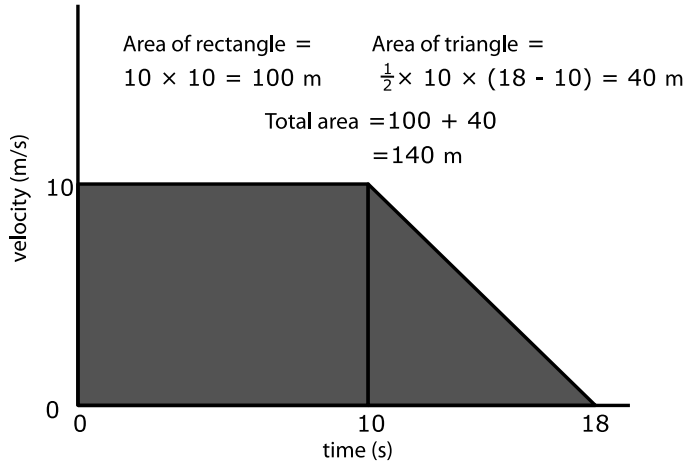
12 Motion Graphs; Velocity–Time (v–t)

The displacement of an object moving with a constant velocity is equal to the product of the velocity and the amount of time the object is in motion.

To find the displacement when the velocity is changing, a velocity-time graph is needed. Normally, velocity is plotted on the y-axis (the vertical axis) and time is plotted on the x-axis (the horizontal axis).

The area under the line on a velocity-time graph is equal to the displacement of the object.



If the shape of the graph can be broken into simple geometric shapes, the total area under the line can be calculated by adding the areas of those shapes.

The area under a speed-time graph is the distance. Speed cannot be negative, and neither can the distance.

The area under a velocity-time graph is the displacement. Velocity can be negative if an object is moving backwards. The displacement can also be negative. An area beneath the x-axis has a negative value. An area above the x-axis has a positive value. Be careful when calculating the total displacement, when summing the displacements remember to include the $+$ and $-$ signs of the displacements.

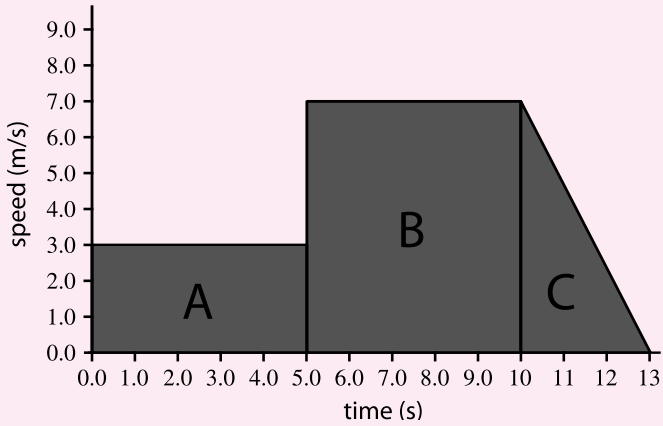
12.1 Using the following speed–time graph:

(a) calculate the distance travelled in A;

(b) calculate the distance travelled in B;

(c) calculate the distance travelled in C;

(d) calculate the total distance travelled.



12.2 Using the following graph:

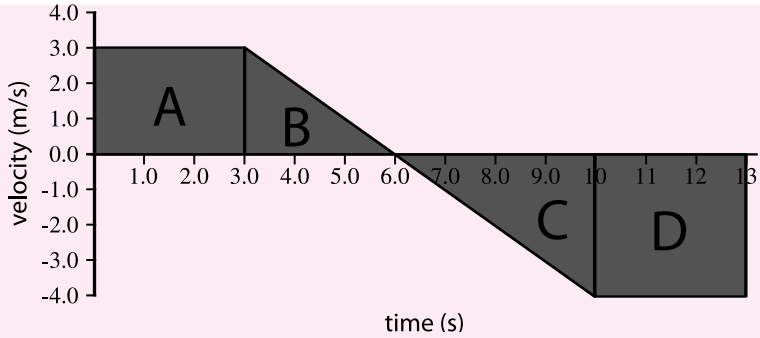
(a) calculate the displacement in A;

(b) calculate the displacement in B;

(c) calculate the displacement in C;

(d) calculate the displacement in D;

(e) calculate the total displacement.



12.3 For the motion described by the following speed–time graph, calculate:

(a) the distance moved in the first 10 s;

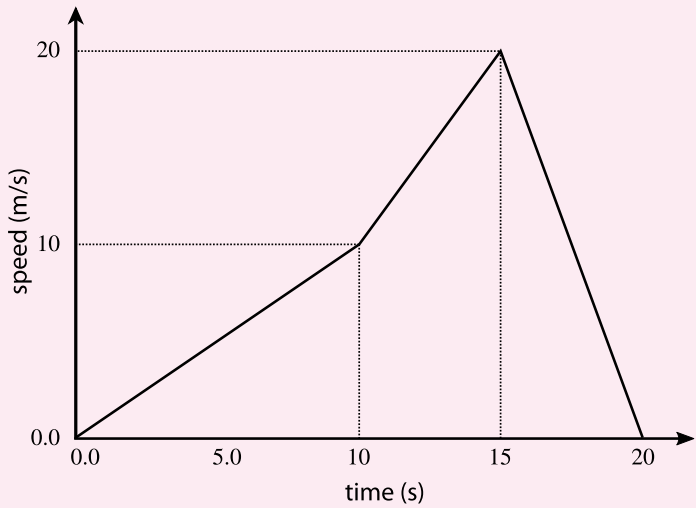
(b) the distance moved in the first 15 s;

(c) the total distance moved.

(d) The acceleration between 0 and 10 seconds.

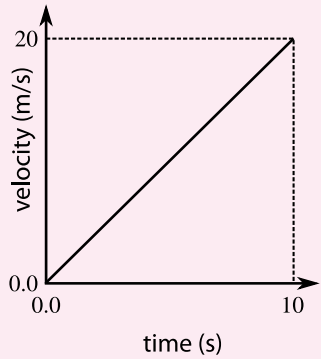
(e) The acceleration between 10 and 15 seconds.

(f) The acceleration between 15 and 20 seconds.

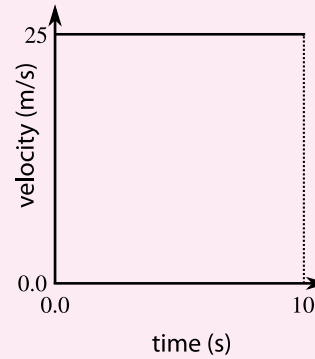


12.4 Calculate the displacement moved and the acceleration for the following velocity–time graphs.

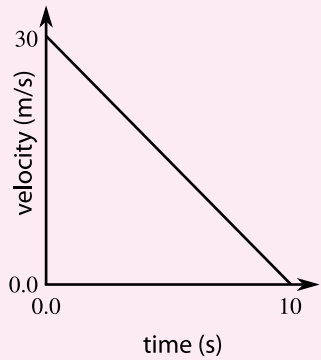
(a)



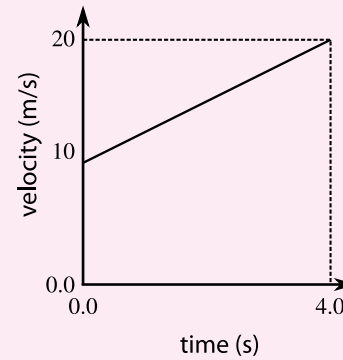
(b)



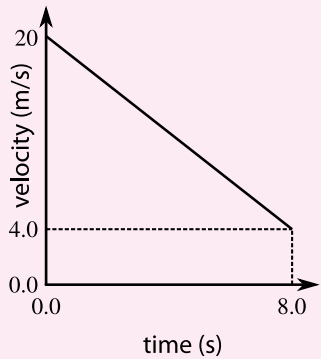
(c)



(d)



(e)



(f)