

I'm not robot!



F8

Distance traveled by a moving object

The area under a speed-time graph represents the distance traveled by the object. If the motion is uniform then the area can be calculated using appropriate formulae for geometrical shapes represented by the graph.

16. EQUATIONS OF MOTION

Q.No.4 Derive the equations of motion for uniformly accelerated rectilinear motion

Ans: Equations of Motion

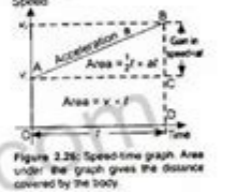
There are three basic equations of motion for bodies moving with uniform acceleration. These equations relate initial velocity, final velocity, acceleration, time and distance covered by a moving body.

Important points in derivation of equations

- We assume that the motion is along a straight line.
- We consider only the magnitude of displacements, velocities, and acceleration.
- Acceleration is taken as uniform.

Case study

Consider a body moving with initial velocity v_i in a straight line with uniform acceleration a . Its velocity becomes v_f after time t . The motion of the body is described by speed-time graph as shown in figure by line AB. The slope of the line AB is acceleration a . The total distance covered by the body is shown by the shaded area under the line AB. Equations of motion can be obtained easily from this graph.



First equation of motion

Speed-time graph for the motion of a body is shown in figure. Slope of line AB gives the acceleration of the body.

$$\text{Slope of line AB} = a = \frac{BC}{AC}$$

$$\text{As } AC = OD \quad \text{and } BC = BD - CD$$

$$\text{So, } a = \frac{BD - CD}{OD}$$

$$\text{As } BD = v_f, \quad CD = v_i \quad \text{and } OD = t$$

$$\text{Hence } a = \frac{v_f - v_i}{t}$$

$$\text{Or } v_f - v_i = at$$

$$\text{Therefore, } v_f = v_i + at$$

Second equation of motion

In speed-time graph as shown in figure, the total distance S traveled by the body is equal to the total area OABD under the graph, i.e.

$$\text{Total distance } = S = \text{area (rectangle OACD + triangle ABC)}$$

Distributive Property (A)

Use the distributive property to simplify each expression.

$$2(4 + 9w) \quad -8(6x + 3)$$

$$-4(-4d - 5) \quad -6(8p + 3)$$

$$2(3v - 8) \quad (2 - 5m)(-5)$$

$$4(-6z + 4) \quad -9(n - 4)$$

$$(-5d + 1)(-2) \quad -4(9k + 9)$$

$$2(-5 - 7j) \quad (3b - 2)(-3)$$

$$-3(3 - 8) \quad -(-5 - 3v)$$

$$-8(2 + 9v) \quad -9(8 - 2h)$$

$$(-5f + 8)4 \quad (7x - 8)(-1)$$

$$-(6 - 4p) \quad 9(8 + 5t)$$

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Exponential Equation with Different Bases

1. Isolate the exponential part of the equation. If there are two exponential parts put one on each side of the equation.
2. Take the logarithm of each side of the equation.
3. Apply power property to rewrite the exponent.
4. Solve for the variable.

Example:

$$3^x - 1 = 4$$

$$3^x = 5$$

$$\log 3^x = \log 5$$

$$x \log 3 = \log 5$$

$$x = \frac{\log 5}{\log 3}$$

Example:

$$5^{x-1} - 2^x = 0$$

$$5^{x-1} = 2^x$$

$$\log 5^{x-1} = \log 2^x$$

$$(x-1)\log 5 = x \log 2$$

$$x \log 5 - \log 5 = x \log 2$$

$$x \log 5 - x \log 2 = \log 5$$

$$x(\log 5 - \log 2) = \log 5$$

$$x = \frac{\log 5}{\log 5 - \log 2}$$

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