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Solution 38

Consider the velocity-time graph of a body shown in figure.

The body has an initial velocity u at a point A and then its velocity changes at a uniform rate from A to B in time t . In other words, there is a uniform acceleration a from A to B, and after time t its final velocity becomes v which is equal to BC in the graph. The time t is represented by OC. To complete the figure, we draw the perpendicular CB from point C, and draw AD parallel to OC. BE is the perpendicular from point B to OE.

Now, Initial velocity of the body,

$$u = OA \text{ -----(1)}$$

And, Final velocity of the body,

$$v = BC \text{ -----(2)}$$

But from the graph $BC = BD + DC$

$$\text{Therefore, } v = BD + DC \text{ -----(3)}$$

Again $DC = OA$

$$\text{So, } v = BD + OA$$

Now, from equation (1), $OA = u$

$$\text{So, } v = BD + u \text{ -----(4)}$$

We should find out the value of BD now. We know the slope of a velocity-time graph is equal to the acceleration, a .

Thus, Acceleration, $a = \text{slope of line AB}$

$$\text{or } a = BD/AD$$

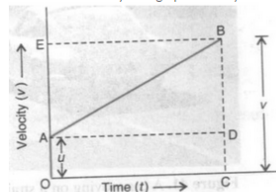
But $AD = OC = t$, so putting t in place of AD in the above relation, we get:

$$\text{or } BD = at$$

Now, putting this value of BD in equation(4), we get:

$$v = u + at$$

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Suppose the body travels a distance s in time t . In the figure, the distance travelled by the body is given by the area of the space

between the velocity-time graph AB and the time axis OC, which is equal to the area of the figure OABC. Thus:

Distance travelled = Area of figure OABC

= Area of rectangle OADC + area of triangle ABD

Now, we will find out the area of rectangle OADC and area of triangle ABD.

(i) Area of rectangle OADC = OA x OC

$$= u \times t$$

$$= ut$$

(ii) Area of triangle ABD = (1/2) x Area of rectangle AEBD

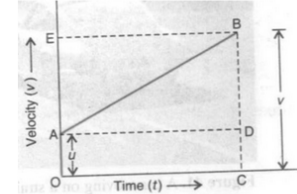
$$= (1/2) \times AD \times BD$$

$$= (1/2) \times t \times at$$

$$= (1/2) at^2$$

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Distance travelled, s = Area of rectangle OADC + area of triangle ABD

$$s = ut + \frac{1}{2} at^2$$

Solution 40

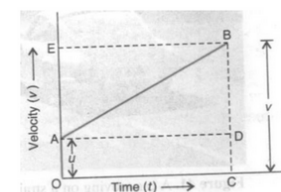
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The distance travelled s by a body in time t is given by the area of the figure OABC which is a trapezium.

Distance travelled, s = Area of trapezium OABC

Now, OA + CB = $u + v$ and OC = t Putting these values in the above relation, we get:

Eliminate t from the above equation. This can be done by obtaining the value of t from the first equation of motion.



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Distance travelled, s = Area of trapezium OABC

$$s = \frac{(\text{Sum of parallel sides}) \times \text{Height}}{2}$$

$$s = \frac{(OA + CB) \times OC}{2}$$

Now, OA + CB = $u + v$ and OC = t Putting these values in the above relation, we get:

$$s = \left(\frac{u + v}{2} \right) \times t \quad \text{-----(1)}$$

Eliminate t from the above equation. This can be done by obtaining the value of t from the first equation of motion.

Thus, $v = u + at$ (first equation of motion)

And, $at = v - u$

***** END *****

