Distance–Time & Velocity–Time Graphs

Graphs are powerful tools in physics because they show how motion changes over time. Two of the most important types are distance–time graphs and velocity–time graphs, and each one tells us something different about how an object moves.

A distance–time graph shows how far an object has travelled from the starting point. The gradient (slope) of the line tells us the speed. This is because speed is defined as speed = distance/time, and the gradient of the graph is calculated in exactly the same way. A steeper line means the object is moving faster because the distance increases more quickly for each second that passes. A horizontal line means the object is not moving at all — time continues, but the distance stays the same, so the speed is zero. Sometimes the line curves upward and becomes steeper. This shows that the object is speeding up, because the distance is increasing faster and faster over time.

A velocity–time graph shows how fast an object is moving and whether its speed is changing. The gradient of this graph tells us the acceleration, because acceleration = change in velocity/time. A horizontal line on this graph means the object is moving at a constant velocity. A line that slopes upward shows that the object is accelerating, while a line that slopes downward shows that it is decelerating or slowing down. One of the most important features of a velocity–time graph is that the area under the graph represents the distance travelled. For example, if the graph shows a horizontal line at 6 m/s for 4 seconds, the area is a rectangle with height 6 and width 4, giving a distance of 6 × 4 = 24 m.

Although distance–time and velocity–time graphs may look similar, they describe motion in different ways. Distance–time graphs focus on how far the object has travelled, while velocity–time graphs focus on how fast it is moving and how that speed changes. Understanding both graphs helps us describe motion clearly, calculate important quantities, and interpret real-world movement.

Questions

Section A: Understanding the Passage

1. What does the gradient of a distance–time graph represent?

2. What does a horizontal line on a distance–time graph show?

3. On a velocity–time graph, what does a sloping line upward represent?

4. What physical quantity is represented by the area under a velocity–time graph?

5. Why might a distance–time graph curve upward?

Section B: Application

6. A student sees a horizontal line on a velocity–time graph at 4 m/s. What does this tell you about the motion?

7. Two distance–time graph lines are drawn: Line A is steeper than Line B. What does this mean about their speeds?

8. A velocity–time graph shows a straight line sloping downward from 10 m/s to 0 m/s in 5 seconds. What is happening to the object?

Section C: Short Calculation

9. On a velocity–time graph, an object moves at a constant velocity of 6 m/s for 4 seconds. How far does it travel?

Answer Key with Detailed Explanations

Section A

1. Speed. The gradient is distance/time, which is the definition of speed.

2. The object is not moving. Distance stays constant while time increases, so speed is zero.

3. The object is accelerating. Velocity increases with time, giving a positive acceleration.

4. Distance travelled. The area under the graph equals v × t, which is distance.

5. Because the object is speeding up. A curve that becomes steeper shows increasing speed.

Section B

6. The object is moving at a constant velocity of 4 m/s. A horizontal line means no change in velocity.

7. Line A represents a faster speed. A steeper gradient means a greater distance covered per second.

8. The object is decelerating to a stop. Velocity decreases uniformly from 10 m/s to 0 m/s.

Section C

9. 24 m. Distance = v × t = 6 × 4 = 24 m. This also matches the area under the graph.