Speed–time graphs

Each speed–time graph below is for a car travelling along a straight road. The gradient tells you how much extra speed is gained every second. So:

On a speed–time graph, the gradient of the line is numerically equal to the acceleration.

In graph E, the car travels at a steady 15 m/s for 5 s, so the distance travelled is 75 m. The area of the shaded rectangle, calculated using the scale numbers, is also 75. This principle works for more complicated graph lines as well. In graph F, the area of the shaded triangle, $^1/_2$ × base × height, equals 50. So the distance travelled is 50 metres.

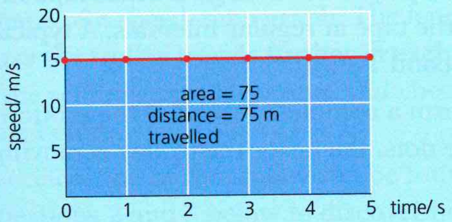
On a speed–time graph, the area under the line is numerically equal to the distance travelled.

Velocity–time graphs

Velocity is speed in a particular direction.
Where there is no change in the direction of motion, a velocity–time graph looks the same as a speed–time graph.

E Car travelling at **steady speed**

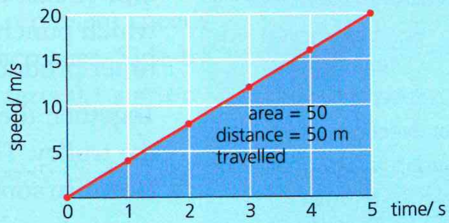
time/ s	0	1	2	3	4	5
speed/ m/s	15	15	15	15	15	15



The speed stays the same, so the line stays at the same level.

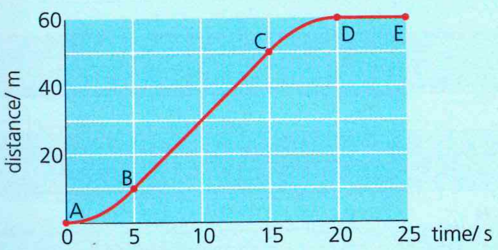
F Car with **steady acceleration**

time/ s	0	1	2	3	4	5
speed/ m/s	0	4	8	12	16	20



As the car gains speed, the line rises 4 m/s on the speed scale for every 1 s on the time scale.

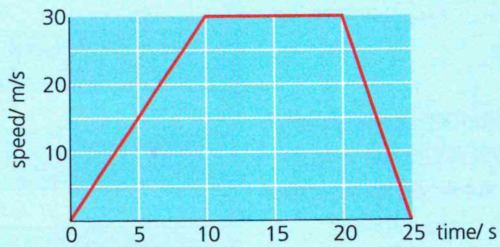
1



The distance–time graph above is for a motor cycle travelling along a straight road.

- **a** What is the motor cycle doing between points D and E on the graph?
- **b** Between which points is it accelerating?
- **c** Between which points is its speed steady?
- **d** What is this steady speed?
- **e** What is the distance travelled between A and D?
- **f** What is the average speed between A and D?

2



The speed–time graph above is for another motor cycle travelling along the same road.

- **a** What is the motor cycle's maximum speed?
- **b** What is the acceleration during the first 10 s?
- **c** What is its deceleration during the last 5 s?
- **d** What distance is travelled during the first 10 s?
- **e** What is the total distance travelled?
- **f** What is the time taken for the whole journey?
- **g** What is the average speed for the whole journey?

2.2 Motion graphs

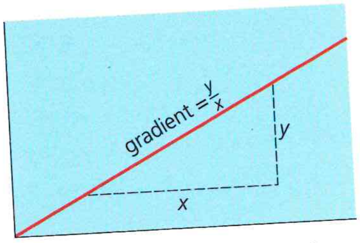
Objectives: to interpret distance-time and speed-time graphs – to know how to calculate speed, acceleration, and distance travelled from such graphs.

Distance–time graphs

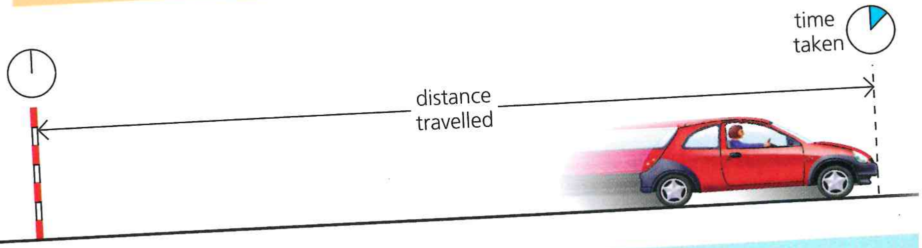
Graphs can be useful when studying motion. Below, a car is travelling along a straight road, away from a marker post. The car's distance from the post is measured every second. The charts and graphs show four different examples of what the car's motion might be.

On a graph, the line's rise on the vertical scale divided by its rise on the horizontal scale is called the **gradient**, as shown on the left. With a distance–time graph, the gradient tells you how much extra distance is travelled every second. So:

On a distance–time graph, the gradient of the line is numerically equal to the speed.

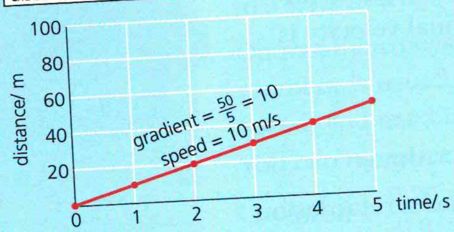


▲ On a straight line graph like this, the gradient has the same value wherever you measure *y* and *x*.



A Car travelling at **steady speed**

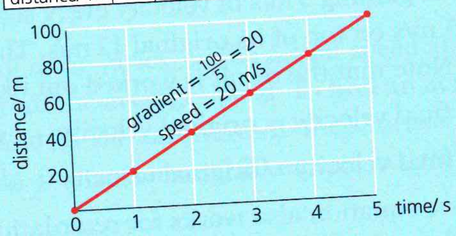
time/ s	0	1	2	3	4	5
distance/ m	0	10	20	30	40	50



The line rises 10 m on the distance scale for every 1 s on the time scale.

B Car travelling at **higher steady speed**

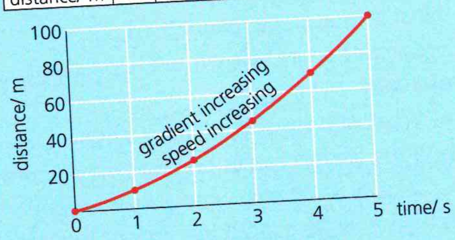
time/ s	0	1	2	3	4	5
distance/ m	0	20	40	60	80	100



The line is steeper than before. It rises 20 m on the distance scale for every 1 s on the time scale.

C Car **accelerating**

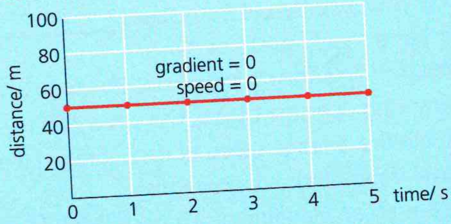
time/ s	0	1	2	3	4	5
distance/ m	0	10	25	45	70	100



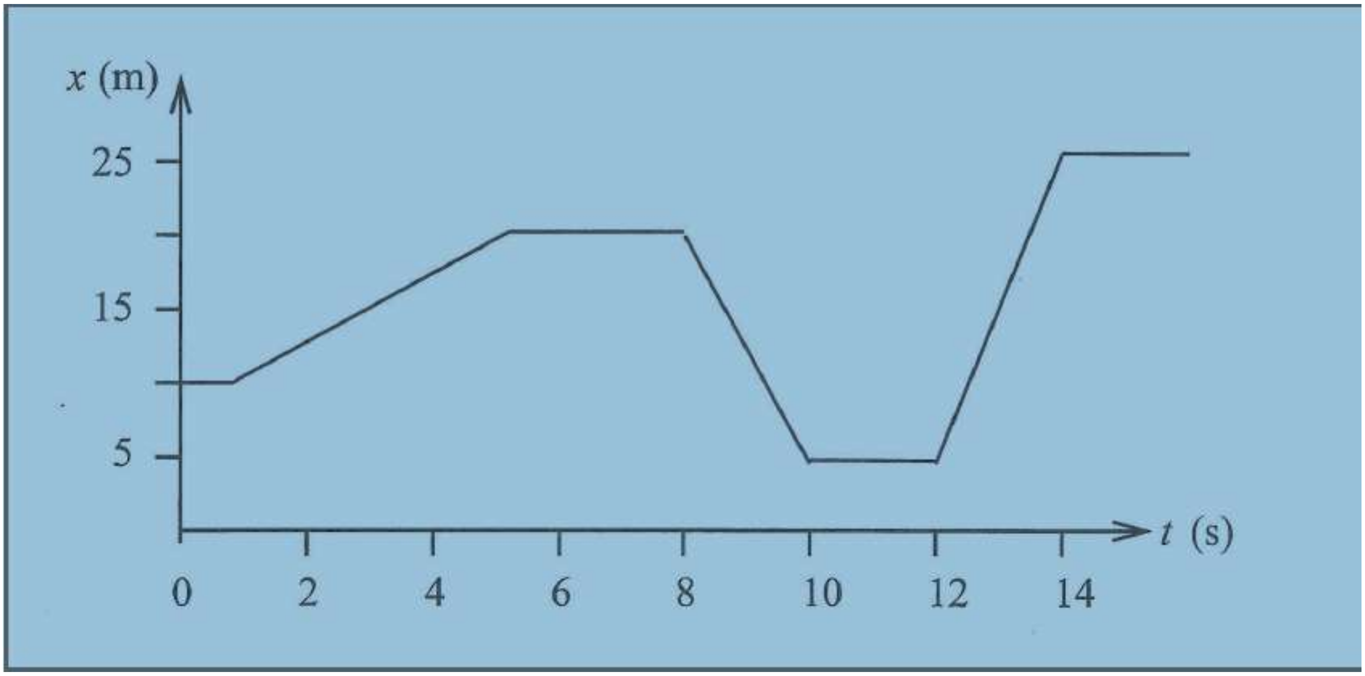
The speed rises. So the car travels further each second than the one before, and the line curves upwards.

D Car **stopped**

time/ s	0	1	2	3	4	5
distance/ m	50	50	50	50	50	50



The car is parked 50 m from the post, so this distance stay[s] the same.


x (m)
25
15
5
t (s)
0
2
4
6
8
10
12
14