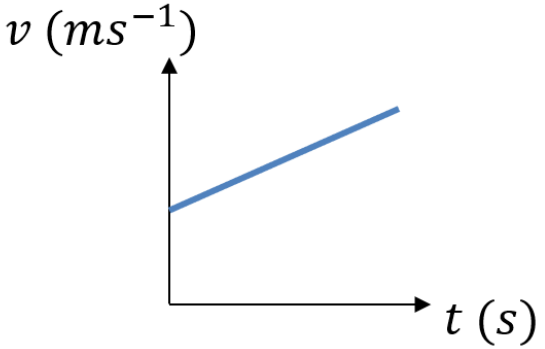
Describe the motion of each object from the velocity-time graph:





Your turn

Describe the motion of each object from the velocity-time graph:



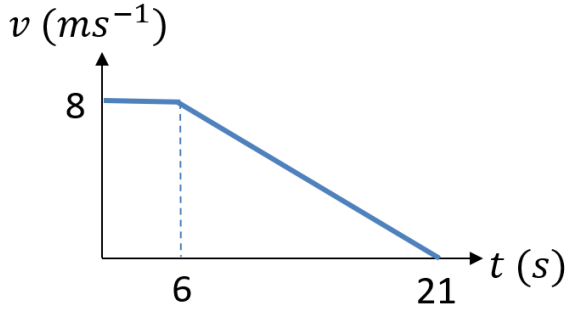
Object has constant acceleration. Velocity is increasing at a constant rate.

Worked example

A cyclist is moving along a straight road for a period of 21 seconds. For the first 6 seconds, she moves at a constant speed of 8 ms^{-1}. She then decelerates at a constant rate, stopping after a further 15 seconds.

(a) Find the displacement from the starting point of the cyclist after this 21 second period.

(b) Work out the rate at which the cyclist decelerates.

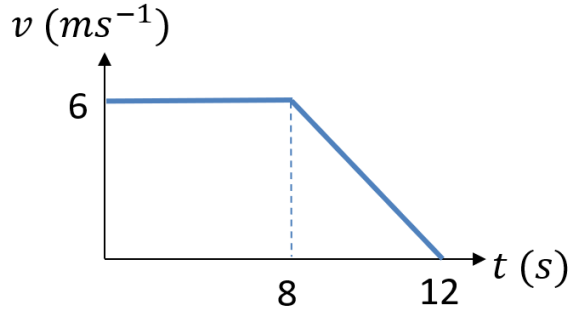


Your turn

A cyclist is moving along a straight road for a period of 12 seconds. For the first 8 seconds, she moves at a constant speed of 6 m s^{-1}. She then decelerates at a constant rate, stopping after a further 4 seconds.

(a) Find the displacement from the starting point of the cyclist after this 12 second period.

(b) Work out the rate at which the cyclist decelerates.



a) 60 m

b) 1.5 ms^{-2}

Diagrams/Graphs used with permission from DrFrostMaths: https://www.drfrostmaths.com/

Worked example

A particle moves along a straight line. The particle accelerates uniformly from rest to a velocity of 16 ms^{-1} in T seconds. The particle then travels at a constant velocity of 16 ms^{-1} for $3T$ seconds. The particle then decelerates uniformly to rest in a further 4 s.

(a) Sketch a velocity-time graph to illustrate the motion of the particle.

Give then the total displacement of the particle is 592m.

(b) find the value of T.

Your turn

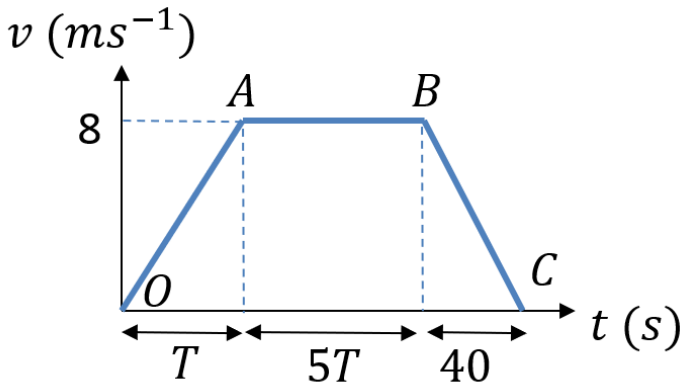
A particle moves along a straight line. The particle accelerates uniformly from rest to a velocity of 8 ms^{-1} in T seconds. The particle then travels at a constant velocity of 8 ms^{-1} for $5T$ seconds. The particle then decelerates uniformly to rest in a further 40 s.

(a) Sketch a velocity-time graph to illustrate the motion of the particle.

Give then the total displacement of the particle is 600m.

(b) find the value of T.

a)



b) $T = 10$

Worked example

A car is travelling along a straight horizontal road. The car takes $60\ s$ to travel between two sets of traffic lights which are $1072.5\ m$ apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for $15\ s$ until its speed is $11\ m\ s^{-1}$. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

a) Sketch a speed-time graph for the motion of the car between the two sets of traffic lights

b) Find the value of T

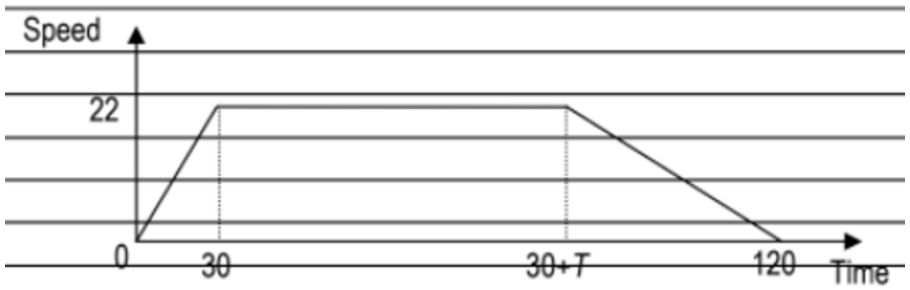
Your turn

A car is travelling along a straight horizontal road. The car takes $120\ s$ to travel between two sets of traffic lights which are $2145\ m$ apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for $30\ s$ until its speed is $22\ m\ s^{-1}$. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

a) Sketch a speed-time graph for the motion of the car between the two sets of traffic lights

b) Find the value of T

a)



b) $T = 75$

Diagrams/Graphs used with permission from DrFrostMaths: https://www.drfrostmaths.com/

Worked example

A car is travelling along a straight horizontal road. The car takes $60\ s$ to travel between two sets of traffic lights which are $1072.5\ m$ apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for $15\ s$ until its speed is $11\ m\ s^{-1}$. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

a) Sketch a speed-time graph for the motion of the car between the two sets of traffic lights

b) Find the value of T

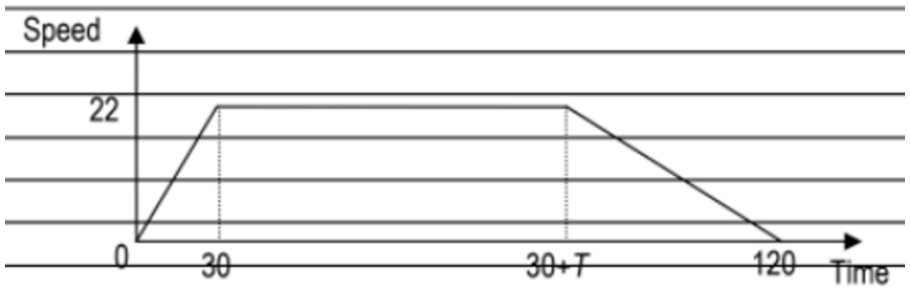
Your turn

A car is travelling along a straight horizontal road. The car takes $120\ s$ to travel between two sets of traffic lights which are $2145\ m$ apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for $30\ s$ until its speed is $22\ m\ s^{-1}$. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

a) Sketch a speed-time graph for the motion of the car between the two sets of traffic lights

b) Find the value of T

a)



b) $T = 75$

Diagrams/Graphs used with permission from DrFrostMaths: https://www.drfrostmaths.com/

Worked example

A car is travelling along a straight horizontal road. The car takes $60\ s$ to travel between two sets of traffic lights which are $1072.5\ m$ apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for $15\ s$ until its speed is $11\ m\ s^{-1}$. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.
A motorcycle leaves the first set of traffic lights 15 s after the car has left the first set of traffic lights. The motorcycle moves from rest with constant acceleration, and passes the car at the point A which is $495\ m$ from the first set of traffic lights. When the motorcycle passes the car, the car is moving with speed $11\ ms^{-1}$

c) Find the time it takes for the motorcycle to move from the first set of traffic lights to the point A

Your turn

A car is travelling along a straight horizontal road. The car takes $120\ s$ to travel between two sets of traffic lights which are $2145\ m$ apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for $30\ s$ until its speed is $22\ m\ s^{-1}$. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

A motorcycle leaves the first set of traffic lights 10 s after the car has left the first set of traffic lights. The motorcycle moves from rest with constant acceleration, and passes the car at the point A which is $990\ m$ from the first set of traffic lights. When the motorcycle passes the car, the car is moving with speed $22\ ms^{-1}$

c) Find the time it takes for the motorcycle to move from the first set of traffic lights to the point A

c) 50 seconds

Worked example

A car is moving along a straight horizontal road.
At time $t = 0$, the car is moving with speed $10\ ms^{-1}$ and is at the point A. The car maintains this speed for $50\ s$.
The car then moves with constant deceleration $0.6\ ms^{-2}$, reducing its speed from $10\ ms^{-1}$ to $4\ ms^{-1}$.
The car then moves with constant speed $4\ ms^{-1}$ for $30\ s$.
The car then moves with constant acceleration until it is moving with speed $10\ ms^{-1}$ at the point B.
Given that the distance from A to B is $980\ m$, find the time taken for the car to move from A to B

Your turn

A car is moving along a straight horizontal road.
At time $t = 0$, the car is moving with speed $20\ ms^{-1}$ and is at the point A. The car maintains this speed for $25\ s$.
The car then moves with constant deceleration $0.4\ ms^{-2}$, reducing its speed from $20\ ms^{-1}$ to $8\ ms^{-1}$.
The car then moves with constant speed $8\ ms^{-1}$ for $60\ s$.
The car then moves with constant acceleration until it is moving with speed $20\ ms^{-1}$ at the point B.
Given that the distance from A to B is $1960\ m$, find the time taken for the car to move from A to B

155 seconds