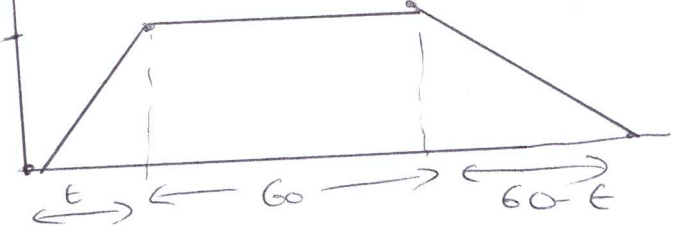
1991 Q1 (HLC)

Total time = 120 secs



Total distance = |PQ|

Reg I: $u=0$, $v=v$, $a=2$, $t=t$

$v = u+at$

$v = 2t$ ①

Reg II

Reg III: $u=v$, $v=0$, $a=-2$, $t=60-t$

$v = u+at$

$0 = v+(-2)(60-t)$

$0 = v-60+t$

$\Rightarrow v = 60-t$ ②

①, ② $\Rightarrow$ $2t = 60-t$

$\Rightarrow 3t = 60$

$\Rightarrow t = 20$ seconds.

and $v = 40$ m/sec.

Total distance $= \frac{1}{2}tv + 60v + \frac{1}{2}(60-t)v$ (Area under curve)

$= \frac{1}{2}(20)(40) + 60(40) + \frac{1}{2}(40)40$

$= 3600$m

(ii) Second particle: $u = ?$, $t = 0$, $v = 2t+50$

$\Rightarrow v = u+at$

$\Rightarrow v = 50+2t$

$\Rightarrow u = 50$ and $a = 2$.

$|PQ| = s = 3600$.

$s = ut + \frac{1}{2}at^2 \Rightarrow 3600 = 50t + \frac{1}{2}2t^2$

$\Rightarrow t^2 + 50t - 3600 = 0$.

$\Rightarrow (t-40)(t+90) = 0$.

$\Rightarrow t = 40$ sec (or $t = -90$)

(R)

P: $u = u$, $g = -g$, $t = t$.

Q: $u = 1.5u$, $g = -g$, $t = t-2$.

s = distance above ground

$s_P = ut - \frac{g}{2}t^2$ $\quad s_Q = 1.5u(t-2) - \frac{g}{2}(t-2)^2$.

Collide where $s_P = s_Q$

$\Rightarrow ut - \frac{g}{2}t^2 = 1.5u(t-2) - \frac{g}{2}(t^2-4t+4)$

$\Rightarrow ut - 4.9t^2 = 1.5ut - 3u - 4.9t^2 + 19.6t - 19.6$

$\Rightarrow ut = 1.5ut + 19.6t - 3u - 19.6$

$\Rightarrow 19.6 + 3u = (19.6 + 0.5u)t \Rightarrow \boxed{t = \frac{19.6+3u}{19.6+0.5u}}$.

$\Rightarrow$ time for $Q = t-2$

$= \frac{19.6+3u}{19.6+0.5u} - 2$

$= \frac{19.6+3u-39.2-u}{19.6+0.5u}$

$= \frac{-19.6+2u}{19.6+0.5u}$.

$t > 0$

$\Rightarrow -19.6+2u > 0$

$\Rightarrow \boxed{|u| > g}$