MOTION

CHAPTER NO.8

SUB: PHYSICS

MOTION

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LEARNING OBJECTIVE

Students will be able to

- Know equations of motion
- Prove of Equation of motion graphically.

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Equations of Motion

A relation between the initial and final velocities, time interval and acceleration of a moving body is called an equation of motion.

Consider a body moving with an initial velocity u and final velocity v, uniform acceleration a, time t and displacement S.

Then the equations of motion are given as follows:

$v = u + at$,

$S = u.t + \frac{1}{2} at^2$,

$v^2 = u^2 + 2aS$

Equation for velocity time relation

- Consider the velocity-time graph of an object that moves under uniform acceleration as shown below in the figure 7.
- From this graph, you can see that initial velocity of the object is u (at point A) and then it increases to v (at point B) in time t. The velocity changes at a uniform rate aa.
- Again from figure it is clear that time t is represented by OC, initial velocity u by OA and final velocity of object after time t by BC.
- From graph as given in figure 7 it is clear that BC=BD+DC=BD+OA.
  So we have
  v=BD + u (1)

- We should now find out the value of BD. From the velocity-time graph (Fig. 7), the acceleration of the object is given by

$$a = \frac{change\ in\ velocity}{time\ taken} = \frac{BD}{AD} = \frac{BD}{OC} = \frac{BD}{t}$$

which gives, BD=at
putting this value of BD in equation 1 we get
v = u + at
which is the equation for velocity time relation.

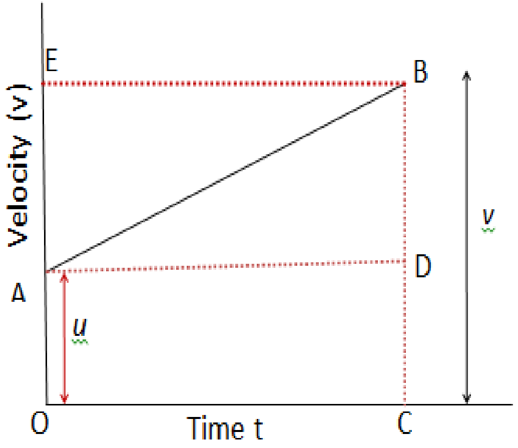

Figure 7:- v-t graph to derive equations of motion

Equation for position time relation

- Let us consider that the object has travelled a distance s in time t under uniform acceleration a. In Fig. 7, the distance travelled by the object is obtained by the area enclosed within OABC under the velocity-time graph AB.
- Thus, the distance s travelled by the object is given by
  s = area OABC (which is a trapezium)
  s= area of the rectangle OADC + area of the triangle ABD
  So,
  $s = OA \times OC + \frac{1}{2} \times AD \times BD$
  Substituting OA=u , OC=AD=t and BD=at, we get
  $s = (u \times t) + 1/2 \times (t \times at)$
  or,
  $s = ut + 1/2\ at^2$
  which is the equation of position time relation

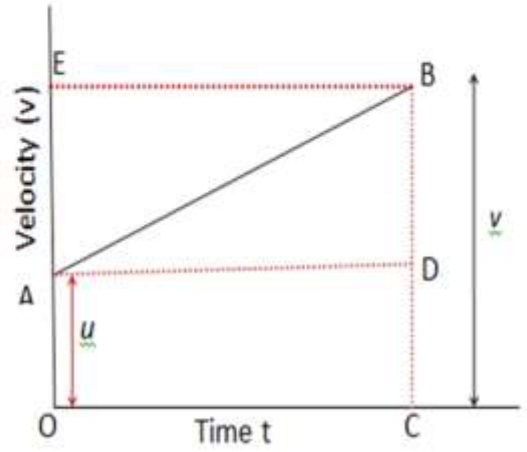

Figure 7:- v-t graph to derive equations of motion

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Equation for position velocity relation

Again consider graph in figure 7. We know that distance travelled s by a body in time t is given by the area under line AB which is area of trapezium OABC. So we have

$$distance\ travelled = s = Area\ of\ trapezium\ OABC$$

$$s = \frac{(sum\ of\ parallel\ sides) \times height}{2} = \frac{(OA + CB) \times OC}{2}$$

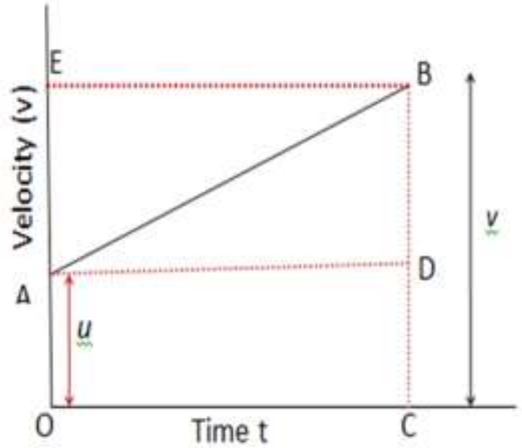

Figure 7:- v-t graph to derive equations of motion

Since OA+CB=u + v and OC=t , we thus have
$s=(u + v)t \times ½$ ……………1
From velocity time relation
$t=(v−u) \times 1/a$ ………………2
putting this t in equation for s we get
$s=(u+ v)/2 \times (v−u /a)$
or we have
$v^2=u^2+2as$
which is equation for position velocity relation.

HOME ASSIGNMENT

Q.A train is travelling at a speed of 90 km/ h. Brakes are applied so as to produce a uniform acceleration of – 0.5 m/ sq. s. Find how far the train will go before it is brought to rest

THANKING YOU
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