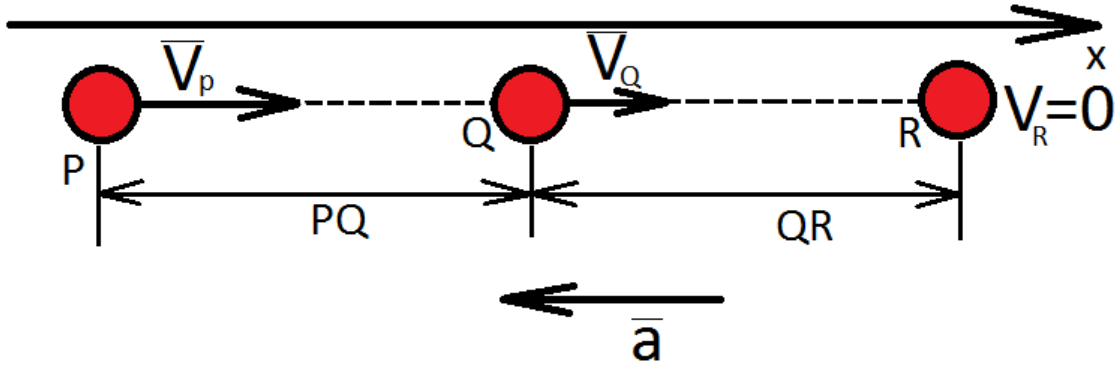
A particle moving in a straight line with uniform deceleration has a velocity of 40m/s at a point P, 20m/s at a point Q and comes to rest at a point R where QR=50m. Calculate the distance PQ, calculate the time taken to cover PQ and the time taken to cover PR

Solution:



The equation of motion along the X-axis for the distance QR:

$$x: QR = V_Q t_{QR} - \frac{a{t_{QR}}^2}{2} \ (1)$$

Rate equation along the X-axis for the distance QR:

$$x: 0 = V_Q - a t_{QR}$$

$$t_{QR} = \frac{V_Q}{a} (2)$$

$$(2) in \ (1): QR = V_Q \frac{V_Q}{a} - \frac{a\left(\frac{V_Q}{a}\right)^2}{2}$$

$$QR = \frac{{V_Q}^2}{a} - \frac{{V_Q}^2}{2a}$$

$$QR = \frac{{V_Q}^2}{2a}$$

$$a = \frac{{V_Q}^2}{2 \cdot QR} = \frac{\left(20\frac{m}{s}\right)^2}{2 \cdot 50m} = 4\frac{m}{s^2}$$

We have found deceleration, you can now find the time t_{QR}, t_{PQ} and distance PQ.

$$(2): t_{QR} = \frac{V_Q}{a} = \frac{20\frac{m}{s}}{4\frac{m}{s^2}} = 5s$$

The equation of motion along the X-axis for the distance PQ:

$$x: PQ = V_P t_{PQ} - \frac{a{t_{PQ}}^2}{2} \ (3)$$

Rate equation along the X-axis for the distance QR:

$$x: V_Q = V_P - at_{PQ}$$

$$t_{PQ} = \frac{V_P - V_Q}{a} = \frac{40\frac{m}{s} - 20\frac{m}{s}}{4\frac{m}{s^2}} = 5s\ (4)$$

$$(4) in (3): PQ = V_P t_{PQ} - \frac{a{t_{PQ}}^2}{2} = 40\frac{m}{s} \cdot 5s - \frac{4\frac{m}{s^2} \cdot (5s)^2}{2} = 150m$$

Answer: $t_{QR} = 5s$

$t_{PQ} = 5s$

$PQ = 150m$