Question 33

A car of mass m kg is travelling on a level roadway. The engine exerts a constant propulsive force of F newtons and the total resistance to the motion of the car is kv^3 newtons, where k is positive constant and v is its speed in m/s. The car moves from rest, the distance travelled in metres until it obtains a speed of V, is given by

A. $\dfrac{V^2}{2\left(F - kV^3\right)}$

B. $\dfrac{mV^2}{2\left(F - kV^3\right)}$

C. $\dfrac{m}{2}\displaystyle\int_0^V \dfrac{v^2}{F - kv^3}\,dv$

D. $\displaystyle\int_0^V \dfrac{mv}{F - kv^3}\,dv$

E. $\displaystyle\int_0^V \dfrac{v}{F - kv^3}\,dv$

ANSWER D

By Newton's law, the equation of motion is given by

$ma = F - kv^3$, using $a = v\dfrac{dv}{dx}$

$mv\dfrac{dv}{dx} = F - kv^3$ integrating from $v = 0$ to $v = V$

the distance s, travelled from rest is given by $s = \displaystyle\int_0^V \dfrac{mv}{F - kv^3}\,dv$